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No. 1.— A NEW PTEROPOD FROM NEW ENGLAND.<sup>1</sup>

BY C. H. DANFORTH.

## INTRODUCTORY NOTE.

THREE pteropods have been found in Casco Bay, Maine. The first noted was *Clione borealis*, reported on by C. B. Fuller on April 6, 1868, and more fully by Dr. William Wood ('69). The second species was *Spirialis gouldii* which was found in considerable abundance in the plankton at the Harpswell laboratory on the evening of August 23, 1901. This species was described by Stimpson ('51) as coming from "the whole coast of New England." It has been recorded by Mr. Alexander Agassiz from Nahant (north of Cape Cod) and Naushon (south of Cape Cod), Massachusetts; by Verrill and Smith from the Georges Banks and from No Man's Land (Massachusetts); and from Newport, Rhode Island, by J. W. Fewkes. It did not occur in our Harpswell collections on the 22d or on the 24th of August. On the 22d the wind was strong from the northward and continued from that direction for twenty-four hours, so the specimens could not have been drifted in by the wind.

The third species is that which forms the basis of the following paper. It occurred in the plankton on the nights of August 28 and September 5, 6, 7, and 8, 1902, and on one or two nights following. On a hasty examination it was regarded as a larva of some gymnosomatous pteropod, and as *Clione* had been taken at Portland, about a dozen miles away, it was thought that it was possibly the young of that form.

All of these last specimens were narcotized with chloral hydrate, killed and hardened with corrosive acetic, and finally preserved in alcohol. Later some of them were sectioned, chiefly with a view to seeing their histological condition. To my great surprise they were found to be not larvae but sexually mature adults. The gonads contained well formed eggs while in the testicular area all stages of spermatogenesis were visible and in some specimens the genital ducts were filled with perfectly formed spermatozoa. The whole material was then turned over to my pupil, Mr. Danforth, for study, the result being the present paper.

<sup>1</sup> Contributions from the Biological laboratories of Tufts college. No. 46.

The animals in life were transparent but the presence of numerous vacuoles, filled with yellow or yellowish brown fluid, in the integument prevented a clear view of the internal organs. They swam vigorously at the surface of the water by means of the fins, and after two or three minutes would retract the fins and partially draw in the head, sinking at the same time to the bottom of the shallow dish in which they were kept, to rise again in a short time and repeat the operation. Several free-hand sketches were made at the time, some of which are reproduced here as "habitus pictures."

*J. S. Kingsley.*

The characters of the gymnosomatous pteropod whose occurrence Professor Kingsley describes above, are such that it cannot be referred to any of the existing genera. I am therefore obliged to describe it as a new genus. This genus does not properly fall under any established family although perhaps it approaches most nearly the Clionidae, from which it differs in having an odd number of cephalocones and in having the entire posterior part of the body filled by the viscera. The following characters will serve to distinguish it from other genera.

**PAEDOCLIONE<sup>1</sup> n. g.**

Body barrel-shaped, slightly larger behind. Head and posterior end retractile. Three bands of cilia resembling the ciliated rings of pteropod larvae. Head with one (anterior) pair of retractile tentacles. Cephalocones unarmed, three in number, two of them on the right, one on the left side of the buccal mass. "Hook sacks" replaced by two thickened areas (ankistrophores) on the dorsal wall of the pharyngeal cavity each bearing a few (5-8) rather strong hooks. Radula with broad non-cuspidate median tooth and five lateral teeth on either side. Foot divided into three lobes; an approximate pair in front, and a large backward-curved median portion behind. The viscera fill the entire posterior part of the body.

**Paedoclione doliiformis n. sp.**

Transparent; barrel-shaped; small, about 1.5 mm. in length; head when expanded elliptical in outline; anterior ciliated band broken up into segments; expanded parapodia (wings) flat, long, ovate; middle lobe of foot rather large.

<sup>1</sup> *παῖς*, child, and Clione.

## GENERAL FEATURES.

The general external appearance of this pteropod is shown in figure 1 (pl. 1) where, however, the parapodia and tentacles are somewhat retracted. Figure 2, *A*, (pl. 1) from a sketch of the living animal by Dr. Kingsley, shows these parts in their expanded condition. There are three well marked ciliated bands around the body: the anterior (pl. 1, fig. 1, *ac*) at the level of the paired lobes of the foot by which it is interrupted, the second (*mc*) at about the middle of the body, and the other (*pc*) near the posterior extremity. The band around the head is further characterized by being broken up into groups of cilia-bearing cells. A section through two of these groups is shown in figure 3 (pl. 1) at *ac* and *ac*. Similar tracts in the anterior ciliated girdle have been described as characteristic of various pteropod larvac. There are also well developed cilia on the outer margin of the parapodia, on the median portion of the small lobes of the foot, on the osphradium, and about the mouth of the oral hood.

The conspicuous appendages of the head are the tentacles and the lobes of the foot. The single pair of tentacles (pl. 1, fig. 1, *t*) are located near the anterior end of the animal, one on either side of the opening that leads into the cavity containing the cephalocones and buccal mass. The foot, located on the ventral side of the head, is divided into three lobes essentially like those of the related forms. The anterior pair (*af*) are small and somewhat retractile. When expanded to their fullest extent, the distal margins are directed outward and away from the median line. As stated above, their ventral surface is ciliated. The more posterior lobe (*pf*) of the foot is larger and usually directed backward. (See, however, figure 3, plate 1, where it is shown as bent forward in a retracted specimen.) Its musculature is weak and its structure delicate. This lobe shows no conspicuous cilia. The "wings" or parapodia arise from the neck just posterior to the foot and near the ventral side. When extended they appear as thin flat swimming organs more or less ovate in outline. In most of the preserved specimens, however, they are in a retracted condition such as is shown in figure 1 (pl. 1). Their outer margins are furnished with long cilia.

There are two conspicuous folds in the body: one where the posterior end is drawn in, the other just back of the head. These folds, especially the posterior one, may be nearly obliterated when the animal

is fully expanded, but when it is contracted, the posterior end and the head with its appendages are almost completely hidden behind them.

The anus (pl. 1, fig. 1, *a*) and opening of the nephridium occur close together just in front of the anterior fold and a little to the right of the median line. The nephridial opening is lateral to the anus, but when the animal is not fully expanded there may be a slight infolding about the two openings forming a kind of short cloaca. To the right of these openings is the strongly ciliated osphradium. This structure appears as a protruding lobe which, as may be seen in figure 1 at *o*, is rather noticeable. Figure 3 (pl. 1) shows the osphradium and the underlying ganglion (*og*) in section.

The common genital opening is close to the attachment of the right fin and dorsal to it, while the penial opening (pl. 1, fig. 1, *po*) is to the right of the foot and below the anterior ciliated band. I have been unable to find any groove or ciliated line running between the two.

In this, as in most allied genera, there are retractile cephalocones surrounded by the oral hood, but here they present a most unusual condition in their lack of symmetry. In other genera where these cones are present there are two or three pairs of them, or (Dexiobranchia) there is one pair and a median cone. In Paedoclione, however, there are two cephalocones on the right side of the buccal mass and only one on the left, this last being the longest. Relationships seem to show that the left cephalocone is the antimere of the dorsal one on the right side, the left ventral cephalocone being therefore lacking. Some study was made of the structure of these cones which so far as it went, revealed no marked differences from the condition described for Clione by Pelseneer ('85). In all the specimens examined, the asymmetrical cone (the ventral right) showed more secretion in the glandular internal cells than occurred in the similar cells of the other cones. Whether this really indicates a differentiation in the cones or whether it is an accidental coincidence I am unable to say. Figure 3 (pl. 1) from a slightly oblique section through the head at about the level of the first band of cilia, shows the cut surface of the three cones and their position in the cavity (*cel*, *cel'*, and *cer*).

The integument of Paedoclione is unpigmented, but the large single-celled dermal glands described by Gegenbaur for Pneumodermon and other forms are also conspicuous in this pteropod. That these glands are evident in the living animal is shown in Dr. Kingsley's drawings. They present no features at variance with Gegenbaur's description.

## MUSCULATURE.

The general differentiations shown in the musculature of this pteropod are, in addition to scattered muscle fibers in various parts of the body, specialized longitudinal bands running between two circular muscles, one near the posterior, the other near the anterior ciliated ring; the muscles of the head, foot, and parapodia; and those belonging to the internal organs. The last group presents no features worthy of note, the most important of them being the muscles of the ankistrophores, lips, esophagus, intestine, and hermaphroditic duct, all of which are mentioned in discussing the organs with which they are connected.

Of the circular muscle rings mentioned above, the anterior one is not well marked off from the other strands in the wall of the head and is composed of fibers which, like the others, are cross striated. It runs around the head, passing just under the cephalic ring of cilia and the anterior lobes of the foot. The other ring running below the third band of cilia is better defined and composed of smooth fibers.

The most prominent of the superficial muscles of the body proper are three pairs of longitudinal bands, the retractor muscles used in shortening the total length of the animal. They all have their anterior and posterior attachments near the surface, in the vicinity, respectively, of the first, or cephalic, and the third ciliated rings. Their main course, however, lies some distance inside the outer body wall, thus causing the head and posterior end of the contracted animal to be drawn behind the body folds as previously described. These six muscles are not well defined throughout but split up posteriorly into smaller branches. The two ventral of these longitudinal muscles, starting one on either side from a point dorsal to the foot, run backward parallel to each other and ventral to the penial gland, then along the lower side of the animal medial to the thick body wall till they reach the posterior circular muscle described above. The lateral pair run between the anterior and posterior circular muscles at a level a little nearer the dorsal than to the ventral retractors, the muscle of the right side passing in front just dorsal to the common genital opening. The dorsal pair of retractors are situated one on either side close to the median line.

Of the three divisions of the foot, the anterior paired lobes have, in proportion to their size, the stronger musculature. They are both supplied with fibers running from the anterior circular ring to their

distal surface. These fibers, like those of the muscle ring from which they come, are cross striated in appearance. In addition, transverse fibers connecting these two lobes of the foot pass near the surface from one to the other. The median lobe of the foot is furnished with two small lateral muscles, one on either side. These arise near the circular muscle and pass down the foot to near the tip. The principal muscle of the parapodia consists of apparently unstriated fibers which extend from one fin over into the other. These fibers, which pass through the neck dorsal to the ventral longitudinal muscles, probably serve to retract the parapodia. Each fin is also supplied with other fibers attached on either side of its base. These latter fibers evidently function in connection with the flapping of the parapodia.

There are four other pairs of muscles in the head, all in front of the cephalic band of cilia. Of these, the two long tentacular retractors start one on either side near the anterior end of the lateral longitudinal muscle and extend up into the tentacles. Just dorsal to the origin of each of these, another muscle takes its rise and extends about to the base of the corresponding tentacle. Still nearer the median dorsal line a third muscle runs from the level of the first ciliated band to the edge of the hood between the tentacles. The fibers of this pair of muscles, like those of the two preceding pairs are cross striated in appearance. The remaining pair of anterior muscles is in front, extending from a point medial to the anterior lobes of the foot forward to the ventral edge of the hood. The last three pairs by their contraction apparently tend to draw the hood back, thus enlarging its mouth when the buccal mass is to be protruded.

In addition to these somewhat specialized muscle fibers there are in the walls of the head a great many other fibers running practically parallel to the cephalic ciliated ring. Rather curiously they all show the cross-striated condition. The anterior circular muscle mentioned above is merely a thickened aggregate of these fibers. Back of the attachment of the parapodia are still other cross-striated fibers running *through* the body and forming a kind of diaphragm between the ganglia in front and the stomach behind.

#### THE DIGESTIVE SYSTEM.

The digestive organs are shown in their relative position in figure 6 (pl. 2, the ruled portions). In most of the specimens examined the

cephalocones and buccal mass are entirely retracted within the hood. The mouth at the apex of the buccal cone is oval or slit-like, having its longest diameter running dorso-ventrally. The lips (*l*) are slightly thickened and supplied with a number of simple glands such as are also present about the margin of the oral hood. Both lips and ankistrophores (to be discussed presently) are supplied with small muscles which extend down to the posterior side of the buccal mass.

In various other genera a pair of structures dorsal to and in front of the radula are called "hook sacks" because of the hooks they bear and because when retracted they are inverted as sacks into the wall of the pharynx. When expanded they project as cones and the hooks, lying on the outer surface, are in position to function in holding the food. In *Paedoclione* the structure differs from this type. The hooks are seated merely on cushions of thick connective tissue, in the normal position, but apparently with little power of distention or retraction — certainly they are not capable of retraction into a sack as in other genera. Hence the term "hook sack" is inapplicable and so for these structures and the homologous hook sacks of other forms I would suggest the term *ankistrophore* (ἀγκιστρον, hook). Each ankistrophore bears a few (not more than eight) hooks. Each of these hooks consists of a large (epithelial) cell, the free surface of which projects as a strong process beyond the adjoining cells. This process is covered with a dense chitinous (?) material which forms the functional hook. Figure 4 (pl. 1) shows these structures in section.

The radular teeth, represented diagrammatically in figure 5 (pl. 1) are arranged according to the formula 5. 1. 5. The lateral teeth are somewhat falcate in shape with widened bases. Their chitinous tips point backward. The median tooth is broad, flat, and without cusp. Among the specimens examined, I find only one or two with more than fifteen ranks of teeth.

As the figure (pl. 2, fig. 6, *sa*) shows, the salivary glands are of moderate size. They empty into the pharynx behind and dorsal to the radula. The contents of the glands is so strongly stained in all the specimens that I can make out almost nothing of its structure.

The esophagus, normally of small diameter, is surrounded by circular and longitudinal fibers. For the most part it is nearly straight, though in a few retracted individuals it is bent a little. Its epithelial lining is ciliated. This lining is raised into folds which perhaps are secretory in character as is the case in *Clionopsis calceola* (Peck, '90).

The stomach, extending from the hinder end of the esophagus back nearly to the posterior end of the animal, is of practically uniform diameter throughout. In transverse section it is circular in outline but its lumen is not concentric with the external surface owing to certain longitudinal thickenings of the inner wall in front. In at least one specimen these internal thickenings give the lumen a tri-radiate figure in cross section. In the thickened portions the glandular cells of the wall are especially abundant. The protoplasm of these cells is filled with small deeply staining granules to such an extent that it is difficult to make out the cell boundaries, while all through the wall are large vacuoles two or more times the diameter of the nuclei. These thickened walls of the stomach are perhaps correlated with the absence of a liver which is entirely lacking. Figure 7 (pl. 3) shows this part of the stomach in cross section. The blind end behind the middle of the body has its wall rather more evenly thickened except for an area near the opening into the intestine where it is not thickened but is well ciliated.

The intestine, as stated above, begins at about the middle or a little behind the middle of the ventral wall of the stomach, *i. e.*, at about the level of the second ciliated band. This portion of the alimentary canal is of small uniform diameter and is surrounded by longitudinal and circular muscles. Its inner surface is covered with cilia. From its beginning at the stomach it extends in a median and anterior direction to the anus, the position of which was described above.

In the vicinity of the anus are glandular cells which, in the various specimens are in different stages of activity. They apparently open to the exterior near the osphradium. These cells from their position would seem to be homologous with the anal gland occurring in various molluscs but, so far as I know, not described for the gymnosomatous pteropods.

#### NERVOUS SYSTEM.

The nervous system in its broader features closely resembles that described by Pelsenceur ('87) for other gymnosomatous pteropods. Paired cerebral, buccal, pedal, pleural, and visceral ganglia are all present. The cerebral and pedal ganglia are of nearly the same size; the visceral are about half as large as the cerebral, and the pleural are considerably smaller than the visceral. The small buccal ganglia are located in front near the salivary glands. The cerebral ganglia

are situated above the esophagus, the pleural beside it, and the remaining pairs below.

The cerebral and pedal ganglia are practically symmetrical but the visceral ganglia are asymmetrical in shape, size, and position. The one on the right is more nearly spherical and gives off but a single nerve, while the one on the left is larger, irregular, and somewhat elongated, and gives off three nerves. Correlated with this asymmetry in the visceral ganglia there is a slight asymmetry in the pleural. The nature and extent of this asymmetry are shown in figure 8 (pl. 3) which gives a diagrammatic representation of the central ganglia as seen in a posterior view.

Strong commissures unite the ganglia of each pair except the pleural, which naturally are unconnected. Pelseneer and others have found a small second pedal commissure in other pteropods but in this form I do not find anything that I can interpret with certainty as such a commissure. One of the sections, however, shows what may be a delicate nerve strand running between the two pedal ganglia close to the primary commissure. This second commissure, if indeed it be such, may perhaps have been torn in sectioning the other specimens owing to the small size of the animal and the delicacy of the structure.

The ganglia of the same side are connected with each other by the usual connectives: cerebro-buccal, cerebro-pedal, cerebro-pleural, pleuro-pedal, and pleuro-visceral. With the exception of the first, all of these connectives are short, bringing the central nervous system into a compact form. The cerebro-buccal arises from the antero-lateral side of the cerebral ganglion and runs forward to the buccal located below the esophagus in front. It is of rather small diameter and slightly elongated. Just behind and a little below its origin there arises a cerebro-pedal connective which enters the pedal ganglion dorsally. This is much shorter and larger than the former. The cerebro-pleural still farther back is very short as is also the pleuro-pedal which arises from the anterior side of the pleural ganglion and immediately enters the pedal. The pleuro-visceral connective is but little longer than the two preceding and arises ventrally from the pleural ganglion and enters the visceral on the dorsal side. Figure 9 (pl. 3) represents the central nervous system in diagrammatic form as seen from the side.

Besides the connectives already enumerated, there arise from each cerebral ganglion five nerves, two somewhat dorsally and three from

the anterior side. Of the two dorsal nerves, the more median and larger one runs to a ganglion-like mass on the side of the neck. This mass, which is of considerable size, sends nerve fibers to the surface as shown in figure 10 (pl. 3), where there may be a small sensory area. This nerve seems to be homologous with that in *Clione* described by Pelseneer ('87) as belonging to the posterior tentacle and by Boas ('86) as probably the olfactory nerve. In this case the slight elevation of the surface would be the representation of the nuchal tentacle. Lateral to this one is the other nerve arising from the dorsal side of the ganglion. This second nerve has a ganglionic swelling at its base. It runs parallel to the first and like it has an enlargement at its end (pl. 3, fig. 9, *opg*). This is evidently the homologue of the optic nerve of *Clione*, but I find nothing in connection with it that I can interpret as an eye. The distal enlargements of these two nerves lie side by side and, as Boas pointed out for *Clione*, there is a connecting nerve near their proximal end. Unlike the condition in *Clione*, the two enlargements are not at all equal in size, that of the more lateral ("optic") nerve being very much the smaller.

Of the three nerves arising more anteriorly from each of the cerebral ganglia, the median (pl. 3, fig. 9, *ce 1*) is a large trunk which divides immediately, sending one branch laterally and forward to supply the back of the head, and another inward to the esophagus and buccal mass. The middle nerve (*ce 2*) which is also large, supplies the tentacle of the corresponding side. The lateral nerve (*ce 3*), smaller than the two others, runs to the buccal mass.

I find six nerves arising from each pedal ganglion. The two largest of these arise close together from the ventral side of the ganglion in front. The anterior one (pl. 3, fig. 9, *fn*) extends forward and supplies the foot, while the other (*pn*) enters the parapodium where it immediately distributes itself. Dorsal to these two is a somewhat smaller nerve (*pd 1*) that takes a general anterior direction. More posteriorly and below the otocyst (*ot*) there arises a very delicate nerve (*pd 4*) and behind and below it a larger one (*pd 5*). These two are probably the cervical nerves of *Clione* and other forms. The sixth nerve (*pd 6*) arises near the posterior side of the ganglion and very soon anastomoses with the nerve from the pleural ganglion. Pelseneer has shown that an anastomosis of these two nerves is common to various pteropods.

Each pleural ganglion gives rise to but a single nerve (*pln*) which,

as was just said, anastomoses with a nerve from the pedal ganglion. Its distribution in the side of the neck was not traced.

As stated above, the visceral ganglia are asymmetrical in the number of nerves given off, the left giving rise to three while the right has only one. The more lateral of the nerves coming from the left visceral ganglion (pl. 3, fig. 8, *lv*) is larger than either of the two others. It arises from the dorsal part of the ganglion near the entrance of the pleuro-visceral connective and extends backward to supply the left side of the body. The two other nerves arise posteriorly from the right side of the ganglion, thus being nearly median in position. The one (*vt*) nearest the commissure is the smaller. Both supply the viscera. The single nerve (*vr*) of the right visceral ganglion corresponds to the large lateral one of the left in size, place of origin, and distribution, except that it differs from that nerve in giving rise, shortly after it leaves the ganglion, to a branch that runs to the osphradial ganglion (pl. 2, fig. 6, *og*) which is located on the right side below the osphradium previously described. Figure 3 (pl. 1) shows a section of the osphradium and its ganglion at *o* and *og*.

Each buccal ganglion, located in front below the esophagus and close to the salivary gland, gives rise to a small nerve that runs into the gland of that side. There is also an unpaired nerve arising from the commissure between the two ganglia. I do not find a second pair of buccal nerves such as are described by Pelseneer for most of the pteropods.

#### HEART AND NEPHRIDIUM.

The circulation of this animal is rudimentary, and apparently largely lacunar in character. As is commonly the case in pteropods, there is an auricle and a ventricle, both within a pericardium. This pericardium (pl. 2, fig. 6, *pe*) is located on the functionally right side, somewhat ventrally, between the intestine and the thick body wall. It extends from a point a little in front of the middle, backward for a distance equal to perhaps one sixth of the entire length of the animal. Its greatest diameter is in front in the region of the ventricle and the inner opening of the nephridium. From this wider anterior portion it tapers gradually backward to its narrow posterior end. The side of the pericardium towards the periphery of the animal adjoins the body wall while the opposite side lies near the intestine but is not in contact with it throughout.

The auricle extends from a point a little behind the middle of the pericardium, forward nearly to its anterior boundary where it constricts and opens into the ventricle. It is a large, loose sack with its greatest diameter near the anterior end where sections show it to be more than half as wide as the pericardium itself. There is no distinct vena cava behind, but the blood would appear to enter the auricle from a number of large lacunae in the tissue between the viscera and the body wall.

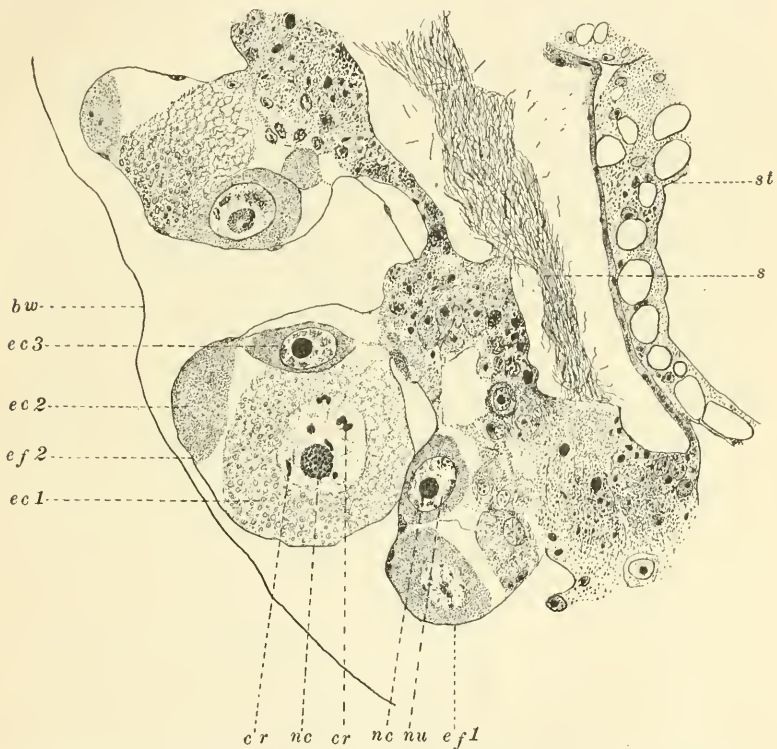
The ventricle, located in front of the auricle, is small and somewhat spherical in form and has thickened walls. The single blood vessel, the aorta, arising from the ventricle, passes through the wall of the pericardium and extends forward between the vagina and intestine to the base of the parapodia where several lacuna-like branches are given off. If, as is barely possible, a branch comes from this trunk before it reaches the parapodia, I have been unable to find it owing to a certain amount of shrinkage and displacement of parts.

The nephridium is a simple tube shown somewhat diagrammatically in figure 6 (pl. 2). It has its opening (nephrostome) into the pericardial cavity just below and a little behind the ventricle. This opening, shown diagrammatically at *ns* in figure 6 (pl. 2) is supplied with long cilia and surrounded by a muscle. From the nephrostome the nephridium runs back nearly to the posterior end of the stomach, where it bends around forming a loop after which it takes a forward direction so that its middle portion comes to lie close beside and lateral to the part at the pericardial end. The anterior third is dilated into a loose sack-like structure which opens to the exterior through a pore close to the anus. Just back of this anterior enlargement there is a more or less noticeable constriction behind which the nephridium again slightly enlarges and then tapers unevenly to the small pericardial end. Its wall is apparently slightly glandular throughout.

#### REPRODUCTIVE SYSTEM.

The organs connected with generation are divided into two separate groups. One of these groups, situated entirely in the body proper, consists of the hermaphroditic gonad, its excurrent duct, the receptaculum seminis, and two accessory glands. The other group consists of the penis and two glands that have their openings in the head. Figure 6 (pl. 2) shows diagrammatically these parts in their relative positions (see also pl. 4, figs. 12, 13, for separate diagrams).

The gonad (pl. 2, fig. 6, *g*) is situated in the posterior part of the body, chiefly on the right of the intestine. It has the general form of a tube and develops sperm from the inner and eggs from the outer side of its wall. There is, however, an area next to the stomach where eggs do not seem to be developed. The sperm is matured first, and with its growth the cavity of the gonad becomes distended until the organ fills



TEXT-FIG. A. — Horizontal section showing a portion of the gonad with developing egg follicles. *bw*, body wall; *cr*, chromatin mass; *ec 1*, *ec 2*, *ec 3*, egg cells; *ef 1*, *ef 2*, egg follicles; *nc*, nucleolus; *nu*, nucleus; *s*, sperm; *st*, stomach.

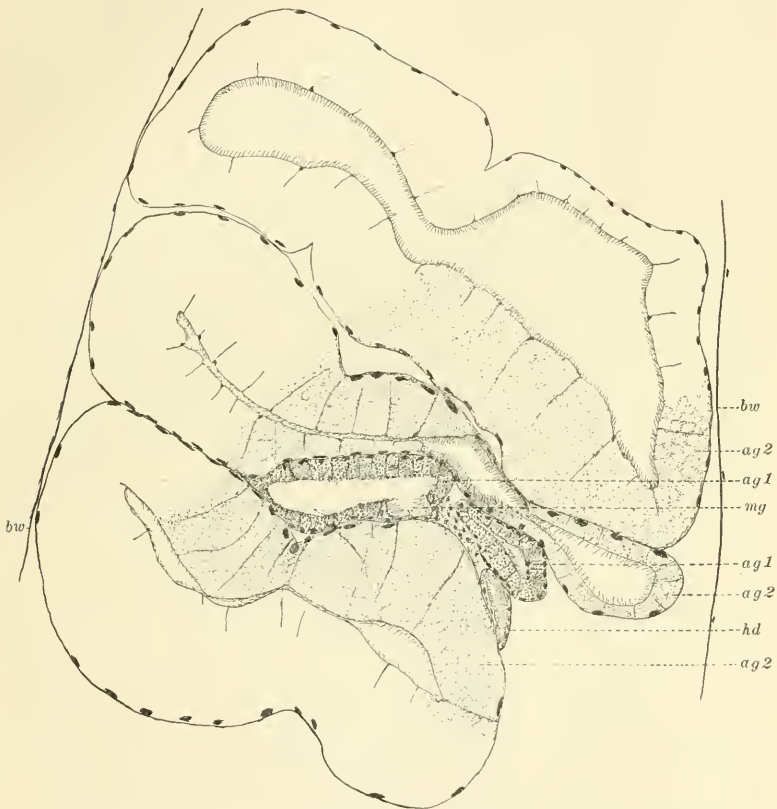
the greater part of the posterior third of the animal. Figure 11 (pl. 4) is from a section of a specimen where the sperm is just beginning to ripen. Other specimens show the sperm in later stages as a deeply staining mass free in the cavity of the gonad. Text-figure A shows

several egg follicles developing on the outer side of this organ. As this figure indicates, several enlarged germinal cells of varying sizes are included in each outpushing of the limiting membrane, but in the follicles thus formed the smaller cells evidently have their substance appropriated by the larger ones and so never function as ova. In the smaller of these cells the cytoplasm stains quite uniformly and rather darkly, in the larger it is lighter and more reticulated in appearance (text-fig. A, *cc 1* and *cc 3*). In the mature ova there are a number of small granules scattered through the cytoplasm. In these cells the nuclei (*nu*) are large and rather clear, showing a coarse reticulum in which may be seen heavily staining chromatin masses (*cr*) and a nucleolus (*nc*), very dark in the small cells but usually lighter in the large ones. This same figure (text-fig. A) also shows some sperm in the gonadial cavity, here much reduced as compared with its size when the sperm is being developed. The presence of this sperm in the cavity of the gonad is apparently a very constant feature even after the eggs are well developed and the male organs in the head have ceased to show signs of activity.

The excurrent hermaphroditic duct may be roughly divided into three parts: a slender tube running to the mouth of the receptaculum seminis and accessory glands, a broader portion into which these parts open, and a glandular walled vagina opening to the exterior dorsal to the right wing. The portion of the duct between the gonad and openings of the glands is short and only slightly convoluted. Its inner surface is ciliated and its wall is supplied with muscle fibers which doubtless assist in expelling the sexual products.

Opening into the hermaphroditic duct somewhat in front of the middle of the body are two glands, the position of which in reference to the duct is shown diagrammatically in figure 12 (pl. 4). Inasmuch as the function of these glands is not very definitely known, it would seem useless and even misleading to attempt to give them names. I shall therefore refer to them, and likewise to the penial glands in the head, merely by number. The posterior one — the first to open into the genital duct on its way to the exterior — is very much smaller and less lobulated than the other. In structure the cells of this first gland appear coarsely granulated, the granules in the sections studied being of a yellowish tint apparently untouched by the stain. The inner surface of the gland is ciliated at least near the mouth. A section of this gland is shown in text-figure B. The second and larger gland

which is much lobulated, opens by a wide mouth into the hermaphroditic duct. When in the state of greatest activity this gland partially overlaps the first as is shown in text-figure B, *ag 1*. Like the first it has cilia on its inner surface but otherwise its appearance is quite different.



TEXT-FIG. B.— Horizontal section through the two accessory glands of the hermaphroditic duct. *ag 1*, first accessory gland of hermaphroditic duct; *ag 2*, second accessory gland of hermaphroditic duct; *bw*, body wall; *hd*, hermaphroditic duct; *mg*, mouth of first accessory gland of hermaphroditic duct.

The secreting cells in this case are very much larger and more numerous with a more reticulated appearance in section. Text-figure B from an oblique longitudinal section, shows the general appearance of

both these glands when in a state of activity. In specimens where the eggs have not reached any considerable degree of development the two glands are of small proportions, appearing simply as folded sacks whose walls are composed of cells with deeply staining nuclei. When at the height of their activity, however, they are greatly enlarged, the second filling the larger portion of the hinder third of the animal. It may be noted that these two glands do not correspond very closely to the albuminiparous and muciparous glands described by Peck ('90) for *Cymbuliopsis calceola* and "probably the Thecosomatous forms generally."

About opposite the mouth of the first of the glands described above there opens into the common genital duct a blind sack which, from position, size, non-glandular wall, and ciliated lining (although it contains no sperm in any of the specimens studied), I am inclined to regard as a receptaculum seminis. This sack is of moderate proportions with a strongly ciliated inner surface. It extends backward towards the gonad as is shown diagrammatically in figure 12 (pl. 4).

Below the mouth of the receptaculum and glands, the genital duct widens out into a vagina, diagrammatically represented in figure 12 (pl. 4). In specimens where the eggs have reached a considerable degree of development this vaginal portion of the duct presents a normal appearance with ciliated inner surface and rather muscular walls; but just previous to the development of the eggs when sperm is maturing in the gonad and the penial glands (to be described presently) are enlarged, the vagina is distended by a deeply staining substance apparently secreted from its walls. Whether or not this secretion (which disappears before the eggs become mature) has anything to do with the transference of the sperm to the penial opening on the side of the head I cannot say. There is a flap-like fold at the mouth of the vagina that may serve to keep this secretion from escaping too early.

The penis and its two accessory glands shown in diagrammatic form in figure 13 (pl. 4), are small and inconspicuous in specimens not in a state of male activity, but when enlarged to their full extent these parts are of considerable dimensions, nearly equaling in their combined bulk the glands connected with the hermaphroditic duct. In figure 6 (pl. 2) these parts have become considerably reduced in size. The penis itself is a tube capable of evagination and when in place extends from near the opening marked *po* in figure 6 (pl. 2)

somewhat obliquely downward and backward so that its posterior end lies near the left pedal ganglion. It is enclosed in a sheath as indicated in figure 14 (pl. 4) which shows the general appearance in a section cut in the horizontal plane. In this section may be noticed the characteristic large nuclei of the inner wall of the penis and also its deeply staining outer fibrous layers. When retracted the penis has its anterior end a little below the surface of the body, thus opening into a kind of cavity which communicates with the exterior at *po* (pl. 2, fig. 6).

Opening into this same cavity is a large gland, a section of which is shown in figure 14, *pg 1* (pl. 4). Indeed, the cavity into which both the penis and this first penial gland open, appears almost as an excurrent duct leading from the gland to the exterior. If it were to be thus regarded the penis would have to be described as opening into this duct just before the latter reaches the exterior. That this gland is really related to the penis is shown by the fact that it reaches its greatest size at a time when the penis is apparently in a condition to function. When the gland enlarges it pushes down into the body till its lower portion comes to lie near the vagina. Its cells are prismatic in form and in the functionally male specimens, distinct in outline as shown in the figure.

Connected with the hinder end of the penis is a second penial gland. This gland is of small size when not functioning, but as it enlarges it pushes backward and downward till it has partially enveloped the esophagus and come to lie in part inside the neural ring. Like the first penial gland it may reach nearly to the vagina. The condition in the specimens studied is such that I can make almost nothing of its finer structure. In section (pl. 4, fig. 14, *pg 2*) it appears as a simple sack with glandular walls. It is filled with a substance which is generally clear and homogeneous in the center but denser and more heavily staining near the walls. Which of these glands, if either, is homologous with the "prostate" gland described for some of the Gastropods I am unable to say, although it might seem to be more probably the second, inasmuch as that gland is directly connected with the penis.

From the foregoing description it may be seen that all of the organs connected with the reproductive system do not function at any one time. Consequently, since the specimens sectioned were in various stages, I am able to summarize what seems to be the sequence of their activities as follows.

Correlated with the development of sperm in the gonad is the very great enlargement of the penis, first and second penial glands, and the vagina, the two latter becoming greatly distended by secretion; while correlated with the development of the egg follicles, which takes place mostly after the parts mentioned above have begun to resume their normal size, is the very considerable enlargement of the two glands opening into the hermaphroditic duct and the partial contraction of the gonadal cavity which, however, still contains some sperm even after the eggs have reached a late stage in their development.

Perhaps the most interesting question in connection with this animal is as to whether we are dealing with a paedogenetic condition of the young of some other pteropod or whether this is a sexually adult form in which some larval characteristics have been retained. Fol ('75) has described an egg-producing form, 2 to 2.5 mm. long ("*Clio aurantiaca*"), from Messina which Pelseneer ('88) regards as the paedogenetic young of *Clione flavescens* though Fol states that he kept the animals in perfect health for three weeks without any alteration in the ciliated bands. It is likewise possible in the case of our Paedoclione that we have an instance of paedogenesis, but even if this be the case, the animal cannot be regarded as the young of any known pteropod. Its larval characters are only the three bands of cilia, its small size, the possession of a distinct caudal lobe, and, possibly, the small number of radular teeth. The many points of structure in which it differs from all allied forms cannot be explained on grounds of immaturity, and hence it has seemed best to describe the animal as new, leaving to the future the decision of the question whether or no it be actually the adult or, if paedogenetic, the discovery of the adult form.

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## EXPLANATION OF PLATES.

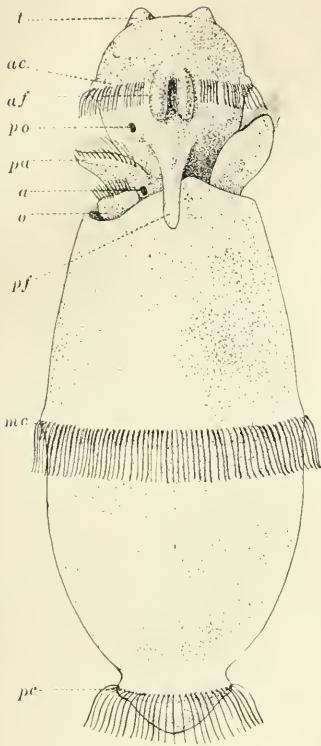
### ABBREVIATIONS.

- |   |   |
|---|---|
| <p><i>a.</i> Anus.</p> <p><i>ac.</i> Anterior band of cilia.</p> <p><i>af.</i> Anterior lobe of foot.</p> <p><i>ag.</i> Accessory glands of hermaphroditic duct.</p> <p><i>ag 1.</i> First accessory gland of hermaphroditic duct.</p> <p><i>ag 2.</i> Second accessory gland of hermaphroditic duct.</p> <p><i>an.</i> Ankistrophore.</p> <p><i>ao.</i> Aorta.</p> <p><i>au.</i> Auricle.</p> <p><i>bg.</i> Buccal ganglion.</p> <p><i>bm.</i> Buccal mass.</p> <p><i>bw.</i> Body wall.</p> <p><i>cc.</i> Cephalocone,</p> <p><i>cd.</i> Left dorsal cephalocone.</p> <p><i>cd'.</i> Left ventral cephalocone.</p> <p><i>ccr.</i> Right cephalocone.</p> <p><i>ce.</i> Cerebral ganglion.</p> <p><i>cc 1, cc 2, cc 3.</i> Cerebral nerves.</p> <p><i>ceb.</i> Cerebro-buccal commissure.</p> <p><i>cm.</i> Connecting membrane.</p> <p><i>cr.</i> Chromatin mass.</p> <p><i>cw.</i> Ciliated wall of esophagus.</p> <p><i>d.</i> Dermal gland.</p> <p><i>ec 1, ec 2, ec 3.</i> Egg cells.</p> <p><i>ef 1, ef 2.</i> Egg follicles.</p> <p><i>fn.</i> Nerve to foot.</p> <p><i>go.</i> Gonad.</p> <p><i>gr.</i> Granule.</p> <p><i>h.</i> Hook.</p> <p><i>hd.</i> Hermaphroditic duct.</p> <p><i>i.</i> Intestine.</p> <p><i>l.</i> Lips.</p> <p><i>lv.</i> Lateral nerve of left visceral ganglion.</p> <p><i>mc.</i> Middle band of cilia.</p> <p><i>mj.</i> Musele fibers.</p> <p><i>mg.</i> Mouth of first accessory gland of hermaphroditic duct.</p> | <p><i>mv.</i> Mouth of vagina.</p> <p><i>nc.</i> Nucleolus.</p> <p><i>ne.</i> Nephridium.</p> <p><i>ns.</i> Nephrostome.</p> <p><i>nu.</i> Nucleus.</p> <p><i>o.</i> Osphradium.</p> <p><i>oc.</i> Esophagus.</p> <p><i>og.</i> Osphradial ganglion.</p> <p><i>on.</i> "Optic" nerve with ganglionated root.</p> <p><i>opg.</i> "Optic" ganglion.</p> <p><i>osn.</i> Nerve to osphradium.</p> <p><i>ot.</i> Otocyst.</p> <p><i>p.</i> Penis.</p> <p><i>pa.</i> Parapodia.</p> <p><i>pc.</i> Posterior ciliated ring.</p> <p><i>pd.</i> Pedal ganglion.</p> <p><i>pd 1, pd 4, pd 5, pd 6.</i> Pedal nerves.</p> <p><i>pe.</i> Pericardium.</p> <p><i>pf.</i> Posterior lobe of foot.</p> <p><i>pg.</i> Penial gland.</p> <p><i>pg 1.</i> First penial gland.</p> <p><i>pg 2.</i> Second penial gland.</p> <p><i>ph.</i> Pharynx.</p> <p><i>phc.</i> Pharyngeal cavity.</p> <p><i>pl.</i> Pleural ganglion.</p> <p><i>pln.</i> Nerve of pleural ganglion.</p> <p><i>pn.</i> Nerve to parapodia.</p> <p><i>po.</i> Penial opening.</p> <p><i>ps.</i> Penial sheath.</p> <p><i>ra.</i> Radula sack.</p> <p><i>rg.</i> Ganglion of rhinophore.</p> <p><i>rn.</i> Nerve of rhinophore.</p> <p><i>rs.</i> Receptaculum seminis.</p> <p><i>s.</i> Sperm.</p> <p><i>sa.</i> Salivary gland.</p> <p><i>sc.</i> Spermatocysts.</p> <p><i>sf.</i> Sensory nerve fibers.</p> <p><i>ss.</i> Sensory surface.</p> <p><i>st.</i> Stomach.</p> <p><i>t.</i> Anterior tentacle.</p> |
|---|---|

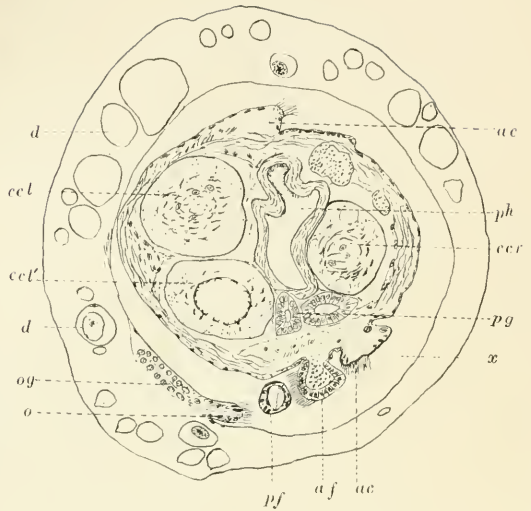
- tn.* Nerve to anterior tentacle.  
*v.* Visceral ganglion.  
*va.* Vagina.  
*va'.* Vagina distended.  
*ve.* Ventricle.  
*vn.* Medial nerve of visceral ganglion.  
*vo.* Larger medial visceral nerve.  
*vr.* Right visceral nerve.  
*vt.* Smaller medial visceral nerve.  
*vu.* Vacuole.  
*x.* Cavity behind anterior fold of body.

PLATE 1.

- Fig. 1. Surface view of *Paedoclione* from the ventral side (from a model).
- Fig. 2. Free-hand sketches of the living animal and details of the parts.  
*A*, ventral view (the median lobe of the foot not seen); *B*, tentacles in another position; *C*, *D*, different degrees of retraction of posterior end; *E*, side view of head and wings, partially retracted.
- Fig. 3. A somewhat oblique section through the head at level of anterior ciliated band. The anterior fold of body shown around the outside.
- Fig. 4. Horizontal section through pharynx showing the ankistrophores and hooks.
- Fig. 5. Diagram of the radular teeth.



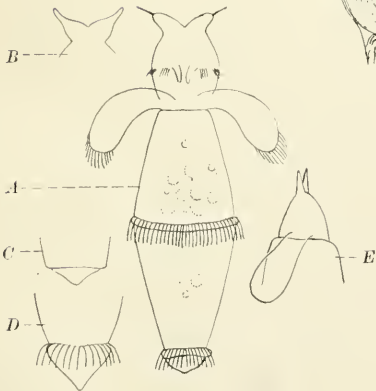
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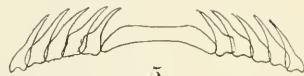
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PLATE 2.

Fig. 6. Diagrammatic representation of the organs in position as seen from the right.

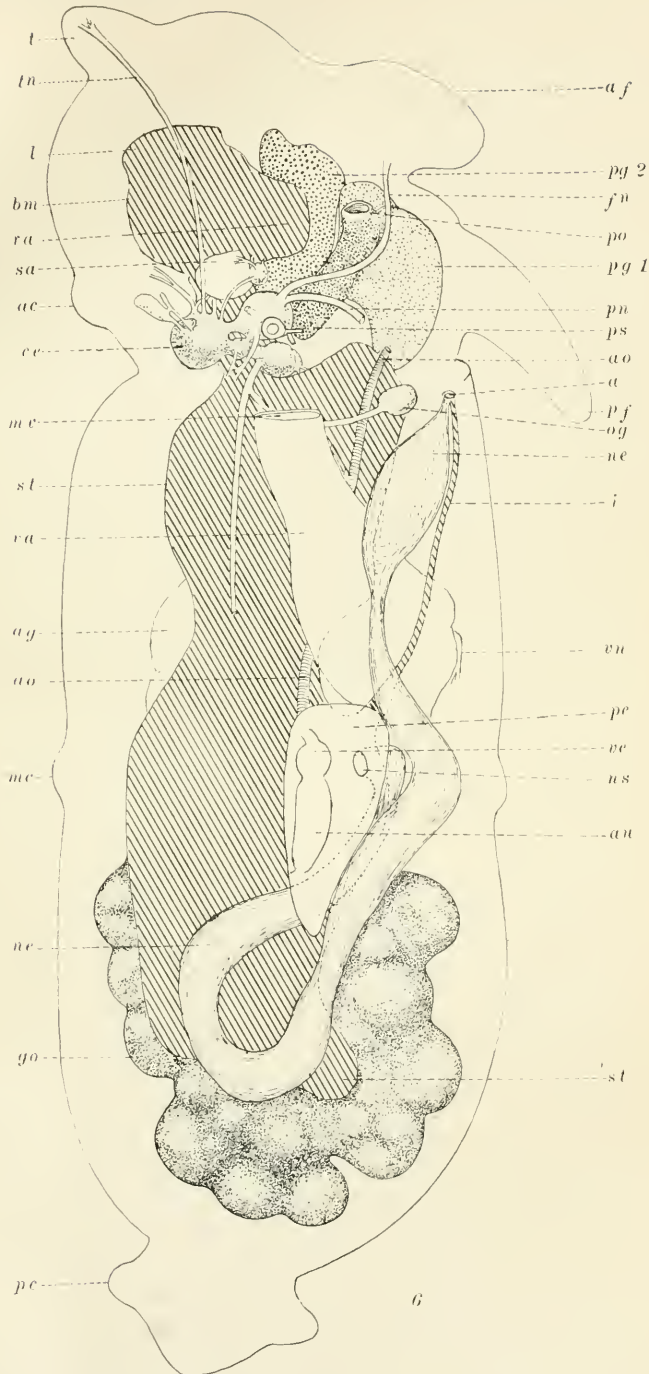






PLATE 3.

- Fig. 7. Slightly oblique section through the body at about the level of the middle ciliated band, showing stomach, intestine, gonad, accessory gland, nephridium, and auricle.
- Fig. 8. Diagram of nervous system as seen in a posterior view.
- Fig. 9. Diagram of the nervous system as seen from the right side.
- Fig. 10. Section through the ganglionic swelling at the end of the larger dorsal cerebral nerve showing also the sensory (?) fibers running to the surface.

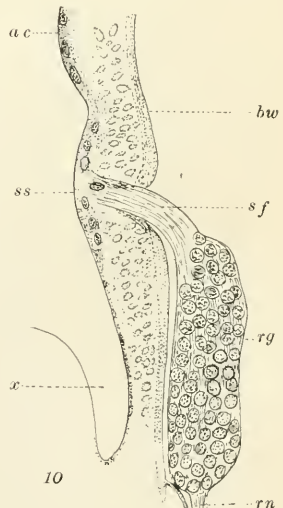
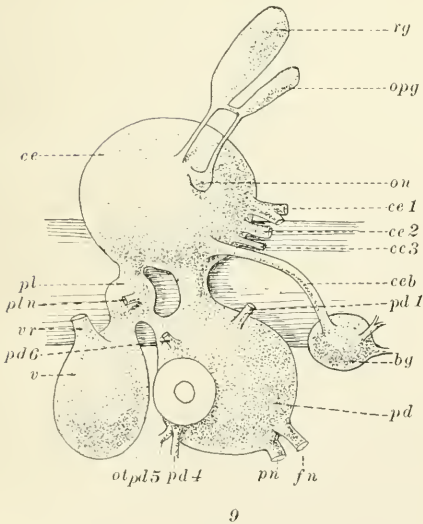
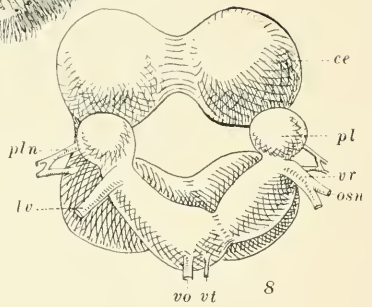




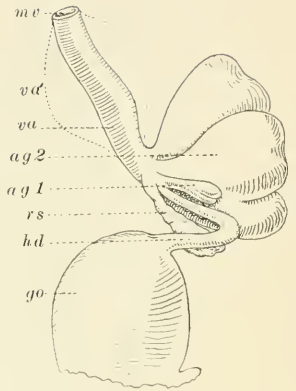


PLATE 4.

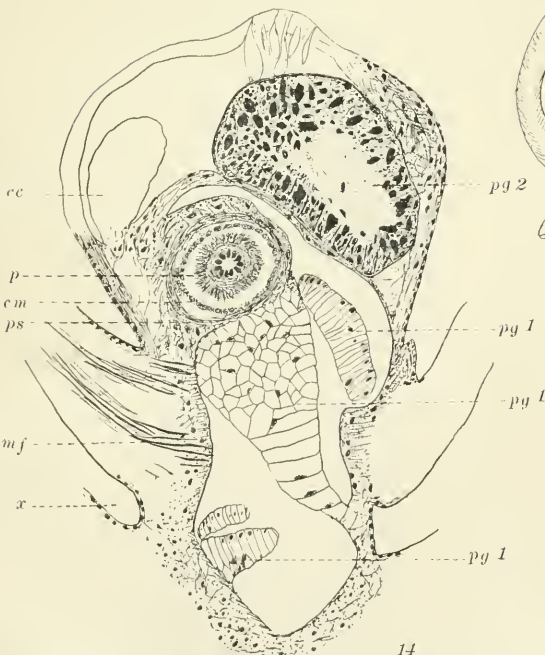
- Fig. 11. Longitudinal section showing developing sperm in the gonad.  
Fig. 12. Diagrams of the hermaphroditic duct, receptaculum seminis, and accessory glands; the dotted outline shows the vagina as distended.  
Fig. 13. Diagram of penis sack and penial accessory glands.  
Fig. 14. Horizontal section through head showing penis and first and second penial glands.



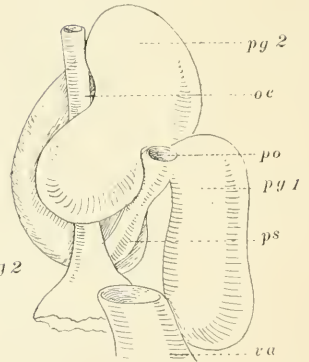
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## No. 2.—FORAMINIFERA OF THE WOODS HOLE REGION.

BY JOSEPH A. CUSHMAN.

VERY little is known concerning the Foraminifera of the New England coast, or, in fact, of the shallow water of any part of our Atlantic coast. The Woods Hole region is, in some respects, a poor one for this particular group. It is not very closely connected with the ocean, being entirely protected except at the entrance to Buzzards Bay and Vineyard Sound, and even there the waters are rather sheltered. The depths in all parts of the region are comparatively shallow, and eighteen fathoms is about the deepest of the dredgings. The bottom conditions also do not favor a varied Foraminiferal fauna especially in parts of Vineyard Sound where the bottom is made up of shifting sands. Here the dead shells of the Foraminifera are found in a worn and broken state. As a result of the conditions few of the deeper-water species seem to occur in the region.

Through the kindness of the United States bureau of fisheries, I was enabled to study the material dredged during July and August, 1905. This dredging was in connection with the biological survey of the region which has been in progress for some time. As a result of this study a partial knowledge of the species represented in the region was obtained. Later a series of bottom samples from about fifty stations was examined and these added somewhat to the previous list. The material used was from dredgings in Buzzards Bay, made by hand from the steamer Phalarope, mostly in the shallower waters near shore and along the inside of the Elizabeth Islands, in from three to nine fathoms of water. Specimens were also obtained from dredgings in Vineyard Sound, extending from a slight distance outside of Gay Head and Cuttyhunk on the west, to a point between Cottage City and Falmouth on the east. To this material, collected during the regular work of the survey, I was enabled to add somewhat by my own efforts. By the use of a scrape-net on the outer piles of the dock at the Fisheries station a good supply of hydroids, algae, and the shells of *Mytilus edulis* was gathered. By washing and scraping the hydroid stems and algae an abundance of Foraminifera was obtained. This consisted, however, almost entirely of a few species. The mud and other extraneous matter was scraped from the *Mytilus* shells and then washed. This was the most productive of rare species of any of the

varied sources of material, giving species not met with at all in any of the survey dredgings.

As a general rule the Foraminifera of the region are most common on bottoms that consist of a mixture of sand and mud, though they are to be found wherever sufficient bottom samples are taken. Specimens are more abundant also in the deeper water of the Sound than elsewhere and in general it may be said that their numbers increase with the depth of the water. While the number of species is not great, representatives of seven of the ten orders of Foraminifera are included. The region in which the material was obtained was in the more protected portion of the area, except the few dredgings which were made at the western end of Vineyard Sound. As a result most of the species are those which are common also in the littoral zone of the European coast of the North Atlantic. Certain others are more interesting as being unlooked for in this region, and extending somewhat the known distribution of the species.

It was found that in a living or fresh condition many of the species have a delicate coloring due to the protoplasmic contents of the shell. This was particularly noticeable in the Miliolinidae, which when dry are usually dead white.

While the majority of the species are free, there are several of those found which in their normal condition are attached. Certain of these, *Webbina* for example, and one species of *Polymorphina*, are attached to the coarser sand grains of the bottom. Others, such as *Discorbina* were met with on all sorts of foreign bodies. Hydroid stems and sponges are frequently covered with them, algae and eel grass are more or less encrusted with them, and even such foreign bodies as parts of an old lobster pot, pieces of coal, and a portion of a shoe dredged off Vineyard Haven had a number of specimens on them.

In all, twenty-eight species representing sixteen genera were found. Further work, will, without doubt, add more species to those recorded here. Especially should this be true of the dredgings as they extend out into the more exposed and deeper waters outside of Gay Head. The following are the species met with during the summer.

#### ASTORRHIZIDAE.

##### *Astrorhiza limicola* Sandahl.

*Astrorhiza limicola* Sandahl, '58, p. 299, pl. 3, figs. 5, 6; Brady, '84, p. 231, pl. 19, fig. 1-4.

This species when found, appeared in great numbers but it is appar-

ently limited to certain localities. It was found to be common at Fish Hawk station 7683 and again in a similar haul from a sandy or slightly muddy bottom in Vineyard Sound, one and one half miles north of Menemsha Bight in 13 fathoms. The larger specimens found, have in some cases as many as seven arms. These are of very considerable length and are often bifurcate at the tips. When dry the delicate arms are easily broken away leaving the central disc with short projections on its periphery. This is the largest of the Foraminifera of the region, measuring with the arms more than ten millimeters in the case of the larger specimens. It has been recorded from the coast of Connecticut in 25 fathoms, and also from off the coast of Maine. It occurs on the coast of northern Europe.

## LITUOLIDAE.

**Reophax dentaliniformis** Brady.

*Reophax dentaliniformis* Brady, '81, p. 49; '84, p. 293, pl. 30, figs. 21, 22.

A very few specimens of this species were found in the region. They were dredged by the Fish Hawk at stations 7651 and 7662. Although the species was supposed by Brady to be confined to deep water, the specimens dredged here were in every way typical, rather smooth, straight specimens with the tubular neck figured by Brady. The specimens were not at all like the ordinary form of *Reophax scoriurus* Montfort.

**Haplophragmium canariense** (d'Orbigny).

*Nonionina canariensis* d'Orbigny, '39a, p. 128, pl. 2, figs. 33, 34.

*Haplophragmium canariense* Siddall, '79, p. 4; Brady, '84, p. 310, pl. 35, fig. 1-5; Flint, '99, p. 277, pl. 20, fig. 3.

A few specimens of this species were found in material dredged by the Phalarope at station 79 off Pasque Island on a muddy bottom in  $5\frac{1}{2}$  fathoms, and from Fish Hawk station 7565 in Vineyard Sound near the southwestern point of Naushon Island. These two stations were not far apart and conditions were similar. Its occurrence in the shallow water near shore may be rare as these records would indicate, but it may easily be overlooked. It has been dredged by the Albatross in the deeper water south of Block Island. It is a common species in the shallow water along the coast of Europe.

## TROCHAMMINIDAE.

**Webbina hemispherica** Jones, Parker, and Brady.

*Webbina hemispherica* Jones, Parker, and Brady, '66, p. 27, pl. 4, fig. 5; Brady, '84, p. 350, pl. 41, fig. 11.

But few specimens of this species were found. They were from Phalarope station 136 in Buzzards Bay and Fish Hawk station 7776. Each specimen consists of a single adherent chamber made up of fine grains of a grayish white color and the whole hemispherical in shape and with a fairly smooth surface. There is no visible aperture. In all cases they were found attached to large sand grains. Their color, small size, and attachment to the sand grains make specimens of this species very easily overlooked. In Europe the species has been dredged a few times off the coast of Great Britain in water from 25 to 33 fathoms in depth. Little is known of its distribution elsewhere. It is interesting to find that this species occurs also on this side of the Atlantic.

## MILIOLINIDAE.

**Spiroloculina limbata** d'Orbigny.

*Spiroloculina limbata* d'Orbigny, '26, p. 299, no. 12; Brady, '84, p. 150, pl. 9, fig. 15-17; Flint, '99, p. 296, pl. 42, fig. 3.

A single fine specimen was obtained from material dredged by the Phalarope at station 85. This was in Buzzards Bay off Quicks Hole. This species is a southern one in its range, occurring more commonly off our southern Atlantic coast. The specimen found was a very typical one but no others were discovered although a careful search was made in the material from the adjacent stations. Single specimens were found in case of other species also, which may indicate that they are extremely rare in this region.

**Biloculina ringens** (Lamarek).

*Miliolites ringens* Lamarek, '04-'07, p. 351, pl. 17, fig. 1.

*Biloculina ringens* d'Orbigny, '26, p. 297, no. 2; Brady, '84, p. 142, pl. 2, figs. 7, 8; Flint, '99, p. 294, pl. 39, fig. 2.

This is a common species throughout the region on various kinds of bottom. It was noticed at sixteen representative stations in Vineyard Sound and Buzzards Bay at varying depths. It is one of the

species to be looked for in the littoral zone in any part of the North Atlantic.

***Biloculina ringens* var. *striatella*, var. nov.**

Plate 5, fig. 1.

Like the typical in general contour, the margin of the outer chamber somewhat irregular especially near its base, the surface with numerous delicate longitudinal channels or striations.

In the material scraped from the wharf piles this variety was often abundant while no true *Biloculina ringens* was obtained as a rule from this sort of material. It is somewhat like var. *striolata* Brady described from Australian waters but differs from that variety in the form and striations. It is very different from *Biloculina comata* which is found in comparatively deep water.

***Biloculina elongata* d'Orbigny.**

Plate 5, fig. 7-9.

*Biloculina elongata* d'Orbigny, '26, p. 298, no. 4; Brady, '84, p. 144, pl. 2, fig. 9, a, b; Flint, '99, p. 294, pl. 39, fig. 4.

Specimens of this species were found in considerable numbers among hydroids and scrapings from the piles of the dock at Woods Hole. Occasionally the species is met with in the dredgings. It may be distinguished from *Biloculina ringens* both by the shape of the aperture and by the general form.

***Biloculina tubulosa* Costa.**

*Biloculina tubulosa* Costa, '56, p. 309, pl. 24, fig. 7; Brady, '84, p. 147, pl. 3, fig. 6, a, b, c; Flint, '99, p. 293, pl. 39, fig. 1.

This species occurs rather frequently throughout the region. The deep groove at the side of specimens of this species varies somewhat but not greatly. It was found most frequently in the deeper waters of Vineyard Sound.

***Miliolina seminulum* (Linné).**

Plate 5, fig. 2.

*Serpula seminulum* Linné, 1767, p. 1264, no. 791.

*Miliolina seminulum* Williamson, '58, p. 85, pl. 7, fig. 183-185; Brady, '84, p. 157, pl. 5, fig. 6, a, b, c; Flint, '99, p. 297, pl. 43, fig. 2.

This species is very abundant throughout the region. It was

observed in dredged material from more than fifty stations of all depths and on all kinds of bottom from mud to gravel. This is the largest *Miliolina* found in the region. When the interior parts are extruded they are seen to be of a light brown color and in the majority of fresh specimens there is a small mass of protoplasm projecting from the aperture. In this species, however, the shell is too thick for the internal coloring to affect the whole color scheme of the shell which is pure white. In sand washed from a dredge haul this species can at once be detected as its chalky white shell stands out clearly against the darker background.

***Miliolina oblonga* (Montagu).**

*Vermiculum oblongum* Montagu, '03, p. 522, pl. 14, fig. 9.

*Miliolina seminulum*, var. *oblonga* Williamson, '58, p. 86, pl. 7, figs. 186, 187.

*Miliolina oblonga* Brady, '84, p. 160, pl. 5, fig. 4, a, b; Flint, '99, p. 297, pl. 43, fig. 3.

Specimens of this species were found in almost as many stations as the preceding but in fewer numbers. The smaller size and narrow oral contour will at once distinguish it from typical *Miliolina seminulum*, but the two are very similar and it is a question whether this should be considered as more than a variety of *Miliolina seminulum*. Both seem to occur in greater numbers in the deeper water.

***Miliolina circularis* (Bornemann).**

Plate 5, figs. 5, 6, 10.

*Triloculina circularis* Bornemann, '55, p. 349, pl. 19, fig. 4.

*Miliolina circularis* Brady, '84, p. 169, pl. 4, fig. 3, a, b, c; pl. 5, figs. 13, 14; Flint, '99, p. 298, pl. 44, fig. 1.

This species is very common in the region. It is best seen as an attached form. On the piles of the wharf at Woods Hole it appears in great numbers attached to the stems of hydroids. In all parts of the region it is found in a similar manner, on hydroids and algae. In life the shell has a beautiful pinkish tinge, due to the color of its protoplasmic contents. When the interior protoplasm is protruded in living specimens the color is even more marked.

***Miliolina boueana* (d'Orbigny).**

*Quinquoloculina boueana* d'Orbigny, '46, p. 293, pl. 19, fig. 7-9.

*Miliolina boueana* Brady, '84, p. 173, pl. 7, fig. 13, a, b, c.

Specimens of this species were obtained on sandy bottoms in Vineyard Sound and in the scrapings from the dock piles at Woods Hole. It cannot be called common in comparison with the preceding three species but seems to be more common than the two following ones. The specimens have the distinct, neatly rounded chambers and well defined striations that distinguish this species from others of the region.

***Miliolina venusta*** (Karrer).

*Quinqueloculina venusta* Karrer, '68, p. 147, pl. 2, fig. 6.

*Miliolina venusta* Brady, '84, p. 162, pl. 5, figs. 5, 7; Flint, '99, p. 298, pl. 44, fig. 2.

Specimens of this species showing the well developed keels and the protuberant extremity of the last chamber were found in the Fish Hawk dredgings from the deeper parts of Vineyard Sound. While the species was recorded from several stations in this portion of the region, it was usually represented by few specimens, sometimes but a single one in a dredge haul. In Buzzards Bay and the shallower water inshore this species seems to be entirely wanting.

***Miliolina bicornis*** (Walker and Jacob).

*Scrpula bicornis* Walker and Jacob, 1798, p. 633, pl. 14, fig. 2.

*Miliolina bicornis* Williamson, '58, p. 87, pl. 7, fig. 190-192; Brady, '84, p. 171, pl. 6, figs. 9, 11, 12; Flint, '99, p. 300, pl. 46, fig. 2.

In similar hauls with the preceding were a very few specimens with the striations and the peculiar last chamber which characterize this species. This chamber extends back and at its posterior end embraces the earlier chambers within a peculiar hook-like portion. Anteriorly it is extended to form a tubular neck. This appears to be the most rare of any of the six species of *Miliolina* noted from the region and it is essentially a shallow-water species. In Europe it is very similar to *Miliolina boucana* d'Orbigny.

TEXTULARIIDAE.

***Verneuilina polystropha*** (Reuss).

*Bulimina polystropha* Reuss, '45, p. 109, pl. 24, fig. 53.

*Verneuilina polystropha* Brady, '78, p. 436, pl. 20, fig. 9, a-c; '84, p. 386, pl. 47, fig. 15-17.

A single specimen of this species was found in material dredged by

the Fish Hawk at station 7565. This may not indicate that the species is rare for it is a small one and on account of its resemblance to the rest of the bottom material is easily overlooked. It is common on the shores of Europe.

## BULIMINIDAE.

***Bolivina punctata*** d'Orbigny.

Plate 5, fig. 13.

*Bolivina punctata* d'Orbigny, '39, p. 61, pl. 8, fig. 10-12; Brady, '84, p. 417, pl. 52, figs. 18, 19; Flint, '99, p. 292, pl. 38, fig. 1.

A number of specimens of *Bolivina* were obtained from the surface of old shells of *Mytilus edulis* attached to the outer piles of the U. S. fisheries dock at Woods Hole. While the specimens were much broader than the typical *Bolivina punctata*, yet they are very similar to the broader form of this species. The colors shown in fresh specimens are very striking. In a living state the proloculum and the succeeding chambers except the last three or four are of a deep orange-red color while the latter ones are nearly colorless. This coloring seemed to be constant in all the living specimens examined. The species is cosmopolitan.

## POLYMORPHINIDAE.

***Polymorphina lactea*** (Walker and Jacob).

*Serpula lactea* Walker and Jacob, 1798, p. 634, pl. 24, fig. 4.

*Polymorphina lactea* Macgillivray, '43, p. 522; Brady, '84, p. 559, pl. 71, fig. 11.

This is the most common species of the genus in this region. It is widely distributed and of good size so that it is usually one of the first species to be singled out in looking over a dredge haul for Foraminifera. Frequently it is found in almost pure sand from the deeper parts of Vineyard Sound, where it is often the only species of Foraminifera dredged. Some of the specimens in general appearance approach *Polymorphina oblonga* and *P. compressa*, but connecting forms with the typical *P. lactea* are usually present.

***Polymorphina concava*** (Williamson).

*Polymorphina lactea*, var. *concava* Williamson, '58, p. 72, pl. 6, figs. 151, 152.

In his work on the recent Foraminifera of Great Britain, in 1858,

Williamson describes this as a variety of *Polymorphina lactea*. The specimen which he figures and describes has a peculiar flattened, concave shell mass at one side. The form has been given little attention since that time. From material dredged by the Phalarope in the shallower water of Buzzards Bay were found specimens which very closely agree with those of Williamson. In all cases they were attached to rather large sand grains. The form of the shell in our specimens and in those figured by Williamson is much shorter than in the ordinary types of *P. lactea* and the peculiar habit of fixation with the resulting development of the concave plate-like portion seems to make it worthy of specific rank. Specimens were dredged by the Phalarope at stations 133 and 148.

***Polymorphina rotundata*** (Bornemann).

*Guttulina rotundata* Bornemann, '55, p. 346, pl. 11; pl. 18, fig. 3.

*Polymorphina rotundata* Reuss, '70, p. 487, no. 14; Brady, '84, p. 570, pl. 73, fig. 5-8.

This species seems to be rare in a living state, but a few specimens obtained during the dredging seem referable to it. These were from Phalarope station 146 and Fish Hawk station 7728. It may be at once distinguished from any of the variations of *P. lactea* by its shorter form and its close set chambers.

ROTALIDAE.

***Patellina corrugata*** Williamson.

Plate 5, fig. 3.

*Patellina corrugata* Williamson, '58, p. 46, pl. 3, fig. 86-89; Brady, '84, p. 634, pl. 86, fig. 1-7.

A single specimen of this interesting and beautiful species was obtained. It was found in material scraped from the surface of a large shell of *Mytilus edulis* taken from the outer piles of the dock at Woods Hole, July 19, 1905. The specimen was drawn to show the characteristic thickenings which project inward from the peripheral border of each chamber. Many other *Mytilus* shells were searched after this species was discovered but not another specimen could be found. It should be found more frequently with further search for it is not uncommon in the littoral zone along European shores.

**Discorbina rosacea** (d'Orbigny).

*Rotalia rosacea* d'Orbigny, '26, p. 273, no. 15.

*Discorbina rosacea* Parker, Jones, and Brady, '65, p. 25, pl. 2, fig. 71; Brady, '84, p. 644, pl. 87, figs. 1, 4; Flint, '99, p. 327, pl. 72, fig. 3.

This is one of the most abundant species of the region. It is found free in the dredgings and also in great numbers attached to the stems of hydroids and to many other foreign bodies, as has already been noted. It may be obtained in quantity from the piles of wharves where there are hydroids. Anything that is stationary in the water for any length of time is sure to have its share of the shells of this species.

**Truncatulina lobatula** (Walker and Jacob).

*Nautilus lobatulus* Walker and Jacob, 1798, p. 642, pl. 14, fig. 36.

*Truncatulina lobatula* d'Orbigny, '39a, p. 134, pl. 2, fig. 22-24; Brady, '84, p. 660, pl. 92, fig. 10; pl. 93, figs. 1, 4, 5; pl. 95, figs. 4, 5.

Specimens of this species are met with throughout the region. It is one of the common shallow-water species of the North Atlantic.

**Truncatulina rosea** (d'Orbigny).

*Rotalia rosea* d'Orbigny, '26, p. 272, no. 7.

*Truncatulina rosea* Brady, '84, p. 667, pl. 96, fig. 1, a, b, c; Flint, '99, p. 334, pl. 78, fig. 2.

One of the most interesting finds of the summer was a single specimen of this beautifully colored little species. It was obtained from the same lot of material scraped from the piles of the dock at Woods Hole in which the single specimen of *Patellina corrugata* was found. It is interesting to record its occurrence much farther north than its usual West Indian habitat. Further search will probably furnish additional specimens.

**Pulvinulina lateralis** (Terquem).

Plate 5, figs. 11, 12.

*Rosalina lateralis* Terquem, '78, p. 25, pl. 2, fig. 11, a, b, c.

*Pulvinulina lateralis* Brady, '84, p. 689, pl. 106, figs. 2, 3.

In the deeper waters of Vineyard Sound this species is not uncommonly met with. Its large size and the very peculiar last chamber

with its large perforations on the ventral side and the irregular shape of the later chambers at once distinguish the species. In the character of perforations in the last chamber it is comparable to the last chamber of *Orbulina* and *Cymbalopora* which also have this coarsely perforate character. The specimen figured shows more than the usual irregularity of shape of the last chambers. These irregular chambers on the upper side (pl. 5, fig. 11), lack the bordering carina typical of the earlier ones. The Challenger dredged this species in the Indian and Pacific Oceans but nowhere else. Later it has been found to be a common littoral species. The majority of the specimens are regular and in general like figure 3 of the Challenger report referred to above.

***Pulvinulina tumida* Brady.**

*Pulvinulina menardii*, var. *tumida* Brady, '77, p. 294.

*Pulvinulina tumida* Brady, '84, p. 692, pl. 103, fig. 4-6; Flint, '99, p. 329, pl. 73, fig. 5.

A few specimens, apparently belonging to this species, were obtained from scrapings from the dock at Woods Hole.

***Rotalia beccarii* (Linné).**

*Nautilus beccarii* Linné, 1767, p. 1162.

*Rotalia beccarii* d'Orbigny, '26, p. 275, no. 42; Brady, '84, p. 704, pl. 107, figs. 2, 3; Flint, '99, p. 331, pl. 75, fig. 2.

This is probably the most abundant of the Foraminifera of the region. It was found at over fifty stations and always in very considerable numbers. It is most abundant on bottoms which may be classed as sandy mud or where at least there is a considerable amount of very fine material. It is small in size and on account of its color, which is often a gray brown, it may be very easily overlooked even with a hand lens. In the majority of the dredgings it is the most abundant species.

POLYSTOMELLIDAE.

***Polystomella striato-punctata* (Fichtel and Moll).**

Plate 5, fig. 4.

*Nautilus striato-punctatus* Fichtel and Moll, '03, p. 61, pl. 9, fig. a-c.

*Polystomella striato-punctata* Parker and Jones, '60, p. 103, no. 6; Brady, '84, p. 733, pl. 109, figs. 22, 23; Flint, '99, p. 337, pl. 80, fig. 2.

This species is one of the commonest in the region having been observed at more than forty stations during the dredging. It is subject to some variation in its surface ornamentation but much less so than is the following species. It is one of the common species of the littoral zone of the whole Atlantic.

***Polystomella crispa* (Linné).**

*Nautilus crispa* Linné, 1767, p. 1162.

*Polystomella crispa* Lamarck, '22, p. 625, no. 1; Brady, '84, p. 736, pl. 110, figs. 6, 7; Flint, '99, p. 338, pl. 80, fig. 3.

Although somewhat less common than the preceding, this species is frequently met with. It seems to be slightly more common in deeper water for it was found more frequently in material from the deeper parts of Vineyard Sound. There is a great variation in the surface characters of this species, much more so than is shown in the published figures.

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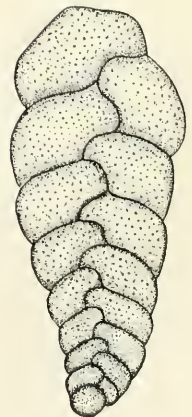
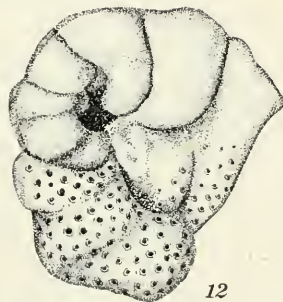
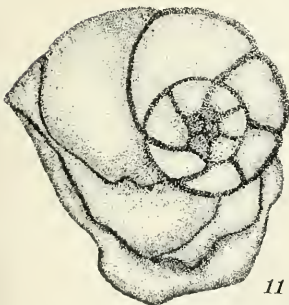
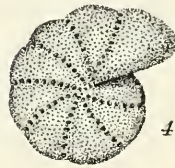
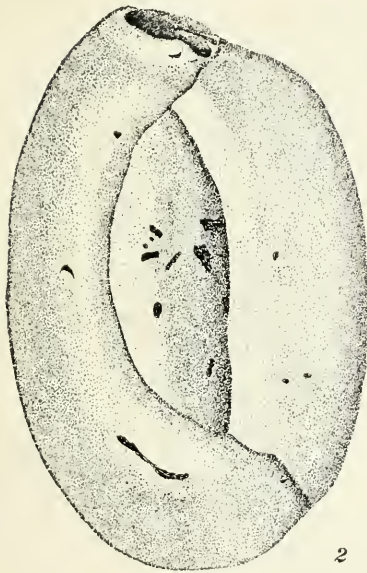
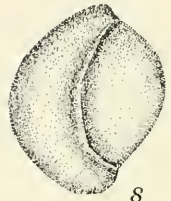
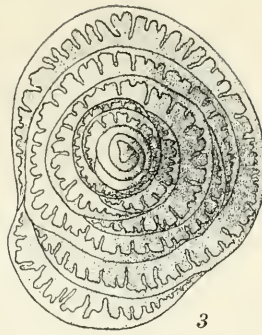
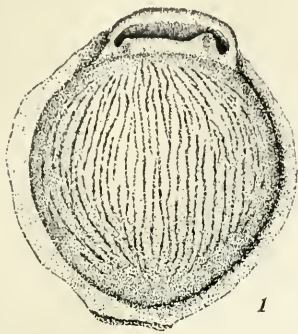
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EXPLANATION OF PLATE 5.

- Fig. 1. *Biloculina ringens* var. *striatella*, var. nov. × 60.  
Fig. 2. *Miliolina seminulum* (Linné). × 50.  
Fig. 3. *Patellina corrugata* Williamson, from dorsal side. × 80.  
Fig. 4. *Polystomella striato-punctata* (Fichtel and Moll). × 50.  
Fig. 5. *Miliolina circularis* (Bornemann), from side. × 30.  
Fig. 6. Same, from apertural end. × 30.  
Fig. 7. *Biloculina elongata* d'Orbigny, front view. × 30.  
Fig. 8. Same from side. × 30.  
Fig. 9. Same from apertural end. × 30.  
Fig. 10. *Miliolina circularis* (Bornemann), from opposite side. × 30.  
Fig. 11. *Pulvinulina lateralis* (Terquem), from dorsal side. × 25.  
Fig. 12. Same from ventral side. × 25.  
Fig. 13. *Bolivina punctata* d'Orbigny. × 60.





No. 3.—CAMAROPHORELLA, A MISSISSIPPIAN MERI-  
STELLOID BRACHIOPOD.

BY JESSE E. HYDE.

INTRODUCTION.

THE genus *Camarophorella* was erected by Hall and Clarke ('94, p. 838) to accommodate a species which they considered as having internal characters normal for *Camarophoria*. The form and outline, however, were so different from those of the known species of this genus that they deemed it worthy of subgeneric rank. It was based on the species *Pentamerus lenticularis* White and Whitfield, from the Burlington beds at Burlington, Iowa, since described by Weller ('01, p. 162) as occurring in the Kinderhook at that locality. Up to the present, no other form has been known that could be associated with it.

The year following that in which the genus was first described and named, the description was repeated in practically the same words with slight additions (Hall and Clarke, '95, p. 215). It is unnecessary to quote both and as the latter is a little the fuller, it is here given:

“The *Camarophorella* (*Pentamerus*) *lenticularis*, White and Whitfield, from the Yellow sandstones beneath the Burlington limestone, at Burlington, Iowa, is a shell widely different from all the foregoing [species of *Camarophoria*] in external features. The valves are biconvex and their outline subcircular; it has no fold and sinus and no plications, the surface being smooth and regularly arched. To associate it generically with the plicate trihedral *Camarophoria* requires an effort of the imagination. At the same time its internal characters are normal for *Camarophoria*, except that the broad, spatuliform spondylium rests upon the valve for most of its length, the median septum penetrating it and projecting above it into the interior cavity of the shell. It is proposed to signalize these differences, and thus to render the association constituting *Camarophoria* the more homogeneous, by giving this species the subgeneric designation, *Camarophorella*.”

This supposed relationship to *Camarophoria* would give the genus a position in the family *Pentameridae* in which no brachial support is known except the crura.

In an extensive collection made by the writer and his father, Mr.

Eber Hyde, from the middle of the Waverly series at Sciotoville, Ohio, there is a common species which, on comparison with the type specimens of *Camarophorella lenticularis*, proves to be congeneric. It is specifically quite distinct from the Burlington form and is undescribed, unless Professor Alexander Winchell's name, *Centronella ? flora*, be available for it. This, however, does not appear possible, for his description, as will be explained presently, deals with specimens representing two widely separated genera. Excellent material has been obtained and it is possible to figure and describe the details of structure in the adult probably more fully than has ever been done for a Paleozoic brachiopod of this type. It is a spire-bearing form and the jugum, which is well preserved in several specimens, is of the general type seen in *Merista* and *Meristella*.

The purposes of the present paper may then be briefly outlined as follows: (1) the transference of *Camarophorella* from the position of subgenus in the family Pentameridae to full generic rank under the subfamily Meristellinae; (2) the redescription of the genus and the description of a new species; (3) the discussion of the structures occurring therein with reference to their general morphological bearing and to the relationship of the genus.

It should be stated at the outset that the two structures of most importance, indeed of any importance at all, in transferring the genus from its former position in the Protremata to the Telotremata, have not been observed in *Camarophorella lenticularis* because of the method of preservation. These are the deltidial plates and the brachial support. As this species must always remain the type of the genus, however little its structures may be known, and as the change is made entirely as a result of the study of the Sciotoville material, it is better to state by way of introduction, the characters in which the two are in complete agreement.

The Sciotoville material is preserved in two ways. Certain individuals, when buried, have been so tightly closed that no sediment has found its way to the interior. Many of these have been subsequently entirely or partially filled with zinc blende, calcite, or pyrite, others have preserved the cavity between the valves without any filling. In these last and to a certain extent in those partially filled, the original structures of the interior are preserved, sometimes perfectly. The muscular platforms and more or less complete spiralia with their jugal attachments may be found in almost as good condition as at the time

of death, although the latter are usually shattered in breaking open the hard sandy concretions in which they occur. The surfaces of the structures are usually coated with a thin film of pyrite which often, however, does not obscure any but the most delicate markings. In other cases the interior has been filled with sediment, since become extremely hard, and the fossils are preserved as internal molds from which the substance of the platforms, septa, etc., has been leached out, leaving them represented by clefts.

The Burlington specimens are preserved only in a form similar to the latter, as internal molds in a moderately fine-grained siliceous sandstone. The surface has not been seen and what is known of the interior structure has been gained through a study of specimens in which the filling between the muscular platforms and the inner surface of the valves has been broken away, exposing the cavities or clefts which these platforms originally occupied. By the very nature of the specimens it would be difficult to learn anything of the deltidial plates or spiral arms even though they were formerly a part of the shell.

In the pedicle valve of both species there is a spondylium, concave inward, formed by the coalescence of the dental lamellae. In both species, apparently, it is supported throughout its length by a median septum. On either side of the spondylium a characteristic accessory supporting plate is developed in both to a greater or less extent. In the brachial valve there is a platform, convex inward, which takes its beginning beneath the hinge plate and extends for one third or more of the length of the valve. It is supported and divided into two parts by a median septum that penetrates it and extends for some distance beyond the inner surface of the platform. This septum also supports the well developed and characteristic hinge plate. It is on the complete identity of these three structures and the general similarity in shape that the statement of their congeneric nature rests. A description of the Sciotoville brachiopod follows.

#### DETAILED DESCRIPTION.

*External form and dimensions.*—The species from Sciotoville shows a great amount of variation. In general the shells are meristelloid in external form and moderately thick. The width is usually greater than the length but the opposite is true of a few individuals.

The outline is elliptical or subelliptical, with the greatest width usually at about the middle of the brachial valve, occasionally considerably above or below it. In old individuals the outline is subpentagonal. A fold and sinus are present in all except very young individuals but this feature also shows variation. In adolescent stages, except the youngest, they may be represented by only a slight flexure on the anterior margin and in the oldest specimens they are only moderately developed. A shallow depressed furrow down the middle of both fold and sinus is a constant feature, and appears in the young before either the fold or the sinus.

So much variation occurs in the general shape of the shell that by some writers the species would probably be made the basis of at least two and possibly more species. All gradations, however, are found between extremes of any character. The individuals do not fall into certain groups more or less well defined with a few intermediate forms, but the whole is a continuous series. There is, further, no association of certain characters; each character varies independently of any other. Lastly, the individuals themselves very commonly show great irregularity as, for example, one specimen in which the right and the left sides of the shell were developed unequally. The length of this specimen is 24.5 millimeters. Had the left side been symmetrical with the right, the breadth would have been 25.3 millimeters; had the right side been symmetrical with the left, it would have been 30.8 millimeters.

Unfortunately almost all the specimens occur as internal molds with ragged edges and the exact measurement of a large number of specimens necessary for biometric work is impossible. If a sufficient number of specimens in fit condition for measurement and showing the exact outlines of the earlier stages were at hand, it is not impossible that a plotting of the results would reveal tendencies toward development in certain lines, and a division into varieties or even species would be advantageous. Under the circumstances, however, there would be nothing gained by such a subdivision. This variation in external characters cannot be emphasized too strongly because, as will be shown presently, it extends to the internal structures as well, where differences between individuals occur which some might consider of specific, if not higher, ordinal value, if found in a type less plastic than the one under consideration.

The outlines on plate 6 and drawings on plate 8 show the range of

variation in external characters. Following is a series of measurements in millimeters made from the molds.

No.	Height.	Breadth.	Thick- ness.	No.	Height.	Breadth.	Thick- ness.
1.	9.0	9.9	5.5	15.	19.0	18.7	10.0
2.	11.7	13.0	6.0	16.	19.3	21.4	11.0
3.	13.5	14.4	6.2	17.	20.4	22.4	13.2
4.	13.7	15.0	7.6	18.	21.0	22.4	11.6
5.	14.5	15.0	7.8	19.	21.6	26.0	15.8
6.	14.8	16.8	8.0	20.	22.0	25.0	12.7
7.	15.9	15.7	7.8	21.	22.1	25.0	14.3
8.	16.3	20.1	9.2	22.	22.3	24.5	14.6
9.	16.4	15.1	8.8	23.	22.6	23.6	15.8
10.	17.5	19.8	—	24.	22.8	25.3	—
11.	17.7	20.4	—	25.	23.0	28.7	15.7
12.	18.2	20.0	11.2	26.	24.3	26.8	15.0
13.	18.2	21.5	9.6	27.	24.5	28.0	15.5
14.	18.3	20.0	9.1				

The surface of the shell is somewhat irregularly marked by fine concentric striae and occasional slight wrinkles of growth. These are crossed by very fine but distinct radiating striae, eight or ten of which occupy the space of one millimeter. These striae are sharply rounded and the flat furrows between are considerably broader.

The beak of the pedicle valve is only moderately incurved, not concealing the delthyrium which is entirely closed by the deltidial plates. The pedicle opening is subterminal and in the adult stages is carried into the shell substance considerably beyond the original limits of the delthyrium. The deltidial plates and pedicle opening are not commonly seen owing to the nature of the material. In one specimen showing the interior of the shell (pl. 9, fig. 44) the inner surfaces of the deltidial plates are shown between the tip of the cardinal plate and the pedicle opening.

*Pedicle valve.*—A spondylium is present in the pedicle valve formed by the coalescence ventrally of the dental lamellae. It is strongly concave toward the interior of the shell and is supported throughout its entire length by a low median septum, except occasionally in the tip of the beak where it may rest for a very short distance on the valve. The median septum extends for one third of its length beyond the anterior end of the spondylium, and its total length is less than half that of the valve. It does not penetrate into the cavity of the spondylium, but a faint ridge only is discernible on the floor of the platform.

The convex surface of the platform is marked by delicate concentric lines of growth, the concave surface by similar lines and by very fine radiating lines.

All the muscles of the pedicle valve are attached to this concave surface; none is implanted directly on the valve. It is remarkable to find so delicate and fragile a platform carrying all the strain of the adductor, diductor, and pedicle muscles. However, the impressions of the respective sets are so light that it is impossible to determine the points of attachment of some and the exact limits of others. The diductors appear to fill most of the cavity but the points of attachment of the pedicle muscles are unknown, except for a small scar on each side close to the hinge line, consequently the relative extent of the two sets is uncertain. The adductor scar is a narrow, tongue-shaped area lying in the median line on the posterior half of the platform. It is always quite distinct when the specimen is in good condition and is slightly variable in length.

Considerable variation occurs in the shape of the spondylium. It may be deeply concave with sides almost parallel at the margins. A cross section of such a one made just anterior to the hinge would show an arc of  $180^{\circ}$ . A section along the median line would show a considerable concavity in the bottom of the plate between the anterior end and the tip of the beak. Such an individual is shown in figures 42 and 43 on plate 8. Compare these with figures 37 and 38 on the same plate, in which the plate is much less curved in all directions. Figures 38 and 43 are drawn with the specimens held in the same position, so that any difference is due to the shape of the plate and not to a difference in viewpoint. The majority of the spondylia examined are shaped more nearly like the one first described.

Two accessory plates occur in the beak, one on either side of the spondylium. They extend from the outer surface of the spondylium to the inner surface of the shell and usually lie close to the hinge line. Whether they functioned as braces or were degenerate and functionless is not certain, but the latter appears to be a plausible explanation of their existence. They are variable with age. In the young they are relatively much more important than in the adult, where they may at times be reduced to the merest trace. In the specimen shown in figures 42 and 43 (pl. 8) they are more pronounced than usual. This feature is taken up in detail in the discussion of the possible line of descent of the type.

*Brachial valve.*— In the brachial valve there is a high median septum, triangular in shape and extending half the length of the valve, on the apex of which the jugum rests after the manner of an inverted V. The septum supports a stout, very concave, triangular hinge plate which projects posteriorly into the pedicle beak considerably beyond the hinge line. The septum usually penetrates the plate as a pronounced ridge along the bottom of the concavity although in some individuals this is almost imperceptible (pl. 8, fig. 39–41; pl. 9, figs. 44, 50). The plate is usually distinctly pointed posteriorly. The crura take their origin on the anterior margin of the hinge plate close to the lateral margins. The dental sockets are contiguous to the sides of the hinge plate; they are deep, narrow, and convergent posteriorly, the thickened edges of the spondylium sometimes even curving slightly toward each other beneath the crural bases so that the two valves completely interlock.

Commencing in the beak under the hinge plate and extending anteriorly to the edge of the septum are two plates, one on each side, which taken together, constitute a platform for the attachment of the adductor muscles. Their proximal edges are implanted on the septum at about half its height; the distal edges rest on the valve. Posteriorly the plates may rest for a short distance directly on the valve, but throughout most of their length each is convex toward the interior of the shell with a cavity beneath it. On each, between the outer margin and the middle of the plate, usually nearer the former, a pronounced longitudinal ridge is formed which may develop into a low septum (pl. 8, fig. 39). These ridges limit the muscular attachments on either side. Their position seems to be determined largely by the position of the primary lamellae of the spiral arms which swing downward close to the plates and just outside the lateral septa. Between the lateral and the median septa one or two indistinct ridges may be formed. The muscle scars are obliquely striate, the striae extending outward and posteriorly. Although the striae are occasionally distinctly preserved, none that has been seen shows a division into anterior and posterior adductors. The writer's father found a specimen, however, which showed this division distinctly but unfortunately it was lost in transportation. No scars have been noted on the septum that might suggest that the muscles were attached in part to it. Some variation occurs. In one instance the plate on one side is placed considerably higher on the septum than is that of the other and this seems

to indicate that the two were, to a certain extent, independent. For practical purposes, however, both may be referred to collectively as a single platform.

The extreme development of the median septum above the platform seems to be for the sole purpose of supporting the jugum. Similar septa occur in the genera *Kayseria* and *Anoplothea* but in these cases, on the ventral surface of the saddle which passes over the septum, a stem is developed that rests against the ventral or pedicle valve, so that all three taken together, septum, saddle, and stem, form a brace between the two valves. In *Camarophorella* it is clearly only a support for the jugum. This is the only occurrence of the kind recorded for the subfamily *Meristellinae*, but the function of the median septum in *Dicamara* and *Camarospira* has not yet been determined. It is possible that the same relation may have existed there.

*The brachidium.*<sup>1</sup>—The crura, as just stated, take their origin on the anterior margin of the hinge plate close to the dental sockets. They are well developed, moderately long, and curve slightly toward the beak. The primary lamellae of the brachidium come in contact with them at a sharp angle (pl. 7, fig. 14) but the evidence that the two were connected in the adult is slight although they almost certainly must have been. Three specimens have been observed showing the crura unbroken but with the brachidium entirely or partially broken away, and four jugal loops in which one or both primary lamellae are in perfect condition to the point of supposed attachment to the crura. Another shows the two structures in conjunction but not united. The crura are cylindrical throughout the half or third of their length above the base, but the free or anterior ends are flattened into a broad blade. In all of the specimens the ventral surface of the crus is very distinctly scarred or grooved as shown in figures 42 and 43 (pl. 8). In no case where the blade is well preserved is any fracture to be seen. Of the four specimens in which primary lamellae are preserved to the point of

<sup>1</sup> Terms descriptive of the brachidium are the same as those used by Hall and Clarke ('95, p. 86). Their diagram of the jugum of *Athyris* and an outline of the same structure in the form under consideration are given in figures 1 and 2 (pl. 6). On these the parts described are indicated by letters. In describing the jugum the writer has found it necessary to use certain terms as dorsal and ventral, anterior and posterior, to indicate the structures. Although this may not seem to be according to the customary usage of these terms, it is based on the orientation of the jugum in the shell, as will be better understood by referring to figure 14 (pl. 7). The dorsal end is the end that is attached to the primary lamellae; the ventral end is the opposite or free end, so called because they are directed respectively toward the dorsal and ventral valves. The anterior and posterior surfaces, likewise, are directed toward the anterior or posterior ends of the shell.

junction, one is slightly broken but not in the place where it would be expected if it had been torn from the crus; the three others show the ends of the lamellae, one with both lamellae, without a fracture. In the specimen in which the lamella and crus are seen in conjunction (the same one from which fig. 13, pl. 7, is reconstructed) the posterior margin of the lamellae rests alongside the outer edge of the blade of the crus but does not touch it.

The ribbons of the brachidium are preserved as flattened hollow tubes and any fracture made recently would be easily detectible. If, however, the fracture was made before mineralization took place, it might be difficult or impossible to detect a break especially if it were small. In some specimens, however, they have been recognized with ease. It must be noted further that in several cases where the spirals or juga are preserved, they are not in the exact position which they originally occupied. Even in the specimen just described (pl. 7, fig. 13) there is a slight displacement. The structures are held in the position in which they are now found by infiltrated sediment or mineral matter and any displacement must have occurred before this infiltration took place. If the lamella and crus were only slightly attached, the fracture resulting upon displacement might have been entirely covered over and concealed.

In the specimen referred to above in which lamella and crus are in close apposition, the brachidium was preserved without a fracture in the entire delicate structure, but there is a slight shifting of the whole from its original position and the point of yielding has been the supposed point of attachment. This specimen is so delicate that it has been badly broken since it was collected, but the relation of the end of the primary lamella to the crus is clearly shown; the two are not in contact but separate by possibly one tenth of a millimeter. Further, both lamella and crus are firmly imbedded in the matrix partially filling the shell cavity, so that the movement must have taken place immediately after death, probably as a result of the weight of the brachidium and of the decaying organic matter. Whatever the cause, it was not sufficient to produce any other disturbance. This example, together with the four others in which the primary lamellae are preserved unbroken to the end, although separated from the crura, and the three specimens in which the crura are unbroken with no remnant of the lamellae still adhering to them, are considered strong evidence in support of the view that there was only a very slight attachment or very incomplete spiculization at the point of attachment.

As to the exact method of attachment, it should be noted that the ends of the primary lamellae when entirely preserved, are always abruptly bent inwards, very much as the edge of a knife blade may be turned by contact with a harder substance, forming a "wire edge." This bending or truncating, for it is not a true bend, is always slight and might be easily overlooked (pl. 6, fig. 4). It does not resemble a break. A close examination of the crura shows the inner edges of the blades slightly roughened at the tips but so slightly that, if the surface were ever broken, it has been almost completely healed by subsequent mineralization, so small in amount as not to destroy the delicate grooves on the surface. It appears most likely that the junction was very much as shown in figure 3 (pl. 6). The outer edge of the lamella rested in the groove on the surface of the erus and the tip was sharply bent and attached to the inner edge of the tip of the erus. Not one of the lamellae seen, however, shows the end bent as much as this explanation requires and the crura do not show any trace of the attachment beyond the very slight roughening. When one recalls the relative position of the erus and the lamella during the life of the individual, it is seen that such an explanation accounts, probably entirely, for the fragile nature of the connection. The weight of the brachidium is borne by the median septum and the crura and not by the attachment. The attachment was either sufficient only to prevent the lamella from slipping off the erus or was so imperfectly spiculated that little trace of it now remains.

From the crura the primary lamellae converge to near the center of the brachial valve beyond which they separate toward the anterior margin and converge again near the center of the pedicle valve, as in *Merista* and *Meristella*. Each spiral ribbon makes from eight to ten, sometimes possibly twelve, volutions in the adult. The cones are somewhat flattened in accordance with the shape of the shell and their bases are approximately parallel to the longitudinal axis of the shell. The anterior curves of the ribbon are fimbriate on the outer margin. Not rarely these fimbriae are found over the entire anterior half of the whorl and sometimes entirely around it. So far as observed they are always located on the side of the ribbon toward the base of the cone (see figures).

The jugum or loop is modeled after the same plan as that of *Merista* and *Meristella* but is more massive and compact. It is situated on the primary lamellae about one third the length of their longer axis from

the crura. The lateral branches of the primary lamellae (pl. 6, fig. 2, *e*) are short and stout. They are triangular in shape, the apices of the triangles uniting to form the stem. It is at their point of union (*u*) that the jugum rests on the elevated median septum. Each lateral branch is braced by a thickened ridge on the inner surface, that extends the length of the branch and onto the primary lamella. These braces, if such they are, are less marked in the adult than in the younger specimens.

The stem (*t*) is variable but shows several constant features. In general it may be said to consist of a circular or elongate plate which is slightly concave toward the anterior margin of the shell, from beneath the upper edge of which (as oriented in the illustrations) an elongated plate projects which is sharply concave in the opposite direction. It is this latter plate that bifurcates to form the two accessory lamellae (*b, b*). The accessory lamellae originate at a considerable angle to the plane of the plate first mentioned, and make with each other an angle of between  $60^{\circ}$  and  $75^{\circ}$ . Each passes to the space between the primary lamella and the second whorl of the spiral ribbon lying between and parallel to them, as in *Athyris*, but reunites with the jugum at the base of the stem.

This description of the jugum, which indicates a more complicated structure than that found in either *Merista* or *Meristella*, has been given in the terms employed for those genera and for *Athyris*. In the two former, the lateral branches unite to form a short straight stem which in turn bifurcates to form the accessory lamellae. After describing more than half a circle these reunite with the stem at its base. Nothing has ever been described which suggests that the structure of the loop of the *Meristellinae* was any more complicated than this, but this is probably due to lack of well preserved material. While, in general, the jugum of *Camarophorella* is built on the same plan, the structures that occur within this general plan are far more complex than has been indicated above, and it is almost impossible to describe it as has been done above in the terms applied to the other genera. This complexity lies in that portion of the structure which is termed the stem. In order to present it properly it is necessary to describe its development in so far as it is known and to introduce at this point a brief discussion of the relation of the structures to corresponding structures in other spire-bearing forms.

In all general descriptions of the structures occurring in spire-

bearing brachiopods the types of jugum are considered in much the same manner as in the following extract from Hall and Clarke ('92, p. 203-205):

"The jugum does not end at the point of union of the two lateral jugal processes [or lateral branches], but is more or less continued, in its simplest form, into a short, straight stem, inclined backward and terminating in an acute angle (*Retzia*, *Rhynchospira*, *Whitfieldella*); in *Bifida* this stem is long and extends to the inner surface of the pedicle-valve where its extremity is inserted into a deep groove in the shell. In *Eumetria* and *Meristina* the extremity of the stem is bifurcate, but the terminal processes do not extend beyond the ends of the crura; while in *Athyris*, *Tetractinella* and *Amphitomella* they are continued backward between the primary and secondary lamellae for about one fourth of a revolution. In *Pexidella* the intercalary lamellae are still longer; in *Amphitomella*,<sup>1</sup> *Kayseria* and *Amphichina* they are continued for the entire length of the spiral cones thus making a double spiral on each side. In *Merista* and *Meristella* the divisions of the stem of the jugum, or intercalary lamellae, are short, recurving and joining the lateral processes near their union."

In this and similar descriptions, the stem is regarded as a continuation of the united jugal processes or lateral branches, and elsewhere the series of gradual stages which is illustrated by the genera named, is regarded by the same authors ('95, p. 345) as indicating in a general way the genetic line that has been followed in the production of such complicated juga as are seen in *Pexidella*, *Diplospirella*, *Kayseria*, etc. The jugum is believed to have been evolved step by step; first a simple  $\Delta$ -shaped bar between the primary lamellae, to the apex of which a simple stem was later added; in time the free end of this stem became slightly cleft, the two lamellae thus formed, lengthening and passing to the outside of the primary lamellae and recurving, more or less parallel to them. Two general lines of development were now followed: the lamellae formed from the split stem might unite with the base of the stem at or just above the apex of the  $\Delta$  as in the *Meristellinae*, or they might continue in their process of elongation parallel to the ribbons of the coil until a double spiral was formed on either side. Hall and Clarke suggest that the last described type may have been developed independently in three entirely separate lines of descent,

<sup>1</sup>The use of *Amphitomella* is probably an error overlooked in the preparation of the work.

each from a type in which the stem was simply bifurcated at the free end.

Nothing, to the writer's knowledge, has ever been produced to show the development of one of these juga from the earliest stages of an individual to the adult. The reason for this is, of course, the great difficulty of obtaining suitable material. If it could be shown that in the development of the individual, there is a series of metamorphoses more or less parallel to the supposed phylogenetic series outlined above, the evidence would be very strongly in favor of, and to some persons, proof of the approximate line of descent.

The Sciotoville material does not offer, as yet, by any means a complete series, but those stages that are at hand indicate a different method for the formation of the jugum, in ontogeny at least. The youngest individual in which the structure was studied is 8.5 millimeters in diameter and has five whorls in the spiral. It is readily seen that it is in a comparatively late stage of development. This specimen is shown in figure 51 (pl. 10), which is magnified eight diameters. The jugum is completely formed and shows very strikingly a feature that is persistent in all the adults, as far as can be observed, but is much less pronounced. This is the distinct saddle formed by the union of the lateral branches or jugal processes of the primary lamellae. It is very similar in form and position to the "saddle" of *Athyris* (pl. 6, fig. 1) but heavier and relatively reduced in size. Strong, brace-like ridges extend from the somewhat flattened posterior surface of this saddle onto the primary lamellae, but it is doubtful whether their function is solely to strengthen the structure. It is far more likely that they are developed in response to the  $\Delta$ -shaped apex necessitated by the habit of resting the jugum on the tip of the median dorsal septum and without which rigidity would be impossible.

The noteworthy fact is that the "stem," so called for convenience, is *not* a continuation of this saddle. Although in contact with its anterior surface, it is not in such intimate contact but that the suture between the two is most striking. The whole suggests that the jugum, as represented in this specimen, consists of two separate parts, the saddle and the remainder of the jugum, which has been laid upon it as a separately formed plate. That is, the portion referred to as the stem and the two accessory lamellae formed by its bifurcation, to and including their point of union with the base of the "stem," have not been formed by a gradual splitting of the stem, a recurving and reunit-

ing, but have probably been formed simultaneously by the spiculization of a particular area of the lophophore. In the smallest specimen seen, at least one third smaller than this one, the jugum was fully formed but was hopelessly broken in the attempt to reveal the posterior surface.

In the adults, the saddle is distinctly shown on the posterior surface (pl. 9, fig. 47; pl. 10, figs. 52, 54) but growth has rendered the suture much less conspicuous. There are four other specimens (all that I have) besides those figured that show this saddle just as distinctly. One of these is represented in figure 56 (pl. 10). It is very similar in its details to the one shown in figures 52 and 54 of the same plate. The two figured do not represent the largest stage as seen in figures 48 and 49 (pl. 9), the posterior surface of which has not been seen, but the structure occurs with little modification in others which are fully as large. In all the adults the brace-like ridges of the saddle are much less conspicuous than in the young.

Further, it will be noted that in the specimens figured the so called stem does not really bifurcate to form the lamellae, as usually described. The lamellae actually take their beginning on the posterior surface of this stem at the tip of the saddle, and from that point up to the point of separation they are well developed and each lies in exactly the same plane as the remainder of the lamella. Thus, instead of speaking of the point of bifurcation of the stem, it would be much better to refer to the point of separation of the lamellae. Each lamella, after completing the circle, returns to near the point of origin, the two arching over the saddle and uniting above it on its anterior surface. The inner edges can sometimes be traced directly to their point of origin, but not always. The outer edges, on the other hand, always end on the outer slopes of the saddle just above its continuation with the primary lamellae, even in the youngest specimens. They seem to fuse with the saddle and cannot be traced onto the anterior surface, where they would be expected to be continuous with each other, under the assumption that the lamellae are united above the saddle to form a distinct plate. This is not believed, however, to weigh heavily against the idea that the whole of the jugum except the saddle was formed simultaneously or nearly so. Two explanations are possible. After the first formation of the plate, conditions of deposition may have been so different on opposite surfaces of the jugum as to permit one to remain in nearly its original condition, the folds of the lopho-

phore maintaining their original contour, while the folds on the other side changed to such an extent during development that the original structure was either resorbed or covered over. Or, the folds of the lophophore at the initial period of spiculization may have been such as to cause the plate to be laid down in a form very like the ones observed, the outer margins of the lamellae being fused with the sides of the saddle from the earliest stages. To the writer, the latter seems to have been the more probable mode, in view of the fact that in the earliest known stages, including the smallest one just mentioned (which was broken), there is nothing to suggest that the former may be the correct explanation.

The last structure to be described in connection with the jugum is the plate-like expansion on the anterior surface between the saddle and the point of separation of the lamellae. It may be broadly expanded and more or less circular as in figure 45 (pl. 9). In this specimen it is nearly flat but slightly concave. Or, as in figures 48 and 49 (pl. 9), and 53 and 55 (pl. 10), it may be relatively narrower and much more concave. It is not certain that either is especially characteristic of certain stages of growth. It is always slightly wrinkled parallel to the edges. In all specimens sufficiently well preserved to admit of judgment, six in number, it has every appearance of an extra plate laid upon the jugum. At the ventral end (upper in drawings) it rests on the united secondary lamellae, the strongly convex surface of which is plainly visible for one fourth or one half the length of the plate. At the dorsal (lower) end the edges are distinctly fused to the outer surfaces of the secondary lamellae near their point of union with the saddle. Figures 52 and 55 (pl. 10), show the relation well. As viewed from the under or posterior surface, the line of contact between this plate and the lamellae at both its dorsal and its ventral ends is marked by a deep suture. Near the center of the plate, however, at the tip of the saddle it is more intimately united with the lamellae.

It is not certain whether this represents a period of spiculization in a portion of the lophophore subsequent to that by which the body of the jugum was formed and is, thus, really a secondary plate, or is due merely to certain peculiarities in the lophophore which have caused it to take the form of a separate plate. It is not seen in the young specimen shown in figure 51 (pl. 10), but only a small portion of the anterior surface of the jugum is here visible. Furthermore

the two lamellae at the tip of the saddle on the under surface are relatively much farther apart than in the adult for the width of the two is as great in proportion to the size of the jugum as is the entire width of this secondary plate in the adult. Thus, it is possible that it is present but concealed in the posterior view by the great breadth of the combined lamellae. It must be noted, further, that in the adult the width of the united lamellae is reduced — not only relatively but actually — just ventral to the tip of the saddle, until the connection is a very slender one indeed. Without the presence of this secondary plate the jugum would be an extremely fragile structure. The juga, of which the posterior sides are figured, are probably from adult individuals but they are not from the largest known. Figure 54 (pl. 10) belonged to a shell which had a length of about 16 or 18 millimeters. In two slightly larger juga in which this plate alone is preserved in a matrix, it is much more intimately fused to the lamellae and the sutures between the two are not nearly as distinct as in the figures. From this, it appears that this plate may be of later origin than the body of the jugum. Certainly it becomes much more important with the decrease in width of the united lamellae. Whether it originates in response to the resulting increasing demand for strength, or, again, is due to the shifting of the folds and fleshy parts of the lophophore with growth in that organ, is not evident.

There is considerable individual variation in the shape of the secondary lamellae just below their dorsal attachment. The simplest is shown in figures 45 and 47 (pl. 9) where the lamellae maintain their natural width throughout, up to the point of fusion with the saddle. This prevails also in the youngest specimen observed (pl. 10, fig. 51), although not shown in this drawing. In the specimen shown in figure 55 (pl. 10), the lamellae are considerably narrowed below the point of union, as if the margin toward the dorsal surface had had a portion cut out of it leaving the present margin a re-entrant arc of a circle. A blunt angle is thus formed on the outer edge of the lamella. In the specimen shown in figures 48 and 49 (pl. 9), the re-entrant is not in the form of the arc of a circle but is a sharp angle, the apex of which falls just below the point of union with the saddle, leaving a small tooth between it and the point of union. The outer edge of the lamella is somewhat prolonged into an acutely pointed lobe. This portion of the lamellae and the plate on the anterior surface are the only jugal structures which vary to any degree.

The outer margins of the lamellae of the jugum are fimbriated,

sometimes remarkably. The fimbriae are usually most abundant and longest near the ventral end, especially about the point of separation of the lamellae. This is somewhat in contrast to the fimbriae of the lamellae of the cones which are always best developed toward the opening of the valves. In further contrast, the fimbriae occurring on the large lamellae of the cones are always situated on the side of the ribbon toward the *base* of the cone. On the lamellae of the jugum they are located on the opposite sides of the ribbon, the ones directed toward the *apices* of the cones. As in the larger lamellae they are situated marginally or submarginally and are always directed outward. Rarely a spine or two occurs on the margin of the anterior plate of the jugum, also directed outward (pl. 9, fig. 45).

*Inner surface of the valves.*—The inner surfaces of the valves are marked by radiating furrow-like vascular sinuses which usually appear on the molds as more or less distinct ridges. They do not appear as the usual, very delicate vascular impressions except in one specimen, (pl. 8, fig. 33), on the anterior half of which, each sinus is represented by a very delicate double ridge in the mold, and several of them can be traced into the more pronounced ridges on the posterior half, which are more typical of this genus. In most cases the ridges extend from the region of the beaks to the anterior periphery, sometimes becoming indistinct as they approach the margins. They are often intermittent; the crest (in the mold) is sometimes divided by a small median furrow, and they rarely bifurcate. Figures 21 and 28 (pl. 8) show the usual method of occurrence. The vascular sinuses can be traced into the beaks and under the platforms of both valves where they gradually disappear without any indication that they were connected with a central canal.

In the one specimen referred to above which differs from this, the method of occurrence of the sinuses on the anterior half is not only unusual for this species, but is anomalous in the class Brachiopoda, in that they bifurcate freely and *reunite* with each other, forming a network of sinuses. It appears from an examination of published drawings of brachiopods that in those types in which the canals branch freely, one may occasionally unite with another, but such a network as is here found is elsewhere unknown to the writer.

In addition, the inner surface of both valves is usually covered with small sharp pits which give the mold a pustulose appearance.

## GENERIC AND SPECIFIC DESCRIPTIONS.

Genus **Camarophorella** Hall and Clarke (emended).<sup>1</sup>

1894. *Camarophorella* Hall and Clarke, Thirteenth ann. rept. state geol. [of New York], p. 838.

1895. *Camarophorella* Hall and Clarke, Geol. surv. New York, palaeontology, vol. 8, pt. 2, p. 215.

Shell transversely elliptical to elongate-elliptical or ovate; broadest near the middle or above or below it; both valves about equally convex; beak of pedicle valve moderately incurved, not enclosing that of brachial valve; pedicle opening moderately large, terminal. Fold and sinus present or absent, never showing more than a moderate development.

Pedicle valve with a spondylium formed by the coalescence ventrally of the dental lamellae, and supported throughout most or, usually, all of its length by a median septum which is slightly longer than the spondylium and about half as long as the valve; all muscles of the pedicle and all of the ventral attachments inserted on this platform; edges of the spondylium thickened and set into deep sockets in the brachial valve on either side of the hinge plate.

Brachial valve with a high, triangular, median septum extending one half the length of the valve and supporting posteriorly a strong, deeply concave hinge plate; a platform takes its origin beneath the hinge plate and extends the length of the septum, being penetrated by and attached to it. On either side of this septum the platform is bent toward the valve and attached to its inner surface, forming a cavity between it and the valve. To it were attached the adductor

<sup>1</sup> Comparison of the emended with the original description will reveal an apparent contradiction in the description of the spondylium. This is due to the lax usage of the term *spondylium* by Hall and Clarke, although they proposed to restrict it definitely to the muscular platform of the pedicle valve (Hall and Clarke, '95, p. 332). Under *Camarophoria* the authors describe "in the pedicle-valve . . . a moderately large spondylium which, in the umbonal region, rests upon the bottom of the valve, but anteriorly is supported by a median septum" (p. 212). On the following page reference is made to "the brachial spondylium of *Camarophorella*." Thus, two structures, one in each valve, are called by the same name in reference to such a structure: "At the same time its internal characters are normal for *Camarophoria*, except that the broad, spatuliform spondylium rests upon the valve for most of its length, the median septum penetrating it and projecting above it into the interior cavity of the shell." There is nothing to indicate which valve is here referred to but doubtless it is the brachial platform which is described. In the present paper the term spondylium is limited to the structure occurring in the pedicle valve.

muscles. The crura are a continuation of the hinge plate and are inserted on its side near the anterior margin. They are long and slightly curved. The primary lamellae converge dorsally, diverge anteriorly, converge ventrally, and diverge posteriorly as in *Meristella*. There are from eight to ten whorls of the spiral ribbon to each cone. The jugum is placed on the primary lamellae at about one third their length from the crura and rests on the high median septum of the brachial valve. It appears to consist of a curved saddle between the two lamellae, in shape not unlike the saddle of *Athyris* but much smaller, on which the remainder of the jugum has been laid down as a single plate or possibly by two separate periods of spiculization. The lamellae of the jugum are placed at a sharp angle to each other, the outer portions lying just without and parallel to the primary lamellae. They recurve and are attached to the jugum near its base.

Surface, as far as known, marked by fine concentric and radiating striae.

*Distribution*.—From the Kinderhook at Burlington, Iowa, and in a mixed Osage-Kinderhook fauna in the Waverly at Sciotoville, Ohio.

In 1870, Professor Alexander Winchell ('70, p. 254) described a species from Sciotoville, Ohio, under the name *Centronella ? flora*, but, as previously stated, he clearly had before him two different species, one of which was the form now under discussion. The material was loaned to him by Professor E. B. Andrews and was collected from the same bed from which the present material was obtained. The writer has an intimate acquaintance with the fauna of this bed and there are only two species out of some seventy-five found therein to which the characters named in the following description can be applied, both common forms, *Cranaena subelliptica* Hall and Clarke (described originally as *Cryptonella*) and the *Camarophorella* described herein. Following are Winchell's description and remarks in full:

"Shell broadly ovate, rather rectilinear along the cardinal slopes, broadly and slightly sinuate, or not, along the ventral commissure; general form of each valve a segment of a sphere. Surface of shell very finely and sharply striate both longitudinally and concentrically.

"Length, fifteen-sixteenths of an inch; breadth, fourteen-sixteenths; thickness of both valves seven-sixteenths.

"This species is broader and less rostrate than *C. Allei*, Win. (Proc.

A. N. S., Phil., July 1865, p. 123) and also less tumid around the margins, besides being much more distinctly striate.

“Though I am not positive of the general relations of this species, it appears to be congeneric with *C. Allei*. These species are both ornamented with beautiful terebratuloid punctations, and both exhibit the elongated ribbon-like muscular markings on the ventral valve which also characterize the well-determined species *C. Julia*. In one of the specimens referred (provisionally) to *C? Flora*, there is a low, but elongated median septum in the dorsal valve, from which, near the beak, proceeds, on each side, a thin horizontal, longitudinal plate, reaching half the length of the septum. In the ventral valve, the dental lamellae are feebly developed, and, instead of reaching the inner surface of the valve, they curve toward the median line and join each other, leaving a small space between the transverse septum thus formed and the surface of the valve — being thus a kind of *shoe-lifter septum inverted*,— or, more strictly, a trough-like plate, as in *Camarophoria*, but not, like that, supported by a median vertical plate. It is worthy of consideration whether these distinctive characters are not of generic importance. The structure noticed in this specimen connects *Pentamerus* with *Terebratula*, as *Camarophoria* connects *Pentamerus* with *Rhynchonella*. I reserve the subject for further study.

“From bed No. 4, Sciotoville, Ohio.”

Of the characters mentioned in Winchell's formal description, every one, except that of the surface of the shell, refers to *Cranaena subelliptica*. The latter is not longitudinally striate but *Camarophorella* is. The dimensions are those of the *Cranaena* which is invariably longer than broad in about the proportions named. This is rarely true of *Camarophorella* which is almost always broader than long (see measurements given above on page 39). *Cranaena* is punctate and possesses the “elongated ribbon-like muscular markings on the ventral valve” mentioned in his additional notes. *Camarophorella* is not punctate and the muscles are inserted on platforms, none of them being attached directly to the inner surface of the valve. On the other hand, the internal structures described as occurring “in one of the specimens referred (*provisionally*<sup>1</sup>) to *C? Flora*” are, without any possible doubt those found in *Camarophorella*. With the exception of the structures occurring in this last mentioned specimen and the radiating striae on the surface, the description through-

<sup>1</sup> Italics are the present writer's.

out is that of *Cranaena subelliptica*; no other species occurs in the bed where it is found to which it will apply.

From the foregoing it appeared to the writer that Winchell's description was based on two species and that the one to which his description applies mostly is the one to which Hall and Clarke in 1895 applied the name *Cryptonella subelliptica*. In this state the question was submitted to Dr. George H. Girty of the United States geological survey, to whom the writer is indebted for the following final word regarding the type of the species under date of February 25, 1908: "The type of *Cranaena flora* appears to be at Alma, Michigan, and while studying the Winchell collection I made the following note:

"Note on *Centronella* (?) *flora* Winchell.

"This is the form which I have identified as *Cranaena subelliptica*. Winchell, however, included two widely different forms in this species, a *Cranaena* and a *Camarophorella*, though he himself became suspicious of this fact since on the figures which he had prepared, those of the *Cranaena* are labeled 'types' and those of the *Camarophorella* are labeled 'uninvestigated.' Both forms enter into the description, the surface ornamentation and the structure being described from the *Camarophorella*.

"As a matter of synonymy I think you will have to consider the terebratuloid as the type of *C. flora* — all the more since Winchell in his description indicated a similar doubt of the *Camarophorella* and a similar choice of the terebratuloid for the type of the species. Thus, *C. subelliptica* becomes a synonym for *C. flora* (pars) and the *Camarophorella* becomes a new species unless it has been previously described."

In the same communication, Dr. Girty kindly enclosed for comparison, a sheet of manuscript written by himself some years ago, but never published, in which the same conclusion was reached regarding the generic position of *Camarophorella* as that herein proposed. It was based on material of the same species from the same locality as that described in the present paper, but not as nearly complete.

The restriction of Winchell's name to the species later described by Hall and Clarke leaves the Sciotoville *Camarophorella* unprovided for. Accordingly a new specific name is here proposed with a summary of the characters of specific importance.

*Camarophorella mutabilis* n. sp.

1870. *Centronella* ? *flora* A. Winchell, in part, Proc. Amer. phil. soc., vol. 11, p. 254.

*Type* and figured specimens in collection of Eber and J. E. Hyde, Lancaster, Ohio, from near the middle of the Waverly series, associated with a mixed Osage-Kinderhook fauna, Sciotoville, Ohio.

Shells very variable, meristelloid in shape and moderately thick. Beak of pedicle valve moderately incurved, not enclosing that of brachial valve nor concealing the triangular deltidial plates. Outline transversely elliptical or subcircular, rarely elongate-elliptical or ovate, being usually broader than high; in old specimens sometimes subpentagonal; greatest breadth near the middle of the brachial valve, sometimes distinctly above or below. Fold and sinus present in all except very immature forms, often represented in the young specimens by a slight flexure on the anterior margin, always distinct in the adult but never showing more than a moderate development even in old specimens. In adults, fold not noticeable on posterior half or two thirds of shell, sinus often more distinct at an earlier stage but very shallow. In all specimens showing the exterior, both fold and sinus marked by a slightly depressed furrow extending down the middle of the valves from the beak to the anterior margin, a feature which is present from a very early stage.

Surface somewhat irregularly marked by fine concentric striae and occasional slight wrinkles of growth, crossed by very fine radiating striae, eight or ten of which occupy the space of one millimeter; radiating striae sharply rounded, the flat furrows between being considerably broader than the ridges. Inner surface of both valves marked by radiating furrows of greater or less strength, the impressions of vascular sinuses of the mantle, and fine pittings.

Muscular platforms and septa not essentially different from those seen in *Camarophorella lenticularis*, as far as the latter is known.

As the characters of specific value of the brachidium of *C. mutabilis* are unknown, it is not necessary to repeat its description.

It seems well to insert the original description of *Camarophorella lenticularis* at this point in order to bring all that is known of the genus into the present paper and the better to facilitate comparison.

**Camarophorella lenticularis** (White and Whitfield).

1862. *Pentamerus lenticularis* White and Whitfield, Proc. Boston soc. nat. hist., vol. 8, p. 295. "Chemung group," Burlington, Iowa.

1865. *Pentamerus lenticularis* Winchell, Proc. acad. nat. sci. Phila., p. 117. Yellow sandstone and base of Burlington limestone, Burlington, Iowa.

1894. *Camarophorella lenticularis* Hall and Clarke, Thirteenth ann. rept. state geol. [of New York], pl. 45, figs. 5, 6. Yellow sandstone of the Burlington group, Burlington, Iowa.

1895. *Camarophorella lenticularis* Hall and Clarke, Geol. surv. New York, palaeontology, vol. 8, pt. 2, pl. 62, fig. 46-48. Yellow sandstone of the Burlington group, Burlington, Iowa.

1901. *Camarophorella lenticularis* Weller, Trans. acad. sci. St. Louis, vol. 11, no. 9, p. 162, pl. 14, fig. 11-13. Kinderhook, Burlington, Iowa.

"Shell small, broadly ovate, or subcircular; length and breadth nearly equal, profile lentiform. Valves subequal, depressed convex. Beaks small, pointed, slightly incurved, sides and front regularly rounded. Ventral valve a little the most convex; the beak pointed, and projecting beyond that of the dorsal. Spoon-shaped process of the interior of the ventral valve proportionally large, in some specimens nearly one-third the width of the shell, and extending about one-third the length of the valve; longitudinal septum reaching to near the center of the shell. Interior of dorsal valve with a single longitudinal septum, with horizontal plates curving toward the cavity of the opposite valve. Strong radiating muscular or vascular markings appear on internal casts of both valves.

"Surface apparently smooth, without mesial fold or sinus.

"This species has the general form of *P. oblongus* as it occurs in the Clinton group of New York, but is quite small, seldom measuring more than six-tenths of an inch in length. The internal characters of the ventral valve are precisely those of *Pentamerus*, but those of the dorsal valve vary somewhat from those of most species of the genus, in having but one longitudinal septum, with the crural appendages spreading horizontally from it."

The writer has been able to compare the type specimens of *C. lenticularis* with the Sciotoville species. The former is the smaller of the two as will be seen by comparing the following measurements of the internal molds with those of *C. mutabilis*:

Height.	Breadth.
14.3 mm.	16.0 mm.
12.3	11.7
9.5	10.5

The thickness is not readily obtainable as the specimens are mostly preserved as molds of single valves, but it is proportionally much the same as in *C. mutabilis*. From the small number studied, and from the figures given by Hall and Clarke and by Weller, it is evident that *C. lenticularis* is almost, if not quite, as variable in its dimensions. In fact the two species are closely related, the only marked difference being in the smaller size, lentiform shape, and almost total absence of fold and sinus in *C. lenticularis*; it resembles very closely, and, possibly, if there were a large suite of specimens, would be found to be almost if not quite identical in shape with the immature specimens of *mutabilis*. There is one of the type specimens of *lenticularis*, a brachial valve, which shows distinctly a faint flexure on the anterior margin, clearly a trace of the fold and sinus although it is so slight as not to be noticeable on the body of the shell. The muscular platforms are practically the same in both species. In the spondylium of the pedicle valve the impression of the adductor is distinctly shown in one specimen. Its position is the same as in *mutabilis* but it is relatively broader. Considerable variation occurs in the height of the brachial platform above the inner surface of the valve.

#### RELATIONSHIP OF THE GENUS.

The one structure that characterizes the subfamily Meristellinae is that "the jugal bifurcations do not enter the spiralia but recurve and join near their origin." Schuchert ('97, p. 129) assigns to it seven genera, the position of two of which, *Pentagonia* and *Camarospira*, is doubtful, as the nature of the jugum is not fully known. Both are middle Devonian forms. Of the remaining five, one, *Dioristella*, is Triassic, the others are Middle Devonian or lower.<sup>1</sup> In seeking for genera which are most nearly related to *Camarophorella*, two more are eliminated by the absence of muscular platforms in either valve, *Meristella* and *Charionella*. Two remain, *Merista* and *Dicamara*, to which *Camarospira* must be added, although the structure of its jugum is unknown.

The jugum is as yet apparently of no value in seeking a relationship. In the genera named above, when it is known, it is not in any such

<sup>1</sup> The *Meristella incerta* of Simpson from the Waverly at Warren, Pa., is probably an *Athyris*, although his description will not permit generic identification. There is a species of *Athyris* found at that locality which agrees very well with his description as far as it goes.

detail as in *Camarophorella* and no comparison is possible. Further, the jugum of *Camarophorella* differs more from those of the others than they do among themselves. In *Merista*, *Meristella*, and *Dioristella*, which are the only ones figured, the branches of the primary lamellae that "unite to form the stem" are much longer than in *Camarophorella*. The lamellae of the jugum are smaller and do not enter the space between the primary and secondary lamellae of the spiralia as in *Camarophorella*. These two differences alone serve to render the two types profoundly different in aspect.

*Camarospira* is the only genus in the subfamily that possesses a spondylium in the brachial valve similar to that of *Camarophorella*. However, Hall and Clarke ('95, p. 82) state that the pedicle muscles only are attached to this platform, the adductors and diductors being attached directly to the shell in both valves. There is a median septum in the brachial valve. The difference in the muscular attachment renders further comparison useless.

*Merista*, the known forms of which are confined to the lower Devonian in this country but are found also in the Upper Silurian (Wenlock) of Europe, is characterized by a spondylium or "shoe-lifter" in the pedicle valve and a median septum in the brachial valve. The spondylium is of an unusual type (pl. 10, fig. 57-59, after Hall and Clarke). "Between the dental plates is an arched free plate (the 'shoe-lifter' process) attached by its posterior and lateral margins, but at its anterior margin extending beyond the dental lamellae and rising in a low broad curve. . . . The muscular area appears to be limited to the space between the dental lamellae and to the surface of the 'shoe-lifter'" (Hall and Clarke, '95, p. 70). There is no median septum supporting this platform.

A few Middle Devonian forms in Europe, possessing this structure and formerly included under *Merista*, were found by Hall and Clarke ('95, p. 72) to "possess a 'shoe-lifter' quite as conspicuously developed in the brachial as in the pedicle valve, while the cavity beneath it is divided into two compartments by the median septum which extends beyond the anterior edge of the platform thus formed." To these the name *Dicamara* was given. This structure which is much the same as that seen in the brachial valve of *Camarophorella*, is shown in figure 60 (pl. 10), after Hall and Clarke.

*Dicamara* with its brachial platform, thus approaches more closely to *Camarophorella* than any other known form, but on first considera-

tion it seems difficult to harmonize the widely different types of spondylium in the pedicle valve. The "shoe-lifter" of *Merista typa* (pl. 10, fig. 57-59), however, suggests a method by which the spondylium of *Camarophorella* might have been evolved. But first it is necessary to describe a minor feature of the spondylium of *Camarophorella* which has been referred to briefly. In the detailed description of *C. mutabilis*, reference was made to two accessory plates in the beak of the pedicle valve, one on each side of the spondylium, connecting the outer surface of the spondylium with the inner surface of the valve. In the molds they are seen as clefts on either side of the pedicle opening and anterior to it. In young shells the plate is well developed and is located about halfway between the hinge and the ventral surface of the mold, so placed that they are not visible in a dorsal view of the shell. With growth, this plate is gradually pushed around close to the hinge line and in some cases is resorbed to a considerable extent, so that in the adult it is readily visible from the dorsal surface and in some cases invisible from the side, quite the contrary of the younger stages. Not infrequently it becomes so reduced that the filling of the cavity between it and the dorsal edge of the spondylium is reduced to the merest spine (pl. 6, fig. 5-12). Apparently the plates are functionless. They have no value in the majority of cases as a strengthening brace in the adult, and there is no apparent need for such a brace in the young.

The "shoe-lifter" of *Merista typa* from the Helderbergian of Maryland is extremely variable. In figure 58 (pl. 10), is shown a specimen which is believed to represent, in a general way, one of the stages in evolution which has resulted in the spondylium of *Camarophorella*. The broad curved plate of the structure is reduced and the dental lamellae occupy much the same position as in *Camarophorella*. If the reduction of the arched plate were carried further and the dental lamellae increased and continued to the bottom of the valve as a median septum, so that they took up the entire muscle strain, a structure very similar to that seen in the young of *Camarophorella* would result. The accessory plates shown in figures 42 and 43, *h* (pl. 8), are better developed than usual and show very well what a late stage in such a line of development would be like. This explains the apparently useless accessory plates of *Camarophorella* as a vestigial remnant of the broad arched plate of *Merista* and *Dicamara*, and makes possible the suggestion that *Camarophorella* was developed from a *Dicamara*-

like form, as *Dicamara* is the only other genus of the subfamily known to have a brachial platform. It should be noted that in the youngest specimens of *Camarophorella* observed, the dental lamellae are always united and continued to the surface of the valve as a median septum much as in the adult, so that there is no known true Meristiform stage.

Whether or not *Camarophorella* has been evolved along some such line as that just indicated, if the type of jugum is considered as proof of a genetic relationship to *Merista*, *Meristella*, and *Dicamara*, it must be considered a more highly specialized form in which there has existed between the position of the jugum, the musculature, and the platforms a much more delicate adjustment than was possible in the earlier types. In them the lateral branches of the primary lamellae were much longer and were set on the lamellae at fully half their length from the crura, the lateral branches were as long as the stem, and the lamellae of the jugum did not enter the space between the primary and secondary lamellae of the spiralia. The jugum lay wholly in the open space within the bases of the cones, and its construction is best described as straggly. Compare with this the compact jugum of *Camarophorella*, its short, stubby, lateral branches placed closer to the crura on the primary lamellae, its long "stem" (using this unsuitable but convenient term) extending obliquely to the ribbons on the opposite side of the cone, the lamellae of the jugum passing at once to the space between the primary and secondary lamellae of the spiralia where they continue practically to their point of reunion with the stem; the whole presenting a compact structure, suggesting that it is much more an intimate part of the brachidium than is the corresponding structure in the earlier forms.

Figure 14 (pl. 7), is a semidiagrammatic attempt to show the arrangement of the platforms and muscles in relation to the jugum. The outline of the shell, the spondylium in the pedicle valve and its adductor muscle scar, the hinge plate, and crus are correctly drawn from a single specimen. To these have been added the brachial platform and median septum, the jugum, and the spiral arm. Although the attachment of the adductor to the brachial platform is represented as extending the length of the median septum, it must be remembered that the dorsal convergence of the primary lamellae which hang very close to the platform, and the angle which the accessory lamellae of the jugum make with each other (between  $60^{\circ}$  and  $75^{\circ}$ ), force the greater portion of the area of attachment of the adductors into the posterior

half of the shaded portion as it is represented in the diagram. This is seen further in the wedge-shaped anterior end of the platform. The greater part of the attachment of the adductor is nearer the beaks than is usual for Meristelliform genera. When it is now recalled that the actual hinge point is at the base of the crura, it is seen that, if the adductor muscles were continued beyond the platforms and attached directly to the valve, the point of hinging would fall almost directly in the line of pull. Attached as they are to the platforms, a considerable mechanical advantage is secured.

It is not intended to imply that the muscles occupy their present position as a direct result of the posterior position of the jugum and that the platforms are an adaptive response to the new mechanical requirements. Such an explanation would apparently involve a long period of accumulation of slight changes, in themselves of little value.

The platforms of *Camarophorella* are so fragile that it is impossible to imagine that they have ever been called on to withstand any considerable strain. Moreover, the muscle scars themselves are so light that the boundaries of some have not been determined. This, together with the relatively small size of the areas of implantation and the closely interlocked hinge, leads to the belief that the musculature was below the average — certainly in bulk it was — and that there was small demand for the formation of platforms in order to protect certain of the visceral organs lying beneath them, as has been assumed to explain similar platforms in other genera. This does not mean to imply that in ancestral forms they were not developed originally for that purpose.

It seems probable that the condition found in *Camarophorella* is the result of a closer integration of previously existing parts, that the shifting of the jugum into the posterior part of the brachidium and the concentration of the muscles posteriorly have proceeded together, rather than that one has been the cause of the other; it seems, further, that both have been made possible by the previous existence of the platforms which have permitted the muscles to assume a position nearer the beaks than would have been mechanically possible otherwise.

The relationship of *Camarophorella* to the subfamily Meristellinae, as just outlined, appears to be approximately correct. The peculiar type of jugum, the muscle platforms, and the general shape of the shell all bear it out. Nevertheless, the study of the jugum has sug-

gested the possibility that these structures are only analogous and that the superficial similarity of the jugum in the several genera in which this type occurs, is not, as ordinarily considered, an indication of genetic relationship. It is true there is little to support such an idea, but it is thought best to make mention of it. The structure of the jugum of *Camarophorella*, a simple  $\Omega$ - or  $\Lambda$ -shaped saddle between the primary lamellae, on which the remainder of the jugum is laid down as a single plate, evidently simultaneously throughout and not by a process of growth, is apparently so different from the simpler juga described for *Merista* and *Meristella*, that the resemblance may be superficial only. The apparent differences may be due, quite possibly, to the more or less unsatisfactory material from which these structures have heretofore been worked out, as a result of which all the finer points have been missed, but it has served to suggest that we may have in this and possibly in other types of jugum, an example similar to that of the modern *Magellania*-like loop, the adult form of which is produced in several genera in different lines of development. That is, that the structure of the adult lophophore has been such as to demand a certain type of jugum and this has been developed in forms not nearly related, and that while the general shape of the adult structures might be the same, they might have been developed each through a different series of metamorphoses as in the modern *Terebratelloids*. As has been mentioned, Hall and Clarke have suggested such a dissimilar origin for the several genera with double-spiraled spiralia.

In view of the little that is really known of the juga of *Merista* and *Meristella*, this can be taken as nothing more than a suggestion and the platforms found in the various genera of the subfamily indicate rather, that we should expect in the jugum of the earlier forms more detail than has yet been found.

The question may well be raised: In how far do the facts known of the jugum of *Camarophorella* bear on the other types of jugum? It is not proposed to enter into such a discussion here, but it may be added that the jugum of *Athyris lamellosa* has been obtained from the same beds as the material herein described, preserved in exactly the same manner. It is very similar to the one figured on plate 6, and offers little suggestion as to its origin. The saddle is relatively better developed than in this figure and the stem is placed on its surface, just anterior to the posterior end, not quite terminally. It does

not suggest a growth from, but rather a piece since inserted onto the surface of the saddle. It can only be cited as certainly not against the idea that this portion of the jugum is separate in origin from the saddle.

#### SUMMARY.

The subgenus *Camarophorella* was founded by Hall and Clarke in 1894 on a single species from the Kinderhook at Burlington, Iowa, *Pentamerus lenticularis* of White and Whitfield. Hall and Clarke associated it with the genus *Camarophoria* in the family Pentameridae, the species of which have no brachial support other than the crura.

Excellent material of a hitherto undescribed species of the same genus, *C. mutabilis*, from the Waverly at Sciotoville, Ohio, shows the incorrectness of the former assignment of the subgenus and is sufficient to elevate it to the rank of a genus in the subfamily Meristellinae.

The jugum and its method of formation have not before been described in detail because material sufficiently well preserved, has not been obtained. It appears to consist of a  $\Omega$ - or  $\Delta$ -shaped saddle between the primary lamellae on which the remainder of the jugum has been formed as a single plate by a process of spiculization apparently simultaneous throughout, or possibly by two such periods, rather than by a gradual growth of the arms of the structure. The resulting jugum is similar in plan to that of *Merista* and *Meristella*, although differing in many details.

The generic characters are re-drawn, the new species, *C. mutabilis*, is described, and the description of *C. lenticularis* is introduced for comparison.

The probable relationship of *Camarophorella* to earlier genera is considered and a method is indicated by which it could readily have been derived from forms like *Merista* and *Dieamara*. Although this method is perfectly feasible and there is considerable evidence for it, it is nevertheless largely conjectural. The genus is more specialized than its supposed ancestors in that the jugum and musculature are compacted more closely into the posterior portion of the shell and exhibit a closer integration of parts than is found in the earlier genera.

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*Printed September, 1908.*

EXPLANATION OF PLATES.

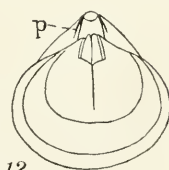
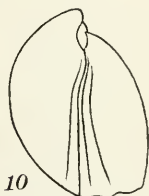
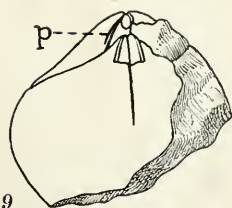
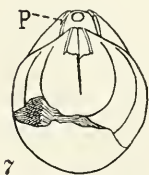
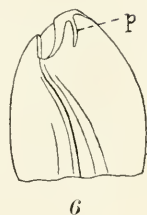
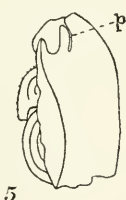
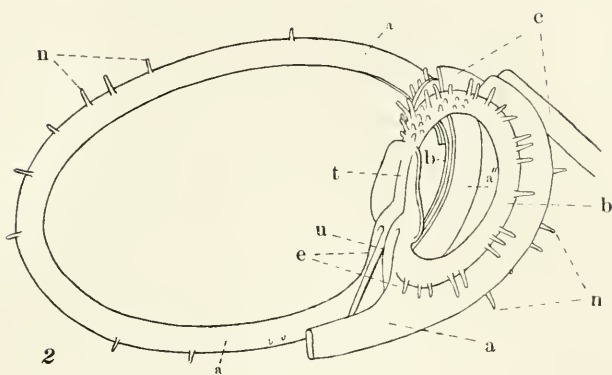
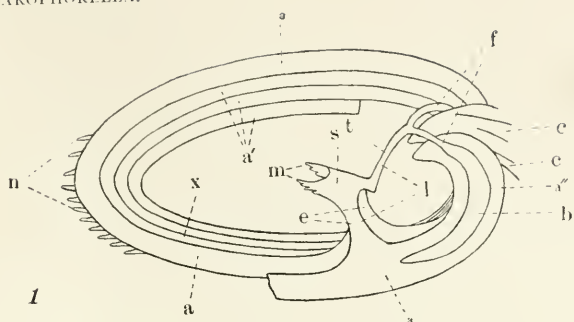
PLATE 6.

Athyris.

- Fig. 1. Diagram of the structure of the brachidium in *Athyris*. After Hall and Clarke, '95, p. 86. *a*, primary lamellae of spiral coil; *a'*, secondary lamellae; *a''*, umbonal blades; *b*, accessory lamellae; *c*, crura; *e*, lateral branches of loop; *f*, arms of loop; *l*, loop; *m*, fimbriated extension of saddle; *n*, fimbriae on outer margin of lamellae; *s*, saddle; *t*, stem of loop; *x*, spiral coil.

*Camarophorella mutabilis*.

- Fig. 2. Structure of brachidium in *Camarophorella*; lettering as in figure 1, and in addition: *u*,  $\Delta$ -shaped notch, the apex of which rests on the median septum of the brachial valve.
- Fig. 3. Supposed method of attachment of the primary lamella to the crus, the edge of the ribbon resting in the grooved anterior surface of the flattened crus. Viewed from side.
- Fig. 4. Inner surface of the end of the primary lamellae at the point of its attachment to the crura, showing the unfractured edge but slightly recurved tip.
- Fig. 5. Lateral view of an internal mold of a young specimen showing position and size of the plate between the inner surface of valve and spondylium at this stage, *p*. This is the specimen illustrated in figure 51 (pl. 10).  $\times 4$ .
- Fig. 6. Similar view of another specimen.  $\times 4$ .
- Figs. 7, 8. Brachial and lateral views of a small specimen showing the reduction in size of this plate and its relative movement toward the hinge line, *p*. The position is such that it is not visible in the lateral view. This figure illustrates also a specimen of the elongate type. Natural size.
- Figs. 9, 10. Two views of a large specimen showing extreme reduction of the plate between the spondylium and inner surface of the valve, *p*. Natural size.
- Figs. 11, 12. Two views of a specimen showing reduction and movement of plate *p*, but not to such an extent as in figures 7 and 8. These two specimens represent the extremes of the elongate and the transverse types. Natural size.



JEH.

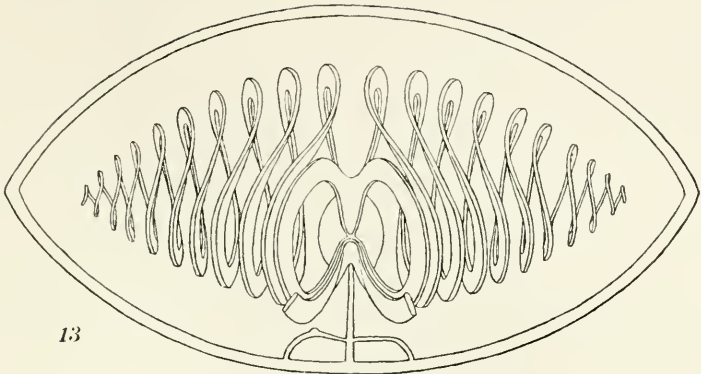




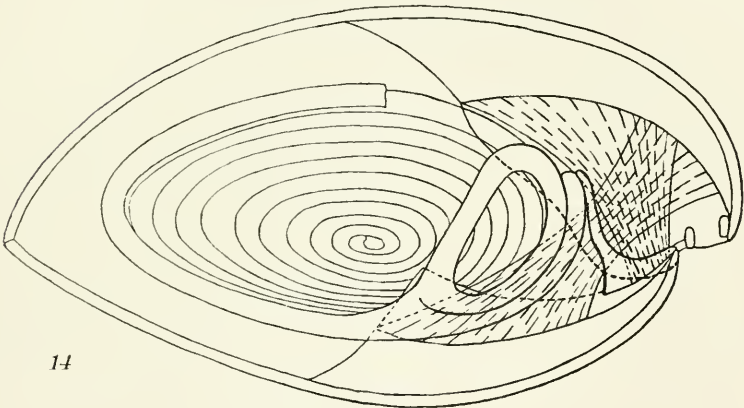
PLATE 7.

*Camarophorella mutabilis*.

- Fig. 13. Brachidium from the posterior end of the shell, showing the jugum resting on the median septum of the brachial valve and the brachial platform in transverse section. The primary lamellae, seen on either side of the median septum, are not continued to their point of attachment to the crura. Semidiagrammatic from the same individual from which figures 37 and 38 (pl. 8), were drawn.  $\times$  about 4.
- Fig. 14. Longitudinal section showing relation of platforms and musculature to jugum. The outline of the shell, spondylium, adductor muscle scar in spondylium, hinge plate, and crus are drawn from a single specimen.  $\times$  5.
- Figs. 15, 16. Outlines of spondylium based largely on the one illustrated in figures 42 and 43 (pl. 8), showing muscle scars as far as known. The outline of the median tongue-shaped adductor muscle is always readily discernible. An indistinct subelliptical impression near the base of the crura is interpreted as the point of attachment of one of the pedicle muscles.
- Fig. 17. Outline of brachial platform and hinge plate showing area of impression of adductor muscles.



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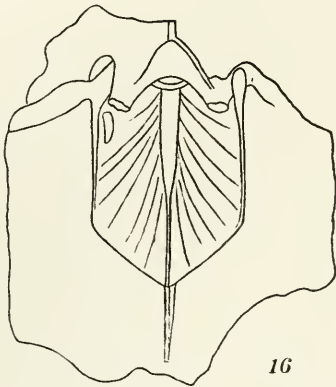
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PLATE 8.

*Camarophorella mutabilis.*

- Figs. 18, 19, 20, 22. Brachial, pedicle, lateral, and anterior views respectively of a moderate-sized specimen thicker than usual, in which a considerable portion of the original shell is preserved, showing the inconspicuous fold and sinus, the depressed furrow extending the length of both valves, and small areas of the internal mold showing the vascular sinuses and pitted surface. Note the slight asymmetry of the depressed median furrow. The pedicle opening is poorly shown and the beak is more incurved than usual. Natural size.
- Figs. 21, 24, 25. Brachial, lateral, and anterior views respectively of a moderately large internal mold of normal thickness selected as the type of the species, showing slight fold and sinus, lenticular shape, and radiating vascular sinuses extending to the anterior margin of the shell. In figure 21 the position of the median septum of the brachial valve is shown and the filling of the cavity between the shell and the brachial platform is partly broken away exposing the platform, *c*, divided into two parts by the septum. Immediately posterior to this platform is seen the mold of the hinge plate, *b*, and just behind it the filling of the spondylium of the pedicle valve, *a*. Natural size.
- Figs. 23, 28. Brachial and anterior views of an internal mold of a large, asymmetrical specimen, showing the subpentagonal outline and more pronounced fold and sinus which are usually found in older individuals, also the radiating vascular sinuses. Natural size.
- Figs. 26, 27. Brachial and lateral views of a gutta-percha cast taken from a mold of the exterior of a moderate-sized specimen, showing the slightly incurved beak, terminal pedicle opening, and deltidial plates, very slight fold and median depressed furrow. Natural size.
- Figs. 29, 30. Pedicle and anterior views of a gutta-percha cast taken from a mold of the exterior. This is the smallest specimen seen and shows the absence of both fold and sinus but distinctly the presence of the median furrows which appear at a very early stage. Natural size.
- Figs. 31, 32. Brachial and anterior views of an internal mold of a larger specimen showing the absence of fold and sinus and the presence of the median furrows. The brachial platform is exposed by the breaking away of the filling between it and the shell, also the spondylium. Natural size.
- Fig. 33. Brachial view of the mold of a moderately large specimen, on the

anterior surface of which are preserved the vascular markings which by branching and uniting form a network that is unique among brachiopods. To the right of the median septum, two of these markings are seen passing into the ridges which occur typically on the mold, the impressions of the vascular sinuses. The impression of the brachial platform, hinge plate, the filling of the spondylium, and pedicle opening are also shown. Natural size.

*Camarophorella lenticularis.*

- Fig. 34. Brachial view of one of the type specimens in the American museum of natural history, New York City. Introduced to show the identity of structure in the platforms. The filling beneath the platform of the brachial valve is broken away exposing it; the hinge plate and filling of the spondylium are also shown. Kinderhook beds, Burlington, Iowa.  $\times 2$ .

*Camarophorella mutabilis.*

- Fig. 35. Lateral view of a specimen showing the median septum and spondylium of the pedicle valve. Natural size.
- Fig. 36. View of a portion of the surface enlarged.  $\times 10$ .
- Figs. 37, 38. Two views of the interior of the pedicle valve showing the spondylium and median septum. In figure 37 the position of the pedicle opening is indicated and the median narrow tongue-shaped scar of the adductor muscle. The concavity of this spondylium is less than normal. The thickness of the valve, as represented in both figures, is too great.  $\times 2$ .
- Fig. 39. Interior of beaks of a large specimen showing the broken spondylium, *a*, and detail of the hinge line, the broken median septum of the brachial valve, *e*, hinge plate, *b*, and bases of the crura, *d*. On the brachial platform, *c*, the secondary lateral septa are well developed.  $\times 2$ .
- Figs. 40, 41. Interior of the beak of a young specimen in which the structures of both valves are preserved, showing the spondylium and its supporting median septum, the position of the pedicle opening, the high median septum of the brachial valve, the brachial platform and hinge plate with the bases of the crura. The septum extends above the hinge plate stronger than usual.  $\times 2$ .
- Figs. 42, 43. Two views of the interior of the beaks of a moderately large specimen showing a spondylium more concave than that shown in figures 37 and 38. The scar of the adductor muscles is indicated in figure 42. The details of the hinge and the crura with their flattened, scarred tips are well shown. The accessory plates between the spondylium and inner surface of the valve, *h*, are visible, better developed than is usual in such a late stage.  $\times 2$ .



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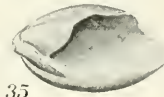
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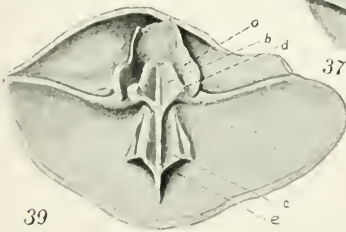
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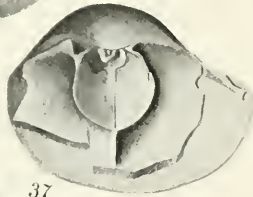
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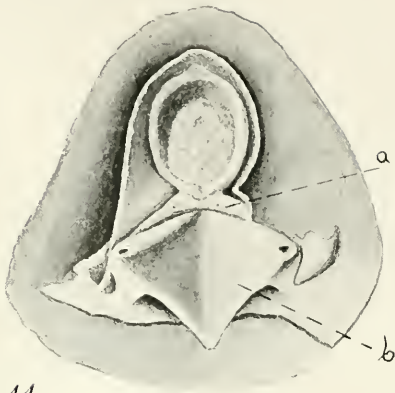




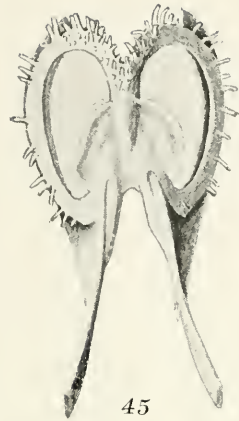
PLATE 9.

*Camarophorella mutabilis.*

- Fig. 44. Specimen showing interior of beaks, the hinge plate, *b*, with the crural bases, from beneath which the median septum is broken away, and the tip of the spondylium, almost all of which is wanting. In the spondylium is seen the thickened ring which surrounds the pedicle opening and between it and the hinge plate, the inner surface of the deltidial plates, *a*.  $\times 8$ .
- Fig. 45. Anterior view of a jugum of a small specimen; a portion of the left-hand primary lamellae has been restored to its point of attachment to the crus, the present extent being indicated in figure 46. The specimen shows well the circular plate, the ventral end (upper in figure) of which is molded around the underlying united lamellae of the jugum.  $\times 8$ .
- Fig. 46. Lateral view of same specimen in which the primary lamellae have been partly restored (indicated by lighter color) to show compact nature of the entire structure and extent of the primary lamellae.  $\times 8$ .
- Fig. 47. Posterior view of same specimen, the left primary lamellae of which is represented as entirely broken away to expose the secondary lamella of the jugum. The saddle formed by the united branches of the primary lamellae, *c*, the constriction of the united secondary lamellae of the jugum just ventral to (above) the tip of the saddle, *b*, and the under surface of the circular plate, *a*, are shown.  $\times 8$ .
- Figs. 48, 49. Anterior and lateral views of jugum of an average-sized specimen.  $\times 4$ .
- Fig. 50. Specimen of moderate size showing the high median septum of the brachial valve, the hinge plate from which the crura have been broken and the brachial platform with a slight indication of the secondary septum on it. This platform should be represented as placed slightly higher on the anterior end of the median septum.  $\times 4$ .



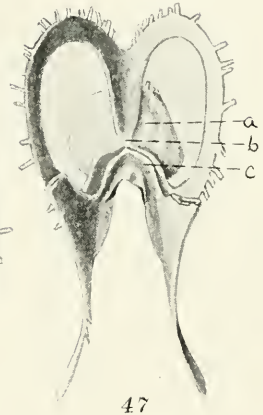
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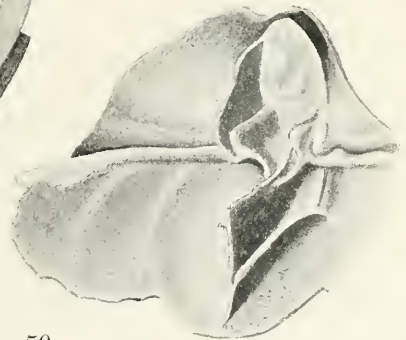


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PLATE 10.

*Camarophorella mutabilis*.

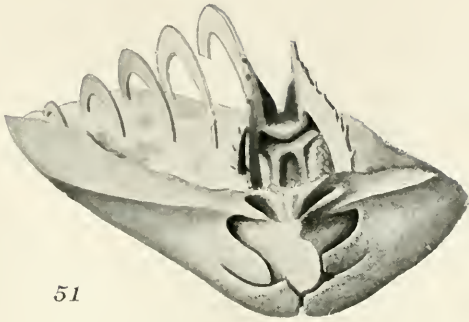
- Fig. 51. Immature specimen viewed from the posterior end showing the structure of the jugum at an early stage. The position of the jugum is inverted with respect to the remainder of the drawings. The saddle which becomes less distinct with growth is here conspicuous, with a pronounced suture between it and the remainder of the jugum. The united portion of the accessory lamellae is much broader at the tip of the saddle than in the adult (compare with this figure 54 which is equally enlarged). The position of the secondary supporting plates in the beak of the pedicle valve between the inner surface of the valve and the spondylium is also shown.  $\times 8$ .
- Figs. 53, 54. Anterior and posterior views of the jugum of a small individual showing typical characters.  $\times 8$ .
- Figs. 52, 55. Side views of the same specimen which show especially the relation of the expanded plate on the anterior surface to the remainder of the jugum, and the features which suggest that it is a separate plate added subsequently.  $\times 8$ .
- Fig. 56. View of the interior of an average-sized pedicle valve with its spondylium in which the brachidium is preserved entire except for the primary lamellae which are broken away and one of the accessory lamellae of the jugum.  $\times 3$ .

*Merista tya* from the Helderbergian, Cumberland, Maryland.

- Figs. 57, 58, 59. Three views of pedicle valves of this species showing the variation in the "shoe-lifter." Figure 58 is the one which has suggested a possible line of evolution by which the spondylium of *Camarophorella* was produced. All after Hall and Clarke, '95, pl. 42, figs. 9, 11, and 12 respectively. All natural size.

*Dicamara scalprum* from Middle Devonian, Pelm, Germany.

- Fig. 60. "The interior of a brachial valve; showing the 'shoe-lifter,' and the dividing median septum. Drawn from a gutta-percha impression which retains on the posterior margin a portion of the pedicle valve." This structure is fundamentally the same as that seen in *Camarophorella* but differs considerably in the details. After Hall and Clarke, '95, pl. 42, fig. 15.



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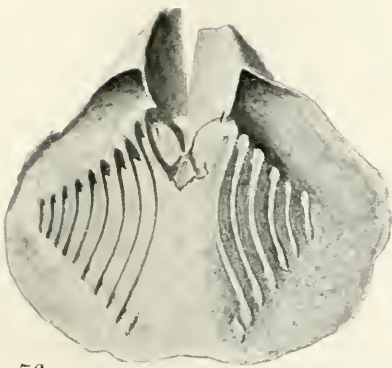
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No. 4.—PYRAMIDELLIDAE OF NEW ENGLAND AND THE ADJACENT REGION.

BY PAUL BARTSCH.

INTRODUCTION.

OUR knowledge of the Pyramidellid fauna of the northeast coast of America began in 1821, when Thomas Say ('21, p. 244) described two species of *Odostomia*: *O. impressa* and *O. bisuturalis* under the genus *Turritella*. To these he added a third, six years later, *Turbonilla* (*Chemnitzia*) *aequalis*, which he likewise referred to *Turritella*.

The next to increase our information was Joseph G. Totten. His two papers on New England shells, published in the American journal of science for 1834 and 1835, contain descriptions and figures of *Actaeon trifida* (Totten, '34, p. 368) and *Turritella interrupta* (Totten, '35, p. 352).

Three years after this, in 1838, *Jaminia exigua* and *Pyramis striatulus* were named by Joseph P. Couthouy ('38, pp. 92, 101) from Massachusetts Bay. The first of these has since proved to be a synonym of *Odostomia* (*Menestho*) *bisuturalis* Say, and the second is removed from the Pyramidellidae to the Eulimidae in the present paper.

The year following, Professor C. B. Adams ('39, pp. 280, 282) described and figured *Jaminia seminuda* and *Pyramis fusca* which are now known as *Odostomia* (*Chrysallida*) *seminuda* C. B. Adams and *Pyramidella* (*Syrnola* ?) *fusca* C. B. Adams. The next year, 1840, he (Adams, '40, p. 322) added *Jaminia producta* which, like *J. fusca*, we have doubtfully referred to the subgenus *Syrnola*.

The "Report on the Invertebrata of Massachusetts" by Augustus A. Gould was published by the State in 1841. In this are described and figured: *Turritella interrupta* Totten, *Pyramis striatula* Couthouy, *Odostomia producta* C. B. Adams, *O. fusca* C. B. Adams, *O. exigua* Couthouy, *O. seminuda* C. B. Adams, *O. trifida* Totten. He cites *Turritella bisuturalis* Say as a synonym of *Odostomia exigua* Couthouy, a decision now reversed by the rule of priority. It is in this paper that we have the name *Odostomia* applied properly for the first time to some of our species. He also states that *Turritella interrupta* does not belong to *Turritella* but may be a *Eulima*, which at least places it in the proper superfamily.

DeKay in his work on the Mollusca of New York (part 5 of the "Zoology of New York," 1843), described and figured *Turritella interrupta* Totten, and refers to *Turritella impressa* Say and *T. aequalis* Say, as extralimital species, giving a terse diagnosis of each. *Pyramis striatula* Couthouy, *Odostomia trifida* Totten, *O. seminuda* C. B. Adams, and *O. fusca* C. B. Adams are also described and figured and *O. insculpta* DeKay is published as new. This last, however, has since proved to be a synonym of *Odostomia (Menestho) trifida* Totten. As extralimital *Odostomiae*, he lists *Odostomia producta* C. B. Adams and *O. exigua* Couthouy.

After this no additions appear to have been made until 1851. In that year Wm. Stimpson published two papers in the Proceedings of the Boston society of natural history, and his "Shells of New England." In the first (Stimpson, '51a, pp. 14, 16) *Rissoa eburnea* (= *Odostomia (Liostomia) eburnea*), the type of the subgenus *Liostomia*, and *Chemnitzia modesta* (= *Odostomia (Odostomia) modesta*) are described, while the second (Stimpson, '51b, p. 114) publishes *Chemnitzia dealbata* (= *Odostomia (Odostomia) dealbata*) and *Chemnitzia nivea* (= *Turbonilla (Turbonilla) nivea*). In his "Shells of New England" he figures *Rissoa eburnea*, places *Pyramis striatulus* wrongly under the synonymy of *Menestho albula* Möller and refers all the rest of the Pyramidellidae to *Chemnitzia*, viz.: *Chemnitzia nivea* Stimpson, *C. interrupta* Totten, *C. producta* C. B. Adams, *C. fusca* C. B. Adams, *C. dealbata* Stimpson, *C. modesta* Stimpson, *C. bisuturalis* Say, *C. trifida* Totten, *C. impressa* Say, *C. seminuda* C. B. Adams. *Odostomia insculpta* DeKay is considered a synonym of *Odostomia impressa* Say.

No important contributions were made to this family after this for twenty years. Binney in his edition of Gould's "Invertebrata of Massachusetts," 1870, described and figured *Odostomia producta* C. B. Adams, *O. fusca* C. B. Adams, *O. dealbata* Stimpson, *O. modesta* Stimpson, *O. bisuturalis* Say, *O. trifida* Totten, *O. seminuda* C. B. Adams, *O. impressa* Say, *Turbonilla interrupta* Totten, *T. nivea* Stimpson, *Rissoella eburnea* Stimpson.

It was in 1872, that Professor A. E. Verrill published his first addition to the Pyramidellidae and in the next twelve years he not only increased our knowledge of the then known forms, but added enough new species to double their number. The following is a list of his additions: 1872, *Turbonilla elegans*, *Aelis polita*; 1873, *Turbonilla*

*areolata*, *T. costulata* = *mighelsi*, *T. stricta*; 1880, *T. rathbuni*, *T. formosa*; 1881, *T. smithii*, *Eulimella ventricosa* Forbes, *Odostomia* (*Menestho*) *sulcata* = *morseana*; 1882, *Turbonilla emertoni*, *T. bushiana* = *formosa*, *T. elegantula* = *elegans*, *Menestho bruneri*; 1884, *Eulimella lucida*, *E. chariessa*, *E. nitida*. The last three must be referred to *Eulima* proper.

There remains but one more work to be mentioned and that is Tryon's "Manual of conchology." In volume 8, 1884, the Pyramidellidae are treated monographically, and the following northeast American forms are diagnosed and illustrated: *Odostomia impressa* Say, *O. trifida* Totten, *O. producta* C. B. Adams, *O. fusca* C. B. Adams, *O. dealbata* Stimpson, *O. modesta* Stimpson, *O. seminuda* C. B. Adams, *O. bisuturalis* Say, *Turbonilla emertoni* Verrill, *T. nivea* Stimpson, *T. rathbuni* Verrill, *T. elegans* Verrill, *T. areolata* Verrill, *T. mighelsi* Verrill, *T. interrupta* Totten.

Lack of time has kept us from giving complete citations from the various local lists that have been published. In the present paper we have confined ourselves to the specimens at hand and to citations of literature necessary to a complete understanding of the nomenclature.

We wish to express our thanks to the U. S. national museum upon whose collections the present paper is largely based; also to the Philadelphia academy of natural sciences and the New York State museum whose collections have been consulted. We have also had for study the large private collection of Rev. H. W. Winkley and the collections from the Wood's Holl laboratory, the latter through the courtesy of the Director, Dr. F. B. Sumner; to both these gentlemen we extend our appreciation.

It is with pleasure, too, that we acknowledge indebtedness to Dr. W. H. Dall, honorary curator, Division of mollusks, U. S. national museum, for assistance and kind advice in the preparation of this report.

The illustrations were drawn by Miss Evelyn G. Mitchell.

In the preparation of the present diagnoses the following terminology is used:—

"*Axial sculpture*," the markings which extend from the summit of the whorls toward the umbilicus.

The axial sculpture may be (1) "Vertical," when the markings are in general parallelism with the axis of the shell; (2) "Protractive," when the markings slant forward from the preceding suture; (3) "Retractive," when the markings slant backward from the suture.

“*Spiral sculpture*,” the markings following the direction of the coil of the whorls.

### PYRAMIDELLA Lamarck.

*Pyramidella* Lamarck, Prod. d'un class. de coq., p. 76, 1799, = *Obeliscus*,<sup>1</sup> Museum Calonnianum, p. 24, 1797, = *Pyramidellus* Montfort, Conch. syst., vol. 2, p. 499, 1810.

Shell elongate-conic, whorls usually inflated and regularly increasing; the pillar with from one to three folds; the outer lip entire.

Type, *Trochus dolabratus* Linné.

#### *Key to the Subgenera of Pyramidella.*

Columellar folds two . . . . .	Eulimella.
Columellar fold single . . . . .	Syrnola.

### EULIMELLA Forbes.

*Eulimella* Forbes, Ann. mag. nat. hist., vol. 14, p. 412, 1846, = *Belonidium* Cossmann, 1896, = *Loxoptaxis* Cossmann, 1888.

Elongate-conic shells, having the surface polished; marked only by faint incremental lines and microscopic spiral striations; base without fasciole; columellar plaits two.

Type, *Eulimella scillae* Scacchi.

#### *Pyramidella (Eulimella) ventricosa* (Forbes).

= *Eulimella ventricosa* Verrill, Proc. U. S. nat. mus., vol. 3, p. 380, 1880.

Of this species, Verrill states in the citation referred to above: “A single dead specimen, not in good condition, but apparently belonging to this species, was dredged by us at Eastport, Me., in 1868. A perfect specimen was dredged by us this season, at station 873, in 100 fathoms. This last has a distinctly incurved, small, nuclear whorl; whorls nine, smooth, polished, white, well rounded, with deep sutures. Aperture broad-ovate, slightly effuse in front. Outer lip broad, well rounded in the middle and projecting well forward. Length, 3.6 mm.”

We have not seen this species from our coast.

<sup>1</sup> Anonymous published name, cf. Proc. biol. soc. Washington, vol. 17, p. 2, 1904.

The following species described as *Eulimella* should be referred to *Eulima*:—

*Eulimella chariessa* Verrill, Trans. Conn. acad. arts and sci., vol. 6, p. 192, pl. 32, figs. 4a, 4b, 1884.

*Eulimella nitida* Verrill, Trans. Conn. acad. arts and sci., vol. 6, p. 194, pl. 32, fig. 5, 1884.

*Eulimella lucida* Verrill, Trans. Conn. acad. arts and sci., vol. 6, p. 192, pl. 32, figs. 3, 3a, 1884.

#### SYRNOLA A. Adams.

*Syrnola* A. Adams, Ann. mag. nat. hist., ser. 3, vol. 5, p. 405, 1860, = *Anisocyclus* Monterosato, 1800, = *Baudonia* Bayan, 1873, = *Raphium* Bayan, 1873, = *Aciculina* Deshayes, 1864.

Shells of acicular outline; surface polished; no axial sculpture excepting lines of growth. Spiral sculpture usually absent; when present it consists of microscopic striations. Columella with a single fold.

Type, *Syrnola gracillima* A. Adams.

#### Key to the Species of *Syrnola*.

Shell elongate, acicular.

With suprapерipheral spiral color band . . . . . *smithi*.

Without spiral color band . . . . . *producta*.

Shell not elongate, acicular.

Shell elongate-ovate . . . . . *fusca*.

Shell broadly conic . . . . . *winkleyi*.

#### **Pyramidella** (*Syrnola*) **smithi** (Verrill).

Pl. 11, figs. 11, 15.

= *Turbonilla smithii* Verrill, Proc. U. S. nat. mus., vol. 3, p. 380, 1881, = *Eulimella smithii* Verrill, Trans. Conn. acad. arts and sci., vol. 5, p. 538, pl. 58, fig. 18, 1882 (not *Syrnola smithii* Tryon, 1886, which may be called **Turbonilla** (**Syrnola**) **tryoni**).

Shell acicular, polished, milk white with a band of light yellowish brown posterior to the periphery of the whorls. Nuclear whorls two and one half, planorboid, one fourth immersed in the first post-nuclear turn, not extending beyond the outline of the spire. The axis of the nuclear spire is almost at right angles to that of the succeeding

turns. Post-nuclear whorls rather high between the sutures, flattened, slightly shouldered at the summit, marked by fine incremental lines and a few scattered microscopic spiral striations. Periphery of the last whorl and base well rounded. Aperture ovate, posterior angle acute; outer lip thin showing the color band within; columella curved and somewhat revolute, bearing an oblique fold at its insertion.

The specimen described comes from U. S. B. F. station 949. It is perfect and has eleven post-nuclear whorls measuring: length, 8.2 mm.; diameter, 1.6 mm.

The following specimens have been examined:—

Cat. no.	No. of spec.	U.S.B.F. sta.	Locality.	Depth (fms.).	Temp.	Disposition of material.
45,482	2	871	Martha's Vineyard, Mass.	115	49°	U. S. nat. mus.
45,483	1	873	" " "	100	51°	" " "
45,485	4	949	" " "	100	52°	" " "
45,486	2	1038	" " "	146	47°	" " "
40,484	1	2242	S. of Martha's Vineyard, Mass.	58	51°	" " "
50,966	1	2540	" " " "	144	47°	" " "
94,819	1	949	Off " " "	100	52°	" " "

**Pyramidella (Syrnola ?) producta** (C. B. Adams).

Pl. 11, fig. 3.

*Jamiania producta* C. B. Adams, Boston journ. nat. hist., vol. 3, p. 322, pl. 3, fig. 8, 1840.

Shell elongate-conic, light yellowish brown, translucent (nuclear whorls eroded in all our specimens). Post-nuclear turns rather high between the sutures, well and evenly rounded, appressed to the preceding turn at the summit, marked by fine lines of growth and numerous microscopic spiral striations. Sutures well impressed. The semitransparent shell allows the preceding whorl to shine through it which gives the whorl the appearance of possessing double sutures. Periphery of the last whorl well rounded. Base somewhat produced, well rounded, marked like the spaces between the sutures. Aperture oblique, irregularly ovate, posterior angle acute, outer lip very thin and translucent, columella rather stout, oblique, twisted and slightly revolute, provided with a strong oblique fold a little anterior to its insertion.

The specimen figured and described, cat. no. 203,741 U. S. N. M., was collected by Rev. H. W. Winkley from the Branford River, Conn.

It has eight post-nuclear whorls and measures: length, 5.1 mm.; diameter, 1.5 mm.

The shells of all our specimens show more or less erosion, even those taken alive.

The following specimens have been examined:—

Cat. no.	Locality.	Disposition of material.
64,357a	Fairhaven, Mass.	U. S. nat. mus.
90,326	Massachusetts Bay	" " "
203,741	Branford R., Conn.	" " "
203,742	Wood's Holl, Mass.	" " "

**Pyramidella (Syrnola ?) fusca** (C. B. Adams).

Pl. 11, fig. 4.

*Pyramis fusca* C. B. Adams, Boston journ. nat. hist., vol. 2, p. 282, pl. 4, fig. 9, 1839.

Shell broadly elongate-conic, light brown, semitranslucent (nuclear whorls decollated in all our specimens). Post-nuclear turns well rounded, appressed at the summit, marked by rather strong irregular lines of growth and numerous exceedingly fine microscopic spiral striations. Sutures well marked. The preceding whorl shining through the shell at the summit lends this the aspect of having a double suture. Periphery of the last whorl well rounded. Base somewhat inflated, rather prolonged, well rounded, marked like the space between the sutures. Aperture rather large, ear-shaped, somewhat effuse anteriorly, posterior angle acute; outer lip thin, columella slender, twisted and revolute, the reflected portion forming a narrow umbilicus. A moderately strong, oblique fold is situated a little below the insertion of the columella. Operculum very thin, paucispiral.

The specimen described, cat. no. 107,063 U. S. N. M., was collected by C. B. Adams at New Bedford, Mass. It has seven post-nuclear turns and measures: length, 5.5 mm.; diameter, 2.1 mm.

The following specimens have been examined:—

Cat. no.	Locality.	Disposition of material.
83,401	Massachusetts Bay	U. S. nat. mus.
64,357	Fairhaven, Mass.	" " "
107,063	New Bedford, "	" " "
202,867	Wood's Holl, "	" " "
203,743	Naushon I'd, "	" " "
203,744	Branford R., Conn.	" " "

*Pyramidella* (*Syrnola* ?) *winkleyi* new species.

Pl. 11, fig. 1.

Shell broadly and regularly elongate-conic, semitranslucent, light yellowish brown (nuclear whorls decollated). Post-nuclear whorls moderately rounded with appressed summits marked only by lines of growth and exceedingly fine microscopic spiral striations. Periphery and base of last whorl rather inflated, the latter rather short, both well rounded and marked like the spaces between the sutures. Aperture ear-shaped, posterior angle acute, outer lip very thin; columella slender, twisted and somewhat revolute, provided with an oblique fold a little below its insertion.

The unique type, cat. no. 203,745 U. S. N. M., was collected by Rev. H. W. Winkley from the Branford River, Conn. It has eight whorls and measures: length, 5.8 mm.; diameter, 2.0 mm.

TURBONILLA Risso.

*Turbonilla* Risso, Hist. nat. Europe Merid., vol. 4, p. 224, 1826, = *Elusa* A. Adams, Ann. mag. nat. hist., ser. 3, vol. 7, p. 297, 1861.

Shell cylindro-conic, many whorled, generally slender, columellar fold single, varying in strength, outer lip entire; shell usually smaller than in *Pyramidella* and larger than in *Odostomia*.

Type, *Turbonilla typica* Dall and Bartsch = *T. plicatula* Risso (not *Turbo plicatula* Scacchi).

*Key to the Subgenera of Turbonilla.*

- A. Spiral sculpture absent, or, if present, consisting of exceedingly fine microscopic lines only.
  - a. Axial ribs obsolete on the later whorls . . . . Ptycheulimella.
  - aa. Axial ribs not obsolete on the later whorls.
    - b. Axial ribs terminating at the periphery of the last whorl  
Chemnitzia.
    - bb. Axial ribs continuing over the base of the last whorl  
Turbonilla.
- AA. Spiral sculpture present, always stronger than mere microscopic lines.
  - c. Spiral sculpture consisting of fine incised lines . . . Strioturbonilla.
  - cc. Spiral sculpture consisting of strongly incised grooves . . . Pyrgiscus.

## PTYCHEULIMELLA Sacco.

*Ptycheulimella* Sacco, Moll. del Piemonte e della Liguria, pt. 11, p. 59, 1892.

Shell elongate-conic. Axial sculpture consisting of obsolete ribs frequently only shown in the early post-nuclear turns. Spiral sculpture, if present, consisting of microscopic striations only.

Type, *Tornatella pyramidata* Deshayes.

**Turbonilla (*Ptycheulimella*) emertoni** Verrill.

Pl. 11, figs. 2, 5.

*Turbonilla emertoni* Verrill, Trans. Conn. acad. arts and sci., vol. 5, p. 536, pl. 58, figs. 14, 14a, 1882.

Shell subulate, having strongly impressed sutures; milk white. Nuclear whorls two and one half, depressed helicoid, about one fourth immersed in the first post-nuclear turn. The axis of the nuclear spire is almost at right angles to that of the succeeding whorls. Post-nuclear whorls slightly flattened in the middle between the sutures, rounding abruptly toward the summit and the periphery. This sudden rounding off above and below gives the sutures their constricted appearance and makes the whorls look rather inflated. All the whorls are marked by traces of obsolete axial ribs which are best developed on the posterior half of the first post-nuclear turn. Periphery of the last whorl well rounded. Base somewhat inflated, well rounded, smooth, marked by indications of faint extensions of the obsolete riblets. Aperture subquadrate (?), outer lip thin, fractured; columella slender, curved, and slightly revolute.

The type, cat. no. 153,543 U. S. N. M., has ten post-nuclear whorls and measures: length, 5.7 mm.; diameter, 1.3 mm. It was dredged by the U. S. fish commission off Martha's Vineyard, Mass., sta. S95, in 238 fathoms.

**Turbonilla (*Ptycheulimella* ?) polita** (Verrill).

*Actis polita* Verrill, Amer. journ. sci., ser. 3, vol. 3, pp. 210, 282, pl. 6, fig. 5, 1872; Trans. Conn. acad. arts and sci., vol. 5, p. 538, fig. 4, 1882.

“Whorls twelve, besides the nucleus, well-rounded, smooth and

glossy, mostly without sculpture, but on some of the upper whorls faint, very slightly elevated, transverse ribs can be detected, with a lens; lines of growth very slight. Suture well impressed, little oblique. Aperture short-ovate; the outer lip is broadly rounded, slightly effuse in front; the columella is smooth, a little excurved, bending to the left, from its junction with the body-whorl, and then joining the outer lip in a regular curve; in the umbilical region its edge is raised and very slightly reflexed. No umbilicus.

“Length, 8 mm.; breadth, 2 mm.

“Eastport, Me., 20 fathoms, 1864,— A. E. Verrill and S. I. Smith.

“The above description is from the original type. No other good specimen has yet been found. The nucleus is broken, but it appears to have been upturned.

“The figure is from a camera-lucida drawing of the original specimen.”

We have not seen this species and have quoted Dr. Verrill’s description.

A specimen labeled *Turbonilla polita* Verrill, cat. no. 203,244, U. S. national museum, comes from the Bay of Fundy. It is so badly decorticated that about all that one can say of it is that it belongs to the genus *Turbonilla*.

TURBONILLA Risso s. s.

*Turbonilla* Risso s. s.

Shell elongate-conic, surface marked with strong axial ribs which extend over the periphery to the umbilical region. Spiral sculpture if present, consisting of microscopic striations only.

Type, *Turbonilla typica* Dall and Bartsch.

Key to Species of *Turbonilla*.

- Axial ribs on the last turn, 18 . . . . . *stricta*.
- Axial ribs on the last turn, 22 . . . . . *nivea*.

***Turbonilla* (*Turbonilla*) *stricta* Verrill.**

Pl. 11, figs. 6, 7.

*Turbonilla stricta* Verrill, Rept. U. S. comm. fish and fisheries, pt. 1, p. 659, 1873.

Shell regularly elongate-conic, milk white. Nuclear whorls two,

very loosely coiled, forming a very oblique, elevated spire the axis of which is situated at right angles to the axis of the succeeding turns. Post-nuclear whorls moderately rounded, separated by well impressed sutures, ornamented with strong, broad, low, protractive axial ribs, of which 12 occur upon the 2d; 14 upon the 3d, 4th, and 5th; 16 upon the 6th; and 17 upon the 7th and the penultimate turn. Intercostal spaces about one half as wide as the ribs, shallow. Periphery of the last whorl well rounded, smooth. Entire surface crossed by exceedingly fine microscopic spiral striations. Aperture broadly ovate, posterior angle acute, outer lip thin, columella moderately strong and curved.

The specimen described and figured is one of a series collected at Wood's Holl, Mass., cat. no. 203,811 U. S. N. M. It has nine and one quarter post-nuclear turns and measures: length, 4.2 mm.; diameter, 1.1 mm.

The type came from Long Island Sound, off New Haven, Conn.

We have seen the following specimens: —

Cat. no.	No. of spec.	Locality.	Disposition of material.
	2	Wood's Holl, Mass.	H. W. Winkley coll.
203,811	15	" " "	U. S. nat. mus.
83,411	5	" " "	" " "
62,340	15	Naushon I'd, "	" " "
203,815	11	" " "	" " "

**Turbonilla (Turbonilla) nivea** (Stimpson).

Pl. 11, figs. 9, 10.

*Chemnitzia nivea* Stimpson, Proc. Boston soc. nat. hist., vol. 4, p. 114, 1851.

Shell regularly elongate-conic, sides of the spire almost forming a straight line; milk white. Nuclear whorls two and one half, helicoid, forming a strongly elevated spire which is situated at right angles to the axis of the post-nuclear turns. Post-nuclear whorls moderately rounded, crossed by broad, low, rounded protractive ribs, about 14 of which appear upon the 2d; 16 upon the 3d and 4th; 18 upon the 5th, 6th, and 7th; 20 upon the 8th and 9th; and 22 upon the penultimate turn. Sutures well impressed. Periphery of the last whorl well rounded. Base short, well rounded, crossed by the weak continuations of the axial ribs. Aperture subquadrate, rather small, posterior angle

acute, outer lip thin, showing the external sculpture within; columella slender, curved, and very slightly revolute.

The specimen described, cat. no. 203,810 U. S. N. M., has ten post-nuclear whorls and measures: length, 5.2 mm.; diameter, 1.4 mm.; it was collected at Wood's Holl, Mass.

We have seen the following specimens:—

Cat. no.	No. of spec.	U. S. F. C. sta.	Locality.	Depth (fms.).	Temp.	Disposition of material.
203,810	1		Wood's Holl, Mass.			U. S. nat. mus.
1128a	3		" " "			Wood's Holl coll.
	1	840	" " "			" " "
203,816	4		" " "			U. S. nat. mus.
	7		" " "			H.W.Winkley coll.
45,481		949	Off Martha's Vineyard, Mass.	100	52°	U. S. nat. mus.

#### CHEMNITZIA D'Orbigny.

*Chemnitzia* D'Orbigny, Hist. nat. Isles Canaries, p. 77, 1839, = ? *Microbeliscus* Sandberger, 1874.

Shell elongate-conic, having strong axial ribs which terminate at the periphery of the whorls; intercostal spaces excavated between the sutures. Spiral sculpture absent or, if present, consisting of microscopic striations only.

Type, *Melania campanellae* Philippi.

#### *Turbonilla* (*Chemnitzia*) *aequalis* (Say).

*Turritella aequalis* Say, Journ. acad. nat. sci. Phila., vol. 5, p. 208, 1827, = *Turbonilla equalis* Verrill, Rept. U. S. comm. fish and fisheries, pt. 1, p. 659, 1873, = *Turbonilla aequalis* Verrill, Trans. Conn. acad. arts and sci., vol. 5, p. 588, 1882.

We have not seen this species and quote Say's ('27, p. 208) description.

"Shell subulate, white; volutions ten, each with about twenty-two transverse, elevated, obtuse, equal lines, with interstitial grooves of the same diameter; suture distinct, impressed; aperture rounded at base, and destitute of any distinct emargination. Length  $\frac{1}{4}$  of an inch."

To this Professor Verrill ('73, p. 659) adds: "My specimens agree well with the above description. The shell is very slender and acute,

with a small distinctly reversed apical whorl; the remaining nine whorls are somewhat flattened, are all crossed by obtuse, transverse costae, which are a little oblique, especially at the upper ends, close to the sutures; on the body-whorl they vanish, leaving it smooth; the interstices between the costae are deep and apparently smooth. The aperture is round ovate, well rounded or sub-circular anteriorly; the inner lip having a raised and thin margin. Length 4.5 mm., breadth 1.25 mm. Vineyard Sound, 6 to 8 fathoms."

#### STRIOTURBONILLA Sacco.

*Strioturbonilla* Sacco, Moll. del Piemonte e della Liguria, p. 94, 1892.

Shell as in *Turbonilla* and *Chemnitzia* but finely and closely spirally striated on spire and base.

Type, *Strioturbonilla alpina* Sacco.

#### **Turbonilla (Strioturbonilla) bushiana** Verrill.

Pl. 11, figs. 8, 12.

*Turbonilla bushiana* Verrill, Trans. Conn. acad. arts and sci., vol. 5, p. 537, pl. 58, fig. 16, 1882, = *Turbonilla formosa* Verrill and Smith, Amer. journ. sci., ser. 3, vol. 20, p. 398, 1880 (not *Chemnitzia formosa* Klipst, Denkschr. kais. akad. wiss. Wien, vol. 12, p. 28, 1856, = *Pseudomelania* ?).

Shell very large, regularly elongate-conic, milk white, shining. Nuclear whorls two, very small, depressed helicoid, about one third immersed in the first post-nuclear turn. The axis of the nuclear spire is at right angles to the axis of the succeeding whorl. Post-nuclear whorls moderately rounded, marked by axial ribs which are poorly developed, irregular in size and spacing. They are very feeble on the early whorls. There are about 20 upon the first to fifth whorl, 22 upon the sixth (this count was taken from the specimen which has served for the description and figure of the nucleus, cat. no. 45,470 U. S. N. M.). The following is from cat. no. 45,471 U. S. N. M., the adult specimen figured. This has lost the nucleus and probably the first two post-nuclear turns. The outer surface of the early whorls of the adult shell is decorticated; the 5th, 6th, and 7th of the remaining ones have 22 axial ribs. On the 8th there are 23, some of which show a strong tendency to bifurcation. The 9th has 24, while on the last half of the

penultimate turn they are irregular and irregularly spaced. All the ribs are protractive. Periphery of the last whorl inflated and well rounded. Base rather short, well rounded, marked by the feeble continuations of the axial ribs. The entire surface of the spire and base is crossed by very fine, closely spaced spiral striations which pass equally strong over the intercostal spaces and ribs. Sutures well impressed. Aperture ovate, somewhat effuse anteriorly, posterior angle acute; outer lip thin; columella slender, curved and slightly revolute, showing a weak oblique fold at its insertion which is scarcely visible when the aperture is viewed squarely.

The adult shell has eleven post-nuclear whorls and measures: length, 11.2 mm.; diameter, 3.0 mm.

The following specimens have been examined:—

Cat. no.	No. of spec.	U.S.F.C. sta.	Locality.	Depth (fms.).	Temp.	Disposition of material.
34,999	1	2076	Off George's Bank	906		U. S. nat. mus.
52,321	1	2571	S.E. of George's Bank	1356	38°	" " "
45,476	1	2213	" of Martha's Vin'd, Mass.	384	39°	" " "
52,319	2	2547	" " " "	390	40°	" " "
45,472	1	894	Off " " "	365	40°	" " "
45,471	4	892	" " " "	487		" " "
45,470	2	891	" " " "	480		" " "
45,467	2	1143	" " " "	452	40°	" " "
37,973	46	2221	S. of " " "	1525	36°	" " "
203,225	7	2221	" " " "	1525	36.9°	" " "
40,264	2	2237	" " Long Island, N. Y.	520	39°	" " "
40,244	1	2234	" " " "	816	39°	" " "

**Turbonilla (Strioturbonilla) bushiana abyssicola** new subspecies.

Pl. 11, fig. 14.

Shell similar to that of *bushiana* but with stronger and much more regular axial ribs. The summits of the whorls are also slightly shouldered and the sutures are rendered subcrenulate by the axial ribs. The specimen here described has lost the nucleus and probably one post-nuclear whorl. There are 19 ribs upon the 4th; 20 upon the 5th to 8th; 22 upon the 9th; 24 upon the 10th; and 28 upon the penultimate turn; upon the last half of this, they become quite enfeebled and irregular as in *bushiana*. The spiral sculpture is the same as in *bushiana*, likewise the nucleus.

The specimen described is cat. no. 153,540a U. S. N. M. It was

dredged by the U. S. bureau of fisheries at station 2221 in 1525 fathoms. It has twelve whorls remaining which measure: length, 13.5 mm.; diameter, 3.9 mm.

The following specimens have been examined:—

Cat. no.	No. of spec.	U.S.F.C. sta.	Locality.	Depth (fms.).	Temp.	Disposition of material.
45,478	4	2084	Off George's Bank	1290	40°	U. S. nat. mus.
52,317	1	2571	S. E. of George's Bank	1356	38°	" " "
153,541	1	2096	Off Martha's Vin'd, Mass.	1451	37°	" " "
153,540a	7	2221	S. of " " "	1525	36°	" " "
45,477	27	2222	" " " " "	1537	36°	" " "

### PYRGISCUS Philippi.

*Pyrgiscus Philippi*, Wieg. Arch., vol. 1, p. 50, 1841, = *Pyrgostelis* Monterosato, Conch. Medit., p. 89, 1884, = *Ortostelis* Aradas, Atti acad. Gio. di Catania, vol. 20, 1843.

Turbonillas having prominent axial ribs and deeply incised spiral grooves but no varices or internal lirations on the outer lip; columella usually somewhat flexuose.

Type, *Melania rufa* Philippi.

#### Key to the Species of *Pyrgiscus*.

- A. Axial ribs evanescent on the base.
- B. Sculpture regular.
  - a. Spiral sculpture consisting of incised lines of equal strength between the sutures.
    - Spiral lines between the sutures 6 . . . . . *verrilli*.
    - Spiral lines between the sutures 7 to 8 . . . . . *vinea*.
  - aa. Spiral sculpture consisting of incised lines of unequal strength between the sutures.
    - b. Spiral lines equally strong between the sutures excepting those upon the shoulder of the whorls which are finer and closer spaced than the rest.
      - c. Whorls well rounded.
        - Shell slender . . . . . *elegantula*.
        - Shell robust . . . . . *elegantula branfordensis*.
      - cc. Whorls almost flat . . . . . *areolata*.<sup>1</sup>
    - bb. Spiral lines not equally strong between the sutures, fine lines not confined to the shoulder.

<sup>1</sup> *T. (P.) areolata* sometimes lacks the fine striae on the shoulder.

Spiral sculpture between the sutures consisting of one coarse peripheral and many fine lines.

Fine lines 14 . . . . . *interrupta*.

Fine lines 20 . . . . . *mighelsi*.

Spiral sculpture consisting of 4 coarse and 17 fine lines . . . *buteonis*.

BB. Sculpture very irregular and variable. The exceeding variability of this species, *Turbonilla (Pyrgiscus) winkleyi* and the variety *senilis* make it impossible to seize upon any few characters to serve in this key. We refer to the description, pp. 90, 92 for their definition.

AA. Axial ribs continuing over the base of the last whorl to the umbilical region.

C. Spiral sculpture consisting of incised lines of equal strength between the sutures.

Axial ribs on all the whorls . . . . . *sumneri*.

Axial ribs feeble on the later whorls . . . . . *whitcavesi*.

CC. Spiral sculpture consisting of incised lines of unequal strength.

Shell large, length of a specimen of 11 whorls 13.5 mm. . . *rathbuni*.

Shell medium, length of a specimen of 10 whorls 7.3 mm . . . *cascoensis*.

Shell small, length of a specimen of 9 whorls 5.2 mm. . . *edwardensis*.

***Turbonilla (Pyrgiscus) verrilli* new species.**

Pl. 12, figs. 21, 26.

Shell regularly broadly conic, creamy white with a slender yellow band a little above the sutures. Nuclear whorls two and one half, depressed helicoid, scarcely at all immersed, having their axis at right angles to that of the succeeding turns. Post-nuclear whorls increasing regularly in size, ornamented with strong, well elevated axial ribs, which are strongest in the middle and somewhat flattened at the summit. They are about half as wide as the intercostal spaces and about 20 appear upon the 2d; 18 upon the 3d to 7th; and 21 upon the penultimate turn. The rather wide intercostal spaces are marked by very fine, crinkly axial striations and six equally strong incised spiral lines. Four of these lines divide the anterior half of the whorl between the sutures into three equal spaces, the basal one of which is at the periphery; the two others divide the posterior half into an equal number of segments, the upper one being about as far below the summit as it is distant from the incised line anterior to it. The color band occupies the space between the 3d and 4th lines. Periphery of the last whorl rounded. Base very short, almost flat, marked by the weak continuations of the axial ribs which vanish before reaching the umbilical area, and six equally strong but unequally spaced,

feebly incised wavy spiral striations. Aperture subquadrate, posterior angle obtuse; outer lip thin, showing the external sculpture within, forming a broad angle with the equally thin basal wall; columella slender, not curved, obliquely placed, and slightly revolute.

The type, cat. no. 94,826a U. S. N. M., comes from Martha's Vineyard, Mass. It has nine post-nuclear whorls and measures: length, 4.9 mm.; diameter, 1.4 mm.

This species is named in honor of Professor A. E. Verrill, the eminent zoologist at Yale university.

***Turbonilla (Pyrgiscus) vineae* new species.**

Pl. 12, figs. 22, 36.

Shell elongate-conic, wax yellow. Nuclear whorls very small, two, depressed helicoid, having their axis at a right angle to that of the succeeding turns. Early post-nuclear whorls well rounded, later ones flattened in the middle, rounding rapidly toward the sutures. The whorls are ornamented by moderately strong, broad, low, retractive axial ribs which become somewhat flattened and less strong as they approach the summit; of these there are about 22 upon all but the penultimate turn, on the latter there are 25. Intercostal spaces about as wide as the ribs, marked between the sutures by fine lines of growth and seven or eight deeply incised spiral lines of pits. The faint shouldering of the later turns lends the sutures a somewhat constricted appearance. Periphery of the last turn well rounded, marked by a smooth spiral band (excepting the weak continuations of the axial ribs which cross it). Base short, somewhat inflated and well rounded, crossed by the feeble continuations of the axial ribs which vanish before reaching the umbilical area, fine incremental lines, and about eight, fine, wavy spiral striations, of which those nearest the periphery are the strongest and the rest successively weaker. Aperture large, irregularly ovate, somewhat effuse at the junction of the lateral and basal lip; outer lip thin, showing the external sculpture within; columella slender, slightly curved, and revolute.

The above description is a composite one, taken from two individuals. The nucleus and the early turns are described from a young individual, cat. no. 203,757 U. S. N. M., while cat. no. 203,756 U. S. N. M., which is an adult having the last nine whorls (the first two probably, and the nucleus being lost) has furnished the remainder of our diagnosis.

This latter specimen measures: length, 6.3 mm.; diameter 2.9 mm.; it comes from Branford, Conn.

We have seen the following specimens: —

Cat. no.	No. of spec.	Locality.	Disposition of material.
678	1	Wood's Holl, Mass.	Wood's Holl. coll.
764	1	" " "	" " "
175,101	1	" " "	U. S. nat. mus.
203,757	6	" " "	" " "
	5	" " "	H. W. Winkley coll.
203,758	1	" " "	U. S. nat. mus.
203,759	1	" " "	" " "
	1	" " "	Wood's Holl coll.
203,760	1	" " "	U. S. nat. mus.
	11	" " "	Wood's Holl coll.
203,761	6	" " "	U. S. nat. mus.
	12	" " "	Wood's Holl coll.
203,762	10	" " "	U. S. nat. mus.
203,763	1	" " "	" " "
203,756	1	Branford, Conn.	" " "
	1	" "	H. W. Winkley coll.

**Turbonilla (Pyrgiscus) elegantula** Verrill.

Pl. 12, figs. 30, 31.

*Turbonilla elegantula* Verrill, Trans. Conn. acad. arts and sci., vol. 5, p. 538, 1882, = *Turbonilla elegans* Verrill, Amer. journ. sci., ser. 3, vol. 3, p. 282, pl. 6, fig. 4, 1872 (not *Turbonilla elegans* Wood, 1842, nor *Chemnitzia elegans* Lycett, 1850, nor *Chemnitzia elegans* D'Orbigny, 1853).

Shell broadly conic with light wax yellow surface and dark wax yellow spirally incised lines. Nuclear whorls very small, at least two, having their axis almost at right angles to that of the succeeding turns. Post-nuclear whorls well rounded, marked by strong, somewhat retractive axial ribs, of which there are about 18 upon the 2d, 3d, and 4th; 20 upon the 5th, 6th, and 7th; and 22 upon the penultimate turn. In addition to these ribs the whorls are marked in the intercostal spaces, which are a little wider than the ribs, by five, broad, deeply incised, equally strong and equally spaced spiral lines. These lines run up on the sides of the ribs, but do not cross them. Between the first of these lines and the summit of the whorls there are four very faint closely spaced spiral striations. Sutures well impressed. Pe-

riphery of the last whorl well rounded, marked only by the feeble extensions of the axial ribs. Base somewhat inflated, well rounded, marked by the vanishing ribs and nine equally strong spiral striations, which are much finer than the incised lines on the spire and are spaced successively narrower from the periphery to the umbilical area. Aperture large, broadly oval, somewhat effuse at the junction of the outer and the basal lip; posterior angle obtuse, columella moderately stout, slightly curved, and reflexed.

The specimen described and figured is the type, cat. no. 203,224 U. S. N. M.; it comes from Vineyard Sound, Mass. It has nine post-nuclear whorls and measures: length, 5.3 mm.; diameter, 1.6 mm.

The following specimens have been examined:—

Cat. no.	spec.	No. of U.S.F.C. sta.	Locality.	Depth (fms.).	Temp.	Disposition of material.
		2	Eel Pond, Wood's Holl.			H.W. Winkley coll.
175,101a	2		Wood's Holl, Mass.			U. S. nat. mus.
203,224	1		Vineyard S'd, "			" " "
184,191	1	1695	Long Island Sound, Conn. (off Old Tower)	9	69.5°	" " "

***Turbonilla (Pyrgiscus) elegantula branfordensis* new subspecies.**

Pl. 12, fig. 27.

Shell stout, pupiform, bluish white with reddish yellow spiral striations (nuclear whorls decollated; in the type the first post-nuclear turn is also lost). Post-nuclear whorls strongly rounded, weakly shouldered at the summit, crossed by strong, low rounded axial ribs of which there are about 18 upon the 3d, 4th, and 5th of the remaining whorls; 20 upon the 6th; 22 upon the 7th; and 24 upon the penultimate turn. The spiral sculpture consists of five strongly impressed lines, grouped in series, the first and second above the periphery being as far apart as the third and fourth, while the space between the second and third is about one and one half times as wide. The space between the fourth and fifth equals that between the second and third. In addition to these strong lines there are three very fine lines on the shoulder of the whorl between the fifth spiral and the summit. Periphery of the last whorl smooth excepting the continuations of the axial ribs. Base moderately long, well rounded, marked by the feeble extensions of the ribs and twelve more or less wavy spiral lines of which the one immediately below the periphery is the strongest, the rest

being subequal. Aperture ?, outer lip fractured; columella stout and slightly revolute.

The type, cat. no. 193,352 U. S. N. M., has nine whorls remaining and measures: length, 5.3 mm.; diameter, 1.6 mm.

The following specimens have been examined:—

Cat. no.	No. of spec.	Locality.	Disposition of material.
83,410	1	Swampscott, Mass.	U. S. nat. mus.
721	1	Wood's Holl, "	Wood's Holl coll.
790	1	" " "	" " "
193,352	19	Branford, Conn.	U. S. nat. mus.
	100	" "	H. W. Winkley coll.

***Turbonilla (Pyrgiscus) areolata* Verrill.**

Pl. 12, figs. 19, 24.

*Turbonilla areolata* Verrill, Rept. U. S. comm. fish and fisheries, pt. 1, p. 658, 1873.

Shell stout, obelisk-shaped, light yellow. Nuclear whorls very small, two and one half, forming a moderately depressed helicoid spire, which has its axis almost at right angles to that of the succeeding turns in the first of which it is about one fourth immersed. Post-nuclear whorls almost flat, faintly shouldered at the summit, crossed by strong, low, rounded axial ribs of which there are 20 upon the 1st, 2d, and 3d; 22 upon the 4th; 24 upon the 5th; 28 upon the 6th; and 26 upon the penultimate turn. The spiral sculpture consists of five rows of strong subequal and subequally spaced pits which cross the intercostal spaces but not the ribs. In addition to these, two very fine spiral striations are situated between the uppermost coarse line and the summit of the whorl. Periphery of the last whorl smooth, excepting the faint continuations of the ribs; well rounded. Base well rounded, marked by eight, wavy, spirally incised lines. Aperture ovate, posterior angle acute; outer lip thin showing the external sculpture within; columella slender, slightly curved, and slightly revolute.

The specimen described and figured, cat. no. 203,765 U. S. N. M., comes from Wood's Holl, Mass. It has eight post-nuclear whorls and measures: length, 5.1 mm.; diameter, 1.5 mm.

The following specimens have been examined: —

Cat. no.	No. of spec.	Locality.	Disposition of material.
203,765	1	Wood's Holl, Mass.	U. S. nat. mus.
203,766	6	" " "	" " "
203,767	1	" " "	" " "
	1	" " "	H. W. Winkley coll.
203,768	5	" " "	U. S. nat. mus.
	13	" " "	H. W. Winkley coll.
203,769	1	Branford, Conn.	U. S. nat. mus.

**Turbonilla (Pyrgiscus) interrupta** (Totten).

Pl. 12, figs. 18, 23.

*Turritella interrupta* Totten, Amer. jour. sci. and arts, vol. 28, p. 352, fig. 7, 1835.

Shell slender, elongate-conic, pale wax yellow. Nuclear whorls two and one quarter, depressed helicoid, about one fourth immersed in the first post-nuclear turn, having their axes almost at right angles to that of the succeeding whorls. Post-nuclear turns quite high between the sutures, very slightly rounded and weakly shouldered at the summit; ornamented by very broad, low, axial ribs which are a little wider than the intercostal spaces. There are about 20 of these ribs upon the 2d and 3d; 22 upon the 4th, 5th, and 6th; and 24 upon the 7th and penultimate turns. In addition to the ribs the whorls are marked by from 11 to 14 deeply incised spiral lines, all of which, excepting the suprapерipheral one, are equal in strength and subequally spaced. The one immediately above the periphery is much heavier and forms a line of deep pits. Peripheral band of the last whorl free from any sculpture, excepting the feeble continuations of the axial ribs; well rounded. Base rather short, well rounded, marked by eight equally strongly incised and equally spaced spiral lines. Aperture moderately large, subquadrate, somewhat effuse at the junction of the outer and basal lip, both of which are thin; columella slender, slightly curved and weakly reflexed.

The specimen described and figured, cat. no. 202,889 U. S. N. M., comes from Narragansett Bay. It has nine post-nuclear whorls and measures: length, 5.7 mm.; diameter, 1.3 mm.

The following specimens have been examined:—

Cat. no.	No. of spec.	U.S.F.C. sta.	Locality.	Depth (fms.).	Temp.	Disposition of material.
203,764	1		Wood's Holl, Mass.			U. S. nat. mus.
678	1		" " "			Wood's Holl coll.
	2		" " "			Winkley coll.
153,550	5	770	Narragansett Bay, R. I.	8	62°	U. S. nat. mus.
202,889	1	770	" " "	8	62.5°	" " "
153,549	7	816	" " "	8-10	66°	" " "
153,551	5	818	" " "	9	65°	" " "
159,806	1	818	" " "	9	65°	" " "
184,236	1	1623	Long Island Sound	10	65°	" " "

**Turbonilla (Pyrgiscus) mighelsi** new name.

Pl. 14, figs. 52, 54.

= *Turbonilla costulata* Verrill, Rept. U. S. comm. fish and fisheries, pt. 1, p. 658, 1873 (not *Turbonilla costulata* Risso, Hist. nat. Europ. Merid., p. 224, fig. 72, 1826; not *Chemnitzia costulata* Adams, Proc. zool. soc., p. 180, 1853).

Shell elongate-conic, light yellowish. Nuclear whorls "large." Post-nuclear whorls almost flat, very faintly shouldered at the summit, crossed by well rounded, moderately strong axial ribs (our specimen has lost the early whorls, the last six only remaining). On the first of these whorls there are 18 ribs; upon the 2d, 20; the 3d, 24; the 4th, 26; and 24 upon the penultimate. The spiral sculpture between the sutures consists of one coarse peripheral line of pits and twenty fine incised lines. These fine lines are arranged in eight groups of two, which divide the space between the sutures into nine subequal parts; the anterior striation of each pair is a trifle stronger than its fellow. The space between the fourth and the fifth pairs above the periphery is crossed in the middle by a spiral line; the space between the sixth and the seventh pairs is divided into three equal parts by two slender spirals, while that between the seventh and the eighth is divided into three unequal parts by two striations. The space between the eighth pair and the summit is divided into two equal parts by a slender line. All these spiral markings pass up on the sides of the ribs but do not cross them. Periphery of the last whorl rounded, crossed only by the feeble continuations of the axial ribs which disappear before reaching the middle of the well rounded base. The spiral markings of the base consist of about ten feeble wavy lines. Aperture

moderately large, irregularly ovate; posterior angle acute; outer lip thin; columella straight, slightly revolute.

The specimen described and figured, cat. no. 203,770 U. S. N. M., comes from Wood's Holl, Mass. It measures: length, 3.8 mm.; diameter, 1.4 mm.

**Turbonilla (Pyrgiscus) buteonis** new species.

Pl. 12, figs. 17, 28, 34.

Shell broadly elongate-conic, yellowish white. Nuclear whorls two, moderately large, depressed helicoid, having their axes almost at right angles to that of the succeeding turns in the first of which they are about one fifth immersed. Post-nuclear whorls weakly rounded, crossed by strong, rounded, axial ribs of which 16 occur upon the 1st and 2d; 18 on the 3d, 4th, and 5th; 20 on the 6th and 7th; 22 upon the 8th, 9th, and the penultimate turn. Intercostal spaces about one and one half times as wide as the ribs, ornamented with four deep pits and 17 fine incised lines between the sutures. The deep pits are one peripheral, two, a median; four about half way between the median and the summit of the whorls, while three is a little nearer to four, than to the median. The fine lines are disposed in the following manner: seven between the peripheral and median pits; one between the median and third pit; and nine between the fourth pit and the summit of the whorl. The fine lines are of orange color. Periphery and base of the last whorl well rounded, crossed by the feeble continuations of the axial ribs, which disappear before reaching the umbilical area. Base marked by 14 slender irregularly spaced incised spiral lines. Aperture moderately large, subquadrate, somewhat effuse at the junction of the outer and basal lip, both of which are thin and show the external sculpture within; columella slender, almost straight, obliquely placed, and slightly revolute.

The type, cat. no. 203,771 U. S. N. M., comes from Wood's Holl, Mass. It has eleven post-nuclear whorls and measures: length, 6.3 mm.; diameter, 1.9 mm.

We have examined the following specimens:—

Cat. no.	No. of spec.	U.S.F.C. sta.	Locality.	Depth (fms.).	Temp.	Disposition of material.
94,827	1		Massachusetts Bay, Mass.			U. S. nat. mus.
203,771	2		Wood's Holl,	"		" " "
	3		" "	"		Winkley coll.

Cat. no.	No. of spec.	U.S.F.C. sta.	Locality.	Depth (fms.).	Temp.	Disposition of material.
203,772	1		Wood's Holl, Mass.			U. S. nat. mus.
45,455	1	865-867	Martha's Vineyard, Mass.	65	68°	" " "
94,826	1		" "	"		" " "

*Turbonilla (Pyrgiscus) winkleyi* new species.

Pl. 12, figs. 35, 37.

Shell elongate-conic, wax yellow. Nuclear whorls small, two and one quarter, depressed helicoid with their axis almost at right angles to that of the succeeding turns; about one quarter immersed in the first post-nuclear whorl. Post-nuclear whorls ornamented by moderately strong axial ribs of which there are 22 upon the 1st, 2d, and 3d; 20 upon the 4th, 5th, 6th, and 7th; 24 upon the 8th; 28 upon the 9th; and 22 upon the penultimate turn. Intercostal spaces of varying width, crossed by spiral striations of varying width, of which four equal and equally spaced occur upon the 1st; 6 unequal ones upon the 2d; 7 upon the 3d, 4th, and 5th; 8 upon the 6th; 10 upon the 7th; 11 upon the 8th; 13 upon the 9th and penultimate whorl. Base rather short, well rounded, marked by the feeble continuations of the axial ribs which disappear entirely shortly after crossing the rounded periphery and about 15 feeble, wavy, irregularly spaced spiral striations. Aperture suboval; outer lip thin, showing the external sculpture within; columella slender, curved, and slightly revolute.

The type, cat. no. 203,776 U. S. N. M., comes from Wood's Holl, Mass. It has eleven post-nuclear turns and measures: length, 7.9 mm.; diameter, 2.0 mm.

This is probably the most abundant and variable species on the Atlantic coast. The above description shows that the sculpture in a single specimen, the type, is quite variable. The variability is emphasized when we examine such a wealth of material as has been at our disposal. The axial ribs may be crowded or distinctly spaced, the spiral markings may vary not only in numbers but also in strength, from deep lines of pits, to fine striations. It is one of those forms in which scarcely two individuals present exactly the same phase of ornamentation, resembling in this respect *Turbonilla (Pyrgiscus) tenuicula* Gould, of the west coast of America. The yellow color which appears on the surface like an epidermis, and the shape, serve as a guide to this form.

Among the Pyramidellidae it seems to be the rule, that the most variable forms are the most abundant and most widely distributed. This leads one to wonder if it is not the optimum condition that weakens specific bonds and tends to throw an organism into the so called "state of flux" rather than the reverse.

An extreme variety of this species, we will designate under the name *senilis*.

We have examined the following specimens: —

Cat. no.	No. of spec.	U.S.F.C. sta.	Locality.	Depth (fms.).	Temp.	Disposition of material.
119	3		Wood's Holl, Mass.			Wood's Holl coll.
120	1		" " "			" " "
155	1		" " "			" " "
761	1		" " "			" " "
826	1		" " "			" " "
844	1		" " "			" " "
203,773	9		" " "			U. S. nat. mus.
	30		" " "			H. W. Winkley coll.
203,774	10		" " "			U. S. nat. mus.
	50		" " "			H. W. Winkley coll.
203,776	6		" " "			U. S. nat. mus.
1,106	16		" " "			Wood's Holl coll.
203,777	2		" " "			U. S. nat. mus.
602	4		" " "			Wood's Holl coll.
203,778	1		" " "			U. S. nat. mus.
766	1		" " "			Wood's Holl coll.
203,779	1		" " "			U. S. nat. mus.
829	2		" " "			Wood's Holl coll.
203,780	2		" " "			U. S. nat. mus.
851	2		" " "			Wood's Holl coll.
203,781	1		" " "			U. S. nat. mus.
858	2		" " "			Wood's Holl coll.
203,782	1		" " "			U. S. nat. mus.
203,783	1		" " "			" " "
655	3		" " "			Wood's Holl coll.
203,784	1		" " "			U. S. nat. mus.
203,775	7		Branford, Conn.			" " "
	16		" " "			H. W. Winkley coll.
203,785	5	1623	Off Penfield Reef (Long Island Sound)	10	65°	U. S. nat. mus.
203,786	6	1624	Off Penfield Reef (Long Island Sound)	5 $\frac{3}{4}$	64°	" " "

**Turbonilla (Pyrgiscus) winkleyi senilis** new var.

Pl. 12, fig. 41.

Shell with the axial ribs retractive and very numerous, about 38 upon the penultimate turn of the type. Spiral sculpture consisting of about 22 incised lines of varying width and spacing. Base with about twelve fine sharply incised lines.

The type, cat. no. 203,787 U. S. N. M., comes from Branford, Conn. It has lost the nucleus and probably the first three post-nuclear turns. The nine remaining whorls measure: length, 7.0 mm.; diameter, 1.9 mm.

The retractive axial ribs which are as a rule enfeebled on the last turn or two, together with the irregular spiral sculpture, characterize this form. In its detail sculpture, number of ribs, and spirals it is as variable as *T. (P.) winkleyi* proper.

We have seen the following specimens: —

Cat. no.	No. of spec.	Locality.	Disposition of material.
203,788	2	Wood's Holl, Mass.	U. S. nat. mus.
203,789	1	" " "	" " "
203,790	1	" " "	" " "
203,791	1	" " "	" " "
203,787	1	Branford, Conn.	" " "

**Turbonilla (Pyrgiscus) sumneri** new species.

Pl. 14, figs. 53, 55.

Shell rather small, pupiform, subdiaphanous. Nuclear whorls very small, two and one quarter, helicoid, having their axis at right angles to that of the succeeding turns in the first of which they are about one quarter immersed. Post-nuclear whorls inflated, angulated about one third of the distance between the sutures posterior to the periphery, sloping from this place almost in a straight line to the summit, and rounding suddenly from it to the anterior suture. Summits of the whorls slightly shouldered. The axial sculpture consists of strong, somewhat sinuous, well rounded ribs which pass over the periphery of the last whorl to the umbilical region; there are 18 of these upon the 4th; 22 upon the 5th; and 28 upon the penultimate turn. The spiral sculpture consists of ten, subequal and subequally

spaced lines of pits which pass up on the sides of the ribs but do not cross them. Sutures strongly constricted. Periphery of the last whorl obscurely angulated. Base well rounded, somewhat inflated, marked by about 15 weakly incised spiral lines, which are rendered wavy by the ribs. Aperture rather large, oval, posterior angle acute; outer lip thin, showing the external sculpture within; columella very slender, strongly curved and reflexed, the reflexed portion forming a suggestion of an umbilicus.

The type, cat. no. 203,792 U. S. N. M., comes from Wood's Holl, Mass. It has six post-nuclear whorls and measures: length, 3.3 mm.; diameter, 1.2 mm.

**Turbonilla (Pyrgiscus) whiteavesi** new species.

Pl. 12, figs. 32, 38.

Shell elongate-conic, rather stout, light horn yellow. Nuclear whorls small, two and one half, depressed helicoid, not at all immersed, having their axis at right angles to that of the succeeding turns. Post-nuclear whorls evenly well rounded, marked by rather closely spaced, obsolete, retractive axial ribs which are scarcely at all defined on the early and last whorls, being indicated practically on the median turns only. The spiral sculpture between the sutures consists of six, more or less continuous, equally strong incised lines, of which the 1st and 2d, 3d and 4th, 4th and 5th, enclose spaces of about equal width, while those between the 2d and 3d and 5th and 6th are of equal width but a little broader than the outer group. Periphery and base of the last whorl well rounded, the latter marked by the obsolete axial ribs only. Aperture moderately large, oval, posterior angle acute; outer lip thin, showing the external sculpture within; columella slender, curved, and somewhat reflexed; parietal wall covered by a thin callus.

There are two lots of this species in the collection of the U. S. national museum: one, cat. no. 83,409, two specimens collected at Shediac Bay, New Brunswick, by Dr. J. F. Whiteaves, for whom the species is named; and three, cat. no. 203,793 collected by Rev. H. W. Winkley at Prince Edward Island. Our description of the nucleus is based upon a young specimen of 203,793, and an adult shell minus the nucleus from 83,409. The last has ten post-nuclear whorls and measures: length, 7.0 mm.; diameter, 2.0 mm.

The specimens from Prince Edward Island differ from those of Shediac, in having from one to three faint spiral lines on the base.

We have seen 13 additional specimens from Prince Edward Island in Rev. H. W. Winkley's collection.

**Turbonilla (Pyrgiscus) rathbuni** Verrill and Smith.

Pl. 12, figs. 33, 39.

*Turbonilla rathbuni* Verrill and Smith, Amer. Journ. Sci., ser. 3, vol. 20, p. 398, 1880; Trans. Conn. Acad. Arts and Sci. vol. 5, p. 536, pl. 58, fig. 15, 1882.

Shell very large, elongate-conic, milk white. Nucleus very small, depressed helicoid, consisting of two and one half whorls, having its axis at right angles to that of the succeeding turns, and about one fourth immersed in the first of them. Post-nuclear whorls slightly flattened in the middle between the sutures, summit appressed, crossed by strong, rounded, axial ribs of which 22 occur upon the 2d, 3d, and 4th; 24 upon the 5th and 6th; 26 upon the 7th; 28 upon the 8th; 34 upon the 9th; 38 upon the 10th; and about 42 upon the penultimate turn. On the last whorl the ribs are less strongly developed than on the preceding turns. The spiral sculpture consists of about 22 lines of varying strength and spacing in the intercostal spaces. Periphery of the last whorl well rounded. Base somewhat inflated, rather short, marked by about 16 diversely spaced spiral lines, which vary in strength from mere striations to well incised lines. Aperture broadly ovate; outer lip thin, showing the external sculpture within; columella curved and somewhat reflexed.

The specimen described and figured, cat. no. 45,459 U. S. N. M., has lost the nucleus and probably the first post-nuclear turn; the remaining eleven measure: length, 13.5 mm.; diameter, 3.8 mm. The nuclear whorls were described from a specimen of lot cat. no. 94,841 U. S. N. M.

The following have been examined:—

Cat. no.	No. of spec.	U.S.F.C. sta.	Locality.	Depth (fms.).	Temp.	Disposition of material.
154	1		Wood's Holl, Mass.			Wood's H. coll.
76,726	1	2240	S. of Martha's Vin'd, Mass.	44		U. S. nat. mus.
45,463	2	849	" "	100	52°	" " "
45,457	1	870	Off " "	155		" " "
45,456	5	869	" "	192	50°	" " "

Cat. no.	No. of spec.	U.S.F.C. sta.	Locality.			Depth (fms.).	Temp.	Disposition of material.		
45,465	1	1096		Martha's	Vin'd, Mass.	317	40°	U. S.	nat.	mus.
53,118	1	2590	Off	"	"	190	47°	"	"	"
34,873	1	2092	"	"	"	197	45°	"	"	"
45,461	4	945	"	"	"	207	44°	"	"	"
45,469	5	2183	S. of	"	"	195	44°	"	"	"
45,466	1	1113	Off	"	"	192	43°	"	"	"
45,459	4	895	"	"	"	238	42°	"	"	"
45,468	4	1154	"	"	"	193		"	"	"
45,464	4	1095	"	"	"	321	40°	"	"	"
45,460	1	925	"	"	"	229	42°	"	"	"
103,444	1	2583	"	"	"	137	47°	"	"	"
45,462	1	947	"	"	"	319	44°	"	"	"
34,808	1	2048	Off	Nantucket	Shoals, Mass.	547		"	"	"
76,687	1	2262	"	"	"	250	41°	"	"	"
94,842	1	995	"	Newport,	R. I.			"	"	"
94,841	3	869	"	"	"			"	"	"

**Turbonilla (Pyrgiscus) cascoensis** new species.

Pl. 12, figs. 29, 40.

Shell elongate-conic, milk white (nuclear whorls decollated). Post-nuclear whorls evenly moderately rounded, with appressed summits; marked by moderately strong, low, broad, rounded axial ribs. Of these there are about 24 upon the fourth remaining turn; 28 upon the 5th, 6th, and 7th; 36 upon the 8th; on the latter part of this whorl they become much enfeebled while on the penultimate they are very ill defined. In addition to the axial ribs the whorls are marked between the sutures by five strong spiral rows of pits and 13 faint lines of different strengths which pass across the intercostal spaces, up on the sides of the ribs, but do not cross them. The detail arrangement is as follows: between the first (peripheral) and the next line of pits, there is one line of moderate strength; between the second and third, there are a fine, a strong, a moderately strong, and another fine line; between the third and fourth there are a strong and a very fine line; between the fourth and fifth one strong line occurs; while posterior to the fifth are three very fine lines then a space followed by two more fine lines. Of the lines of pits the fourth is the strongest, the fifth next, while the three others are of equal strength. Periphery and base of the last whorl well rounded, the latter crossed by the continuations of the axial ribs and about 14 fine wavy spiral striations,

which are more crowded about the umbilical area than at the peripheral part of the base. Aperture small, oval, posterior angle acute; outer lip thin, showing the external sculpture within; columella short, slender, and very strongly curved.

The type and two additional specimens, cat. no. 203,795 U. S. N. M., come from Casco Bay, Maine. The type has lost the nucleus and probably the first post-nuclear turn; the ten remaining whorls measure: length, 7.3 mm.; diameter, 2.0 mm.

**Turbonilla (Pyrgiscus) edwardensis** new species.

Pl. 12, figs. 20, 25.

Shell slender, elongate-conic, yellow. Nuclear whorls small, one and one half, having their axis at right angles to that of the succeeding turns, and slightly immersed in the first of these. Post-nuclear whorls well rounded, faintly shouldered at the summit, marked by irregular, retractive obsolete axial ribs, which are very ill defined on the last turns. The spiral sculpture between the sutures consists of five strongly incised continuous lines and one feeble one. The feeble line divides the space between the second and third strong spirals. The space enclosed between the first and second spirals is equal to that between the fifth and sixth and these are considerably wider than the others which are subequal. Periphery well rounded. Base inflated, well rounded, marked by the obsolete riblets and about 13 well incised spiral lines of varying strength and spacing. Aperture oval, outer lip thin, showing the external sculpture within; columella very slender and strongly curved.

The type, cat. no. 203,794 U. S. N. M., and one other specimen come from Prince Edward Island. The type has nine post-nuclear whorls and measures: length, 5.2 mm.; diameter, 1.5 mm.

ODOSTOMIA Fleming.

*Odostomia* Fleming, Edinburgh encyclop., vol. 7, pt. 1, p. 76, 1813, = *Odontostomia* Jeffreys, 1839, = *Ptychostomon* Locard, 1886, = *Turritodostomia* Sacco, 1892.

Shell usually short, few whorled, subconic or ovate, columellar fold single, varying in strength, outer lip entire.

Type, *Turbo plicatus* Montagu.

*Key to the Subgenera of Odostomia.*

- A. Whorls nodulose between the sutures . . . . . *Chrysalida*.  
 AA. Whorls not nodulose between the sutures.  
 a. Spiral markings consisting of fine lirations.  
 Axial ribs present on the posterior half of the whorls between the sutures  
*Evalina*.  
 aa. Spiral markings consisting of well developed cords, axial sculpture  
 reduced to mere raised lines, confined to the grooves between the  
 cords.  
 b. Shell umbilicated . . . . . *Iolaea*.  
 bb. Shell not umbilicated . . . . . *Menestho*.  
 aaa. Spiral markings absent or if present consisting of extremely fine  
 microscopic striations only.  
 Columellar fold present . . . . . *Odostomia*.  
 Columellar fold absent . . . . . *Liostomia*.

## CHRYSALLIDA Carpenter.

*Chrysalida* Carpenter, Cat. Mazatlan shells, p. 416, 1856, = *Noemia* De Folin, 1870, = *Noemiamea* De Folin, 1885 (not *Noemia* Pascal, 1857).

Shell ornamented between the sutures by axial ribs and spiral cords, the junctions of which form nodules; base spirally grooved; grooves crossed by numerous slender axial lirations.

Type, *Chemnitzia communis* C. B. Adams.

*Key to the Species of Chrysalida.*

- All four spiral keels nodulous between the sutures.  
 Shell large, adult about 3.8 mm. or more . . . . . *seminuda*.  
 Shell small, adult about 2.5 mm. or more . . . . . *willisi*.  
 Only three spiral keels nodulous, the anterior one smooth . . . *bushiana*.

**Odostomia (Chrysalida) seminuda** C. B. Adams.

Pl. 13, figs. 45, 48.

*Odostomia seminuda* C. B. Adams, Boston journ. nat. hist., vol. 2, p. 280, pl. 4, fig. 13, 1839.

Shell very elongate-ovate, milk white. Nuclear whorls at least two, smooth, depressed helicoid, a little more than half obliquely immersed in the first of the succeeding turns. Post-nuclear whorls well rounded, somewhat shouldered at the summit, ornamented between the sutures by nodular axial ribs of which 18 occur upon the 2d; 22 upon the 3d;

24 upon the 4th and the penultimate whorl. In addition to the ribs, there are four low, broad, spiral ridges which divide the space between the sutures into four equal areas, one of which is at the periphery and one at the summit, while the remaining two divide the space between them. Spaces between the spiral ridges about one sixth as wide as the ridges. The junctions of the spirals and the axial ribs form the nodules. Sutures channelled. Periphery and base of the last whorl inflated, marked by about seven strongly incised spiral grooves which are a little more distantly spaced near the periphery than the umbilical area. Spiral grooves crossed by many slender lirations. Aperture irregularly auriculate, effuse at the junction of the outer lip and columella, posterior angle very obtuse; outer lip rather thick within, thin at the edge, showing the external sculpture within; columella strong, decidedly twisted and reflexed, re-enforced throughout almost its entire length by the attenuated base, provided with a strong oblique fold near its insertion which becomes enfeebled as it approaches the visible part of the aperture; parietal wall covered by a faint callus.

The specimen described is one of a lot from Vineyard Sound, cat. no. 159,098 U. S. N. M., has six post-nuclear whorls, and measures: length, 3.8 mm.; diameter, 1.8 mm.

The following specimens have been examined:—

Cat no.	No. of spec.	U.S.F.C. sta.	Locality.	Depth (fms.).	Temp.	Disposition of material.
159,092	11		North of No Man's Land, Mass.			U. S. nat. mus.
159,100	2		Buzzards Bay, Mass.			" " "
159,096	38		Quisset, "			" " "
	790a	1	Wood's Holl, "			Wood's Holl coll.
	721	1	" " "			" " "
		30	" " "			H. W. Winkley coll.
159,093	1	1205-	" " (off East Chop)	11	72°	U. S. nat. mus.
159,098	58		Vineyard Sound, Mass.			" " "
159,099	7		" " "			" " "
159,095	32	834	Sakomet Riv., R. I.	11	71°	" " "
159,094	1	835	" " "	3	71°	" " "
159,097	1	798	Off Newport, "	12	59°	" " "
			Branford Riv., Conn.			H. W. Winkley coll.
94,849	2		Mass.			U. S. nat. mus.
97,510	3		East coast of U. S.			" " "
55,213	1		" " " " (?)			" " "

**Odostomia (Chrysallida) willisi** new species.

Pl. 13, fig. 42.

Shell very small, elongate-ovate, milk white. Nuclear whorls small, smooth, obliquely immersed in the first of the succeeding turns above which only a fraction of the uptilted last and a bit of the preceding whorl project. Post-nuclear whorls weakly rounded, somewhat shouldered at the summit, ornamented by weak nodulous axial ribs of which about 20 occur upon the 2d, 26 upon the 3d and the penultimate turn. In addition to the ribs there are four low broad spiral cords, separated by narrow grooves that divide the space between the sutures into four subequal areas of which the peripheral one is the widest and the one at the summit the narrowest. The junctions of ribs and cords form the nodules, the posterior row of which is the strongest and gives the whorl a coronated appearance. Periphery of the whorls marked by a deep groove which is visible between the sutures above the summit on the last turn. Base of the last turn well rounded, marked by six spiral grooves which are subequal and unequally spaced. The grooves are crossed by many slender, closely placed lirations which give them a punctate appearance. Aperture (of adolescent specimen) elongate-ovate, somewhat effuse at the junction of the columella and outer lip; posterior angle obtuse; outer lip thin showing the external sculpture within; columella evenly curved, reflexed, and re-enforced throughout its entire length by the attenuated base, provided with a strong oblique fold at the insertion which is just visible when the aperture is viewed squarely; parietal wall covered by a thin callus.

The type has four and one half post-nuclear whorls and measures: length, 2.3 mm.; diameter, 1.2 mm. The type and eight specimens, cat. no. 203,796 U. S. N. M., were collected by Mr. Willis at Summerside, Prince Edward Island.

Another lot, cat. no. 203,798 U. S. N. M., 23 specimens, was collected by Rev. H. W. Winkley at the same locality.

**Odostomia (Chrysallida) bushiana** new species.

Pl. 13, fig. 44.

Shell elongate-ovate, chalk white. Nuclear whorls completely immersed in the first of the succeeding turns. Post-nuclear whorls

moderately rounded, strongly shouldered at the summit, ornamented between the sutures by nodulous axial ribs of which about 18 occur upon the 2d, 22 upon the 3d, and 26 upon the penultimate turn. In addition to the ribs they are marked by four rather strong spiral cords the posterior two of which are placed closely together, being separated only by a very narrow groove; the next one anterior to them occupies the middle of the whorl, and the first is immediately above the deep, wide peripheral groove. The groove between the peripheral cord and the second one is a little wider than that between the second and third. The axial ribs extend only as feeble riblets across the groove between the first and second spiral cords and do not render the first one tuberculate as they do the three others. Sutures deeply channelled. Periphery of the last whorl marked by a deep, broad groove, which is visible in the sutures of all the whorls. Base rather short, well rounded, marked by about five subequally spaced spiral grooves which, like the peripheral one, are crossed by many slender axial lirations. Aperture irregularly ovate (?), somewhat effuse anteriorly, outer lip fractured, columella strong, curved, and somewhat revolute, re-enforced by the attenuated base, provided with a stout, oblique fold at its insertion.

The type, cat. no. 159,101 U. S. N. M., was dredged by the U. S. bureau of fisheries at station 816, ten fathoms, bottom temperature 66°, in Narragansett Bay. It has five post-nuclear whorls and measures: length, 2.2 mm.; diameter, 1.1 mm. Another specimen, cat. no. 159,099 U. S. N. M., comes from Vineyard Sound.

#### EVALINA Dall and Bartsch.

*Evalina* Dall and Bartsch, Proc. biol. soc. Washington, vol. 17, p. 12, 1904.

Axial ribs indicated only near the summit of the whorls, spiral markings consisting of many subequally spaced spiral lirations, shoulders of the whorls not tabulated.

Type, *Odostomia (Evalina) americana* Dall and Bartsch.

*Odostomia (Evalina) winkleyi* new species.

Pl. 13, fig. 47.

Shell pupiform, bluish white (nuclear whorls eroded). Post-nuclear whorls well rounded, somewhat inflated, slightly shouldered

at the summit, marked by fine, irregular, obsolete axial riblets which are strongest near the summit of the whorls, and many fine spiral lirations about five of which are a little coarser than the rest, between the sutures. Periphery and base of the last whorl well rounded, the latter weakly umbilicated and marked by lines of growth and fine spiral lirations. Aperture oval; posterior angle obtuse; outer lip thin, showing the external marking within; columella very slender, strongly curved and slightly reflexed, provided with a weak internal fold.

The type and one other specimen, cat. no. 203,797 U. S. N. M., were collected by Rev. H. W. Winkley at Branford, Conn. The type has six post-nuclear whorls and measures: length, 2.8 mm.; diameter, 1.3 mm. Four additional specimens from the same locality are in Rev. Winkley's collection.

#### IOLAEA A. Adams.

*Iolaea* A. Adams, Proc. zool. soc. London, p. 310, 1867, = *Iole* A. Adams, Ann. mag. nat. hist., ser. 3, vol. 5, p. 300, 1860 (not *Iole* Blyth, Journ. Asiat. soc. Bengal, vol. 13, pt. 1, p. 386, 1844).

Shell umbilicated, marked by spiral cords and axial riblets which cross the grooves between them.

Type, *Iole scitula* A. Adams.

#### *Odostomia* (*Iolaea*) *hendersoni* new species.

Pl. 13, fig. 43.

Shell thin, elongate-ovate, shining, white, broadly umbilicated. Nuclear whorls very small, obliquely completely immersed in the first of the succeeding turns, which gives the spire a truncated appearance. Post-nuclear whorls inflated, strongly rounded, anterior half between the sutures marked by about ten slender spiral grooves; posterior half smooth, excepting many exceedingly fine microscopic spiral lines. Periphery and base of the last whorl inflated, well rounded, the latter marked by about four incised spirals immediately anterior to the periphery, which agree with those between the sutures in strength and spacing. The rest of the base is smooth. The axial threads which usually cross the spiral grooves in species of this subgenus are here reduced to mere fine lines. Base widely umbilicated.

Aperture elongate-ovate; posterior angle obtuse, outer lip thin; columella slender, decidedly curved, slightly reflexed, provided with a very weak fold at its insertion which is not visible when the aperture is viewed squarely; parietal wall covered by a thin callus.

The type, cat. no. 203,813 U. S. N. M., comes from Wood's Holl, Mass.; it has five post-nuclear whorls and measures: length, 3.3 mm.; diameter, 1.7 mm. Three additional specimens, cat. no. 203,814 U. S. N. M., also from Wood's Holl, Mass.

MENESTHO Möller.

*Menestho* Möller, Ind. Moll. Greenland, p. 10, 1842.

Shell not umbilicated, marked by moderately well developed and usually equally spaced spiral cords; axial sculpture reduced to mere lines of growth which frequently appear as *very slender* raised threads in the grooves between the cords.

Type, *Turbo albulus* Fabricius.

*Key to the Species of Menestho.*

- A. Spiral sculpture confined to the anterior two thirds of the body-whorl  
*bruneri*.
- AA. Spiral sculpture not confined to the anterior two thirds of the body-whorl.
  - a. Spiral sculpture alike on the spire and base.
    - Spiral cords between the sutures:
      - 4 . . . . . *impressa*.
      - 6 . . . . . *morseana*.
  - aa. Spiral sculpture not alike on the spire and base.
    - c. Spiral sculpture between the sutures consisting of a single groove.
      - Adult shell 4.0 mm. long . . . . . *trifida*.
      - Adult shell 5.0 mm. long . . . . . *trifida bedequensis*.
    - cc. Spiral sculpture between the sutures consisting of from two to four strong grooves.
      - Adult shell 4.7 mm. long . . . . . *bisuturalis*.
      - Adult shell 5.6 mm. long . . . . . *bisuturalis ovilensis*.

*Odostomia (Menestho) bruneri* (Verrill).

*Menestho bruneri* Verrill, Trans. Conn. acad. arts and sci., vol. 5, p. 539, 1882.

"Shell small, white, with an elongated, acute-conical spire, the apical whorl very small, upturned, and incurved. Whorls six, with

a rounded shoulder close to the suture, the portion next the suture rising abruptly, nearly at a right angle; periphery flattened, or very slightly rounded; suture little oblique, impressed, or subcanaliculate. Aperture narrowly contracted posteriorly, narrow-ovate anteriorly; outer lip little convex, slightly produced anteriorly; columella excurved, flattened, with no fold nor tooth. Sculpture delicate, incised, spiral grooves, separated by wider intervals, and covering the anterior two-thirds of the body-whorl, extending a little back of the aperture, but mostly absent on the preceding whorls. No umbilicus. Length, 5 mm.; breadth, 2.5 mm.; length of body-whorl, 3.5 mm.; of aperture, 2.5 mm.; its breadth, 1 mm.

“Off Newport, R. I., station 892, in 487 fathoms, 1880.

“I have named this species in honor of Mr. H. L. Bruner, an assistant in the conchological work of the Fish Commission during the season of 1881.”

We have not seen this species and have quoted Verrill's original statement.

*Odostomia (Menestho) impressa* (Say).

Pl. 13, fig. 51.

*Turritella impressa* Say, Journ. acad. nat. sci. Phila., vol. 2, p. 244, 1821.

Shell elongate-conic, milk white. Nuclear whorls small, about half obliquely immersed in the first of the succeeding turns. Post-nuclear whorls flattened, shouldered at the summit, marked by three, strong, deeply incised spiral grooves, which almost equal the spaces that separate them in width. Grooves crossed by numerous fine axial threads. The spaces between the spiral grooves are rounded on the sides and obliquely flattened at the top, marked only by incremental lines. Sutures channelled, the first basal cord usually showing in it the last three volutions. Periphery marked by a deep channel, like those above it. Base somewhat produced, well rounded, marked like the spaces between the sutures by seven spiral grooves which are of almost equal strength and spacing, but less strong than those on the spire. Aperture elongate-ovate, somewhat effuse anteriorly, posterior angle acute; outer lip thin, slightly sinuous at the edge, showing the external sculpture within; columella very stout, reinforced by the attenuated base, provided with a strong oblique fold at the insertion; parietal wall covered by a thin callus.

The specimen described and figured is one of four, cat. no. 94,847 U. S. N. M., which were collected by Dr. Stimpson at New Bedford, Mass. It has eight post-nuclear whorls and measures: length, 4.8 mm.; diameter, 1.6 mm. Another lot from Massachusetts Bay, cat. no. 94,848 U. S. N. M., was also collected by Dr. Stimpson.

**Odostomia (Menestho) morseana** new name.

= *Odostomia (Menestho) sulcata* Verrill, Proc. U. S. nat. mus., vol. 3, p. 380, 1880; Trans. Conn. acad. arts and sci., vol. 5, p. 539, pl. 58, fig. 13, 1882 (not *Odostomia (Evalea) sulcata* A. Adams, Ann. mag. nat. hist., ser. 3, vol. 6, p. 417, 1860; nor *Oscilla sulcata* A. Adams, Proc. zool. soc. London, p. 311, 1867; nor *Ondina sulcata* de Folin, Fonds de la mer, vol. 1, p. 214, pl. 29, fig. 1, 1871; nor *Odostomia sulcata* Garrett, Proc. acad. nat. sci. Phila., p. 224-225, pl. 3, fig. 46, 1873.

"Shell small, white, long-ovate; spire regularly tapered, acute, whorls about six, moderately convex, covered with many, regular, rather strong, revolving grooves. Nuclear whorl strongly inflexed and reversed. Aperture regularly ovate. No tooth on the columella. Length 2.8 mm., of body-whorl 1.8 mm., breadth 1.4 mm., length of aperture 1.1 mm., its breadth 0.7 mm.

"Stations 871 and 894, in 115 and 365 fathoms.

"This differs from all other related species of our coast, except *O. striatula* Couth. (= *Menestho albula* Gould, non Fabr.) in being strongly grooved spirally; from the latter it differs in having fewer whorls and a regularly tapered acute spire, and in having the spiral lines coarser and fewer. Perhaps it is more closely related to the real *Menestho albula* of Greenland, which, according to Jeffreys, is distinct from our shell, so named by Gould. These three forms all belong to *Menestho* Möller (= *Liostomia* G. O. Sars)."

The above is Verrill's original diagnosis; we have not seen this species.

**Odostomia (Menestho) trifida** (Totten).

Pl. 13, fig. 46.

*Actaeon trifida* Totten, Amer. journ. sci. and arts, vol. 26, p. 368, figs. 4a, 4b, 1834, = *Odostomia insculpta* DeKay, Moll. N. Y., p. 115, pl. 31, fig. 297, 1847.

Shell elongate-ovate, shining white. Nuclear whorls small, almost completely obliquely immersed in the first of the succeeding turns.

Post-nuclear whorls almost flattened, somewhat shouldered at the summit, crossed by three deeply incised spiral grooves and a faint one. The first of these grooves is a little posterior to the periphery; this is followed by the weak line, while the two other strong channels are on the posterior half between the sutures. These channels are crossed by many very weak, axial threads. Sutures feebly impressed. Periphery of the last whorl slightly angulated. Base well rounded, somewhat attenuated, marked by about ten feebly incised spiral lines, which are not of uniform strength or spacing. Aperture elongate-oval, somewhat effuse anteriorly, posterior angle acute; outer lip thin, showing the external sculpture within; columella re-enforced by the attenuated base, rather short, reflexed, provided with a strong oblique fold at its insertion.

The specimen described and figured is one of a lot, cat. no. 83,404 U. S. N. M., that comes from Massachusetts Bay. It has seven post-nuclear whorls and measures: length, 4.0 mm.; diameter, 1.5 mm.

This species is somewhat variable in the intensity of the spiral sculpture. On some, the line described above as faint, appears as strong as the rest, *i. e.*, the whorls are then crossed by four deep channels between the sutures. In other individuals the second channel below the summit appears only as a faint line and even the peripheral one may be reduced to a mere line; in such instances the shell resembles *Odostomia (Menestho) bisuturalis*. These lines and channels, however, are never quite absent, and this leads us to consider *O. (M.) bisuturalis* as distinct.

The following specimens have been examined:—

Cat. no.	No. of spec.	Locality.	Disposition of material.
129,329	7	Newcastle, Maine.	U. S. nat. mus.
	3	Sheepscoot Riv., "	H. W. Winkley coll.
83,404	11	Massachusetts Bay, Mass.	U. S. nat. mus.
83,473	1	New Bedford, Mass.	" " "
203,799	3	Wood's Holl, "	" " "
159,087a	3	" " "	" " "
9,679	1	" " "	Wood's Holl coll.
203,800	12	" " "	U. S. nat. mus.
	50	" " "	H. W. Winkley coll.
203,249	1	Weepeeket Island, Mass.	U. S. nat. mus.
94,844	3	Kettle Point, Prov. R., R. I.	" " "
83,474	11	New Haven, Conn.	" " "
203,801	60	Branford, "	" " "
	1000	" "	H. W. Winkley coll.

**Odostomia (Menestho) trifida bedequensis** new subspecies.

Pl. 13, fig. 49.

Shell similar to that of *Odostomia (Menestho) trifida* but much larger in every way. The spiral sculpture is usually stronger than in *trifida*, and there is a tendency to split the spaces between the deeply incised grooves by the introduction of additional spiral lines.

The type has seven post-nuclear whorls and measures: length, 5.0 mm.; diameter, 2.1 mm.

The type, cat. no. 203,802 U. S. N. M., and nine additional specimens were collected by Rev. H. W. Winkley, at Bedeque, Prince Edward Island; ten more from the same lot are in Rev. H. W. Winkley's collection.

**Odostomia (Menestho) bisuturalis** (Say).

Pl. 14, fig. 59.

*Turritella bisuturalis* Say, Journ. acad. nat. sci. Phila., vol. 2, p. 244, 1821, = *Jamnia exigua* Couthouy, Boston journ. nat. hist., vol. 2, p. 92, pl. 1, fig. 7, 1838.

Shell conic, milk white. Nuclear whorls at least two, depressed helicoid, a little more than half obliquely immersed in the first of the succeeding turns. Post-nuclear whorls moderately rounded, somewhat shouldered at the summit, marked axially by incremental lines only; spirally, by one deeply incised channel situated a short distance anterior to the summits of the whorls, and many microscopic wavy spiral striations. The deep channel is crossed by numerous fine raised axial threads. Sutures well impressed. Periphery and base of the last whorl inflated, marked by incremental lines and microscopic wavy spiral lines only. Aperture large, elongate-oval, somewhat effuse anteriorly, posterior angle acute; outer lip thin; columella slender, slightly curved, strongly reflexed, with the anterior half free, provided with an oblique fold at its insertion, which is not visible when the aperture is viewed squarely; parietal wall glazed by a thin callus.

The specimen described and figured, cat. no. 159,816 U. S. N. M., comes from Parker's Point, Wood's Holl, Mass. It has eight post-nuclear whorls and measures: length, 4.7 mm.; diameter, 1.8 mm.

The following specimens have been examined:—

Cat. no.	No. of spec.	Locality.	Disposition of material.
	1	Bedeque, Prince Edward Island.	H. W. Winkley coll.
	3	Sheepscoot Riv., Maine.	" " "
203,805	1	" " "	U. S. nat. mus.
107,037	11	Newcastle, "	" " "
126,547	3	Wiscasset, "	" " "
203,806	1	Biddeford Pool, "	" " "
94,846	7	Mass.	" " "
83,405	1	Massachusetts Bay, "	" " "
90,327	2	" " "	" " "
94,843	7	" " "	" " "
94,845	6	" " "	" " "
87,132	12	Boston, "	" " "
153,198	5	Off Cape Cod, "	" " "
159,090	1	Provincetown, "	" " "
203,238	5	" " "	" " "
	200	Wood's Holl, "	H. W. Winkley coll.
159,087	5	" " "	U. S. nat. mus.
159,088	1	" " "	" " "
203,808	7	" " "	" " "
203,809	15	" " "	" " "
203,240	9	Wood's Holl (Little Harbor), Mass.	" " "
203,241	12	" " (Great Harbor), "	" " "
159,089	3	" " (Parker's Point), "	" " "
159,816	1	" " " " "	" " "
203,193	9	" " " " "	" " "
159,086	1	Naushon Island, Mass.	" " "
159,091	1	Vineyard Sound, "	" " "
203,242	2	" " "	" " "
83,475	5	New Haven, Conn.	" " "
203,239	32	" " (Sabin Rock), Conn.	" " "
203,807	9	Branford, "	" " "
	150	" " "	H. W. Winkley coll.

*Odostomia (Menestho) bisuturalis ovilensis* new subspecies.

Pl. 14, fig. 57.

Shell similar to that of *O. (M.) bisuturalis* but larger in every way, with the whorls more inflated and rounded, and the fine spiral sculpture much more strongly developed.

The type, cat. no. 203,803 U. S. N. M., from Sheepscoot River, Maine, has the last five and one half whorls remaining which measure: length, 5.6 mm.; diameter, 2.6 mm. Eight young individuals, cat. no. 203,804 U. S. N. M., come from Sheepscoot River, Maine, while

two other immature specimens, cat. no. 126,546 U. S. N. M., are from Wisasset, Maine.

ODOSTOMIA Fleming s. s.

*Odostomia* Fleming, Edinburgh encyclop., vol. 7, pt. 1, p. 76, 1813, = *Odonostomia* Jeffreys, 1839, = *Ptychostomon* Locard, 1886, = *Turritodostomia* Sacco, 1892.

Axial and spiral sculpture absent, the latter sometimes indicated by exceedingly fine microscopic spiral striations. Columellar fold present.

Type, *Turbo plicatus* Montagu.

***Odostomia (Odostomia) modesta* (Stimpson).**

Pl. 13, fig. 50.

*Chemnitzia modesta* Stimpson, Proc. Boston soc. nat. hist., vol. 4, p. 16, 1851.

Shell thick, ovate, yellowish white, shining. Nuclear whorls small, obliquely completely immersed in the first of the succeeding turns. Post-nuclear whorls inflated, the summit with well rounded shoulders. Periphery of the last whorl obscurely angulated. Base rather inflated, well rounded. Sutures well impressed. Entire surface marked by only fine lines of growth and exceedingly fine indistinct spiral striations. Aperture broadly oval, very slightly effuse anteriorly, posterior angle acute; outer lip thick within, edge thin; columella stout, decidedly curved, strongly reflexed over the re-enforcing base (which gives it a slight umbilical chink at its posterior extremity) and provided with a strong oblique fold at its insertion; parietal wall covered by a wavy thin callus.

The specimen described, cat. no. 203,812 U. S. N. M., was collected at Wood's Holl, Mass. It has five post-nuclear whorls and measures: length, 3.2 mm.; diameter, 1.8 mm.

Another specimen, a young individual from the same locality, is in Rev. H. W. Winkley's collection.

***Odostomia (Odostomia) dealbata* (Stimpson).**

*Chemnitzia dealbata* Stimpson, Proc. Boston soc. nat. hist., vol. 4, p. 114, 1851, = *Odostomia dealbata* Binney-Gould, Invert. of Mass., p. 327, fig. 595, 1870.

Shell ovate-conic, white, smooth, pellucid; whorls six, rather convex; aperture ovate, hardly effuse; furnished with a small inconspicuous fold. Length, seventeen hundredths of an inch; breadth, six and a half hundredths of an inch.

The above is Stimpson's original description based on a specimen from Boston Harbor, Mass. We have not seen the species.

#### LIOSTOMIA G. O. Sars.

*Liostomia* G. O. Sars, Moll. reg. arct. Norveg., p. 205, 1878.

Shell without axial or spiral sculpture, columellar fold absent.

Type, *Rissoa eburnea* Stimpson.

#### Odostomia (*Liostomia*) *eburnea* (Stimpson).

*Rissoa eburnea* Stimpson, Proc. Boston soc. nat. hist., vol. 4, p. 14, 1851; Shells of New England, p. 34, pl. 1, fig. 1, 1851.

Shell small, ovate conic, white, shining, smooth. Whorls 4, rather convex, subangulated at the suture, aperture ovate-elliptic, anteriorly effuse, lip thin, simple, acute.

Length, 4.0 mm.; diameter, 2.3 mm.

Two specimens were taken in thirty fathoms off Cape Ann.

The above description is from the original diagnosis by Stimpson; we have not seen specimens of the species.

#### COUTHOUYELLA new genus.

Animal without radula, eyes sessile at the outer bases of the tentacles. Shell elongate-conic, many whorled, spirally grooved, operculum thin, horny, paucispiral.

Type, *Pyramis striatula* Couthouy.

The species for which the present genus has been erected, has enjoyed rather varied experiences. It was described under *Pyramis*, a genus without status; from this it was transferred to the Pyramidellid genus *Odostomia* and later to *Menestho*. It has certain superficial resemblances to *Actacopyramis*, part of whose species have at times been considered under *Menestho*. The resemblance, however, is

only superficial, since *Couthouyella* has neither a sinistral nucleus, nor a columellar fold of which the first is always, and the second usually, present in *Pyramidellidae*. The position of the eyes is characteristic of *Eulimidae*, to which family we refer the new genus.

We are indebted to Messrs. Kurtz and Stimpson for a manuscript figure of the animal.

***Couthouyella striatula* (Couthouy).**

Pl. 11, figs. 13, 16; Pl. 14, figs. 56, 58.

*Pyramis striatulus* Couthouy, Proc. Boston soc. nat. hist., vol. 2, p. 101, pl. 1, fig. 6, 1839, = *Odostomia striatula* (Couthouy) Verrill = *Menestho albula* auct. (not *Turbo albulus* O. Fabricius, 1780, = *Odostomia (Menestho) albula* O. Fabricius).

Shell elongate-conic, strong, milk white. Nucleus composed of about one and one quarter smooth dextral turns. Early post-nuclear whorls well rounded, the later ones slightly rounded on the anterior two thirds between the sutures, having the summits appressed and somewhat excurved, which renders the outline of each turn slightly sigmoid. The space immediately anterior to the summit is smooth, barring the faint incremental lines which cover the entire surface of the shell; the rest is marked by low spiral cords of which there are four on the second, five on the third, and six on the fourth to seventh, after which the shell seems to reach a senile stage in which the spiral cords become much divided, less regular, and less strong. On the penultimate whorls of the adult shell there are fifteen low cords between the summit and the periphery. Sutures well impressed. Periphery rounded. Base moderately rounded, marked by eight spiral cords, those nearest the periphery being the best developed, the rest growing successively weaker, the anterior third of the base being unmarked. Aperture ovate, somewhat effuse anteriorly, posterior angle acute; outer lip thick within, curving to a sharp edge; columella curved, re-enforced for a little more than half its length by the base, reflexed in the free anterior portion.

An adult specimen that has lost its nucleus and probably the first two and one half post-nuclear turns, measures: length, 13.6 mm.; diameter, 4.3 mm.

Not one of all the adult specimens of this species that we have examined, was complete. In all, the early whorls were decollated.

The description given above is based upon a young individual which consists of the nucleus and the first four post-nuclear turns, cat. no. 77,055 U. S. N. M., from Gloucester, Mass., U. S. F. C. sta. 180, ten fathoms, and an adult having the last eight post-nuclear turns, cat. no. 74,763 U. S. N. M., Cashe's Ledge.

The following specimens have been examined:—

Cat. no.	No. of spec.	U.S.F.C. sta.	Locality.	Depth (fms.).	Temp.	Disposition of material.
74,765	1	70	Bedford Basin, N. S.	190	39°	U. S. nat. mus.
74,766	1	72-6	Halifax Harbor, "	18	41°	" " "
52,325	1	2484	Bet. St. Peters and Banquereau.	204		" " "
74,760	5		Bay of Fundy, "			" " "
	1		Eastport, Maine.			Winkley coll.
	10		Casco Bay, "			" "
74,761	2		" " "			U. S. nat. mus.
94,824	6		" " "			" " "
74,763	1	55 & 56	Cashe's Ledge, Mass.	46		" " "
77,054	1	167	Annisquam Harbor, Mass.	35	41°	" " "
74,768	1	141-145	Gloucester Harbor, "	8	51°	" " "
74,769	1	152	" " "	7-10		" " "
77,055	1	180	" " "	10		" " "
159,102	2		" " "	10		" " "
74,771	1	227	Off Gloucester, "	23	58°	" " "
203,018	1	182	" Eastern Point, "			" " "
74,762	2		" Halfway Rock, "	29		" " "
74,770	1	209	Massachusetts Bay, "	17	48°	" " "
74,772	1	228	" " "	19		" " "
74,776	3	345-348	" " "	16	46°	" " "
83,412	7		" " "			" " "
74,773	1	368	Off Cape Cod, "	15		" " "
74,774	3	245 & 7	" " "	28-34		" " "
74,775	2	329	" " "	26	42°	" " "
74,777	1	369	" " "	18		" " "
74,778	4	376	" " "	46	45°	" " "
74,781	1	965	Buzzards Bay, "	15	53°	" " "
74,782	1	980	" " "	14	53°	" " "

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'51b. [Descriptions of several new species of shells from the northern coast of New England.] *Proc. Boston soc. nat. hist.*, 1851, vol. 4, p. 113-114.

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'34. Description of some new shells, belonging to the coast of New England. *Amer. journ. sci. and arts*, 1834, vol. 26, p. 366-369.

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'80. Notice of the remarkable marine fauna occupying the outer banks off the southern coast of New England. *Amer. journ. sci.*, 1880, ser. 3, vol. 20, p. 390-403.

'81. Notice of recent additions to the marine Invertebrata of the north-eastern coast of America, with descriptions of new genera and species

and critical remarks on others. Part 2.—Mollusca, with notes on Annelida, Echinodermata, etc., collected by the United States fish commission. Proc. U. S. nat. mus., 1881, vol. 3, p. 356–405.

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*Printed February, 1909.*

EXPLANATION OF PLATES.

In some instances the very fine, closely crowded striation has been omitted, while in other cases where shown it has been exaggerated by the artist. Attention is called to this under the explanation of the figures. The measurements cited after the names refer to the axial length of the specimen.

PLATE 11.

All figures on this plate have been enlarged seven times.

- Fig. 1. *Pyramidella* (*Syrnola* ?) *winkleyi* new species. 5.8 mm. p. 74.  
The fine spiral markings have been omitted in this figure.
- Fig. 2. *Turbonilla* (*Ptycheulimella*) *emertoni* Verrill. 5.7 mm. p. 75.
- Fig. 3. *Pyramidella* (*Syrnola* ?) *producta* (C. B. Adams). 5.1 mm. p. 72.  
The fine spiral markings have been omitted in this figure.
- Fig. 4. *Pyramidella* (*Syrnola* ?) *fusca* (C. B. Adams). 5.5 mm. p. 73.
- Fig. 5. Nucleus of *Turbonilla* (*Ptycheulimella*) *emertoni* Verrill, lateral view much enlarged.
- Fig. 6. Nucleus of *Turbonilla* (*Turbonilla*) *stricta* Verrill, lateral view much enlarged.
- Fig. 7. *Turbonilla* (*Turbonilla*) *stricta* Verrill. 4.2 mm. p. 76.
- Fig. 8. *Turbonilla* (*Strioturbonilla*) *bushiana* Verrill. 11.2 mm. p. 79.
- Fig. 9. *Turbonilla* (*Turbonilla*) *nivea* (Stimpson). 5.2 mm. p. 77.
- Fig. 10. Nucleus of same, lateral view much enlarged.
- Fig. 11. Nucleus of *Pyramidella* (*Syrnola*) *smithi* (Verrill), lateral view much enlarged.
- Fig. 12. Nucleus of *Turbonilla* (*Strioturbonilla*) *bushiana* Verrill, lateral view much enlarged.
- Fig. 13. Nucleus of *Couthouyella striatula* (Couthouy), lateral view much enlarged.
- Fig. 14. *Turbonilla* (*Strioturbonilla*) *bushiana abyssicola* new subspecies. 13.5 mm. p. 80.
- Fig. 15. *Pyramidella* (*Syrnola*) *smithi* (Verrill). 5.8 mm. p. 71.
- Fig. 16. *Couthouyella striatula* (Couthouy). 13.6 mm. p. 110.

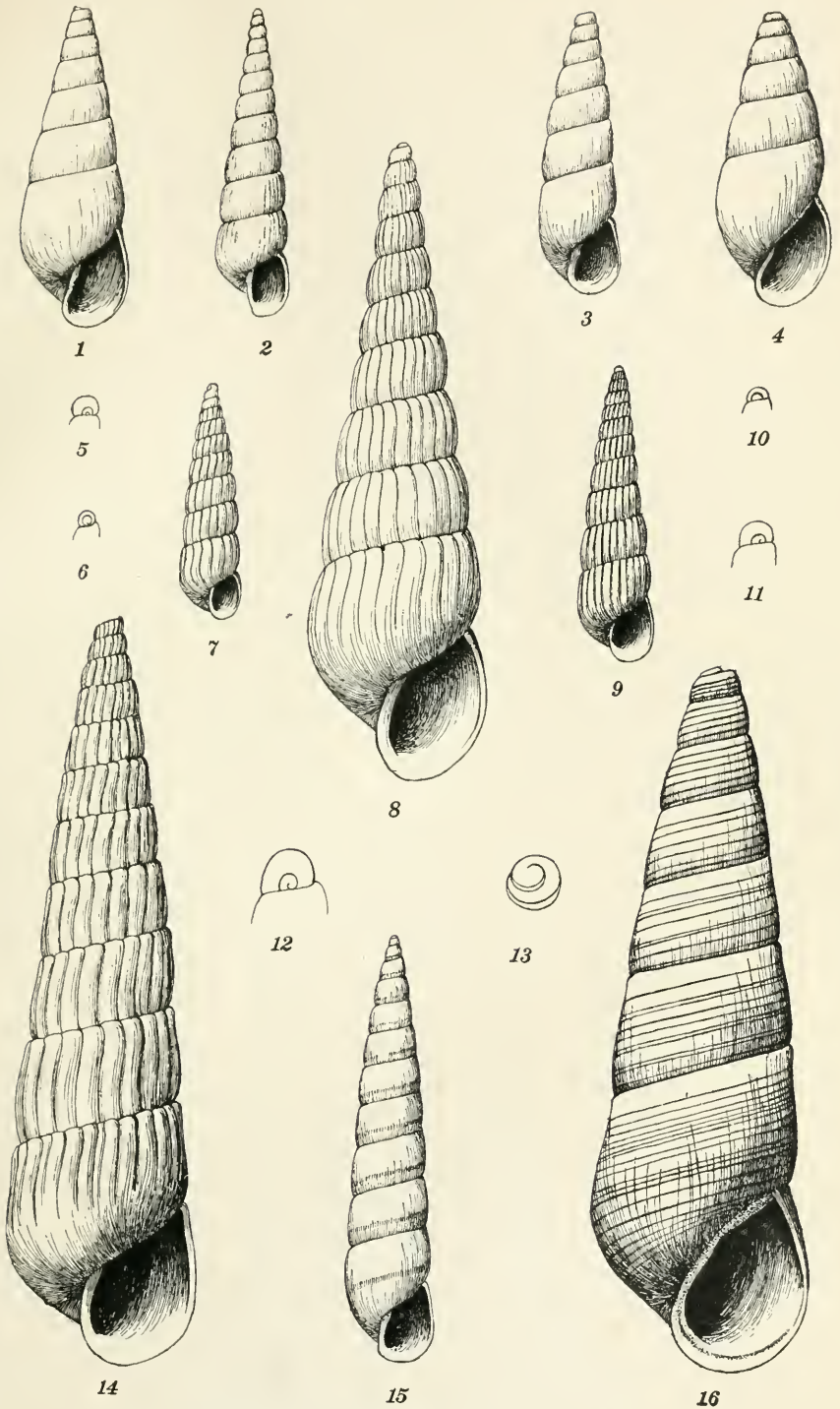






PLATE 12.

All figures on this plate have been enlarged seven times.

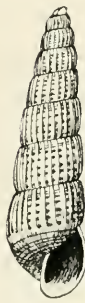
- Fig. 17. *Turbonilla (Pyrgiscus) butconis* new species. 6.3 mm. p. 89.  
 Fig. 18. *Turbonilla (Pyrgiscus) interrupta* (Totten). 5.7 mm. p. 87.  
 Fig. 19. *Turbonilla (Pyrgiscus) areolata* Verrill. 5.1 mm. p. 86.  
 Fig. 20. *Turbonilla (Pyrgiscus) edwardensis* new species. 5.2 mm. p. 96.  
 Fig. 21. *Turbonilla (Pyrgiscus) verrilli* new species. 4.9 mm. p. 82.  
 Fig. 22. *Turbonilla (Pyrgiscus) vincae* new species. 6.3 mm. p. 83.  
 Fig. 23. Nucleus of *Turbonilla (Pyrgiscus) interrupta* (Totten), lateral view much enlarged.  
 Fig. 24. Nucleus of *Turbonilla (Pyrgiscus) areolata* Verrill, lateral view much enlarged.  
 Fig. 25. Nucleus of *Turbonilla (Pyrgiscus) edwardensis* new species, lateral view much enlarged.  
 Fig. 26. Nucleus of *Turbonilla (Pyrgiscus) verrilli* new species, lateral view much enlarged.  
 Fig. 27. *Turbonilla (Pyrgiscus) elegantula branfordensis* new subspecies. 5.3 mm. p. 85.  
 Fig. 28. Detail of intercostal spiral sculpture between sutures, much enlarged, of *Turbonilla (Pyrgiscus) butconis* new species.  
 Fig. 29. Detail of intercostal spiral sculpture between sutures much enlarged, of *Turbonilla (Pyrgiscus) cascoensis* new species.  
 Fig. 30. *Turbonilla (Pyrgiscus) elegantula* Verrill. 5.3 mm. p. 84.  
 Fig. 31. Nucleus of same, lateral view much enlarged.  
 Fig. 32. Nucleus of *Turbonilla (Pyrgiscus) whiteavesi* new species, lateral view much enlarged.  
 Fig. 33. *Turbonilla (Pyrgiscus) rathbuni* Verrill and Smith. 13.5 mm. p. 94.  
 Fig. 34. Nucleus of *Turbonilla (Pyrgiscus) butconis* new species, lateral view much enlarged.  
 Fig. 35. Nucleus of *Turbonilla (Pyrgiscus) winkleyi* new species, lateral view much enlarged.  
 Fig. 36. Nucleus of *Turbonilla (Pyrgiscus) vincae* new species, lateral view much enlarged.  
 Fig. 37. *Turbonilla (Pyrgiscus) winkleyi* new species. 7.9 mm. p. 90.  
 Fig. 38. *Turbonilla (Pyrgiscus) whiteavesi* new species. 7.0 mm. p. 93.  
 Fig. 39. Nucleus of *Turbonilla (Pyrgiscus) rathbuni* Verrill and Smith, lateral view much enlarged.  
 Fig. 40. *Turbonilla (Pyrgiscus) cascoensis* new species. 7.3 mm. p. 95.  
 Fig. 41. *Turbonilla (Pyrgiscus) winkleyi senilis* new subspecies. 7.0 mm. p. 92.



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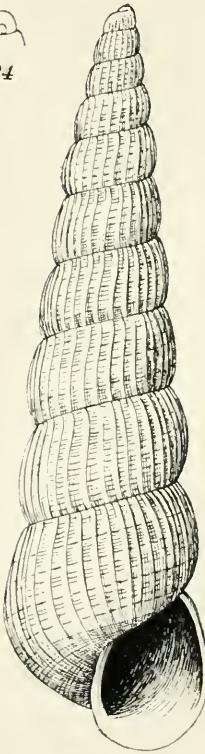
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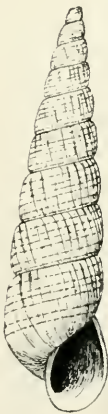
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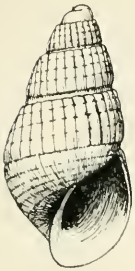




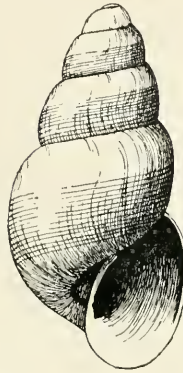
PLATE 13.

All figures on this plate are enlarged fourteen times.

- Fig. 42. *Odostomia (Chrysallida) willisi* new species. 2.3 mm. p. 99.  
Fig. 43. *Odostomia (Iolaca) hendersoni* new species. 3.3 mm. p. 101.  
Fig. 44. *Odostomia (Chrysallida) bushiana* new species. 2.2 mm. p. 99.  
Fig. 45. Nucleus of *Odostomia (Chrysallida) seminuda* C. B. Adams, lateral view much enlarged.  
Fig. 46. *Odostomia (Menestho) trifida* (Totten). 4.0 mm. p. 104.  
Fig. 47. *Odostomia (Eralina) winkleyi* new species. 2.8 mm. p. 100.  
Fig. 48. *Odostomia (Chrysallida) seminuda* C. B. Adams. 3.8 mm. p. 97.  
Fig. 49. *Odostomia (Menestho) trifida bedequensis* new subspecies. 5.0 mm. p. 106.  
Fig. 50. *Odostomia (Odostomia) modesta* (Stimpson). 3.2 mm. p. 108.  
Fig. 51. *Odostomia (Menestho) impressa* (Say). 4.8 mm. p. 103.



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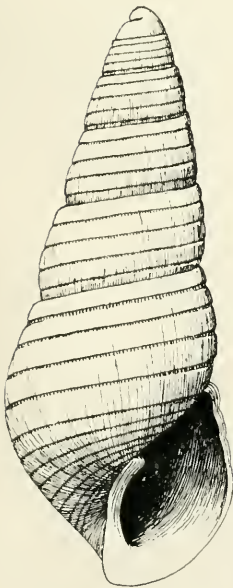
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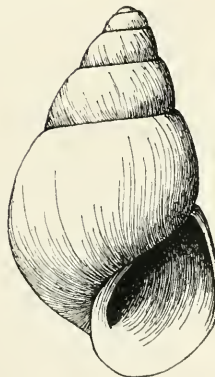
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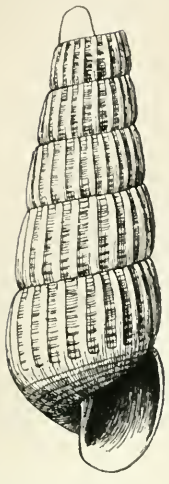




PLATE 14.

All figures on this plate are enlarged fourteen times.

- Fig. 52. *Turbonilla (Pyrgiscus) mighelsi* new name. 3.8 mm. p. 88.  
Fig. 53. Nucleus of *Turbonilla (Pyrgiscus) sumneri* new species, lateral view much enlarged.  
Fig. 54. Detail of intercostal spiral sculpture between sutures much enlarged of *Turbonilla (Pyrgiscus) mighelsi* new name.  
Fig. 55. *Turbonilla (Pyrgiscus) sumneri* new species. 3.3 mm. p. 92.  
Fig. 56. Lateral view of head of *Couthouyella striatula* (Couthouy) enlarged.  
Fig. 57. *Odostomia (Menestho) bisuturalis ovilensis* new subspecies. 5.6 mm. p. 107.  
Fig. 58. Top view of head of *Couthouyella striatula* (Couthouy) enlarged.  
Fig. 59. *Odostomia (Menestho) bisuturalis*. 4.7 mm. p. 106.



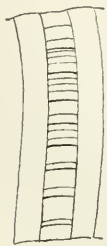
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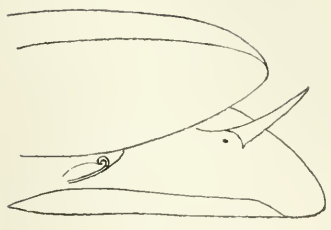
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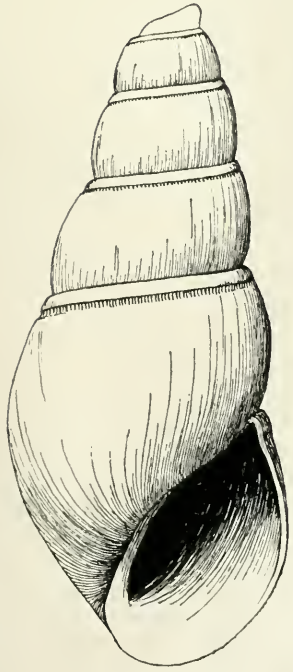
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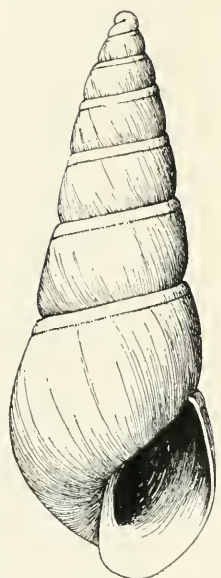
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No. 5.—NEW AND LITTLE KNOWN TIPULIDAE.

BY CHARLES W. JOHNSON.

THE following notes and descriptions are the results, in part, of determining species for several faunal lists in course of preparation. Owing to insufficient material some portions are not entirely satisfactory, but it seems better to call attention to these interesting species rather than to omit them, for they cannot be inserted without some explanation or description.

During my last summer's collecting at Riverton, New Jersey, (1902), a number of large Tipulid larvae were found about the middle of June, in a spring run flowing into Pompeston Creek about a mile above the railroad bridge. A few were taken hoping that they would soon pupate, but the change from the cold water of the spring to that of the Schuylkill was fatal. I therefore resolved to visit the locality whenever possible and endeavor to capture some adults. On July 20, five males of a large, unknown Tipulid were taken close to the spring run. On a second visit, one week later, none were to be found. The specimens were set aside, as I hoped during another season to obtain more material. Leaving Philadelphia in March, 1903, I have not had the opportunity further to study the matter and can only present the following facts for future investigators.

The specimens represent a very interesting species having antennae resembling those of *Longurio*, but with a venation that will not permit of its being placed in that genus nor in the genus *Tipula*. The genitalia are also very different from those of either of the above genera. The following generic name is therefore proposed:—

*AESHNASOMA* new genus.

Antennae short, apparently twelve-jointed,\* second joint globose, the three basal joints of the flagellum ovate, gradually diminishing in size, with a slight basal contraction; the remainder of the flagellum very slender, the joints scarcely perceptible, with long hairs irregularly verticillated toward the end. Wings with the branch of the subcosta

at the extreme tip; second branch of the media joins the median cross-vein. Hypopygium (pl. 16, figs. 14, 15) elongate, unarmed, and simple in structure. Abdomen long and slender resembling that of a dragonfly, hence the generic name.

***Aeshnasoma rivertonensis*** new species.

Pl. 16, fig. 13-15.

♂.—Head reddish, orbits light yellow, palpi brown, antennae yellow, the flagellum brown. Thorax reddish brown with three narrow, dark brown lines ending at the suture; the subdorsal lines indistinct except near the suture; a small dark brown spot also present at the base of the wing; scutellum, metanotum, and pleurae yellow. Abdomen reddish brown, long and slender. Halteres yellowish, knobs brown. Wings brown, vein slightly darker. Legs reddish, tip of the tibiae and tarsi brown; the relative length of the tibiae to the metatarsi varies from tibia 14, metatarsus 25 mm., to tibia 17, metatarsus 33 mm. Length of body, 35 mm.; wing, 18 mm.

Riverton, New Jersey, July 20, 1902. Type in the author's collection.

DOLICHOPEZINA.

This section of the Tipulidae is represented in the eastern United States by four genera: Dolichopeza, Oropeza, Brachypremna, and Megistoceera. For some time I have been collecting material in this group to ascertain the true position of Say's *Tipula annulata*. Several species are rather common in certain localities, especially in damp shady places and particularly about overhanging rocks, where they cling to the under sides in great numbers. Their extremely delicate structure and peculiar, quick dancing flight, enable them to disappear very suddenly and effectually when disturbed. They are also very difficult to obtain in any degree of perfection, for their slender legs often fall off with the slightest touch. Among the one hundred and eleven specimens before me, were five true Dolichopeza. The remainder represent a closely related genus Oropeza, recently described by Professor James G. Needham.

**Dolichozeza americana** Needham.

Pl. 15, fig. 1.

*D. americana* Needham, N. Y. state mus., bull. 124, p. 211, pl. 16, fig. 5, 1908.

To the distribution of this species, the type of which was obtained at Old Forge, New York, in August, I can add the following localities: Hammond's Pond, near Brookline, Massachusetts, June 11, 1905; Auburndale, Massachusetts, July 11, 1904; North Adams, Massachusetts, July 19, 1906, collected by the writer; and a specimen from Rigolet, Labrador, July 16, 1906, collected by Dr. G. M. Allen.

From the description it seems very close to *D. albipes* Ström, but European specimens are necessary to decide positively.

**OROPEZA** Needham.

In this genus the genitalia, though simple in structure, seem to form excellent characters for defining a number of species which otherwise would be hard to separate, although there are minor differences, which, when studied in connection with the genitalia, are readily apparent.

Osten Sacken (Studies on Tipulidae, pt. 1, p. 158, 1886) in referring to the genus *Apileisis* Macquart, says: "What Macquart takes for and figures as the male forceps, are simply digitiform appendages to the forceps, homologous I believe to similar, although smaller, appendages of *Dolichozeza* and especially of the North American *D. annulatus* Say." Skuse ("Diptera of Australia," Proc. Linn. soc. New So. Wales, vol. 5, p. 60, 1891) refers to them as digitiform appendages. The following is a provisional table of the species:—

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|--|--------------------------|
| 1. Tarsi, at least, entirely white . . . . .   | 2.                       |
| Tarsi yellow or brownish . . . . .   | 3.                       |
| 2. Digitiform appendages short or rudimentary; ventral margin deeply and narrowly emarginate . . . . . | <i>albipes</i> n. sp.    |
| Digitiform appendages moderately long; ventral margin broadly emarginate . . . . .                     | <i>subalbipes</i> n. sp. |
| 3. Halteres with dark brown knobs . . . . .  | 5.                       |
| Halteres entirely yellow . . . . .   | 4.                       |
| 4. Style short, simple; ventral margin deeply and narrowly emarginate . . . . .                        | <i>sayi</i> .            |
| Style short, forked; ventral margin broadly emarginate . . . . .                                       | <i>similis</i> n. sp.    |

- |   |                        |
|---|------------------------|
| 5. Stripes of the thorax distinct; ventral margin deeply emarginate   | 6.                     |
| Stripes of the thorax obscure; ventral margin but slightly emarginate | 7.                     |
| 6. Pleurae yellow, immaculate; style short . . . . .                  | <i>dorsalis</i> n. sp. |
| Pleurae yellow, spotted; style long . . . . .                         | <i>venosa</i> n. sp.   |
| 7. Thorax opaque . . . . .  | <i>obscura</i> n. sp.  |
| Thorax shining . . . . .  | <i>polita</i> n. var.  |

**Oropeza sayi** new name.

Pl. 15, figs. 2, 3.

*Tipula annulata* Say, Journ. acad. nat. sci. Phila., vol. 3, p. 25, 1823 (*non* Linné, 1758).

*Dolichopeza annulata* Osten Sacken, Cat. No. Amer. Dipt., p. 40, 1878; Aldrich, Cat. No. Amer. Dipt., p. 96, 1905.

*Oropeza annulata* Needham, N. Y. state mus., bull. 124, p. 211, pl. 16, fig. 5, 1908.

Say's description of this species is as follows: "Antennae fuscous, first and second joints whitish; rostrum, and lower portion of the front whitish; vertex and occiput dusky; palpi fuscous; thorax yellowish-brown, the indented lines paler; metathorax light livid; wings with a brown stigmata, nervures brown, arranged like those of Meigen's fig. 9, pl. 6; feet dusky-brownish; abdomen yellowish-white, incisures and their margins black, forming annulations complete. Length two-fifths of an inch." "Inhabits Pennsylvania."

There seems to be no doubt of the identification of this species. The only discrepancy is Say's reference to "Meigen's fig. 9, pl. 6" which is a true *Tipula*; he probably overlooked the absence of the anterior branch of the "second vein." There is a species of *Tipula* which closely resembles this in general appearance but the "incisures and their margins" are yellowish white. There are, however, forms of *Oropeza* which more closely resemble this species, but the genitalia and minor characters seem to warrant their separation. The specimens agreeing closely in detail with the description, and most widely distributed, are selected to represent Say's species. Specimens sent to Professor James G. Needham proved to be the same as he selected for the type of the genus *Oropeza*. The short median cubital cross-vein is either present or absent.

The genitalia yellow; appendages light yellow; the small forceps are armed with black hooks; style short, black; appendages at base of style yellow, broadened at the tips, the ventral margin deeply emarginate. Halteres yellowish.

Twenty-five specimens: Hammond's Pond, near Brookline, Massachusetts, June 11; Mt. Tom, Massachusetts, July 14, 1905; North Adams, Massachusetts, June 19, 1906; Martha's Vineyard, Massachusetts, July 17 (J. A. Cushman); Burlington, Vermont, June 24, 1906; Montpelier, Vermont, June 25, 1906; Norwich, Vermont, July 7, 1908; Hanover, New Hampshire, July 6, 1908; Capens, Moosehead Lake, Maine, July 17, 1907; Niagara Falls, New York, June 23; Westville, New Jersey, June 6; and Acquia Creek, Virginia, May 24, 1896.

*Oropeza similis* new species.

Pl. 15, fig. 4.

♂, ♀.—Head yellow, vertex brown, palpi yellow, antennae yellow becoming fuscous toward the tips. Thorax yellowish, with three wide and poorly defined black stripes covering the dorsum; scutellum, metanotum, and pleurae light yellow, with livid spots between the coxae, on the pleurae, and at the end of the metanotum. Abdomen yellow, with blackish rings at the margins of the segments. Genitalia brown, appendages yellow, style black and slightly forked, appendages at base of style irregular, curved, and hamate. Ventral margin broadly emarginate. Ovipositor yellow. Halteres and legs yellow. Wings yellowish hyaline, veins and stigma dark brown. Length, ♂, 10 mm.; ♀, 13 mm.

Four specimens: types, ♂, Rickett's, North Mountain, Pennsylvania, June 8, 1898, in the author's collection; ♀, Auburndale, Massachusetts, June 4, in the New England collection, Boston society natural history.

*Oropeza dorsalis* new species.

Pl. 15, fig. 6.

♂, ♀.—Face yellow, rostrum and vertex dark brown, palpi blackish; antennae with the three basal joints yellow, the remainder fuscous. Thorax dark brown, the three stripes indistinct, the brown extending over the scutellum and metanotum as a broad stripe, leaving only a narrow lateral margin of yellow; pleurae yellowish white, sub-translucent. Abdomen yellow with a dorsal stripe of brown, spreading over the third to the seventh segments and somewhat obscuring the black bands. Genitalia yellowish, appendages black, style short,

ventral margin deeply emarginate. Ovipositor brown. Halteres yellow, knobs dark brown. Legs brown, coxae and basal portion of the femora yellow. Wings light smoky brown, vein and stigma slightly darker, the petiole between the discal and second posterior cell very short, the median cubital cross-vein present. Length, ♂, 9 mm.; ♀, 10.5 mm.

Two specimens: Capens, Moosehead Lake, Maine, July 14, 15, 1907. Types in the New England collection of the Boston society of natural history.

***Oropeza venosa*** new species.

Pl. 15, fig. 9.

♂.—Front and rostrum yellow, vertex and occiput dark brown, palpi brown, antennae yellow, becoming fuscous beyond the first joint of the flagellum. Thorax yellowish with three broad, dark brown stripes, the dorsal stripe ending at the suture, the lateral stripes abbreviated anteriorly and interrupted at the suture; pleurae subtranslucent; collar, scutellum, metanotum, a large spot on the center of the pleurae, smaller spots at the base of the halteres and between the coxae dark brown. The black bands of the abdomen are united along the dorsal line, leaving a large yellow spot on the side of each segment. Halteres long, yellow; knobs dark brown. Legs light yellow, the tarsi yellowish white. Wings brownish hyaline; stigma and veins dark brown, the radial and cubital veins noticeably prominent, and the short median cubital cross-vein wanting. Genitalia brown, appendages black, style long, reaching the end of the penultimate segment, reddish, base black; appendages at the base of style acute, brown, tipped with black, margin deeply emarginate. Length, 10 mm.

Seven specimens: Hammond's Pond, near Brookline, Massachusetts, June 18; Mt. Greylock, Massachusetts, June 15, 1906; Capens, Moosehead Lake, Maine, July 11, 1907; Hanover, New Hampshire, July 5, 1908; St. Johnsbury, Vermont, June 27, 1906 (C. W. Johnson); Kearsarge Mt., 3270 ft., Bartlett, New Hampshire, July 2 (A. P. Morse). Type from Mt. Greylock, Massachusetts, in the New England collection of the Boston society of natural history. The specimen from St. Johnsbury, Vermont, has the cross-vein forming the discal cell, wanting in the left wing.

**Oropeza albipes** new species.

Pl. 15, fig. 12.

♂, ♀.—Face yellow, rostrum and vertex brown, palpi brown. Antennae yellow, the three basal joints lighter than the others. Thorax dark brown, showing three rather distinct stripes; pleurae, scutellum, and metanotum light yellow, translucent, with livid spots below the base of the wings, between the coxae, at the base of the halteres, and on the posterior margin of the metanotum. Abdomen yellow, the black bands connected on the dorsal line leaving a row of large spots on the sides as in *O. venosa*. In the female the bands are more distinct. Genitalia yellow, appendages light yellow, very short or rudimentary, style red, base black, appendages at base of style short and tipped with a slightly curved spine, ventral margin deeply emarginate. Ovipositor reddish brown. Femora yellow, tibiae and tarsi white, tipped with brown. Halteres white, knobs brown. Wings brownish hyaline, veins light brown, stigma dark brown, median cubital cross-vein present or wanting. Length, ♂, 10 mm.; ♀, 13 mm.

Twenty-two specimens. Types, ♂, Cohasset, Massachusetts, July 1, 1907 (Owen Bryant); ♀, Dummerston, Vermont, July 14, 1908, in collection of the Boston society of natural history. Specimens have also been collected by the writer at Mt. Tom, Massachusetts, July 14; Brattleboro, Vermont, July 15, 1908; Delaware Water Gap, New Jersey, July 11, 1898; Dover, New Jersey, June 17, 1892; Riverton, New Jersey, Aug. 3-11, 1899; Philadelphia, Pennsylvania, Sept. 2, 1892; Pendleton, North Carolina, June 7, 1895; and Hampton, New Hampshire, the last collected by Mr. S. A. Shaw.

**Oropeza subalbipes** new species.

Pl. 15, figs. 5, 11.

♂, ♀.—Similar to *O. albipes*, but readily separated by the genitalia. Tibiae more or less yellowish, tarsi entirely white. Genitalia yellow, appendages moderately long, yellow at the base, fuscous toward the tip; style yellow, appendages at the base short and tipped with small black spines, ventral margin slightly emarginate. Length, ♂, 9 mm.; ♀, 13 mm.

Seven specimens: types, Clementon, New Jersey, ♂, June 3, ♀, Aug. 8, 1897, author's collection. Specimens have also been collected near Long Branch, New Jersey, June 12, (one specimen has discal cell in the right wing open); Westville, New Jersey, June 6, 1897; Riverton, New Jersey, Aug. 11. A specimen from Auburn-dale, Massachusetts, June 16, has discal cell of left wing open.

***Oropeza obscura*** new species.

Pl. 15, figs. 7, 10.

♂, ♀.—Head and thorax dark brown, opaque; palpi black, antennae fuscous, the two basal joints yellow; abdomen light brown somewhat shining, the black bands at the incisures not connected on the dorsal line. Genitalia yellowish, appendages blackish; style yellow, long and very slender, curved and often extending to the base of the penultimate segment, appendages at the base of style short and armed with small black spines, margin but slightly emarginate. Ovipositor brown, cerci yellow. Halteres yellow, knobs brown. Legs brownish yellow. Wings smoky brown, the veins and stigma a slightly darker brown, the median cubital cross-vein wanting. Length, ♂, 8 mm.; ♀, 10 mm.

Thirty-four specimens: types, ♂, North Adams, Massachusetts, June 19, 1906; ♀, Hammond's Pond, near Brookline, Massachusetts, June 18, 1908, in the New England collection, Boston society of natural history. Other specimens: Auburndale, Massachusetts, July 11, 1905 (C. W. Johnson), Aug. 8, 1907 (Owen Bryant), one with discal cell in left wing open; Squam Lake, New Hampshire, July 14, 1907 (Dr. G. M. Allen); Norwich, Vermont, July 7, 1908; Capens, Moosehead Lake, Maine, July 17, 1907; Riverton, New Jersey, Aug. 11, 1899. A specimen from North Adams, Massachusetts (June 19) has the discal cell on the right wing pointed at the outer end (fig. 7).

***Oropeza obscura*** var. ***polita*** new variety.

Pl. 15, fig. 8.

Distinguished from the typical form by having the entire dorsum highly polished. One specimen has the vein forming the anterior side of the discal wanting or indicated by a stub. Length, ♂, 9 mm.; ♀, 11 mm.

Five specimens: types, ♂, ♀, North Adams, Massachusetts, Aug. 8, 1907 (Owen Bryant), in New England collection, Boston society of natural history; Hanover, New Hampshire, July 5, 1908 (C. W. Johnson).

***Brachypremna dispellens*** (Walker).

Pl. 16, fig. 16.

*Tipula dispellens* Walker, Trans. ent. soc. London, new ser., vol. 5, p. 333, 1858.

*Brachypremna dispellens* Osten Sacken, Studies on Tipulidae, Berlin. ent. zeit., vol. 30, p. 162, 1886.

This species previously recorded from Washington, D. C.; Dallas, Texas; and Mexico, has been collected by the writer at Tick Island, Volusia Co., Florida, May 12, 1894; Jacksonville, Florida, May 22, 1894; Pendleton, North Carolina, June 7, 1895; and one specimen at Shark River, New Jersey, July 12, 1897. There is also a specimen from Kentucky in the Museum of comparative zoology.

A conspicuous insect of the more southern woods. Hovering up and down in the more densely shaded places, with a dancing motion covering a vertical space of three or four feet, it might well be called the king of the dancing Tipulids.

***Megistocera longipennis*** (Macquart).

*Tipula longipennis* Macquart, Dipt. exot., vol. 1, pt. 1, p. 57, pl. 5, fig. 1, 1837.

*Megistocera longipennis* Osten Sacken, Berlin. ent. zeit., vol. 30, p. 161, 1886.

A specimen labeled Lake Okeechobee, Florida, is in the collection of the Museum of comparative zoology.

***Rhipidia bryanti*** new species.

Pl. 16, fig. 20.

♀.—Rostrum and occiput black, grayish pollinose, hairs black; palpi black, base of the antennae blackish, thickened, the flagellum yellow, joints monilliform, and unipectinate, the latter black and curving forward; occiput grayish pruinose. Thorax grayish with a wide

brown dorsal stripe extending to the suture, with two black points on each side in front, a smaller one back of the humerus and one on each side of the dorsal stripe near the middle; beyond the suture are two wide subdorsal lines, with a small spot above the base of the wing; metathorax with a narrow dorsal line; pleurae gray with a black longitudinal line. Abdomen yellowish, with wide blackish bands occupying nearly the posterior half of each segment; venter and ovipositor yellowish. Legs black, coxae and basal half of the anterior and two thirds of the middle and posterior femora light yellow. Halteres yellow, knobs brown.

Wings hyaline, maculated with black as follows: five large spots along the costal margin, the first at the humeral cross-vein extending into the basal portions of both the first and the second basal cells; the second midway between this spot and the one at the origin of the radial sector, both of these spots extending almost to the median vein; the fourth spot is at the end of the subcosta and extends nearly across the submarginal cell; the fifth spot at the end of the radius  $R_1$  extends almost across the marginal cell; there are also cloudings at the origin of the branches of the radial and median veins, along all the cross-veins at the middle of the cubitus, and near the end of the second anal vein. Length, 9 mm.

Six specimens: type, Cohasset, Massachusetts, July 10, 1907 (Owen Bryant) in New England collection, Boston society of natural history; other specimens collected June 20, July 6, 12, and 20. A specimen was also taken by the writer at Dover, New Jersey, June 25, 1892.

This species is remarkable from the fact that the female has such long pectinations on the flagellum. It will be interesting to know to what extent this feature is developed in the male.

#### *Geranomyia distincta* Doane.

Two specimens collected by Mr. Erich Daecke, at Manumuskin, New Jersey, June 23, 1902, agree in every respect with the description of this species, except that the discal cell is closed. I am inclined to think that this is normal, and that the single specimen from New Bedford, Massachusetts, on which the species is based, is an anomaly.

***Limnobia fallax*** new species.

*Limnobia solitaria* Johnson, in Smith's Cat. insects N. J., p. 630, 1900 (non Osten Sacken).

♂, ♀.—Head dark brown above, yellowish below; antennae dark brown, the basal joints of the flagellum light brown. Thorax reddish yellow with four obscure dark brown stripes; pleurae, scutellum, and metanotum yellow, the last margined with stripes of dark brown. Abdomen yellowish obscurely banded with brown on the posterior portions of the segments, less prominent in the female; hypopygium and ovipositor reddish. Halteres dark brown. Femora yellowish, the brown on the apical third divided by a light yellow band; tibiae brown, basal portions yellow, tarsi brown. Wings yellowish, with dark brown spots along the anterior; those in the first basal cell varying in size, and in number from three to seven. There is a large spot at the junction of the radial section (praefurea), one at the end of the subcosta extending obliquely across the inner end of the submarginal cell, and another at the end of the radius, the last ocellated. Length, ♂, 6 mm.; ♀, 7 mm.

Three specimens: types, ♂, Dunnfield Creek, Delaware Water Gap, New Jersey, July 14, 1898; ♀, Morton, Delaware Co., Pennsylvania, May 8, 1892, both in the author's collection.

From the description this was inadvertently referred to *L. solitaria* Osten Sacken, in the list of New Jersey Diptera. Since that time I have collected numerous specimens of *L. solitaria* (which is really a boreal species) and find that the two are distinct. It is distinguished from *L. solitaria* by its smaller size, darker antennae, less conspicuous thoracic stripes, and proportionately narrower wings.

***Limnobia parietina*** (Osten Sacken).

Of this beautiful species (which has only been recorded from Trenton Fall, New York, and the White Mts., New Hampshire), I have the following additional records: Prouts Neck, Maine; Intervale, New Hampshire, Sept. 15 (Dr. G. M. Allen); Hampton, New Hampshire, Sept. 9 (S. A. Shaw); and Lake Ganoga, North Mt., Pennsylvania, Aug. 28, Sept. 1, 1897 (C. W. Johnson).

**Hexatoma megacera** (Osten Sacken).

*Anisomera megacera* Osten Sacken, Proc. acad. nat. sci. Phila., 1859, p. 242.

A specimen of this species was obtained by Dr. W. E. Britton, at Chapinville, Connecticut, May 26, 1904.

*Hexatoma* Latreille 1809, *non* Meigen 1820 (Tabanidae), will have to be adopted in place of *Anisomera* Meigen, 1818.

**Antocha saxicola** Osten Sacken.

*A. saxicola* Osten Sacken, Proc. acad. nat. sci. Phila., 1859, p. 219.

*A. opalizans* Osten Sacken, Proc. acad. nat. sci. Phila., 1859, p. 220.

The species described first in the publication will have to be adopted, and the later species placed in the synonymy. There seems to be little ground for considering one a variety. Whether it will prove to be the same as *A. vitripennis* (Meigen) of Europe remains to be seen.

**Cladura flavoferruginea** Osten Sacken.

This species which has only been recorded from the District of Columbia, has been taken by Mr. S. A. Shaw at Hampton, New Hampshire, Sept. 30 and Oct. 5. A specimen was also collected by the writer at Philadelphia, Pennsylvania, Oct. 4, 1891.

**Cryptolabis paradoxa** Osten Sacken.

In naming some Diptera for Professor John Barlow, I found a specimen of this interesting species captured at Wolfville, Nova Scotia. Nineteen specimens were collected by the writer at Norwich, Vermont, and Hanover, New Hampshire, July 6 to 8, 1908. It was previously known only from the types collected by Baron Osten Sacken at White Sulphur Springs, Virginia, June 30, 1859:

**Limnophila alleni** new species.

Pl. 16, fig. 18.

♂.—Head blackish, narrow, the neck and collar brown, rostrum reddish brown, palpi black; the first and second joints of the antennae

black, the flagellum red, becoming a dark brown toward the tip, with moderately long verticils. Thorax brown, with three velvety black stripes; the anterior portion of the broad dorsal stripe is divided by a narrow brown line, beyond the transverse suture the dorsal stripe consists of only a narrow black line extending to the suture; the subdorsal stripes are much shorter, beginning just back of the deep thoracic depressions, and dividing a short distance beyond the suture into four irregular spots; pleurae and coxae dark brown and covered with a hoary bloom; scutellum black, metathorax dark brown. Abdomen yellow, the first, sixth, seventh, eighth segments, and the posterior and lateral margins of the other segments brown; forceps dark brown and conspicuously hairy. Femora and tibiae yellow, tips of the femora, and the base and tips of the tibiae and all the tarsi black; the anterior femora also have a broad middle band of black. Halteres yellow. Wings brown clouded with black, which forms three very conspicuous spots: the first situated at base of the first and second basal cells; the second at the base of the subcostal and extending across the middle of the first basal cell; the third near the middle of the subcostal and extending to the outer end of the first basal, base of the marginal, and base of the first and second submarginal cells; between the black spots are square yellow markings, base of the wing also yellow; the costal cell (except the base and outer end), end of the subcostal, center of the second basal cell, and of the cross-veins more or less clouded with black. Length, 27 mm.

One ♂, collected by Dr. Glover M. Allen, at Intervale, New Hampshire, June 17, 1904. Type in the New England collection, Boston society of natural history.

*Limnophila irrorata* new species.

Pl. 16, fig. 17.

♀.—Head brown, covered with a yellowish pollen and with yellow hairs; basal joints of the antennae black, flagellum brown, palpi black. Thorax brown, with a fine dark, dorsal line; scutellum and metanotum light yellow when viewed from the anterior, pleurae dark brown. Abdomen brown with a lateral margin of brownish black, ovipositor reddish. Legs yellow, coxae brown, a broad apical band on the femora and tibiae black, tip of the metatarsi and tarsi brown. Halteres brown. Wings grayish, thickly maculated with dark brown;

a large spot at the humeral cross-vein, origin of the radial sector, end of the subcosta, and radius ( $R_1$   $R_2$ ) with smaller spots at the ends of all the other veins; the largest one at the end of the subcosta is slightly ocellate and extends to the radial cross-vein; aside from these there are ten small spots in the costal cell, two or three in the marginal, three in the first and six in the second submarginal, about eight in each of the basal cells, seven in the first, one in the second, four in the third, two in the fourth, and one in the fifth posterior cells; the discal cell has two, anal and axillary cells about ten each, and the spurious cell five. Length, 8 mm.

One ♀, Riverton, New Jersey, Aug. 5, 1902. Type in the author's collection.

***Limnophila rufbasis*** Osten Sacken.

Pl. 16, figs. 21-23.

Among some specimens received from Professor John B. Smith for determination, was a remarkable anomaly of this species. It is a small male in which the venation of both wings is very different and in both cases abnormal. In the right wing (pl. 16, fig. 22) the discal cell seems to extend from the radius ( $R_5$ ), to the cubitus ( $Cu_1$ ), owing to the presence of a supernumerary cross-vein across the first posterior cell and the absence of the basal portion of the median  $M_1$ ; a very slight stub, however, indicates the position of this vein. The branch  $M_2$  of the normal wing, is also wanting. In the left wing (pl. 16, fig. 23) the discal cell opens into the first posterior cell owing to the absence of the basal portion of the median  $M_1$ , the vein being deflected, and appearing as if branching from  $M_3$ . The branch  $M_2$  of the normal vein is present. The dotted line shows the probable position of the missing vein. Figure 21 (pl. 16) represents the normal wing. The specimen was associated with a normal specimen from Culver's Lake, Warren County, New Jersey.

In the Tipulidae there seems to be a tendency in certain species, of a large genus, to have an unusual number of specimens with abnormal venation. This seems to be the case in this species. Another specimen before me has a supernumerary cross-vein in the marginal and another in the second submarginal cell, while minor variations are numerous.

**Tricyphona inconstans** (Osten Sacken).

*Amalopis inconstans* Osten Sacken, Proc. acad. nat. sci. Phila., 1859, p. 247; Mon. No. Amer. Dipt., pt. 4, p. 266, pl. 2, fig. 15; pl. 4, fig. 30, 1869.

Since publishing on the variation of the venation of this species (Ent. news, vol. 12, p. 305, 1901) specimens showing the following additional variations have been collected. A specimen from Auburndale, Massachusetts, June 16, has an adventitious cross-vein in the third posterior cell. One from Danvers, Massachusetts, Sept. 23, 1908, has on the left wing five adventitious cross-veins in the second submarginal, and one in the second posterior cell; the right wing has one cross-vein in the first submarginal near the outer end, and four in the second submarginal cell. A specimen from Riverton, New Jersey, has two of the three cross-veins in the second submarginal cell on the left wing united in the form of a V.

**Tricyphona hyperborea** (Osten Sacken).

*Amalopis hyperborea* Osten Sacken, Proc. acad. nat. sci. Phila., 1861, p. 292; Mon. No. Amer. Dipt., pt. 4, p. 269, 1869.

A specimen of this species was collected by Dr. George Dimmock, "Camp, Cambridge Entomological Club," White Mts., July 21, 1875. The camp was situated below the "Ledge" near the Half-way House on Mt. Washington, New Hampshire.

**Tricyphona vernalis** (Osten Sacken).

*Amalopis vernalis* Osten Sacken, Proc. acad. nat. sci. Phila., 1861, p. 291; Mon. No. Amer. Dipt., pt. 4, p. 270, 1869.

The distribution of this species seems to extend from the upper austral to the southern limits of the boreal zone. The gap between the original localities — District of Columbia and White Mountains, New Hampshire — is now well filled by specimens received and collected from the following localities: Merchantville, New Jersey, March 30; Lucaston, New Jersey, April 14, 1902, and Sept. 28, 1903 (E. Daecke); Clementon, New Jersey, May 1, 1904 (H. S. Harbeck); Sharon, Massachusetts, May 26, 1908; North Adams, Massachusetts, June 18; and near summit of Mt. Greylock, Massachusetts, June 15, 1908

(C. W. Johnson). The New Jersey data would indicate that possibly the species or some specimens may hibernate as imagos. The seven show considerable variation; the one from Mt. Greylock has the discal cell of the right wing open. The length of the discal and second posterior cells also varies greatly; the specimen from North Adams has the discal cell extending beyond the inner end of the second posterior cell, and in all specimens there is some variation in the length of the petiole. The spots on the wings are noticeably smaller in the specimens (females) from western Massachusetts.

***Tricyphona auripennis*** (Osten Sacken).

*Amalopis auripennis* Osten Sacken, Proc. acad. nat. sci. Phila., 1859, p. 247; Mon. No. Amer. Dipt., pt. 4, p. 268, 1869.

One specimen (♀) collected by Mrs. Annie T. Slosson on Mt. Washington, New Hampshire. Owing to the variability in the venation of the species of this genus, I can only refer this specimen doubtfully to this species, until more are obtained. It agrees in every respect with the description except that the first submarginal cell is longer than the second; there is also a slight clouding at the end of the radius ( $R_1$ ) and along the outer edge of the discal cell. Length, 15 mm.

***Tricyphona calcar*** (Osten Sacken).

*Amalopis calcar* Osten Sacken, Proc. acad. nat. sci. Phila., 1859, p. 247; Mon. No. Amer. Dipt., pt. 4, p. 268, pl. 2, fig. 14, 1869.

This species, the only one in this section with truly immaculate wings, shows but little tendency to vary. It has been collected in the following localities: East Walpole, Massachusetts, May 26, 1908; Dedham, Massachusetts, Sept. 4, 1904; Brookline, Massachusetts, Sept. 6; Mt. Greylock, Massachusetts, June 15, 1906; North Mt., Pennsylvania, June 8, 1898 (C. W. Johnson); and White Cap Mt., Maine, Aug. 17, 1905 (F. M. Jones); Cohasset, Massachusetts, Oct. 1 (Owen Bryant).

In regard to the standing of the genus *Tricyphona* which has been so fully discussed by Dr. Bergroth and Baron Osten Sacken, the question is not whether the type of *Tricyphona* (*Limnobia immaculata* Meigen) is characteristic of the genus as a whole; it is not generically distinct; therefore according to the rules *Amalopis* Haliday, 1856, is a synonym of *Tricyphona* Zetterstedt, 1840.

**Triogma exsculpta** Osten Sacken.

Pl. 16, fig. 19.

Three specimens of this interesting species were taken by Mr. S. A. Shaw at Hampton, New Hampshire, April 20, 1907, and May 20, 1908. The only previous record for this species is the type locality, "Pennsylvania."

**Stygeropis fuscipennis** Loew.

This species, which seems to be recorded from Illinois only, has been either collected by the author or received for determination, from the following localities: Hammond's Pond, near Brookline, Massachusetts, Aug. 23; Provincetown, Massachusetts, June 25, 1904; Burlington, Vermont, June 25, 1906 (C. W. Johnson); Wellesley, Massachusetts, July 27 (A. P. Morse); Montreal, Canada, July 5, 1902 (G. Beaulieu); New Jersey "salt marshes" (Dr. J. B. Smith).

**Tipula perlongipes** new name.

*T. filipes* Walker, List Dipt. Brit. mus., pt. 1, p. 65, 1848 (*non* Fabricius, 1805).

Walker's specimen (♂) was collected at St. John's Bluff, Florida. A specimen (♂) taken by the writer at Jacksonville, Florida, May 22, 1894, agrees with Walker's description; specimens have also been collected at Pendleton, North Carolina, June 7, 1895; Boykin, Virginia, June 10, 1895; Folsom, Pennsylvania, July 7, 1893; Avalon, New Jersey, June 30; Long Branch, New Jersey, June 11; Brookline, Massachusetts, June 28; Kingston, Rhode Island, June 21, 1908 (J. Barlow); and Cohasset, Massachusetts, July 19 (Owen Bryant).

The unusually long legs, brown wings, darker along the costa with an "indistinct colourless spot at the tip of the first longitudinal vein," seem to distinguish the species.

**Tipula oropezoides** new species.

♂, ♀.—Head dark brown, vertex pruinose, rostrum yellow, palpi brown, two basal joints of the antennae yellow, the rest dark brown. Thorax grayish, with three wide, obscure, brown stripes, the middle one divided by a fine dorsal line; scutellum dull yellow;

metanotum pruinose, pleurae yellow, with livid spots more or less obscured by a pruinose covering. Abdomen dark brown, yellow on the sides, and with narrow greyish bands at the posterior margin of each segment; genitalia yellow. Halteres yellow, knobs dark brown. Legs dark brown, coxae and basal half of the femora yellow. Wings yellowish hyaline with a slight whitish tinge (including the veins) at the base of the stigma and discal cell, stigma and veins dark brown. Length, ♂, 10 mm.; ♀, 14 mm.

Six specimens: North Adams, Massachusetts, June 14 and 19, 1906; Framingham, Massachusetts, May 28, 1904. Types, ♂, ♀, from North Adams, in the New England collection, Boston society of natural history.

This species so closely resembles in general appearance several species of *Oropeza* as to be easily mistaken for them; it is, however, readily separated by the venation.

***Tipula jejuna* new species.**

♀.—Head reddish brown, palpi brown, antennae dark brown, the basal half of the joints of the flagellum dark brown. Thorax, including the scutellum and metanotum, a uniform reddish brown, the latter subtranslucent. Abdomen reddish brown, the posterior margins and three last segments dark brown; ovipositor reddish yellow. Halteres dark brown. Legs reddish brown, tarsi dark brown. Wings light brown, veins dark brown, a light band extending from the end of the subcostal vein to the posterior side of the discal cell, its appearance due in part to a small section of the veins being white. Length, 10 mm.

Three specimens: type, Wellesley, Massachusetts, July 18, 1895 (A. P. Morse) in the New England collection, Boston society of natural history; Riverton, New Jersey, July 20 and Aug. 4, 1907.

This species is readily distinguished by its small size and uniform reddish brown color.

***Tipula dejecta* Walker.**

*T. dejecta* Walker, Dipt. Saund., p. 442, 1856.

From the descriptions, the specimens referred to this species seem to agree very closely with *T. fumosa* Doane (Journ. N. Y. ent. soc.,

vol. 9, p. 99, 1901) which may prove to be a synonym. *T. dejecta* Walker is a widely distributed species, common during April and May. The time of appearance is a very important factor in the Tipulidae, and the absence of full data with the great number of described species is to be deplored. In all of the genera containing numerous species, there are spring, summer, and autumn species, closely related, yet apparently distinct, although in some cases they may only represent seasonal forms.

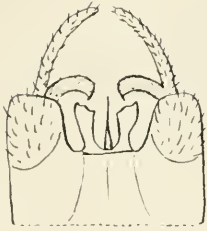
In studying the variations in the venation of the Tipulidae, I have been greatly interested in Professor James G. Needham's paper in Bulletin 124 of the New York state museum (p. 199-248, pl. 11-30, 1908). It seems high time that dipterists should adopt a nomenclature conforming as closely as possible to that used in other orders of insects, thus avoiding confusion and materially aiding in establishing a more uniform nomenclature for venation and advancing homological studies.

*Printed April, 1909.*

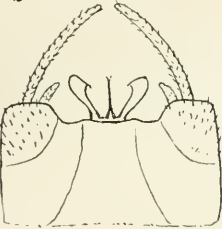
EXPLANATION OF PLATES.

PLATE 15.

- Fig. 1. *Dolichozepe americana* Needham. Wing.  
Fig. 2. *Oropeza sayi* new name. Male genitalia, ventral view.  
Fig. 3. *Oropeza sayi* new name. Wing.  
Fig. 4. *Oropeza similis* new species. Male genitalia, ventral view.  
Fig. 5. *Oropeza subalbipes* new species. Wing with open discal cell.  
Fig. 6. *Oropeza dorsalis* new species. Male genitalia, ventral view.  
Fig. 7. *Oropeza obscura* new species. Wing with an abnormal discal cell.  
Fig. 8. *Oropeza obscura* var. *polita* new variety. Portion of the median vein forming the discal cell wanting.  
Fig. 9. *Oropeza venosa* new species. Male genitalia, ventral view.  
Fig. 10. *Oropeza obscura* new species. Male genitalia, ventral view.  
Fig. 11. *Oropeza subalbipes* new species. Male genitalia, ventral view.  
Fig. 12. *Oropeza albipes* new species. Male genitalia, ventral view.



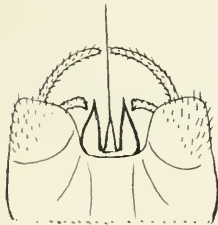
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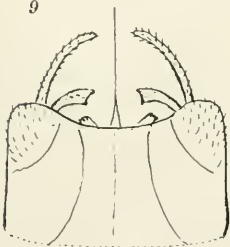
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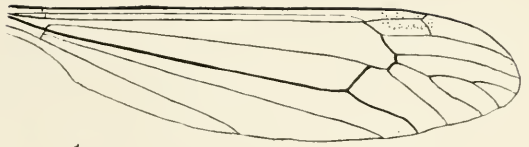
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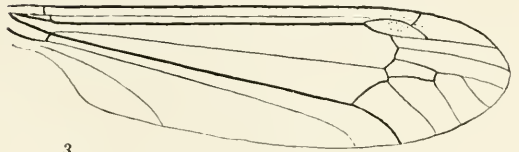
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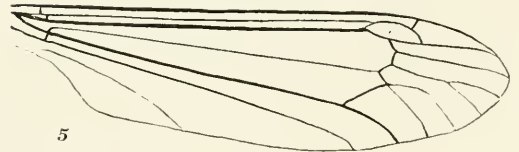
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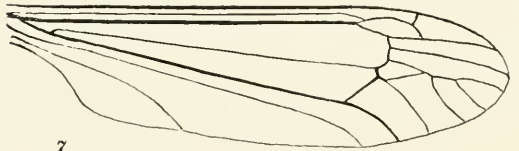
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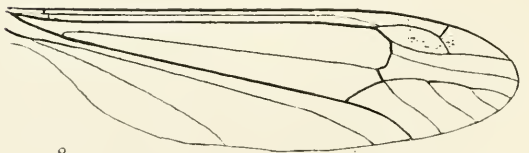
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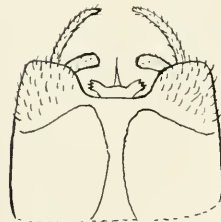
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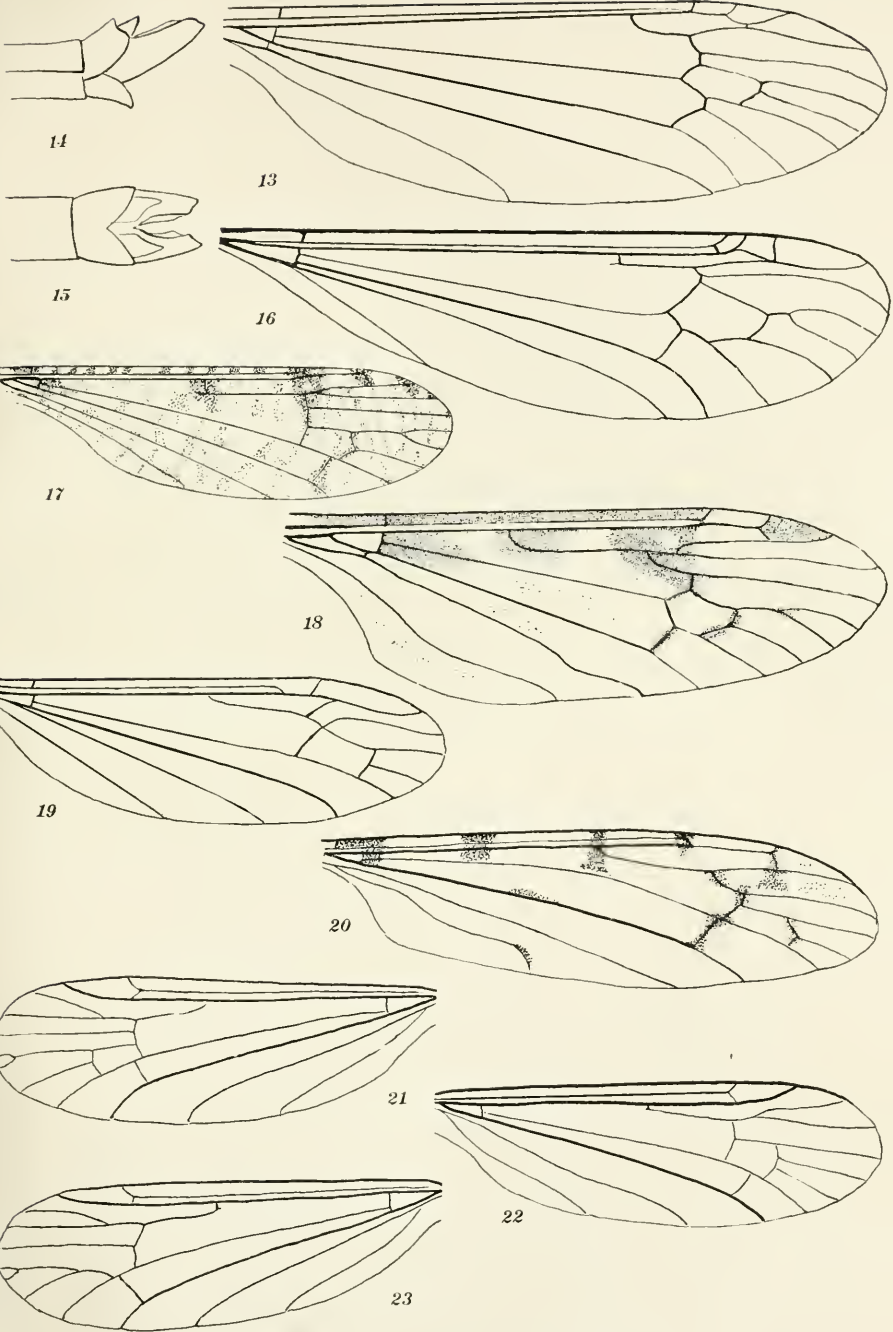
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PLATE 16.

- Fig. 13. *Aeshnasoma rivertonensis* new genus and species. Wing.  
Fig. 14. *Aeshnasoma rivertonensis* new genus and species. Male genitalia, lateral view.  
Fig. 15. *Aeshnasoma rivertonensis* new genus and species. Male genitalia, dorsal view.  
Fig. 16. *Brachypremna dispellans* (Walker). Wing.  
Fig. 17. *Limnophila irrorata* new species. Wing.  
Fig. 18. *Limnophila alleni* new species. Wing.  
Fig. 19. *Triogma exsculpta* Osten Sacken. Wing.  
Fig. 20. *Rhipidia bryanti* new species. Wing.  
Fig. 21. *Limnophila rufibasis* Osten Sacken. Wing.  
Fig. 22. *Limnophila rufibasis* Osten Sacken. Abnormal right wing.  
Fig. 23. *Limnophila rufibasis* Osten Sacken. Abnormal left wing. Both wings (Figs. 22 and 23) are from the same individual.





# No. 6.—A GEOLOGICAL EXCURSION IN THE GRAND CAÑON DISTRICT.

BY DOUGLAS WILSON JOHNSON.

## INTRODUCTION.

THE salient features of the Grand Cañon district have been made familiar by the classic works of Powell and Dutton, and by the more detailed local studies of later observers. An approximately parallel series of north-south faults and folds divides the district into a number of subordinate plateaus, as indicated on the accompanying sketch map (fig. A).

North of the Colorado River the several plateau blocks are called from east to west, the Marble Cañon Platform, the Kaibab Plateau, the Kanab Plateau, the Uinkaret Plateau, and the Shivwits Plateau. South of the river the displacements are less prominent, and have not been carefully traced. Hence a single name, the San Francisco Plateau, is given to this portion of the district.

The name Colorado Plateau has often been applied to this southern area, but such usage leads to confusion, inasmuch as the whole province is known as the Colorado Plateau province. It seems better to follow Powell ('75, pp. 186, 195; '95, p. 94) in his employment of the name San Francisco for this subdivision of the province. Gilbert ('75, p. 47) formally applies the name Colorado Plateau to this area but later speaks of it repeatedly as the San Francisco Plateau (Gilbert, '75, pp. 109, 116, 542). Robinson ('07, p. 109) has recently defined the limits of this particular subdivision of the plateau province, and employed the name San Francisco to designate it. The name is appropriate, for the district is dominated by the San Francisco Mountain group, of which San Francisco Peak is the highest point, while a large part of the area is included in the San Francisco Forest Reserve. The name Coconino Plateau is generally restricted to the higher portion of the San Francisco Plateau lying south of the Kaibab.

The following notes were made during the summer of 1906 in the course of a wagon trip from Prescott, Arizona, to Salt Lake City, Utah, and are offered as a brief contribution to our knowledge of the physiographic features of the Grand Cañon district.

In the course of this trip we followed along the western side of the Echo Cliffs Monocline for sixty miles, making three traverses across

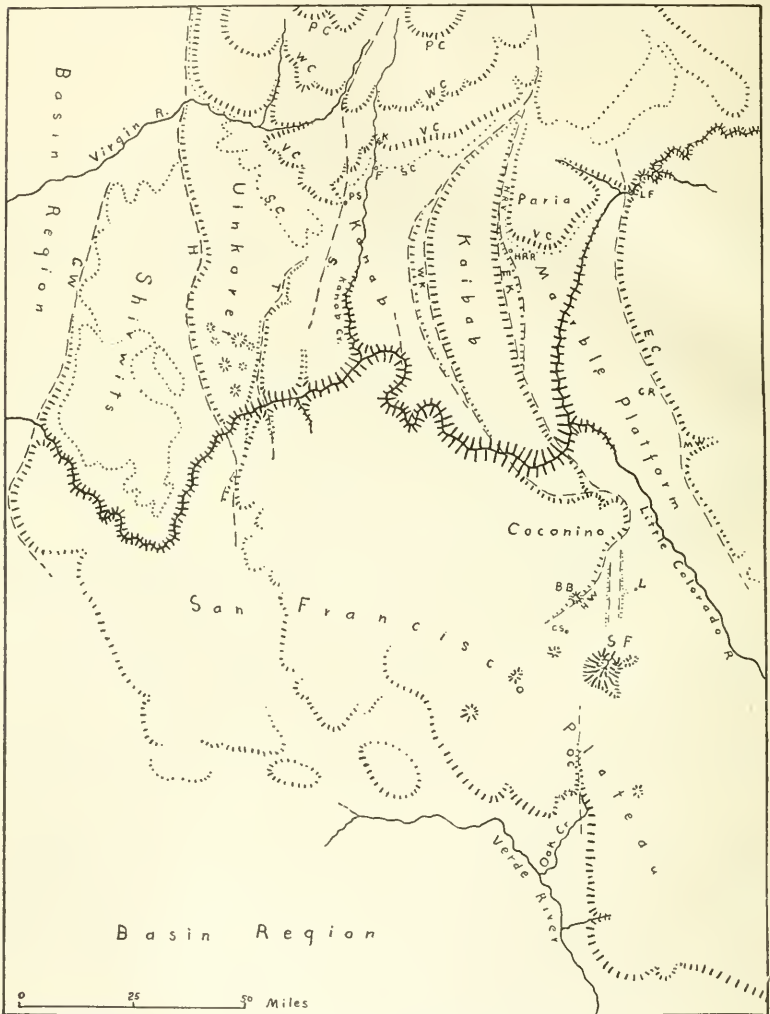


FIG. A.—Sketch map of Grand Cañon district.

the cliffs to their eastern side. We examined the East Kaibab Monocline for several miles north and south of House Rock Ranch, finally

passing up over the surface of the great double fold to the summit of the Kaibab Plateau. Passing down Jacob's Cañon we had an opportunity to see the West Kaibab Fault where this cañon opens on the Kanab Plateau at the face of the fault scarp. At Pipe Spring we encountered the Sevier Fault, and followed it southwestward for ten or twelve miles. Turning west, we reached the northern end of the Toroweap Fault and followed it southwest to a point near the Grand Cañon. Returning to Pipe Spring along the Toroweap and Sevier Faults, we next turned westward, crossing the Hurricane Fault near the Arizona-Utah line, and followed it northward into Utah.

In meeting the expenses of the excursion, we were aided by grants from the Massachusetts Institute of Technology and the Sturgis-Hooper fund of Harvard University, and by private contributions from Mr. George H. Crocker, Sr., and other friends of the Institute. Our party included Dr. H. W. Shimer of the Institute, and Mr. C. H. Decker, E. M., of Bingham Cañon, Utah.

It is not necessary to preface these notes with any extensive review of the literature. A short summary of observations made by previous workers in the Grand Cañon district, together with a fairly full bibliography will be found in one of Davis's ('01) papers cited below. It is sufficient to note in the present connection that two theories have been entertained regarding the relative ages of the displacements and the main drainage lines of the district. According to Dutton, the courses of the Colorado River and its main tributaries were established before the faults and folds came into existence. The development of the displacements at a much later period was so gradual that these main drainage lines were able to maintain their courses, cutting their channels downward as fast as uplift occurred, wherever barriers were raised across their paths. In other words, the drainage lines are older than the lines of displacement; the Colorado, with its main tributaries, is an antecedent river system. The same conclusion had been reached by Powell ('75, p. 198) some years earlier.

An alternative theory has been advanced by Davis ('01, '03). According to his interpretation the displacements are much older than supposed by Powell or Dutton. After the displacements occurred, the region was reduced to a peneplain. Across this surface of faint relief the Colorado river system found its way, its course having been determined in part by a series of complex adjustments during the cycle which ended in the peneplanation, while in places the stream

courses came to lie across the lines of displacement because the baselevelling process had often reduced hard and soft rocks on the two sides of a displacement to much the same level. Subsequent elevation permitted the river to entrench itself. Weak rock areas were quickly swept away, leaving resistant areas as higher plateaus, the lines of displacement usually marking the boundaries between the two. According to this theory the displacements are older than the river's course. From the standpoint of the present cycle, the Colorado is a structurally superposed river system, having been let down from the surface of the former peneplain.

One object which our party had in view was to test the above theories by personal observation in the field.

#### FAULTS OF THE SAN FRANCISCO PLATEAU.

Under this heading are briefly considered several fault lines which we encountered on our way across the San Francisco Plateau, from the termination of the plateau in the great escarpment overlooking the valley of the Verde River, to the crossing of the Little Colorado River. These fault lines we could not trace far, nor study carefully, because of limited time. They are of minor importance when compared with the great displacements farther north, but indicate a more strongly faulted condition of the San Francisco Plateau than is usually ascribed to this part of the district.

Our approach to the San Francisco Plateau from the Basin region was by a road which follows up the valley of Oak Creek until near the escarpment; here we entered Bear Wallow Gulch (pl. 17, fig. 1), a small tributary cañon, and made the ascent of the escarpment near the head of the gulch. As seen from the Basin region, the scarp is wonderfully abrupt, and the angular changes in direction of the cliff line suggest the influence of faulting. In the face of the scarp, minor faults are occasionally seen. Bear Wallow Gulch, a tributary to Oak Creek, appears to be developed along a northeast-southwest fault line, and the contact between the Lower Aubrey red beds and the overlying crossbedded sandstone is somewhat higher on the northwest side than on the southeast. The wagon road makes the steep ascent of the escarpment, or the Mogollon Rim as it is locally called, by a series of zigzags, near the head of the gulch. At the first of the westernmost

bends in the road the red beds are seen dipping steeply to the southwest where they are dragged up along a fault plane. Farther up, the grey crossbedded sandstone is similarly affected. The continuation of this fault toward the southeast is distinctly visible on the southeast wall of the valley, where the lava capping the crossbedded sandstone abuts against the sandstone at the contact, indicating a considerable displacement. It would appear that the general trend of the displacement where it crosses Oak Creek is northwest-southeast.

From the first western bend in the road, above referred to, one has a splendid view of a prominent fault in one of the outlying mesas (pl. 17, fig. 2, *F*), where the lava-capped crossbedded sandstone on the eastern side of the displacement has dropped down 800 or 1,000 feet (estimated). This fault (which appears to be independent of the one just described) has a north-south trend and coincides with Oak Creek for an unknown distance northward, and may be called the Oak Creek Fault (fig. A, *O. C.*). The eastern side of Oak Creek is thus distinctly lower than the western side. Near the outlying mesa, however, the creek swings to the east of the fault line, leaving a fragment of the downfaulted block west of the creek, and affording the precise contact visible in the end of the mesa. It is evident that the lava is older than the faulting, and from the character of the contact between the lava and underlying sandstone it appears that the lava was outpoured upon a surface at least somewhat diversified, with a valley several hundred feet deep near the present location of Oak Creek.

The topographic features along this portion of the great escarpment terminating the Plateau Province show a fairly pronounced angularity, while segments of the escarpment and portions of the stream courses are relatively straight for considerable distances (see Verde sheet, U. S. topographic atlas). The location of Upper Oak Creek has evidently been determined by the Oak Creek Fault. In like manner, Bear Wallow Gulch appears to have been eroded along a fault line. There is thus a suggestion that faulting has exerted an important control over erosion in this region. More field work will be necessary before the evidence in favor of general fault-control can be regarded as conclusive.

In the vicinity of Oak Creek the beds of the plateau series dip gently northward, thus preserving the general dip observed in other parts of the San Francisco Plateau. Farther north the dip has carried the crossbedded sandstone below the surface, and the overlying Aubrey

limestones constitute the upper member of the sedimentary series. The surface remains fairly uniform, so far as we could judge, and it is for the most part covered by basalt flows (whose appearance indicates that they should be classed with the recent rather than with the ancient basaltic outpourings recognized elsewhere in the Plateau region). These relations suggest a peneplain surface bevelling the underlying inclined sediments and covered with sheets of lava. Robinson ('07, p. 109-129) has recently presented evidence from other localities pointing to the same conclusion. The displacement of the lava along the Oak Creek Fault indicates a relatively recent date for the fault, and it is probably correlated in time with the more recent movements along the Hurricane Ledge in the vicinity of the Virgin River, described below.

From Cedar Spring, (fig. A, *C. S.*) northwest of San Francisco Mountain, a broad valley or wash, known as Hull Wash (fig. A, *H. W.*) runs northeast to the Little Colorado. The northwestern side of this wash is bounded by a rather prominent line of cliffs. For long distances the cliff-line is remarkably straight, and small valleys often debouch from the face of the cliffs into the broad wash through sharply cut V-shaped openings, rather than by gradually widening valley mouths. It is believed that the cliffs have been developed along a fault line trending northeast-southwest. Baker's Butte (fig. A, *B. B.*), a volcano six miles northeast of Cedar Spring, was apparently formed across the line of displacement.

A short distance west of Lockett's Tank (fig. A, *L.*) there is a north-south line of cliffs several miles in extent, due either to a faulting movement that dropped the area west of the fault line, or to erosion on a faulted mass. The face of the cliff is of lava, as is also the floor of the valley just west. But limestone appears a short distance back of the cliff face. No time was available for careful study, but the features seemed to indicate that a broad north and south valley, possibly related to an early fault line, had been floored with lava, while a recent uplift along the eastern side of the valley had developed the west-facing scarp. A narrow gorge passes from the broad valley eastward through the scarp. Lava flowed through this gorge, and for several miles along its continuation eastward across the plateau. Much of the lava has been removed from the eastern part of this channel, but toward its western end the lava is still in place in the bottom of the gorge. Lockett's Tank is a pool developed where the run-off

from occasional heavy rains drops from the surface of the lava down to the bottom of the limestone gorge from which the lava has been largely removed (Davis, '01, fig. 13).

A few miles farther west is another north and south line of cliffs, developed in limestone, and dissected by small ravines which open on steep alluvial cones well up the face of the cliff. This line of cliffs faces east, and forms the west side of a valley which has less regular limestone cliffs, of less altitude, on its eastern side. The relations suggest a north-south fault with a downthrow toward the east. Toward the northern end of the east-facing scarp there is a low hill in front of the cliffs which seems to be a down-faulted block. Toward the southern end a side valley from the west enters through the cliffs. From this side valley lava has entered the main valley and floored it with igneous rock in very recent geological time. Lava has also entered the main valley through shallow ravines cut in the face of the cliffs. The amount of displacement in both of these north-south faults is small.

If our observations are correctly interpreted, there are displacements south of the Grand Cañon in greater number than has generally been supposed, but less extensive and much more irregularly developed than the great displacements north of the Cañon. Careful field work will be necessary before the detailed relations can be ascertained.

#### ECHO CLIFFS MONOCLINE.

Of our observations along the Echo Cliffs Monocline, only those which bear on the origin of the peculiar form of certain parts of the cliffs need be noted here. Brief mention, however, may be made of the remarkable landslides which begin toward the northern end of the cliffs and continue around the base of the Paria Plateau to House Rock Valley, a distance of some fifty miles (pl. 18, fig. 1). These landslides have been described by Davis ('01, p. 121-126) who believes them to be the result of a revival of erosive activity following the uplift of the region which permitted the incision of the present Cañon. We did not observe the slides until we reached a point south of Bitter Spring, where a branch of the Colorado River first reaches eastward to the foot of the cliffs. The sudden development of landslide topography at this point is in accordance with the interpretation quoted above.

As seen in profile the Echo Cliffs Monocline frequently exhibits an eastern slope which is almost if not quite as steep as the bold west-facing scarp; as seen from the west the crest-line of the cliffs is serrate, a succession of sharp peaks or crags, with intervening sags. This departure from the normal tabular form of the cliffs is very striking, and has been mentioned by Powell, Dutton, and Davis. Powell ('75, p. 192) relates the peculiar form of the cliffs to the "line of displacement" in a general way; Dutton ('82, p. 205) considers it the effect of "the considerable inclination of the strata"; but Davis ('01, p. 141-142) suggests that "strike faults with small throw, torn on the slope of the monocline," may be responsible for the features observed. As has been shown by Davis, the character of the cliffs is not due to local increase in the dip of the strata, nor to changes in the thickness of the cliff-making sandstones.

In order to determine whether the back slope of the monocline was cut by longitudinal faults which might account for the oversteepening, I crossed to the eastern side of the cliffs at three points: first, at a point eight miles north of Willow Spring, later at a point a mile or two southeast of Cottonwood Tank, and finally at a point five or six miles south of Bitter Spring. At the two first points the peculiar feature in question was well marked, while at the place of the third traverse, the back slope of the monocline was more gentle. In no case was any evidence of a fault observed. The sandstone composing the upper part of the cliffs is characterized by very pronounced cross-bedding having a prevailing, strong dip to the east and southeast. That part of the eastern slope developed on these beds has an inclination fairly coincident with the angle of crossbedding. Lower parts of the slope, developed on beds which show crossbedding but slightly inclined, have a more gentle inclination. Many smaller pinnacles or hills formed from the upper beds have a sharply inclined eastern face undoubtedly developed on one of the steep crossbedding planes, while the pronounced jagged or saw-toothed profile of some of the small ridges seems to be traceable to the influence of the same planes of weakness. At the northernmost section, where the oversteepening of the back slope is not marked, the crossbedding seemed less pronounced, and the eastward inclination of the laminae less uniform than usual. Still farther north, notably between Bitter Spring and Echo Peaks, the Echo Cliffs show strongly developed joint structure, such as is also visible in the Vermilion Cliffs on the opposite side of

the Colorado. Erosion, guided by this joint structure gives a sharp, pointed form to spurs and pinnacles in the face of the cliffs. At other places we observed evidence of local faulting cutting obliquely across the cliff-line, but these did not seem to be related to the oversteepened slopes. It seemed to us that the influence of the crossbedding and jointing on erosion might account for the peculiar form of the cliffs.

#### EAST KAIBAB MONOCLINE.

The East Kaibab Monocline (fig. A, *E. K.*) is a great fold which carries the Carboniferous limestone of the Marble Platform upward toward the west to an elevation from 2,500 to 4,000 feet higher, where it forms the surface of the Kaibab Plateau, or "Buckskin Mountains," as the plateau is locally called. The monocline is in part double, and as one views it from the east he can distinctly see the up-arched limestone rising from 1,500 to 2,000 feet above the desert level of the Marble Platform, then continuing westward across a great bench or terrace from two to four miles wide, from the western side of which it rises in another arch to the summit of the plateau. To the north and to the south he can see the lower fold swing gradually westward until it merges with the upper, and the ascent from the Marble Platform to the summit of the Kaibab is made in a single great arch. As a rule the monocline is free from faulting, but several miles south of House Rock Ranch (fig. A, *H. R. R.*) we observed several minor faults, apparently trending with the strike of the fold.

The Kaibab Plateau is higher toward the south than farther north, and it is near the highest part of the plateau that the Colorado River has cut its way through the fold which rises across its path. It is evident that the river could not have acquired such a course under the present surface conditions of the region, and it was partly to account for the river's course at this particular point that Dutton proposed the theory of antecedence. He believed that the river acquired its present course, and removed the Mesozoic beds from much of the district before the fold developed. At a comparatively recent period the great monocline was gradually raised above the river's path, but so slowly that the river was able to cut down as rapidly as the rocks were uplifted, and so to maintain its course. At this same general period the Echo Cliffs Monocline, and the great faults farther west, were believed to have been developed.

As a part of the drainage system of the Colorado which was fully established previous to the period of folding, Dutton cites the House Rock Valley, which follows the eastern base of the Kaibab Monocline along its northern part. "Just at the base of the East Kaibab flexure is House Rock Valley, which once held a river which has long since vanished, though leaving well marked traces of its former action. None of the great displacements which traverse these masses had any existence at that remote epoch" (Dutton, '82, p. 188). The valley, in common with the rest of the main Colorado drainage, was thus considered antecedent to the uplift which developed the monocline. Davis ('01, pp. 153, 157) has interpreted this same valley as one produced by erosion along a belt of weak rocks after the development of the monoclinal uplift. Walcott ('90, pp. 60, 64) cites the flexing of the hard, compact limestones now forming the surface of the monocline, as an evidence that when the folding occurred a considerable thickness of overlying strata must have been present.

The valley is bounded on the west by the Carboniferous limestone which rises in the symmetrical arch of the lower member of the double monocline. Along the southern part of the valley, at least, the arch has not been cut into by the main stream, but everywhere presents the smooth, arched surface of the upper Carboniferous limestone, from the surface of which the soft overlying beds have been washed away. The eastern side of the valley is bounded by erosion cliffs of Triassic sandstone. The monocline does not show the same dip at all points, nor is its base a straight north-south line. On the contrary, the dip is fairly gentle in some places and much steeper in others, while the base of the fold forms a line which curves distinctly toward the east or west in different localities. Along the southern portion of House Rock Valley one of these curves is well marked, concave toward the east. The cliffs on the east side of the valley curve in sympathy with the curved base of the monocline, so that the width of the valley remains fairly constant (fig. B). It seems clear that House Rock Valley has been produced by the erosion of the weak shales between the Triassic sandstone and Carboniferous limestone, after the development of the monoclinal fold had determined the course the valley was to follow.

The small streams which dissect the east-facing slope of the monocline are characterized in their lower courses by steep-sided gorges that open abruptly on the surface of the Marble Platform. In their

upper courses these same streams have broadly open, mature valleys. Inasmuch as the geological series cut by the streams is the same in both parts of their courses, there is a suggestion that the upper courses of these streams may have been developed before the lower courses. This would be the case if the upper part of the Kaibab arch were exposed above a baselevel of erosion which bevelled across softer rocks concealing the lower part of the arch. During the baselevelling period mature valleys would develop on the exposed part of the arch. Subsequent uplift would permit the removal of the soft rocks, exposing the lower part of the arch, and allowing the extended portions of the

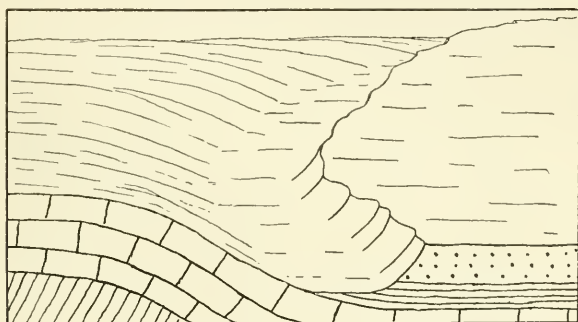


FIG. B.—Diagram illustrating relation of House Rock Valley to curving monocline.

mature streams to cut new gorges in the newly exposed lower portions of the monoclinal slope.

Where we crossed the East Kaibab Monocline on our way to the summit of the Kaibab Plateau, at a point a few miles south of House Rock Ranch, there was a distinct difference in the amount of stream dissection observed in the two parts of the fold. As already described, the lower member of the fold is but little dissected, the surface over large areas arching gracefully with the curve of the rocks, and occasional gorges alone destroying the symmetry of the monocline. When we reached the upper member of the fold, however, we noted a mature dissection of the slope of the monocline; closely spaced ravines, separated by rather sharp-crested divides, have consumed most of the original surface. We made the ascent of the first part of the fold by passing up over the surface of the arch itself, because there is plenty of surface left, and very little room in the bottoms of the gorges which

dissect it. In ascending the upper member of the fold, however, we first passed up a fairly mature ravine and then up a dividing ridge, because there was little or none of the original surface left. If this striking contrast in the degree of dissection prevails elsewhere along the double monocline it is a strong indication that after the fold was developed the upper part was subjected to erosion while the lower portion was yet concealed below the overlying baselevelled Permian. Later stripping of the Permian revealed the lower member of the fold, and exposed it to erosion in the next cycle.

Some miles south of House Rock Ranch, at a point where the monocline rapidly steepens its dip with an accompanying westward swinging of the base line, there is found a series of well marked terraces. These terraces bevel across the softer beds which overlie the Carboniferous limestones in the plateau series, slope gently downward toward the east, and are capped by a considerable thickness of alluvium consisting largely of limestone débris. They are now much dissected, but still persist over a considerable area, marking two or three distinct levels; the lowest series extends far out across the platform east of the monocline, and an unknown distance to the south. The higher terraces cover a much more restricted area than the lower series. A small remnant of a similar terrace is found near the foot of the monocline just north of the ranch.

That these terraces mark a baselevel of erosion there can be no doubt. But it is quite possible that they represent a temporary local baselevel, not of great significance in the general history of the region. Their greatest significance lies in their relation to the monocline. According to the antecedent theory, the softer beds overlying the limestone were largely removed from the Marble Platform region before the folding, although occasional remnants remained. The preservation of these remnants could bear no relation to the great monoclinal fold, believed to be developed only after this work of erosion was largely completed. According to the alternative theory, the fold was developed at an earlier period and included the overlying rocks in the up-arching. Subsequent erosion to general or local baselevels would bevel the softer beds east of the monocline and the bevelled surface might be covered by débris brought down from the hard limestone arch which was too resistant to experience rapid reduction. Later erosion would dissect the débris-covered surface, leaving remnants as terraces. These terraces would remain longest near the base of the monocline,

where they would be farthest from the main stream lines and covered by the thickest and coarsest débris from the monocline just west. The finding of the terraces near the base of the monocline south of House Rock Ranch adds one more link to the chain of evidence indicating an ancient date for the displacements in the Grand Cañon district.

#### WEST KAIBAB FAULT.

After traversing the summit of the Kaibab Plateau, where we were impressed by the maturity of the drainage features, a peculiarity discussed at length by other writers, we entered Jacob's Cañon, one of the cañons leading to the Kanab Plateau on the west. The head of this cañon was of mature aspect, wide and open, with graded side slopes. But as we continued downward to the west we entered a narrow gorge cut in the bottom of the broader valley. The change from the more mature to the younger portion of the cañon is well marked. A good road has been built down the gorge, but so active is erosion during wet weather that we found many places badly washed out, and passing with our wagons was difficult.

Continuing down the gorge, we suddenly passed from between the cañon walls, across the West Kaibab Fault (fig. A, *W. K.*) and out upon the Kanab Plateau. Looking back, we obtained the view shown in plate 18, figure 2. The more mature portion of the valley is seen in cross section, with the steeper-sided gorge cut in its rather flat bottom. The gorge is not located in the center of the older valley, but is at this point cut in its southern side.

It is possible that the existence of harder rock at the level of the inner gorge may in part account for its more youthful character. But if this were alone responsible, we should expect the retreat of the overlying beds to take place at the same rate on both sides of the valley, leaving the gorge symmetrically located with reference to the more open upper portion.

The fact that an inner gorge occupies an unsymmetrical position in a more mature valley, suggests that the upper portion of the valley may have been developed with reference to a higher and older base-level on the soft Permian beds west of the fault. Subsequent regional uplift permitted the removal of the soft rocks, and allowed the streams to incise a gorge in the hard rocks in whatever portion of the older

valley it happened to be located. The feature might also be explained as the result of an older and a later uplift along the fault line.

#### SEVIER FAULT.

In common with the other displacements which traverse the Grand Cañon district, the Sevier Fault (fig. A, S.) was regarded by Dutton as of recent age. He described this fault as terminating a few miles southwest of Pipe Spring, where the principal topographic evidence of the fault does vanish (Dutton, '82, p. 20-21). It was a part of Dutton's theory that the faulting was so very recent that erosion had not yet been able materially to affect the fault cliffs. He writes: "It may be remarked here that every fault in the district is accompanied with a corresponding break in the topography. I do not recall an instance where the lifted beds are planed off by erosion, so as to make a continuous level with the thrown beds" (Dutton, '82, p. 130). Yet he recognizes the greater retreat of the plateau terraces on the up-thrown side of the faults as one result of the faulting. Thus, he states that the faults occurred so long ago that the Vermilion and Shinarump Cliffs have been worn back from ten to twenty-five miles on the up-thrown side, in excess of the amount of wearing back on the down-thrown side, since the time of the faulting (Dutton, '82, p. 200); also that the faults occurred so recently that the fault cliffs have been worn back but little (Dutton, '82, pp. 94, 117, 130). Such a discrepancy in the amount of erosion suffered by the two types of cliffs points strongly to some other interpretation than that given by Dutton.

It has already been shown that the retreat of the Vermilion and Shinarump Cliffs in the Pipe Spring district affords evidence of an ancient date for the Sevier Fault (Davis, '01, p. 143-145; '03, p. 12-15). It has likewise been shown by the same writer that the drainage in that district is from the down-thrown side of the fault toward the up-thrown, and that cliffs of the down-thrown rocks overlook lower areas eroded on the up-thrown rocks (Davis, '01, p. 145-146; '03, p. 15-16). A complete reversal of the topographic effects of faulting is thus shown, pointing to an ancient date for the fault, and at least one period of extensive baseleveling between the faulting and the present time. The following paragraphs present similar evidence observed farther southwest, and add another argument for the ancient date of the Sevier Fault.

About seven miles southwest of Pipe Spring is a line of low hills the most prominent of which is called Cedar Knoll. As seen from the west the hills present a more or less pronounced north and south es-

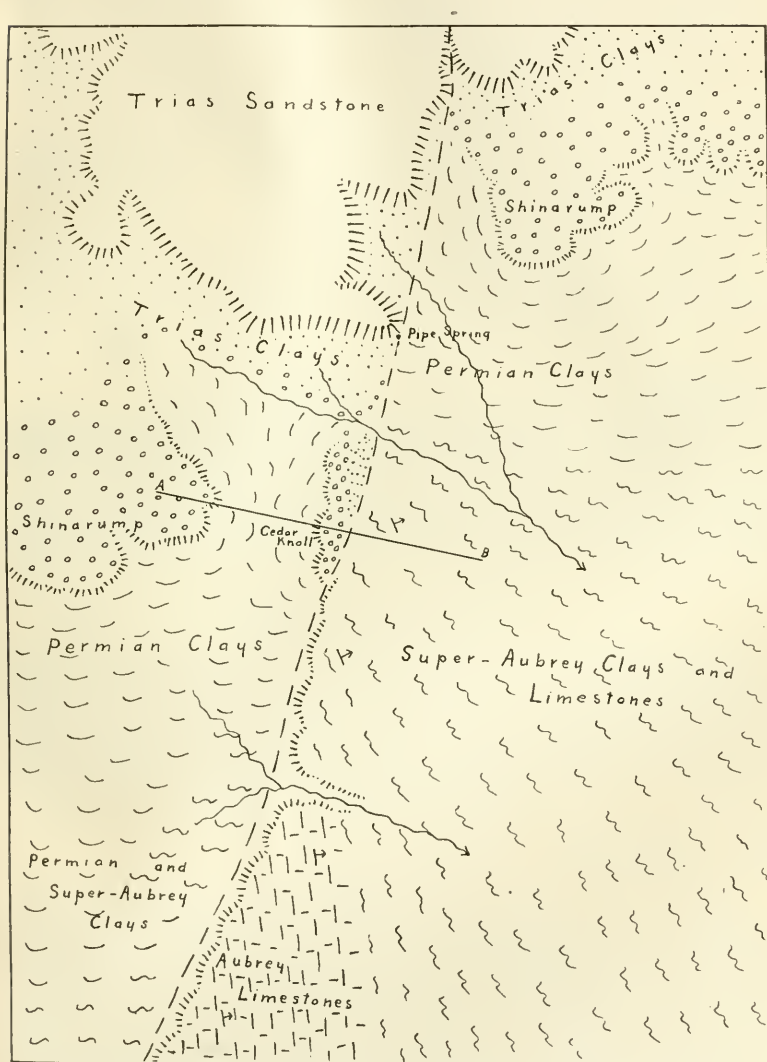


FIG. C.—Geological sketch map showing general relation of beds along Sevier Fault, in the Cedar Knoll - Pipe Spring district.

carpment. To the south the escarpment, with a slight break, continues for a number of miles, being of moderate elevation only, but having lower and lower beds rise to form its face. These west-facing cliffs are about in line with the supposed southward continuation of the Sevier Fault, and would naturally be considered the face of the fault scarp throughout its length. As will appear from the accompanying sketch map (fig. C), however, the portion of the cliff-line forming the west side of Cedar Knoll is an erosion cliff capped by the Shinarump conglomerate; the fault scarp dies out near the point where the erosion scarp appears, because here relatively non-resistant beds form the surface on both sides of the displacement.

The fault is easily detected on the lowland east of Cedar Knoll, where Triassic shales one hundred feet above the Shinarump conglomerate abut against Carboniferous limestone and red shales. Even

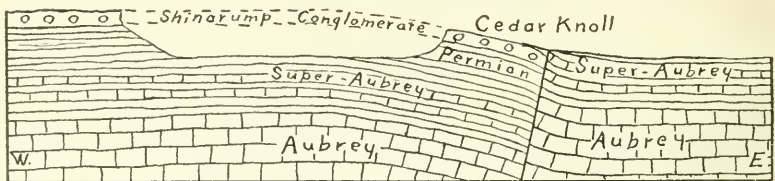


FIG. D.—East-west section along line AB (figure C) showing relation of beds at Sevier Fault, in Cedar Knoll district.

the transition from the weak red Triassic shales to the more resistant red Carboniferous shales can be readily discerned on close inspection. It will be seen that the beds on the down-throw side of the fault bend downward on approaching the fault, as shown in Cedar Knoll (fig. D), while the beds on the up-throw side are flexed upward in places,—thus conforming to the peculiarity noted elsewhere in the faults of the Grand Cañon district.

At Cedar Knoll the beds of the downthrown side are higher than and overlook the beds of the upthrown side. In addition to this complete reversal of the topographic expression of faulting, there is an obliteration of all topographic effect of faulting northeast of the knoll, where the beds on both sides of the fault line are weak shales; while southwest of the knoll the cliffs are traversed by a stream channel which drains a large area of the downthrown rocks west of the fault, through a narrow gorge cut in the cliffs, to the upthrown rocks east of the fault.

A dam built across the entrance to the gorge serves to retain a part of the small amount of water which falls in this desert region, forming a pool at which cattle and horses may drink. In common with the reversal of the topographic effect of faulting at the knoll, the absence of cliffs farther northeast, and the drainage relations may be best explained on the basis of an ancient date for the faulting.

As stated in a preceding paragraph, successively lower beds rise in the face of the cliff as the latter is traced toward the southwest. This feature becomes especially noticeable when the upper Carboniferous limestones appear. Bed after bed of this series rises from beneath the general level of the Uinkaret Plateau, to take its part in forming the west-facing escarpment. Yet the escarpment does not show a corresponding increase in height. On the contrary, the beds are bevelled across at a fairly uniform elevation, so that the outcrops of the successive layers swing away from the summit of the scarp, toward the east, as shown in the map (fig. C). Such relations indicate that there has been an uplift accompanied by warping along the east side of the fault, with subsequent baselevelling to reduce the uplifted beds to a fairly uniform surface. The softer beds (upper Carboniferous and lower Permian shales) which the faulting left opposite the limestones on the western side of the fault, have been more or less removed by erosion, so that the surface on the west is now lower, consisting of the Carboniferous limestone series with considerable remnants of the overlying shales. There would seem to be no doubt that we have here to deal with a cliff developed along an ancient fault after a period of more or less extensive baselevelling had once destroyed the original topographic effect of faulting. It has been suggested that such cliffs may be called "fault-line cliffs," to distinguish them from true fault cliffs resulting directly from displacement.

#### TOROWEAP FAULT.

According to Dutton the Sevier and Toroweap Faults are independent, the first having its southern end near Pipe Spring (fig. A, *P. S.*), the latter its northern end twenty miles north of the Grand Cañon. The faults are therefore represented as distinct on the maps accompanying Dutton's monograph.

Davis recognized that the Sevier Fault continued farther southwest

than supposed by Dutton, and concluded that it joined the northern end of the Toroweap Fault, or in other words, that the Sevier and Toroweap Faults were one and the same. He therefore describes the two as a single fault, under the name "Sevier-Toroweap Fault" (Davis '01, p. 143-144; '03, pp. 3, 4, 17-18).

In making our trip from Pipe Spring to the Toroweap Valley we traced the position of the Sevier Fault to a point some miles southwest of Cedar Knoll. Continuing in a more westerly direction, we encountered a low monocline which gradually increased in height as we followed it southwest. Later this monocline gave place to a fault, which we traced practically without interruption into the Toroweap Valley, proving that it was the Toroweap Fault (fig. A, *T.*). We concluded, therefore, that the two faults were independent, and that the Toroweap Fault died out north of the Cañon, as supposed by Dutton; the Sevier Fault, however, continued much farther south than he supposed. Plate 19, figure 1, shows the Toroweap monocline near where we first encountered it, west of the Wild Band Pockets, the displacement at this point being only fifty feet. Climbing to the summit of this low hill, the escarpment of the Sevier Fault could be distinctly seen six or eight miles away, toward the southeast.

In plan, the Toroweap monocline curves quite distinctly, as shown in the sketch map (fig. A). In section it appears as a simple monoclinal fold of gentle inclination toward its northeastern part, where the displacement is of small amount (pl. 19, fig. 1). Still farther northeast the limestones have passed beneath the surface, and the monocline developed in the overlying shales has been planed off by erosion. Its presence can be detected in the dip of the shales as exposed in the gullies near the Wild Band Pockets. Toward the southwest the displacement increases in amount, and the simple monocline changes to a double monoclinal fold, similar to the double portion of the East Kaibab Monocline although on a much smaller scale. How far this double character is maintained we did not ascertain, but it is well shown in a ravine traversing the fold several miles west of Sawyer's Tank. At some point near the head of the Toroweap Valley proper the monocline changes to a fault (pl. 19, fig. 2) which increases in throw toward the south, the displacement amounting to 600 or 700 feet at the Cañon, according to Dutton ('82, p. 93). It is thus certain that the northward decrease in the amount of displacement, described by Dutton, is really present, and that it cannot be explained as an appar-

ent decrease due to the location of the lava flows, as suggested by Davis ('03, p. 20).

Near the head of the Toroweap Valley the beds on the western side of the valley flex downward toward the east, while lower beds on the eastern side of the valley dip in the same direction. The presence of the Toroweap Fault is thus indicated, as well as the fact that the beds of the downthrow flex downward and the beds of the upthrow flex upward as the fault plane is approached, a peculiarity noted repeatedly in the faults of this region. The monoclinal folding which preceded the faulting and determined the direction of the flexing noted, was presumably older than, and distinct from, the westward-facing monocline farther northeast, which is a part of the later fault displacement.

At two places along its course the fold or fault disappears under volcanoes which are built over the zone of displacement, part of the cone being on the upper and part on the lower side. One is a short distance west of Sawyer's Tank, the other near the head of the Toroweap Valley. In neither case does there appear to be any doubt that the displacement visible on either side of the volcanic covering is the same and continuous.

The Toroweap Valley was regarded by Dutton as one of the ancient tributaries to the Colorado whose valleys were carved before the faults developed (Dutton, '82, pp. 94, 99, 201). This interpretation was based in part upon general considerations already referred to and in part upon the fact that the Esplanade (upon which the Toroweap Valley opens and with reference to which level the valley was believed to have been developed) is displaced where the Toroweap Fault crosses it. That the break in the level of the Esplanade does not afford evidence of a recent date for the fault has been pointed out by Davis ('01, pp. 143, 174). In addition to the fact that the valley closely follows the line of displacement, there are two features which indicate an ancient date for the fault.

As in the case of the Sevier Fault, the drainage in the Toroweap area is in part across the displacement, from the downthrown to the upthrown side. Sawyer's Tank is formed by building a dam across a narrow gorge in the monocline, to intercept the drainage, which flows from the low area eroded on the soft rocks of the downthrow side, through the monoclinal uplift, to the upthrown area east of the fold.

That the Toroweap Fault is not a recent development is further

indicated by the maturity of the valleys which dissect the uplifted rocks east of the fault line. These side valleys are as thoroughly mature as is the main valley, which is to be expected if the fault is old, and if both main and branch valleys developed simultaneously after a period of baselevelling; but which is incompatible with the idea that the main valley is ancient, the fault recent, and the branch valleys still more recent. A view of one of these side valleys is shown in plate 21, figure 2. It may be contrasted with the young valley shown in plate 20, a valley eroded in the uplifted block along a part of the Hurricane escarpment where the faulting is truly recent.

#### HURRICANE FAULT.

Our observations along the Hurricane Fault were for the most part confined to that portion of its course north of the Grand Cañon district, between the High Plateaus and the Great Basin. Such facts as we noted in the Grand Cañon district related to features already described by Davis ('01, p. 146-147; '03, p. 26-31), and by Huntington and Goldthwait ('04), but are in part presented below because they led us to an interpretation which differs in certain details from the conclusions reached by Huntington and Goldthwait.

It has been shown by the authors above mentioned that the "Hurricane Ledge" is in the main a fault-line cliff, developed by erosion of softer beds west of the fault after baselevelling had destroyed the original topographic effect of faulting; but that at a more recent period movement has taken place along part of the fault line, so that the basal portion of the cliffs in the Toquerville district is of true fault cliffs. In other words, a part of the Hurricane scarp is believed to have been exposed by erosion after the occurrence of an ancient fault movement; while part is believed to have been exposed recently as the direct result of a recent fault movement along the same plane.

We recognize that the two fault movements above indicated have occurred, but believe that the features in the vicinity of the Virgin River, as described by Huntington and Goldthwait, and as observed by us in the field, indicate a third period of faulting quite as distinct as the two others.

A few miles south of the Virgin River, a lava-capped butte of Permian shales is found on the very edge of the limestone cliffs of the Hurri-

cane Ledge. This butte, known as Sugar Loaf Mesa, is seen in the distance in plate 22 (fig. 1). According to Huntington and Goldthwait ('04, p. 224-225), the continuation of the lava cap is found at the base of the Ledge, on the downthrow side of the fault, covering *different* (lower) beds from those under the cap in the butte. It is clear from this that there must have been a displacement *before* the lava flow, bringing different rocks opposite each other, followed by baselevelling to reduce the rocks on both sides to a uniform level, over which the lava was spread across the fault line; also a displacement *after* the lava flow, producing the present break of hundreds of feet between the two parts of the flow. These are the two movements along the fault line recognized by Huntington and Goldthwait.

On the face of the limestone cliffs overlooking the downthrow side of the fault, and two to three hundred feet above the base of the cliffs, is a thin strip of lava (pl. 21, fig. 1) which adheres to the rugged cliff face along several miles of the fault, although removed by erosion in places. This lava strip is represented on the geological map by Huntington and Goldthwait, but its significance is not discussed by them. It is probable that they regarded it as a fault splinter broken from the main lava cap when it was downfaulted, in which case it would have no special significance.

The lava strip does not appear to represent a fault splinter, however. Its contact with the limestone back of it is an irregular, igneous contact, produced by the flowing of the liquid lava against the face of the cliff; and wherever a stream valley occurs in the limestone cliffs, the lava strip follows up the valley for some distance. There is no evidence of faulting between the lava and the face of the limestone cliffs. The lava strip was traced far enough south to see that it could have no possible relation to the cap of Sugar Loaf Mesa. The existence of any peculiar warping or splintering of the former lava cap to produce such a relation is thus excluded. The conditions are essentially as represented in the accompanying diagram (fig. E).

As shown by the figure, three faulting movements are necessary to bring about the conditions indicated in the field: (1) the ancient fault, bringing different rocks opposite each other, which were then peneplained and covered by the lava flow *aa'*, as demonstrated by Huntington and Goldthwait; (2) a second fault dropping the rocks west of the fault down to the position indicated by the dotted lines. After considerable erosion of the fault cliffs, a volcano west (?) of the fault

poured out a lava flow, *bb'*, which flowed against the cliff base. (3) A third faulting movement, dropping the region west of the fault to its present position, but leaving a thin strip of the later lava adhering to the face of the cliff.

It appears from the foregoing that this part of the Hurricane Cliffs is directly due to the second and third comparatively recent faulting movements, and that the erosion which followed the first faulting reduced the region to a peneplain which was covered by the older lava flow. This lava flow prevented the differential erosion which gave fault-line cliffs along some of the other faults, and along other portions of this same fault. The cliffs in the Virgin River portion of the Hurri-

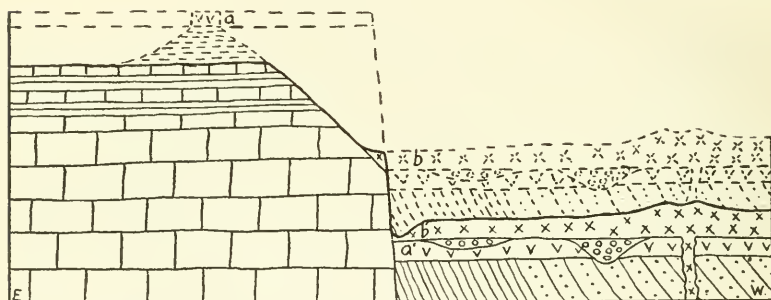


FIG. E.—East-west section through Hurricane Fault, south of Virgin River, showing relation of beds to Sugar Loaf Mesa (farther south), with evidence of three periods of faulting.

cane Ledge are then true fault cliffs of much more recent date than the fault-line cliffs we have considered under preceding headings.

If we take into account the monoclinical folding of the plateau series which preceded the first faulting, and ignore the "drag" of the down-thrown beds which is strongly developed in the Virgin River section, the succession of events in the geological history of the Hurricane Ledge region of which we are cognizant may be represented by the accompanying rough diagrams (fig. F-M; not drawn to scale).

Since the last faulting there has been sufficient erosion to remove part of the lava strip from the face of the cliff in places, to develop erosion channels in the surface of the flow at the base of the cliffs, and to allow the gorges which open in the face of the cliffs partially to grade their courses, although cascades may be found in the lower,

recent parts of the small gorges a short distance back from their mouths (pl. 20).

The facts set forth above require certain modifications of the excellent report by Huntington and Goldthwait. Their geological map (plate 7 of their report) correctly represents the distribution of the lava-capped mesas at the crest of the cliff, the lava strip adhering to the face of the cliff, and the lava at the base of the cliff. But the cross-section E-F on plate 6 of their report, incorrectly represents the strip of lava adhering to the face of the cliff as a fault splinter. Their cross section of this same lava strip where it crosses the Virgin River is correctly shown to lie in its original position against the face of the cliff (fig. 5, p. 225). But they erroneously interpret the strip at this point as being the same as the lava cap of Sugar Loaf Mesa. This accounts for their statement that the recent displacement was but 300 feet at this point, although a displacement of 1,400 feet was noted just south. No attempt is made to explain the manner in which the lava capping the Permian shales at an elevation 1,000 feet higher could have its continuation on the face of the cliff of Carboniferous limestone below. It should be appreciated that figures 4 and 5, placed on opposite pages of their report as illustrating two examples of the same feature ("The first faulting"), really represent different features, separated by a long interval of erosion. The lava caps in the two cases are of different ages, as well as the faults which they cover. The features shown in their figure 4 did formerly exist in the region represented by figure 5, but erosion completely destroyed those features in the latter region; and the close resemblance of the present relations to those which formerly existed should not prevent a full recognition of the significant difference between the two. In figure 5, the lava covering the eastern branch of the fault should be slightly displaced if the conditions are to be accurately represented, as the last faulting movement affected the main fault plane to that extent, although the principal displacement was along a plane just west, in the region of this particular cross section. The 300-foot displacement recorded by Huntington and Goldthwait at the Virgin River represents the movement due to the third faulting only; while the 1,400-foot displacement noted a little farther south represents the movements of both the second and the third faulting periods. The total recent displacement at the two localities is probably about the same.

The baselevelling which followed the first faulting was probably more nearly complete than supposed by Huntington and Goldthwait.

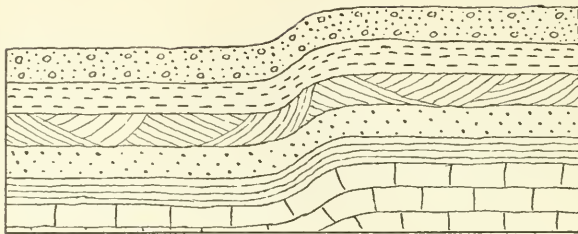


FIG. F.—The folding.

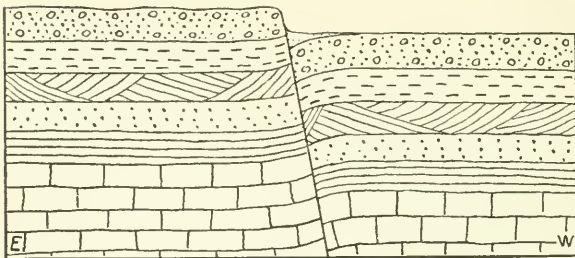


FIG. G.— The first faulting.

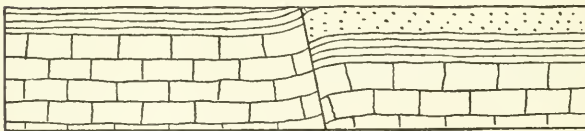


FIG. H.— The great denudation.

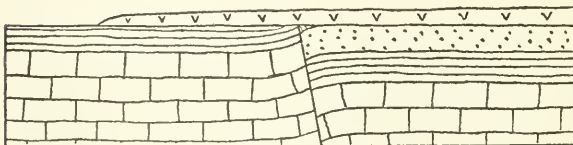


FIG. I.— The first lava flow.

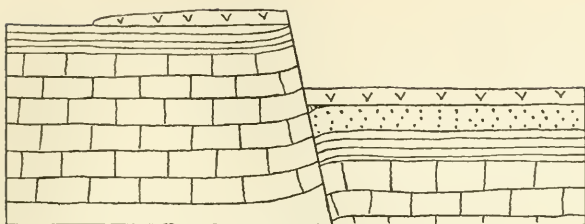


FIG. J.— The second faulting.

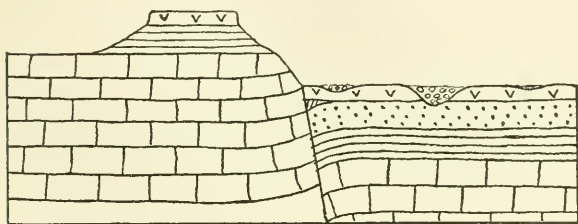


FIG. K.— The second erosion.

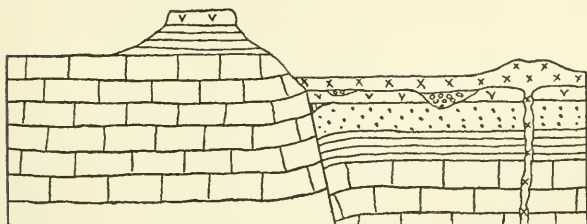


FIG. L.— The second lava flow.

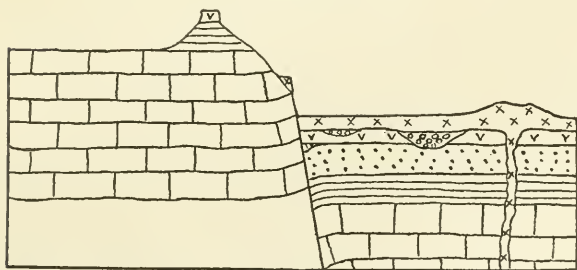


FIG. M.— The third faulting.

They have recognized its completeness farther south, but conclude that in the Virgin River district the baselevelling was not so perfect, since "the lava after crossing the fault was soon checked by an escarpment of limestone rising two or three hundred feet with a fairly strong slope" (Huntington and Goldthwait, '04, p. 230). We have seen, however, that the lava here referred to was the recent flow which followed the second faulting movement, and that the "escarpment" was the one produced by this second faulting, and not one left after the baselevelling period. At the close of that period, the scarp formed by the first faulting was probably as completely obliterated here as elsewhere, the position of the baselevel surface being possibly 1,000 feet higher than the surface covered by the lava flow exposed at the crossing of the Virgin. It appears that this same confusion occurs in the authors' interpretation of the fault north of Toquerville, as three movements instead of two are indicated by the topography along that portion of the fault.

According to our observations the Hurricane Cliffs in the Virgin River district are wholly the result of recent faulting, and represent two different movements separated from each other by an erosion period, and from the first faulting by a long baselevelling period.

#### SUMMARY.

South of the Cañon, in the San Francisco Plateau, displacements are more numerous than has been supposed, although of little importance compared with the great displacements north of the Cañon. The "craggs" of the Echo Cliffs probably owe their peculiar form to erosion guided by strongly marked crossbedding, and possibly in part also to the influence of a well developed system of joints. The Sevier and Toroweap Faults are independent and do not join each other to form one great displacement, as has been thought might be the case. The Hurricane Cliffs in the vicinity of the Virgin River are true fault cliffs wholly due to recent faulting at two different periods. In all, three periods of faulting along the same plane have occurred in that region, the first and second periods being separated from each other by a long era of baselevelling, while the second and third periods were separated by a shorter, but none the less distinct, erosion interval. Observations made along other displacements in the Grand Cañon district confirm the theory that the faults of this district are in the main of ancient date.

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EXPLANATION OF PLATES

PLATE 17.

- Fig. 1. Bear Wallow Gulch, a small cañon in southern edge of San Francisco Plateau.
- Fig. 2. Oak Creek Fault (*F*), cutting mesa near Mogollon Rim.



1



2





PLATE 18.

- Fig. 1. Landslide at base of Vermilion Cliff, near Jacob's Pool. Photograph by H. W. Shimer.
- Fig. 2. Mouth of Jacob's Cañon, at West Kaibab Fault, showing gorge in more mature valley.



1



2





PLATE 19.

- Fig. 1. Toroweap Monocline west of Wild Band Pockets.  
Fig. 2. Toroweap scarp, east side of Toroweap Valley, a dissected fault-line cliff.



1



2





JOHNSON.—Grand Cañon District.

PLATE 20.

Young valley cut in recently uplifted Carboniferous limestone along Hurricane Fault.







PLATE 21.

- Fig. 1. Hurricane Ledge south of Virgin River, showing lava strip adhering to face of scarp.
- Fig. 2. Mature branch of Toroweap Valley.



1



2





PLATE 22

- Fig. 1. Hurricane Ledge in the Virgin River district; Sugar Loaf Mesa in the distance.
- Fig. 2. The Hurricane Fault where it crosses the Virgin River. Horizontal Aubrey limestone on east (upthrown) side of fault, upturned Permian sands and shales on west (downthrown) side.



1



2



No. 7.— CONTRIBUTIONS FROM THE GRAY HERBARIUM  
 OF HARVARD UNIVERSITY. NEW SERIES.— NO.  
 XXXVII. FLORA OF THE ISLANDS OF  
 MARGARITA AND COCHE,  
 VENEZUELA.

BY JOHN ROBERT JOHNSTON, M. S.

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GENERAL CONSIDERATIONS ON THE FLORA OF VENEZUELA.

PROFESSOR Goebel's ('91) most interesting account of the vegetative conditions to be found on the Cordilleras of Merida in Venezuela is descriptive of an excellent field for botanical research. Within 150 kilometers (93 miles) of the shores of Lake Maracaibo the moun-

tains rise to an altitude of 4000 meters (12,000 ft.) so that a traveler in passing from the Lake up to the mountains traverses the lowland forests, the higher and barren hills, the rich valleys, the forested mountain sides and gorges, to the treeless summits, some of which are capped with snow.

In this short range occur all variations from the swampy seashore and the barren hills to the luxuriant valleys, and the alpine regions. On the mountain sides occur furthermore at various altitudes not only quiet gorges in which the woods are dripping with moisture but also knolls exposed to the fierce winds, often accompanied by great changes in temperature. A greater variety of vegetative conditions is difficult to find within so small an area in any other country.

Venezuela may well be considered as consisting of three different regions: the Andean extending from Lake Maracaibo southwest over the mountain ranges to Colombia; the coastal region from Lake Maracaibo eastward to the Gulf of Paria at Trinidad, including all the coastal islands and extending inland to the llanos by the Orinoco; and the third region consisting of the Orinoco district and all of the extensive and little known forests to the south. While each of these three divisions shows some of the characteristics of the others, each has features of interest peculiar to itself, the first region being alpine, the second consisting of the barren or desert hills of the coast and of the islands, and the third being characterized by the grassy plains and forest areas of the llanos and selvas.

Such a variety of conditions as is presented in this country leads one to expect much of botanical interest. There must be both a remarkable variety of plants and many interesting adaptations of the plants to their environments. A number of collections have been made, but not nearly so many as the conditions warrant, and unfortunately the reports of these collections are scattered and incomplete. The need for more work on the flora of Venezuela is strongly felt. Brazil has the elaborate work of Martius ('40-'06); the Guianas those of Schomburgk ('47-'48) and Pulle ('06); Colombia that of Karsten ('58-'69) and also the recent collections of Smith and Pittier. The West Indies as a whole have Grisebach's ('64) well known Flora, and the recent *Symbolae Antillanae* of Professor Urban ('03). But in Venezuela, lying between these lands, no botanical work at all complete has been done.

The first recorded visit of a naturalist to Venezuela is that of Peter

Loeffling (1776). He sailed from Cadiz, February 15, 1754, for Cumaná where he spent six months. Then he journeyed to New Barcelona, the missions of Píritu, and the river Guyana, where he stayed three months. Thence he traveled to the missions on the Curoni and returned to Cumaná. In the description of his travels are noted thirty-four plants occurring about Cumaná.

In the years from 1807 to 1825 were published various works by Humboldt, Bonpland ('14-'29; '14; '08) and Kunth ('15-'25) describing the travels of the first two and then giving notes on their observations. Their list of plants, collected for the most part about Cumaná and along the Rio Negro and Cassiquiari Rivers, comprises some 1200 numbers. Most of these are now in the herbarium of the Museum of natural history at Paris.

Funck and Linden landed at La Guaira in 1840. Linden went to Peru while Funck went toward the Orinoco, visiting Cumaná, Guana-Guana, San Augustin where he made a rich collection, the Grotto de Guacharos, Caripe and its mountains. In 1842 and 1845 he visited Santa Marta, San Sebastian, and Galipan, and thence went to Curaçoa and to the region of the Silla de Caracas. His plants are in the Delessert herbarium at Geneva. There is no published list of them. Linden arrived at Caracas in January, 1842, and in May of the same year sent plants to Delessert. This collection (235 species) contained plants from the Silla de Caracas and the Cerro de Avila. In May, 1842, he left Caracas for the Andes of Merida. In January, 1843, he sent from Merida to the consul of France at Maracaibo plants collected in the high Andes of Truxillo and Merida. Linden's plants of Colombia, which may include his Venezuelan ones, are at the following places: University of Ghent, herbarium de Candolle (2066 species), herbarium of the University at Leipzig, and the herbarium of the Royal museum at Vienna.

There are plants of Funck collected at Caracas at the herbarium of the Academy of sciences at St. Petersburg (819 species).

Plants of Funck and Schlim (Reichenbach, '54b) collected in tropical America are in the herbariums of the universities of Ghent and Leipzig as well as in the Delessert herbarium.

Plants collected by Moritz (see Hampe '47a, '47b) are in the British museum, at the Royal botanical gardens in Berlin, in the herbarium of the Imperial botanical garden of St. Petersburg, and in that of the Imperial academy of St. Petersburg, of the Royal museum at Vienna, and of the University at Leipzig.

Plants of Wagner collected in Panama and Ecuador are in the royal herbarium of Munich and University of Göttingen. Possibly these include his Venezuelan plants.

Karsten ('58-'69) who published the extensive flora of Colombia and the adjacent regions included seventy-nine plants collected in Venezuela.

Plants collected by Birschel at Caracas are in the Gray herbarium.

Fendler's (see Eaton '61) collections of Venezuelan plants are in the herbariums of de Candolle, Delessert, Engelmann, Franqueville, University of Dublin, Gray herbarium, and British museum. August Fendler was a German botanist who lived in Colonia Tovar near Caracas from 1854-59. His collection comprised nearly 3000 numbers. There is no published list excepting that of the ferns and orchids, and a large part of the plants remain in the herbariums entirely or partially unidentified. Fendler was at one time an assistant at the Gray herbarium and his collecting was carried on to some extent under Dr. Gray's encouragement and patronage. It is believed that the set of his plants in the Gray herbarium is as nearly complete as any in existence.

Adolphus Ernst, who for a number of years was secretary of agriculture in Venezuela and also a professor at the University of Caracas, has contributed more to our knowledge of the Venezuelan flora than any other man since Humboldt's time. Ernst had in preparation a flora of Venezuela but owing to his death in 1899 it was never completed. He did, however, publish numerous short articles pertaining to the vegetation. A complete list of these occurs in the bibliography of his works published at Jena in 1900 (Ernst, '00b). The more important of these are the lists of the plants of Los Roques (Ernst, '72a), of La Tortuga (Ernst, '76b), of Margarita (Ernst, '86), and the list of ferns and of the orchids of Venezuela. The plants which he collected appear to be entirely inaccessible today. They are not to be found in the University museum at Caracas nor in the old National museum of natural history. It is possible that they have been sent to various European herbariums. As his lists contain merely the names of the plants with few or no notes, their identification in some cases must remain a matter of question.

In 1896, Professor H. H. Rusby ('96) and Roy W. Squires collected about the lower Orinoco. Their plants are in the New York college of pharmacy and in the Gray herbarium.

In 1900, Captain Wirt Robinson and Dr. M. W. Lyon, Jr., collected at La Guaira, Macuto, and San Julian about sixty plants which are now in the U. S. national herbarium (see Johnston, '08).

In 1901, with a party of three others I spent the months of July and August on the island of Margarita. About 300 species of plants were collected. On another trip to the same island in 1903, we increased the known flora of Margarita to 654 species. At the same time a collection was made on the island of Coche and visits were made to Carupano, Cumaná, La Guaira, and Caracas to compare their floras. Again in 1907, I was enabled to visit Venezuela although no collecting was done on Margarita. Visits to Pampatar on Margarita and to Carupano, Cumaná, Barcelona, Guanta, La Guaira, Caracas, and Valencia on the mainland, all have been of value to me in comparing the flora of Margarita with that of adjacent regions.

It is believed that the above collections comprise all that have been made in Venezuela with the exception of a few by Venezuelans. In some cases the data are incomplete and unsatisfactory but they may nevertheless furnish a basis for further research work along this line.

#### FLORA OF THE ISLAND OF MARGARITA.

##### *Introduction.*

The island of Margarita is only a small part of Venezuela, nevertheless its flora has proved to be of considerable interest, particularly as revealing several new species and as increasing the known geographical distribution of other species. The island was visited in 1873 by Dr. Adolphus Ernst who published a report of the plants discovered. Captain Wirt Robinson visited the island in 1898 making a collection of the birds and mammals. In 1901 a party of four students of Harvard university consisting of Austin H. Clark, O. O. Miller, Walter P. Jenkins, and myself spent the months of July and August collecting specimens of animal and plant life. In 1903, through the kindness of one of the friends of the Gray herbarium of Harvard university, I was enabled to visit Margarita again. This time I was accompanied by Dr. Albert F. Blakeslee, who devoted himself to the collection of algae and fungi, and by Clifford Wilson, who assisted us in our work. These visits to Margarita, which are all that have been reported of scientific workers, taken together furnish fairly complete data as to the character of the flora and its vegetative conditions.

*Physical Features.*

The island of Margarita as seen from the mainland thirty-two kilometers distant appears as two conical mountains separated by a long stretch of lowland. It may be seen on the accompanying map that it consists of two irregular polygonal areas connected by a narrow strip of land, each of these areas rising from the lowlands of the plain to the foothills and mountain ridge of the center, thus giving the conical appearance in the distance.

Located about eleven degrees north, and sixty-four degrees west, Margarita is sixty-seven kilometers long and thirty-two wide. It is eleven kilometers from the desert islands Cubagua and Coche, and is the largest of the Venezuelan islands that extend along the coast from Curaçoa to Trinidad. The highest peaks of the two ends are about forty-two kilometers apart. The relative extent of plains, foothills, and mountains can best be understood by considering the two ends separately and in detail.

The mountains of the eastern end rise to an altitude of 795 meters and have many spurs jutting out in different directions. Surrounding the mountain and its spurs are the valleys and plains which in some cases extend to the sea. On the eastern and northern sides are what may be termed outlying mountains which are less extensive than the central mountain mass, San Juan Mountain, and border directly on the sea. The top of San Juan Mountain, between the altitudes 650 and 795 meters, is destitute of trees. Bare rock ledges jut out from beneath the low shrubbery. Occasionally the summit is in clear sunshine, but quite as often the heavy clouds laden with moisture are rapidly flitting over, now completely enveloping it, and now exposing it to the warmth of the sun. Within thirty meters of the top is one spring on the El Valle side, and fifteen meters below that is another. Though these are entirely exposed they never seem to dry up. The dense woods which cover the mountains above 400 meters collect and retain the moisture of the clouds, thus together with the two springs furnishing a source for small streams below.

On the map of the island it is shown that the mountain ridge as a whole not only extends from northeast to southwest, but also rises gradually from the west in a succession of hills to the highest point which is above El Valle and San Juan, thence lowering a little for a distance of one and one half kilometers, and then dropping abruptly

down to the plain near Asuncion. Each of the successively higher hills of the western end swerve to the south in the form of ridges sloping gradually to the open plain at San Antonio. From the highest point, however, there proceeds a very distinctive ridge between San Antonio and El Valle. This South Hill, as named for the collector's convenience, together with a similar hill to the north of El Valle, called North Hill, curves so as partially to enclose El Valle, the most characteristic valley of the island. Farther around the mountain to the northeast of it, is the large valley of Asuncion, and northwest of this is Tacarigua and at the western end again, on the north side, and opposite El Valle, is the valley of San Juan.

With this system of narrow valleys surrounding the mountain, it may be expected that there are mountain torrents in the time of heavy rains, and such is the case. The valleys of San Antonio and of San Juan, however, have only the dry river beds in ordinary weather, while the three other valleys alone have permanent streams.

The above-mentioned springs are the source of one river in El Valle which has been directed into a reservoir at the head of the valley at an altitude of fifty meters, whence it is piped to the villages of El Valle and Porlamar. There are ten public and a few private drinking fountains or "pelas" on the way, a distance of eight kilometers. The valley forks at its head so that to the northeast occurs a narrow ravine in which flows a small stream. This is used for laundry purposes, and is lost in the soil before it reaches the lower valley. There is also a short distance to the east of this another stream which is confined to private grounds on which are three concrete reservoirs provided for it.

The region between El Valle and Asuncion valley has no distinctive features, nor is there any stream. Although down in the valley of Asuncion proper there is only one stream bed and not much water, one and one half kilometers or more above the village at an altitude of 450 meters there are no less than eight stream beds of which six always contain running water. A trail passing through the forest at the above altitude from one side of the valley around the end to the other, furnishes an excellent opportunity to study these streams. The valley is most curved toward the southeast and gradually straightens out to the northwest. Beginning from the southeast the streams or stream beds were numbered in collecting merely for convenience, but the numbers may well serve here.

The first stream has a very shallow and rather indistinct bed. The land is wet and muddy on both sides of it. The second stream is a little larger and forms distinct pools at intervals. Below the trail this river has a very steep bed and appears on the surface only occasionally from underneath the rocks. Intervening between this and the next river is a slight elevation which extends as a small ridge into the valley. On the northwest side of this ridge is a ravine about twenty meters deep, at the bottom of which runs the third river. The southeast slope is very steep, the northwest is a gradual rise. A little farther on is another ravine of similar depth and its southeast side is almost perpendicular. The northwest slope is gradual. A short way from this is the third and deepest ravine containing the fifth river. Another and shallower ravine is near by containing the sixth river. These four ravines are similar in having a steep slope on the southeast side and a gradual rise on the opposite side. The unimportant dry river beds of the seventh and eighth streams are but a short way farther, very near to the ridge separating the large Asuncion valley from that of Tacarigua.

The valley of Tacarigua, the next in the series around the mountain, is very long and has steep sides. The one river, the Rio Blanco, flows down to the bottom of the valley where it is lost eleven or twelve kilometers from the sea. The water is very impure though from what source I do not know. It is slightly muddy in color and tastes similar to a sulphur spring. Adjoining the valley of Tacarigua is that of San Juan, the last of the series surrounding the mountain. As this has nothing but a dry river bed it is of little importance.

As has been said, the mountain as a whole is covered by dense woods. The summit of San Juan Mountain is the only exposed part. The highest part of all the ridges is covered with shrubs which lower down gradually give place to small trees and still lower to the very tall trees. In all parts rocks are projecting in an irregular fashion. Not even in the densest part of the woods is there a soil of any considerable depth, and of course the river beds are extremely rocky. Where the mountain slope is interrupted by some hill, there the woods stop, but where the slope is continuous with a valley the woods extend to a much lower level. This latter condition occurs characteristically in El Valle and in the valley of Asuncion which are the only two worthy of detailed consideration.

The woods of El Valle are heavy as low as fifty meters, the height

of the reservoir, although they are rapidly being cleared off in all directions. Immediately below this is the extensive coconut grove reaching down into Porlamar. The configuration of the land about the village of El Valle makes it an ideal place for botanical study. North and South Hills as before mentioned leave the mountain in a southerly direction and both give off short ridges running toward each other and also away from each other on the other side.

About a kilometer and a half from the mountain, South Hill turns to the southeast, and North Hill turns to the southwest, the two stopping but a short way from each other, thus leaving a narrow entrance into a nearly enclosed valley. In this small area there are exposures to all points of the compass. There is one dry river bed extending from the foot of the mountain to the sea, that is important in the rainy season. It is here that the heavy vegetation of the valley grows.

Asuncion is the only other valley of importance. The head of it has been described in the discussion of the mountain rivers. The lower part is quite open and is continuous with the plains to the sea. This valley faces to the northeast so that it gets the wind and moisture. The clouds, however, are usually at an altitude of from 400 to 600 meters so that it is only the upper part of the valley that is extremely moist, the richest part of the island. Otherwise the valley is similar to any of the lowlands.

Intervening between the valleys, partially surrounding them, and also standing as outlying features are the hills and small mountains conspicuous by their red soil and by their desolation. In the case of the hills attaining the height of 300 meters the summit has a few scattered trees. Other vegetation is either lacking or restricted to small patches of dry bushes. The soil is very conspicuously red, or on a few hills made gray by the preponderance of limestone. It is loose and easily weathered into small slabs or into a crumbling mass, which rapidly washes or rolls down the steep hills. At the time of the heavy showers the hills are gullied everywhere. As a consequence of their condition the soil is thin and can maintain only shallow-rooted vegetation.

From the very nature of the rock it is to be expected that caverns of some size are to be found. Within twenty meters of the summit of Bat Cave Peak is a large cave which opens above near the summit, and also at the side. About one hundred meters from the foot of the hill there is a hole in the rocks through which I could with diffi-

culty lower myself. Below was a cave about three meters deep and large enough to hold several men. Both of these caves are inhabited by bats, and the lower one contains numerous lizards.

The barrenness of the hills is increased several fold in the plains excepting at the mouth of a valley. The surface of the plain is undulating only slightly and in few places. It is for the most part sandy, reddish near the hills and white toward the sea. In places, notably between San Antonio and the sea, the surface is covered with irregular broken rock, small fragments, angular, and very little weathered. By the sea the plains contain several lagoons as may be noted on the map.

On the plain a mile inland from Juan Griego is a small pond of brackish water always turbid and used merely for laundry purposes. At Punta Moreno is a small lagoon connected by a narrow outlet to the bay of Porlamar. At Punta Mosquito is Laguna Chica surrounded by mangroves. This is about six kilometers long and navigable by sloops. At Punta Mangles and at Punta Piedras are also small lagoons and mangrove swamps. The lagoon at Punta Piedras is open to the sea by an inlet about one meter deep and six meters wide. Inside the mangrove border is a clear circular body of water about one-half kilometer across.

From the above description of the eastern end, it is hoped that a good idea of the physical features may be derived. When the distribution of the plants is discussed the picture of the district will be more complete. Then one may see along the shore at intervals the mangrove-bordered lagoons, then stretching inland the sandy plain dotted with the cactus and low shrubs exposed to the burning sun; the brown hills with small dead bushes, the valleys with the waving coconut palms and higher up the green-clad mountain side with the top reaching into the clouds.

The land intervening between the two ends is for the most part a large mangrove swamp, open to the sea on the north side and a short distance on the south side. Although the lagoon is about eleven kilometers long, it has very little clear water.

The western end of the island is of much less importance than the eastern. The conditions recorded here are taken from the meager encyclopedic references and from the observations which I made from the distant San Juan Mountain and on the Coche-Punta Piedras voyage and on board the steamship from Porlamar to La Guaira and also from reports of the natives.

According to encyclopedias, the mountain peak of this end is 60 meters higher than that of the eastern end. Though in the distance that looks very probable, it makes little difference in the character of the vegetation. Little of the mountain range anywhere approaches the height of the peak. Most of the ridges are very steep and apparently have no forest growth, whatever. Cliffs are exposed in numberless places. Under such conditions, although the peaks are often hidden in the clouds there can be little moisture retained and consequently no springs nor rivers, a condition which agrees with the reports of the natives. The single town of Macanao on the west coast is supplied with "posa" water (rainwater and seepage collected in clay pits) and with imported water. One large ridge with short spurs runs east and west along the south shore, and to the northeast is a series of high hills. The only plain is on the northwest side. The character of the western end as a whole then is similar to that of the hills and plains of the eastern end.

The above paragraphs give some idea of the topography of Margarita. It seems advisable also to discuss so far as possible the temperature and moisture as they affect the conditions of vegetation.

The above description distinctly suggests that Margarita is a very dry island. During the time from July 3 to August 22, in 1901, there were only two heavy rains in El Valle each lasting much less than an hour, and I did not observe any light showers. This it must be remembered was during the rainy season on the mainland only twenty-seven kilometers distant. At this time conditions seemed to be quite normal. Orange trees and the coconut palms were bearing fairly well, and the valley bottoms were filled with thriving weeds.

Observations made from June 29 to September 4, in 1903, were very different. At this time the coconut trees were dying, the oranges had turned color on the tree when less than half grown, and scarcely a weed could be found. The island and especially El Valle was in a bad drought. According to the natives there had been no rain for two or three and some said even five years. This latter time is shown to be incorrect by my own observations in 1901, but at any rate it is suggestive of very little rain for several years past. Records for 1903 are as follows:—

July 14. Heavy rain in Porlamar; very light at El Valle.

July 17. Light showers at El Valle.

August 14. Very heavy rains on the mountain and down through

El Valle. Trails on the hillside were in many places washed away. Gullies were deepened considerably. Rained from about midnight till 10 A. M. of August 15.

August 16. Light showers.

August 21. Very heavy rain in El Valle. The heavy sheets of rain seemed to ascend one valley to the mountain top and retreat to ascend the other valley. The rain was very light on the surrounding hills. During the storm and immediately after it a continuous roaring sound arose from the valley. On investigation this proved to be the rapid falling of the water down the steep gulches. Farther down the small streams united and flowed into the "dry river bed." The two trails running for a distance of a mile from the foot of the mountain into the plaza at El Valle proved themselves to be veritable rivers. They were loosely paved with stones and were walled on each side so that they held in the water well. A half hour after this rain the trails were still submerged, and uniting with the river near the plaza they formed a perfect torrent at least until 7.25 P. M.

A very different factor from the rain is the heavy mist which almost constantly hangs above the mountain. About one third of the time the mountains above 600 meters are in the clouds. Very often from night until 6 or 7 A. M. the hills over 300 meters are in the clouds but they are never cloudy in the daytime except in case of storms. The clearing of the woods which everywhere seems to be inevitable, is going on here slowly. Where previously all the vegetation was dripping with moisture now for the most part conditions are much drier because trees have been cut down thus allowing the sunlight to enter.

In the preceding paragraphs it is seen that compared with other tropical districts, Margarita has almost no rainfall. The mainland in the summer season has a shower nearly every day. So has Trinidad off the northeast coast of Venezuela. While my records are mostly from the south side of the island, yet excursions made to Juan Griego and that vicinity indicate that it is but slightly better off.

Although the island is desert-like in character yet from the fact that it gets the northeast trades, a comfortable temperature may be expected. My records average as follows: at 6 A. M., 29 degrees C.; at 1 P. M., the hottest, 32.4 degrees C. These records are from El Valle. Porlamar always seemed hotter than this. The coolest is of course on the mountain top at San Juan Mountain. The average coolest is 25 degrees C., the single coldest record was 24.5 C. This

is the most delightful temperature condition imaginable, often cloudy and always breezy. El Valle is comfortable, but the villages on the plains are in the daytime very warm. At night it is comfortable everywhere.

*Catalogue of the Plants of Margarita.*

Dr. Ernst in his visit to Margarita, in 1873, spent the month of May collecting at Juan Griego, Santa Ana, and Asuncion. His collection amounting to 242 different species are the first plants reported from that island but unfortunately they do not seem to be available for reference today. Their location is unknown to me; certainly they are not accessible in any place in Venezuela.

The only other collections from Margarita and the only ones readily available for reference today are those made by our parties in 1901 and 1903. In 1901, we collected over 300 different species spending most of the time from July 4 to August 22 in El Valle and the plains toward Porlamar, with only occasional trips to Juan Griego, Asuncion, and Punta Moreno. In 1903, from June 28 to September 4, we found the region about El Valle in such a drought that for our collections we had to resort to the mountains for the most of our work. One trip was made to Juan Griego, Tacarigua, and Asuncion, one to Peilar and several to Punta Moreno and Punta Mosquito. We also made one excursion to the island of Coche and to Punta Piedras on Margarita. In each of these trips, that of 1901 and that of 1903, between 3000 and 4000 specimens were secured, all of which have been distributed among the leading herbariums in this country and abroad, the most nearly complete set being at the Gray herbarium of Harvard university. It is unfortunate that the first collection was distributed in an incomplete and poorly identified condition but it is hoped that the present listing of the species together with the citation of the collection numbers and dates may tend to correct any previous errors. In the main the identifications have been carried on at the Gray herbarium. Mr. O. O. Miller of the party of 1901 assisted in the identifications of the collection of that year. The rest of the work, in which I have been generously assisted by the staff of the Gray herbarium, has devolved upon me. Mr. Oakes Ames identified part of the Orchidaceae; Dr. Carl Mez, part of the Bromeliaceae; Dr. Casimir de Candolle, the Piperaceae; Professor Radlkofer, one of the Sapin-

aceae; and Mr. W. R. Maxon has revised the list of ferns. Professor I. Urban has made some corrections in my identifications and has published several new species based upon my plants. The collection of fungi and of algae made by Dr. A. F. Blakeslee has been identified by Professor W. G. Farlow and is deposited in the Cryptogamic herbarium of Harvard university. This collection is not included in the following list of Margaritan plants.

To all these who have so generously assisted me and especially to Professor B. L. Robinson under whose supervision this work has been done and to Miss M. A. Day, librarian of the Gray herbarium, who has verified the references and otherwise assisted in the bibliographical work, many thanks are due.

In working out the identifications of the plants listed in the following catalogue many difficulties were encountered, chief among them being the great lack of South American plants for comparison, and the uncertain condition of many South American genera and species. These difficulties have been overcome to some extent by the assistance, already referred to, of specialists on certain groups. The bulk of the plants, however, remained in groups which have not been revised for some time.

The citations to be found in the catalogue, consist of the original references to the names which are used, a reference to the earliest use of the specific name, and in addition reference to either or both Grisebach's *Flora of the British West Indies* and Martius' *Flora Brasiliensis*, as well as a reference to some published illustration, and when possible a citation of monographs of the various groups. These are the works which have been used in conjunction with herbarium specimens to make the identifications, to determine the character of the species. From these my idea of the species was obtained and for that reason it seems desirable to cite them in this list. In addition to these references I have also given the occurrence of the species in Venezuela as a whole, this being ascertained by reference both to publications and to specimens. All specimens here reported and collected by Fendler, by Rusby and Squire, by Robinson and Lyon, by Birschel, and by A. H. Moore have been personally examined by me and compared with my own material. Other references than those of species to Venezuela are taken from publications and are given for only what they may be worth under such circumstances. The reference to Ernst with some page number is to Ernst's *Estudios sobre la flora y fauna*.

After the citation of Venezuelan plants, I have given reference to the occurrence of the species in Porto Rico as found in Urban's Flora portoricensis. These citations are based upon Professor Urban's comparison of my plants with his so that the distribution of the plants in these two localities is made certain. The last note after a species is in regard to its general distribution.

The arrangement of the families is as in Engler and Prantl's Pflanzenfamilien, and the genera and species are alphabetically arranged in their respective groups.

While it is to be regretted that each species could not be subjected to the critical examination of a specialist it is to be hoped that this list in connection with the distributed plants may be of value in future work upon the flora of Venezuela.

### PTERIDOPHYTA.<sup>1</sup>

#### GLEICHENIACEAE.

##### DICRANOPTERIS Bernh.

D. FLEXUOSA (Schrad.) Underw., Bull. Torr. bot. club, vol. 34, p. 254 (1907). *Mertensia flexuosa* Schrad., Goett. Anz., p. 863 (1824). *M. rigida* Kunze, Linnaea, vol. 9, p. 16 (1834). *Gleichenia flexuosa* Mett., Ann. Lug. Bot., vol. 1, p. 50 (1863). *G. rigida* Bommer & Christ, Bull. soc. bot. Belg., vol. 35, p. 174 (1896).—San Juan Mt., alt. 700 m., July 16, *Johnston*, no. 180. Tropical America.

#### CYATHEACEAE.

##### CYATHEA Sm.

C. TENERA (J. Sm.) Hook. ex Moore, Ind. Fil., p. 274 (1861). *Alsophila tenera* J. Sm., Lond. Journ. bot., vol. 1, p. 666 (1842), nomen nudum. *A. tenera* J. Sm. ex Hook., Sp. Fil., vol. 1, p. 49 (1846).—Rio Asuncion, alt. 450 m., *Johnston*, no. 143, July 29. Also on Trinidad and several of the West Indies.

##### HEMITELIA R. Br.

H. GRANDIFOLIA (Willd.) Spreng. Syst., vol. 4, p. 125 (1827). *Cyathea grandifolia* Willd., Sp. pl., vol. 5, p. 490 (1810).—El Valle,

<sup>1</sup> The identifications in this group are as revised by Mr. W. R. Maxon, who has also added the synonymy and the notes in regard to the species.

*Miller & Johnston*, no. 164, in part, Aug. 16; San Juan Mt., alt. 500 m., *Johnston*, no. 191, July 16. Porto Rico: Urban, *Symb. Ant.*, vol. 4, p. 10 (1903). Tropical America.

## POLYPODIACEAE.

## ELAPHOGLOSSUM Seholt.

*E. TOVARENSE* (Mett.) Moore, *Ind. Fil.*, p. 369 (1862), name only. *Achrostichum tovarense* Moritz ex Eaton, *Mem. Amer. acad. arts and sci.*, (new series) vol. 8, pt. 2, p. 194 (1860), name only; Kuhn, *Linnaea*, vol. 36, p. 60 (1869).— Juan Griego trail, alt. 450 m., *Johnston*, no. 146. Known also from Mexico and Central America.

## MONOGRAMMA Commerson.

*M. LINEARIFOLIA* Desv. *Mag., Gesellsch. nat. Fr. Berlin*, vol. 5, p. 302, pl. 7, fig. 5 (1811). *Pleurogramme immersa* Fée, *3me Mém.*, p. 37, pl. 4, fig. 5 (1851-52). *Monogramme immersa* Hook., *Sp. Fil.*, vol. 5, p. 125 (1864).— San Juan Mt., alt. 600 m., *Johnston*, no. 186, July 2. West Indies and northern South America.

## CAMPYLONEURUM Presl.

*C. PHYLLITIDIS* (L.) Presl, *Tent. Pterid.*, p. 190, pl. 7, fig. 18 (1836). *Polypodium phyllitidis* L., *Sp. pl.*, vol. 2, p. 1083 (1753); Urb., *Symb. Ant.*, vol. 4, p. 57 (1903), where reported as occurring on Margarita Island.— El Valle, *Miller & Johnston*, no. 165, July 30; San Juan Mt., alt. 400 m., *Johnston*, no. 151, July 27. Generally distributed throughout tropical America.

## GONIOPHLEBIUM Presl.

*G. CHNOODES* (Spreng.) Fée, *Gen. Fil.*, p. 255 (1850-52). *Polypodium chnoodes* Spreng., *Neue Entdeck.*, vol. 2, p. 6 (1822).— San Juan Mt., alt. 600 m., *Johnston*, no. 193, July 2. Tropical America, commonest in the West Indies.

*G. LORICEUM* (L.) J. Sm. ex Hook., *Gen. Fil.*, under pl. 51 (1840). *Polypodium loriceum* L., *Sp. pl.*, vol. 2, p. 1086 (1753).— Rio Asuncion, alt. 500 m., *Johnston*, no. 169, Aug. 12-15. Tropical America generally. Variable.

*G. PILOSELLOIDES* (L.) J. Sm. ex Hook., *Gen. Fil.*, under pl. 51

(1840). *Polypodium piloselloides* L., Sp. pl., vol. 2, p. 1083 (1753). *Lopholepis piloselloides* J. Sm. in Seem., Bot. voy. Herald, p. 229 (1854).— Juan Griego trail, alt. 500 m., *Johnston*, no. 150, July 31. Tropical America.

G. NERIIFOLIUM (Schkuhr) Hook., Gen. Fil., pl. 70 B (1841). *Polypodium neriifolium* Schkuhr, Krypt. Gewächse, vol. 1, p. 14, pl. 15 (1806).— San Juan Mt., alt. 700 m., *Johnston*, no. 176, Aug. 28. Tropical America.

G. VACCINIIFOLIUM (Langsd. & Fisch.) J. Sm. ex Hook., Gen. Fil., under pl. 51 (1840). *Polypodium vacciniifolium* Langsd. & Fisch., Ic. Fil., vol. 8, pl. 7 (1810).— El Valle, *Miller & Johnston*, no. 159, July 31. Tropical America.

#### PHLEBODIUM J. Sm.

P. AUREUM (L.) J. Sm., Journ. bot., vol. 4, p. 59 (1841). *Polypodium aureum* L., Sp. pl., vol. 2, p. 1087 (1753).— Rio Asuncion, alt. 500 m., *Johnston*, no. 170, Aug. 12-15. Widely distributed in tropical America.

#### PHYMATODES Presl.

P. NEMATORHIZON (D. C. Eaton) Underw. ex Maxon, Contrib. U. S. nat. herb., vol. 10, p. 493 (1908). *Polypodium nematorhizon* D. C. Eaton, Bot. gaz., vol. 3, p. 90 (1878).— Juan Griego trail, alt. 500 m., *Johnston*, no. 147, Aug. 12-15. Known hitherto only from Trinidad.

P. PROMINULA Maxon, Contrib. U. S. nat. herb., vol. 10, p. 501 (1908). ? *Polypodium salicifolium* Willd., Sp. pl., vol. 5, p. 149 (1810), not Vahl (1807).— San Juan Mt., alt. 500 m., *Johnston*, no. 155 (type). Tropical America.

#### POLYPODIUM L.

P. JUBAEFORME Kaulf., Flora, vol. 6, pt. 1, p. 364 (1823). *Polypodium saccatum* Fée, Gen. Fil., p. 239 (1850-52).— San Juan Mt., alt. 600 m., *Johnston*, no. 164, July 2. The West Indies and Panama to Brazil.

P. PECTINATUM L., Sp. pl., vol. 2, p. 1085 (1753).— El Valle, *Miller & Johnston*, no. 163; Juan Griego trail, alt. 450 m., *Johnston*, no. 167, July 19. Tropical America generally.

P. POLYPODIOIDES (L.) A. S. Hitchcock, Rep. Mo. bot. garden, vol. 4, p. 156 (1893). *Acrostichum polypodioides* L., Sp. pl., vol. 2, p. 1068 (1753). *Polypodium incanum* Sw., Prod. veg. Ind. Occ., p. 131 (1788).—San Juan Mt., alt. 450 m., *Johnston*, no. 157, July 6. Southern and central United States to Argentina.

#### XIPHOPTERIS Kaulf.

X. SERRULATA (Sw.) Kaulf., Enum. Fil., pp. 85, 300 (1824). *Acrostichum serrulatum* Sw., Prod. veg. Ind. Occ., p. 128 (1788). *Polypodium serrulatum* Mett., Fil. hort. Lips., p. 30 (1856), not Sw. (1800). *Xiphopteris extensa* Fée, 11me Mém., p. 14, pl. 19, fig. 3 (1866), not *Polypodium extensum* Forst. (1786), Presl (1825), nor Fée (1869).—Juan Griego trail, alt. 450 m., *Johnston*, no. 144, Aug. 12–15. Tropical America generally. Also occurs in Africa.

#### ADIANTOPSIS Fée.

A. RADIATA (L.) Fée, Gen. Fil., p. 145 (1850–52). *Adiantum radiatum* L., Sp. pl., vol. 2, p. 1094 (1753).—San Juan Mt., alt. 400 m., *Johnston*, no. 184, July 6. Not uncommon in the American tropics.

#### ADIANTUM L.

A. TETRAPHYLLUM H. & B. ex Willd., Sp. pl., vol. 5, 441 (1810); Urb., Symb. Ant., vol. 4, p. 45 (1903), where reported as occurring on Margarita Island.—El Valle, *Miller & Johnston*, no. 166, July 25; Juan Griego trail, alt. 300 m., *Johnston*, no. 162. Tropical America.

#### CEROPTERIS Link.

C. CALOMELAENA (L.) Link, Fil. sp. hort. bot. Berol., p. 141 (1841). *Acrostichum calomelanos* L., Sp. pl., vol. 2, p. 1072 (1753). *Gymnogramma calomelanos* Kaulf., Enum. Fil., p. 76 (1824).—San Juan Mt., alt. 550 m., *Johnston*, no. 182, July 19. Tropical America. Africa. Escaped from cultivation in Luzon.

C. TARTAREA (Cav.) Link, Fil. sp. hort. bot. Berol., p. 142 (1841). *Acrostichum tartareum* Cav., Descr. pl., p. 242 (1802). *Gymnogramma tartarea* Desv., Mag., Gesellsch. nat. Fr. Berlin, vol. 5, p. 305 (1811).—San Juan Mt., alt. 795 m., *Johnston*, no. 181, Aug. 28. Tropical America; uniformly at a higher elevation than the preceding.

## PTERIDIUM Scop.

*P. CAUDATUM* (L.) Maxon, Proc. U. S. nat. mus., vol. 23, p. 631 (1901). *Pteris caudata* L., Sp. pl., vol. 2, p. 1075 (1753). *Pteris aquilina*, var. *caudata* Hook., Sp. Fil., vol. 2, p. 196 (1858).—San Juan Mt., alt. 790 m., *Johnston*, no. 177, Aug. 28. Tropics.

## ASPLENIUM L.

*A. ABSCISSUM* Willd., Sp. pl., vol. 5, p. 321 (1810). *Asplenium laetum* Schkuhr, Krypt. Gewächse, vol. 1, p. 65, pl. 70 (1809), not Sw. (1806). *A. Schkuhrianum* Presl, Tent. Pterid., p. 107 (1836). *A. firmum* Kunze, Bot. Zeit., vol. 3, p. 283 (1845).—Juan Griego trail, alt. 450 m., *Johnston*, no. 154, July 29. Tropical America generally.

*A. CIRRHATUM* Rich. ex Willd., Sp. pl., vol. 5, p. 321 (1810). *Asplenium rhizophorum* (simple-pinnate form) of most authors.—Juan Griego trail, alt. 450 m., *Johnston*, no. 142, July 31. Tropical America; commonest in the West Indies.

*A. CRISTATUM* Lam., Encyc., vol. 2, p. 310 (1786). *Asplenium cicutarium* Sw., Prod. veg. Ind. Occ., p. 130 (1788); Urb., Symb. Ant., vol. 4, pp. 38, 39 (1903), where reported as occurring on Margarita Island.—El Valle, *Miller & Johnston*, no. 162, Aug. 2; Juan Griego trail, alt. 450 m., *Johnston*, no. 161, July 22. American tropics; reaching its best development in the West Indies.

*A. CUNEATUM* Lam., Encyc., vol. 2, p. 309 (1786).—Juan Griego trail, alt. 450 m., *Johnston*, no. 172, July 31. Tropical America, the typical form being West Indian. Ascribed also to the tropics of the Old World.

*A. SALICIFOLIUM* L., Sp. pl., vol. 2, p. 1080 (1753). *Asplenium auriculatum* and *A. semicordatum* of authors, as to West Indian specimens (see Maxon, Contrib. U. S. nat. herb., vol. 10, p. 476 (1908) for synonymy).—Juan Griego trail, alt. 450 m., *Johnston*, no. 168, July 31. Tropical America.

*A. SERRATUM* L., Sp. pl., vol. 2, p. 1079 (1753).—San Juan Mt., alt. 400 m., *Johnston*, no. 141, July 6. American tropics. Common.

## BLECHNUM L.

*B. OCCIDENTALE* L., Sp. pl., vol. 2, p. 1077 (1753); Urb., Symb. Ant., vol. 4, p. 39 (1903), where reported from Margarita Island.—

El Valle, *Miller & Johnston*, no. 155, Aug. 2; San Juan Mt., alt. 400 m., *Johnston*, no. 160, July 16. American tropics; ubiquitous.

#### DIPLAZIUM Sw.

*D. ARBOREUM* (Willd.) Presl, Tent. Pterid., p. 114 (1836), not of most authors. *Asplenium arboreum* Willd., Sp. pl., vol. 5, p. 320 (1810). *A. Shepherdii* Spreng., Nov. act. acad. Caes. Leop., vol. 10, p. 231, pl. 17, figs. 5 and 6 (1821). *Diplazium Shepherdii* Link, Hort. Berol., vol. 2, p. 70 (1833).—Juan Griego trail, alt. 450 m., *Johnston*, no. 158, July 29. Tropical America.

*D. CRENULATUM* Liebm. Vid. selsk. skr., ser. 5, vol. 1, p. 254 (1849). Earlier synonymy much confused: the Linnaean name not available. Referred under *D. striatum* (L.) Presl by Urban (Symb. Ant., vol. 4, p. 33 (1903) as occurring on Margarita Island.—El Valle, *Miller & Johnston*, no. 161, Aug. 16; Juan Griego trail, alt. 450 m., *Johnston*, no. 153, July 29. Tropical America.

*D. GRANDIFOLIUM* Sw. in Schrad., Journ. bot., 1800, pt. 2, p. 62 (1801). *Asplenium grandifolium* Sw., Prod. veg. Ind. Occ., p. 130 (1788).—Juan Griego trail, alt. 450 m., *Johnston*, no. 159, July 29. Tropical America.

#### DRYOPTERIS Adans.

*D. AMPLA* (H. & B.) Ktze., Rev. gen., vol. 2, p. 812 (1891). *Polypodium amplum* H. & B. ex Willd., Sp. pl., vol. 5, p. 207 (1810).—El Valle, *Miller & Johnston*, no. 169, Aug. 2; Juan Griego trail, alt. 450 m., *Johnston*, no. 187 in part, July 29. Tropical America. Florida.

*D. JOHNSTONI* Maxon, Contrib. U. S. nat. herb., vol. 10, p. 498 (1908).—Juan Griego trail, alt. 450 m., *Johnston*, no. 192, July 22 (type). Known also from Trinidad, *Jenman*; *Fendler*, no. 54.

*D. MEGALODUS* (Schkuhr) Urb., Symb. Ant., vol. 4, p. 21 (1903). *Polypodium megalodus* Schkuhr, Krypt. Gewächse, vol. 1, p. 24, pl. 19b (1806).—El Valle, *Miller & Johnston*, no. 164 in part. Tropical America.

*D. PARASITICA* (L.) Ktze., Rev. gen., vol. 2, p. 811 (1891). *Polypodium parasiticum* L., Sp. pl., vol. 2, p. 1090 (1753). *Nephrodium parasiticum* Desv., Mém. soc. Linn. Paris, vol. 6, p. 260 (1827). *Polypodium molle* Jacq., Coll. bot., vol. 3, p. 188 (1789), not Schreb. (1771), nor All. (1785). *Nephrodium molle* R. Br., Prod. fl. Nov.

Holl., p. 149 (1810).— Juan Griego trail, alt. 450 m., *Johnston*, no. 194, July 19. Tropical and subtropical regions of both hemispheres. Rare in the southern United States.

D. PUBESCENS (L.) Ktze., *Rev. gen.*, vol. 2, p. 813 (1891). *Polypodium pubescens* L., *Syst. nat.*, ed. 10, vol. 2, p. 1327 (1759).— Juan Griego trail, alt. 450 m., *Johnston*, no. 195, Aug. 12–15. The specimens are broader and less produced than the typical Jamaican form. West Indies.

D. MERCURII (A. Br.) Hieron., *Hedwigia*, vol. 46, p. 335, pl. 5, fig. 9 (1907). *Aspidium Mercurii* A. Br. ex Christ., *Bull. herb. Boiss.*, ser. 2, vol. 6, p. 58 (1906), name only.— Juan Griego trail, alt. 450 m., *Johnston*, no. 190, July 29. Determined by Christensen, who attributes the species also to Mexico, Costa Rica, Colombia, and Ecuador.

[D. TETRAGONA (Sw.) Urb., *Symb. Ant.*, vol. 4, p. 20 (1903). *Polypodium tetragonum* Sw., *Prod. veg. Ind. Occ.*, p. 132 (1788).— Stated by Urb., *l. c.*, to grow on Margarita Island, a report based upon material collected by Miller & Johnston in 1901.]

D. VILLOSA (L.) Ktze., *Rev. gen.*, vol. 2, p. 314 (1891). *Polypodium villosum* L., *Sp. pl.*, vol. 2, p. 1093 (1753). *Nephrodium villosum* Presl, *Rel. Haenk.*, vol. 1, p. 38 (1825). Juan Griego trail, alt. 450 m., *Johnston*, no. 187 in part, July 29. Tropical America.

#### MENISCIUM Schreb.

M. RETICULATUM (L.) Sw. in Schrad., *Journ. bot.*, 1801, pt. 1, p. 274 (1803). *Polypodium reticulatum* L., *Syst. nat.*, ed. 10, vol. 2, p. 1325 (1759). *Nephrodium reticulatum* Keyserling, *Pol. Cyath. herb. Bung.*, p. 49 (1873). *Dryopteris reticulata* Urb., *Symb. Ant.*, vol. 4, p. 22 (1903).— El Valle, *Miller & Johnston*, no. 156, Aug. 16; Juan Griego trail, alt. 450 m., *Johnston*, no. 166, July 22. Tropical America.

#### OLFERSIA Raddi.

O. CERVINA (L.) Kunze, *Flora*, vol. 7, pt. 1, p. 312 (1824). *Osunda cervina* L., *Sp. pl.*, vol. 2, p. 1065 (1753). *Polybotrya cervina* Kaulf., *Enum. Fil.*, p. 55 (1824).— Juan Griego trail, alt. 450 m., *Johnston*, no. 152, July 31. Tropical America.

#### TECTARIA Cav.

T. HERACLEIFOLIA (Willd.) Underw., *Bull. Torr. bot. club*, vol. 33, p. 200 (1906). *Aspidium heracleifolium* Willd., *Sp. pl.*, vol. 5, p. 217

(1810). *Aspidium trifoliatum* of authors, in part, not *Polypodium trifoliatum* L., based on Plumier's plate 148, see Underw., *l. c.*, p. 199-200.—El Valle, *Miller & Johnston*, no. 168, Aug. 2. Reported by Urb. (*Symb. Ant.*, vol. 4, p. 23), under the name of *Aspidium trifoliatum*, as occurring upon Margarita Island, his determination being based upon some of Miller & Johnston's material of 1901. Tropical America generally.

T. PLANTAGINEA (Jacq.) Maxon, *Contrib. U. S. nat. herb.*, vol. 10, p. 494 (1908). *Polypodium plantagineum* Jacq., *Coll. bot.*, vol. 2, p. 104, pl. 3, fig. 1 (1788). *Aspidium plantagineum* Griseb., *Abh. kön. Gesellsch. Wiss. Göttingen*, vol. 7, p. 286 (1857).—Juan Griego trail, alt. 500 m., *Johnston*, no. 148, July 31. Tropical America. Variable.

T. PURDIAEI (Jenman) Maxon, *Contrib. U. S. nat. herb.*, vol. 10, p. 494 (1908). *Aspidium Purdiaei* Jenman, *Gard. chron.*, ser. 3, vol. 22, p. 282 (1897). *Nephrodium Sherringiae* Jenman, *Journ. bot.*, vol. 25, p. 99 (1887), not *N. Sherringii* Jenman (1879). *Aspidium psammisorum* C. Chr., *Ind. Fil.*, p. 89 (1905).—El Valle, *Miller & Johnston*, no. 158, Aug. 10; Juan Griego trail, alt. 450 m., *Johnston*, no. 173, July 31. Known also from Trinidad.

#### OLEANDRA Cav.

O. NODOSA (Willd.) Presl, *Tent. Pterid.*, p. 78 (1836). *Aspidium nodosum* Willd., *Sp. pl.*, vol. 5, p. 211 (1810).—Juan Griego trail, alt. 300 m., *Johnston*, no. 189, July 29. American tropics. Ascribed also to Africa.

#### DENNSTAETIA Bernh.

D. ORDINATA (Kaulf.) Moore, *Ind. Fil.*, p. 306 (1861). *Dicksonia ordinata* Kaulf., *Enum. Fil.*, p. 226 (1824).—El Valle, *Miller & Johnston*, no. 160, Aug. 16; Juan Griego trail, alt. 450 m., *Johnston*, no. 185, July 29. Widely distributed in tropical America.

#### NEPHROLEPIS Schott.

[N. EXALTATA (L.) Schott, *Gen. Fil.*, pl. 3 (1834). *Polypodium exaltatum* L., *Syst. nat.*, ed. 10, vol. 2, p. 1326 (1759).—Referred by Urban, *Symb. Ant.*, vol. 4, p. 27, to Margarita.]

N. PECTINATA (Willd.) Schott, *Gen. Fil.*, under pl. 3 (1854). *Aspidium pectinatum* Willd., *Sp. pl.*, vol. 5, p. 223 (1810).—San Juan Mt., alt. 790 m., *Johnston*, no. 149, July 16. Tropics.

*N. RIVULARIS* (Vahl) Mett. ex Krug in Engl., Bot. jahrb., vol. 24, p. 122 (1897). *Polypodium rivulare* Vahl, Ecl. Am., vol. 3, p. 51 (1807). *Aspidium sesquipedale* Willd., Sp. pl., vol. 5, p. 230 (1810). *Nephrolepis sesquipedalis* Presl, Tent. Pterid., p. 79 (1836).—El Valle, *Miller & Johnston*, no. 167, Aug. 2; Juan Griego trail, alt. 450 m., *Johnston*, no. 163, July 22. Tropical America.

## HYMENOPHYLLACEAE.

## HYMENOPHYLLUM J. E. Sm.

*H. POLYANTHOS* Sw. in Schrad., Journ. 1800, pt. 2, p. 102 (1801). *Trichomanes polyanthos* Sw., Prod. veg. Ind. Occ., p. 137 (1788).—El Valle, *Miller & Johnston*, no. 157, July 31; Juan Griego trail, alt. 500 m., *Johnston*, no. 165, July 2. Porto Rico: Urban, Symb. Ant., vol. 4, p. 8. Widespread in the tropics, the typical form being West Indian.

*H. CILIATUM* Sw. in Schrad., Journ. bot., 1800, pt. 2, p. 100 (1801) et Fl. Ind. Occ., vol. 3, p. 1753 (1806).—This species is reported by Urban (Symb. Ant., vol. 4, p. 9) as occurring on Margarita, this being his determination of *Miller & Johnston's* material of 1901. The specimen in question may possibly be referable, however, to *Trichomanes*.

*H. KOHAUTIANUM* Presl, Hymenoph., p. 32 and p. 56 (1843). Referred by Urban to Margarita. See note on preceding species.

## TRICHOMANES L.

*T. ALATUM* Sw. in Schrad., Journ. bot., 1800, pt. 2, p. 97 (1801).—Ric Asuncion, alt. 450 m., *Johnston*, no. 145, July 29. Tropical America: the type from Jamaica. Variable.

*T. CRISPUM* L., Sp. pl., vol. 2, p. 1097 (1753).—San Juan Mt., alt. 600 m., *Johnston*, no. 171, July 2. Tropical America.

*T. MEMBRANACEUM* L., Sp. pl., vol. 2, p. 1097 (1753).—Juan Griego trail, alt. 450 m., *Johnston*, no. 15, Aug. 12–15. Tropical America.

*T. POLYPODIOIDES* L., Sp. pl., vol. 2, p. 1098 (1753). *T. sinuosum* Rich. ex Willd., Sp. pl., vol. 5, p. 502 (1810); Hook. & Grev., Ic. Fil., vol. 1, pl. 13 (1831).—Rio Asuncion, alt. 450 m., *Johnston*, no. 175, Aug. 12–15. Tropical America.

## LYCOPODIACEAE.

## LYCOPODIUM L.

L. FUNIFORME Bory in Brongn., Vég. foss., vol. 2, p. 10 (1837); Spring, Mém. acad. Brux., vol. 15, pt. 6, p. 50 (1842), vol. 24, p. 22 (1849).—San Juan Mt., alt. 600 m., July 2, *Johnston*, no. 179. Tropical America; commonest in the West Indies.

L. TAXIFOLIUM Sw., Prod. veg. Ind. Occ., p. 138 (1788).—San Juan Mt., alt. 600 m., *Johnston*, no. 156, July 2. Tropical America.

## SPERMATOPHYTA.

## HYDROCHARITACEAE.

## THALASSIA Banks.

T. TESTUDINUM Kon. in Kon. & Sims, Ann. bot., vol. 2, p. 96 (1806); Griseb., Fl. Brit. W. Ind., p. 507.—Juan Griego, *Ernst*. Jamaica and Caribbean Is.

## GRAMINEAE.

## ANTHEPHORA Schreb.

A. HERMAPHRODITA (L.) Ktze., Rev. gen., vol. 2, p. 759 (1891); Urb., Symb. Ant., vol. 4, p. 80. *Tripsacum hermaphroditum* L., Syst. nat., ed. 10, vol. 2, p. 1261 (1759). *A. elegans* Schreb., Beschr. Gräs., vol. 2, p. 105, pl. 44 (1810).—El Valle, *Miller & Johnston*, no. 173, July 18. Venezuela: near Villa del Pao, HBK. Nov. gen. et sp. vol. 1, p. 116; Porto Rico: Urban, *l. c.* Widely distributed in tropical America.

## CENCHRUS L.

C. ECHINATUS L., Sp. pl., vol. 2, p. 1050 (1753); Griseb., Fl. Brit. W. Ind., p. 556; Mart., Fl. Bras., vol. 2, pt. 2, pl. 43; Cav., Ic. pl., p. 462.—Santa Ana, *Ernst*. Venezuela: near Cumaná, HBK. Nov. gen. et sp., vol. 1, p. 114; Loeffling, Reise nach den spanischen Ländern, 152–153. Widely distributed in tropical countries.

C. VIRIDIS Spreng., Syst., vol. 1, p. 301 (1825); Doell in Mart. Fl. Bras., vol. 2, pt. 2, p. 309; Urb., Symb. Ant., vol. 4, p. 97.—El Valle, *Miller & Johnston*, no. 186 and 179. Tropical America.

## DACTYLOCTENIUM Willd.

*D. AEGYPTIUM* (L.) Richter, Pl. Eu., vol. 1, p. 68 (1890); Urb., Symb. Ant., vol. 4, p. 104. *Cynosurus aegyptius* L., Sp. pl., p. 72 (1753). *Eleusine aegyptia* Desf., Fl. Atl., vol. 1, p. 85 (1798). *D. aegyptiacum* Willd., Enum. hort. Berol., p. 1029 (1809).—El Valle, *Miller & Johnston*, no. 174, July 8. Widely distributed in tropical countries.

## ERAGROSTIS Host.

*E. CILIARIS* (L.) Link, Hort. Berol., vol. 1, p. 192 (1827); Griseb., Fl. Brit. W. Ind., p. 532; Doell in Mart., Fl. Bras., vol. 2, pt. 3, p. 155; Urb., Symb. Ant., vol. 4, p. 108. *Poa ciliaris* L., Syst. nat., ed. 10, vol. 2, p. 875 (1759).—El Valle, *Miller & Johnston*, no. 175, Aug. 15. Venezuela: Ernst in Seem., Journ. bot., vol. 5, p. 295 (1867). Widely distributed in tropical countries.

## GYNERIUM H. &amp; B.

*G. SAGITTATUM* (Aubl.) Beauv., Agrost., p. 138 (1812); Urb., Symb. Ant., vol. 4, p. 105. *Saccharum sagittatum* Aubl., Pl. Guian., vol. 1, p. 50 (1775). *G. saccharoides* H. & B., Pl. Aequin., vol. 2, p. 112, pl. 115 (1809).—El Valle, *Miller & Johnston*, no. 193, July 30. Venezuela: near Cumaná, HBK. Nov. gen. et sp., vol. 1, p. 149. Widely distributed from Mexico and Cuba to Brazil.

## ICHNANTHUS Beauv.

*I. PALLENS* (Sw.) Munro ex Benth., Fl. Hongk., p. 414 (1861); Doell in Mart., Fl. Bras., vol. 2, pt. 2, p. 290; Urb., Symb. Ant., vol. 4, p. 94. *Panicum pallens* Sw., Prod. veg. Ind. Occ., p. 23 (1788); Steud., Gram., p. 93.—San Juan Mt., alt. 600 m., *Johnston*, no. 208, July 16. Venezuela: Ernst, Sobre la flora y fauna, p. 223. American tropics and East Indies.

## LEPTOCHLOA Beauv.

*L. FILIFORMIS* (Lam.) Beauv., Agrost., p. 71 (1812); Doell in Mart., Fl. Bras., vol. 2, pt. 3, p. 93; Urb., Symb. Ant., vol. 4, p. 104. *Festuca filiformis* Lam., Ill., vol. 1, p. 191 (1791). *L. mucronata* Kth., Rev. Gram., vol. 1, p. 91 (1829).—El Valle, *Miller & Johnston*, no. 16, July 30. Venezuela: Ernst in Seem., Journ. bot., vol. 5, p. 295 (1867) as *L. mucronata*. Distributed generally in tropical countries.

*L. VIRGATA* (L.) Beauv., *Agrost.*, p. 71 (1812); Griseb., *Fl. Brit. W. Ind.*, p. 538; Urb., *Symb. Ant.*, vol. 4, p. 105. *Cynosurus virgatus* L., *Syst. nat.*, ed. 10, vol. 2, p. 876 (1759).—El Valle, *Miller & Johnston*, no. 197, July 26. Widely distributed in tropical America.

#### OLYRA L.

*O. LATIFOLIA* L., *Syst. nat.*, ed. 10, vol. 2, p. 1261 (1759); Griseb., *Fl. Brit. W. Ind.*, p. 535.—Juan Griego trail, alt. 450 m., *Johnston*, no. 314, July 29. Distributed generally in tropical America.

#### PANICUM L.

*P. DIVARICATUM* L., *Syst. nat.*, ed. 10, vol. 2, p. 871 (1759); Griseb., *Fl. Brit. W. Ind.*, p. 551.—El Valle, *Miller & Johnston*, no. 184, July 30. Venezuela: near Maypurea, HBK., *Nov. gen. et sp.*, vol. 1, p. 101. Porto Rico: Urb., *Symb. Ant.*, vol. 4, p. 91. American tropics.

*P. INSULARE* (L.) G. F. W. Mey., *Prim. Esseq.*, p. 60 (1818); Urb., *Symb. Ant.*, vol. 4, p. 86. *Andropogon insulare* L., *Syst. nat.*, ed. 10, vol. 2, p. 1304 (1759).—El Valle, *Miller & Johnston*, no. 183, July 20. American tropics and subtropics.

*P. LATIFOLIUM* L., *Sp. pl.*, vol. 1, p. 58 (1753).—Juan Griego trail, alt. 450 m., *Johnston*, no. 196, Aug. 12–15. Venezuela: Ernst, *Sobre la flora y fauna*, p. 223. Distribution general in North America and West Indies.

*P. MAXIMUM* Jacq., *Ic. pl. rar.*, vol. 1, pl. 13 (1781); Griseb., *Fl. Brit. W. Ind.*, p. 549; Doell in *Mart.*, *Fl. Bras.*, vol. 2, pt. 3, p. 202.—El Valle, *Miller & Johnston*, no. 177, July 7. Venezuela: Ernst, *Sobre la flora y fauna*, p. 223. Porto Rico: Urb., *Symb. Ant.*, vol. 4, p. 89. Distribution general in tropical America.

*P. PANICULATUM* (L.) Nash, *Bull. Torr. bot. club*, vol. 30, p. 381 (1903); Urb., *Symb. Ant.*, vol. 4, p. 90. *Paspalum paniculatum* L., *Syst. nat.*, ed. 10, vol. 2, p. 855 (1759).—El Valle, *Miller & Johnston*, no. 180, July 26. Distribution general in tropical America.

*P. PROSTRATUM* Lam., *Illustr.*, vol. 1, p. 171 (1791); Griseb., *Fl. Brit. W. Ind.*, p. 546.—El Valle, *Miller & Johnston*, no. 171, Aug. 6. Venezuela: Ernst, *Sobre la flora y fauna*, p. 223. Porto Rico: Urb., *Symb. Ant.*, vol. 4, p. 88. Widely distributed in tropical countries.

*P. SANGUINALE* L., var. *HORIZONTALIS* (Willd.) Schweinf., *Bull.*

herb. Boiss., vol. 2, app. 2, p. 18 (1894); Urb., Symb. Ant., vol. 4, p. 86. *Digitaria horizontalis* Willd., Enum., vol. 1, p. 92 (1809).—El Valle, *Miller & Johnston*, no. 185, July 10. Distribution general in tropics.

## PASPALUM L.

P. CONJUGATUM Berg., Act. Helv., vol. 8, p. 129, pl. 8 (1772); Griseb., Fl. Brit. W. Ind., p. 541.—El Valle, *Miller & Johnston*, no. 178, July 26; Juan Griego trail, *Johnston*, no. 198, Aug. 12–15. Venezuela: near San Fernando de Atabapo and near Bordones, Cumaná, etc., HBK., Nov. gen. et sp., vol. 1, p. 91. Porto Rico: Urb., Symb. Ant., vol. 4, p. 81. Common in tropical countries.

P. COMPRESSUM (Sw.) Rasp., Ann. sci. nat., ser. 1, vol. 5, p. 301 (1825); Griseb., Fl. Brit. W. Ind., p. 541; Urb., Symb. Ant., vol. 4, p. 84. *Milium compressum* Sw., Prod. veg. Ind. Occ., p. 24 (1788). *Paspalum platycaulon* Poir., Encyc., vol. 5, p. 34 (1804).—Juan Griego trail, *Johnston*, no. 197, Aug. 12–15. Venezuela: Ernst, Sobre la flora y fauna, p. 223. Distribution general in tropical America.

## PHARUS P. Br.

P. LATIFOLIUS L., Syst. nat., ed. 10, vol. 2, p. 1269 (1759); Griseb., Fl. Brit. W. Ind., p. 536; Urb., Symb. Ant., vol. 4, p. 99.—El Valle, *Miller & Johnston*, no. 170, Aug. 2; Juan Griego trail, alt. 400 m., *Johnston*, no. 200, Aug. 12–15. Venezuela: Ernst, Sobre la flora y fauna, p. 223. Distribution general in tropical America.

## SACCHARUM L.

S. OFFICINARUM L., Sp. pl., vol. 1, p. 54 (1753); Griseb., Fl. Brit. W. Ind., p. 561.—Cultivated in El Valle and in Asuncion.

## SETARIA Beauv.

S. GLAUCA (L.) Beauv., Agrost., p. 51 (1812); Urb., Symb. Ant., vol. 4, p. 95. *Panicum glaucum* L., Sp. pl., vol. 1, p. 56 (1753). *Chaetochloa glauca* Scribn., U. S. dept. agr., div. agrost., bull. no. 4, p. 39 (1897).—El Valle, *Miller & Johnston*, no. 181, July 26. Venezuela: Ernst, Sobre la flora y fauna, p. 223. Tropical countries.

## SPOROBOLUS R. Br.

S. DOMINGENSIS (Trin.) Kunth, Enum. pl., vol. 1, p. 214 (1833); Griseb., Fl. Brit. W. Ind., p. 533. *Vilfa domingensis* Trin. in Spreng.,

Neue Entdeck., vol. 2, p. 59 (1821).—Pt. Piedras, *Johnston*, no. 325, Aug. 6, and at Laguna Chica, *Johnston*, no. 327, Aug. 10, a much reduced form. Venezuela: Ernst, *Sobra la flora y fauna*, p. 223. Jamaica and Haiti.

S. VIRGINICUS (L.) Kunth, *Rev. Gram.*, vol. 1, p. 67 (1829); Griseb., *Fl. Brit. W. Ind.*, p. 533. *Agrostis virginica* L., *Sp. pl.*, vol. 1, p. 63 (1753).—Pt. Mosquito, *Johnston*, no. 326, Aug. 10. Venezuela: Tortuga, *Ernst*; Los Roques, *Ernst*. Widely distributed in tropical countries.

#### TRAGUS Haller.

T. RACEMOSUS (L.) Scop., *Introd.*, p. 73 (1777); Doell in *Mart.*, *Fl. Bras.*, vol. 2, pt. 2, p. 122. *Cenchrus racemosus* L., *Sp. pl.*, vol. 2, p. 1049 (1753).—Reported by Urban (*Symb. Ant.*, vol. 4, p. 80) as occurring on Margarita, a determination based on Miller & Johnston's material of 1901.

#### ZEAL.

Z. MAYS L., *Sp. pl.*, vol. 2, p. 971 (1753); Griseb., *Fl. Brit. W. Ind.*, p. 561; Doell in *Mart.*, *Fl. Bras.*, vol. 2, pt. 2, p. 31.—Cultivated in El Valle and Asuncion.

### CYPERACEAE.

#### CYPERUS L.

C. DISTANS L. f., *Suppl.*, p. 103 (1781); Griseb., *Fl. Brit. W. Ind.*, p. 565; Jacq., *Ic. rar.*, vol. 2, pl. 299; Nees in *Mart.*, *Fl. Bras.*, vol. 2, pt. 1, p. 40; Urb., *Symb. Ant.*, vol. 4, p. 112.—El Valle, *Miller & Johnston*, no. 182, Aug. 15. Venezuela: Ernst, *Sobre la flora y fauna*, p. 223. Widely distributed in tropical countries.

#### DICHROMENA Michx.

D. CILIATA Vahl, *Enum.*, vol. 2, p. 240 (1806); Urb., *Symb. Ant.*, vol. 4, p. 121. *Rhynchospora Vahliana* Griseb., *Fl. Brit. W. Ind.*, p. 577 (1864).—El Valle, *Miller & Johnston*, no. 189, July 16; San Juan Mt., alt. 500 m., *Johnston*, no. 201, July 2. Venezuela: Ernst, *Sobre la flora y fauna*, p. 223. Distribution general from the Southern United States to Brazil.

## ELEOCHARIS R. Br.

*E. CAPITATA* (L.) R. Br., Prod., p. 225 (1810); Urb., Symb. Ant., vol. 4, p. 117 (Heleocharis). *Scirpus capitatus* L., Sp. pl., vol. 1, p. 48 (1753); Griseb., Fl. Brit. W. Ind., p. 570.—El Valle, *Miller & Johnston*, no. 191, July 28, and *Johnston*, no. 204, July 21, alt. 300 m., near small stream on the North Hill. Venezuela: Ernst in Seem., Journ. bot., 1867, p. 290–296. Widely distributed in tropical countries.

## FIMBRISTYLIS Vahl.

*F. AUTUMNALIS* (L.) Roem. & Schult., Syst., vol. 2, p. 97 (1817). *Scirpus autumnalis* L., Mant., vol. 2, p. 180 (1771); Griseb., Fl. Brit. W. Ind., p. 571.—San Juan Mt., alt. 650 m., *Johnston*, no. 311, Aug. 28. Venezuela: Ernst, Sobre la flora y fauna, p. 226. Widely distributed from the United States to Brazil.

*F. FERRUGINEA* (L.) Vahl, Enum., vol. 2, p. 291 (1806); Urb., Symb. Ant., vol. 4, p. 118. *Scirpus ferrugineus* L., Sp. pl., ed. 2, vol. 1, p. 74 (1762).—El Valle, *Miller & Johnston*, no. 188, July 28, and *Johnston*, no. 205, July 21. Venezuela: Ernst, Sobre la flora y fauna, p. 226. Further distribution, tropical and subtropical countries.

## FUIRENA Rottb.

*F. UMBELLATA* Rottb., Desc. et ic. pl., p. 70, pl. 19, fig. 3 (1773); Griseb., Fl. Brit. W. Ind., p. 573; Nees in Mart., Fl. Bras., vol. 2, pt. 1, p. 107; Urb., Symb. Ant., vol. 4, p. 120.—El Valle, *Miller & Johnston*, no. 172, July 24. Venezuela: Ernst in Vargasia, 1868–69, p. 182. Common in all tropical countries.

## MARISCUS Gaertn.

*M. LIGULARIS* (L.) Urb., Symb. Ant., vol. 2, p. 165 (1900). *Cyperus ligularis* L., Amoen. acad., vol. 5, p. 391 (1759) et Sp. pl., ed. 2, vol. 1, p. 70.—El Valle, *Miller & Johnston*, no. 194, July 27. Venezuela: Ernst in Seem., Journ. bot., 1867, p. 290–296. Tropical America and Africa.

## PYCREUS Beauv.

*P. ODORATUS* (L.) Urb., Symb. Ant., vol. 2, p. 164 (1900) et vol. 4, p. 110. *Cyperus odoratus* L., Sp. pl., vol. 1, p. 46 (1753), in part.—El Valle, *Miller & Johnston*, no. 195, Aug. 15. Distribution general in tropical countries.

## RYNCHOSPORA Vahl.

R. BARBATA (Vahl) Kunth, Enum. pl., vol. 2, p. 290 (1837); Griseb., Fl. Brit. W. Ind., p. 574. *Schoenus barbatus* Vahl, Ecl., vol. 2, p. 4 (1798).—San Juan Mt., alt. 600 m., *Johnston*, no. 207, Aug. 28. Venezuela: Ernst, Sobre la flora y fauna, p. 226. Distribution general in tropical America.

R. GRACILIS Vahl, Enum., vol. 2, p. 234 (1806); Griseb., Fl. Brit. W. Ind., p. 574.—San Juan Mt., alt. 600 m., *Johnston*, no. 310, July 11. Venezuela: Ernst, Sobre la flora y fauna, p. 226.

## HEMICARPHA Nees &amp; Arn.

H. MICRANTHA (Vahl) Britton, Bull. Torr. bot. club, vol. 15, p. 104 (1888). *Scirpus micranthus* Vahl, Enum., vol. 2, p. 254 (1806).—El Valle, *Miller & Johnston*, no. 196, Aug. 10. Venezuela: Ernst, Sobre la flora y fauna, p. 226. Distribution general in tropical America.

## SCLERIA Berg.

S. BRACTEATA Cav., Ic., vol. 5, p. 34, pl. 457 (1799); Griseb., Fl. Brit. W. Ind., p. 579. *Macrolomia bracteata* Schrad. ex Nees in Mart., Fl. Bras., vol. 2, pt. 1, p. 182 (1842).—El Valle, *Miller & Johnston*, no. 187, July 28; San Juan Mt., alt. 700 m., *Johnston*, no. 203, July 16. Venezuela: Ernst, Sobre la flora y fauna, p. 226. Distribution general in tropical America.

S. HIRTELLA Sw., Prod. veg. Ind. Occ., p. 19 (1788); Griseb., Fl. Brit. W. Ind., p. 579.—San Juan Mt., alt. 600 m., *Johnston*, no. 312, Aug. 28. Venezuela: in woods of Javite, HBK., Nov. gen. et sp., vol. 1, p. 232. Distribution general in tropical America.

S. LITHOSPERMA (L.) Sw., Prod. veg. Ind. Occ., p. 18 (1788). *Scirpus lithospermus* L., Sp. pl., vol. 1, p. 51 (1753).—San Juan Mt., alt., 600 m., *Johnston*, no. 328, Aug. 28. Venezuela: Ernst, Sobre la flora y fauna, p. 226. Distribution general in tropical countries.

## PALMAE.

## ACROCOMIA Mart.

A. SCLEROCARPA Mart., Hist. nat. Palm., vol. 2, p. 66, pls. 56, 57, 100, fig. 5 (1823–50); Griseb., Fl. Brit. W. Ind., p. 521.—En route El Valle to Juan Griego, alt. 400 m., *Johnston*, no. 221, July 29. Jamaica, Grenada, Trinidad, Guiana, and Brazil.

## BACTRIS Jacq.

*B. FALCATA* Johnston, Proc. Amer. acad. arts and sci., vol. 40, p. 683 (1905).—Rio Asuncion, in heavy woods near Juan Griego trail, *Johnston*, no. 220, July 16.

## Cocos L.

*C. NUCIFERA* L., Sp. pl., vol. 2, p. 1188 (1753); Griseb., Fl. Brit. W. Ind., p. 522; Desc., Ant., vol. 1, pl. 21.—Observed by Loeffling, 1754, at Cumaná. Widely distributed in tropical countries. There is a coconut grove extending from El Valle to Porlamar, and another large one in the valley of Asuncion.

## PHOENIX L.

*P. DACTYLIFERA* L., Sp. pl., vol. 2, p. 1188 (1753); Mart., Hist. nat. Palm. vol. 3, p. 257, pl. 120; Cook, Bull. Torr. bot. club, vol. 28, p. 528.—Cultivated in El Valle. Widely grown in tropical countries.

## OREODOXA Willd.

*O. OLERACEA* Mart., Hist. nat. Palm., vol. 3, p. 166, pl. 156, figs. 1, 2 (1836–1850); Griseb., Fl. Brit. W. Ind., p. 517.—San Juan Mt., alt. 600 m., *Johnston*, no. 222, July 11. Widely distributed in West Indies.

Palma Carana: "eine kleine Palme mit fächerförmigen Blättern, zur Zeit meines Besuehes der Insel, ohne Blüten und Früchte. Trotz der Aenlichkeit des Namens glaube ich nicht, dass es *Mauritia* Carana Wall. sein könne" (Ernst). This may well be *Acrocomia sclerocarpa* above mentioned. An unidentified specimen, no. 347 of *Johnston*, July 29, alt. 500 m., on the Juan Griego trail is different from any of the above.

## ARACEAE.

## ANTHURIUM Schott.

*A. HOOKERI* Kunth, Enum. pl., vol. 3, p. 74 (1841); Schott, Ic. Aroid., p. 15–17.—San Juan Mt., alt. 400 m., *Johnston*, no. 297, July 11. Venezuela: Ernst, Sobre la flora y fauna, p. 226. Distribution general in the West Indies.

A. SCANDENS (Aubl.) Engl., in Mart., Fl. Bras., vol. 3, pt. 2, p. 78 (1878). *Dracontium scandens* Aubl., Guian., vol. 2, p. 836 (1775).—South Hill, El Valle, *Johnston*, no. 14, July 18. Found on the branches of trees. Venezuela: Ernst, Sobre la flora y fauna, p. 226. Brazil.

## DIEFFENBACHIA Schott.

D. SEGUINE (Jacq.) Schott, Melet., vol. 1, p. 20 (1832); Griseb., Fl. Brit. W. Ind., p. 509. *Arum seguiné* Jacq., Enum., p. 31 (1760).—Rio Asuncion, alt. 400 m., *Johnston*, no. 214, Aug. 12–15. Venezuela: Ernst, Sobre la flora y fauna, p. 226. Jamaica, French Ids., Guiana.

## PHILODENDRON Schott.

P. EXIMIUM Schott, Oestr. bot. Wochenbl., vol. 3, p. 378 (1853).—Juan Griego trail, alt. 450 m., *Johnston*, no. 305, Aug. 12–15. Described from Brazil. Ernst reported an undetermined species of Philodendron from Margarita.

## BROMELIACEAE.

## AECHMEA R. &amp; P.

A. FENDLERI André, Bromel. Andreanae, p. 13 (1890); Mez in DC., Monog. Phanerog., vol. 9, p. 223 (1896).—South Hill, El Valle, alt. 335 m., *Johnston*, no. 335; also on the mountain ridge from San Juan Mt. to Juan Griego trail, alt. 500–700 m., *Johnston*, no. 209, July 2. Venezuela: Ernst, Sobre la flora y fauna, p. 226; between Petaquira and Colonia Tovar, *Fendler*, no. 2454, according to Mez, *l. c.*

## ANANAS Adans.

A. SATIVUS (Lindl.) Schult. f., Syst., vol. 8, p. 1283 (1830); Rheede, Hort. Mal., vol. 11, pls. 1, 2. *Ananassa sativa* Lindl. Bot. Reg. vol. 13, under pl. 1068 (1827); Griseb. Fl. Brit. W. Ind., p. 591.—Cultivated at El Valle, Tacarigua. Distribution general in the West Indies and South America.

## BROMELIA L.

B. PINGVIN L., Sp. pl., vol. 1, p. 285 (1753); Griseb., Fl. Brit. W. Ind., p. 591; Red., Lil., vol. 7, p. 396.—El Valle, *Miller & Johnston*, no. 247, July 26, and *Johnston*, no. 211, July 6. Venezuela: Ernst, Sobre la flora y fauna, p. 226. Distribution general from Cuba to Guiana and Colombia.

## CHEVALIERIA Gaudich.

C. sp.— Juan Griego, *Ernst*.

## GLOMEROPITCAIRNIA Mez.

G. ERECTIFLORA Mez, Bull. herb. Boiss., ser. 2, vol. 5, p. 233 (1905).  
— San Juan Mt., alt. 750 m., *Johnston*, no. 303. Endemic.

## GRAVISIA Mez.

G. AQUILEGA (Salisb.) Mez in Mart., Fl. Bras., vol. 3, pt. 3, p. 300 (1892), nomen, et in DC., Monog. Phanerog., vol. 9, p. 173 (1896). *Bromelia aquilega* Salisb., Parad., pl. 40 (1805). *Aechmea aquilega* Griseb., Fl. Brit. W. Ind., p. 592 (1864).— South Hill, El Valle, alt. 335 m., *Johnston*, no. 302, July 10. Venezuela: Ernst, Sobre la flora y fauna, p. 226; Angostura, *Fendler*, no. 2455. Distribution Tobago, Trinidad, and South America.

## GUZMANIA R. &amp; P.

G. LINGULATA (L.) Mez in DC., Monog. Phanerog., vol. 9, p. 899 (1896). *Tillandsia lingulata* L., Sp. pl., vol. 1, p. 286 (1753).— Juan Griego trail, alt. 400–500 m., *Johnston*, no. 301, July 2. Venezuela: Ernst, Sobre la flora y fauna, p. 226. Tropical America.

G. TRICOLOR R. & P., Fl. Per., vol. 3, p. 38, pl. 261 (1802); Griseb., Fl. Brit. W. Ind., p. 598.— South Hill, El Valle, alt. 300 m., *Johnston*, no. 295, Aug. 31. Distribution general from the West Indies to Venezuela and Peru.

## THECOPHYLLUM André.

T. JOHNSTONEI Mez, Bull. herb. Boiss., ser. 2, vol. 4, p. 872 (1904).  
— San Juan Mt., alt. 500 m., *Johnston*, no. 304, July 6. Endemic.

## TILLANDSIA L.

T. LESCAILLEI Wright in Sauv., Fl. Cub., p. 167 (1873).— San Juan Mt., alt. 600 m., *Johnston*, no. 313, July 19. Venezuela: Ernst, Sobre la flora y fauna, p. 226. Cuba.

T. RECURVATA L., Sp. pl., ed. 2, vol. 1, p. 410 (1762); Griseb., Fl. Brit. W. Ind., p. 598. *Renalmia recurvata* L., Sp. pl., vol. 1, p. 287 (1753).— Santa Ana, *Ernst*; El Valle, *Johnston*, no. 219, July 8.

Venezuela: Cumaná, HBK., Nov. gen. et sp., vol. 1, p. 291. Distribution general in tropical America.

T. UTRICULATA L., Sp. pl., vol. 1, p. 286 (1753).—San Juan Mt., alt. 500 m., *Johnston*, no. 296, July 27. Venezuela: San Julian, *Robinson & Lyon*, July, 1900. The spike is much more crowded than in the typical form. Distribution general in the West Indies and Venezuela.

#### VRIESIA Lindl.

V. LONGEBRACTEATA Mez in DC., Monog. Phanerog., vol. 9, p. 568 (1896).—Juan Griego trail, alt. 450–550 m., *Johnston*, no. 300, July 2. Venezuela: Ernst, Sobre la flora y fauna, p. 226; between Petaquirá and the sea, *Fendler*, no. 2449, acc. to Mez, *l. c.*

V. SCALARIS Morr., Belg. Hort., vol. 29, p. 301 (1879), also vol. 30, p. 309, pl. 15 (1880).—San Juan Mt., *Johnston*, no. 294, July 16. Venezuela: Ernst, Sobre la flora y fauna, p. 226. Brazil.

#### WITTMACKIA Mez.

W. LINGULATA (L.) Mez in Mart., Fl. Bras., vol. 3, pt. 3, p. 275 (1892). *Bromelia lingulata* L., Sp. pl., vol. 1, p. 285 (1753).—South Hill, alt. 300 m., *Johnston*, no. 294, July 18. Venezuela: Ernst, Sobre la flora y fauna, p. 226. West Indies.

### COMMELINACEAE.

#### ATHYROCARPUS Schlecht.

A. PERSICARIFOLIUS (Delile) Hemsl., Biol. Cent.-Am. bot., vol. 3, p. 386 (1885). *Commelina persicariaefolia* Delile in Red., Lil., vol. 8, pl. 472 (1816).—Rio Asuncion, alt. 400 m., *Johnston*, no. 309, Aug. 12–15. Venezuela: Ernst, Sobre la flora y fauna, p. 226. Distribution general in tropical America.

#### COMMELINA L.

C. ERECTA L., Sp. pl., vol. 1, p. 41 (1753); Dill., Elth., vol. 1, pl. 77. —El Valle, *Miller & Johnston*, no. 40, July 8. Venezuela: Ernst, Sobre la flora y fauna, p. 226. Common in the southern U. S.

C. NUDIFLORA L., Sp. pl., vol. 1, p. 41 (1753); Richb., Hort. bot., vol. 2, pl. 136. *C. cayennensis* Rich., Act. soc. hist. nat. Par., vol. 1, p. 106 (1792).—Santa Ana, *Ernst* (reported as *C. cayennensis* Rich.) Tropical countries.

## LILIACEAE.

## ALOË L.

A. VERA L., Sp. pl., vol. 1, p. 320 (1753). *A. vulgaris* Lam., Encycl., vol. 1, p. 86 (1783); DC., Pl. grasses, pl. 27; Griseb., Fl. Brit. W. Ind., p. 582.—Juan Griego, *Ernst*. Naturalized and cultivated in the West Indies.

## SMILAX L.

S. CUMANENSIS H. & B. ex Willd., Sp. pl., vol. 4, p. 783 (1806).—San Juan Mt., alt. 600 m., *Johnston*, no. 134, July 19. Venezuela: near Cumaná and Bordones, HBK., Nov. gen. et sp., vol. 1, p. 272.

## AMARYLLIDACEAE.

## AGAVE L.

A. AMERICANA L., Sp. pl., vol. 1, p. 323 (1753); Griseb., Fl. Brit. W. Ind., p. 582; Revue horticole, 1862, p. 291.—Santa Ana, *Ernst*. Distribution general in West Indies and Mexico.

## FURCRAEA Vent.

F. FOETIDA (L.) Haw., Syn. pl. succ., p. 73 (1812). *Agave foetida* L., Sp. pl., vol. 1, p. 323 (1753); Jacq., Ic. pl. rar., vol. 2, pl. 379. *F. gigantea* Vent., Bull. soc. philom., vol. 1, p. 65 (1793). *Fourcroya gigantea* Griseb., Fl. Brit. W. Ind., p. 582 (1864).—Santa Ana, *Ernst*. Distribution from the French Ids. to Brazil.

## HYMENOCALLIS Salisb.

H. CARIBAEA (L.) Herb., Bot. reg., vol. 7, app., p. 44 (1821). *Pancreatium caribaeum* L., Sp. pl., vol. 1, p. 291 (1753); Griseb., Fl. Brit. W. Ind., p. 583.—Juan Griego trail, alt. 300 m., *Johnston*, no. 268, Aug. 14. Venezuela: Ernst, Sobre la flora y fauna, p. 226. West Indies, Guiana.

## ZEPHYRANTHES Herb.

Z. SP.—Bat Cave Peak, El Valle, *Johnston*, no. 260, July 4.

## DIOSCOREACEAE.

## DIOSCOREA L.

*D. ALATA* L., Sp. pl., vol. 2, p. 1033 (1753); Griseb., Fl. Brit. W. Ind., p. 587.—Cultivated according to Ernst. Distribution general in the West Indies.

*D. POLYGONOIDES* H. & B. ex Willd., Sp. pl., vol. 4, p. 795 (1806).—Juan Griego trail, alt. 450 m., *Johnston*, no. 320, Aug. 12–15. Venezuela: between Carichana and Rio Meta, HBK., Nov. gen. et sp., vol. 1, p. 274.

## IRIDACEAE.

## TRIMEZA Salisb.

*T. sp.*—San Juan Mt., alt. 600 m., *Johnston*, no. 138, July 11.

## MUSACEAE.

## HELICONIA L.

*H. BIHAI* L., Mant., vol. 2, p. 211 (1771); Griggs, Bull. Torr. bot. club, vol. 30, p. 656. *Musa Bihai* L., Sp. pl., vol. 2, p. 1043 (1753).—San Juan Mt., alt. 400 m. Venezuela: San Julian, *Robinson & Lyon*, July 20, 1900. Common in tropical America.

*H. PSITTACORUM* L. f., Suppl., p. 158 (1781); Griseb., Fl. Brit. W. Ind., p. 600.—El Valle, *Miller & Johnston*, no. 3, July 25; Rio Asuncion, alt. 450 m., *Johnston*, no. 210, Aug. 12–15. Venezuela: in Valle Caripe, HBK., Nov. gen. et sp., vol. 1, p. 326. West Indies, Venezuela to Brazil.

## MUSA L.

*M. PARADISIACA* L., Sp. pl., vol. 2, p. 1043 (1753), subsp. *NORMALIS* (O. Ktze.) Urb., Symb. Ant., vol. 4, p. 156 (1903). *M. sapientum* Griseb., Fl. Brit. W. Ind., p. 599. Subsp. *SAPIENTUM* (L.) Urb., Symb. Ant., vol. 4, p. 156 (1903). *M. paradisiaca* Griseb., Fl. Brit. W. Ind., p. 599.—Cultivated. Common in tropical countries.

## ZINGIBERACEAE.

## COSTUS L.

*C. GLABRATUS* Sw., Prod. veg. Ind. Occ., p. 11 (1788); Griseb., Fl. Brit. W. Ind., p. 602.—Juan Griego trail, alt. 450 m., *Miller &*

*Johnston*, no. 213, Aug. 12-15. Venezuela: Ernst, Sobre la flora y fauna, p. 226. Further distribution St. Lucia, Haiti, Guiana.

## RENEALMIA L.

R. LUTEA *Johnston*, Proc. Amer. acad. arts and sci., vol. 40, p. 683 (1905).—Rio Asuncion, in damp woods along the Juan Griego trail, *Johnston*, no. 298, Aug. 12-15. Endemic. PLATE 26, fig. 1.

## MARANTACEAE.

## CALATHEA G. F. W. Mey.

C. LUTEA (Aubl.) G. F. W. Mey., Prim. Fl. Esseq., p. 10 (1818). *Maranta lutea* Aubl., Guian., vol. 1, p. 4 (1775). *C. discolor* G. F. W. Mey., *l. c.*, p. 7 (1818); Griseb., Fl. Brit. W. Ind., p. 604.—Juan Griego trail, alt. 450 m., *Johnston*, no. 212, July 29. Venezuela: Ernst, Sobre la flora y fauna, p. 226. Further distribution, Dominica, Trinidad, Guiana, Colombia.

## MARANTA L.

M. ARUNDINACEA L., Sp. pl., vol. 1, p. 2 (1753); Griseb., Fl. Brit. W. Ind., p. 605.—Rio Asuncion, alt. 400 m., *Johnston*, no. 206 Aug. 12-15. Distribution general in tropical America.

## STROMANTHE Sond.

S. TONCKAT Eichl., Berl. phys. Abh., p. 80 (1884). *Maranta tonckat* Griseb., Fl. Brit. W. Ind., p. 605 (1864).—San Juan Mt., alt. 400 m., *Johnston*, no. 202, July 16. Venezuela: Ernst, Sobre la flora y fauna, p. 226. Further distribution, Trinidad, tropical South America.

## ORCHIDACEAE.

## DICHAEA Lindl.

D. GRAMINOIDES (Sw.) Lindl., Gen. et sp. Orch., p. 209 (1833). *Epidendrum graminoides* Sw., Prod. veg. Ind. Occ., p. 125 (1788). *D. graminea* Griseb., Fl. Brit. W. Ind., p. 625 (1864).—San Juan Mt., alt. 600 m., *Johnston*, no. 242, July 16. Venezuela: Caracas, Lindl., *l. c.*, also Bonpl., vol. 2, p. 15, and Ann. bot., vol. 6, p. 823. Distribution general in tropical America.

D. MURICATA (Sw.) Lindl., Gen. et sp. Orch., p. 209 (1833); Griseb., Fl. Brit. W. Ind., p. 624. *Cymbidium muricatum* Sw., Act. Ups., vol. 6, p. 71 (1799).—El Valle to Juan Griego, alt. 450 m., *Johnston*, no. 224, Aug. 12–15. Venezuela: according to Lindl., *l. c.* Distribution general in the West Indies.

#### ELLEANTHUS Presl.

E. ATTENUATUS Johnston, Proc. Amer. acad. arts and sci., vol. 40, p. 684 (1905).—San Juan Mt., in wet woods at the summit, alt. 640 m., *Miller & Johnston*, no. 270, July 30, and *Johnston*, no. 233, July 6. Endemic. PLATE 26, fig. 2.

#### EPIDENDRUM L.

E. ANCEPS Jacq., Hist. Stirp. Am., p. 224, pl. 138 (1763). *E. fuscum* Sm., Spic. bot., p. 21, pl. 23 (1791); Griseb., Fl. Brit. W. Ind., p. 617.—El Valle, on rocks of a dry river bed on the mountain side, *Miller & Johnston*, no. 269, July 29; Juan Griego trail, alt. 450 m., *Johnston*, no. 232, Aug. 12–15. Venezuela: Ernst, Sobre la flora y fauna, p. 226. Distribution general from Cuba to Guiana.

E. ATROPURPUREUM Willd., Sp. pl., vol. 4, p. 115 (1805).—El Valle, *Miller & Johnston*, no. 212, July 5; Bat Cave Peak, *Johnston*, no. 226, July 4. Found both in flower and in fruit. In 1901, this species was found only on North Hill growing on the tree-like cactus *Cereus eburneus*. In 1903, there was none in blossom in this place but on the cliffs above the entrance to Bat Cave, alt. about 300 m., the species was growing in abundance. West Indies.

E. COCHLEATUM L., Sp. pl., ed. 2, vol. 2, p. 1351 (1763); Griseb., Fl. Brit. W. Ind., p. 616.—San Juan Mt., alt. 400 m., *Johnston*, no. 229, July 3. Venezuela: Caracas, see Ann. bot., vol. 6, p. 359. Distribution general from Mexico to Venezuela.

E. GLOBOSUM Jacq. Enum. pl. Carib., p. 29 (1760); Griseb., Fl. Brit. W. Ind., p. 619.—San Juan Mt., alt. 400 m., *Johnston*, no. 230, July 11. Further distribution, Cuba to the French Ids.

E. JOHNSTONI Ames, Proc. Amer. acad. arts and sci., vol. 40, p. 684 (1905).—San Juan Mt., alt. 600 m., *Johnston*, no. 236, July 2. Endemic.

E. NOCTURNUM Jacq., Enum. pl. Carib., p. 29 (1760); Griseb., Fl. Brit. W. Ind., p. 619.—San Juan Mt., alt. 650 m., *Johnston*, no.

228, July 6. Venezuela: Caracas, see Ann. bot., vol. 6, p. 404. Distribution general from Cuba to Guiana and Peru.

*E. RIGIDUM* Jacq., Enum. pl. Carib., p. 29 (1760); Griseb., Fl. Brit. W. Ind., p. 618.—Juan Griego trail, alt. 450 m., *Johnston*, no. 231, Aug. 12–15. Very few specimens found. Venezuela: Caracas, see Ann. bot., vol. 4, p. 400. Distribution general in tropical America.

*E. SECUNDUM* Jacq., Enum. pl. Carib., p. 29 (1760). *E. elongatum* Jacq., Ic. pl. rar., vol. 3, p. 17, pl. 604 (1786–1793); Griseb., Fl. Brit. W. Ind., p. 617.—San Juan Mt., alt. 700 m., *Johnston*, no. 227, July 6. Reclining on low shrubs of the mountain top, abundant; flowers pink. Distribution general from the French Ids. to Venezuela.

#### HUNTLEYA Batem.

*H. SP.*—San Juan Mt., alt. 500 m., *Johnston*, no. 239, July 2. Only three specimens found.

#### MAXILLARIA R. & P.

*M. VIRGUNCULA* Rehb. f., Bonplandia, vol. 2, p. 16 (1854).—San Juan Mt., alt. 500 m., *Johnston*, no. 240, July 2. Venezuela: Caracas, see Ann. bot., vol. 6, p. 522, and Xenia Orchid., vol. 1, p. 24, pl. 10.

#### ONCIDIUM Sw.

*O. LURIDUM* Lindl., Bot. Reg., pl. 727 (1823); Griseb., Fl. Brit. W. Ind., p. 632.—South Hill, El Valle, *Miller & Johnston*, no. 37, July 10; Tacarigua, alt. 300 m., *Johnston*, no. 306, Aug. 14. Very few flowering specimens. Venezuela: see Ann. bot., vol. 6, p. 781, and Bonpl., vol. 2, p. 13. Widely distributed from Cuba to Venezuela.

#### PELEXIA Poit.

*P. ADNATA* (Sw.) Spreng., Syst., vol. 3, p. 704 (1826); Urb., Symb. Ant., vol. 4, p. 164. *Satyrium adnatum* Sw., Prod. veg. Ind. Occ., p. 118 (1788).—El Valle, *Miller & Johnston*, no. 116, July 25; San Juan Mt. and Juan Griego trail, alt. 400–500 m., *Johnston*, no. 243, July 27. Common but very scattered in the damp woods of the mountain top. Further distribution, West Indies.

#### PLEUROTHALLIS R. Br.

*P. RUSCIFOLIA* (Jacq.) R. Br. in Ait., Hort. Kew., ed. 2, vol. 5, p. 211 (1813); Griseb., Fl. Brit. W. Ind., p. 608. *Epidendrum rusci-*

*folium* Jacq., Enum. pl. Carib., p. 29 (1760).— Juan Griego trail, alt. 450 m., *Johnston*, no. 225, Aug. 12–15. Very abundant, growing in clusters. Venezuela: Caracas, Ernst, Sobre la flora y fauna, p. 268. Distribution general from Cuba to Guiana and Peru.

P. sp. affinis *P. platycauli* Rehb. f.— Juan Griego trail, alt. 600 m., *Johnston*, no. 241, July 31.

P. JOHNSTONII Ames, Orchidaceae, vol. 2, p. 271 (1908).— San Juan Mt., alt. 600 m., *Johnston*, no. 238, July 16. Endemic.

P. sp. San Juan Mt., *Johnston*, no. 237, July 16.

P. sp. San Juan Mt., *Johnston*, no. 235, July 11.

P. sp. San Juan Mt., *Johnston*, no. 234, July 11.

## PIPERACEAE.

### PEPEROMIA R. & P.

P. GLABELLA (Sw.) A. Dietr., Sp. pl., vol. 1, p. 156 (1831); Griseb., Fl. Brit. W. Ind., p. 165. *Piper glabellum* Sw., Prod. veg. Ind. Occ., p. 16 (1788).— Bat Cave Peak, El Valle, alt. 300 m., *Johnston*, no. 12, July 4. Further distribution, Trinidad, Antigua, and Jamaica.

P. SCANDENS R. & P., Fl. Per., vol. 1, p. 32, pl. 51, fig. b (1798). *P. repens* HBK., Nov. gen. et sp., vol. 1, p. 65 (1815); Griseb., Fl. Brit. W. Ind., p. 165.— Santa Ana, Ernst (reported under the name *P. repens* HBK.); Rio Asuncion, *Johnston*, no. 13, Aug. 12–15. Abundant on the rocks of the rivulet. Widely distributed in tropical America.

P. VICTORIANA C. DC., var. MARGARITANA C. DC., Proc. Amer. acad. arts and sci., vol. 40, p. 685 (1905).— Bat Cave Peak, on the cliffs, alt. 300 m., *Johnston*, no. 18, July 4. Endemic.

### PIPER L.

P. JOHNSTONI C. DC., Proc. Amer. acad. arts and sci., vol. 40, p. 685 (1905).— Juan Griego trail, alt. 500 m., *Johnston*, no. 19, July 22. Endemic.

P. MARGARITANUM C. DC., Proc. Amer. acad. arts and sci., vol. 40, p. 685 (1905).— El Valle, *Miller & Johnston*, no. 216, Aug. 5; San Juan Mt., alt. 700 m., *Johnston*, no. 20, July 11. Endemic.

P. PSEUDO-MOLLI-COMUM C. DC. in DC., Prod., vol. 17, pt. 1, p. 278 (1869).— Juan Griego trail, alt. 450 m., *Johnston*, no. 17, July 22. Further distribution, Peru.

## ULMACEAE.

## CELTIS L.

*C. IGUANAEA* (Jacq.) Sarg., *Silva*, vol. 7, p. 64 (1895); *Urb.*, *Symb. Ant.*, vol. 4, p. 194. *Rhamnus iguanaeus* Jacq., *Enum.*, p. 16 (1760). *Celtis aculeata* Sw., *Prod. veg. Ind. Occ.*, p. 53 (1788).—Santa Ana, *Ernst* (reported under the name *C. aculeata* Sw.); El Valle, *Miller & Johnston*, no. 116, Aug. 14, along the trail up the mountain. Venezuela: Colonia Tovar, *Fendler*, no. 220, 1854–55. Further distribution, tropical America. Shrub, 2–3 m. high.

## TREMA Lour.

*T. MICRANTHA* (L.) Blume, *Mus. bot. Lugd. Bat.*, vol. 2, p. 58 (1853?). *Rhamnus micranthus* L., *Syst. nat.*, ed. 10, vol. 2, p. 937 (1759). *Sponia micrantha* Dene., *Nouv. ann. mus. Par.*, vol. 3, p. 498 (1834); Griseb., *Fl. Brit. W. Ind.*, p. 150 (1864).—Santa Ana, *Ernst*; San Juan Mt., *Johnston*, no. 245, July 19. Tropical America.

## MORACEAE.

## ARTOCARPUS Forst.

*A. INCISA* L. f., *Suppl.*, p. 411 (1781); Griseb., *Fl. Brit. W. Ind.*, p. 152; *Desc.*, *Ant.*, vol. 8, pl. 539.—Asuncion, *Ernst*. Further distribution, tropical countries.

## CECROPIA L.

*C. PELTATA* L., *Syst. nat.*, ed. 10, vol. 2, p. 1286 (1759); Griseb., *Fl. Brit. W. Ind.*, p. 153; *Desc.*, *Ant.*, vol. 2, pl. 75.—Santa Ana, *Ernst*; San Juan Mt., *Johnston*, no. 132. Common in the woods of the mountain above the Juan Griego trail. Venezuela: Cumaná, HBK., *Nov. gen. et sp.*, vol. 2, p. 43. Further distribution, Jamaica and the Caribbean Ids.

## FICUS L.

*F. sp.*—Santa Ana, *Ernst*.

## PROTEACEAE.

## ROUPALA Aubl.

*R. sp. affinis R. ovali.*—Juan Griego trail, alt. 450 m., *Johnston* no. 330, Aug. 12–15.

## OLACACEAE.

## XIMENIA L.

X. AMERICANA L., Sp. pl., vol. 2, p. 1193 (1753); Griseb., Fl. Brit. W. Ind., p. 310.—El Valle, *Johnston*, no. 40, Aug. 31. Further distribution, tropical countries.

## LORANTHACEAE.

## LORANTHUS L.

L. AVICULARIS Mart. ex Schult. f., Syst., vol. 7, p. 132 (1829); Griseb., Fl. Brit. W. Ind., p. 312.—Santa Ana, *Ernst*. Further distribution, tropical America.

L. EMARGINATUS Sw., Prod. veg. Ind. Occ., p. 58 (1788); Griseb., Fl. Brit. W. Ind., p. 312.—South Hill, El Valle, alt. 300 m., *Johnston*, no. 127, July 10. Further distribution, San Domingo.

L. ORINOCENSIS Spreng., Syst., vol. 2, p. 129 (1825); Griseb., Fl. Brit. W. Ind., p. 311.—El Valle, *Miller & Johnston*, no. 250, Aug. 1; North Hill, El Valle, *Johnston*, no. 264, July 15, parasitic on *Bourreria exsucca* Jacq.; also common on the trees in the plain between San Antonio and Punta Mosquito. Further distribution, Trinidad and Venezuela.

## ARISTOLOCHIACEAE.

## ARISTOLOCHIA L.

A. RINGENS Vahl, Symb. bot., vol. 3, p. 99 (1794); Griseb., Fl. Brit. W. Ind., p. 299; Bot. mag., vol. 94, pl. 5700.—Juan Griego trail, alt. 450 m., *Johnston*, no. 131, July 29. Venezuela: near Buenavista and Los Teques, HBK., Nov. gen. et sp., vol. 2, p. 147; Colonia Tovar, *Fendler*, no. 1063, 1856-57. Jamaica and Colombia.

## POLYGONACEAE.

## ANTIGONON Endl.

A. LEPTOPUS Hook. & Arn., Bot. Beech. voy., p. 308, pl. 69 (1840); Griseb., Fl. Brit. W. Ind., p. 164.—El Valle, *Miller & Johnston*, no. 53, Aug. 1. Venezuela: Sacupana, *Rusby & Squires*, no. 35.

1896. Abundant on fences near dwellings. A garden plant in the West Indies.

## COCOLOBA L.

*C. EXCORIATA* L., Syst. nat., ed. 10, vol. 2, p. 1007 (1759). *C. nivea* Jacq., Enum. pl. Carib., p. 19 (1760), and Hist. Stirp. Amer., p. 115, pl. 78; Griseb., Fl. Brit. W. Ind., p. 163.—South Hill, El Valle, *Johnston*, no. 274, Aug. 31. Further distribution, West Indies.

*C. ERNSTII* Johnston, Proc. Amer. acad., arts and sci., vol. 40, p. 685 (1905).—South Hill, El Valle, *Johnston*, no. 250, Aug. 31. PLATE 27, fig. 2

## CHENOPODIACEAE.

## ATRIPLEX L.

*A. CRISTATA* H. & B. ex Willd., Sp. pl., vol. 4, p. 959 (1806). *Obione cristata* Moq., Chenop. Enum., p. 73 (1840).—Juan Griego, *Ernst*; Pt. Moreno, *Johnston*, no. 316, July 17. Venezuela: at promontory of Araya, HBK., Nov. gen. et sp., vol. 2, p. 192.

## CHENOPODIUM L.

*C. AMBROSIODES* L., Sp. pl., vol. 1, p. 219 (1753); Griseb., Fl. Brit. W. Ind., p. 60; Fenzl in Mart., Fl. Bras., vol. 5, pt. 1, p. 145; Desc., Ant., vol. 1, pl. 58.—Santa Ana, *Ernst*. Venezuela: near Cumaná and Cocollar, HBK., Nov. gen. et sp., vol. 7, p. 191. Further distribution, tropical countries.

## SALICORNIA L.

*S. FRUTICOSA* L., Sp. pl., ed 2, vol. 1, p. 5 (1762). *S. ambigua* Michx., Fl., vol. 1, p. 2 (1803); Griseb., Fl. Brit. W. Ind., p. 60.—Juan Griego, *Ernst*; Pt. Moreno, *Johnston*, no. 109, July 8. Further distribution, from United States to Peru.

## AMARANTHACEAE.

## ACHYRANTHES L.

*A. ASPERA* L., Sp. pl., vol. 1, p. 204 (1753); Griseb., Fl. Brit. W. Ind., p. 62; Wight, Ic. Ind. Or., vol. 5, p. 1777.—Juan Griego, *Ernst*. Venezuela: Cumaná, Loeffling, Reise nach den spanischen Ländern, p. 152–153. Further distribution, tropical countries.

## ALTERNANTHERA Forsk.

A. CANESCENS HBK., Nov. gen. et sp., vol. 2, p. 204 (1817).— Pt. Moreno, *Johnston*, no. 317, July 8. Venezuela: Cumaná and Bordones, HBK., Nov. gen. et sp., vol. 2, p. 204. Coche, see page 291. Abundant about the lagoon at Pt. Moreno.

A. MUSCOIDES (Sw.) Benth. & Hook. f., Gen., vol. 3, p. 39 (1880), by implication, though without the exact combination. *Lithophila muscoides* Sw., Prod. veg. Ind. Occ., p. 14 (1788); Griseb., Fl. Brit. W. Ind., p. 66.— Juan Griego, *Ernst*. Further distribution, the Lesser Antilles.

## AMARANTHUS L.

A. CRASSIPES Schlecht., Linnaea, vol. 6, p. 757 (1831); Urb., Symb. Ant., vol. 4, p. 219.— El Valle, *Miller & Johnston*, no. 29, July 26. Further distribution, tropical America.

A. PANICULATUS L., Sp. pl., ed. 2, vol. 2, p. 1406 (1763); Griseb., Fl. Brit. W. Ind., p. 69; Seubert in Mart., Fl. Bras., vol. 5, pt. 1, p. 238; Willd., Hist. Am., pl. 2.— Santa Ana, *Ernst*. Further distribution, tropical countries.

A. SPINOSUS L., Sp. pl., vol. 2, p. 991 (1753); Griseb., Fl. Brit. W. Ind., p. 68; Seubert in Mart., Fl. Bras., vol. 5, pt. 1, p. 239; Desc., Ant., vol. 5, p. 314.— Santa Ana, *Ernst*. Further distribution general, especially in tropical countries.

A. TRISTIS L., Sp. pl., vol. 2, p. 989 (1753); Griseb., Fl. Brit. W. Ind., p. 69; Seubert in Mart., Fl. Bras., vol. 5, pt. 1, p. 237; Wight, Ic. Ind. Or., vol. 2, p. 713.— El Valle, *Miller & Johnston*, nos. 149 and 30, Aug. 21. Further distribution, Jamaica to Trinidad, also in Chili.

## CYATHULA Lour.

C. PROSTRATA (L.) Bl., Bijdr., p. 549 (1825); Griseb., Fl. Brit. W. Ind., p. 63; Seubert in Mart., Fl. Bras., vol. 5, pt. 1, p. 230. *Achyranthes prostrata* L., Sp. pl., ed. 2, vol. 1, p. 296 (1762).— Juan Griego and Santa Ana, *Ernst*.

## GOMPHRENA L.

G. PILOSA (Mart. & Gal.) Moq. in DC., Prod., vol. 13, pt. 2, p. 395 (1849). *Mogiphanes pilosa* Mart. & Gal., Bull. acad. Brux., vol. 10, p. 348 (1843).— El Valle, *Miller & Johnston*, no. 260, July 28; and *Johnston*, no. 106, July 14.

## IRESINE P. Br.

I. ELATIOR Rich. ex Willd., Sp. pl., vol. 4, p. 766 (1806); Griseb., Fl. Brit. W. Ind., p. 64; Seubert in Mart., Fl. Bras., vol. 5, pt. 1, p. 226.—Santa Ana, *Ernst*.

I. LATIFOLIA (Mart. & Gal.) Benth. & Hook. f., Gen., vol. 3, p. 42 (1880). *Gomphrena latifolia* Mart. & Gal., Bull. acad. Brux., vol. 10, p. 349 (1843).—El Valle, *Miller & Johnston*, no. 67, July 8; Juan Griego trail, *Johnston*, no. 107, July 2. Shrub, 1–2 m. high; stem often 2.5 cm. in diameter near base.

## PHILOXERUS R. Br.

P. VERMICULARIS (L.) R. Br., Prod., vol. 1, p. 416 (1810), as *vermiculata*; Krug, Ic. pl., p. 202; Urb., Symb. Ant., vol. 4, p. 223. *Gomphrena vermicularis* L., Sp. pl., vol. 1, p. 224 (1753).—Porlamar, *Miller & Johnston*, no. 4, July 31, abundant on the low plains near the sea; Pt. Moreno, *Johnston*, no. 111, July 8.

## TELANTHERA R. Br.

T. FICOIDEA (L.) Moq. in DC., Prod., vol. 13, pt. 2, p. 363 (1849); Seubert in Mart., Fl. Bras., vol. 5, pt. 1, p. 171. *Gomphrena ficoidea* L., Sp. pl., vol. 1, p. 225 (1753). *Alternanthera ficoidea* R. Br., Prod., p. 417 (1810); Griseb., Fl. Brit. W. Ind., p. 67.—Juan Griego, *Ernst*. Further distribution, tropical America and tropical Africa.

## NYCTAGINACEAE.

## BOERHAAVIA L.

B. ERECTA L., Sp. pl., vol. 1, p. 3 (1753); Griseb., Fl. Brit. W. Ind., p. 69; Schmidt in Mart., Fl. Bras., vol. 14, pt. 2, p. 370; Jacq., Vind., vol. 1, p. 2, pls. 5, 6; Urb., Symb. Ant., vol. 4, p. 224.—El Valle, *Miller & Johnston*, no. 204, July 20. Further distribution, Georgia, Florida, tropical America to the Galapagos Ids.

B. PANICULATA Rich., Act. soc. hist. nat. Par., vol. 1, p. 105 (1792); Griseb., Fl. Brit. W. Ind., p. 69; Schmidt in Mart., Fl. Bras., vol. 14, pt. 2, p. 369, pl. 86; Urb., Symb. Ant., vol. 4, p. 224.—El Valle, *Miller & Johnston*, no. 203, July 10. Venezuela: Colonia Tovar, *Fendler*, no. 1083, 1854–55. Further distribution, tropical America and the Cape Verde Ids.

## BUGINVILLAEA Commerson.

*B. SPECTABILIS* Willd., Sp. pl., vol. 2, p. 348 (1799). *Bougainvillea spectabilis* Schmidt in Mart., Fl. Bras., vol. 14, pt. 2, p. 350, pl. 82 (1872).— El Valle, *Miller & Johnston*, no. 99, July 31, in a yard. Further distribution, tropical America. This specimen is almost as glabrous as *B. glabra* Choisy.

## MIRABILIS L.

*M. JALAPA* L., Sp. pl., vol. 1, p. 177 (1753); Griseb., Fl. Brit. W. Ind., p. 69; Schmidt in Mart., Fl. Bras., vol. 14, pt. 2, p. 349.— Santa Ana, *Ernst*. Further distribution, tropical America.

## PISONIA L.

*P. ACULEATA* L., Sp. pl., vol. 2, p. 1026 (1753); Griseb., Fl. Brit. W. Ind., p. 70; Schmidt in Mart., Fl. Bras., vol. 14, pt. 2, p. 354.— Juan Griego, *Ernst*. Further distribution, tropics.

*P. INERMIS* Jacq., Select. Am., p. 275 (1763); Griseb., Fl. Brit. W. Ind., p. 71.— Juan Griego, *Ernst*; El Valle, *Miller & Johnston*, no. 231, July 8; Juan Griego trail, alt. 400 m., *Johnston*, no. 335, Aug. 12–15, also San Juan Mt., alt. 600 m., *Johnston*, no. 121, Aug. 28. Venezuela: Colonia Tovar, *Fendler*, no. 1126, June 20, 1855. Further distribution, tropical America.

## BATIDACEAE.

## BATIS L.

*B. MARITIMA* L., Syst. nat., ed. 10, vol. 2, p. 1289 (1759); Griseb., Fl. Brit. W. Ind., p. 61; Jacq., Hist. stirp. Am., p. 260.— Juan Griego, *Ernst*; Pt. Moreno, *Johnston*, no. 108, July 13. Further distribution, from Florida to Venezuela.

## PHYTOLACCACEAE.

## PETIVERIA L.

*P. ALLIACEA* L., Sp. pl., vol. 1, p. 342 (1753); Griseb., Fl. Brit. W. Ind., p. 59; Schmidt in Mart., Fl. Bras., vol. 14, pt. 2, p. 332; Urb., Symb. Ant., vol. 4, p. 229.— Santa Ana, *Ernst*; El Valle, *Miller &*

*Johnston*, no. 13, July 15. Venezuela: near Bordones, HBK., *Nov. gen. et sp.*, vol. 2, p. 188; Caracas, *Birsehel*; Colonia Tovar, *Fendler*, nos. 865 and 1805, 1854-57. Further distribution, temperate and tropical America.

## RIVINA L.

*R. HUMILIS* L., *Sp. pl.*, vol. 1, p. 121 (1753); Schmidt in *Mart.*, *Fl. Bras.*, vol. 14, pt. 2, p. 336; *Urb.*, *Symb. Ant.*, vol. 4, p. 228. *R. laevis* L., *Mant.*, vol. 1, p. 41 (1767); Griseb., *Fl. Brit. W. Ind.*, p. 59.—Santa Ana, *Ernst*; El Valle, *Miller & Johnston*, no. 263, July 8. Venezuela: Cumaná, Loeffling, *Reise nach den spanischen Ländern*, p. 152-153; Colonia Tovar, *Fendler*, no. 1088, 1854-55; Sacupana, *Rusby & Squires*, no. 80, 1896. Further distribution, tropical America.

## AIZOACEAE.

## CYPSELEA Turp.

*C. HUMIFUSA* Turp., *Ann. mus. Par.*, vol. 7, p. 219, pl. 121, fig. 5 (1806); Griseb., *Fl. Brit. W. Ind.*, p. 56.—Shores of Juan Griego pond, *Johnston*, no. 252, Aug. 14. Further distribution, Caribbean Ids., Haiti to Guadeloupe.

## MOLLUGO L.

*M. VERTICILLATA* L., *Sp. pl.*, vol. 1, p. 89 (1753); Griseb., *Fl. Brit. W. Ind.*, p. 56; Rohrbach in *Mart.*, *Fl. Bras.*, vol. 14, pt. 2, p. 240; *Urb.*, *Symb. Ant.*, vol. 4, p. 230.—Juan Griego, *Ernst*; El Valle, *Miller & Johnston*, no. 21, Aug. 10; Juan Griego, *Johnston*, no. 126, Aug. 14. This species was seen as a much-branched specimen on the dry roadside and as few-branched specimens on the shores of the Juan Griego pond. Venezuela: Cumaná, HBK., *Nov. gen. et sp.*, vol. 6, p. 20; Loeffling, *Reise nach den spanischen Ländern*, p. 152-153. Common in tropical America.

## SESUVIUM L.

*S. PORTULACASTRUM* L., *Syst. nat.*, ed. 10, vol. 2, p. 1058 (1759); Griseb., *Fl. Brit. W. Ind.*, p. 57; Rohrbach in *Mart.*, *Fl. Bras.*, vol. 14, pt. 2, p. 310.—Juan Griego, *Ernst*. Venezuela: near Camaná, HBK., *Nov. gen. et sp.*, vol. 6, p. 86; Tortuga and Los Roques, *Ernst*; near La Guaira, *Fendler*, no. 62, Aug. 16, 1855.

## TRIANTHEMA L.

T. PORTULACASTRUM L., Sp. pl., vol. 1, p. 223 (1753); Moench, Meth., p. 700; Urb., Symb. Ant., vol. 4, p. 231. *T. monogynum* L., Mant., vol. 1, p. 69 (1767); Griseb., Fl. Brit. W. Ind., p. 58.— Juan Griego, *Ernst*; El Valle, *Miller & Johnston*, no. 12, July 12; Pt. Moreno, *Johnston*, no. 110, July 8. Very abundant near the lagoon at Pt. Moreno. Venezuela: La Guaira, *Fendler*, no. 64, Aug. 1855. Further distribution, tropical America.

## PORTULACACEAE.

## PORTULACA L.

P. HALIMOIDES L., Sp. pl., ed. 2, vol. 1, p. 639 (1762); Griseb., Fl. Brit. W. Ind., p. 57. *P. pilosa* a Rohrbach in Mart., Fl. Bras., vol. 14, pt. 2, p. 304.—*Ernst*. Found in the West Indies.

P. MILLERI Urb., Symb. Ant., vol. 5, p. 344 (1907).—Porlamar, *Miller & Johnston*, no. 11 (in part), July 31. Endemie.

P. OLERACEA L., Sp. pl., vol. 1, p. 445 (1753); Griseb., Fl. Brit. W. Ind., p. 57.—Common on Margarita, *Miller & Johnston*. Venezuela: Colonia Tovar, *Fendler*, no. 61, 1854-55. Widely distributed.

P. PILOSA L., Sp. pl., vol. 1, p. 445 (1753); Griseb., Fl. Brit. W. Ind., p. 57; Rohrbach in Mart., Fl. Bras., vol. 14, pt. 2, p. 303.—Santa Ana, *Ernst*.

P. VENEZUELENSIS Urb., Symb. Ant., vol. 5, p. 344 (1907).—Porlamar, *Miller & Johnston*, no. 11 (in part), July 31. Found also on the mainland by Gollmer, according to Urban.

## TALINUM Adans.

T. PANICULATUM (Jacq.) Gaertn., Fruct., vol. 2, p. 219, pl. 128 (1791); Urb., Symb. Ant., vol. 4, p. 231. *Portulaca paniculata* Jacq., Enum., p. 22 (1760). *T. patens* Willd., Sp. pl., vol. 2, p. 863 (1800); Ernst, Bot. excurs. Margarita, p. 2.— Juan Griego, *Ernst*; El Valle, *Miller & Johnston*, no. 28, Aug. 1. Venezuela: La Guaira, *Fendler*, no. 66, Aug. 16, 1855. Common in tropical America.

T. TRIANGULARE (Jacq.) Willd., Sp. pl., vol. 2, p. 862 (1800); Griseb., Fl. Brit. W. Ind., p. 56; Urb., Symb. Ant., vol. 4, p. 231. *Portulaca triangularis* Jacq., Enum., p. 22 (1760).—*T. racemosum* Rohrbach in Mart., Fl. Bras., vol. 14, pt. 2, p. 297 (1872).—El Valle, *Miller & Johnston*, no. 262, July 20. Common in tropical America.

## MENISPERMACEAE.

## CISSAMPELOS L.

C. PAREIRA L., Sp. pl., vol. 2, p. 1031 (1753); Griseb., Fl. Brit. W. Ind., p. 10; Desc., Ant., vol. 3, p. 231, pl. 201; Urb., Symb. Ant., vol. 4, p. 237.—El Valle, *Miller & Johnston*, no. 151, Aug. 2. Venezuela: near Caripe, HBK., Nov. gen. et sp., vol. 5, p. 66; Santa Catalina, *Rusby & Squires*, no. 138, 1896. Common to all tropical countries.

## ANNONACEAE.

## ANNOXA L.

A. RETICULATA L., Sp. pl., vol. 1, p. 537 (1753); Griseb., Fl. Brit. W. Ind., p. 5; Mart., Fl. Bras., vol. 13, pt. 1, p. 15; Jacq., Obs., p. 13, pl. 6.—Asuncion, *Ernst*. Found also in Jamaica, St. Vincent, and Guadeloupe.

A. SQUAMOSA L., Sp. pl., vol. 1, p. 537 (1753); Griseb., Fl. Brit. W. Ind., p. 5; Mart., Fl. Bras., vol. 13, pt. 1, p. 14; Jacq., Hist. Stirp. Am., p. 162; Urb., Symb. Ant., vol. 4, p. 242.—El Valle, *Miller & Johnston*, no. 51, July 22. Further distribution, tropical America.

## LAURACEAE.

## NECTANDRA Roland.

N. CORIACEA (Sw.) Griseb., Fl. Brit. W. Ind., p. 281 (1860); Urb., Symb. Ant., vol. 4, p. 249. *Laurus coriacea* Sw., Prod. veg. Ind. Occ., p. 65 (1788). *N. Willdenoviana* Nees, Syst. Laurin., p. 321 (1836).—San Juan Mt., alt. 600 m., *Johnston*, no. 258, July 11. Further distribution, West Indies.

N. sp.—San Juan Mt., alt. 600 m., *Johnston*, no. 336, July 20, and no. 334, Aug. 28. No. 334 has leaves smooth and the cupule truncate. It is possibly only *N. coriacea* in fruit.

## PHOEBE Nees.

P. CINNAMOMIFOLIA (HBK.) Nees, Linnaea, vol. 21, p. 488 (1848). *Persea cinnamomifolia* HBK., Nov. gen. et sp., vol. 2, p. 160 (1817).—San Juan Mt., alt. 600 m., *Johnston*, no. 267, July 11; also no. 258, July 11, and no. 336, July 20, at 600 m. alt. Distribution general in American Tropics.

## PAPAVERACEAE.

## ARGEMONE L.

*A. MEXICANA* L., Sp. pl., vol. 1, p. 508 (1753); Lam., Encycl., pl. 452; Griseb., Fl. Brit. W. Ind., p. 13; Eichler in Mart., Fl. Bras., vol. 13, pt. 1, p. 316; Urb., Symb. Ant., vol. 4, p. 250.— Santa Ana, *Ernst*; El Valle, *Miller & Johnston*, no. 245, July 25. Venezuela: near Caracas, *Fendler*, no. 19, Jan. 14, 1854. Further distribution, Caribbean Ids.

## CAPPARIDACEAE.

## CAPPARIS L.

*C. BREYNIA* L., Syst. nat., ed. 10, vol. 2, p. 1071 (1759); Jacq., Hist. Stirp. Am., p. 161, pl. 103; Eichler in Mart., Fl. Bras., vol. 13, pt. 1, p. 271. *C. amygdalina* Lam., Encycl., vol. 1, p. 608 (1783); Griseb., Fl. Brit. W. Ind., p. 17.— Juan Griego, *Ernst*. Venezuela: Cumaná, HBK., Nov. gen. et sp., vol. 5, p. 97; Loeffling, Reise nach den spanischen Ländern, p. 152–153; Valencia, *Fendler*, no. 2273, Mar. 5, 1857. Further distribution, tropical America.

*C. COCCOLOBIFOLIA* Mart. ex Eichler in Mart., Fl. Bras., vol. 13, pt. 1, p. 284 (1865). *C. collina* Johnston, Proc. Amer. acad. arts and sci., vol. 40, p. 686 (1905).— Tree, 5 m. high, on hillside north of El Valle, *Johnston*, no. 10, July 15. Further distribution, tropical America.

*C. CYNOPHALLOPHORA* L., Sp. pl., ed. 2, vol. 1, p. 721 (1762); Jacq., Hist. Stirp. Am., p. 158; Griseb., Fl. Brit. W. Ind., p. 18; Eichler in Mart., Fl. Bras., vol. 13, pt. 1, p. 282.— El Valle, *Miller & Johnston*, no. 111, July 12; North Hill, El Valle, alt. 200 m., *Johnston*, no. 5, July 3. A tree, about 5 m. high. Further distribution, tropical America.

*C. JAMAICENSIS* Jacq., Enum. pl. Carib., p. 23 (1760), and Hist. Stirp. Am., p. 160; Griseb., Fl. Brit. W. Ind., p. 18; Eichler in Mart., Fl. Bras., vol. 13, pt. 1, p. 270.— El Valle, *Miller & Johnston*, no. 106, July 18. Venezuela: Victoria, *Fendler*, no. 2274, Mar. 4, 1857. Further distribution, West Indies and Venezuela. The Margaritan specimen is very closely allied to *C. linearis*.

*C. LINEARIS* Jacq., Enum. pl. Carib., p. 24 (1760), and Hist. Stirp. Am., p. 161.— El Valle, alt. 150 m., *Johnston*, no. 4, July 3. Tree, about 3 m. high; the wood brittle. Venezuela: Golfo de Cariaco,

Punta Araya, and Laguna Chica, HBK., Nov. gen. et sp., vol. 5, p. 87. Further distribution, northern South America.

C. PACHACA HBK., Nov. gen. et sp., vol. 5, p. 93 (1821); Eichler in Mart., Fl. Bras., vol. 13, pt. 1, p. 281.—Santa Ana, *Ernst*; El Valle, *Johnston*, no. 9, July 3. Venezuela: Cumaná, HBK., Nov. gen. et sp., vol. 5, p. 93. Tree, about 5 m. in height.

C. STENOSEPALA Urb., Symb. Ant., vol. 5, p. 529 (1908).—El Valle, alt. 200 m., *Johnston*, no. 8, July 27. Tree, about 7 m. high; flowers yellowish outside, purple within. Endemic. Occurs in Coche.

C. TENUISILIQUA Jacq., Enum. pl. Carib., p. 24 (1760); Eichler in Mart., Fl. Bras., vol. 13, pt. 1, p. 278.—El Valle, *Miller & Johnston*, no. 9, July 13; also *Johnston*, no. 6, July 21, and in fruit Aug. 8, alt. 150 m. Venezuela: Colonia Tovar, *Fendler*, no. 30, Aug. 16, 1855. Further distribution, Colombia.

C. VERRUCOSA Jacq., Enum. pl. Carib., p. 23 (1760), and Hist. Stirp. Am., p. 159; Griseb., Fl. Brit. W. Ind., p. 19.—North and South Hills, alt. 60–300 m., El Valle, *Johnston*, no. 1, July 26. Shrub, 2–3 m. high. Venezuela: Cumaná, HBK., Nov. gen. et sp., vol. 5, p. 90; Colonia Tovar, *Fendler*, no. 34 B, Aug. 16, 1855. Further distribution, tropical America.

#### CRATEVA L.

C. GYNANDRA L., Sp. pl., ed. 2, vol. 1, p. 636 (1762); Griseb., Fl. Brit. W. Ind., p. 17.—Santa Ana, *Ernst*; El Valle, *Johnston*, no. 2, July 1. Venezuela: Cumaná, HBK., Nov. gen. et sp., vol. 5, p. 86; Turmera, *Fendler*, no. 1893, Mar. 14, 1857. Common in tropical America. Tree, about 20 m. high, with a trunk 7 dm. in diameter at base.

#### GYNANDROPSIS DC.

G. PENTAPHYLLA DC., Prod., vol. 1, p. 238 (1824); Eichler in Mart., Fl. Bras., vol. 13, pt. 1, p. 261, pl. 58, fig. 3; Urb., Symb. Ant., vol. 4, p. 252.—El Valle, *Miller & Johnston*, no. 73, July 29. Distribution general in tropical countries.

#### MORISONIA L.

M. AMERICANA L., Sp. pl., vol. 1, p. 503 (1753); Griseb., Fl. Brit. W. Ind., p. 19.—Santa Ana, *Ernst*. Venezuela: Colonia Tovar, *Fendler*, no. 2472, Jan. 6, 1855. West Indies.

M. JOHNSTONII Urb., Symb. Ant., vol. 5, p. 348 (1907).— El Valle, alt. 300 m., *Johnston*, no. 7, July 10. A tree, about 7 m. high; trunk 6 dm. in diameter at base; wood of strong odor, brittle. Endemic.

#### STERIPHOMA Spreng.

S. ELLIPTICA Spreng., Syst., vol. 4, pt. 2, p. 139 (1827); Griseb., Fl. Brit. W. Ind., p. 20.— El Valle, *Miller & Johnston*, no. 267, July 30, and *Johnston*, no. 3, July 15, alt. 60–300 m. Small tree, 5 m. high. Further distribution, Trinidad and Cumaná.

### CRUCIFERAE.

#### CAKILE Juss.

C. AEQUALIS L'Hér. ex DC., Syst., vol. 2, p. 430 (1821); Griseb., Fl. Brit. W. Ind., p. 14; Deless., Ic., vol. 2, p. 17, pl. 57.— Juan Griego, *Ernst*. Venezuela: Ernst, Sobre la flora y fauna, p. 223. Further distribution, West Indies.

#### LEPIDIUM L.

L. VIRGINICUM L., Sp. pl., vol. 2, p. 645 (1753); Griseb., Fl. Brit. W. Ind., p. 14.— Santa Ana, *Ernst*. Common to the West Indies and eastern United States.

### LEGUMINOSAE.

#### ABRUS L.

A. PRECATORIUS L., Syst. nat., ed. 12, vol. 2, p. 472 (1767); Griseb., Fl. Brit. W. Ind., p. 190; Desc., Ant., vol. 4, p. 194, pl. 275.— Juan Griego and Santa Ana, *Ernst*. Common in tropics.

#### ACACIA Mill.

A. MACRACANTHA H. & B. ex Willd., Sp. pl., vol. 4, p. 1080 (1806); Griseb., Fl. Brit. W. Ind., p. 221; Kunth, Mim., p. 90, pl. 28.— El Valle, *Miller & Johnston*, no. 114, Aug. 2, and River trail, El Valle, *Johnston*, no. 28, July 15. Venezuela: Colonia Tovar, *Fendler*, no. 362, 1854–55. Slender shrub, 5 m. high; flowers yellow. Further distribution, tropical America.

A. PANICULATA Willd., Sp. pl., vol. 4, p. 1074 (1806); Griseb.,

Fl. Brit. W. Ind., p. 221; Mart., Fl. Bras., vol. 15, pt. 2, pl. 102.—Santa Ana, *Ernst*. Venezuela: Colonia Tovar, *Fendler*, no. 351, 1854–55. Further distribution, St. Lucia, Cuba, Guiana, and Brazil.

A. TAMARINDIFOLIA (L.) Willd., Sp. pl., vol. 4, p. 1092 (1806); Griseb., Fl. Brit. W. Ind., p. 221. *Mimosa tamarindifolia* L., Sp. pl., vol. 1, p. 523 (1753).—El Valle, *Miller & Johnston*, no. 113, July 15; en route Peilar to Pt. Moreno, *Johnston*, no. 37, July 8. Venezuela: Bordones, HBK., Nov. gen. et sp., vol. 6, p. 277; La Guaira, *Robinson & Lyon*, July 12, 1900. Slender shrub, 5 m. high. Tropical America.

#### BAUHINIA L.

B. CUMANENSIS HBK., Nov. gen. et sp., vol. 6, p. 321 (1823); Bot. reg., vol. 14, pl. 1133.—South Hill, El Valle, *Miller & Johnston*, no. 70, July 27. Observed on North Hill, Aug. 15, 1903, not in flower. Venezuela: Bordones, HBK., Nov. gen. et sp., vol. 6, p. 277. Further distribution, northern South America.

#### CAESALPINIA L.

C. CORIARIA (Jacq.) Willd., Sp. pl., vol. 2, p. 532 (1799). *Libidibia coriaria* Schlecht., Linnaea, vol. 5, p. 193 (1830); Griseb., Fl. Brit. W. Ind., p. 206. *Poinciana coriaria* Jacq., Hist. Stirp. Am., p. 123, pl. 175 (1763).—Santa Ana, *Ernst*; El Valle, *Johnston*, no. 29. Further distribution, tropical America.

C. PULCHERRIMA (L.) Sw., Obs., p. 166 (1791); Griseb., Fl. Brit. W. Ind., p. 205.—Santa Ana, *Ernst*; El Valle, *Miller & Johnston*, no. 64, July 22. Common in tropical countries.

#### CAJANUS DC.

C. INDICUS Spreng., Syst., vol. 3, p. 248 (1826); Griseb., Fl. Brit. W. Ind., p. 191; Urb., Symb. Ant., vol. 4, p. 306. *Poinciana pulcherrima* L., Sp. pl., vol. 1, p. 380 (1753).—El Valle, *Miller & Johnston*, no. 139, Aug. 6. Venezuela: Caracas, *Birschel*; Santa Catalina, *Rusby & Squires*, no. 191, 1896; Colonia Tovar, *Fendler*, no. 303, 1854–55. Common in tropical countries.

#### CALLIANDRA Benth.

C. PORTORICENSIS Benth. in Hook., Lond. journ. bot., vol. 3, p. 99 (1844); Griseb., Fl. Brit. W. Ind., p. 224. *Mimosa portoricensis*

Jacq., Ic. pl. rar., vol. 3, p. 20, pl. 633 (1793).— El Valle, *Miller & Johnston*, no. 264, July 29. Tropical America.

C. PANLOSIA Johnston, Proc. Amer. acad. arts and sci., vol. 40, p. 686 (1905).— Abundant on hills at alt. 300–600 m., El Valle to Juan Griego, *Miller & Johnston*, no. 58, July 22, and *Johnston*, no. 27, July 2. Endemic.

#### CANAVALLIA DC.

C. OBTUSIFOLIA (Lam.) DC., Prod., vol. 2, p. 404 (1825); Griseb., Fl. Brit. W. Ind., p. 197; Rheede, Hort. Mal., vol. 8, pl. 43. *Dolichos obtusifolius* Lam., Encycl., vol. 2, p. 295 (1786).— Juan Griego, *Ernst*. Common in tropical countries.

#### CASSIA L.

C. BIFLORA L., Sp. pl., vol. 1, p. 378 (1753); Griseb., Fl. Brit. W. Ind., p. 208; Bot. reg., vol. 16, pl. 1310.— Santa Ana, *Ernst*; El Valle, *Miller & Johnston*, no. 61, July 22. Further distribution, tropical America.

C. EMARGINATA L., Sp. pl., vol. 1, p. 376 (1753); Griseb., Fl. Brit. W. Ind., p. 207; Urb., Symb. Ant., vol. 4, p. 274.— El Valle, *Miller & Johnston*, no. 201, July 6, and also *Johnston*, no. 24, July 15. Growing in the River trail in El Valle and also on the hillside. Venezuela: Cumaná, Loeffling, Reise nach den spanischen Ländern, p. 152–153. Found also in Jamaica, St. Vincent, and Haiti.

C. FISTULA L., Sp. pl., vol. 1, p. 377 (1753); Griseb., Fl. Brit. W. Ind., p. 206; Desc., Ant., vol. 2, p. 231, pl. 125; Urb., Symb. Ant., vol. 4, p. 272.— El Valle, *Miller & Johnston*, no. 69, July 15. Venezuela: *Ernst*, Sobre la flora y fauna, p. 226. Further distribution, tropical countries.

C. NICTITANS L., Sp. pl., vol. 1, p. 380 (1753); Griseb., Fl. Brit. W. Ind., p. 211; Urb., Symb. Ant., vol. 4, p. 276.— Margarita, according to Urb., *l. c.*, p. 276; Santa Ana, *Ernst*. Distribution general in American Tropics and Sub-tropics.

C. OBOVATA Collad., Hist. Cas., p. 92, pl. 15 (1816); Griseb., Fl. Brit. W. Ind., p. 209.— El Valle, *Miller & Johnston*, no. 228, July 26. Also in Jamaica, according to Griseb., introduced from tropical Africa.

C. OCCIDENTALIS L., Sp. pl., vol. 1, p. 377 (1753); Griseb., Fl. Brit. W. Ind., p. 209; Desc., Ant., vol. 2, p. 277, pl. 135; Urb., Symb. Ant., vol. 4, p. 273.— Santa Ana and Asunción, *Ernst*; El Valle, *Miller*

& *Johnston*, no. 60, July 11. Venezuela: Cumaná, Loeffling, *Reise nach den spanischen Ländern*, p. 152-153. Common in tropical countries.

*C. OXYPHYLLA* Kunth, *Mimos.*, p. 129, pl. 39 (1819-24).—El Valle, *Miller & Johnston*, no. 62, Aug. 5. Venezuela: on Mt. Cocolar, HBK., *Nov. gen. et sp.*, vol. 6, p. 342; La Guaira, *Robinson & Lyon*, July 6, 1900. Further distribution, Mexico to Ecuador.

*C. SERICEA* Sw., *Prod. veg. Ind. Occ.*, p. 66 (1788), and *Fl. Ind. Occ.*, vol. 2, p. 724; Griseb., *Fl. Brit. W. Ind.*, p. 209; Mart., *Fl. Bras.*, vol. 15, pt. 2, p. 116, pl. 35.—El Valle, *Miller & Johnston*, no. 56, July 5. Further distribution, Cuba to Panama and Brazil.

*C. STENOCARPA* Vog., *Syn. Cass.*, p. 68 (1837).—El Valle, *Miller & Johnston*, no. 210, July 14. Venezuela: Colonia Tovar, *Fendler*, no. 321, 1854-55. Very closely allied to *C. nictitans* L., if not identical with it. Found also in Brazil.

*C. TORA* L., *Sp. pl.*, vol. 1, p. 376 (1753). *C. obtusifolia* L., *Sp. pl.*, vol. 1, p. 377 (1753); Griseb., *Fl. Brit. W. Ind.*, p. 209.—Santa Ana, *Ernst*. Further distribution, tropical countries.

#### CENTROSEMA Benth.

*C. BRASILIANUM* Benth., *Ann. Wien. Mus.*, vol. 2, p. 118 (1837); Mart., *Fl. Bras.*, vol. 15, pt. 1, p. 128, pl. 34. *Bradburya brasiliiana* Ktze., *Rev. gen.*, vol. 1, p. 164 (1891).—Asuncion, *Miller & Johnston*, no. 54, Aug. 9. Venezuela: Colonia Tovar, *Fendler*, no. 1778, 1856-57. Found also in Brazil.

*C. VIRGINIANUM* (L.) Benth., *Ann. Wien. Mus.*, vol. 2, p. 120 (1837), *Urb.*, *Symb. Ant.*, vol. 4, p. 300. *Clitoria virginiana* L., *Sp. pl.*, vol. 2, p. 753 (1753); *Bot. reg.*, vol. 13, p. 1047. *Bradburya virginiana* Ktze., *Rev. gen.*, vol. 1, p. 164 (1891).—El Valle, *Miller & Johnston*, no. 256, Aug. 15. Further distribution, tropical America and Nigeria.

#### CERCIDIUM Tulasne.

*C. SPINOSUM* Tulasne, *Arch. mus. Par.*, vol. 4, p. 134 (1844).—El Valle, alt. 200 m., *Johnston*, no. 31, July 3. Shrub, 3 m. high; trunk 2 dm. in diameter at base; bark green; stem thorny; flowers yellow. Further distribution, Brazil.

*C. VIRIDE* (Karst.) Taub. in *Engl. & Prantl, Natürl. Pflanzenfam.*, vol. 3, pt. 3, p. 172 (1892). *Rhetinophloeum viride* Karst., *Fl. Columb.*, vol. 2, p. 25, pl. 113 (1862).—Santa Ana, *Ernst*. Found in northern South America.

## CLITORIA L.

C. TERNATEA L., Sp. pl., vol. 2, p. 753 (1753); Griseb., Fl. Brit. W. Ind., p. 192; Garden, vol. 38, p. 132, pl. 765; Urb., Symb. Ant., vol. 4, p. 299.—El Valle, *Miller & Johnston*, no. 55, July 15, and *Johnston*, no. 36, July 15. Tropical countries.

## CRACCA Benth.

C. CARIBAEA Benth. ex Oerst. in Kjoeb. Vidensk. meddel., p. 9, (1853); Griseb., Fl. Brit. W. Ind., p. 183.—El Valle, *Miller & Johnston*, nos. 135 & 141, July 27 and Aug. 2, respectively. Further distribution, tropical America.

## CROTALARIA L.

C. INCANA L., Sp. pl., vol. 2, p. 716 (1753); Griseb., Fl. Brit. W. Ind., p. 180; Cav., Ic., pl. 322; Urb., Symb. Ant., vol. 4, p. 281.—Santa Ana, *Ernst*; El Valle, *Miller & Johnston*, no. 50, July 8. Further distribution, tropical America and tropical Africa.

## DESMANTHUS Willd.

D. VIRGATUS Willd., Sp. pl., vol. 4, p. 1047 (1806); Griseb., Fl. Brit. W. Ind., p. 218.—Santa Ana, *Ernst*. Further distribution, temperate and tropical America and East Indies.

## DESMODIUM Desv.

D. SCORPIURUS (Sw.) Desv., Journ. bot., vol. 1, p. 122 (1813); Griseb., Fl. Brit. W. Ind., p. 187; Urb., Symb. Ant., vol. 4, p. 293. *Hedysarum Scorpiurus* Sw., Prod. veg. Ind. Occ., p. 107 (1788).—El Valle, *Miller & Johnston*, no. 214, July 12. Further distribution, tropical America and Society Ids.

D. SPIRALE (Sw.) DC., Prod., vol. 2, p. 332 (1825); Griseb., Fl. Brit. W. Ind., p. 188. *Hedysarum spirale* Sw., Prod. veg. Ind. Occ., p. 107 (1788).—Santa Ana, *Ernst*. Further distribution, tropical countries.

D. SUPINUM (Sw.) DC., Prod., vol. 2, p. 332 (1825); Urb., Symb. Ant., vol. 4, p. 290. *Hedysarum supinum* Sw., Prod. veg. Ind. Occ., p. 106 (1788). *D. incanum* DC., Prod., vol. 2, p. 332 (1825).—El Valle, *Miller & Johnston*, no. 123, July 14. Further distribution, tropical countries.

## DOLICHOS L.

D. sp.—*Ernst*.

## ENTEROLOBIUM Mart.

E. CYCLOCARPUM (Jacq.) Griseb., Fl. Brit. W. Ind., p. 226 (1860). *Mimosa cyclocarpa* Jacq., Frag., p. 30, pl. 34, fig. 1 (1809).—Santa Ana, *Ernst*. Occurs also in Jamaica and Venezuela.

## ERIOSEMA Desv.

E. CRINITUM (HBK.) G. Don, Syst., vol. 2, p. 348 (1832). *Glycine crinita* HBK., Nov. gen. et sp., vol. 6, p. 421 (1823).—Santa Ana, *Ernst*. Further distribution, tropical America.

## ERYTHRINA L.

E. CORALLODENDRUM L., Sp. pl., vol. 2, p. 706 (1753); Griseb., Fl. Brit. W. Ind., p. 199.—El Valle, *Johnston*, no. 259, July 16. Venezuela, according to *Ernst* in World's Columbian exposition at Chicago. Further distribution, from Mexico to Brazil.

## GLIRICIDIA HBK.

G. LUTEA *Johnston*, Proc. Amer. acad. arts and sci., vol. 40, p. 687 (1905).—On dry hillside, El Valle, *Miller & Johnston*, no. 246, and *Johnston*, no. 34, Aug. 15. Endemic. PLATE 30, fig. 1, 1a-d.

## HYMENEAE L.

H. COURBARIL L., Sp. pl., vol. 2, p. 1192 (1753); Griseb., Fl. Brit. W. Ind., p. 213.—El Valle, *Johnston*, no. 290, Aug. Venezuela: near Carichana, HBK., Nov. gen. et sp., vol. 6, p. 322. Further distribution, Cuba, Panama, Guiana.

## INDIGOFERA L.

I. SUBULATA Vahl ex Poir., Suppl., vol. 3, p. 150 (1813); Griseb., Fl. Brit. W. Ind., p. 181.—El Valle, *Miller & Johnston*, no. 142, July 26. Further distribution, Mexico to Venezuela and in East Indies.

I. SUFFRUTICOSA Mill., Gard. dict., ed. 8, no. 2 (1768). *I. Anil* L., Mant., vol. 2, p. 272 (1771); Urb., Symb. Ant., vol. 4, p. 181.—Santa Ana, *Ernst*; El Valle, *Miller & Johnston*, no. 52, July 26, and *Johnston*, no. 35, July 24. Further distribution, temperate and tropical countries.

## INGA Scop.

I. INGOIDES (Rich.) Willd., Sp. pl., vol. 4, p. 1012 (1806); Griseb., Fl. Brit. W. Ind., p. 228. *Mimosa ingoides* Rich., Act. soc. hist. nat. Par., vol. 1, p. 113 (1792).—Juan Griego trail, alt. 400 m., *Johnston*, no. 26, Aug. 12–15. Tree, about 20 m. high. Further distribution, West Indies and Guiana.

I. MACRANTHA Johnston, Proc. Amer. acad. arts and sci., vol. 40, p. 687 (1905).—On Juan Griego trail, alt. 400 m., *Johnston*, no. 25, July 11. Endemic. PLATE 28, fig. 1.

## LONCHOCARPUS HBK.

L. LATIFOLIUS (Willd.) HBK., Nov. gen. et sp., vol. 6, p. 383 (1823); Griseb., Fl. Brit. W. Ind., p. 199. *Amerimum latifolium* Willd., Sp. pl., vol. 3, p. 909 (1803).—Santa Ana, *Ernst*. Further distribution, tropical America.

L. VELUTINUS Benth. in Scem., Bot. voy. Herald., p. 111 (1853).—El Valle, *Johnston*, no. 23, July 7. Further distribution, Central America.

L. VIOLACEUS (Jacq.) HBK., Nov. gen. et sp., vol. 6, p. 383 (1823), in note; Griseb., Fl. Brit. W. Ind., p. 200. *Robinia violacea* Jacq., Enum. pl. Carib., p. 28 (1760).—El Valle, *Miller & Johnston*, no. 257, July 21; and *Johnston*, no. 22, Aug. Further distribution, tropical America. Tree, about 15 m. high.

## MACHAERIUM Pers.

M. STRIATUM Johnston, Proc. Amer. acad. arts and sci., vol. 40, p. 688 (1905).—North Hill, El Valle, *Johnston*, no. 124, Aug. 8. Endemic. PLATE 28, fig. 2.

## MIMOSA L.

“*M. FASTIGIATA* W.” acc. to Ernst (a combination wholly obscure and probably due to some clerical error).—Santa Ana, *Ernst*.

## MYROSPERMUM Jacq.

M. FRUTESCENS Jacq., Enum. pl. Carib., p. 20 (1760); Griseb., Fl. Brit. W. Ind., p. 204.—Juan Griego, *Ernst*. Venezuela: near Parapara and on the banks of the Rio Guárico, HBK., Nov. gen. et sp., vol. 6, p. 372. Further distribution, Trinidad and Colombia.

## NISSOLIA Jacq.

*N. WISLIZENI* Gray, Journ. Linn. soc., vol. 5, p. 25 (1861). *Chaetocalyx Wislizeni* Gray, Pl. Wright., vol. 1, p. 51 (1852).— El Valle, *Miller & Johnston*, no. 259, Aug. 4. Further distribution, Mexico.

## PARKINSONIA L.

*P. ACULEATA* L., Sp. pl., p. 375 (1753); Griseb., Fl. Brit. W. Ind., p. 204; Urb., Symb. Ant., vol. 4, p. 277.— Asuncion, *Ernst*; El Valle, *Miller & Johnston*, no. 63, July 20. Venezuela: Cumaná, Loeffling, Reise nach den spanischen Ländern, p. 152–153. Found in all tropical countries.

## PELTOPHORUM Walp.

*P. acutifolium*, n. comb. *Caesalpinia acutifolia* Johnston, Proc. Amer. acad. arts and sci., vol. 40, p. 686 (1905). *Peltophorum Suringari* Urb., Symb. Ant., vol. 5, p. 363 (1908).— On the hillside, El Valle, *Miller & Johnston*, no. 200, Aug. 15, and *Johnston*, no. 33, Aug. 3. Found also on Aruba and Curaçoa.

## PHASEOLUS L.

*P. LUNATUS* L., Sp. pl., vol. 2, p. 724 (1753); DC., Prod., vol. 2, p. 393; Benth. in Mart., Fl. Bras., vol. 15, pt. 1, p. 181; Urb., Symb. Ant., vol. 4, p. 308.— Margarita according to Urban, *l. c.* Distribution general in tropical and temperate countries; cultivated.

*P. sp.*— *Ernst*.

*P. sp.*— El Valle, *Miller & Johnston*, no. 57, July 26. Possibly this is a specimen of the above *P. lunatus*.

## PITHECOLOBIUM Mart.

*P. LIGUSTRINUM* (Jacq.) Klotzsch ex Benth., Trans. Linn. soc., vol. 30, p. 571 (1875). *Mimosa ligustrina* Jacq., Fragin., p. 29, pl. 32, fig. 6, not Vahl.— El Valle, *Miller & Johnston*, no. 242, July 30, and no. 121; *Johnston*, no. 38, July 1. Tree, about 8 m. high, and 1.2 dm. in diameter at its base. Further distribution, American tropics.

*P. UNGUIS-CATI* (L.) Benth. in Hook., Lond. journ. bot., vol. 3, p. 200 (1844); Griseb., Fl. Brit. W. Ind., p. 226. *Mimosa unguis cati* L., Sp. pl., vol. 1, p. 517 (1753).— Santa Ana, *Ernst*; El Valle,

*Johnston*, no. 43, July 14. Venezuela: Cumaná, Loeffling, Reise nach den spanischen Ländern, p. 152-153. A slender tree, about 5 m. high, branching copiously and growing in clumps. Common in tropical America.

PLATYMISCIUM Vog.

*P. POLYSTACHYUM* Benth. in Seem., Bot. voy. Herald., p. 111, pl. 21 (1853). *P. platystachyum* Griseb., Fl. Brit. W. Ind., p. 200 (1860).—Santa Ana, *Ernst*. Further distribution, St. Vincent, Trinidad, Panama, and Venezuela.

POINCIANA L.

*P. REGIA* Boj. ex Hook., Bot. mag., pl. 2884 (1829); Urb., Symb. Ant., vol. 4, p. 278.—El Valle, *Miller & Johnston*, no. 59, July 29. Common in tropical countries.

PROSOPIS L.

*P. JULIFLORA* (Sw.) DC., Prod., vol. 2, p. 447 (1825); Griseb., Fl. Brit. W. Ind., p. 217. *Mimosa juliiflora* Sw., Prod. veg. Ind. Occ., p. 85 (1788). *P. cumanensis* HBK., Nov. gen. et sp., vol. 6, p. 310 (1823).—Santa Ana, *Ernst*; El Valle, *Johnston*, no. 42, July 15. A tree, about 5 m. high, with wide-spreading top. Further distribution, Mexico to Guayaquil, also Jamaica.

RHYNCHOSIA Lour.

*R. MINIMA* (L.) DC., Prod., vol. 2, p. 385 (1825); Griseb., Fl. Brit. W. Ind., p. 190; Urb., Symb. Ant., vol. 4, p. 307. *Dolichos minimus* L., Sp. pl., vol. 2, p. 726 (1753).—El Valle, *Miller & Johnston*, no. 118, July 19. Common in tropical countries.

STYLOSANTHES Sw.

*S. HUMILIS* HBK., Nov. gen. et sp., vol. 6, p. 506, pl. 594 (1823).—Asuncion, *Miller & Johnston*, no. 68, Aug. 9. Venezuela: near Carichana, HBK., *l. c.*

*S. VISCOSA* Sw., Prod. veg. Ind. Occ., p. 108 (1788); Griseb., Fl. Brit. W. Ind., p. 188.—El Valle, *Miller & Johnston*, no. 268, July 30; Pt. Mosquito, *Johnston*, no. 249, Aug. 10. Further distribution, tropical America.

TAMARINDUS L.

*T. INDICA* L., Sp. pl., vol. 1, p. 34 (1753); Griseb., Fl. Brit. W. Ind., p. 213; Urb., Symb. Ant., vol. 4, p. 270.—El Valle, *Miller & Johnston*,

no. 65, July 21. Venezuela: Cumaná, Loeffling, Reise nach den spanischen Ländern, p. 152-153. Common to all tropical countries.

TEPHROSIA Pers.

T. CINEREA (L.) Pers., Syn., vol. 2, p. 328 (1807); Griseb., Fl. Brit. W. Ind., p. 182; Urb., Symb. Ant., vol. 4, p. 283. *Galega cinerea* L., Syst. nat., ed. 10, vol. 2, p. 1172 (1759).—Santa Ana, Juan Griego, *Ernst*; El Valle, *Miller & Johnston*, no. 136, July 20. Further distribution, tropical America.

TERAMNUS Sw.

T. UNCINATUS (L.) Sw., Prod. veg. Ind. Occ., p. 105 (1788); Griseb., Fl. Brit. W. Ind., p. 193. *Dolichos uncinatus* L., Sp. pl., ed. 2, vol. 2, p. 1019 (1763).—Juan Griego, Santa Ana, *Ernst*. Further distribution, tropical America.

VIGNA Savi.

V. VEXILLATA (L.) A. Rich. in Sagra, Cub., vol. 10, p. 191 (1845); Griseb., Fl. Brit. W. Ind., p. 195. *Phaseolus vexillatus* L., Sp. pl., vol. 2, p. 724 (1753).—Santa Ana, *Ernst*. Distributed generally in tropical countries.

ZORNIA Gmel.

Z. DIPHYLLA (L.) Pers., Syn., vol. 2, p. 318 (1807); Griseb., Fl. Brit. W. Ind., p. 185. *Hedysarum diphyllum* L., Sp. pl., vol. 2, p. 747 (1753).—Santa Ana, *Ernst*. Further distribution, general in tropical countries.

OXALIDACEAE.

OXALIS L.

O. BARRELIERI Jacq., Oxal., p. 24, pl. 3 (1794); Griseb., Fl. Brit. W. Ind., p. 133.—El Valle, *Miller & Johnston*, no. 122, July 30. Further distribution, tropical America.

O. PLUMIERI Jacq., Oxal., p. 23 (1794). *O. frutescens* Griseb., Fl. Brit. W. Ind., p. 133 (1859), not L.—San Juan Mt., alt. 795 m., *Johnston*, no. 128, July 6. Further distribution, Dominica, St. Vincent, and Martinique.

## ERYTHROXYLACEAE.

## ERYTHROXYLUM P. Br.

*E. HAVANENSE* Jacq., Stirp. Am., p. 135, pl. 87, fig. 2 (1763). *E. ovatum* Cav., Diss., p. 404, pl. 233 (1789); Griseb., Fl. Brit. W. Ind., p. 113.—Santa Ana, *Ernst*; El Valle, River trail, *Johnston*, no. 72, Aug. 20. Slender tree, 5 m. high; flowers small, white. Further distribution, Dominica, Trinidad, Guiana, and Bahia.

## STIGMATOPHYLLUM Juss.

S. sp.—Santa Ana, *Ernst*.

## ZYGOPHYLLACEAE.

## GUAJACUM L.

*G. ARBOREUM* (Jacq.) DC., Prod., vol. 1, p. 707 (1824). *Zygo-phyllum arboreum* Jacq., Stirp. Am., p. 130, pl. 83 (1763).—Santa Ana, *Ernst*; El Valle, *Miller & Johnston*, no. 20, July 6; *Johnston*, no. 30, Aug. 8. Common on the road between Porlamar and Juan Griego by way of Asuncion. Further distribution, tropical America.

*G. OFFICINALE* L., Sp. pl., vol. 1, p. 381 (1753); Griseb., Fl. Brit. W. Ind., p. 134.—Pt. Mosquito, *Johnston*, no. 117, Aug. 10. Venezuela: *Ernst*, Sobre la flora y fauna, p. 226. Distribution general from Cuba to Venezuela.

## KALLSTROEMIA Scop.

*K. MAXIMA* (L.) Wight & Arn., Prod., vol. 1, p. 145 (1834); Torr. & Gray, Fl. N. Amer., vol. 1, p. 213; Engl. in Mart., Fl. Bras., vol. 12, pt. 2, p. 71; Urb., Symb. Ant., vol. 4, p. 315. *Tribulus maximus* L., Sp. pl., vol. 1, p. 386 (1753).—El Valle, *Miller & Johnston*, no. 7, July 12; Juan Griego pond, *Johnston*, no. 292, Aug. 14. Venezuela: near Cumaná, HBK., Nov. gen. et sp., vol. 6, p. 11. Further distribution, tropical America.

## TRIBULUS L.

*T. TERRESTRIS* L., Sp. pl., vol. 1, p. 387 (1753), var. *CISTOIDES* (L.) Oliv., Fl. trop. Afr., vol. 1, p. 284 (1868); Urb., Symb. Ant., vol. 4, p. 315. *T. cistoides* L., Sp. pl., vol. 1, p. 387 (1753).—Santa Ana,

*Ernst*; El Valle, *Miller & Johnston*, no. 98, July 20; *Johnston*, no. 32, Aug. 3. Distribution general in tropics.

## RUTACEAE.

## AMYRIS P. Br.

A. MARITIMA Jacq., Enum. pl. Carib., p. 19 (1760); Griseb., Fl. Brit. W. Ind., p. 174; Sargent, Silva N. Amer., vol. 1, p. 85, pl. 36.—San Juan Mt., alt. 500 m., *Johnston*, no. 277, Aug. 28. Further distribution, tropical America.

## CITRUS L.

C. AURANTIUM L., Sp. pl., vol. 2, p. 782 (1753); Desc., Ant., vol. 1, p. 181, pl. 38.—El Valle, *Miller & Johnston*, no. 39, July 11. Cultivation general in tropical and sub-tropical countries.

## ESENBECKIA HBK.

E. PILOCARPOIDES HBK., Nov. gen. et sp., vol. 7, p. 248, pl. 655 (1825).—El Valle, *Miller & Johnston*, no. 226, July 25. Venezuela: near Quetepe, HBK., *l. c.* Distribution general in tropical America.

## ZANTHOXYLUM L.

Z. PTEROTA (L.) HBK., Nov. gen. et sp., vol. 6, p. 3 (1823). *Fagara Pterota* L., Syst. nat., ed. 10, vol. 2, p. 897 (1759). *F. lentiscifolia* Griseb., Fl. Brit. W. Ind., p. 137 (1859), not Willd.—Santa Ana, *Ernst*. Further distribution, southern United States, West Indies to Trinidad.

## SIMARUBACEAE.

## CASTELA Turp.

C. DEPRESSA Turp., Ann. mus. Par., vol. 7, p. 79, pl. 5 (1806).—Juan Griego, *Ernst*. Further distribution, San Domingo.

C. NICHOLSONI Hook., Bot. misc., vol. 1, p. 271, pl. 55 (1830). *C. erecta* Griseb., Fl. Brit. W. Ind., p. 140 (1859), not Turp.—El Valle, *Miller & Johnston*, no. 236, July 18; Pt. Moreno, *Johnston*, no. 118, July 8. Further distribution, Texas, Antigua.

## SURIANA L.

S. MARITIMA L., Sp. pl., vol. 1, p. 284 (1753); Griseb., Fl. Brit. W. Ind., p. 58.—Juan Griego, *Ernst*; Pt. Mosquito, *Johnston*, no. 284, Aug. 10. Distribution general in tropics.

## BURSERACEAE.

## BURSERA Jacq.

B. SIMARUBA (L.) Sarg., Gard. and for., vol. 3, p. 260 (1890) and Silva N. Amer., vol. 1, p. 97, pls. 41, 42; Urb., Symb. Ant., vol. 4, p. 324.—South Hill, El Valle, alt. 270 m., *Johnston*, no. 270, July 3. Venezuela: Ernst, Sobre la flora y fauna, p. 226. Further distribution, West Indies, Panama. Tree, about 7 m. high; wood odorous and bitter.

## MELIACEAE.

## MELIA L.

M. AZEDARACH L., Sp. pl., vol. 1, p. 384 (1753); Urb., Symb. Ant., vol. 4, p. 325.—Cultivated, El Valle, *Miller & Johnston*, no. 112, July 18. Venezuela: valley of Aragua, HBK., Nov. gen. et sp., vol. 5, p. 218. Distribution general in tropical countries.

## TRICHILIA P. Br.

T. HIRTA L., Syst. nat., ed. 10, vol. 2, p. 1020 (1759); Griseb., Fl. Brit. W. Ind., p. 129. *T. spondiodes* Jacq., Enum. pl. Carib., p. 20 (1760).—Santa Ana, *Ernst*. Further distribution, Jamaica, Cuba.

## MALPIGHIACEAE.

## HETEROPTERIS HBK.

H. LAURIFOLIA (L.) Juss., Ann. sci. nat., bot., ser. 2, vol. 13, p. 276 (1840); Griseb., Fl. Brit. W. Ind., p. 119. *Banisteria laurifolia* L., Sp. pl., ed. 2, vol. 2, p. 611 (1762).—South Hill, El Valle, alt. 300 m., *Miller & Johnston*, no. 46, Aug. 1; Juan Griego trail, alt. 300 m., *Johnston*, no. 54, Aug. 14. Further distribution, Jamaica, Cuba, and Porto Rico.

H. PURPUREA (L.) HBK., Nov. gen. et sp., vol. 5, p. 164 (1821),

in obs.; Griseb., Fl. Brit. W. Ind., p. 119. *Banisteria purpurea* L., Sp. pl., vol. 1, p. 427 (1753).—El Valle, climbing over a hedge of *Clerodendron molle*, Johnston, no. 55, July 9. Flowers light purple or pink. Venezuela: near Cumaná, HBK., Nov. gen. et sp., vol. 5, p. 164. Further distribution, West Indies and Venezuela.

## MALPIGHIA L.

*M. GLABRA* L., Sp. pl., vol. 1, p. 425 (1753); Griseb., Fl. Brit. W. Ind., p. 116.—Juan Griego and Santa Ana, *Ernst*. Further distribution, tropical America.

*M. PUNICIFOLIA* L., Sp. pl., ed. 2, vol. 1, p. 609 (1762), var. *VULGARIS* Ndz., Gen. Malpigh., p. 8 (1899).—El Valle, *Miller & Johnston*, no. 253, Aug. 11; *Johnston*, no. 130, Aug. 30. Distribution general in tropical America.

## POLYGALACEAE.

## SECURIDACA L.

*S. CORDATA* Johnston, Proc. Amer. acad. arts and sci., vol. 40, p. 688 (1905).—North Hill, El Valle, alt. 250 m., *Johnston*, no. 60, Aug. 8. Endemic.

## EUPHORBIACEAE.

## ACALYPHA L.

*A. MACROSTACHYA* Jacq., Hort. Schoenb., vol. 2, p. 63, pl. 245 (1797); Griseb., Fl. Brit. W. Ind., p. 47.—San Juan Mt., alt. 400 m.; *Johnston*, no. 122, July 6. A single group of this species was found growing among *Heliconia Bihai*. Distribution general in northern South America.

## ADELIA L.

*A. RICINELLA* L., Syst. nat., ed. 10, vol. 2, p. 1298 (1759), and Pl. Jam. Pugill., p. 29; Browne, Jam., pl. 36, fig. 3.—Santa Ana, *Ernst*. Further distribution, Jamaica, Cuba.

## ARGITHAMNIA Sw.

*A. CANDICANS* Sw., Prod. veg. Ind. Occ., p. 39 (1788); Griseb., Fl. Brit. W. Ind., p. 44; Juss., Euph., pl. 7.—Juan Griego and Santa Ana, *Ernst*. Further distribution, West Indies and Caribbean Ids.

A. ERUBESCENS Johnston, Proc. Amer. acad. arts and sci., vol. 40, p. 689 (1905).—El Valle, *Miller & Johnston*, no. 213, July 22; *Johnston*, no. 58, Aug. 21. Endemic. PLATE 30, figs. 4, 4a-c, 5, 5a-c.

## CROTON L.

C. CHAMAEDRIFOLIUS Lam., Encycl., vol. 2, p. 215 (1786); Griseb., Fl. Brit. W. Ind., p. 41; Muell. Arg. in Mart., Fl. Bras., vol. 11, pt. 2, p. 271; Desc., Ant., vol. 7, p. 491.—Santa Ana, *Ernst*. Further distribution, West Indies, Panama, Guiana.

C. FLAVENS L., Syst. nat., ed. 10, vol. 2, p. 1276 (1759), and Pl. Jam. Pugill., p. 28; Griseb., Fl. Brit. W. Ind., p. 38.—El Valle, *Miller & Johnston*, no. 38, July 15; *Johnston*, no. 45, Aug. 8. Further distribution, Jamaica, Trinidad, St. Thomas.

C. GLANDULOSUS L., Syst. nat., ed. 10, vol. 2, p. 1275 (1759); Griseb., Fl. Brit. W. Ind., p. 41; Muell. Arg. in Mart., Fl. Bras., vol. 11, pt. 2, p. 267; Jacq., Ic., vol. 1, p. 104; Urb., Symb. Ant., vol. 4, p. 343.—Hillside, El Valle, *Miller & Johnston*, no. 5, July 11. Further distribution, temperate and tropical America.

C. HELICOIDEUS Muell. Arg., Linnaea, vol. 34, p. 97 (1865-66).—El Valle, *Miller & Johnston*, no. 232, July 30; *Johnston*, no. 339, Aug. 8. Found also in St. Vincent.

C. LOBATUS L., Sp. pl., vol. 2, p. 1005 (1753); Griseb., Fl. Brit. W. Ind., p. 42; Muell. Arg. in Mart., Fl. Bras., vol. 11, pt. 2, p. 237; Urb., Symb. Ant., vol. 4, p. 343.—Santa Ana, *Ernst*; El Valle, *Miller & Johnston*, no. 120, July 16. Venezuela: near Bordones, HBK., Nov. gen. et sp., vol. 2, p. 90. Distribution general in tropical America.

C. MARGARITENSIS Johnston, Proc. Amer. acad. arts and sci., vol. 40, p. 689 (1905).—Among shrubs near summit of San Juan Mt., alt. 700 m., *Johnston*, no. 50, Aug. 28. Endemic. PLATE 30, figs. 3 and 3a.

C. MILLERI Johnston, Proc. Amer. acad. arts and sci., vol. 40, p. 690 (1905).—El Valle, *Miller & Johnston*, no. 229, July 18; *Johnston*, no. 48, Aug. 10. Common on the plains between El Valle and Pt. Mosquito. Endemic. PLATE 30, figs. 2, 2a-d.

C. NIVEUS Jacq., Enum. pl. Carib., p. 32 (1760); Griseb., Fl. Brit. W. Ind., p. 40.—Santa Ana, *Ernst*; El Valle, *Miller & Johnston*, no. 107, July 20. Further distribution, Jamaica, Dominica, Colombia.

C. OVALIFOLIUS Vahl in West, Bidr. Ste. Croix, p. 307 (1793);

Griseb., Fl. Brit. W. Ind., p. 41.—Santa Ana, *Ernst*; El Valle, *Miller & Johnston*, no. 199, July 14; *Johnston*, no. 46, Aug. 31. Further distribution, West Indies and Venezuela.

C. POPULIFOLIUS Mill., Gard. dict., ed. 8, no. 7 (1768), as *Populi folia*; Griseb., Fl. Brit. W. Ind., p. 41.—San Juan Mt., alt. 500 m., *Johnston*, no. 47, Aug. 28. Further distribution, West Indies.

C. PSEUDOCINA Schlecht., Linnaea, vol. 5, p. 84 (1830), as *Pseudo-China*; Griseb., Fl. Brit. W. Ind., p. 39.—Santa Ana, *Ernst*. Further distribution, tropical America.

#### EUPHORBIA L.

E. BUXIFOLIA Lam., Encycl., vol. 2, p. 421 (1786); Griseb., Fl. Brit. W. Ind., p. 53; Muell. Arg. in Mart., Fl. Bras., vol. 11, pt. 2, p. 681.—Juan Griego, *Ernst*; Pt. Mosquito, *Johnston*, no. 44, Aug. 10. Found growing on the dunes of shifting sands. Further distribution, tropical America.

E. HYPERICIFOLIA L., Sp. pl., vol. 1, p. 454 (1753); Griseb., Fl. Brit. W. Ind., p. 54; Muell. Arg. in Mart., Fl. Bras., vol. 11, pt. 2, p. 677.—El Valle, *Miller & Johnston*, no. 109, July. Var. LASIOCARPA Griseb., l. c., p. 54 (1859). *E. lasiocarpa* Klotzsch, Nov. act. nat. eur., vol. 19, suppl. 1, p. 414 (1843).—Santa Ana, *Ernst*. Venezuela: near Cumaná, HBK., Nov. gen. et sp., vol. 2, p. 56 (typical form); Loeffling, Reise nach den spanischen Ländern, p. 152-153. Common in tropical countries.

E. PETIOLARIS Sims, Bot. mag., vol. 23, pl. 883 (1806).—El Valle, *Miller & Johnston*, no. 235, July 18. Also from Island of St. Thomas.

E. PILULIFERA L., Sp. pl., vol. 1, p. 454 (1753); Griseb., Fl. Brit. W. Ind., p. 54; Muell. Arg. in Mart., Fl. Bras., vol. 11, pt. 2, p. 684.—El Valle, *Miller & Johnston*, no. 108, July. Common in tropical countries.

E. THYMIFOLIA L., Sp. pl., vol. 1, p. 454 (1753); Burm. f., Fl. Ind., p. 112; Muell. Arg. in Mart., Fl. Bras., vol. 11, pt. 2, p. 684. *E. maculata* Griseb., Fl. Brit. W. Ind., p. 53, not L.—El Valle, *Miller & Johnston*, no. 150, Aug. 9; Juan Griego, at the pond and on the seashore, *Johnston*, no. 251, Aug. 14. Widespread in tropical countries.

#### HIPPOMANE L.

H. MANCINELLA L., Sp. pl., vol. 2, p. 1191 (1753); Griseb., Fl. Brit. W. Ind., p. 50.—Juan Griego, *Ernst*; Pt. Moreno, *Johnston*, no. 261,

July 13. Venezuela: Cumaná, Loeffling, *Reise nach den spanischen Ländern*, p. 152-153. Further distribution, Cuba to Venezuela and Panama.

## HURA L.

H. CREPITANS L., Sp. pl., vol. 2, p. 1006 (1753); Griseb., Fl. Brit. W. Ind., p. 50; Muell. Arg. in Mart., Fl. Bras., vol. 11, pt. 2, p. 632.—Asunción, *Ernst*. Further distribution, Cuba, Brazil.

## JATROPHA L.

J. CURCAS L., Sp. pl., vol. 2, p. 1006 (1753); Griseb., Fl. Brit. W. Ind., p. 36; Muell. Arg. in Mart., Fl. Bras., vol. 11, pt. 2, p. 487.—Santa Ana, *Ernst*; El Valle, *Miller & Johnston*, no. 237, July 24. Venezuela: Nova Andalusia, HBK., Nov. gen. et sp., vol. 2, p. 104. Distribution general in tropics.

J. GOSSYPIFOLIA L., Sp. pl., vol. 2, p. 1006 (1753); Griseb., Fl. Brit. W. Ind., p. 36; Muell. Arg. in Mart., Fl. Bras., vol. 11, pt. 2, p. 491; Urb., *Symb. Ant.*, vol. 4, p. 350.—Santa Ana, *Ernst*; El Valle, *Miller & Johnston*, no. 27, July 11. Venezuela: near Cumaná and La Guaira, HBK., Nov. gen. et sp., vol. 2, p. 104. Distribution general in tropical America.

J. URENS L., Sp. pl.; vol. 2, p. 1007 (1753), var. *STIMULOSA* (Michx.) Muell. Arg. in DC., *Prod.*, vol. 15, pt. 2, p. 1101 (1862). *J. stimulosa* Michx., Fl., vol. 2, p. 216 (1803).—Santa Ana, *Ernst*; El Valle, *Miller & Johnston*, no. 48, July 8; *Johnston*, no. 57, Aug. 3. Venezuela: near Cumaná, HBK., Nov. gen. et sp., vol. 2, p. 106. La Guaira, *Robinson & Lyon*, July 12, 1900. Common in American tropics.

## MANIHOT Adans.

M. UTILISSIMA Pohl, Pl. Bras. Ic., vol. 1, p. 32, pl. 24 (1827); Muell. Arg. in Mart., Fl. Bras., vol. 11, pt. 2, pp. 457, 707; Urb., *Symb. Ant.*, vol. 4, p. 350. *Janipha Manihot* HBK., Nov. gen. et sp., vol. 2, p. 108 (1817); Griseb., Fl. Brit. W. Ind., p. 37.—El Valle, *Miller & Johnston*, no. 102, July 24. Widely cultivated in the hills and on the plain by Asunción. Commonly cultivated in American tropics and subtropics.

## PEDILANTHUS L.

P. TITHYMALOIDES (L.) Poit., Ann. mus. Par., vol. 19, p. 390, pl. 19 (1812); Griseb., Fl. Brit. W. Ind., p. 52. *Euphorbia tithymaloides*

L., Sp. pl., vol. 1, p. 453 (1753).— Santa Ana, *Ernst*; El Valle, *Miller & Johnston*, no. 31, July 10; *Johnston*, no. 59, July 27. Slender shrub, about 1 m. high, with red flowers. Venezuela: *Ernst*, Sobre la flora y fauna, p. 226; between Bordones and Cumaná, *HBK.*, Nov. gen. et sp., vol. 2, p. 63; La Guaira, *Robinson & Lyon*, July 6, 1900. Further distribution, West Indies.

#### PHYLLANTHUS L.

P. NIRURI L., Sp. pl., vol. 2, p. 981 (1753); Griseb., Fl. Brit. W. Ind., p. 34; Muell. Arg. in Mart., Fl. Bras., vol. 11, pt. 2, p. 53, 705.— Santa Ana, *Ernst*; Juan Griego trail, alt. 400 m., *Johnston*, no. 140, Aug. 14. Further distribution, tropical countries.

#### RICINUS L.

R. COMMUNIS L., Sp. pl., vol. 2, p. 1007 (1753); Griseb., Fl. Brit. W. Ind., p. 37; Muell. Arg. in Mart., Fl. Bras., vol. 11, pt. 2, p. 420.— Santa Ana, *Ernst*. Venezuela: Cumaná, Loeffling, Reise nach den spanischen Ländern, p. 152-153. Further distribution, tropics.

#### SEBASTIANIA Spreng.

S. CORNICULATA (Juss.) Muell. Arg. in DC., Prod., vol. 15, pt. 2, p. 1168 (1862) and in Mart., Fl. Bras., vol. 11, pt. 2, p. 551. *Microstachys corniculata* Juss., Euphorb. Tent., p. 49 (1824); Griseb., Fl. Brit. W. Ind., p. 49.— Margarita according to *Ernst*. Further distribution, Trinidad and northern South America.

#### TRAGIA L.

T. VOLUBILIS L., Sp. pl., vol. 2, p. 980 (1753); Griseb., Fl. Brit. W. Ind., p. 48; Muell. Arg. in Mart., Fl. Bras., vol. 11, pt. 2, p. 412.— Santa Ana, *Ernst*; El Valle, *Miller & Johnston*, no. 15, July 24; Juan Griego trail, *Johnston*, no. 253, July 31. Further distribution, West Indies and tropical South America.

#### GENERA EUPHORBIACEARUM ADHUC INDETERMINATA.

EUPHORBIACEA *Actinostemoni* affinis.— *Johnston*, no. 332 and 333, alt. 400 m., July 29.

EUPHORBIACEA *Argithamniae* affinis.— *Miller & Johnston*, no. 251, Aug. 3.

## ANACARDIACEAE.

## ANACARDIUM L.

*A. OCCIDENTALE* L., Sp. pl., vol. 1, p. 383 (1753); Jacq., Hist. Stirp. Am., p. 124; Griseb., Fl. Brit. W. Ind., p. 176.—Reported by Ernst. Cultivated in the Asuncion valley. Distribution general in tropical countries.

## MANGIFERA L.

*M. INDICA* L., Sp. pl., vol. 1, p. 200 (1753); Griseb., Fl. Brit. W. Ind., p. 176.—Cultivated extensively. Common to all tropical countries.

## MAURIA Kunth.

*M. HETEROPHYLLA* HBK., Nov. gen. et sp., vol. 7, p. 13, pl. 606 (1825).—Juan Griego and Santa Ana, *Ernst*. Venezuela: Colonia Tovar, *Fendler*, no. 174, 1856–57. Further distribution, Colombia and Peru.

## SPONDIAS L.

*S. LUTEA* L., Sp. pl., ed. 2, vol. 1, p. 613 (1762); Griseb., Fl. Brit. W. Ind., p. 175.—Cultivated according to Ernst. In the market place of El Valle also. Venezuela: Cumaná, Loeffling (1754), *Reise nach den spanischen Ländern*, p. 152–153. Common to all tropical countries.

## CELASTRACEAE.

## ELAEODENDRON Jacq.

*E. sp.* *Johnston*, no. 307. Related to *E. xylocarpum* DC., Prod., vol. 2, p. 11, from St. Thomas. Similar to no. 926 of P. Sintenis's *Plantae Portoricenses* (1885) determined by I. Urban. Differs in having broader leaves, which are often orbicular and very broad at the base. In general the leaves are larger than in *E. xylocarpum*.

## MYGINDA Jacq.

*M. RHACOMA* Sw., Prod. veg. Ind. Occ., p. 39 (1788); Griseb., Fl. Brit. W. Ind., p. 146.—Juan Griego, *Ernst*. Venezuela: near Laguna Chica, HBK., Nov. gen. et sp., vol. 7, p. 67. Florida, Jamaica, Cuba.

*M. sp.* San Juan Mt., alt. 600 m., *Johnston*, no. 282, Aug. 28. Allied to *M. latifolia* Sw. and *M. Grisebachii* Sarg. Leaves in this form larger than those of the others, obovate, entire, sometimes 5 cm. long and 3 cm. wide, the base often obtuse, decurrent into a short petiole, the apex rounded, obtuse or minutely retuse; flowers on the plan of four.

## SAPINDACEAE.

## CARDIOSPERMUM L.

*C. HALICACABUM* L., Sp. pl., vol. 1, p. 366 (1753); Griseb., Fl. Brit. W. Ind., p. 122; Desc., Ant., vol. 4, pl. 241.— Santa Ana, *Ernst*; El Valle, *Miller & Johnston*, no. 208, July 20, Venezuela: *Ernst*. Sobre la flora y fauna, p. 226. Common in tropical countries.

## MELICOCCA L.

*M. BIJUGA* L., Sp. pl., ed. 2, vol. 1, p. 495 (1762); Griseb., Fl. Brit. W. Ind., p. 127.— El Valle, *Miller & Johnston*, no. 128, July 18. Further distribution, tropical America.

## PAULLINIA L.

*P. CURURU* L., Sp. pl., vol. 1, p. 365 (1753); Desc., Ant., vol. 3, pl. 181.— El Valle, *Miller & Johnston*, no. 239, July 30; Tacarigua, *Johnston*, no. 66, Aug. 14. Distribution general in West Indies. Not the same as *Serjania nodosa* as claimed by some authors, for the fruit is pyriform and not at all alate.

## SAPINDUS L.

*S. SAPONARIA* L., Sp. pl., vol. 1, p. 367 (1753); Griseb., Fl. Brit. W. Ind., p. 126.— Santa Ana, *Ernst*; El Valle, *Miller & Johnston*, no. 127, July 18. Further distribution, Jamaica, and Venezuela.

## TALISIA Aubl.

*T. OLIVAEFORMIS* (HBK.) Radlk., Sitzb. math.-phys: Akad., Muench., vol. 8, p. 342 (1878). *Melicocca olivaeformis* HBK., Nov. gen. et sp., vol. 5, p. 130 (1821).— Santa Ana, *Ernst*; El Valle, alt. 300 m., *Johnston*, no. 299, July 4. Further distribution, Colombia.

## URVILLEA HBK.

*U. ULMACEA* HBK., Nov. gen. et sp., vol. 5, p. 106, pl. 440 (1821).— El Valle, *Miller & Johnston*, no. 23, July 31. Venezuela: near Caracas, HBK., *l. c.* Further distribution, tropical America.

## RHAMNACEAE.

## ZIZIPHUS Juss.

*Z. sp.*— El Valle, River trail, *Johnston*, no. 269, July 15. A tree, about 7 m. high, with wide-spreading top. Related to *Z. mexicana* Rose, Contrib. U. S. nat. herb., vol. 1, p. 315. Differs in having leaves more broadly oval, more rounded at base, and distinctly three-nerved. The margin is almost the same in each.

## VITACEAE.

## CISSUS L.

*C. SICYOIDES* L., Syst. nat., ed. 10, vol. 2, p. 897 (1759); Griseb., Fl. Brit. W. Ind., p. 102; Desc., Ant., vol. 7, pl. 481.— Santa Ana, *Ernst*; El Valle, *Miller & Johnston*, no. 244, Aug. 1. Further distribution, tropical America.

## TILIACEAE.

## CORCHORUS L.

*C. ACUTANGULUS* Lam., Encycl., vol. 2, p. 104 (1786); Wight, Ic. pl. Ind. Or., vol. 3, p. 739; Griseb., Fl. Brit. W. Ind., p. 97.— El Valle, *Miller & Johnston*, no. 97, July 11. Common to all tropical countries.

*C. HIRSUTUS* L., Sp. pl., vol. 1, p. 530 (1753); Jacq., Hort. Vind., vol. 3, pl. 57; Griseb., Fl. Brit. W. Ind., p. 97.— Juan Griego, *Ernst*. Further distribution, Antigua, Guadeloupe, Venezuela.

*C. SILIQUOSUS* L., Sp. pl., vol. 1, p. 529 (1753); Jacq., Hort. Vind., vol. 3, pl. 59; Griseb., Fl. Brit. W. Ind., p. 97.— Santa Ana, *Ernst*. Further distribution, southern United States and tropical America.

## TRIUMFETTA L.

*T. LAPPULA* L., Sp. pl., vol. 1, p. 444 (1753); Griseb., Fl. Brit. W. Ind., p. 95.— Santa Ana, *Ernst*. Venezuela: Colonia Tovar, *Fendler*, no. 1918, 1856–57. Further distribution, Mexico, West Indies Panama, and Cape Verde Ids.

## MALVACEAE.

## ABUTILON Hill.

A. CRISPUM (L.) G. Don, Gen. syst., vol. 1, p. 502 (1831); Wight, Ic. pl. Ind. Or., vol. 1, pl. 68; Griseb., Fl. Brit. W. Ind., p. 79; Schumann in Mart., Fl. Bras., vol. 12, pt. 3, p. 382. *Sida crispa* L. Sp. pl., vol. 2, p. 685 (1753).—El Valle, *Miller & Johnston*, no. 71; Juan Griego, *Johnston*, no. 271, Aug. 14. Venezuela: Colonia Tovar, *Fendler*, no. 97, 1854–55. Common in tropics.

A. UMBELLATUM (L.) Sweet, Hort. Brit., ed. 1, p. 53 (1827); Griseb., Fl. Brit. W. Ind., p. 78. *Sida umbellata* L., Syst. nat., ed. 10, vol. 2, 1145 (1759); Jacq., Hort. Vind., vol. 1, pl. 56.—El Valle, *Miller & Johnston*, no. 152, July 7. Further distribution, Jamaica, St. Thomas.

## BASTARDIA HBK.

B. VISCOSA HBK., Nov. gen. et sp., vol. 5, p. 256 (1821); Griseb., Fl. Brit. W. Ind., p. 80; Schumann in Mart., Fl. Bras., vol. 12, pt. 3, p. 360.—Asuncion, *Ernst*. Venezuela: near Cumaná, HBK., *l. c.*; Colonia Tovar, *Fendler*, no. 2543, 1856–57. Distribution, Cuba to Brazil and Peru.

## CIENFUEGOSIA Cav.

C. HETEROPHYLLA (Vent.) Garcke in Bonplandia, vol. 8, p. 150 (1860). *Redutea heterophylla* Vent., Descr. pl. jard. Cels, pl. 11 (1800).—El Valle, *Miller & Johnston*, no. 66, July 5. Further distribution, tropical America.

## GOSSYPIUM L.

G. BARBADENSE L., Sp. pl., vol. 2, p. 693 (1753); Griseb., Fl. Brit. W. Ind., p. 86; Gürke in Mart., Fl. Bras., vol. 12, pt. 3, p. 582.—El Valle, *Miller & Johnston*, no. 207, July 31. Venezuela: Cumaná, *Loefling*, 1754. Common in tropical America.

## MALVASTRUM Gray.

M. SPICATUM Gray, Mem. Amer. acad. arts and sci., n. s., vol. 4, p. 22 (1849); Griseb., Fl. Brit. W. Ind., p. 72; Schumann in Mart., Fl. Bras., vol. 12, pt. 3, p. 271.—Santa Ana, *Ernst*. Venezuela: Colonia Tovar, *Fendler*, no. 118, 1854–55. Further distribution, tropical countries.

## PAVONIA Cav.

*P. SPINIFEX* Cav., Diss., vol. 3, p. 133, pl. 45 (1787); Griseb., Fl. Brit. W. Ind., p. 82; Gürke in Mart., Fl. Bras., vol. 12, pt. 3, p. 480.— Juan Griego, *Ernst.* Venezuela: near Caripe, HBK., Nov. gen. et sp., vol. 5, p. 280. Further distribution, tropical America.

## SIDA L.

*S. ACUTA* Burm. f., Fl. Ind., p. 147 (1768); Schumann in Mart., Fl. Bras., vol. 12, pt. 3, p. 325. *S. carpinifolia* L. f., Suppl., p. 307 (1781); Griseb., Fl. Brit. W. Ind., p. 73.— Santa Ana, *Ernst.* Distribution general in tropical countries.

*S. CILIARIS* L., Syst. nat., ed. 10, vol. 2, p. 1145 (1759); Griseb., Fl. Brit. W. Ind., p. 73; Schumann in Mart., Fl. Bras., vol. 12, pt. 3, p. 283.— Santa Ana, *Ernst*; El Valle, *Miller & Johnston*, no. 209, Aug. 9. Distribution general in tropical America.

*S. RHOMBIFOLIA* L., Sp. pl., vol. 2, p. 684 (1753); Griseb., Fl. Brit. W. Ind., p. 74; Schumann in Mart., Fl. Bras., vol. 12, pt. 3, p. 337.— Santa Ana, *Ernst.* Venezuela: near Cumaná, *Loefling*, 1754; HBK., Nov. gen. et sp., vol. 5, p. 261. Found in tropical countries.

*S. SPINOSA* L., Sp. pl. 5, p. 261, vol. 2, p. 683 (1753), var. *ANGUSTIFOLIA* (Lam.) Griseb., Fl. Brit. W. Ind., p. 74 (1859); Schumann in Mart., Fl. Bras., vol. 12, pt. 3, p. 298. *S. angustifolia* Lam., Encycl., vol. 1, p. 4 (1783).— Asuncion, *Miller & Johnston*, no. 6, July 30. Found in tropical countries.

## THESPESIA Soland.

*T. POPULNEA* (L.) Soland. ex Correa in Ann. mus. Par., vol. 9, p. 290, pl. 8, fig. 2 (1807); Griseb., Fl. Brit. W. Ind., p. 87. *Hibiscus populneus* L., Sp. pl., vol. 2, p. 694 (1753).— Juan Griego, *Ernst.* Further distribution, tropical countries.

## WISSADULA Medic.

*W. PERIPLOCIFOLIA* (L.) Griseb., Cat. pl. Cuba, p. 25 (1866). *Sida periplocifolia* L., Sp. pl., vol. 2, p. 684 (1753).— El Valle, *Miller & Johnston*, no. 126, Aug. 31. Further distribution, Jamaica.

## BOMBACACEAE.

## BOMBAX L.

*B. CUMANENSE* HBK., Nov. gen. et sp., vol. 5, p. 300 (1821).— Santa Ana, *Ernst*. Venezuela: near Cumaná, HBK., *l. c.* There are several Bombax trees occurring in El Valle, but no specimens were collected.

## STERCULIACEAE.

## GUAZUMA Adans.

*G. ULMIFOLIA* Lam., Encycl., vol. 3, p. 52 (1789); Griseb., Fl. Brit. W. Ind., p. 91.— Santa Ana, *Ernst*. Distributed from Cuba to Brazil.

## HELICTERES L.

*H. BARUENSIS* Jacq., Enum. pl. Carib., p. 30 (1760), and Hist. Stirp. Am., p. 236; Schumann in Mart., Fl. Bras., vol. 12, pt. 3, p. 20.— Santa Ana, *Ernst*. Venezuela: Vargas, Flora, p. 192. Further distribution, tropical America.

## MELOCHIA L.

*M. TOMENTOSA* L., Syst. nat., ed. 10, vol. 2, p. 1140 (1759); Griseb., Fl. Brit. W. Ind., p. 93.— Santa Ana, *Ernst*; El Valle, *Miller & Johnston*, no. 44, July 5; Juan Griego trail, *Johnston*, no. 56, July 31. Shrub, 1 m. high; flowers pink or purplish. Venezuela: near Cumaná, HBK., Nov. gen. et sp., vol. 5, p. 323; Caracas, *Birschel*; Colonia Tovar, *Fendler*, no. 2289, 1856–57. Further distribution, tropical America.

## WALTHERIA L.

*W. AMERICANA* L., Sp. pl., vol. 2, p. 673 (1753); Griseb., Fl. Brit. W. Ind., p. 95.— El Valle, *Miller & Johnston*, no. 202, July 8. Venezuela: near Bordones and Cumaná, HBK., Nov. gen. et sp., vol. 5, p. 333; Colonia Tovar, *Fendler*, nos. 110 and 112, 1854–55. Widely distributed in tropical countries.

## MARCGRAVIACEAE.

## CARACASIA Szyszyl.

*C. TREMADENA* (Ernst) Szyszyl. in Engl. et Prantl, Natürl. Pflanzenfam., vol. 3, pt. 6, p. 164 (1893). *Vargasia tremadena* Ernst, Vár-

gas consid. como bot., p. 23 (1877).—Alt. 700 m., San Juan Mt., *Johnston*, no. 279, Aug. 28. A shrub, 2 m. high. Venezuela: near Caracas, *Ernst*, May, 1876.

## GUTTIFERAE.

## CLUSIA L.

*C. FLAVA* Jacq., Enum. pl. Carib., p. 34 (1760), and Hist. Stirp. Am., p. 272; Griseb., Fl. Brit. W. Ind., p. 107.—San Juan Mt., alt. 700 m., *Johnston*, no. 133, July 31. Occurs also in Jamaica.

## BIXACEAE.

## BIXA L.

*B. ORELLANA* L., Sp. pl., vol. 1, p. 512 (1753); Griseb., Fl. Brit. W. Ind., p. 20; Eichler in Mart., Fl. Bras., vol. 13, pt. 1, p. 433, pl. 87.—Santa Ana, *Ernst*; Juan Griego trail on open hillside, alt. 300 m., *Johnston*, no. 11, July 2. Shrub, 3–4 m. high.—Venezuela: Cumaná, *Loefling*, 1754. Found in tropical countries.

## VIOLACEAE.

## HYBANTHUS Jacq.

*H. oppositifolius* (L.), n. comb. *Viola oppositifolia* L., Sp. pl., ed. 2, vol. 2, p. 1327 (1763). *Ionidium oppositifolium* Roem. & Schult., Syst., vol. 5, p. 395 (1819).—El Valle, *Miller & Johnston*, no. 124, July 6. Venezuela: Colonia Tovar, *Fendler*, no. 2419, 1856–57; Cumaná, *Loefling* according to Roem. & Schult., *l. c.*

## RINOREA Aubl.

*R. marginata* (Tr. & Planch.) Rusby in herb. *Alsodeia marginata* Triana et Planchon, Ann. sci. nat., bot., ser. 4, vol. 17, p. 127 (1862).—El Valle, *Miller & Johnston*, no. 225, July 27; San Juan Mt., alt. 300 m., *Johnston*, no. 120, Aug. 28. Further distribution, Colombia.

## SAUVAGESIA L.

*S. ERECTA* L., Sp. pl., vol. 1, p. 203 (1753); Griseb., Fl. Brit. W. Ind., p. 112.—San Juan Mt., alt. 795 m., *Johnston*, no. 90, Aug. 28.

Venezuela: near Caripe and Cumanacoa, HBK., Nov. gen. et sp., vol. 5, p. 389; Colonia Tovar, *Fendler*, no. 2319, 1856-57. Distribution general in tropics.

## FLACOURTIACEAE.

## CASEARIA Jacq.

*C. PARVIFOLIA* Willd., Sp. pl., vol. 2, p. 628 (1799); Jacq., Hist. Stirp. Am., p. 127; Griseb., Fl. Brit. W. Ind., p. 23.—South Hill, El Valle, *Johnston*, no. 129, Aug. 31. Distributed from Cuba to Guiana.

*C. guianensis* (Aubl.), n. comb. *Iroucana guianensis* Aubl., Pl. Guian., vol. 1, p. 329, pl. 127 (1775). *Cascaria ramiflora* Vahl, Symb., vol. 2, p. 50 (1791); Griseb., Fl. Brit. W. Ind., p. 24.—El Valle, *Miller & Johnston*, no. 19, Aug. 5. Distributed from Cuba to Bahia.

*C. SPIRALIS* Johnston, Proc. Amer. acad. arts and sci., vol. 40, p. 691 (1905).—El Valle, River trail, *Johnston*, no. 283, Aug. 30. Endemic.

*C. SYLVESTRIS* Sw., Fl. Ind. Occ., vol. 2, p. 752 (1800).—El Valle, *Miller & Johnston*, no. 105, July 18; San Juan Mt., alt. 500 m., *Johnston*, no. 266, July 19. Further distribution, tropical America.

## XYLOSMA Forst. f.

*X. NITIDUM* (Hellen.) Gray ex Griseb., Fl. Brit. W. Ind., p. 21 (1859). *Hisingera nitida* Hellen., Vet. akad. handl. Stockh., 1792, p. 32, pl. 2 (1792).—Santa Ana, *Ernst*. Distributed in tropical America.

## TURNERACEAE.

## TURNERA L.

*T. DIFFUSA* Willd. ex Schult., Syst., vol. 6, p. 679 (1820).—El Valle, *Miller & Johnston*, no. 266, July 30, and *Johnston*, no. 288, July 15. Further distribution, Brazil, West Indies, and Central America.

*T. ULMIFOLIA* L., Sp. pl., vol. 1, p. 271 (1753).—Asuncion, *Miller & Johnston*, no. 223, July 30. Further distribution, tropical America.

## PASSIFLORACEAE.

## PASSIFLORA L.

P. FOETIDA L., Sp. pl., vol. 2, p. 959 (1753); Griseb., Fl. Brit. W. Ind., p. 294.—Santa Ana, *Ernst*; El Valle, *Miller & Johnston*, no. 85, July 9, and *Johnston*, no. 63, Aug. 3. Venezuela: Cumaná, *Loefling*, 1754; in Prov. Cumaná, in Sierra de Chacao, and near the town of Fernando de Apure, HBK., Nov. gen. et sp., vol. 2, p. 138; Colonia Tovar, *Fendler*, no. 475, 1854-55. Distribution general in tropical America.

P. LAURIFOLIA L., Sp. pl., vol. 2, p. 956 (1753); Griseb., Fl. Brit. W. Ind., p. 293.—Juan Griego trail, alt. 450 m., *Johnston*, no. 289, Aug. 12 to 15. Further distribution, tropical America.

P. MONTICOLA *Johnston*, Proc. Amer. acad. arts and sci., vol. 40, p. 692 (1905).—Climbing over low shrubs at the mountain top, alt. 700 to 795 m., San Juan Mt., *Johnston*, no. 64, July 11. Endemic.

P. NITENS *Johnston*, Proc. Amer. acad. arts and sci., vol. 40, p. 692 (1905).—El Valle, South Hill, *Johnston*, no. 65, Aug. 31. Endemic.

## CARICACEAE.

## CARICA L.

C. PAPAYA L., Sp. pl., vol. 2, p. 1036 (1753); Griseb., Fl. Brit. W. Ind., p. 290.—In Asuncion valley. Venezuela: Cumaná, *Loefling*, *Reise nach den spanischen Ländern*, p. 152-153. Cultivated in all tropical countries.

## LOASACEAE.

## MENTZELIA L.

M. ASPERA L., Sp. pl., vol. 1, p. 516 (1753); Griseb., Fl. Brit. W. Ind., p. 298.—Juan Griego, *Ernst*. Venezuela: Colonia Tovar, *Fendler*, no. 453, 1856-57. Further distribution, in tropical America.

## BEGONIACEAE.

## BEGONIA L.

B. SCANDENS Sw., Prod., p. 86 (1788).—Juan Griego trail, alt. 400 m., *Johnston*, no. 291, July 31. Further distribution, West Indies, Brazil, Peru.

## CACTACEAE.

## CEREUS Mill.

C. CARIPENSIS (HBK.) DC., Prod., vol. 3, p. 467 (1828). *Cactus caripensis* HBK., Nov. gen. et. sp., vol. 6, p. 66 (1823).—South Hill, El Valle, alt. 300 m., *Johnston*, no. 217, July 18. Further distribution, Mexico.

C. EBURNEUS Salm-Dyck, Obs. bot., p. 6 (1822).—El Valle, *Johnston*, no. 342, July 27. Further distribution, Curaçoa and Chili.

C. JAMACARU DC., Prod., vol. 3, p. 467 (1828).—Tacarigua, *Johnston*, no. 341, Aug. 15. Further distribution, Brazil.

C. MARGARITENSIS Johnston, Proc. Amer. acad. arts and sci., vol. 40, p. 693 (1905).—El Valle, on the hillside, *Johnston*, no. 344, July 27. Endemic.

C. SWARTZII Griseb., Fl. Brit. W. Ind., p. 301 (1860).—Santa Ana, *Ernst*. Found also in Jamaica.

## MAMMILLARIA Haw.

M. SIMPLEX Haw., Syn. pl. succ., p. 177 (1812); Griseb., Fl. Brit. W. Ind. p. 300.—Juan Griego, *Ernst*. Further distribution, Haiti and Venezuela.

## MELOCACTUS Link &amp; Otto.

M. COMMUNIS Link & Otto in Verh. preuss. Ver. Gartenb., vol. 3, p. 417, pl. 11 (1827); Griseb., Fl. Brit. W. Ind., p. 300.—Juan Griego, *Ernst*; El Valle, plain by sea, *Miller & Johnston*, no. 272, Aug. 3; Pt. Moreno, *Johnston*, no. 343, Aug. 10. Further distribution, West Indies.

## OPUNTIA Mill.

O. LEPTOCAULIS DC. in Mém. mus. Par., vol. 17, p. 118 (1828).—En route El Valle to San Antonio, *Johnston*, no. 340, Aug. 3. Further distribution, Mexico.

O. TUNA Mill., Gard. dict., ed. 8, no. 3 (1768); Griseb., Fl. Brit. W. Ind., p. 302.—Common everywhere on the plains and hillsides. El Valle, *Johnston*, no. 218, July 4. Common in tropical America.

## PERESKIA Mill.

P. OPUNTIAEFLOA DC. in Mém. mus. Par., vol. 17, p. 76, p. 19 (1828).—Pt. Moreno, *Johnston*, no. 216. Further distribution, Mexico.

P. SP., reported by *Ernst* at Santa Ana, is probably the above.

#### RHIPSALIS Gaertn.

R. CASSUTHA Gaertn., *Fruct.*, vol. 1, p. 137, pl. 28 (1788); Griseb., *Fl. Brit. W. Ind.*, p. 302 as *cassytha*.—El Valle, *Johnston*, no. 16. Found hanging from the branches of trees; fruit becoming white. Further distribution, tropical America.

#### THYMELAEACEAE.

##### DAPHNOPSIS Mart. & Zucc.

*D. americana* (Mill.), n. comb. *Laurus americana* Mill., *Dict.*, ed. 8, no. 10 (1768). *Daphne tinifolia* Sw., *Prod. veg. Ind. Occ.*, p. 63 (1788). *Daphnopsis tinifolia* Griseb., *Fl. Brit. W. Ind.*, p. 278 (1860).—Juan Griego trail, alt. 450 m., *Johnston*, no. 257, Aug. 14. Further distribution, Jamaica.

#### LYTHRACEAE.

##### ROOTALA L.

R. DENTIFERA (Gray) Koehne in *Engl., Bot. Jahrb.*, vol. 1, p. 161 (1881). *Ammannia dentifera* Gray, *Pl. Wright.*, vol. 2, p. 55 (1853).—Juan Griego, *Johnston*, no. 276, Aug. 14. Further distribution, Mexico.

#### RHIZOPHORACEAE.

##### RHIZOPHORA L.

R. MANGLE L., *Sp. pl.*, vol. 1, p. 443 (1753); Griseb., *Fl. Brit. W. Ind.*, p. 274.—Laguna Chica, *Johnston*, no. 246, Aug. 10, also at Pt. Piedras, and at Laguna Grande. Venezuela: *Ernst, Sobre la flora y fauna*, p. 223. Common to tropical countries.

#### MYRTACEAE.

##### MYRCIA DC.

M. CORIACEA (Vahl) DC., *Prod.*, vol. 3, p. 243 (1828); Griseb., *Fl. Brit. W. Ind.*, p. 234. *Myrtus coriacea* Vahl., *Symb.*, vol. 2, p. 59 (1791).—San Juan Mt., alt. 780 m., *Johnston*, no. 263, July 6. These

specimens differ from the typical form in having oval leaves with short blunt points, and in having narrow calyx-lobes. Further distribution, West Indies.

PSIDIUM L.

P. GUAJAVA L., Sp. pl., vol. 1, p. 470 (1753). *P. Guava* Radd. acc. to Griseb., Fl. Brit. W. Ind., p. 241 (1860).—El Valle, *Miller & Johnston*, no. 140, July 14, and *Johnston*, no. 244, July 2. Venezuela: Cumaná, Loefling Reise nach den spanischen Ländern, p. 152–153. Common to tropical countries.

COMBRETACEAE.

COMBRETUM L.

C. SECUNDUM Jacq., Enum. pl. Carib., p. 19 (1760).—Santa Ana, *Ernst*. Further distribution, Trinidad, Venezuela, Colombia, Guiana.

CONOCARPUS L.

C. ERECTUS L., Sp. pl., vol. 1, p. 176 (1753); Jacq., Hist. Stirp. Am., p. 78; Griseb., Fl. Brit. W. Ind., p. 277.—Juan Griego, *Ernst*; Laguna Chica, *Johnston*, no. 215, Aug. 10. Further distribution, tropical America and tropical Africa.

LAGUNCULARIA Gaertn.

L. RACEMOSA Gaertn. f., Fruct., vol. 3, p. 209, pl. 217, fig. 3 (1805); Griseb., Fl. Brit. W. Ind., p. 276.—Juan Griego, *Ernst*; Laguna Chica, *Johnston*, no. 247, Aug. 10. Further distribution, tropical America and tropical Africa.

QUISQUALIS L.

Q. INDICA L., Sp. pl., ed. 2, vol. 1, p. 556 (1762).—El Valle, *Miller & Johnston*, no. 91, July 29. Cultivated in Margarita from tropical Asia.

TERMINALIA L.

T. BUCERAS (L.) Wright in Sauv., Fl. Cub., p. 38 (1873). *Bucida Buceras* L., Syst. nat., ed. 10, vol. 2, p. 1025 (1759).—San Juan Mt., *Johnston*, no. 275, Aug. 28. Further distribution, tropical America.

## MELASTOMACEAE.

## BLAKEA P. Br.

B. MONTICOLA Johnston, Proc. Amer. acad. arts and sci., vol. 40, p. 693 (1905).—Abundant on the exposed top of San Juan Mt., alt. 700 to 795 m., *Johnston*, no. 51, July 6. Shrub, 1–2 m. high, branching copiously; flowers pink. Endemic. PLATE 27, fig. 1.

## CLIDEMIA D. Don.

C. NEGLECTA D. Don, Mem. Wern. soc., vol. 4, p. 307 (1823); Mart., Fl. Bras., vol. 14, pt. 4, p. 483.—El Valle, alt. 600 m., *Miller & Johnston*, no. 33, July 25. Further distribution, Peru and Brazil.

## MICONIA Ruiz &amp; Pav.

M. LAEVIGATA (L.) DC., Prod., vol. 3, p. 188 (1828). *Melastoma laevigata* L., Sp. pl., ed. 2, vol. 1, p. 559 (1762).—El Valle, *Miller & Johnston*, no. 119, July 24; San Juan Mt., alt. 600 m., *Johnston*, no. 52, July 11. Venezuela: Colonia Tovar, *Fendler*, no. 2262, 1856–57. Further distribution, tropical America.

M. PRASINA (Sw.) DC., Prod., vol. 3, p. 188 (1828). *Melastoma prasina* Sw., Fl. Ind. Occ., vol. 2, p. 777 (1800).—Juan Griego trail, alt. 450 m., *Johnston*, no. 53, Aug. 12–15. A slender tree, about 7 m. high, with small white flowers. Further distribution, tropical America.

## ONAGRACEAE.

## JUSSIAEA L.

J. SUFFRUTICOSA L., Sp. pl., vol. 1, p. 388 (1753); Griseb., Fl. Brit. W. Ind., p. 273.—Juan Griego, *Miller & Johnston*, no. 45, Aug. 9. Common to tropical countries.

## ARALIACEAE.

## GILBERTIA Ruiz &amp; Pav.

G. ARBOREA (L.) March. in Durand & Pittier, Bull. soc. bot. Belg., vol. 30, p. 281 (1891). *Aralia arborea* L., Pl. Jam. Pugill., pt. 2, p. 11, and Syst. nat., ed. 10, vol. 2, p. 967 (1759). *Dendropanax arboreum*

Dene. & Planch., Rev. hort., ser. 4, vol. 3, p. 107 (1854).— Juan Griego trail, alt. 450 m., *Johnston*, no. 112, July 31. Further distribution, tropical America. A tree, 20 m. high, with a clear trunk, which is 10 m. high and 35 cm. in diameter. Spread of foliage about 15 m.

OREOPANAX Dene. & Planch.

O. CAPITATUM (Jacq.) Dene. & Planch., Rev. hort., ser. 4, vol. 3, p. 108 (1854). *Aralia capitata* Jacq., Hist. Stirp. Am., p. 89 (1763).— Juan Griego trail, alt. 450 m., *Johnston*, no. 308, Aug. 12–15. Venezuela: Colonia Tovar, *Fendler*, nos. 1320 and 526, 1854–55; Funk & Schlim, no. 91, according to Seemann, Journ. bot., vol. 3, p. 270. Further distribution, Jamaica and Brazil.

ERICACEAE.

VACCINIUM L.

V. LATIFOLIUM B. & H. f., Gen., vol. 2, p. 575 (1876), by implication. *Thibaudia latifolia* Griseb., Fl. Brit. W. Ind., p. 143 (1859).— San Juan Mt., alt. 700 m., *Johnston*, no. 272, Aug. 28; also found on Juan Griego trail, alt. 450 m., July 31. Further distribution, Trinidad.

PLUMBAGINACEAE.

PLUMBAGO L.

P. CAPENSIS Thunb., Prod. pl. Cap., p. 33 (1794).— El Valle, in a garden, *Miller & Johnston*, no. 117, July 29. Cultivated in Margarita from South Africa.

P. SCANDENS L., Sp. pl., ed. 2, vol. 1, p. 215 (1762); Griseb., Fl. Brit. W. Ind., p. 390.— Santa Ana, *Ernst*; El Valle, *Miller & Johnston*, no. 36, July 17. Venezuela: lower Orinoco, *Rusby & Squires*, no. 68, 1896. Tropical America.

SAPOTACEAE.

ACHRAS L.

A. ZAPOTA L., Sp. pl., vol. 2, p. 1190 (1753); Jacq., Hist. Stirp. Am., p. 57, pl. 61. *Sapota Achras* Mill., Gard. dict., ed. 8, no. 1 (1768); Griseb., Fl. Brit. W. Ind., p. 399.— El Valle, *Miller & Johnston*, no.

103. Cultivated in El Valle, Asuncion, and Tacarigua. Found in tropical countries.

BUMELIA Sw.

B. CUNEATA Sw., Fl. Ind. Occ., vol. 1, p. 496 (1797); Griseb., Fl. Brit. W. Ind., p. 401; *Jacquinia petiolata* Johnston, Proc. Amer. acad. arts and sci., vol. 40, p. 693 (1905).—Pt. Mosquito, east of Laguna Chica, *Johnston*, no. 273, Aug. 10, and Coche, Aug. 5. Distribution general in West Indies.

OLEACEAE.

LINOCIERA Sw.

L. CARIBAEA (Jacq.) Knobl., Bot. Centralbl., vol. 61, p. 87 (1895). *Chionanthus caribaea* Jacq., Coll., vol. 2, p. 110 (1788). *Linociera compacta* R. Br., Prod., p. 523 (1810); Griseb., Fl. Brit. W. Ind., p. 405.—Juan Griego trail, alt. 350 m., *Johnston*, no. 136, July 2. Tree, 10 m. high. Further distribution, tropical America.

GENTIANACEAE.

COUTOUBEA Aubl.

C. DENSIFLORA Mart., Nov. gen. et sp., vol. 2, p. 111, pl. 185 (1826); Griseb., Fl. Brit. W. Ind., p. 423.—San Juan Mt., alt. 650 m., *Johnston*, no. 123, July 6. Further distribution, tropical America. Flowers white.

APOCYNACEAE.

ECHITES P. Br.

E. SECUNDFLORA A. DC. in DC., Prod., vol. 8, p. 457 (1844).—San Juan Mt., alt. 750 m., *Johnston*, no. 137, July 11. Venezuela: Colonia Tovar, *Fendler*, nos. 1033, 1034, 1854-55. Further distribution, Mexico.

E. SUBSAGITTATA Ruiz & Pav., Fl. Per., vol. 2, p. 19 (1799); Griseb., Fl. Brit. W. Ind., p. 413.—Santa Ana, *Ernst*. Further distribution, tropical America.

E. UMBELLATA Jacq., Enum. pl. Carib., p. 13 (1760), and Hist. Stirp. Am., p. 30; Griseb., Fl. Brit. W. Ind., p. 414.—Santa Ana, *Ernst*. Further distribution, West Indies.

## NERIUM L.

N. OLEANDER L., Sp. pl., vol. 1, p. 209 (1753).— El Valle, *Miller & Johnston*, no. 209, July 11. Cultivated for ornament in all warm countries.

## PLUMERIA L.

P. ALBA L., Sp. pl., vol. 1, p. 210 (1753); Griseb., Fl. Brit. W. Ind., p. 411.— Santa Ana, *Ernst*. Venezuela: near Cumaná and Caracas, HBK., Nov. gen. et sp., vol. 3, p. 230. Distributed from Cuba to the French Ids.

P. CARACASANA Johnston, Contrib. U. S. nat. herb., vol. 12, p. 108 (1908).— El Valle, *Miller & Johnston*, no. 100, July 24. Venezuela: between Caracas and La Guaira, alt. 500 m., *Fendler*, no. 1026, Aug. 16, 1855; La Guaira, *Robinson & Lyon*, July 13, 1900.

## RAUVOLFIA L.

R. LAMARKII DC., Prod., vol. 8, p. 337 (1844); Griseb., Fl. Brit. W. Ind., p. 408.— El Valle, *Miller & Johnston*, no. 43, July 5, and *Johnston*, no. 135, July 15. Further distribution, West Indies.

## TABERNAEMONTANA L.

T. AMYGDALIFOLIA Jacq., Enum. pl. Carib., p. 14 (1760); Bot. reg., vol. 4, p. 338.— El Valle, *Miller & Johnston*, no. 90, and *Johnston*, no. 68, July 1. Venezuela: Colonia Tovar, *Fendler*, no. 1029, Mar. 13, 1855. Further distribution, tropical America. Varying from a tree about 8 meters high with a trunk 1 decimeter in diameter at its base to a diffuse shrub in form.

T. PSYCHOTRIFOLIA HBK., Nov. gen. et sp., vol. 3, p. 227 (1818); Griseb., Fl. Brit. W. Ind., p. 409.— Santa Ana, *Ernst*. Venezuela: Sacupana, *Rusby & Squires*, no. 85, 1896. Further distribution, Trinidad.

## THEVETIA Adans.

T. NEREIFOLIA Juss. ex Steud., Nom., ed. 2, vol. 2, p. 680 (1841); Griseb., Fl. Brit. W. Ind., p. 407; Mart., Fl. Bras., vol. 6, pt. 1, pl. 10.— Santa Ana, *Ernst*; El Valle, garden, *Miller & Johnston*, no. 101, July 31. Distribution, tropical America.

## ASCLEPIADACEAE.

## ASCLEPIAS L.

A. CURASSAVICA L., Sp. pl., vol. 1, p. 215 (1753); Griseb., Fl. Brit. W. Ind., p. 419; Desc., Ant., vol. 2, p. 191, pl. 116.—Santa Ana, *Ernst*; El Valle, *Miller & Johnston*, no. 84, July 11. Venezuela: near Cumaná, HBK., Nov. gen. et sp., vol. 3, p. 190; Consejo, *Fendler*, no. 1037, Mar. 13, 1855; Sacupana, *Rusby & Squires*, no. 26, April, 1896. Further distribution, tropical America.

## CALOTROPIS R. Br.

C. PROCERA (Willd.) Dryand. in Ait. f., Hort. Kew., ed. 2, vol. 2, p. 78 (1811); Griseb., Fl. Brit. W. Ind., p. 420; Bot. reg., vol. 21, pl. 1792. *Asclepias procera* Willd. Sp. pl., vol. 1, p. 1263 (1798).—Juan Griego, *Ernst*; El Valle, *Miller & Johnston*, no. 252, July 6. Venezuela: La Guaira, *Fendler*, no. 1053, Aug. 16, 1855. Common in tropical countries.

## DITASSA R. Br.

D. SUBULATA Johnston, Proc. Amer. acad. arts and sci., vol. 40, p. 694 (1905).—San Juan Mt., climbing over low shrubs at the summit, alt. 740 m., *Johnston*, no. 262, July 6. Endemic.

## IBATIA Dcne.

I. MARITIMA (L.) Dcne. in DC., Prod., vol. 8, p. 599 (1844). *Cynanchum maritimum* L., Mant., p. 54 (1767); Jacq., Hist. Strip. Am., p. 83, pl. 56. *Ibatia muricata* Griseb., Fl. Brit. W. Ind., p. 421 (1861).—Juan Griego, *Ernst*. Further distribution, West Indies, Venezuela.

## MARSDENIA R. Br.

M. MACULATA Hook., Bot. mag., pl. 4299 (1847); Griseb., Fl. Brit. W. Ind., p. 422.—El Valle, *Miller & Johnston*, no. 17, July 18, and *Johnston*, no. 67, Aug. 8. A vine hanging from trees. Further distribution, Central America and Colombia.

## METASTELMA R. Br.

M. SCHLECTENDAHLLII Dcne. in DC., Prod., vol. 8, p. 513 (1844); Griseb., Fl. Brit. W. Ind., p. 417.—El Valle, *Miller & Johnston*, no. 14, July 14. Venezuela: according to *Ernst* in *Seem.*, Journ. bot., vol. 5, p. 294 (1867). Further distribution, tropical America.

## SARCOSTEMMA R. Br.

S. GLAUCA HBK., Nov. gen. et sp., vol. 3, p. 194, pl. 229 (1818).—Santa Ana, *Ernst*. Venezuela: near La Guaira, Maiqueti, and Cabo Blanco, HBK., *l. c.*

## CONVOLVULACEAE.

## CUSCUTA L.

C. AUSTRALIS R. Br., Prod., p. 491 (1810). *C. obtusiflora* HBK., Nov. gen. et sp., vol. 3, p. 122 (1818); Mart., Fl. Bras., vol. 7, p. 380, pl. 127; Griseb., Fl. Brit. W. Ind., p. 476.—Santa Ana, *Ernst*. Distributed from Florida to Peru.

## EVLVULUS L.

E. ARENICOLA Johnston, Proc. Amer. acad. arts and sci., vol. 40, p. 694 (1905).—Along the trail from Porlamar to San Antonio, *Miller & Johnston*, no. 218, Aug. 2. Endemic.

E. FILIPES Mart., Flora, vol. 24, pt. 2, Beibl., p. 100 (1841).—El Valle, *Miller & Johnston*, no. 16, Aug. 9. Further distribution, Brazil.

E. INCANUS Pers., Syn., vol. 1, p. 288 (1805). *E. sericeus* Sw., Prod. veg. Ind. Occ., p. 55 (1788); Griseb., Fl. Brit. W. Ind., p. 475.—Santa Ana, *Ernst*. Distribution general in tropical America.

E. MUCRONATUS Sw. ex Wikstr., Vet. akad. handl. Stockh., p. 61 (1827); Griseb., Fl. Brit. W. Ind., p. 475.—Santa Ana, *Ernst*. Distributed from Porto Rico to Peru.

## IPOMOEA L.

I. BATATAS Poir., Encycl., vol. 6, p. 14 (1804); Griseb., Fl. Brit. W. Ind., p. 468. Cultivated, according to Ernst. Commonly cultivated in warm climates.

I. PES-CAPRAE (L.) Sweet, Hort. suburb. Lond., p. 35 (1818); Griseb., Fl. Brit. W. Ind., p. 470. *Convolvulus pes caprae* L., Sp. pl., vol. 1, p. 159 (1753). *Ipomoea biloba* Forsk., Fl. Aegypt.-Arab., p. 44 (1775).—Juan Griego, *Ernst*. Venezuela: Colonia Tovar, *Fendler*, no. 937, 1854-55. All tropical countries.

I. CARNEA Jacq., Enum. pl. Carib., p. 13 (1760); Griseb., Fl. Brit.

W. Ind., p. 469.—El Valle, *Miller & Johnston*, no. 79, July 18, and *Johnston*, no. 80, Aug. 8, and no. 39. Further distribution, Nicaragua, Jamaica, Colombia.

I. COCCINEA L., Sp. pl., vol. 1, p. 160 (1753); Griseb., Fl. Brit. W. Ind., p. 472.—El Valle, *Miller & Johnston*, no. 75, July 19. Venezuela: Colonia Tovar, *Fendler*, nos. 933, 2075, 1854–57. Further distribution, temperate and tropical countries.

I. QUAMOCLIT L., Sp. pl., vol. 1, p. 159 (1753); Griseb., Fl. Brit. W. Ind., p. 472.—El Valle, *Miller & Johnston*, no. 76, July 12. Venezuela: near Cumanacoa and Angostura, HBK., Nov. gen. et sp., vol. 3, p. 110. Further distribution, tropical countries.

I. SINUATA Orteg., Hort. Matr. dec., 84 (1798). *I. dissecta* Pursh acc. to Griseb., Fl. Brit. W. Ind., p. 467.—Asunción, *Miller & Johnston*, no. 78, Aug. 9. Venezuela: Ernst in Seem., Journ. bot., 1867, p. 290–296. Further distribution, tropical countries.

I. TRIFIDA G. Don, Gen. syst., vol. 4, p. 280 (1838).—El Valle, *Miller & Johnston*, no. 77, July 16. Venezuela: La Victoria, *Fendler*, no. 2074B, Nov. 21, 1856. Further distribution, tropical America.

I. TUBEROSA L., Sp. pl., vol. 1, p. 160 (1753); Griseb., Fl. Brit. W. Ind., p. 467.—Santa Ana, *Ernst*. Further distribution, tropical countries.

#### JACQUEMONTIA Choisy.

J. VIOLACEA (Vahl.) Choisy in Mém. soc. phys. Genève., vol. 8, p. 61 (1838). *Convolvulus violaceus* Vahl, Symb., vol. 3, p. 29 (1794). *C. pentanthos* Jacq., Coll., vol. 4, p. 210 (1790); Griseb., Fl. Brit. W. Ind., p. 474.—El Valle, *Miller & Johnston*, no. 80, July 12. Venezuela: Ernst in Seem., Journ. bot., 1867, p. 293. Further distribution, Cuba and Mexico to Peru.

#### BORRAGINACEAE.

##### BOURRERIA P. Br.

B. EXSUCCA Jacq., Enum. pl. Carib., p. 14 (1760); Griseb., Fl. Brit. W. Ind., p. 482.—Santa Ana, *Ernst*; El Valle, *Miller & Johnston*, no. 10, July 8, and *Johnston*, no. 86, July 15. A slender tree, 3 to 4 m. high. Further distribution, St. Vincent, Colombia, Venezuela.

##### CORDIA L.

C. ALBA (Jacq.) Roem. & Schult., Syst., vol. 4, p. 466 (1819); Griseb., Fl. Brit. W. Ind., p. 478. *Varronia alba* Jacq., Hist. Stirp.

Am., p. 41 (1763).— El Valle, *Miller & Johnston*, no. 72, July 6, and *Johnston*, no. 87, July 24. Venezuela: Ernst, *Sobre la flora y fauna*, p. 227; La Guaira, *Fendler*, no. 921, Aug. 16, 1855. A slender tree, 5 m. high. Further distribution, tropical America.

C. CYLINDRISTACHYA (Ruiz & Pav.) Roem. & Schult., *Syst.*, vol. 4, p. 459 (1819); Griseb., *Fl. Brit. W. Ind.*, p. 480. *Varronia cylindrostachya* Ruiz & Pav., *Fl. Peruv.*, vol. 2, p. 23, pl. 147 (1799).— Juan Griego, Santa Ana, *Ernst*; El Valle, *Miller & Johnston*, no. 26, July 4, and *Johnston*, no. 85, July 15. Further distribution, Lower California, West Indies to Uruguay.

C. DISCOLOR Cham., *Linnaea*, vol. 4, p. 482 (1829).— San Juan Mt., alt. 570 m., *Johnston*, no. 296, July 19. Leaves narrower than in the typical specimen. Further distribution, Brazil and Bolivia.

C. GERASCANTHUS Jacq., *Hist. Stirp. Am.*, p. 43, pl. 175 (1763); Griseb., *Fl. Brit. W. Ind.*, p. 478.— Santa Ana, *Ernst*. Venezuela: Colonia Tovar, *Fendler*, no. 2054, 1856–57. Further distribution, West Indies, Guatemala to Brazil.

C. GLOBOSA (Jacq.) HBK., *Nov. gen. et sp.*, vol. 3, p. 76 (1818); Griseb., *Fl. Brit. W. Ind.*, p. 481. *Varronia globosa* Jacq., *Enum. pl. Carib.*, p. 14 (1760).— El Valle, *Miller & Johnston*, no. 221, July 18; Asuncion, *Johnston*, no. 84, July 9. Slender bush, 2–3 m. high. Venezuela: Ernst, *Sobre la flora y fauna*, p. 227. Further distribution, tropical America.

C. RETICULATA Vahl, *Eclog. Am.*, vol. 3, p. 5 (1807); Griseb., *Fl. Brit. W. Ind.*, p. 479.— Juan Griego, *Ernst*. Further distribution, West Indies, Venezuela.

C. SEBESTENA L., *Sp. pl.*, vol. 1, p. 190 (1753); Griseb., *Fl. Brit. W. Ind.*, p. 478; Jacq., *Hist. Stirp. Am.*, p. 42.— Juan Griego, *Ernst*; El Valle, *Miller & Johnston*, no. 219, July 26. Further distribution, West Indies to Guiana and Colombia.

#### HELIOTROPIMUM L.

H. CURASSAVICUM L., *Sp. pl.*, vol. 1, p. 130 (1753); Griseb., *Fl. Brit. W. Ind.*, p. 486.— Juan Griego, *Ernst*. Venezuela: Tortuga, Ernst in *Seem.*, *Journ. bot.*, vol. 14, p. 179 (1876). Common to tropical countries.

H. FILIFORME HBK., *Nov. gen. et sp.*, vol. 3, p. 86, pl. 204 (1818); Griseb., *Fl. Brit. W. Ind.*, p. 486.— El Valle, *Miller & Johnston*, no. 148, Aug. 8; Juan Griego, *Johnston*, no. 331, Aug. 14. Venezuela: at Rio Apure, between the towns of El Diamante and San Fernando,

HBK., Nov. gen. et sp., vol. 3, p. 86. Further distribution, American tropics.

H. INDICUM L., Sp. pl., vol. 1, p. 130 (1753); Griseb., Fl. Brit. W. Ind., p. 485.— Juan Griego, Santa Ana, Asuncion, *Ernst*; El Valle, *Miller & Johnston*, no. 206, July 5, and *Johnston*, no. 49, July 15. Found in all tropical countries.

H. PARVIFLORUM L., Mant., vol. 2, p. 201 (1771); Griseb., Fl. Brit. W. Ind., p. 485.— El Valle, *Miller & Johnston*, no. 32, July 7, and *Johnston*, no. 93, Aug. 8; also found at Juan Griego. Further distribution, tropical America.

#### TOURNEFORTIA L.

T. GNAPHALODES R. Br., Prod., p. 496 (1810), by implication; Griseb., Fl. Brit. W. Ind., p. 483.— Juan Griego, *Ernst*; Pt. Moreno, *Johnston*, no. 105, July 8. Further distribution, Florida, Bahamas, West Indies. A shrub, 0.5–1 m. high, growing in the loose sand near the sea.

T. HIRSUTISSIMA L., Sp. pl., vol. 1, p. 140 (1753); Griseb., Fl. Brit. W. Ind., p. 483.— El Valle, *Miller & Johnston*, no. 47. Venezuela: near Cumaná and Bordones, HBK., Nov. gen. et sp., vol. 3, p. 80. Further distribution, tropical America.

T. INCANA Lam., Illust., vol. 1, p. 417 (1791); Griseb., Fl. Brit. W. Ind., p. 485.— Santa Ana, *Ernst*. Further distribution, Cuba, Haiti.

T. SCANDENS Mill., Gard. dict., ed. 8, no. 4 (1768).— El Valle, *Miller & Johnston*, no. 2, Aug. 2, and no. 249, July 20, and *Johnston*, no. 254, July 27. Further distribution, Jamaica.

T. VOLUBILIS L., Sp. pl., vol. 1, p. 140 (1753); Griseb., Fl. Brit. W. Ind., p. 484.— Santa Ana, *Ernst*. Further distribution, tropical America.

T. sp. Shrubby; leaves oval, entire, glabrous on upper side, pilose on lower side, with acuminate apex and rounded unequal base, 4 cm. wide and 8 cm. long, and smaller; petiole 5 to 10 mm. long; inflorescence cymose, reddish-pubescent; calyx-lobes narrowly acute.— El Valle to San Juan, *Johnston*, no. 83, July 11.

#### VERBENACEAE.

##### AVICENNIA L.

A. NITIDA Jacq., Enum. pl. Carib., p. 25 (1760), and Jacq., Hist. Stirp. Am., p. 177.— Pt. Mosquito, *Johnston*, no. 139, Aug. 10.

Venezuela: Ernst, *Sobre la flora y fauna*, p. 223. Further distribution, Cuba to Brazil, tropical Africa.

BOUCHEA Cham.

B. EHRENBERGII Cham. in *Linnaea*, vol. 7, p. 253 (1832); Griseb., *Fl. Brit. W. Ind.*, p. 493.—El Valle, *Miller & Johnston*, no. 205, July 20. Venezuela: La Guaira according to Schauer, *Linnaea*, vol. 20, p. 478. Further distribution, tropical America.

CITHAREXYLUM Mill.

C. QUADRANGULARE Jacq., *Enum. pl. Carib.*, p. 26 (1760); Griseb., *Fl. Brit. W. Ind.*, p. 497; Jacq., *Hort. Vind.*, vol. 1, pl. 22.—Santa Ana, *Ernst*. Further distribution, West Indies, Guiana.

CLERODENDRON L.

C. MOLLE HBK., *Nov. gen. et sp.*, vol. 2, p. 244 (1817).—El Valle, *Miller & Johnston*, no. 8, July 30; en route El Valle to Asuncion, *Johnston*, no. 82, July 9. A form with small flowers, especially a small calyx. Short spines occur in some axils. Further distribution, Peru and Galapagos Ids.

DURANTA L.

D. PLUMIERI Jacq., *Hist. Stirp. Am.*, p. 186, pl. 176, fig. 76 (1763); Griseb., *Fl. Brit. W. Ind.*, p. 498.—Santa Ana, *Ernst*; El Valle, *Miller & Johnston*, no. 115, July 15. Venezuela: Cumaná, *Moritz*, no. 424, according to Schauer, *Linnaea*, vol. 20, p. 482. Further distribution, tropical America.

LANTANA L.

L. CAMARA L., *Sp. pl.*, vol. 2, p. 627 (1753); Griseb., *Fl. Brit. W. Ind.*, p. 495; Desc., *Ant.*, vol. 4, p. 330, pl. 304.—Santa Ana, *Ernst*; El Valle, *Miller & Johnston*, no. 95, July 6. Venezuela: Caracas and Valencia, *Moritz*, according to Schauer, *Linnaea*, vol. 20, p. 481; Colonia Tovar, *Fendler*, no. 860 (in part), Jan. 31, Feb. 23, 1854; Sacupana, *Rusby & Squires*, no. 4; Paloma, *Rusby & Squires*, no. 312; Caracas, *A. II. Moore*, Mar. 16, 1899; San Julian, *Robinson & Lyon*, July 17, 1900. Distribution general in tropical America.

L. LILACINA Desf., *Cat. hort. Par.*, ed. 3, p. 392 (1829); Schauer in *Mart.*, *Fl. Bras.*, vol. 9, p. 261, pl. 44, fig. 1. *L. stricta*, var. *lilacina*

Griseb., Fl. Brit. W. Ind., p. 496 (1861).— El Valle, *Miller & Johnston*, no. 94. Venezuela: Caracas, *Moritz*, according to Schauer, *Linnaea*, vol. 20, p. 481. Distributed from Mexico to Brazil.

L. RETICULATA Pers., Syn., vol. 2, p. 141 (1807); Griseb., Fl. Brit. W. Ind., p. 496; Ernst, Bot. Excurs. Margarita, p. 7. *L. Sellowiana* Link & Otto, Ic. pl. sel. Berol., p. 107, pl. 50 (1828).— Santa Ana, *Ernst*. Further distribution, West Indies, Venezuela.

L. TRIFOLIA L., Sp. pl., vol. 2, p. 626 (1753); Griseb., Fl. Brit. W. Ind., p. 496.— Santa Ana, *Ernst*. Venezuela: Aragua, *E. Otto & Moritz*, according to Schauer, *Linnaea*, vol. 20, p. 481. Further distribution, tropical America.

#### LIPPIA L.

L. GEMINATA HBK., Nov. gen. et sp., vol. 2, p. 266 (1817); Griseb., Fl. Brit. W. Ind., p. 495.— Santa Ana, *Ernst*; El Valle, *Miller & Johnston*, no. 125, Aug. 16, and *Johnston*, no. 81, Aug. 8. Further distribution, tropical America. A spreading bush, 1 m. high.

L. MICROMERA Schauer in DC., Prod., vol. 11, p. 587 (1847); Griseb., Fl. Brit. W. Ind., p. 495.— Juan Griego, *Ernst*. Venezuela: Angostura, *Moritz*, according to Schauer, *Linnaea*, vol. 20, p. 480. Distributed from West Indies to Guiana.

#### PRIVA Adans.

P. LAPPULACEA (L.) Pers., Syn., vol. 2, p. 139 (1807). *P. echinata* JUSS., Ann. mus. Par., vol. 7, p. 69 (1806); Griseb., Fl. Brit. W. Ind., p. 493. *Verbena lappulacea* L., Sp. pl., vol. 1, p. 19 (1753).— Santa Ana, *Ernst*; El Valle, *Miller & Johnston*, no. 96, July 9. Further distribution, tropical America.

#### STACHYTARPHETA Vahl.

S. CAJANENSIS Vahl, Enum., vol. 1, p. 208 (1804); Griseb., Fl. Brit. W. Ind., p. 494.— Santa Ana, *Ernst*; El Valle, *Miller & Johnston*, no. 93, July 6, and *Johnston*, no. 92, Aug. 8. Venezuela: near Cumaná. Bordones, and Caripe, HBK., Nov. gen. et sp., vol. 2, p. 280; Guayre River, *Moritz*, and Orinoco, *S. Ayres*, according to Schauer, *Linnaea*, vol. 20, p. 478. Further distribution, tropical America.

S. JAMAICENSIS (L.) Vahl, Enum., vol. 1, p. 206 (1804); Griseb., Fl. Brit. W. Ind., p. 494. *Verbena jamaicensis* L., Sp. pl., vol. 1, p. 19 (1753). *S. indica* Vahl, Enum., vol. 1, p. 206 (1804); Griseb.,

Fl. Brit. W. Ind., p. 494. *Verbena indica* L., Sp. pl., ed. 2, vol. 1, p. 27 (1762).—El Valle, *Miller & Johnston*, no. 92, July 5. Venezuela: near Cumaná, HBK., Nov. gen. et sp., vol. 2, p. 279. Further distribution, tropical countries.

## LABIATAE.

## COLEUS Lour.

C. AMBOINICUS Lour., Fl. Cochinch., vol. 2, p. 372 (1790); Griseb., Fl. Brit. W. Ind., p. 487. *Plectranthus aromaticus* Roxb., Hort. Bengal., p. 45 (1814). *C. aromaticus* Benth. in Wallich, Pl. As. rar., vol. 2, p. 15 (1831); Bot. reg., vol. 18, pl. 1520.—Santa Ana, *Ernst*. Introduced into the West Indies from the East Indies.

## HYPTIS Jacq.

H. CAPITATA Jacq., Coll., vol. 1, p. 102 (1786), and Ic. rar., vol. 1, pl. 114; Griseb., Fl. Brit. W. Ind., p. 488.—Santa Ana, *Ernst*. Further distribution, tropical America, Manila.

H. PECTINATA (L.) Poit., Ann. mus. Par., vol. 7, p. 474, pl. 30 (1806); Griseb., Fl. Brit. W. Ind., p. 489. *Nepeta pectinata* L., Syst. nat., ed. 10, vol. 2, p. 1097 (1759).—El Valle, *Miller & Johnston*, no. 110, July 24. Further distribution, tropical America, East Indies.

## LEONOTIS R. Br.

L. NEPETIFOLIA R. Br. in Ait. f., Hort. Kew., ed. 2, vol. 3, p. 409 (1811); Griseb., Fl. Brit. W. Ind., p. 492.—Santa Ana, *Ernst*; El Valle, *Miller & Johnston*, no. 74, July 19. Common in tropical countries.

## SALVIA L.

S. COCCINEA Juss. ex Murr., Comm. Goetting., vol. 1, p. 86, pl. 1 (1778); Griseb., Fl. Brit. W. Ind., p. 490.—Santa Ana, *Ernst*. Further distribution, tropical America.

S. OCCIDENTALIS Sw., Prod. veg. Ind. Occ., p. 14 (1788); Griseb., Fl. Brit. W. Ind., p. 490.—Santa Ana, *Ernst*. Further distribution, tropical America.

S. TILIAEFOLIA Vahl, Symb. bot., vol. 3, p. 7 (1794).—Santa Ana, *Ernst*. Venezuela: valley of Caracas, HBK., Nov. gen. et sp., vol. 2, p. 299 (as *S. fimbriata*). Further distribution, Mexico.

## SOLANACEAE.

## BASSOVIA Aubl.

*B. CILIATA* Johnston, Proc. Amer. acad. arts and sci., vol. 40, p. 694 (1905).—El Valle, River trail, *Miller & Johnston*, no. 255, July 15, and *Johnston*, no. 75, Aug. 30.

## BRACHISTUS Miers.

*B. PRINGLEI* Wats., Proc. Amer. acad. arts and sci., vol. 25, p. 159 (1890).—El Valle, *Miller & Johnston*, no. 35, July 27. Further distribution, Mexico, Central America, and Colombia.

## BRUNFELSIA L.

*B. HOPEANA* (Hook.) Benth. in DC., Prod., vol. 10, p. 200 (1846); Griseb., Fl. Brit. W. Ind., p. 432; Mart., Fl. Bras., vol. 8, pt. 1, p. 261, pl. 43. *Franciscea Hopeana* Hook., Bot. mag., pl. 2829 (1828).—El Valle, *Miller & Johnston*, no. 265, Aug. 2, and *Johnston*, no. 71, Aug. 31 on South Hill. Further distribution, Trinidad, Brazil.

## CAPSICUM L.

*C. ANNUM* L., Sp. pl., vol. 1, p. 188 (1753); Desc., Ant., vol. 6, p. 172, pl. 422.—El Valle, *Miller & Johnston*, no. 81, July 24. Venezuela: Cumaná, Loeffling, Reise nach den spanischen Ländern, p. 152–153. All tropical countries.

*C. BACCATUM* L., Mant., vol. 1, p. 47 (1767); Griseb., Fl. Brit. W. Ind., p. 436; Desc., Ant., vol. 6, p. 177, pl. 423.—El Valle, *Miller & Johnston*, no. 82, July 12. Venezuela: between Cumaná and Bordones, HBK., Nov. gen. et sp., vol. 3, p. 49. Found in all tropical countries.

*C. FRUTESCENS* L., Sp. pl., vol. 1, p. 189 (1753); Griseb., Fl. Brit. W. Ind., p. 436; Lam., Encycl., pl. 116.—Cultivated, according to Ernst. Venezuela: near Bordones, HBK., Nov. gen. et sp., vol. 3, p. 48. Found in all tropical countries.

## CESTRUM L.

*C. VESPERTINUM* L., Mant., vol. 2, p. 206 (1771); Griseb., Fl. Brit. W. Ind., p. 443; Jacq., Hort. Schoenbr., vol. 3, pl. 328.—River trail, El Valle, *Johnston*, no. 285, Aug. 30. Further distribution, West Indies to Panama, Peru, and Brazil.

## DATURA L.

D. METEL L., Sp. pl., vol. 1, p. 179 (1753); Griseb., Fl. Brit. W. Ind., p. 434; Bot. mag., vol. 35, pl. 1440.—El Valle, *Miller & Johnston*, no. 83, July 30. Further distribution, tropical America, tropical Africa, Spain.

D. TATULA L., Sp. pl., ed. 2, vol. 1, p. 256 (1762); Griseb., Fl. Brit. W. Ind., p. 434; Sweet, Brit. fl. gard., vol. 1, pl. 83.—Santa Ana, *Ernst*. Further distribution, tropical and temperate countries.

## LYCIUM L.

L. SALSUM Ruiz & Pav., Fl. Per., vol. 2, p. 46, pl. 183 (1799).—El Valle, *Miller & Johnston*, no. 153, July 31, and *Johnston*, no. 61, Aug. 3. Further distribution, Peru.

## LYCOPERSICUM Hill.

L. HUMBOLDTII (Willd.) Dunal, Solan., p. 112 (1813); Griseb., Fl. Brit. W. Ind., p. 436. *Solanum Humboldtii* Willd., Hort. Berol., p. 27, pl. 27 (1804).—Cultivated, according to Ernst. Distributed from Mexico to Brazil.

## NICOTIANA L.

N. TABACUM L., Sp. pl., vol. 1, p. 180 (1753); Griseb., Fl. Brit. W. Ind., p. 434.—Cultivated. Widely grown in temperate and tropical countries.

## PHYSALIS L.

P. PERUVIANA L., Sp. pl., ed. 2, vol. 2, p. 1670 (1763); Griseb., Fl. Brit. W. Ind., p. 435.—Santa Ana, *Ernst*. Widely distributed in temperate and tropical countries.

## SOLANUM L.

S. ACULEATISSIMUM Jacq., Coll., vol. 1, p. 100 (1786); Griseb., Fl. Brit. W. Ind., p. 442.—Santa Ana, *Ernst*. Further distribution, tropical America.

S. HIRTUM Vahl, Symb. bot., vol. 2, p. 40 (1791).—Santa Ana *Ernst*.

S. LANCEAEFOLIUM Jacq., Coll., vol. 2, p. 286 (1788).—San Juan Mt., alt. 790 m., *Johnston*, no. 69, July 6. Slender shrub, ascending, 1–1.5 m. high. Further distribution, West Indies, Venezuela.

*S. MARGARITENSE* Johnston, Proc. Amer. acad. arts and sci., vol. 40, p. 695 (1905).—El Valle, a single ascending stem branching copiously near the top, found at the side of the River trail, *Johnston*, no. 315, Aug. 20. PLATE 29, fig. 2.

*S. NIGRUM* L., Sp. pl., vol. 1, p. 186 (1753). *S. nodiflorum* Jacq., Ic. pl. rar., vol. 2, p. 11, pl. 326 (1781); Griseb., Fl. Brit. W. Ind., p. 437.—Santa Ana, *Ernst*; El Valle, *Johnston*, no. 73, July 16. Venezuela: Cumaná, Loefling, Reise nach den spanischen Ländern, p. 152–153. A low herb, about 5 dm. high. Temperate and tropical countries.

*S. POLYGAMUM*, Vahl, Symb. bot., vol. 3, p. 39, pl. 55 (1794); Griseb., Fl. Brit. W. Ind., p. 442.—El Valle, *Miller & Johnston*, no. 143, July 18. Further distribution, Trinidad, St. Thomas, St. Croix.

*S. SEAFORTHIANUM* Andr., Bot. rep., vol. 8, pl. 504 (1799–1811).—El Valle, *Miller & Johnston*, no. 104, July 18. Further distribution, tropical America.

*S. TRISTE*, Jacq., Enum. pl. Carib., p. 15 (1760); Griseb., Fl. Brit. W. Ind., p. 437.—Juan Griego trail, alt. 450 m., *Johnston*, no. 70, July 22. Venezuela: near Cumanacoa and Guanaguana, HBK., Nov. gen. et sp., vol. 3, p. 34. Further distribution, tropical America.

*S. VERBASCIFOLIUM* L., Sp. pl., vol. 1, p. 184 (1753); Griseb., Fl. Brit. W. Ind., p. 438.—Santa Ana, *Ernst*; El Valle, *Miller & Johnston*, no. 222, and *Johnston*, no. 74, July 15. Venezuela: near Cumaná, HBK., Nov. gen. et sp., vol. 3, p. 30; Ernst in Scemann's Journ. bot., vol. 3, p. 319. Further distribution, tropical America to East Indies. A low shrub, about 1 m. high.

*S. UMBRATILE* Johnston, Proc. Amer. acad. arts and sci., vol. 40, p. 695 (1905).—Rio Asuncion, in the heavy woods along the trail to Juan Griego, *Johnston*, no. 321, July 22.

## SCROPHULARIACEAE.

### BEYRICHIA Cham. & Schlecht.

*B. SCUTELLARIOIDES* Benth., Scroph. Ind., p. 9 (1835), in note; Griseb., Fl. Brit. W. Ind., p. 429; Mart., Fl. Bras., vol. 8, pt. 1, pl. 50, fig. 2.—Santa Ana, *Ernst*. Further distribution, Trinidad, Venezuela, Brazil.

### CAPRARIA L.

*C. BIFLORA* L., Sp. pl., vol. 2, p. 628 (1753); Griseb., Fl. Brit. W. Ind., p. 427; Desc., Ant., vol. 4, p. 313, pl. 300.—Santa Ana, *Ernst*,

reported as *C. mexicana*; El Valle, *Miller & Johnston*, no. 41, July 30, and *Johnston*, no. 265, Aug. 8. Venezuela: near Cumaná, HBK., Nov. gen. et sp., vol. 2, p. 354. Further distribution, tropical America and tropical Africa.

#### ILYSANTHES Rafin.

I. RIPARIA Rafin., Ann. nat., p. 13 (1820).—Juan Griego, *Johnston*, no. 125, Aug. 14. Further distribution, tropical America.

#### SCOPARIA L.

S. DULCIS L., Sp. pl., vol. 1, p. 116 (1753); Griseb., Fl. Brit. W. Ind., p. 427.—Juan Griego, *Ernst*; El Valle, *Miller & Johnston*, no. 144, Aug. 11. Venezuela: between Caracas and Bordones, HBK., Nov. gen. et sp., vol. 2, p. 354; Cumaná, Loeffling, Reise nach den spanischen Ländern, p. 152–153. Further distribution, tropical countries.

### BIGNONIACEAE.

#### BIGNONIA L.

B. ACUMINATA Johnston, Proc. Amer. acad. arts and sci., vol. 40, p. 696 (1905).—El Valle, *Johnston*, no. 345. Endemic. PLATE 29, figs. 1, 1a, 1b.

B. AEQUINOCTIALIS L., Sp. pl., vol. 2, p. 623 (1753); Griseb., Fl. Brit. W. Ind., p. 448; Plum., Ic. Burm., pl. 55.—El Valle, *Johnston*, no. 78, Aug. 8. Further distribution, tropical America. A vine or sprawling shrub.

B. SP.—El Valle, *Miller & Johnston*, no. 154, Aug. 6. Leaves trifoliolate, glabrous, smooth; calyx cupulate; margin undulate, shortly 5-parted; corolla purple, 5-lobed, slightly 2-lipped, about 2.5 cm. long.

B. SP.—El Valle, *Johnston*, no. 77, Aug. 15. Calyx cupulate, with 5 procurent short teeth; corolla purple, 5-lobed, slightly 2-lipped, 3–5 cm. long.

#### CRESCENTIA L.

C. CUJETE L., Sp. pl., vol. 2, p. 626 (1753); Jacq., Hist. Stirp. Am., p. 175; Griseb., Fl. Brit. W. Ind., p. 445.—Santa Ana, *Ernst*; El Valle, *Johnston*, no. 248. A tree, about 4 m. high, with wide-spreading top and trunk 2.5 dm. in diameter at the base. Common to tropical America.

## MACFADYENA A. DC.

M. CORYMBOSA Griseb., *Bouplandia*, vol. 6, p. 10 (1858).—El Valle, *Johnston*, no. 255, July 24. Distributed from Panama to equatorial Brazil.

## TABEBUIA Gom.

T. RUFESCENS Johnston, *Proc. Amer. acad. arts and sci.*, vol. 40, p. 696 (1905).—San Juan Mt., alt. 500 m., *Johnston*, no. 79, July 2. Endemic.

## TECOMA Juss.

T. STANS (L.) Juss., *Gen.*, p. 139 (1789); Griseb., *Fl. Brit. W. Ind.*, p. 447. *Bignonia stans* L., *Sp. pl.*, ed. 2, vol. 2, p. 871 (1762).—El Valle, *Miller & Johnston*, no. 220, July 18, and *Johnston*, no. 76, July 24. Venezuela: Mt. Cocollar, HBK., *Nov. gen. et sp.*, vol. 3, p. 144. Further distribution, Mexico and West Indies.

## MARTYNIACEAE.

## CRANIOLARIA L.

C. ANNUA L., *Sp. pl.*, vol. 2, p. 618 (1753); Jacq., *Hist. Stirp. Am.*, p. 173; Griseb., *Fl. Brit. W. Ind.*, p. 466.—El Valle, *Miller & Johnston*, no. 89, July 12. Venezuela: Ernst, *Sobre la flora y fauna*, p. 227; llanos of New Barcelona, HBK., *Nov. gen. et sp.*, vol. 3, p. 153. Distribution, New Mexico to Venezuela.

## GESNERIACEAE.

## DRYMONIA Mart.

D. SERRULATA (Jacq.) Mart., *Nov. gen. et sp.*, vol. 3, p. 59 (1829). *D. bicolor* Lindl., *Bot. reg.*, vol. 24, pl. 4 (1838). *Besleria serrulata* Jacq., *Hort. Schoenb.*, vol. 3, p. 21 (1798).—Rio Asuncion, alt. 400–500 m., *Johnston*, no. 278, Aug. 12–15. Found in the West Indies.

## LENTIBULARIACEAE.

## UTRICULARIA L.

U. ALPINA Jacq., *Enum. pl. Carib.*, p. 11 (1760). *U. montana* Jacq., *Hist. Stirp. Am.*, p. 7, pl. 6 (1763); Griseb., *Fl. Brit. W. Ind.*,

p. 390.—San Juan Mt., alt. 600 m., *Miller & Johnston*, no. 271, Aug. 2, and *Johnston*, no. 223, July 2. Further distribution, tropical America.

## ACANTHACEAE.

## DIANTHERA L.

D. SECUNDA (Vahl) Griseb., *Goett. Abh.*, vol. 7, p. 246 (1857). *Justicia secunda* Vahl, *Symb. bot.*, vol. 2, p. 7 (1791).—San Juan Mt., alt. 795 m., *Johnston*, no. 89, July 2. Further distribution, tropical America.

## JACOBINIA Moric.

J. PAUCIFLORA (Nees) Benth. & Hook. f., *Gen.*, vol. 2, p. 1115 (1876). *Sericographis pauciflora* Nees in *Mart., Fl. Bras.*, vol. 9, p. 110 (1847).—South Hill, El Valle, alt. 300 m., *Johnston*, no. 19, July 27. Further distribution, Brazil.

## RUELLIA L.

R. TUBEROSA L., *Sp. pl.*, vol. 1, p. 635 (1753); Griseb., *Fl. Brit. W. Ind.*, p. 452.—El Valle, *Miller & Johnston*, no. 88, July 12. Venezuela: Colonia Tovar, *Fendler*, no. 799, Aug. 16, 1855. Further distribution, tropical America.

## SIPHONOGLOSSA Oerst.

S. PILOSELLA (Nees) Torr., *Bot. Mex. bound.*, p. 124 (1859). *Monochma Pilosella* Nees in *DC., Prod.*, vol. 11, p. 412 (1847).—El Valle, *Miller & Johnston*, no. 227, July 26. Further distribution, Texas, Mexico, and St. Thomas.

## RUBIACEAE.

## BASANACANTHA Hook. f.

B. TETRACANTHA (Cav.) Hook. f. in Benth. & Hook. f., *Gen.*, vol. 2, p. 83 (1873). *Mussaenda tetraantha* Cav., *l.c.*, vol. 5, p. 20, pl. 435 (1799).—Santa Ana, *Ernst*. American tropics.

## CEPHAELIS Sw.

C. MUSCOSA (Jacq.) Sw., *Prod. veg. Ind. Occ.*, p. 46 (1788); Griseb., *Fl. Brit. W. Ind.*, p. 347. *Morinda muscosa* Jacq., *Hist. Stirp. Am.*,

p. 65, pl. 45 (1763).—San Juan Mt., alt. 500 m., *Johnston*, no. 113, July 11. Further distribution, West Indies, Guiana to Brazil. A slender shrub, 0.5–1 m. high.

#### CHIOCOCCA P. Br.

*C. MICRANTHA* Johnston, Proc. Amer. acad. arts and sci., vol. 40, p. 696 (1905).—San Juan Mt., in woods above South Hill, alt. 400 m., *Johnston*, no. 115, July 27. Endemic. PLATE 29, figs. 3, 3a, 3b, 3c.

*C. RACEMOSA* Jacq., Hist. Stirp. Am., p. 68 (1763); Griseb., Fl. Brit. W. Ind., p. 336.—El Valle, *Miller & Johnston*, no. 42, July 15, on bank of the River trail; Tacarigua, *Johnston*, no. 119, Aug. 15. Widely distributed in tropical America.

#### CHÔMELIA Jacq.

*C. SPINOSA* Jacq., Enum. pl. Carib., p. 12 (1760), & Hist. Stirp. Am., p. 18.—Santa Ana, *Ernst*.

#### COUTAREA Aubl.

*C. hexandra* (Jacq.), n. comb. *Portlandia hexandra* Jacq., Hist. Stirp. Am., p. 63, pl. 182, fig. 20 (1763). *Coutarea speciosa* Aubl., Pl. Guian., vol. 1, p. 314, pl. 122 (1775); Griseb., Fl. Brit. W. Ind., p. 323.—Santa Ana, *Ernst*. Widely distributed in tropical America.

#### DIODIA L.

*D. RIGIDA* (HBK.) Cham. & Schlecht., Linnaea, vol. 3, p. 341 (1828); Griseb., Fl. Brit. W. Ind., p. 348. *Spermacoce rigida* HBK., Nov. gen. et sp., vol. 3, p. 342 (1818).—Santa Ana, *Ernst*. Further distribution, West Indies to Paraguay.

#### ERITHALIS P. Br.

*E. FRUTICOSA* L., Syst. nat., ed. 10, vol. 2, p. 930 (1759); Griseb. Fl. Brit. W. Ind., p. 336.—Juan Griego, *Ernst*. Further distribution, tropical America.

#### GONZALAGUNIA Ruiz & Pav.

*G. HIRSUTA* (Jacq.) Schum. in Mart., Fl. Bras., vol. 6, pt. 6, p. 291 (1889). *Justicia hirsuta* Jacq., Enum. pl. Carib., p. 11 (1760).

*Gonzalea spicata* DC., Prod., vol. 4, p. 437 (1830); Griseb., Fl. Brit. W. Ind., p. 321.—El Valle, *Miller & Johnston*, no. 217, July 24. San Juan Mt., *Johnston*, no. 100, July 11. Distribution general in tropical America.

## GUETTARDA L.

*G. PARVIFLORA* Sw., acc. to Ernst, by which, however, is probably meant *G. parvifolia* Sw., Fl. Ind. Occ., vol. 3, p. 1958 (1806); Griseb., Fl. Brit. W. Ind., p. 333.—Santa Ana, *Ernst*.

*G. SCABRA* Lam., Tabl. encycl., vol. 2, p. 218, pl. 154, fig. 3 (1793).—San Juan Mt., alt. 600 m., *Johnston*, no. 114, July 19. Tree, 6 m. high; wood very brittle. Distribution general in tropical America.

## HILLIA Jacq.

*H. PARASITICA* Jacq., Enum. pl. Carib., p. 18 (1760), and Hist. Stirp. Am., p. 96, pl. 66. *H. longiflora* Sw., Prod. veg. Ind. Occ., p. 58 (1788); Griseb., Fl. Brit. W. Ind., p. 325.—San Juan Mt., alt. 550 m., *Johnston*, no. 41, July 16. Shrub, 2–4 m. high; flowers waxy, white. Further distribution, Mexico, West Indies, Colombia.

## PSYCHOTRIA L.

*P. GLABRATA* Sw., Prod. veg. Ind. Occ., p. 43 (1788); Griseb., Fl. Brit. W. Ind., p. 341.—El Valle, *Miller & Johnston*, no. 215, Aug. 15; Juan Griego trail, alt. 450 m., *Johnston*, no. 337, Aug. 12–15. Further distribution, Jamaica, Antigua, Cuba.

*P. HORIZONTALIS* Sw., Prod. veg. Ind. Occ., p. 44 (1788); Griseb., Fl. Brit. W. Ind., p. 344.—El Valle, *Miller & Johnston*, no. 49, July 27. Further distribution, tropical America.

## RANDIA L.

*R. ACULEATA* L., Sp. pl., vol. 2, p. 1192 (1753); Griseb., Fl. Brit. W. Ind., p. 318.—South Hill, El Valle, *Johnston*, no. 280, Aug. 31. Venezuela: Ernst in Seem., Journ. bot., vol. 5, p. 292 (1867). Distribution general in West Indies.

## SPERMACOCE L.

*S. TENUIOR* L., Sp. pl., vol. 1, p. 102 (1753) excl. syn. Dill.; Griseb., Fl. Brit. W. Ind., p. 349.—El Valle, *Miller & Johnston*, no. 198, July 15; Juan Griego trail, *Johnston*, no. 99, Aug. 12–15. Widely distributed in tropical America.

S. VERTICILLATA L., Sp. pl., vol. 1, p. 102 (1753).—Santa Ana, *Ernst*. Distributed in tropical America and Africa.

## CUCURBITACEAE.

## ANGURIA L.

A. UMBROSA HBK., Nov. gen. et sp., vol. 2, p. 121 (1817); Griseb., Fl. Brit. W. Ind., p. 289.—Juan Griego trail, alt. 450 m., *Johnston*, no. 287, Aug. 12-15. Venezuela: near Bordones and Cumaná, HBK., *l. c.* Further distribution, Mexico, Trinidad, Venezuela.

## ANGURIOPSIS Johnston.

A. MARGARITENSIS Johnston, Proc. Amer. acad. arts and sci., vol. 40, p. 697 (1905).—Along the roadside from El Valle to San Antonio, *Johnston*, no. 286, Aug. 8. Climbing over such shrubs as *Lycium salsum* and *Cereus eburneus*.

## CERATOSANTHES Adans.

C. TUBEROSA J. F. Gmel., Syst., p. 102 (1791); Griseb., Fl. Brit. W. Ind., p. 289.—El Valle, *Miller & Johnston*, nos. 258, 248; Tacarigua, *Johnston*, no. 62, Aug. 14. Further distribution, Grenada, Martinique, Venezuela.

## CITRULLUS Forsk.

C. VULGARIS Schrad. ex Eckl. & Zeyh., Enum., p. 279 (1835); Duthie & Fuller, Field and gard. crop, vol. 2, pls. 55, 56.—Cultivated.

## CUCUMIS L.

C. MELO L. Sp. pl., vol. 2, p. 1011 (1753).—El Valle, *Miller & Johnston*, no. 87. Cultivated.

C. ANGURIA L., Sp. pl., vol. 2, p. 1011 (1753); Griseb., Fl. Brit. W. Ind., p. 288; Mart., Fl. Bras., vol. 6, pt. 4, p. 16.—El Valle, *Miller & Johnston*, no. 224, July 14. Distribution general in tropical America.

## CUCURBITA L.

C. PEPO L., Sp. pl., vol. 2, p. 1010 (1753); Desc., Ant., vol. 5, pl. 323.—Cultivated, according to Ernst.

## MELOTHRIA L.

M. PERVAGA (Macf.) Griseb., Fl. Brit. W. Ind., p. 289 (1860). *Landersia pervaga* Macf., Fl. Jamaic., vol. 2, p. 142 (1837).— Santa Ana, *Ernst*. Distribution general in tropical America.

## MOMORDICA L.

M. CHARANTIA L., Sp. pl., vol. 2, p. 1009 (1753); Griseb., Fl. Brit. W. Ind., p. 287.— Santa Ana, *Ernst*; El Valle, *Miller & Johnston*, no. 86, July 12. Widely distributed in tropical countries.

## CAMPANULACEAE.

## CENTROPOGON Presl.

C. SURINAMENSIS (L.) Presl, Prod. monog. Lobel., p. 48 (1836); Paxt., Mag., vol. 13, p. 149; Griseb., Fl. Brit. W. Ind., p. 385. *Lobelia surinamensis* L., Sp. pl., ed. 2, vol. 2, p. 1320 (1763).— San Juan Mt., alt. 750 m., *Johnston*, no. 88, July 6. Further distribution, St. Vincent, Trinidad, and tropical South America.

## GOODENIACEAE.

## SCAEVOLA L.

S. PLUMERII Vahl, Symb. bot., vol. 2, p. 36 (1791); Griseb., Fl. Brit. W. Ind., p. 388.— Pt. Mosquito, *Johnston*, no. 319, Aug. 10. Venezuela: Tortuga, *Ernst*, Fl. Chelon. in Journ. bot., vol. 14, p. 178. Widely distributed in tropical countries.

## COMPOSITAE.

## ACANTHOSPERMUM Schrank.

A. AUSTRALE (Loeffl.) Ktze., Rev. gen., vol. 1, p. 303 (1891). *A. brasiliun* Schrank, Pl. rar. hort. Monac., vol. 2, p. 53 (1819). *A. xanthioides* DC., Prod., vol. 5, p. 521 (1836); Griseb., Fl. Brit. W. Ind., p. 369. *Melampodium australe* Loeffl., It. Hisp., p. 268 (1758).— Santa Ana, *Ernst*. Further distribution, West Indies, Venezuela, Guiana to Buenos Ayres.

## AGERATUM L.

A. CONYZOIDES L., Sp. pl., vol. 2, p. 839 (1753); Griseb., Fl. Brit. W. Ind., p. 356.—Santa Ana, *Ernst*. Common in tropical countries.

## BACCHARIS L.

B. RHEXIOIDES HBK., Nov. gen. et sp., vol. 4, p. 66 (1820).—El Valle, *Miller & Johnston*, no. 230, July 30; San Juan Mt., alt. 600 m., *Johnston*, no. 98, Aug. 28. Further distribution, Peru, Brazil.

## BIDENS L.

B. PILOSA L., Sp. pl., vol. 1, p. 832 (1753). *B. leucantha* Willd., Sp. pl., vol. 3, p. 1719 (1804); Plum., Ic. Burm., pl. 53; Griseb., Fl. Brit. W. Ind., p. 373.—Santa Ana, *Ernst*. Distribution general in tropical countries.

## BLAINVILLEA Cass.

B. BAHIENSIS (DC.) Baker in Mart., Fl. Bras., vol. 6, pt. 3, p. 177, pl. 57 (1882). *Oligogyne bahiensis* DC., Prod., vol. 5, p. 629 (1836).—El Valle, *Miller & Johnston*, no. 131, July 20. Further distribution, Brazil.

## CLIBADIUM L.

C. SURINAMENSIS L., Mant., vol. 2, p. 294 (1771). *C. asperum* DC., Prod., vol. 5, p. 506 (1836); Griseb., Fl. Brit. W. Ind., p. 367.—Santa Ana, *Ernst*. Distribution general in tropical America.

## ECLIPTA L.

E. ALBA (L.) Hassk., Pl. Jav. rar., p. 528 (1848); Griseb., Fl. Brit. W. Ind., p. 370. *E. erecta* L., Mant., vol. 2, p. 286 (1771). *Verbesina alba* L., Sp. pl., vol. 2, p. 902 (1753).—Santa Ana, *Ernst*; El Valle, *Miller & Johnston*, no. 241, July 30. Widely distributed in temperate and tropical countries.

## ELEPHANTOPUS L.

E. SPICATUS B. Juss. ex Aubl., Pl. Guian., vol. 2, p. 808 (1775). *Distreptus spicatus* Cass., Dict. sci. nat., vol. 13, p. 367 (1819); Griseb., Fl. Brit. W. Ind., p. 355.—Santa Ana, *Ernst*. Venezuela: Caracas, according to Sch. Bip., Linnaea, vol. 20, p. 519. Widely distributed in tropical America.

## ELEUTHERANTHERA Poit.

*E. OVATA* Poit. ex Steud., *Nom.*, ed. 2, vol. 1, p. 549 (1841).— El Valle, *Miller & Johnston*, no. 132, July 18. Distributed in tropical America.

## ERIGERON L.

*E. SPATHULATUS* Vahl in West, *Bidr. Ste-Croix*, p. 303 (1793); Griseb., *Fl. Brit. W. Ind.*, p. 365.— Rio Asuncion, alt. 450 m., *Johnston*, no. 324, July 29. Further distribution, Antigua, and Virgin Ids.

## EUPATORIUM L.

*E. BALLOTAEFOLIUM* HBK., *Nov. gen. et sp.*, vol. 4, p. 121 (1820); Mart., *Fl. Bras.*, vol. 6, pt. 2, p. 380.— El Valle, *Miller & Johnston*, no. 234, July 15; San Juan Mt., alt. 500 m., *Johnston*, no. 94, July 19. Venezuela: Colonia Tovar, *Fendler*, no. 653, 1854-55; La Guaira, *Robinson & Lyon*, July 12, 1900. Further distribution, Colombia, Brazil.

*E. IRESINOIDES* HBK., *Nov. gen. et sp.*, vol. 4, p. 106, pl. 340 (1820); Griseb., *Fl. Brit. W. Ind.*, p. 360.— El Valle, *Miller & Johnston*, no. 129, July 30; San Juan Mt., alt. 500 m., *Johnston*, no. 95, July 19. Widely distributed in West Indies, Panama, Venezuela. A thick shrub, 2-3 m. high.

## ISOCARPHA R. Br.

*I. OPPOSITIFOLIA* R. Br., *Trans. Linn. soc.*, vol. 12, p. 110 (1816); Griseb., *Fl. Brit. W. Ind.*, p. 376.— El Valle, *Miller & Johnston*, no. 138, July 10. Further distribution, Bahamas, Jamaica, Trinidad.

## LACTUCA L.

*L. INTYBACEA* Jacq., *Ic. pl. rar.*, vol. 1, pl. 162 (1781-1786). *Brachyramphus intybaceus* DC., *Prod.* vol. 7, pt. 1, p. 177 (1838); Griseb., *Fl. Brit. W. Ind.*, p. 384.— El Valle, *Miller & Johnston*, no. 25, July 27, and *Johnston*, no. 351, Aug. 12-15. Widely distributed in tropical countries.

## MIKANIA Willd.

*M. AMARA* Willd., *Sp. pl.*, vol. 3, p. 1744 (1804).— En route El Valle to Juan Griego, *Johnston*, no. 104, Aug. 12-15. Further distribution, Martinique, Bolivia.

## PARTHENIUM L.

P. HYSTEROPHORUM L., Sp. pl., vol. 2, p. 988 (1753); Griseb., Fl. Brit. W. Ind., p. 369.—Santa Ana, *Ernst*; El Valle, *Miller & Johnston*, no. 233. Venezuela: near Caracas and on the banks of the Orinoco, HBK., Nov. gen. et sp., vol. 4, p. 259. Widely distributed in temperate and tropical America.

## PLUCHEA Cass.

P. ODORATA (L.) Cass., Dict. sci. nat., vol. 42, p. 3 (1826); Griseb., Fl. Brit. W. Ind., p. 366. *Conyza odorata* L., Syst. nat., ed. 10, vol. 2, p. 1213 (1760).—Santa Ana, *Ernst*; El Valle, *Miller & Johnston*, no. 1, July 21, and *Johnston*, no. 318. Distribution general in tropical America.

## POROPHYLLUM Adans.

P. RUDERALE (Jacq.) Cass., Dict. sci. nat., vol. 43, p. 56 (1826); Griseb., Fl. Brit. W. Ind., p. 379. *Kleinia ruderalis* Jacq., Enum. pl. Carib., p. 28 (1760), as *rudcalis*.—Santa Ana, *Ernst*; El Valle, *Miller & Johnston*, no. 130, July 24. Distribution general in tropical America.

## SENECIO L.

S. SONCHIFOLIA (L.) Moench, Meth. suppl., p. 231 (1802). *Cacalia sonchifolia* L., Sp. pl., vol. 2, p. 835 (1753). *Emilia sonchifolia* DC., Prod., vol. 6, p. 302 (1837).—El Valle, *Miller & Johnston*, no. 137, July 19. Widely distributed in tropical countries.

## SONCHUS L.

S. OLERACEUS L., Sp. pl., vol. 2, p. 794 (1753); Griseb., Fl. Brit. W. Ind., p. 384.—Santa Ana, *Ernst*. Widely distributed in temperate and tropical countries.

## SPILANTHES Jacq.

S. OCYMIFOLIA (Lam.) A. H. Moore, Proc. Amer. acad. arts and sci., vol. 33, p. 531 (1907). *Bidens ocymifolia* Lam., Encycl., vol. 1, p. 416 (1783). *Spilanthus exasperata* Jacq., Ic. pl. rar., vol. 3, p. 15, pl. 584 (1786-93).—Rio Asuncion, alt. 450 m., *Johnston*, no. 102, Aug. 12-15. Venezuela: Caracas, *Birschel*; Colonia Tovar, *Fendler*, no. 691, 1854-55. Distribution general in tropical America.

## SYNEDRELLA Gaertn.

S. NODIFLORA Gaertn., Fruct., vol. 2, p. 456, pl. 171 (1791); Griseb., Fl. Brit. W. Ind., p. 377.—Santa Ana, *Ernst*. Distribution genera in tropical America.

## TRIXIS P. Br.

T. RADIALE (L.) Lag., Amen. nat., vol. 1, p. 36, in obs. (1811), combination implied but not specifically made; Hook. f. & Jacks., Ind. Kew., vol. 2, p. 1131 (1895). *Perdicium radiale* L., Sp. pl., ed. 2, vol. 2, p. 1248 (1763). *Trixis frutescens* P. Br. ex Spreng., Syst., vol. 3, p. 501 (1826); Griseb., Fl. Brit. W. Ind., p. 383; Ernst, Bot. Excurs. Margarita, p. 6.—Santa Ana, *Ernst*; El Valle, *Miller & Johnston*, no. 24, Aug. 1. Widely distributed in tropical America.

## VERBESINA L.

V. ALATA L., Sp. pl., vol. 2, p. 901 (1753); Griseb., Fl. Brit. W. Ind., p. 374; Sims., Bot. mag., pl. 1716.—Santa Ana, *Ernst*. Distribution general in tropical America.

## VERNONIA Schreb.

V. ARBORESCENS (L.) Sw., Fl. Ind. Occ., vol. 3, p. 1320 (1806); Griseb., Fl. Brit. W. Ind., p. 353; Plum., Ic. Burm., pl. 130, fig. 2. *Conyza arborescens* L., Syst. nat., ed. 10, vol. 2, p. 1213 (1759).—San Juan Mt., alt. 500 m., *Johnston*, no. 96, July 19. Flowers blue; stem 2–3 m. high. Distribution general in tropical America.

V. MILLERI Johnston, Proc. Amer. acad. arts and sci., vol. 40, p. 698 (1905).—Summit of South Hill, alt. 300 m., *Miller & Johnston*, no. 254, July 31, and *Johnston*, no. 329, Aug. 31. Endemic.

V. SCORPIOIDES (Lam.) Pers., Syn., vol. 2, p. 404 (1807); Griseb., Fl. Brit. W. Ind., p. 353. *Conyza scorpioides* Lam., Encycl., vol. 2, p. 88 (1786).—El Valle, *Miller & Johnston*, nos. 133, 134, July; Juan Griego trail, *Johnston*, nos. 322, 323, July. Venezuela: Caracas, according to Sch. Bip., Linnaea, vol. 20, p. 510. Further distribution, Trinidad and tropical South America.

## WEDELIA Jacq.

W. BUPHTHALMOIDES Griseb., Goett. Abh., vol. 7, p. 235 (1857).—El Valle, *Miller & Johnston*, nos. 145, 146, and 147, July and Aug.

Shrubby, spreading, 0.3 to 1 m. high. Further distribution, West Indies.

W. CARACASANA DC. Prod., vol. 5, p. 541 (1836); Griseb., Fl. Brit. W. Ind., p. 371.—San Juan Mt., alt. 600 m., *Johnston*, no. 97, July 11. Venezuela: near Caracas, *Vargas*, no. 97, 1829; *Birsehel*; *A. H. Moore*, Mar. 16, 1899; Colonia Tovar, *Fendler*, nos. 682, 683, in 1854–55, and 1961, Jan. 25, 1857; La Guaira, *Robinson & Lyon*, July 6. Further distribution, Trinidad, Panama.

#### WULFFIA Neck.

W. BACCATA (L. f.) Ktze., Rev. gen., vol. 1, p. 373 (1891). *Corcopsis baccata* L. f., Suppl., p. 380 (1781). *Helianthus* ? *sarmentosus* Rich., Act. soc. nat. hist. Par., vol. 1, p. 112 (1792). *Wulffia stenoglossa* DC., Prod., vol. 5, p. 563 (1836); Griseb., Fl. Brit. W. Ind., p. 372.—San Juan Mt., alt. 500 m., *Johnston*, no. 101, July 19. Bush, 1–1.5 m. high. Further distribution, West Indies, Guiana to Peru.

#### *Economic Plants of Margarita.*

The most important of the plants, which are cultivated on Margarita, is the coconut palm. Although there are only the two large groves, one completely filling the lower part of El Valle and the other extending through Asuncion valley, yet they furnish a large part of the coconuts used on the island. The huts of the poor people are constructed of the leaves, and the fruit constitutes an important part of their food. The cultivation of these groves consists merely in keeping the undergrowth down and in maintaining irrigation ditches.

The next most important vegetable product of the island is cassava made from *Manihot utilissima*. Fields of this are usually upon a hillside and it is abundantly grown in such places in El Valle. There is, however, in Asuncion, one large field of cassava on the plain. The cultivation of this plant on the hillside, which is preferable on account of loose soil and good drainage, is rendered difficult by the steepness of the slopes. Planting is done by setting out cuttings from the stem each about 15 cm. (6 in.) long, that are placed in rows about 1.5 m. apart. The earth is heaped in small ridges between the rows and the plants so as to form ridges about each plant, thus serving to hold whatever water may come down. In some parts, a single row of stones extends between each two rows of plants, in that way forming

a sort of a stone wall about each plant. This contrivance is to prevent the heavy rains from washing all the soil down the hillside. When the crops are mature, the roots are gathered and treated in the customary way, bruised, mashed, and the poisonous juice pressed out. The dried remainder is grated into meal and made into cassava bread which is sold in large, thin, circular disks.

Indian corn is grown very little upon the island, and then it is used mostly for fodder. A few acres were given up to its cultivation at an altitude of 500 m. in 1901. In 1903, however, the same space was entirely occupied by a rank growth of *Cordia cylindristachya* and other weeds.

The bread-fruit tree, *Artocarpus incisa*, is to be found in Asuncion valley. Bananas and plantains are to be had in moderate amount and only fair in quality.

Dates grow in sufficient abundance for the needs of the natives. There are probably a half dozen mature trees in El Valle. The foot of the mountain with its moist soil and extremely hot atmosphere is a good place for growing the trees.

The cashew-nut (*Anacardium occidentale*) and the hog-plum (*Spondias lutea*) are to be found sparingly near Asuncion.

*Maranta arundinacea*, the arrowroot plant, grows in the woods above Asuncion but it is not cultivated.

The mamon (*Melicocca bijuga*) and the toco (*Crataeva Tapia*) are often eaten and sometimes found for sale in the market-place.

The mango is the most abundant fruit in Margarita and though of inferior quality is largely used by all the people.

There are orange trees in El Valle, Asuncion, and Tacarigua, those from the last place being superior. The few bitter orange and the lime trees are of little importance.

Good sapodillas or nisperos grow both in El Valle and at Asuncion.

A poor quality of pineapple is to be found in the market in season. There are several pineapple fields on the hillsides of El Valle.

Sugar cane grows well in very few places on the island. There are several small cane-presses, turned either by hand or by burro. The product is for home consumption, and there is not enough of it to supply the people. Most of the sugar that is used is brought over from Cumaná in the form of large brown cakes called *papelón*. The cane-juice may be found in the market in a slightly fermented condition when it is known as *guarapo*.

The following fruits and vegetables grow in El Valle and at Asuncion though sparingly, not being cultivated to any extent: *Annona reticulata*, the custard-apple; *Malpighia puniceifolia* a small fruit not used much; *Cajanus indieus*, the pigeon pea; *Dolichos* sp., a pea; *Phaseolus vulgaris*, a bean; *Psidium guajava*, from which guava jelly is made; *Passiflora laurifolia*, the belle-apple; *Dioscorea alata*, a yam; *Cucumis Melo* and *C. Anguria*, both small melons; *Physalis peruviana*, the "tomato"; *Tamarindus indica*, the tamarind, quite abundant in El Valle.

The foregoing plants may be considered as the only ones of much economic importance to the inhabitants; that is, they are the only ones that are cultivated or made much use of. As a matter of fact the number of plants that are found growing on Margarita and that are important commercially on the mainland and elsewhere is rather large. The list contains a few specimens of timber trees, of medicinal plants, of plants producing resins and gums, and other products such as dyes and tannins. The fact that these do grow upon Margarita suggests that they might be cultivated in greater abundance. That they are not found in greater quantities, while of course due largely to the physical conditions of the island, is also owing to the ignorance and lack of care on the part of the inhabitants. This is strikingly illustrated in two or three small private haciendas where such things as grapes, egg-plants, tomatoes, and peppers are successfully cultivated. The fact that so many of the plants furnish useful products suggests the possibility that Margarita may be made more productive than it is at present; for that reason it is desirable to enumerate them here together with their uses.

Material for the following has largely been drawn from La Exposicion nacional de Venezuela en 1883 by A. Ernst; the World's Columbian Exposition in Chicago — Venezuela; and Medicinal plants of Caracas by A. Ernst in Seemann's Journal of botany for 1865.

#### WOODS.

ANACARDIUM OCCIDENTALE. Wood strong and durable. Little used, as its fruit is of more importance. Trees scarce.

ACHRAS ZAPOTA. *Nispero*. Wood very hard, strong, and heavy, of a reddish color and taking a beautiful polish. Chiefly valued for its fruit. Trees abundant.

BOURRERIA EXSUCCA. Wood good but little used. This is a small tree averaging between 3 and 5 m. in height. Fairly common.

BURSERA SIMARUBA. Soft and resinous wood. Common on hilltop.

CAESALPINIA CORIARIA. *Dividive*. On the mainland a large tree reaching sometimes a height of 30 m. with a clear trunk 10 m. high. On Margarita and on Coche it occurs as bushes about 2 m. high. The wood is very heavy, strong, and fine-grained. The sapwood is whitish yellow, the heartwood black and almost as hard as iron. Rather scarce.

CAPPARIS PACHACA. *Ajicito*. A small tree with a light-colored wood of not much hardness, used for cabinet work. Very few trees.

CASSIA FISTULA. *Cañafistula*. Wood of a flesh-color, heavy, hard, and strong but not much used. Few trees.

CLUSEA ROSEA. *Copey*. Wood of a reddish color, rather heavy, used considerably on Margarita for building-posts, but not much elsewhere. Common.

CORDIA ALBA. *Caujaro*. Attains a height of 12 to 15 m. with a trunk 4 to 5 m. high. A tolerably good wood for building purposes. Only a few trees.

CRATAEVA GYNANDRA. *Toco*. Very light and soft, generally of a whitish color though sometimes showing reddish veins. Sawn into boards for boxes. Common in El Valle.

CRESCENTIA CUJETE. *Taparo*. Wood yellowish white, close-grained, and rather hard and strong. The tree is of medium size. Common.

GUAJACUM ARBOREUM. *Vera*. A large tree yielding a wood similar to the following.

GUAJACUM OFFICINALE. *Guayacan*. Wood exceedingly hard and tough, the fibers crossing each other, so that it does not split. The sap wood is of a yellowish color; the heart wood is brown with dark greenish veins and markings. Used for turnery work. Both of these trees are abundant.

GUAZUMA ULMIFOLIA. *Guacimo*. Of a grayish white color with a somewhat reddish hue and occasionally some dark veins; it is fibrous, not very fine-grained, and comparatively light.

HIPPOMANE MANCINELLA. *Manzanilla de playa*. Good wood, durable and heavy, fine grain, annual rings distinct, and pores numerous. Few trees.

HURA CREPITANS. *Jobillo*. Wood light and soft, of fibrous texture, durable under water, and color white. Few trees.

HYMENAEA COURBARIL. *Algarrobo*. A very hard and heavy wood, of dark yellowish color with some greenish veins; it has straight fibers and is free of knots, so that it can be easily worked. It is used especially for crushing-wheels and similar things in coffee estates. Height usually 20 to 25 m., with a clear trunk 7 to 8 m. On Margarita, however, the only specimens observed were very low trees.

LAGUNCULARIA RACEMOSA. *Mangle amarillo*. Wood hard and heavy, fibrous and compact in texture. Color gray with many black points. Common about the lagoons.

LONCHOCARPUS SP. *Mahomo*. Very hard and elastic. The species on Margarita are from 15 to 20 m. high. Few trees.

MALPHIGIA PUNICIFOLIA. Wood very compact, light, not very durable, of a clear brown color. Few trees.

MELICOCCA BIJUGA. *Mamon*. Wood hard and heavy, compact and close-grained, color yellowish with very narrow and somewhat darker veins. Its fruit is usually valued more highly than the wood. Common.

MORISONIA SP. Wood white, soft and light. Scarce.

NECTANDRA CORIACEA. Very strong and resistant, not heavy, with good grain, and a more or less agreeable odor. Is easy to work, being used in carpentry and cabinet work. Scarce.

OREOPANAX CAPITATUM. *Candeleró*. Wood whitish, brittle and light. Scarce.

PISONIA INERMIS. Wood of little weight, light in color, good for use under water. Common.

RHIZOPHORA MANGLE. *Mangle colorado*. Wood red, strong, and heavy. Much used for rafters. Very abundant about lagoons.

TABERNAEMONTANA PSYCHOTRIFOLIA. *Berraco*. The wood is fibrous, not very hard, and of an olive color, sometimes with darker veins. It is easily worked and takes a good polish. Common.

Other trees found in small numbers on Margarita and not much used are INGA INGOIDES, GUETTARDA SCABRA, MORISONIA JOHNSTONII, ACACIA MACRACANTHA, and LINOCIERA LATIFOLIA.

#### FIBER PLANTS.

All of the following grow rather sparsely in Margarita: —

AGAVE AMERICANA. *Cocuy*.

BOMBAX CEIBA. *Ceiba*. The fibers are short and are used solely for stuffing pillows, etc.

BROMELIA PINGVIN. *Maya*.

GOSYPIUM BARBADENSE. *Algodon*. Many hammocks are hand-made from cotton on Margarita. See Ernst: La Exposicion nacional de Venezuela en 1883, pages 560, 561 for quotation describing method of making hammocks according to A. A. Level, La Margarita, pages lxxviii and lxxix.

MUSA PARADISIACA. *Platano*.

TOURNEFORTIA HIRSUTISSIMA. *Niguo*.

TRAGIA VOLUBILIS. *Pringamosa Morada*.

PALMA CARANA so called by the natives and mentioned by Ernst. Its specific identity is doubtful. The leaves are used to make brooms, ropes, etc.

#### GUMS AND RESINS.

ACHRAS ZAPOTA. *Gum Chicle*. Milk juice obtained by incision in bark. Tapping may occur once in three years without danger to life of tree. The raw milk is boiled and then allowed to harden into the gum. Used for chewing gum.

BURSERA GUMMIFERA. *Resina indio desnudo*.

CERCIDIUM VIRIDE. *Res na de cuica ó yabo*. This resin exudes from the bark of the stem and branches, covering them in a continuous layer. It is used by soap manufacturers.

CLUSEA ROSEA. *Resina de Copey*.

HYMENAEA COURBARIL. *Resina de algarrobo*. The resin exudes from the stem and roots of the tree and is often found in a semi-fluid state in the soil. It may be used for making varnish, like copal. Is used for incense.

SPONDIAS LUTEA. *Goma de jobo*.

#### DYES AND TANNIN.

BIXA ORELLANA. *Onoto*. The seeds are covered with a deep red pulp which hardens when dry, and being separated from the seeds forms the annatto of commerce, used by dyers and varnish-makers also for coloring cheese and butter. The South American Indians paint their bodies with it.

CAESALPINIA CORIARIA. *Dividive*. The pods contain from 30 to 40% tannin and form an important article of exportation from several ports of Venezuela.

CECROPIA PELTATA. The bark may be used for tanning.

INDIGOFERA SUFFRUTICOSA. Formerly much used in making indigo.

PERSEA GRATISSIMA. The bark of this might be used for tanning leather.

RHIZOPHORA MANGLE. Contains from 22 to 33% of tannin according to the age of the tree, and likewise a pigment which colors the leather.

### MEDICINAL PLANTS.

ABRUS PRECATORIUS. Substitute for licorice in India. Is a poison and a medicine.

ACACIA MACRACANTHA. *Corteza de Cuji*. Astringent.

AGAVE AMERICANA. *Raiz de Cocuy*. Purgative.

ANACARDIUM OCCIDENTALE. Root is purgative the green fruit astringent. In the middle layer of shell of fruit is an oily liquid capable of poisoning the skin, and turning black on exposure. This is used as an indelible ink.

ANNONA MURICATA. Root yields a fish poison.

ANNONA SQUAMOSA. Bark has drastic properties.

ARGEMONE MEXICANA. *Cardo santo*. Used as a mild cathartic and in cases of intermittent fever, and dropsy.

ARISTOLOCHIA RINGENS. *Congrina*. For rheumatism.

ASCLEPIAS CURASSAVICA. The root is a diuretic and carminative, in large doses a cathartic and an emetic.

BASTARDIA VISCOSA. *Chivatera ó fistulera*. Aromatic. The powder is said to cure fistula.

BIXA ORELLANA. The red arillus is used in soups and sauces.

BRUNFELSIA HOPEANA. The dried root and stem used for chronic muscular rheumatism.

BURSERA GUMMIFERA. *Indio desnudo*. Used for rheumatism.

CAMPYLONEURUM PHYLLITIDIS. *Lengua de sierpe*. Antisyphilitic.

CAPPARIS JAMAICENSIS and CAPPARIS CYNOPHALLOPHORA. Root bark possesses blistering properties and may be taken internally as a diuretic.

CAPSICUM BACCATUM. The berries used as caustics, and the leaves bruised and mixed with tallow, are applied to tumors to promote suppuration.

CAPRARIA BIFLORA. The root is a tonic.

CARICA PAPAYA. The juice from the fruit aids in digestion.  
 CASSIA BIFLORA. Leaves soaked in water make a refreshing draught, principally taken in fever caused by insolation, but also in intermittents.

CASSIA FISTULA. *Cañafistula*. Mild purgative.

CASSIA OCCIDENTALIS. *Brusca*. Febrifuge and astringent. The seeds roasted give a drink similar to coffee.

CERATOSANTHES TUBEROSA. *Raiz de pepino*. Emetic.

CISSAMPELOS PAREIRA. Diuretic.

CORDIA GERASCANTHUS. *Cantaro*. Sudorific and pectoral.

COSTUS SPICATUS. *Raiz de Caña de la India*. Antisiphilitic.

CRANIOLARIA ANNUA. *Escorzonera*. The seeds are used against the irregularities of the blood, the root is a purgative and cooling.

DACTYLOCTENIUM AEGYPTIUM. *Raiz de Guarataro*. Diuretic.

DIFFENBACHIA SEGUINE. Decoction made from stem, thickened with gum arabic is used in cases of gonorrhoea.

GUAZUMA ULMIFOLIA. *Guasimo*. Mucilaginous, refreshing and healing.

HIPPOMANE MANCINELLA. Fish poison from juice. Caustic, emetic, cathartic.

HYMENAEA COURBARIL. The dried pulp of the fruit is a pectoral.

JATROPHA CURCAS. *Pinon*. Emetic.

JATROPHA GOSSYPIFOLIA. *Tivatua*. Emetic.

LANTANA CAMARA. *Cariaquito encarnado*. Diuretic and refreshing. The root is used against gonorrhoea.

MANGIFERA INDICA. Seed is anthelmintic; juice of trunk antisiphilitic; bark and leaves astringent.

MELIA AZEDARACH. Decoction of bark is an anthelmintic for the removal of the round worm.

MELOCHIA TOMENTOSA. *Bretonica*. Used in the infirmities of the eyes.

PARTHENIUM HYSTEROPHORUM. Large doses have an antipyretic effect.

PEDILANTHUS TITHYMALOIDES. The milky sap is an emetic.

PERSEA GRATISSIMA. Astringent kernel, cut in pieces, roasted, and reduced to powder, good for diarrhoea and dysentery.

PETIVERIA ALLIACEA. *Raiz de Mapurite*. Antispasmodic and vermifuge.

PHYLLANTHUS NIRURI. Laxative and alterative, especially against jaundice.

PLUMBAGO SCANDENS. *Guapote*. Rubefacient.

PORTULACA OLERACEA. Decoction is anthelmintic and refreshing.

PORTULACA PILOSA. *Verdolaga salvaje*. A bitter and tonic.

SCOPARIA DULCIS. *Raiz de escobilla*. A decoction used to restrain diarrhea and vomiting.

SIDA RHOMIFOLIA. *Escoba blanca ó babosa*. The root is a diuretic.

SPONDIAS LUTEA. *Corteza de Jobo*. A decoction is used to cauterize stubborn ulcers.

STACHYTARPHETA JAMAICENSIS. *Verbena*. A bitter, tonic, and febrifuge.

TRIXIS RADIALE. *Juan de la Calle*. Antirheumatic.

TURNERA DIFFUSA. Contains damiana, a stimulant tonic; in large quantities a laxative.

TURNERA ULMIFOLIA. Carminative and tonic.

#### *Distribution of the Plants.*

It may easily be seen from the description of the physical features of the island that the variety of the vegetative conditions is very great and also that the conditions for vegetative growth are much more favorable in the rainy than in the dry season. The distribution of the plants is naturally determined by their adaptation to particular conditions.

Bordering the sandy beaches are bushes of *Tournefortia gnaphalodes* and *Suriana maritima*, both of these being narrow-leaved, and the former being woolly-pubescent. *Croton flavens* is a similar plant. Next inland occur the low spiny bushes of *Castela Nicholsoni*. The small and long-rooted *Euphorbia buxifolia* grows in the sand dunes and near by are the small trees of *Bumelia cuneata* and *Guaiacum officinale*. On the exposed rocky shores by Juan Griego, *Euphorbia thymifolia* grows in abundance in almost no soil.

The region nearest in character to the seashore is the lagoon. This is often bordered by *Rhizophora Mangle*, *Laguncularia racemosa*, and *Aricennia nitida*, all shrubby or aborescent plants. On clear sandy stretches by the lagoons and sometimes partly submerged in the water are the low succulent plants, *Batis*, *Salicornia*, and *Trianthema*. Mingled with these in the drier places are *Alternanthera canescens* and *Iresine portulacoides*, both having a low sprawling habit. On the muddy shores of the brackish pond near Juan Griego grow the

tiny *Cypselea humifusa*, *Euphorbia thymifolia*, *Ilysanthes riparia*, and small specimens of *Mollugo verticillata*.

Inland from these wastes are the plains covered with the melon cactus, the flat-stemmed *Opuntia*, the symmetrical tree-like *Pereskia*, and the candelabra-shaped, tall *Cereus eburneus*. All these are thorny and more or less fleshy plants. In addition are the arborescent acacias, and *Capparis cynophallophora*; the shrubby *Croton flavescens*, *Croton Milleri*, *Jatropha gossypifolia*, and *Jatropha urens*, and the small shrub *Stylosanthes*.

The desolation of the plains is emphasized on the hills by the addition of great stretches of *Agave* and *Aloe* which make the regions almost inaccessible. The high parts of the hills have dense growths of bushes, as *Cordia cylindristachya*, *C. globosa*, *Securidaca*, *Capparis verrucosa*, and *Heteropteris laurifolia*. Then scattered over the hills are the small trees of *Capparis cynophallophora*, *C. linearis*, *Bursera*, and *Steriphoma*. Along the hilltops are a few larger trees of *Morisonia* and *Clusia*. These trees have leathery and very large leaves in all cases except *Bursera* and *Capparis linearis*. The undergrowth among the trees on the hills consists of the green-stemmed *Pedilanthus*, the bushy *Brunfelsia*, and the bromeliaceous plants *Aechmea* and *Thecophyllum*. Here are a few epiphytes as *Oncidium*, the cactus *Rhipsalis*, a few *Polypodiums*, some of the *Bromeliaceae*, and *Anthurium scandens*.

The vegetation of the valleys, with the exception of *Asuncion* and *El Valle*, is similar in general to that of the hills and the plains. These two valleys have groves of coconut, mango, sapodilla, and orange trees, and in consequence afford a good place for the growth of annual plants. The river beds and arroyas are the most interesting places in the valleys. The only large river bed on the island is that extending from the mountain through *El Valle* to the sea at *Porlamar*. It is bordered with such trees as *Crataeva Tapia*, *Guajacum arboreum*, *Lonchocarpus*, *Pithecolobium*, and *Bombax*, all with tall gray trunks. There are many bushes, some half-climbers, *Chiococca*, *Cestrum*, *Malpighia purpurea*, *Solanum*, *Acacia*, and *Marsdenia*. The arroyas or gullies high up in the valleys have the small tree *Tecoma*, the shrub *Cordia globosa*, and the vine *Bignonia*.

The mountain furnishes varied situations and conditions for the growth of plants. In general it is forested from 300 m. nearly to the summit; in the valleys the woods grow at a lower altitude also. The

trees which make up the forest are *Bombax*, *Clusia rosea*, *Cecropia*, *Inga*, *Gilibertia*, *Linociera*, and the palms *Acrocomia*, *Oreodoxa*, and *Bactris*, all these being trees of a more or less straight trunk. The crooked trees of 500 m. altitude or more are *Guettarda*, *Hellia*, *Pisonia*, *Nectandra*, *Phoebe*, *Psychotria*, and *Clusia lutea*. At the summit of the mountain are the dwarfed *Clusia lutea*, the wide-spreading *Blakea*, *Vaccinium*, and *Myrcia*.

Among the trees of the lower altitudes there is little undergrowth, consisting of the ferns or orchids. At an altitude of 400 m. on the San Juan trail there is a small marshy area covered with *Heliconia Bihai* and at one side is *Acalypha*. At an altitude of 500 m. in the Asuncion valley, that is, the northeast side of the island, there is considerable undergrowth. In the woods, *Dioscorea*, *Smilax*, *Piper*; by the "rios," *Athyrocarpus*, *Costus*, *Calathea*, *Renealmia*; and on the rocks and trees, *Philodendron*, *Anthurium*, and *Dieffenbachia*, together with many terrestrial and epiphytic ferns and orchids, may be found. Various members of the Gramineae are scattered throughout the woods. In open thickly grown places is *Scleria bracteata*; by rivulets are *Cyperus*, *Scirpus*, *Eleocharis*, and a few other Cyperaceae. *Drymonia serrulata* is one of the vines among the trees by the "rio." *Gonzalugania* and *Chiococca mierantha* at lower altitudes have slender ascending or climbing habits. Above 500 m. the melastomaceous *Clidemia* and *Miconia* are to be found. The deep ravines are characterized by the abundance of ferns, especially one ravine by the tree-fern, *Cyathea*.

The wooded mountain top between 600 and 700 m. has practically no undergrowth. The low trees already mentioned are crooked and crowded together. They are covered with moss which is saturated with moisture. On the trunks may be found *Polypodium jubaeforme* and *Xiphopteris serrulata*, but practically nothing else, unless it is *Lycopodium* and mosses. Above 700 m. or on the exposed part of the mountain top is a great variety of plants. The bromeliaceous genus *Glomeropiteairnia* is found growing thickly over parts of the top. The delicate *Utricularia* is abundant in the rich and moist humus. The tiny shrub *Sauvagesia*, the vine *Echites*, and the sprawling *Epidendrum secundum*, the erect *Epidendrum nocturnum*, the beautiful *Centropogon*, several passion-flowers, the gentian *Coutoubea*, the silver fern and several sedges cover the top of the mountain. Such in general is the distribution of the plants according to regions.

In connection with this discussion there is an interesting field for study in the distribution of the individual species of plants whether in groups or singly, whether in one place or scattered in many, and whether on one slope and not on another.

The species of plants found on the seashore and by the lagoons are without exception growing in groups with but little intermixture. Almost any of the plants illustrate this, *Rhizophora*, *Avicennia*, *Batis*, *Salicornia*, and *Trianthema*. The species growing on the plains are found in abundance though well interspersed with other species. So far as was discovered *Opuntia leptocaulis* was growing in abundance but over only a small area to the west of Porlamar. Similarly, *Croton Milleri* was localized though well mixed with other plants. Many of the plants were to be found in different locations, which, however, had similar moisture conditions. This was even more accentuated in the valleys and hillside than on the plains. While many plants could be found in a fairly large quantity, the majority of the hillside plants occurred in small numbers. Some plants which were found only on the south slope of a hill might be found on the south slope of another hill but not on the north side. Further detailed exploration might tend to generalize this statement but the conditions as given were rather striking to me. For example, *Steriphoma elliptica* occurs on the south slope of South Hill and on the south slope of North Hill but not on the other parts of the island so far as explored. *Bauhinia cumanensis* occurs similarly. Cases of isolation are *Securidaca* only on the north side of North Hill, *Hymenaea Courbaril* on the south side of South Hill and *Pedilanthus* on the summit of South Hill.

The instances in which only two or three plants of a species were found are few and it must be admitted that a thorough examination of the hills and valleys in a better season would probably show more of the plants. Notwithstanding this the paucity of specimens was only too apparent to me when collecting, and it seems to be a fact that in the majority of cases (striking exceptions are *Tribulus*, *Stachytarpheta*, *Jatropha*, and *Croton*) the number of plants of the individual species is very much smaller than is the case with our common plants of the United States. Only one plant was found of *Chiococca micrantha*, a half dozen near together of *Securidaca*, a single one of *Hymenaea*, a single tree of *Acacia macracantha* in San Antonio valley and three or four along the river trail of El Valle, three plants of *Oncidium luridum*, three of *Huntleya*, and three of *Elleanthus attenuatus*. The list

might easily be extended and with a more thorough study might furnish an interesting question as to the rapidity of multiplication of these plants and as to the means by which they hold their own among the more rapidly multiplying plants. As to the question why certain plants are found on one slope and not on another, the palms as an example may explain. At an altitude of 500 or more meters, palms of various kinds are scattered about among the other forest vegetation. This occurs, however, only on slopes to the northeast, that is, exposed to the northeast trades. The opposite sides at this high altitude present an ordinary forest front undotted by a single palm. Moisture, then, either by its immediate presence or in its relation to the winds very probably is a factor in the distribution of all the plants.

So far as methods of distribution are concerned it may be said that there are very few special adaptations to dispersal. *Cenchrus echinatus* seems to be the only one adapted for dispersal by means of its prickly fruit, which adheres to animals. The various members of the Bignoniaceae and of the Asclepiadaceae are suited for wind dispersion as are also *Gossypium* and *Bombax*. Of course there is no limit to the carrying of seeds by birds from one valley to another so that the absence or presence of moisture is probably the most potent factor restricting the mountain plants to the mountain and the lowland plants to the lowlands.

The further question as to the distribution of the plants according to season is quite as interesting as the distribution of the plants in the various topographical regions. There is a striking difference in the appearance of the plains, the hills, and the valleys as seen in the rainy season and in the dry. In the rainy period the fields are carpeted with green and the bushes and trees are heavy with foliage and bright with blossoms. In the dry season the fields are almost devoid of stick or leaf and many bushes and trees are to every appearance dead. When the rains come on in July or August, *Tribulus terrestris* and *Kalstroemia maxima* cover the roadsides and plains; *Stachytarpheta coccinea* and *S. jamaicensis*, *Spermacoce tenuior*, *Argemone mexicana*, *Asclepias curassavica*, and many others form a rank growth of weeds in the coconut groves and cane fields; various shrubs of the hillside, *Capparis verrucosa*, *Cassia emarginata*, *Bauhinia cumanensis*, and others are out in leaf and in flower; and the climbing shrubs and vines form a luxuriant growth along the "rio" beds. In the dry season only a few of these plants can be found in flower. It is noteworthy that in several

cases the flowers appear before the leaves on shrubs; for example, *Cercidium viride*, *Gliricidia lutea*, several Bignonias, *Erythrina*, *Cassia emarginata*, and *Pedilanthus tithymaloides*.

In pleasing contrast to the plains, the mountain summit is constantly clothed in green vegetation and many blossoms are always to be found. The presence the year round of the moisture-laden clouds accounts for this difference between the mountain top and the plains. The latter have only a few months (August to February) of green vegetation, with the remainder of the season characterized by gray lifeless bushes and trees and by an utter lack of low herbs.

The foregoing represents in brief the distribution of the plants on Margarita. The discussion has been more suggestive than exhaustive. A thorough exploration of the island according to scientific methods in such work would yield valuable information not particularly in regard to Margarita but from the point of view of the life history of the plants themselves. As evinced in the above paragraphs the following topics have seemed to the writer of paramount importance in considering the plant distribution: occurrence of the plants in regions of different vegetative conditions; occurrence in groups or scattering; and the effect of the seasons both on the occurrence of the plants in different regions and on the abundance of the plants.

#### *Composition of the Flora.*

In order to compare the vegetation of Margarita and Coche with that of the adjacent regions in as thorough a way as is desirable, it is necessary to have a full understanding of the composition of the vegetation.

The purpose of studying the flora of these islands from an economic as well as a purely scientific point of view, has necessitated cataloguing the cultivated plants. These may or may not be native of the region but in either case they are so widely cultivated in all of tropical America and some of them commonly in the East Indies that for the purposes of comparing floras they must be entirely disregarded. Of those that come under this head the following have been included in the catalogue of plants. Although they are not all cultivated in Margarita yet they are in many other places (see Alph. De Candolle, *Géographie bot.*, vol. 2, p. 981-983):

Achras Zapota	Ananas sativa
Agave americana	Annona reticulata
Anacardium occidentale	Annona squamosa

Antigonon leptopus	Maranta arundinacea
Artocarpus ineisa	Momordica Charantia
Buginvillea spectabilis	Musa paradisiaca
Capsicum annuum	Nerium oleander
Carica papaya	Nicotiana Tabacum
Citrullus vulgaris	Phaseolus vulgaris
Citrus Aurantium	Phoenix dactylifera
Cocos nucifera	Physalis peruviana
Crescentia Cujete	Plumbago capensis
Cucumis Anguria	Psidium guajava
Cucumis Melo	Quisqualis indica
Cucurbita Pepo	Ricinus communis
Dioscorea alata	Saccharum officinarum
Ipomoea Batatas	Spondias lutea
Ipomoea tuberosa	Tamarindus indica
Mangifera indica	Thevetia nereifolia
Manihot utilissima	Zea Mays

The above list of forty names includes plants cultivated for ornament as well as those of more practical value. Out of the 634 plants of Margarita and Coche this leaves 590 as constituting the wild plants of the islands. But of this number many are found to be plants of widespread distribution. Undoubtedly some are native and yet many have been introduced. Margarita is one of the oldest known and longest settled (1525) parts of America, hence the opportunities for introduction have been great. The plants found in this catalogue and more or less common in all tropical countries are as follows:

Achyranthes aspera	Cissampelos pareira
Ageratum conyzoides	Clitoria Ternatea
Amaranthus paniculatus	Conocarpus erectus
Amaranthus spinosus	Crotolaria incana
Amaranthus tristis	Cyperus distans
Bidens pilosa	Cyperus ligularis (Mariscus)
Caesalpinia pulcherrima	Dactyloctenium aegyptium
Cajanus indieus	Datura Metel
Calotropis proeera	Datura Tatula
Canavallia obtusifolia	Desmanthus virgatus
Capraria biflora	Desmodium incanum
Capsicum baccatum	Eclipta alba
Capsicum frutescens	Eleocharis capitata
Cassia fistula	Eragrostis eiliaris
Cassia occidentalis	Fuirena umbellata
Cassia Tora	Heliotropium curassavicum
Cenchrus echinatus	Heliotropium indicum
Chenopodium ambrosioides	Hyptis capitata

Hyptis pectinata	Psidium guajava
Indigofera suffruticosa	Rhizophora Mangle
Ipomoea coccinea	Sauvagesia erecta
Ipomoea Quamoelit	Scaevola Plumieri
Ipomoea sinuata	Scoparia duleis
Jatropha Curcas	Senecio sonchifolia
Jussiaea suffruticosa	Sesuvium portulacastrum
Laguncularia racemosa	Sonchus oleraceus
Leonotis nepetaefolia	Solanum verbascifolium
Leptochloa mucronata	Sporobolus virginicus
Panicum prostratum	Stachytarpheta jamaicensis
Parkinsonia aculeata	Suriana maritima
Paspalum conjugatum	Telanthera ficoides
Passiflora foetida	Tribulus cistoides
Pisonia aculeata	Ximenia americana

These widely distributed plants are, of course, common enough in most of tropical America in their respective habitats. With the exception of the sedges, grasses, and ferns, most of the above plants are found about the valleys and along the routes of travel. The exceptions are made because the groups mentioned require the moisture that is found in Margarita only above the valleys in the mountains.

Excluding both the cultivated plants and those of general tropical distribution, there are left but 524 whose habitat is restricted to the American tropics. Margarita is a continental island, belonging to Venezuela. The question naturally arises whether the most of its flora pertains to that part of the American tropics or to the West Indies. A study of the remainder of the plants makes it very evident that the flora still retains its general character in that the majority of the species are common both to the West Indies and to South America. The exceptions to this are worth noting and are as follows:—

*Common to West Indies.*

Tillandsia Lescaillei
Epidendrum globosum
Pelexia adnata
Peperomia glabella
Coccoloba excoriata
Loranthus emarginatus
Cypselea humifusa
Annona reticulata
Oxalis Plumieri
Castela Nicholsoni
Heteropteris laurifolia

*Common to South America.*

Anthurium scandens
Philodendron eximium
Aechmea Fendleri
Gravisia aquilega
Vriesia scalaris
Stromanthe tonckat
Piper pseudo-mollicomum
Alternanthera canescens
Alternanthera muscoides
Loranthus orinocensis
Steriphoma elliptica

*Common to West Indies.*

Adelia Ricinella  
 Argithamnia candicans  
 Croton helicoideus  
 Croton populifolius  
 Abutilon umbellatum  
 Wissadula periflocifolia  
 Clusia flava  
 Cereus caripensis  
 Cereus Swartzii  
 Opuntia leptocaulis  
 Pereskia opuntiaeflora  
 Daphnopsis americana  
 Rotala dentifera  
 Myrcia coriacea  
 Bumelia cuneata  
 Echites secundiflora  
 Echites umbellata  
 Tournefortia gnaphalodes  
 Tournefortia incana  
 Tournefortia scandens  
 Rauvolfia Lamarkii  
 Drymonia serrulata  
 Psychotria glabrata  
 Randia aculeata  
 Erigeron spathulatus  
 Wedelia buphthalmoides

*Common to South America.*

Bauhinia eumanensis  
 Centrosema brasilianum  
 Cercidium spinosum  
 Myrospermum frutescens  
 Esenbeckia pilocarpoides  
 Sebastiana corniculata  
 Talisia olivaeformis  
 Caracasia tremadena  
 Hybanthus oppositifolius  
 Rinorea marginata  
 Cereus eburneus  
 Cereus Jamacaru  
 Combretum secundum  
 Clidemia neglecta  
 Vaccinium latifolium  
 Tabernaemontana psychotrifolia  
 Evolvulus filipes  
 Cordia discolor  
 Clerodendron molle  
 Brunfelsia Hopeana  
 Lycium salsum  
 Beyrichia scutellarioides  
 Macfadyena corymbosa  
 Jacobinia pauciflora  
 Baccharis rhexioides  
 Eupatorium ballotaefolium  
 Vernonia scorpioides  
 Wedelia caracasana  
 Maxillaria virguncula

In this list of the plants of limited distribution there are thirty-seven to be found in the West Indies or Mexico and forty in South America. To this last number there should be added the forty-two endemic species. The flora of Margarita may then be said to consist of the following elements in the given proportions:—

Cultivated plants	40
Cosmopolitan plants	66
Common to tropical America	419
Limited to West Indies	37
Limited to South America	82
	—
Total	644

The great variety of plants in Margarita is for the most part in widely separated genera and families. It is seldom that there are

more than two or three species in any one genus. The well marked exceptions to this are the large tropical genera *Panicum*, *Epidendrum*, *Piper*, *Euphorbia*, *Croton*, *Cassia*, and *Solanum*. The 644 species are distributed among 398 genera and in 98 families, the larger proportion being among the choripetalous groups.

The families having the largest representation in the flora are as follows:—

	Genera	Species
Leguminosae	41	65
Compositae	25	30
Euphorbiaceae	14	31
Gramineae	15	25
Rubiaceae	13	17
Solanaceae	11	23
Verbenaceae	11	19
Bromeliaceae	11	15

Members of the Leguminosae are the most common plants. Everywhere these shrubs and trees with their often numerous small leaflets are to be found. These have also some of the most striking flowers, as the *Poinciana*, the *Caesalpinias*, *Tamarindus*, the *Cassias*, and *Calliandra*.

The paucity of the Compositae, on the other hand, and the inconspicuous character of their flowers are remarkable when compared with the traits of the group in other regions, either tropical or temperate. In Margarita the family is chiefly represented by insignificant weeds.

The lack of grasses and sedges, of course, is very striking to a traveler from the temperate regions. There is no such thing as turf and the few grasses that are to be found are rather scattered.

One of the families that is largely represented in individuals if not in species is the Cactaceae, a group which covers the plains for miles. On Margarita there are twelve species of this family distributed in six genera. Of these, five are more or less tall and candelabra-shaped, with little or no secondary branching; two are melon-shaped, one (*Pereskia*) is a low much-branched tree, and one (*Rhipsalis*) is a small cord-like epiphyte.

Another family, that of the Bromeliaceae, is characteristic not because of its few individuals but because of their striking colors and general appearance. All of the representatives of the eleven genera and fifteen species possess a rosette habit and more or less fleshy leaves. Their colors, too, are attractive.

Other groups characteristic of tropical regions and to be found on Margarita are the Melastomaceae, Aroideae, Piperaceae, Loranthaceae, and such members of the Filices as *Trichomanes*, *Hymenophyllum*, and *Cyathea*.

Thus it may readily be seen that the variety of plants is rather great. One finds all conditions from that in which the halogens and other xerophytes of the seashore and plains are found to that of the mesophytes in the moist mountain regions, and not alone terrestrial plants but also many epiphytes and a few phanerogamic parasites.

#### FLORA OF THE ISLAND OF COCHE.

##### *Description of the Vegetative Conditions.*

The island of Coche is a typical desert island and, so far as reported, had never been visited by a botanist. The conditions existing on such an island were of great interest to me, and the fact that two new species of plants were found together with the fact that few descriptions of such an island are on record, makes it seem desirable to describe the flora of Coche and the vegetative conditions in such detail as may be possible.

It was through the kindness of friends at Porlamar, Margarita, that I was enabled with a companion, Dr. A. F. Blakeslee, to visit Coche. The party, in charge of Sr. Antonio and Sr. Guilarte, left Porlamar at noon, Aug. 4, 1903, in a sloop, and reached San Pedro on the western end of Coche shortly after nightfall. Although the sign over one doorway proclaimed "Restaurant" within, yet the proprietor refused to furnish either food or shelter. Fortunately, our companions had friends there so that rooms in different houses were assigned where hammocks, which had been brought along, could be slung. The meals were picked up as well as could be done at the stores. Drinking water cost two and one-half cents a liter. It was found that this water was brought over from Porlamar and from the mainland. Water was to be had from pits on the shore but it was undesirable for drinking purposes.

On the morning of the 5th of August Dr. Blakeslee and I traversed the low shore of this end from the south point to the north. The beach stretches for a kilometer and a half to the northwest into a narrow strip of land. On this extent of lowland is a salt lake, where great piles of salt are gathered for shipment. Beyond the lake itself for another

kilometer the beach extends eastward, still a dazzling white. In one portion of the lake, the bottom is covered with a pink animal growth while the rest is a clear blue. The presence of quicksands prevented any close examination of the lake.

Inland from the beach on this end the hills rise gradually and are rounded. In general, the hilltops are hard, covered with loose stone and sand. A few hilltops are entirely without soil, merely a mass of loose broken fragments of rock with no vegetation. The surface inland is rolling, there being no level surface of any extent. From the hilltops to the hollows or small valleys, the surface gradually gets sandier until at the bottom it is a clear stretch of sand free from any stones.

The seashore on the southwest side presents a contrast to that on the west. The beach is about a meter in width for three kilometers or more, and gravel and stony cliffs rise abruptly to the height of twenty-five or thirty meters. From the top of the cliffs the inland surface does not rise over thirty meters higher. About three kilometers from San Pedro the cliffs are lower, and here show abundance of hard rock. The lower part of the cliff and also huge boulders broken off are smoothly worn and dark red or brown in color. At the eastern extremity of the south shore, the beach stretches to the southwest in a long narrow spit of land.

The total length of the island is about twelve kilometers, and breadth three kilometers. From almost any of its hills can be seen Margarita, at the nearest point within eight kilometers; and to the south the high mountain ranges show distinctly on the mainland about twenty-four kilometers away. The village of San Pedro is composed entirely of homes of ordinary fishermen and of the pearl fishers. There is a church, a graveyard, and seventy-five to a hundred houses besides several stores. The eastern extremity of the island is used for the pearl-fishing business but there is no village there.

No mention of rain on the island has been made because the existence of any at any time was not apparent. The natives claimed there never was any. As a matter of fact at the time of this visit there was a slight mist in the afternoon during the passing of a heavy thunder-storm on the coast of the mainland. This mist was barely perceptible and of course not sufficient to furnish water in any quantity. No streams or springs exist on the island. The unweathered condition of the rocks suggests the great lack of rain, while the presence of the sand

in the hollows rather than on the hilltops may be entirely accounted for by the wind movements. The rounded hills are wind worn, and there are no gullies due to rushing water. It is noticeable that it is the northern shore that has the gradual slope, and the southern that is precipitous. This of course is due to the fact that the prevalent wind is from the northeast rather than from the south.

As to the vegetation that occurs on such an island it is either adapted to a life on the salt seashore or suited to withstand extreme drought inland. The land spit on the eastern end is bordered on the inside shore by mangroves. The beach about the "salina" or salt lake produces the customary *Batis*, *Salicornia*, *Trianthema*, and *Alternanthera*. On the inland side of the salt plain the bushes of *Castela* are abundant. *Cassia hispidula* is scattered here also. *Pavonia cochensis* is abundant in the sandy valley back of San Pedro. The valleys are characterized by the low *Pereskia* trees, the *Acacias*, and *Gomphia*, *Guaiacum*, *Pithecolobium*, and the largest of the trees, *Bumelia cuneata*, about three meters high. The smaller plants here are *Jatropha gossypifolia*, *Solanum polyacanthos* in the valleys; *Croton*, *Argithamnia*, *Opuntia*, *Melocactus*, and *Waltheria* on the rocky hillsides or hilltops; and in the most rocky as well as in sandy places *Stylosanthes viscosa*, the most abundant plant on the island.

Of all the foregoing plants only one, *Argithamnia cochensis*, is exceptional in color. This is dark red throughout. The other plants are gray at least as to the trunk and stem, and the leaves are a gray-green and either protected by dense pubescence or are leathery.

There appeared to be no plants of economic importance on the island. A few straggling palms are in the village of San Pedro, but they appeared to be neither in flower nor in fruit.

At the time of our visit, the only plants in bloom were *Stylosanthes*, *Caesalpinia*, and *Bumelia*. On *Gomphia* many dried remnants of fruits still remained. This, together with the fact that several trees showed signs of budding, suggests that at another time more flowers and possibly more plants might be found. As a matter of fact no annuals were collected, but all were plants with extremely long and woody roots. Some specimens of *Stylosanthes* which were but 8 cm. in height above ground had roots 22 cm. long.

This collection while meager in its specimens probably represents well the flora of the island. The result may be summarized as follows:—

Species of Plants	37
Genera	33
Families	21
Endemic species	2

Following is a list of the plants of Coche, those numbered being collected and the others merely noted. Citations are given for those plants which I found only on Coche, citations for the others being referred to the list of Margaritan plants.

*Catalogue of Plants.*

GRAMINEAE.

SPOROBOLUS VIRGINICUS (L.) Kunth.— On Margarita also.

BROMELIACEAE.

TILLANDSIA RECURVATA L.— No. 14. On Margarita also.

T. UTRICULATA L. —No. 15. On Margarita also.

LORANTHACEAE.

PHORADENDRON RUBRUM (L.) Nutt., Journ. acad. Phila., n. s., vol. 1, p. 185 (1848); Griseb., Fl. Brit. W. Ind., p. 314. *Viscum rubrum* L., Sp. pl., vol. 2, p. 1023 (1753).—No. 10. Distribution general in tropical America.

CHENOPODIACEAE.

ATRIPLEX CRISTATA H. & B.— On Margarita also.

SALICORNIA FRUTICOSA L.— No. 9. On Margarita also.

AMARANTHACEAE.

ALTERNANTHERA CANESCENS HBK.— On Margarita also.

GOMPHRENA PILOSA (Mart. & Gal.) Moq.— No. 13. On Margarita also.

BATIDACEAE.

BATIS MARITIMA L.— No. 16. On Margarita also.

AIZOACEAE.

TRIANTHEMA PORTULACASTRUM L.— On Margarita also.

## CAPPARIDACEAE.

CAPPARIS SP.—No. 1.

CAPPARIS STENOSEPALA Urb.—No. 2. On Margarita also.

## LEGUMINOSAE.

CAESALPINIA CORIARIA (Jacq.) Willd.—No. 3. On Margarita also.

CASSIA HISPIDULA Vahl, Eclog. Am., vol. 3, p. 10 (1807); Mart., Fl. Bras., vol. 15, pt. 2, p. 131.—No. 4. Further distribution, Mexico.

PITHECOLOBIUM UNGUIS-CATI (L.) Benth.—No. 11. A tree, 3 m. high, top wide-spreading. On Margarita also.

STYLOSANTHES VISCOSA Sw.—No. 6. On Margarita also.

ZORNIA BRACTEATA (Walt.) Gmel., Syst., p. 1096 (1791).—*Anonymos bracteata* Walt., Fl. Car., p. 181 (1788).—No. 5. Further distribution, North America and South Africa.

## ZYGOPHYLLACEAE.

GUAJACUM OFFICINALE L.—No. 19. On Margarita also.

## SIMARUBACEAE.

CASTELA NICHOLSONI Hook.—On Margarita also.

## EUPHORBIACEAE.

ARGITHAMNIA COCHENSIS Johnston, Proc. Amer. acad. arts and sci., vol. 40, p. 688 (1905).—No. 12. Endemic.

CROTON FLAVENS L.—No. 7. On Margarita also.

JATROPHA GOSSYPIFOLIA L.—On Margarita also.

J. URENS, var. STIMULOSA Muell. Arg.—On Margarita also.

## MALVACEAE.

PAVONIA COCHENSIS Johnston, Proc. Amer. acad. arts and sci., vol. 40, p. 690 (1905).—No. 18. Endemic.

## STERCULIACEAE.

WALTHERIA AMERICANA L.—No. 24. On Margarita also.

## OCHNACEAE.

GOMPHIA PYRIFOLIA Griseb., Fl. Brit. W. Ind., p. 105 (1859).— No. 20. A tree, about 3 m. high.

## TURNERACEAE.

TURNERA DIFFUSA Willd.— No. 21. On Margarita also.

## CACTACEAE.

CEREUS MARGARITENSIS Johnston.— On Margarita also.

C. EBURNEUS Salm-Dyck.— On Margarita also.

MELOCACTUS COMMUNIS Link & Otto.— No. 22. On Margarita.

OPUNTIA TUNA Mill.— On Margarita also.

PERESKIA OPUNTIAEFLOA DC.— On Margarita also.

## RHIZOPHORACEAE.

RHIZOPHORA MANGLE L.— On Margarita also.

## MYRSINACEAE.

JACQUINIA BERTERII Spreng., Syst., vol. 1, p. 668 (1825) — Further distribution, San Domingo. A tree, about 3 m. high.

## SAPOTACEAE.

BUMELIA CUNEATA Sw.— On Margarita also.

## SOLANACEAE.

LYCIUM SALSUM Ruiz. & Pav.— No. 8. On Margarita also.

SOLANUM POLYACANTHOS Lam., Illust., vol. 2, p. 23 (1793).— No. 17.

## COMPARISON OF THE FLORA OF MARGARITA AND COCHE WITH THAT OF OTHER REGIONS.

Two different points of view may be taken in comparing the floras of various regions: one consists of a study of the lists of plants collected from the regions in question, and the other consists of a study of the types of vegetation. In using the former method one need only

resort to the collection of plants in the various herbariums and to the lists of plants published in various books and journals; in this way the distribution of the plants is discovered, the knowledge of which is valuable both to the taxonomist and the biologist. In this method the research worker must either for himself consult all the plants in the herbariums and represented in the lists and must verify their identification or else depend for their value upon the person identifying the plant or publishing its name. It is not necessary to see the plant growing. The species are all units and are well represented as such by mere names.

In using the second method of comparative study, that of considering types of vegetation, one encounters a very different proposition. Types represent groups of plants and groups which do not necessarily consist of separate species, in fact a type of vegetation may be made up of a number of species. Types of vegetation, then, can be represented only very indefinitely by published lists of names of plants or by the plants themselves as they occur mounted on herbarium sheets. It is true that names are in use to designate certain types of vegetation, terms such as xerophyte, hydrophyte, mesophyte, and others of more restricted meaning; and it is certain that these terms picture to one at all familiar with such work definite features in the vegetation. Moreover, the characteristics of any type of vegetation are often so well shown in the species constituting that type that one can by examining herbarium specimens very commonly determine to what type of vegetation the plant in question belongs.

So far it may be seen that one can by research among collections and lists of plants obtain both a fair idea of the species of plants from any particular region and some knowledge of the type or types of vegetation found in that region. So much can be done at home. The types, however, represent groups, and as the groups are often composed of many species which have one feature in common but often have a wide range in size, outline, method of branching, and color, it is impossible to give a complete and at all real picture of a locality without considering these various features, characteristics which can be ascertained only by traveling among the regions in question and by viewing personally the types of groups or composites of species as they are growing together in the various localities. The modifications of groups are so great that it is necessary to visit many localities and to visit the same localities at various times of the year before one can obtain a true knowledge of the character of the vegetation.

In order then to make an intelligent and thorough comparison of the flora of Margarita and Coche with that of other regions about the Caribbean Sea, it would be necessary for one to have access to specimens of plants and lists of plants collected in all lands bordering the Caribbean and also to have traveled in those regions. So far as the lists of plants and the collections are concerned it must be said that despite the many visits of American botanists to the West Indies and tropical America, and despite their intense activity in the United States, there is yet very much to be known about the plants in those regions. Parts of Mexico and of Central America are being well worked over. Colombia and Venezuela have had so little work done on them that comparison of lists of their plants is almost valueless. The West Indies as a whole have the useful works of Grisebach and of Professor Urban but these contain no lists of plants of the individual islands, so that they are scarcely to be used in comparative work. A few of the American botanists frequent Mexico and parts of Central America, a very few have visited Colombia, still fewer Venezuela, and some frequent Cuba, Hayti, Porto Rico, and Jamaica. Seldom is the traveling extensive or in more than one region. Both plant and animal surveys of the United States are fairly thorough through many parts, but in tropical America and the west Indies, biologically closely related to our southern States, little such systematic work has been done.

In view of the situation as above discussed it is perhaps particularly desirable that I make such a complete comparison of the flora of Margarita and of Coche as may be possible with that of other regions, especially considering that I have what I believe to be a complete list of all plants ever collected in or recorded from Venezuela and also that I have been enabled to visit personally many parts of Venezuela, British Guiana, and Panama, and many of the West Indian islands.

In a preceding chapter on the composition of the flora of Margarita, it would seem that the vegetation of Margarita partook equally of the nature of the West Indian and of the South American elements. This appearance I believe to be due to the large proportion of cosmopolitan plants present. In reality Margarita is, as would be expected, distinctly South American in its flora as will appear in the following pages.

The two islands under discussion, Margarita and Coche, are the

most eastern of all those along the northern coast of Venezuela. The other islands to be considered are Testigos, Blanquilla, Orchilla, Los Aves, Los Roques, Cubagua, Tortuga, Aruba, Buen Ayre, and Curaçoa, the respective positions of which may be seen by referring to the accompanying map of the Carribean Sea and its surrounding lands (Pl. 23). All of these islands are identical in topographical features with the plains and hills of Margarita.

Of this group Cubagua is eight and one half kilometers (5.25 mi.) from Margarita and twice the distance from Coche, of which it is almost a counterpart in size and physical characteristics. No botanical research has been made upon it, though I have passed very near the shore several times and have observed that it has the same barren features that Coche possesses. There is no water on the island and never has been any within historical time, and though in the early sixteenth century it was the site of a thriving city of Spanish pearl-fishers, at present there may be seen only a few fishers' huts.

The next nearest island is La Tortuga, ninety kilometers (60 mi.) from Margarita and the same distance from the coast of Venezuela. The island is twenty kilometers (12 mi.) from east to west and ten kilometers (6 mi.) from north to south. It is merely a raised coral reef and presents the appearance of a low waste of land with an almost level surface and a very narrow beach. The vegetation as reported by Ernst consists of sixty-nine different species of plants largely common to American tropics of which, however, twenty-three are not to be found on Margarita.

The islands Los Aves, Testigos, and Blanquilla, so far as is known, have never been visited by a botanist. Los Aves consists of a number of small rocky and barren islets midway between Buen Ayre and Los Roques. They have been noted solely as a source of guano. The vegetation would naturally be very scanty. Testigos is a small group eighty kilometers (50 mi.) north of Margarita; and Blanquilla which is somewhat larger, being twenty-five kilometers in circumference, is seventy kilometers north of Margarita. Though there are no recorded visits to these islands, the flora may be assumed to be very scanty and to consist for the most part of cosmopolitan seashore plants.

Los Roques is a group of islands one hundred and thirty kilometers (80 mi.) from the coast of Venezuela and consists of a dozen or more rocky islands none over a kilometer in length. The flora is entirely

that of a tropical seashore, and is similar to that of Tortuga and Coche and the coast of Margarita, though more limited. As reported by Ernst there are twenty-four different species, of which *Cyperus brunneus*, *Cyperus caesius*, *Eragrostis prolifera*, and *Opuntia spinosissima* have not been reported from either Margarita or Coche. Two of these, *Cyperus caesius* and *Opuntia spinosissima*, are not found on Tortuga. It will be noticed, however, that these are of wide distribution.

The three western islands lying off the coast of Venezuela belong to the Dutch Republic. The most important work that has been done upon them botanically was by Suringar ('86). He lists, however, scarcely a dozen plants from Aruba and Buen Ayre. From the character of these two islands one is led to expect a flora similar to that of Curaçoa though more limited. Buen Ayre is about forty kilometers (25 mi.) east of Curaçoa and has an area of twenty-four thousand hectares (85 sq. mi.), while Aruba is nearly seventy kilometers west of Curaçoa with an area of seventeen thousand hectares (69 sq. mi.).

Curaçoa is the one of this group upon which some botanical work has been done. Several botanists have visited the islands, the most notable of whom was perhaps Suringar. As determined from his list of Curaçoan plants (117 species), fifty have not been reported from Margarita. To be sure Suringar's list is not taken to be at all complete of the flora of Curaçoa. Simons ('68) has published a much longer list but unfortunately the names are in a great part old ones and quite impossible to identify for certain with those at present in use. Even considering this list, Margarita has over four hundred plants not on Curaçoa. This difference in the flora is due to marked contrast in physical conditions and to their difference in geographical position. In physical condition Curaçoa resembles the plains and hills of Margarita, and has a vegetation similar to theirs, but the heavy woods and the varied vegetation of the mountain tops are to be found in Margarita only. In geographical position, although they are both coastal islands and are on nearly the same parallel, yet they are five hundred kilometers (300 mi.) apart and Curaçoa is ninety kilometers (50 mi.) from the coast of Venezuela. It is probable that complete exploration of both islands would show more resemblances between them, but according to present knowledge, the differences in physical conditions and in geographical situation alone may well account for the differences in the floras.

All of these islands extending along the north coast of Venezuela not only resemble each other very much but they are also like the coast of the mainland. There are to be found much the same species constituting the seashore flora, the flora of the lagoon, of the wild cactus-covered hills, and of the few fertile coconut valleys. This is well illustrated by almost any part of the north coast. Carúpano is in a long narrow valley with arid hills on each side. Cumaná is on a sandy plain at the foot of the hills. Guanta is in a small valley with the appearance of a perpetual drought on every side. La Guaira is on a hillside by the edge of the sea and the hill is a brown and sun-baked exposure although it is broken here and there by green valleys and by a green mountain rising above. A short way inland but still in the coastal region between Caracas and Valencia and about the Lake of Valencia trees are scarce or lacking, the mountains are brown and clothed only in small shrubs or in dry grass, and in the valley are scorching sandy plains with here and there the shade of a tree.

These islands are similar to the coastal land as naturally they should be, having been in early times a part of the coast and yet there is a vast country behind the coast to which they are not at all like. The mountain region of the Andes, anywhere from one thousand to four thousand meters high, the grassy plains of the Orinoco, and the forests to the south present features vastly different in every respect. Unfortunately our knowledge of their flora is very limited. Many plants were described as new from Humboldt's travels, but since that time there have been few collections and fewer plants described. It is known that there are many plants which are common to the rest of the tropics. Altogether our information is one-sided as tending to show the cosmopolitan rather than the characteristic plants. I have compiled a list of all the published names of Venezuelan plants which comprises some three thousand names. That some of these are names which may not be in good standing today cannot be denied, but I have at least made reasonably sure that they represent nearly three thousand different species.

Out of the six hundred and thirty-four Margaritan plants two hundred and ninety-five have not been published as occurring anywhere else in Venezuela. Inasmuch as many of these are cosmopolitan plants it shows not the peculiarity of the Margaritan flora but the small amount of work that has been done on the mainland.

Close to the mainland but yet not considered one of the Venezuelan Islands is Trinidad lying to the northeast of Venezuela. In general the flora and vegetative conditions of the island are similar to those of the mainland. There is a large collection of well identified plants at the St. Clair experiment station at Port-of-Spain and I had the opportunity of comparing my first collection with them. From this I found that one hundred and seventy-nine Margaritan plants were not in the Trinidad herbarium and one hundred and sixty-one were there. Unfortunately it has been impossible for me to compare the remainder of my plants. Of those plants that were not in the Herbarium the majority were of wide distribution. Of the plants of restricted distribution, however, the greater number were Venezuelan rather than pertaining to the West Indies.

Trinidad presents a distinct contrast in the appearance of its vegetation to that of the islands of the north coast. The latter are dry as is the adjacent coast. Trinidad, however, resembles and is really a part of the east coast, characterized by low land, well watered, and heavily wooded. Thus appears the east coast of Venezuela and of British Guiana, green with luxuriant vegetation, broken here and there, to be sure, with sandy stretches and low hills, but in effect with a truly tropical verdure. Trinidad has a series of hills across the low end of the island and a range of low mountains across the northern end. The regions about these hills are in many places heavily covered with forests. Across the middle of the island is a belt of almost unbroken savannah land much used for grazing and for cane crops. Both on the eastern and on the western side are extensive swamp lands. Only in isolated and restricted areas are there any arid districts at all resembling those of Margarita.

The entire chain of small islands extending from Trinidad northward is with few and unimportant exceptions similar in vegetative conditions to Trinidad. For the most part they consist of well cultivated plains and green-clad hills and mountains. Porto Rico at the northern end of this chain of islands and the easternmost of the Great Antilles presents features somewhat different. With the exception of a narrow plain about the island, the surface of Porto Rico is undulating and broken into sharp hills and ridges from one end to the other. In marked contrast to Trinidad, Porto Rico has very little forest land and only a few small savannahs. Moreover, the waste lands, barren or cactus-covered, along the south shore are comparable

with the wastes of Margarita. This northern island is perhaps in a condition midway between that of the coast and coastal islands of Venezuela and that of Trinidad, the former being in a condition of drought and the latter in a state of excessive moisture for much of the year. In regard to the species of plants, there is of course a vast difference. Professor Urban's *Flora Portoricensis* is very complete so far as published. In it are sixty-one plants to be found on Margarita, although the author does not refer more than twenty-five to the island, these references being only from my first collection of plants. As many as this is naturally to be expected from the wide distribution of many of the plants. Moreover, there are fully five hundred plants of Margarita not to be found on Porto Rico, and of course many more on the much larger island not on Margarita.

In the small Cayman Islands farther west in the region of the Great Antilles there is also a diversity from Margarita. These islands consist of Grand Cayman, Little Cayman, and Cayman Brac, two hundred and eighty-nine kilometers (180 mi.) northwest of Jamaica and about the same distance south of the center of Cuba. Grand Cayman is twenty-seven kilometers from east to west, six to eight wide at the eastern end and eleven to thirteen kilometers (7 to 8 mi.) wide at the western end. There is no elevation exceeding fifty meters (150 ft.). Some forest land is present, and in the center is considerable boggy soil suggesting the presence of sufficient moisture for much vegetative growth. Collections of plants have been made on the Caymans by Professor C. F. Millspaugh and by Mr. W. Fawcett. From the total of two hundred and twenty-eight species constituting these lists eighty-four are found on Margarita. Five hundred and eighty Margaritan plants are not found on the Caymans. This suggests a distinctly different flora notwithstanding the presence of so many plants of wide distribution. This difference can be accounted for partially in the vegetative conditions, but in the main it is due to geographical position, the Cayman Islands being some seventeen hundred kilometers northwest of Margarita. Moreover in comparing the flora of the Cayman with that of the other Venezuelan islands or with Trinidad the same result is obtained.

It is impossible to make a definite comparison of the plants of Jamaica and Cuba with those of Margarita, for the lists are so incomplete. It must suffice to say that from the material available for comparison it is certain that a very large part of the plants of Jamaica and

Cuba is not to be found in northern Venezuela excepting of course the flora common to all tropical countries. The vegetative conditions of these islands can be said to differ from portions only of Venezuela. The waste plain west of Kingston is duplicated in the plain of Margarita. The valleys and ridge of the Blue Mountains resemble those of the coast range above Caracas in Venezuela. The barren mountains about Santiago de Cuba are identical in appearance with range after range extending from Caracas to Valencia. The rolling land that occupies the most of Cuba with its cane fields and tobacco fields is similar to that of the interior of Venezuela. There still remains in Cuba some of the virgin forest. In fact there is considerable of it and it suggests that of the more nearly equatorial countries. Only in a limited way, however, does it begin to compare with a truly tropical forest. Such vegetation as is to be found along the shores of the Orinoco, Essequibo, and the Amazon is nowhere to be found among the northern islands.

Further north than the islands of Jamaica and Cuba, in subtropical Florida there are naturally many changes from the tropics. Some districts approach in their wild luxuriance of vegetation that of countries near the equator and on the other hand there are to be found some stretches barren as the desert regions of the Venezuelan islands. As a whole, however, the individual species making up the type of vegetation have changed. The difference in temperature of the regions sets a limit upon the distribution of the species. In passing, it is of interest to note that notwithstanding the great differences in species, exclusive of cultivated plants there are ninety-seven different species occurring in both southern Florida and Margarita.

#### CONCLUSION.

In writing the foregoing pages three objects have been foremost in my mind: to catalogue the plants of Margarita, to describe its vegetative conditions, and to compare its flora with that of adjacent regions.

The catalogue of the species comprises 644 names, all of the plants that have been reported from Margarita. Collections, however, have been made only on part of the eastern end and during only a part of the year (March, July, August, and the first four days in September) thus leaving opportunity for much additional work. It is doubtful if this catalogue comprises much more than three fourths of the entire

flora of the island. Forty-two new species, including two new genera, have been discovered on the island.

The vegetative conditions of Margarita are much more varied than those of the other islands. Margarita has both a rich mountain flora and also the flora of arid plains and hills. Curaçoa and the others possess only arid vegetative conditions.

In regard to the comparison of the flora with that of adjacent regions, it is much to be regretted that data are so insufficient as to lessen the value of any comparison and in some cases actually to prohibit it. The flora of Margarita comprises all the plants found on Coche with three exceptions. The other small islands are probably similar in this respect. La Tortuga has twenty-three out of sixty-nine plants not to be found on Margarita and Los Roques has four out of twenty-eight not on Margarita. Though it is impossible to speak accurately of Curaçoa, to judge by the references cited on previous pages there are about four hundred plants there of which one hundred are not on Margarita.

Although there is a large list (240) of plants of Margarita not published as occurring in Venezuela, it is probable that a large proportion of them do. The vegetation on the mainland (near Carúpano and Cumaná) opposite Margarita is identical in appearance with that of Margarita.

Trinidad has a very large flora, yet over two hundred Margaritan plants have not been reported from there, and are not in the Herbarium of the Trinidad botanical gardens.

The entire chain of islands to the east of the Caribbean Sea possesses a vegetation consisting of many species not to be found on Margarita. It is of a much more luxuriant character. In the extensive flora of Porto Rico so far as can be ascertained there are less than one hundred Margaritan plants to be found. Most of these are common to the American tropics.

In the flora of the Cayman islands it is seen that out of their two hundred and twenty-eight species only eighty-four are on Margarita. The reference to the plants of the southern United States similarly shows about a hundred from Margarita which are, however, cosmopolitan.

In the comparison of the flora with that of other regions about the Caribbean Sea it is evident that the flora of Margarita is largely composed of plants common to many parts of the American tropics. It

is also seen in studying the distribution of the individual plants that Margarita contains twice as many plants which are characteristic of South America as are characteristic of the West Indies. And finally, it is still as clearly evident from comparing it with other islands about the Caribbean Sea that while Margarita has some plants common to all of the islands, yet as a whole it has a flora quite distinct from the northern islands and at the same time closely approaching that of the Venezuelan islands and the north coast of the mainland.

## LITERATURE.

To show the more important publications on the exploration, botanical collecting, and geography of Venezuela, the following bibliography is added.

## GEOGRAPHY OF VENEZUELA.

Note.—The following are selected from a list of about fifty books on Venezuela, and include, it is believed, all that are of any value to the botanical worker.

Anonymous.

'24. Letters written from Colombia during a journey from Caracas to Bogotá. G. Corvie & Co.: London, 1824, 208 pp., map.

Gives description of the route as to forests, meadows and cliffs, as to agriculture, towns, etc.

'73. Memoria de la Direccion general de estadistica al Presidente de los Estados Unidos de Venezuela en 1873. Impr. Nacional: Caracas, 1873, 3 vols.

Very complete as to geography and commerce.

André, Eugéne.

'04. A naturalist in the Guianas. Scribner's Sons: New York, 1904, 310 pp., 32 pls., map.

André went on two expeditions up the Orinoco and Caura Rivers.

Bénard, Charles.

'97. Le Vénézuéla. Impr. G. Gounouilhou: Bordeaux, 1897, 106 pp., map.

Gives heights of mountains, length of rivers and drainage area, table of temperatures, agriculture, and animals.

Caulin, Antonio.

1779. Historio corographica natural y evangelica de la Nueva Andalucía, prov. de Cumaná, Guayana y vertientes del rio Orinoco. J De San Martin: Madrid 1779, 482 pp., 3 pls., map.

A natural history, including descriptions of the rivers.

Cazeneuve, Paul de and François.

'88. Les États-Unis de Vénézuéla. Sauvaire: Paris, 1888, 300 pp., map.

A good map, a very good guide containing population of many cities, courses and lengths of many rivers, medicinal plants, and history.

Codazzi, Agustín.

'41. Resúmen de la geografia de Venezuela. Impr. de H. Fournier y Compia: Paris, 1841, 648 pp.

The most complete geographical work on Venezuela.

Dauxion-Lavaysse, Jean François.

- '20. A statistical, commercial, and political description of Venezuela, Trinidad, Margarita, and Tobago. G. & W. B. Whittaker: London, 1820, 479 pp.

Contains an interesting sketch of Margarita.

Duane, William.

- '26. A visit to Colombia in the years 1822 and 1823. Venezuela, p. 1-351. T. H. Palmer: Philadelphia, 1826, 632 pp.

Gives a good description of the hills and the valleys, and the wooded and the barren regions between Caracas and Colombia.

Engel, Franz.

- '88. Auf der Sierra Neváda de Merida. A. G. Richter: Hamburg, 1888, 36 pp. Sammlung gemein verständlicher wissenschaftlicher Vorträge, n. f., series 3, no. 58.

Ernst, Adolphus.

- '68-'69. Ascension á la Sierra Neváda de Merida, Feb. 18, 1868. Vargasia. Caracas, 1868-69, p. 199-202.

- '84-'86. La Exposicion Nacional de Venezuela en 1883. Impr. de la Opinión Nacional: Caracas, 1884-86, 2 vols., map.

Gerstácher, Friedrich.

- '68-'69. Neue Reisen durch die Vereinigten Staaten, Mexico, Ecuador, West-indien und Venezuela. H. Castenoble: Jena, 1868-69, 3 vols. Chapters on La Guaira, Caracas, Valley of Aragua, llanos, San Fernando de Apure, Apure River, Orinoco River, and mines at Angostura.

Goering, Anton.

- '93. Vom tropischen Tieflande zum ewigen Schnee. Eine malerische Schilderung des schönsten Tropenlandes. A. Fischer: Leipzig, 1893, 54 text figs., 12 colored pls.

Though rough sketches, the illustrations of this work give some idea of Maracaibo, Merida, and Mucuchies.

Humboldt, Alexander, and Bonpland, Aimé.

- '14-'29. Personal narrative of travels to the equinoctial region of the new continent, during the years 1799-1804, translated by Helen M. Williams. Longman, Hurst, Rees, Orme, and Brown: London, 1814-29, 7 vols.

Contains descriptions of the country about Cumaná, Cumanacoa, and San Fernando de Apure.

- '14. Voyage aux régions équinoxiales du nouveau continent. F. Schoell: Paris, 1814, 3 vols., 2 atlases.

Contains full description of route.

Kol, H. van.

- '04. Naar de Antillen en Venezuela. A. W. Sijthoff: Leiden, 1904, 552 pp.

Description of Curaçoa. Good illustrations of islands.

Landaeta Rosales, Manuel.

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Impr. Bolivar: Carácas, 1889.

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Indiën in de jaren 1837-40. J. F. Schleijs: Amsterdam, 1842, 359 pp.  
Chapters on Curaçoa, Aruba, Bonaire, and Venezuela.

Lével, André Aurelio.

- '81. Esbozos de Venezuela I. Margarita. Caracas, 1881, p. 26-50.

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eurs: Paris, 1904, 474 pp., 4 maps, diagram.  
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and British Guiana. Pertains particularly to the mining regions.

Ober, Fred A.

- '91. The Knockabout club on the Spanish Main. Estes and Lauriat:  
Boston, 1891, 239 pp.  
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new to the country.

Paez, Ramon.

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ner & Co.: New York, 1868, 473 pp., map.  
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de S. Hallet: New York, 1864, 32 pp.  
Description of shores, winds, and currents of Lake Maracaibo.

Robinson, J. H.

- '22. Journal of an expedition 1400 miles up the Orinoco and 300 up the  
Arauca. Black, Young, and Young: London, 1822, 397 pp.  
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Roncayolo, L.

- '94. Au Venezuela, 1876-1892. P. Dupont: Paris, 1894, 208 pp.  
Excellent photographs, chapter on Merida, etc.

Sievers, Wilhelm.

- '88a. Die Cordillere von Mérida nebst Bemerkungen über das kari-  
bische Gebirge. Geogr. Abhand., vol. 3, no. 1. Hölzel: Wien, 1888, 238  
pp., geolog. chart.

Good chapters on rivers, lakes, climate, vegetation, agriculture, etc.  
Bibliography especially good on geology.

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map.

Full description of paramo region, of alpine or mountain regions in general, and of llanos. Good geography of Venezuela.

'96. *Zweite Reise in Venezuela in den Jahren 1892-93.* L. Friederichsen & Co.: Hamburg, 1896, 327 pp., map.

Contains a good map of coast and islands from Coro to Trinidad.

#### MAPS.

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'97-'98. *Orinoco-Essequibo Region.* Map 2. Senate doc., vol. 9, no. 91, pt. 4, 1897-98.

There are also a number of coast charts issued by the U. S. hydrographic office.

#### VEGETATION OF VENEZUELA.

Anonymous.

'64. *Indicacion de algunos de los principales objetos de historia natural, es decir: minerales, vegetales y animales — para la exhibicion 1864.* Imprenta de lo Estados Unidos de Venezuela, por Felix é Bigotte, Caracas, 1864, 22 pp.

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Excellent in every way.

Bellermann, F.

'94. *Landschafts- und Vegetations-Bilder aus den Tropen Süd-Amerika's nach der Natur gezeichnet von Prof. F. Bellermann.* R. Friedlander & Sohn: Berlin, 1894, 24 pls.

Illust. of Cumana, La Guaira, Caracas, Merida, and vicinities. Text by H. Karsten.

Braun, A.

'58. *Übersicht der Characeen aus Columbien und Guyana.* Monatsber. königl. preuss. Akad. Wissensch. Berlin, 1858, p. 354-367.

Caulin, Antonio.

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Chapters on the trees, fruits, medicinal plants, gums, resins, balsam, various animals, and rivers.

Dozy, F.

'54. *Prodromus florae bryologicae Surinamensis. Accedit pugillus specierum novarum florae bryologicae Venezuelanae.* Arniz & Co.: Düsseldorf, 1854, 54 pp., 19 pls.

Eaton, Daniel C.

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Ernst, Adolphus.

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201 plants of Venezuela mentioned.

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'66a. Formas características de la flora venezolana. Las palmas.

El Porvenir, Caracas, 1866, vol. 1, no. 6; vol. 2, no. 7, vol. 3, no. 8.

'66b. List of Venezuelan woods, with their Venezuelan names and specific gravity. Seemann's Journ. of bot., 1866, vol. 4, p. 359-360.

Gives names of 48 plants, 24 of which are on Margarita.

'67a. On the plants common to the southern United States and Venezuela. Seemann's Journ. of bot., 1867, vol. 5, p. 290-296.

There are 2684 plants in Chapman's Flora; of these 283 are in Venezuela.

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'68-'69a. Los Helechos de la Flora Caracasana. Vargasia, Caracas, 1868-69, p. 100-103.

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'72b. Sertulum Naiguatense; Notes on a small collection of alpine plants from the summit of Naiguatá, in the mountains of Caracas. Trim., Journ. of bot., Sept. 1872, vol. 10, p. 261-264.

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Some of these plants were collected by Sr. Fermin Toro of Caracas; 24 plants mentioned, 6 of these new species of Ernst and 1 of Toro.

'76a. Descriptive catalogue of the Venezuelan department at the Philadelphia International exhibition, 1876. McCalla & Stavely: Philadelphia, 1876, 55 pp.

'76b. Florula Chelonesiaca. Trim., Journ. of bot., London, 1876, vol. 14, p. 176-179.

Thirty-one out of the 69 plants occur also on Margarita.

'77a. Estudios sobre la flora y fauna de Venezuela. Imprenta Federal: Caracas, 1877, 330 pp.

This work is also found in Primer anuario estadístico de Venezuela ano de 1877, Impr. Nacional: Caracas. Lists 412 orchids and 399 ferns and fern allies.

- '77b. Várgas consid. como bot., Caracas, 1877. A paper presented to the society of physical and natural sciences in Caracas, 1877.
- '79. Enumeracion de las plantas mas notables que fueron observadas en la excursion à Naiguatá. Repertorio Caraqueño, 1879, p. 141-146.
- '86. Eine botanische Excursion auf der Insel Margarita. Nederl. kruidk. arch. Nijmegen, 1886, vol. 4.
- '92. La vegetacion de los Páramos de los Andes Venezolanos. Boletin del Ministerio de obras publicas, Caracas, 1892, no. 157, p. 159-163, Feb., March.
- '00a. Sertulum Aturense, ó sea, lista de una pequeña coleccion den plantas que recojio el Sr. Alfredo John, hijo, en Octubre de 1887 cerca de Atures, Alto Orinoco. Revista cientif. de la Universidad Central de Venezuela, Caracas, 1900. vol. 1, p. 219-223.
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Goebel, K.

- '91. Die Vegetation der venezolanischen Paramos, in Pflanzenbiologische Schilderungen, 1889-93, pt. 2, no. 1. N. G. Elwert: Marburg, 1891.  
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Hampe, E.

- '47a. Bericht über die Hepaticae welche Hr. Moritz in Columbien sammelte und dem königlichen Herbarium in Schönberg überlieferte, nach der Synopsis Hepaticarum und den Moritzschen Nummern aufgeführt. Linnaea, 1847, vol. 20, p. 321-336.  
Lists 48 plants of Venezuela.
- '47b. Ein Referat über die columbischen Moose, welche von Herrn Moritz gesammelt worden. Linnaea, 1847, vol. 20, p. 65-98.  
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Hegelmaier, Friedrich.

- '68. Die Lemnaceen. Eine monographische Untersuchung. Wilhelm Engelmann: Leipzig, 1868, 169 pp., 16 pls.

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Humboldt, Bonpland, et Kunth.

- '15-'25. Nova genera et species plantarum. F. Schoell: Paris, 1815-25, 7 vols. Vol. 7 contains summaries entitled "Flora provinciarum Novae Andalusiae Venezuelae, nec non Planitiei Barcinonensis," and "Flora Orinoci et fluminis Nigri" the two containing 1170 Venezuelan plants.

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- '08. Plants collected in the vicinity of La Guaira, Venezuela. Contrib. U. S. nat. herb., 1908, vol. 12, pt. 2, p. 105-111.

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'58-'69. Florae Columbiae terrarumque adjacentium specimina selecta, etc., 1858-69.

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Vol. 1, p. 68-72, contains a list of Venezuelan plants under their vernacular names.

Loefling, Peter.

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'54b. Orchideae Schlimianae. Bonplandia, 1854, vol. 2, p. 277-284.

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Rusby, H. H.

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- '57. Catalog der Orchideen-Sammlung von G. W. S. zu Ovelgönne an der Elbe. Hamburg. Ed. 3, 1857.

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Millspaugh, C. F.

- '00. Plantae Utowanae. Publ. Field Col. mus., no. 43, bot. ser., 1900, vol. 2, no. 1, p. 1-135.

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Schomburgk, R.

- '47-'48. Reisen in Britisch-Guiana in den Jahren 1840-44. Leipzig: J. J. Weber, 1847-48, 3 vols. illustr., map.

Urban, I.

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Only through Euphorbiaceae.

*Printed June, 1909.*



EXPLANATION OF PLATES.

PLATE 23.

Map of Caribbean Sea and its bordering lands.







PLATE 24.

Map of Margarita, Coche, and Cubagua. Modified from map no. 2035 issued by the U. S. hydrographic survey.

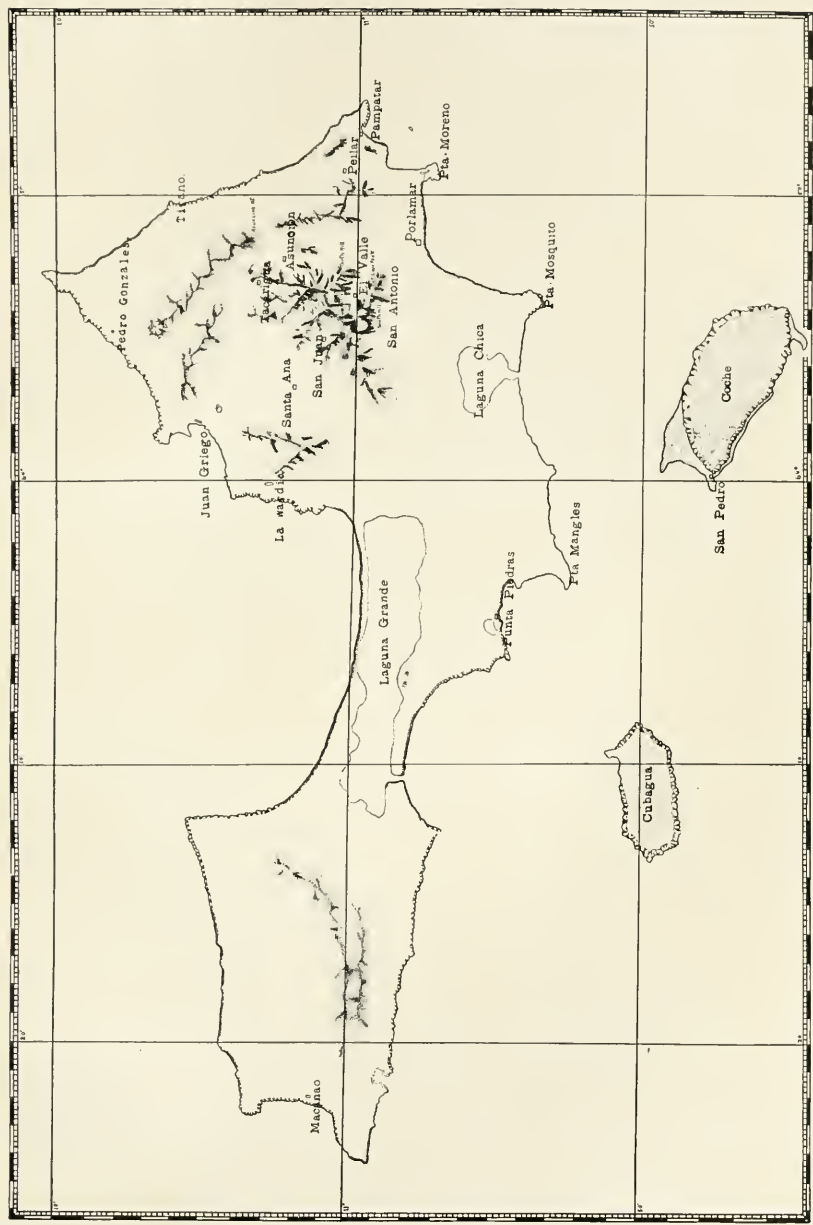






PLATE 25.

- Fig. 1. Road from Asuncion to Juan Griego.  
Fig. 2. Road from Porlamar to Asuncion.



1



2





PLATE 26.

Fig. 1. *Renealmia lutea*.

Fig. 2. *Elleanthus attenuatus*.



1



2





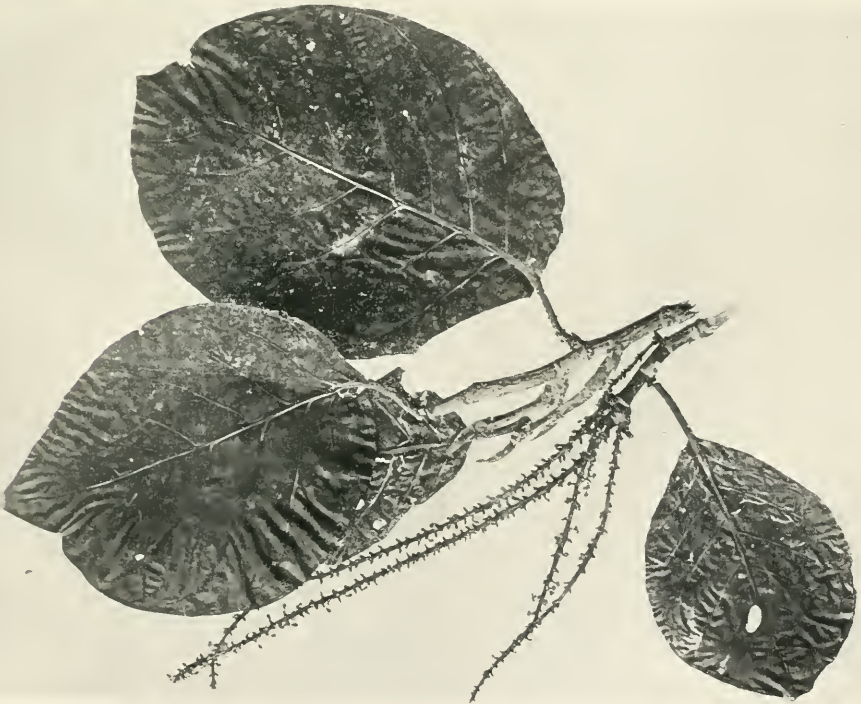
PLATE 27.

Fig. 1. *Blakea monticola*.

Fig. 2. *Coccoloba Ernestii*.



1



2





PLATE 28.

Fig. 1. *Inga macrantha*.

Fig. 2. *Machaerium striatum*.



1



2





PLATE 29.

- Fig. 1. *Bignonia acuminata*.  
Fig. 1a. Corolla opened to show stamens.  
Fig. 1b. Calyx and style.  
Fig. 2. *Solanum margaritense*, a single flower.  
Fig. 3. *Chiococca micrantha*, inflorescence with buds.  
Fig. 3a. Flower minus corolla.  
Fig. 3b. Mature ovary and old calyx.  
Fig. 3c. Interpetiolar stipule.

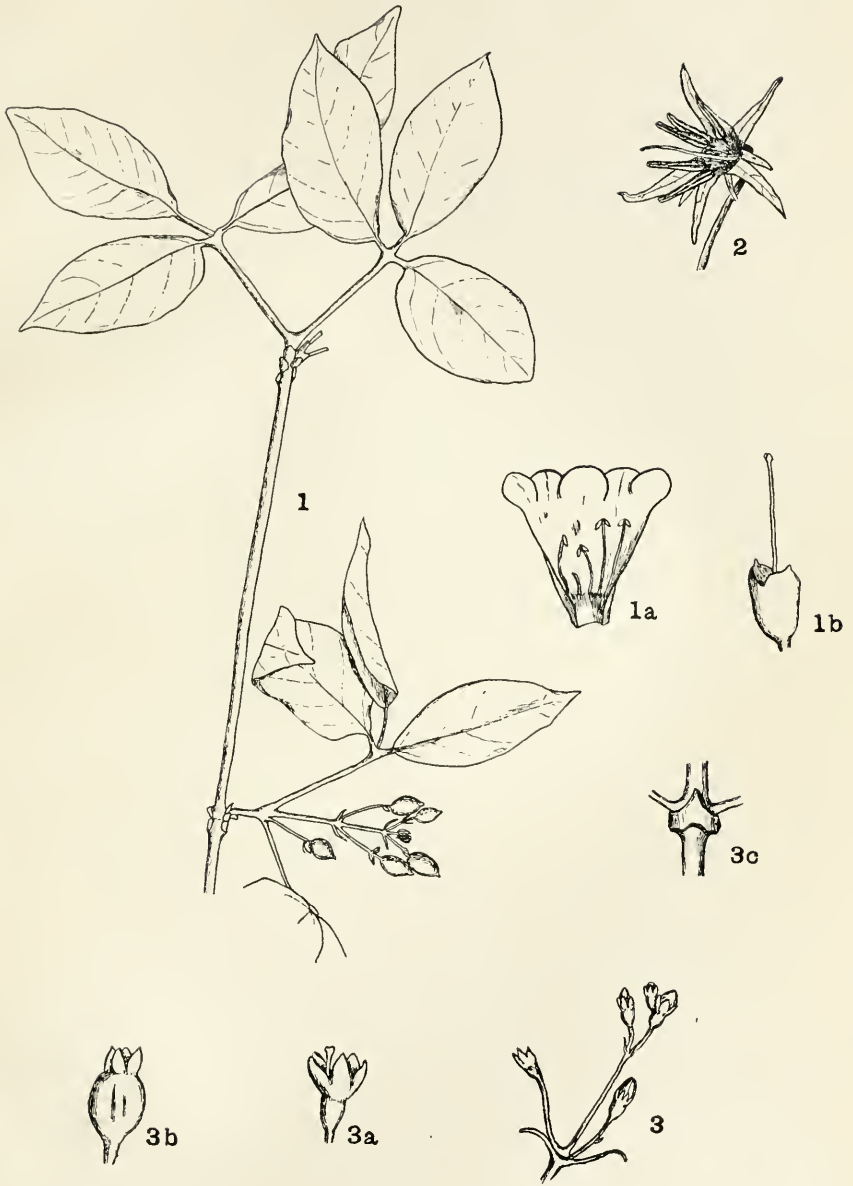






PLATE 30.

- Fig. 1. *Gliricidia lutea*, standard of corolla.  
Fig. 1a and 1b. Wings of corolla.  
Fig. 1c. Calyx and stamens.  
Fig. 1d. Keel of corolla.  
Fig. 2. *Croton Milleri*, pistillate flower.  
Fig. 2a. Ovary and style.  
Fig. 2b. Petal of staminate flower.  
Fig. 2c. Staminate flower.  
Fig. 2d. Stamens.  
Fig. 3. *Croton margaritensis*, staminate flower.  
Fig. 3a. Pistillate flower.  
Fig. 4. *Argilhamnia erubescens*, corolla of pistillate flower.  
Fig. 4a. Petal of pistillate flower.  
Fig. 4b. Pistillate flower.  
Fig. 4c. Ovary.  
Fig. 5. Corolla of staminate flower.  
Fig. 5a. Staminate flower.  
Fig. 5b. Petal of staminate flower.  
Fig. 5c. Stamens.





## No. 8.—AN EARLY STAGE OF ACMAEA.

BY EDWARD S. MORSE.

THE group of Mollusca of which the common limpet may be regarded as the type, formerly included the most diverse genera. Even within fifty years Troschel included in this group such incongruous forms as Chiton and Dentalium. He suggested the ordinal name Docoglossa, referring to the curious plate-like dentition of its radula and this name is still retained for the order. We are indebted to Dr. W. H. Dall for first reducing the order to a rational association of genera by excluding not only Chiton and Dentalium, whose shells were so unlike the patelloid form, but also a number of genera whose shells were remarkably limpet-like, but whose soft parts were widely different, such as Siphonaria and Gadinia.

The Docoglossa, as thus restricted by Dall, forms a very natural group, and, as we shall see, a very archaic one. The so called nautiloid shell,<sup>1</sup> which is so universally seen in the early stages of gastropods, even in forms which in their later stages show no trace of a shell, as in nudibranchs and naked pulmonates, is a marked character in the ontogeny of the class. It will be interesting to inquire whether this nautiloid stage is equally marked in all the genera of the Docoglossa. Unfortunately we have but few contributions to the embryological history of this group; indeed all that we know on this subject is contained in Professor William Patten's (9) valuable memoir on the embryology of *Patella vulgata*. In this work, owing to conditions which he could not control, he was unable to carry the embryo beyond the suggestion of a shell. Only at one time did he succeed in obtaining a few embryos with a normal beginning of a shell in which also an operculum appeared. "Other embryos which had been kept twice as long, or fourteen days, developed no shell at all, although the conditions were apparently the same in both cases." In those stages in

<sup>1</sup> I have used the conventional term "nautiloid shell" in this paper, though this early stage is by no means nautiloid in form. Dr. Robert T. Jackson has called attention to the obvious inaccuracy of calling the protoconch of a gastropod nautiloid. It is simply a coiled shell with one or more whorls, the apex being at one side. It is possible that in *Homalogyra* and *Caecum* the protoconch may be nautiloid, as an examination of the nucleus in these genera seems to indicate a shell coiled in a plane as in their later stages.

which the shell appeared, he says, "the posterior surface of the foot which, at first, was convex, now becomes flattened and develops a thin, horny operculum, with which the mouth of the shell can be closed." Pelseneer (10) figures the shell of a young *Patella vulgata* (Fig. 1) with as pronounced a coiled nucleus as one sees in the young of *Fissurella* or *Cemoria*.



Fig. 1.

Lang (6) says, "The cup-shaped shell of *Fissurella* is only secondarily symmetrical, *i. e.* that *Fissurella* is descended from forms which possessed a spirally coiled shell. The same is the case with the *Patellidae*."

Walter K. Fisher (2), in his admirable memoir on the anatomy of *Lottia gigantea*, says that "Dr. Harold Heath has found specimens of *Aemaca spectrum* and likewise of *Nacella* sp. less than a millimeter in length, which possess a tiny nautiloid coil, at the apex of the flaring shell. This larval coil is soon lost through decollation, and the familiar conical shell is left." In his summary Fisher says, "The *Aemacidae* possess a larval nautiloid shell." In the above references therefore we have



Fig. 2.



Fig. 3.

definite statements that a coiled nautiloid shell first appears in *Patella vulgata* and *Aemaca spectrum*, and is characteristic of the family *Aemacidae*.

Patten's figure shows the beginning of what appears to be a nautiloid shell and were it not for Pelseneer's figure of a definite coiled apical process in the young of *P. vulgata*, I should believe it to be the beginning of a blunt caecal-like cap without the suggestion of a coil, identical

with a stage I have discovered in *Acmaea testudinialis*. In the young of this species, less than half a millimeter in length, though freely crawling about (Figs. 2 and 3) I found a nucleus, as may be seen by the figures, in which there was no suggestion of a coiled nautiloid shell. It was simply a caecal-like shell with slight dorsal flexure, and minutely granulated without lines of growth. In this stage the tentacles were short and thick and the eyes distinctly marked. In the anterior portion of this embryonic shell, on each side of its aperture as it joins the permanent shell, is a slightly elongated area rounded anteriorly — the outline of this area being parallel to the edge of the aperture. These markings may be called for convenience lateral folds (Fig. 4). The lines of growth of the permanent shell

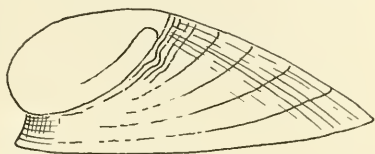


Fig. 4.

seem to be depressed at the middle part of these folds. Precisely what these folds may be in the embryo I do not know. Patten's figure of the advanced embryo in *P. vulgata* gives no clue as to their meaning.

No structure shows which might be instrumental in making these folds. In the cicatrix left on the shell of *Acmaea alveus* (Fig. 5) after the disappearance of the embryo shell are right and left circular marks between the divided schar which may possibly be associated with these folds. The lateral folds are exceedingly faint and can only be detected by direct light. This embryo shell is early separated by decollation, and apparently never passes beyond the condition of the early veliger stage. It may be observed that a portion of the viscera occupies the embryo shell, there being free communication between the embryo shell and the new patelloid shell forming. A partition evidently forms

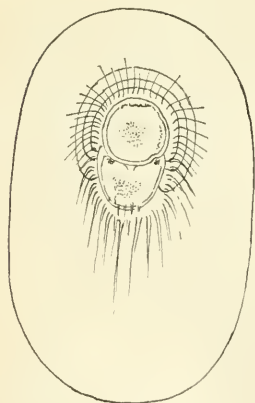


Fig. 5.

before the embryo shell breaks away. It will be observed also that the embryo shell turns posteriorly and the increments of growth of the permanent patelloid shell are at the outset mainly on its anterior margin. In a short time the increments increase posteriorly, so that

the conical apex becomes central, though in most cases slightly eccentric; then the posterior growth of the shell is far in excess of the anterior growth and the apex finally occupies the anterior third of the shell in its approach to maturity. In these stages the veliger shell usually turns to the left and for some time overhangs the posterior margin of the permanent shell-growth (Figs. 6 and 7). I have not yet succeeded in finding the young of *Acmæa alveus* before losing its embryo shell. The cicatrix on the apex of the smaller specimens of *A. alveus* resembles so closely a similar cicatrix on the young of *A. testudinalis* that I am convinced the embryo shell must be identical in the



Fig. 6.

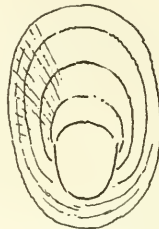


Fig. 7.

two species. Dr. Robert T. Jackson (4) was the first investigator to figure and describe the cicatrix in *A. alveus*. He believed, as I did at first, that the cicatrix indicated a trace of an early nautiloid shell, the round area representing the aperture of the embryo shell as it really does, while the lunar cicatrix behind was supposed to show a section of the backward coil, or body whorl. In both species here considered there is considerable individual variation; in *A. alveus* the cicatrix usually shows two parts, a round area distinctly outlined which marks the immediate apex of the shell, and, directly behind and closely connected with it, a blunt semi-lunar outline, this portion representing the position of the Caecum-like embryo shell. In some specimens this portion of the cicatrix is wanting as if the concentric lines of accretion of the permanent shell passed beneath it, leaving the embryo shell free and overhanging posteriorly. In *A. testudinalis* the cicatrix is precisely the same as in *alveus* though not so clearly defined nor evenly marked, and this is probably due to the different environment of the two species — *alveus* living in quiet water on swaying eel grass, while *testudinalis* is found in rock pools at low tide exposed to pounding waves.

A line drawn through the cicatrix of *alveus* longitudinally varies a few degrees from a similar line drawn through the permanent shell, the direction indicating that the embryo shell was turned to the left as in *testudinalis*.

The primitive condition of the embryo shell, as we have seen it in the two species of *Acmaea* studied, with no trace of a coiled nautiloid shell, at least, in *testudinalis*, is certainly a low character and is correlated with many low characters of the order. By all students the Patelloidea and its allies have been regarded as among the most primitive gastropods. In running through the molluscan part of Korschelt and Heider's "Text-book of the embryology of invertebrates," (5), revised by Professor Woodward, nearly every reference to *Patella* emphasizes the archaic character of the group. I must here acknowledge my indebtedness to this compendium of embryological research. I can do no better than to transcribe briefly the few references to *Patella* that the student may appreciate the relations between this genus at least and Mollusca far below *Patella* in classification. In speaking of the row of ciliated cells and the frontal or apical tuft in the embryo *Chiton*, Korschelt says, "Very similar embryonic stages are met with in the ontogeny of other mollusca, *i. e.* *Patella*." Patten, in his memoir on *Patella* (9) calls attention to the exceedingly simple method of its oviposition. The eggs are laid singly and are apparently fertilized in the water as copulatory organs are wanting in this genus. Korschelt remarks that the early larval stages of *Dentalium* closely resemble those of *Patella* and also points out that in Gastropoda "gastrulation is attained in different ways in accordance with the variation in cleavage. In the simplest cases, *e. g.* *Planorbis* and *Patella* a blastula with a comparatively large cleavage cavity arises. The vegetative pole of the blastula is formed by the macromeres and consequently appears much thickened. After the mesoderm has become differentiated, the entomeres begin to increase in number, and the whole entoderm becomes invaginated into the cleavage-cavity, and thus a typical invaginated-gastrula forms. In *Patella*, on the contrary, an extremely large solid ingrowth of macromeres takes place from the vegetative pole of the blastula. From this ingrowth, the mesoderm and entoderm become differentiated and, at a later period, an archenteric cavity forms within the till now solid entoderm."

"The ontogeny of *Patella* shows primitive conditions in so far as

the egg-envelope is thrown off very early, even while cleavage is still going on. Since cilia appear as early as the blastula-stage the embryo is very soon able to move freely and thus become a larva. In this way *Patella* resembles a Lamellibranch, but such early locomotion is not common among the gastropods, most of the larvae hatching at a much later stage." "In later stages the displacement of the blastophore (as shown by Patten in *Patella*) becomes much more striking and recalls the condition already described in connection with *Dentalium*." In certain stages "the *Patella* larva closely resembles the trochophore stage met with in the Lamellibranch." Korschelt says it is a striking fact that a few specially low forms of gastropods such as *Haliotis* and still more *Patella* and *Fissurella* are distinguished by a reduction of coils and the adoption of a flat cup-shaped shell. In youth the shell was, as in other gastropods, distinctly coiled. This is so in *Fissurella*, *Cemoria*, and other associated forms, but, as I have shown here, it is not so in regard to the two species of *Aemaea* studied. Korschelt regrets that the development of *Patella* was carried by Patten only to a stage at which the larva is still far removed from the shape of an adult. He speaks of *Patella* and its allies as one of the most lowly groups of gastropods.

Walter K. Fisher, in his anatomy of *Lottia gigantea*, emphasizes the primitive character of the Acmaeidae when he says, "There is little foundation for Thiele's dictum that the single ctenidium of the monobranchiate *Docoglossa* is a secondary structure and that the primary gill has degenerated. As a matter of fact nothing is known of the development of these forms while everything about the structure points to the fact that the existing ctenidium is not secondary. The nervous supply is very abundant and springs from the selfsame ganglion as does that of the corresponding gill of *Haliotis* which this investigator is so anxious to prove primitive and in a direct line of descent. Furthermore the attachment of the gill by its base in the Acmaeidae is much more similar to the condition in the Chitons, than is that of *Haliotis*, where the gill is fastened alongside of the efferent vein. The passage of the blood in *Lottia* from the ctenidium into a pallial sinus, and thence into the heart is more primitive than the direct connection found in *Haliotis*, and again agrees more closely with the condition of affairs found in Chitons."

Lankester (7), in his "Mollusca" in the *Encyclopaedia Britannica*, says, "The eyes of the Limpet deserve mention as examples of the most

primitive kind of eye in the Molluscan series. They are found one on each cephalic tentacle and are simply minute open pits or depressions of the epidermis, the epidermic cells lining them being pigmented and connected with nerves."

Dr. Dall (1) in speaking of the Docoglossa as a group says the various forms manifest what may be termed a peculiar persistency of immaturity when compared with other groups of gastropods. Pelseneer regards the Docoglossa and Rhipidoglossa as the most archaic of all gastropods.

We have shown the primitive character of the embryo shell of *A. testudinalis* and have referred to the work and opinions of others testifying to the low character of the group; there are, however, a number of curious features associated with the Docoglossa that indicate its peculiar character. We find, for example, that the radula is markedly different from that of other gastropods, not only in the peculiar formula of its dentition but in its curious dark brown color. The radula of Acmaea is widely different from that of *Patella vulgata*. While the egg of gastropods usually has a yellow yolk, Patten found that the egg of *P. vulgata* was bluish green. Dr. E. Ray Lankester discovered that the nephridia were paired in *Patella* and both were functional though one was larger than the other.

It is interesting to observe that a diagrammatic view of Acmaea resembles somewhat closely the various figures given by authors of a gastropod archaetype.

In considering these low and archaic characters of the Docoglossa it is interesting to inquire into the past geological history of the group. We find, in accordance with what might have been expected, that the earliest trace of molluscan life in the past is a group of shells in the Cambrian known as Capulids from their resemblance to a liberty-cap. These shells have been regarded as allied to Acmaea. Hall described a species from the Silurian which he named Palaeacmaea. The genus *Scenella* from the Cambrian, described by Billings, was regarded by him as belonging to the family Acmaeidae. Lindstrom describes the genus *Tryblidium* from these low geological horizons as related to Acmaea. Dr. Charles D. Walcott (11) in his second contribution to the studies of the Cambrian fauna of the United States gives a figure of *Stenotheca rugosa* (Fig. 10) which bears a remarkable resemblance to an early stage of *A. testudinalis*, as may be seen by comparison with Fig. 6. It will be noticed that the apex is turned to the right in

the fossil and not to the left as in *testudinalis*. Professor C. Fred Hartt described a shell from the Cambrian of St. John Basin as a brachiopod under the name of *Discina acadica*. Dr. G. F. Matthew (8), with better material, described the structural features of the shell and says that Mr. R. P. Whitfield first drew attention to the calcareous nature of the shell and suggested that it was a gastropod allied to *Palaeacmaea* or *Metoptoma*. Dr. C. D. Walcott afterwards placed it in the genus

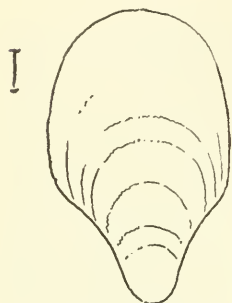


Fig. 8.

*Stenotheca*. Matthew gives a figure of the shell from the interior showing the characteristic horseshoe-shaped muscle scar opening at the anterior end while the apex of the shell is directed backward. He says that it lived in shallow seas along the coast judging from the species associated with it, and was probably a bottom-crawler. The shell he figures is about four millimeters in length and the apex is one millimeter from the posterior margin. In the above comparison I have assumed that the nucleus or apex of *Stenotheca* is posterior as it is in

*Acmæa* in its early stages. Palaeontologists in recognizing *Scenella*, *Stenotheca*, *Tryblidium*, and others as related to *Acmæa* and its allies have assumed that the position or direction of the beak or nucleus indicated the anterior region as it does in recent *Acmæa* and *Patella*. To determine the anterior margin of these Cambrian fossils, it would be necessary to examine the muscle scar within. This horseshoe-shaped scar opens over the head of the creature and consequently indicates the anterior margin. Matthew (8) figures the interior of one of these forms from the Cambrian, and the muscle impression is clearly shown. Its opening indicates the anterior region. The apex of the shell is nearer the opposite margin which is therefore posterior as it is in the early stages of *Acmæa* of the present day as herein described. In the living *Acmæa* studied the apex is about central when the shell is about one millimeter long and by the time it reaches two millimeters in length the apex is within half a millimeter of the anterior margin and this position is retained till maturity. As we have shown, in the extreme young the apex is at the extreme posterior margin of the shell.

In these early Cambrian forms delicate lines are seen radiating from the apex to the rim of the shell. Dr. Walcott has kindly sent me

*Scenella varians* from the Stephen Shale, Middle Cambrian of British Columbia and in some of the specimens faint traces of radiating lines may be detected. These lines are interrupted by faint lines of growth which give a reticulated appearance to the surface. This feature is characteristic of the young of *A. testudinalis* and is strongly marked in the young of *A. alveus*. This feature begins immediately on the formation of the permanent shell and continues to maturity.

The difference between the ancient and the modern shell is that the former retains at a much later stage the rudimentary embryo shell, while in the modern representative the nucleus is lost by decollation at a very early stage leaving the peculiar cicatrix already described. Furthermore in the Cambrian form *Stenotheca*, the apex remains near the posterior end throughout life, while in the modern form the apex is at the posterior end in the earliest stages only. Thus in the early Cambrian forms a very close resemblance is seen to the very earliest shell stage of the modern *Acmaea*.

If these resemblances hold true we have another demonstration of the recapitulation theory, or the law of morphogenesis so ably presented by Hyatt in his memoir on the Arietidae, with his subsequent nomenclature of successive stages, and the later contributions by Beecher, Jackson, and Schuchert in Mollusca and Brachiopoda.

In this paper I have dealt with *Acmaea testudinalis* and *A. alveus* as distinct species. At the outset I began the work solely for the purpose of determining the specific value of *Acmaea alveus* and the propriety of its separation from *A. testudinalis*. By the earlier students of the subject the two species were regarded as distinct, but later Tryon, Verrill, Dall, and others had come to regard *A. alveus* as only a variety of *A. testudinalis*. Mr. Henry Jackson, Jr., (3) in a communication to the "Nautilus," published the results of a very careful study of the radula of the two forms, and shows marked differences between them. So far as I have observed *testudinalis* occurs in pools at low tide exposed to dashing waves. I have never seen a specimen of this species on eel grass; *alveus* on the contrary lives on eel grass in quiet water and in certain places hundreds may be collected in a short time. It was naturally believed by some observers that the long narrow form of *alveus* had become so by adaptation to its narrow resting place; if so, it is a good example of a species in the process of establishing itself. Whatever may be the case the specific characters are now so firmly fixed that I have never seen a specimen, young or

old, that the difference between them could not be told at a glance. Their only resemblance is in the color markings which in rare instances are alike.

In studying *alveus* alive it is found to move freely on the eel grass, swinging its head from side to side, its tentacles projecting far beyond the lateral edge of the shell; *testudinalis*, on the contrary remains fixed for hours and only in the extreme young have I seen considerable freedom of motion. Mr. Dwight Blaney has found *alveus* on the under side of stones on a coarse pebbly beach at Ironbound Island, Maine, and I have observed it in similar situations in Salem Harbor, Massachusetts. In both these instances, however, the creature might have become detached from its usual resting place on eel grass by storms and washed by the waves to these unaccustomed places.

In the young *testudinalis* a millimeter or more in length, the shell is rounder, the apex more elevated, blunter, and brown in color; the radiating lines being scarcely visible. In *alveus* of the same size the shell is longer, apex not so elevated, white in color and the radiating lines are sharply defined.

I am greatly indebted to Dr. Charles G. Weld and Dr. Harold S. Colton for important aid in collecting material for this paper.

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No. 9.—A NEW ARAUCARIAN GENUS FROM THE TRIASSIC.

BY EDWARD C. JEFFREY.

IN the early part of the year 1908, my friend Professor J. B. Woodworth of the Geological Department of Harvard University, turned over to me for investigation a remarkable trunk, from the Triassic forest, south of Adamana, Arizona. The specimen to be described was collected by Mr. John B. Lewis, Jr., of Reading, Massachusetts, and by him presented to the Geological Museum of Harvard University, whence it came into my hands through the kindness of Professor Woodworth. In December, 1899, Dr. Lester F. Ward, at that time paleontologist to the United States Geological Survey, made a report on the fossil forests of Arizona ("Report on the Petrified Forests of Arizona," Washington, 1900). More recently Dr. Ward returned to the same subject in one of the Monographs of the United States Geological Survey (Monogr. U. S. Geol. Surv., no. 48, 1905). Since the present investigation was completed, a large amount of material, some of it collected by Dr. Ward himself, from this region has come into my possession for examination, through the courtesy of Dr. David White and Dr. F. H. Knowlton of the United States Geological Survey, as well as through the kindness of my colleagues Professors Wolff and Woodworth. It represents a considerable variety of forms and promises to yield results of great interest to evolutionary botanists, which will be published subsequently.

Fig. 1 (Pl. 31) represents a photograph of about two thirds of the length of the petrified stem in my possession, reduced to one half its natural magnitude. The missing third of the specimen was used for the purpose of securing sections, showing microscopic structure, which were prepared with his usual skill, by Mr. James Lomax of the Lomax Paleobotanical Company, Bolton, England. On the right of Fig. 1, the specimen presents some adherence of the matrix in which the tree was included. Towards the left the surface of the trunk has become clear of the surrounding rock as a result of the weathering process to which it has been exposed. Externally the wood is a pale yellow or orange color, while inwardly the natural dark brown hue of the silici-

fied wood is retained. Over the surface of the trunk are a number of scars. The smaller of these would naturally be interpreted as either the cicatrices of possibly Araucarian leaves or perhaps as the rootlet scars of a Stigmarian root, if it were conceded that this genus were present so late as the Arizona Triassic. Investigation showed that neither of the more obvious interpretations of the smaller superficial scars could be adopted. Two larger scars appear, one in the middle line and another to the right of it. In the light of subsequent description of the internal structure, it is clear that these are the broken bases of branches of the main axis. In Fig. 2 (Pl. 31) is shown the opposite side of the same slightly flattened trunk. Part of the surface is obscured by the label of the Geological Museum, but enough is left clear to show that this surface presents a close similarity to that shown in Fig. 1. A little to the left of the middle line below, is seen a third larger scar, representing the broken base of a ramification. With some clearness on the right and left above may be seen, in longitudinal aspect, the organs which are responsible for the rounded scars in the middle line. The appearance thus presented indicates that a considerable amount of the surface of the trunk has been removed either previous to fossilization or more recently as a consequence of the weathering of the petrified trunk. By regarding the smaller scars shown in Figs. 1 and 2 with a pocket lens, it may be made out that they are multiple in their nature in some instances and represent a large main scar accompanied by one or more smaller scars. This can be made out with special clearness in the upper median region of Fig. 2. Fig. 3 represents the natural weathered end of the trunk shown in the two foregoing figures. The process of weathering has etched out admirably the annual rings, so that they appear much more distinctly than they do even in microscopic sections of the better preserved parts of the trunk. By examination of the rings with a lens it may be readily determined that the trunk was approximately half a century in age, when the tree was fossilized, if all the annual increments of growth are represented, which seems probable. It is possible to make out that some of the original layers of the wood are missing on the flattened surfaces of the trunk. Radiating lines can be distinguished on the end of the log, which represent the organs seen as the smaller scars in Figs. 1 and 2. A little to the right of the geometrical center of Fig. 3 (Pl. 31) and a little above it, appears the medullary region of the trunk.

With the foregoing description of the external features of our fossil we may now pass to the consideration of its internal structure. The preservation of the tissues left much to be desired, but by the examination of a considerable number of sections, data were reached, which make it evident that in the present specimen we have to do with a new and very interesting Araucarian genus. Fig. 4 (Pl. 32), shows the wood of the trunk under moderate magnification. In no case was it found profitable to employ very high magnifications of the histological structure, on account of the somewhat unsatisfactory condition of preservation. Fig. 4 illustrates the transition from one annual ring to the next. It is to be observed that the autumnal pause in wood formation is very slightly marked, much less so than we have observed to be the case in Cretaceous material from the eastern United States. The rays do not stand out clearly in the transverse section, since they are indifferently preserved. Certain dark spots occur throughout the field of the photograph, which do not, as might be supposed, represent resiniferous parenchyma, but merely carbonized aggregations, such as are not infrequent in petrified woods. Fig. 5 (Pl. 32), shows the radial section of our wood, which indicates very clearly the indifferent condition of preservation. The pitting, however, is clearly that of Araucarioxylon and as in that type the pitted regions are not coincident with the whole surface of the tracheids but are distinctly localized towards their ends, as in the woods of the living Araucarian genera, *Agathis* and *Araucaria*. The same carbonized blotches as are apparent in the transverse section can also be made out in the radial view. The rays have not been shown, as their condition of preservation as seen in this plane is indifferent. By looking over a considerable number of preparations, however, it was possible to discern that the ray cells had numerous pits on their lateral walls and apparently were entirely devoid of pits on their terminal and horizontal wall, precisely as is the case in the rays of the living Araucarian genera. Fig. 6 (Pl. 32), shows the tangential view of a less badly preserved portion of the wood. It can be made out that the rays are strictly uniseriate and from two to eight or nine rows of cells in height. Evidence of tangential pitting of the autumnal tracheids was rather dubiously discerned. The condition of preservation left always some uncertainty on this point. It will be seen from the description of the wood of our specimen given in the above lines, that it represents a quite typical Araucarioxylon. The frequently rounded pits of the Brachyoxylon

type were not made out, although this type of wood was found in other petrified fragments from the same general horizon. Fig. 7 (Pl. 32) is of particular interest because it shows in the upper part, in transverse section, one of the organs responsible for the scarred surface of the trunk. It is quite obvious that we have to do in this case with an appendage not of the nature of a leaf, on account of the cylindrical character of its trace. By looking carefully, by preference with a lens, at the lower part of the figure, it is possible to make out clearly that the organ just referred to is subtended by a leaf-trace. The organ in question is consequently clearly an axillary structure and either a root or a branch. An examination of its transverse section with the microscope makes it clear that it is not a root. Hence we must interpret it as of shoot value. It is in fact a short-shoot, as is shown by its failure to develop annual rings in the outer part of the trunk. Fig. 8 (Pl. 32) shows one of these short-shoots in transverse section at a point considerably farther out. The cylindrical character of the woody axis of the organ can be clearly made out as well as the absence of annual increments of growth. Fig. 9 (Pl. 32) shows the appearance of the organs in question, very near to the surface of the trunk, under the same magnification as Fig. 8. It will be seen, that the pith and as a consequence the woody cylinder of the short-shoot have both become considerably larger.

Not infrequently the short-shoots of this remarkable Gymnosperm branch in the course of their journey outward and sometimes at the surface of the trunk they are represented by as many as four or even five branches. This is all the more remarkable because there are no leaf-traces emitted from the cylinder of the short-shoot in their passage through the wood of the main axis, as is the case in *Ginkgo biloba*, in which I have observed a similar branching of the short-shoots within the wood of the parent axis. *Ginkgo* also differs from our genus in the fact that its short-shoots generally show the presence of annual rings, which are always absent in the type under discussion. The short-shoots apparently were lengthened in accordance with the thickening of the woody cylinder of the main trunk, through the activity of the cambium of the mother axis, exactly as is the case with the short-shoots of the living genus *Pinus*, in which the short-shoots persist in some species for a half a score or more years.

The leaf-trace in our genus is also of considerable interest, because unlike the short-shoot, which it subtends, it has a limited duration and

disappears in the wood of the main axis at a comparatively short distance from the pith. In living Araucarian Conifers, as well as in allied fossil forms, a remarkable feature of structure is the persistence of the leaf-trace in the wood throughout the life of the axis. This feature has been referred to by Sir William Thiselton-Dyer ("Persistence of Leaf-Traces in Araucarieae," *Ann. Bot.*, vol. 15, p. 547, 1901). Professor Seward has also called attention to it in his recent monograph on the Araucarieae ("The Araucarieae, Recent and Extinct," *Phil. Trans. Roy. Soc. London, ser. B*, vol. 198, p. 305-411, pls. 23, 24, 1906) and considers it a primitive feature which the Araucarian Conifers have retained from the past. Professor Lignier likewise refers to the persistent Araucarian leaf-trace in the case of Mesozoic representatives of the group, in a recently published memoir. It appears very doubtful if Professor Seward's view of the primitive nature of the persistent leaf-trace of the Araucarieae can be maintained, as it is not found in the case of the very ancient Araucarian genus at present under discussion. It is my intention to show in a subsequent article that the general condition of the leaf-trace in the older Araucarieae of the Mesozoic does not at all support the view put forward by Professor Seward, that the persistence of this structure in the secondary wood of certain modern representatives of the tribe is an inherited primitive feature. The opposite conclusion seems to be warranted by the facts, *viz.*, that the persistence of the trace of the leaf in the secondary growth of the living genera is not a palingnetic feature, but one which has been more recently acquired.

It is apparent from the description given above, that in the genus which is the subject of the present article, we have to do with a representative of the Coniferous stock, characterized by the wood structure of the modern Araucarieae, without the persistent leaf-trace which is characteristic of these, and with short-shoots, such as are found today clearly marked in the genus *Pinus* only. Since there is no indication of any but Araucarian characters in the wood we are justified in including our genus with the general Araucarian stock. That it is an entirely new type of that stock is likewise apparent. For that reason it must be put in a new genus, which we propose to call in honor

of Professor J. B. Woodworth, to whom we are indebted for the material

**Woodworthia arizonica**, genus et species nov.

Wood of the Araucarioxylon type, with alternating radial pitting of the tracheids, generally grouped at the ends of the elements; short-shoots present, which persist through many years, probably as long as the axis, which bears them; leaf-traces subtending short-shoots and not persistent throughout the secondary wood as in existing representatives of the Araucarineae; annual rings not strongly marked.

Triassic forest near Adamana, Arizona.

CONCLUSIONS.

It will be apparent to the reader that in the case of the new genus, which is the subject of the present article, we have to do with a remarkable Araucarian type. Although it is not the first extinct Araucarian conifer known to possess short-shoots, since another type has been described from the Lower Cretaceous of Staten Island, N. Y., ("Araucariopitys, A New Genus of Araucarians," Bot. Gaz., vol. 44, p. 435-444, pl. 28-30, 1907) it is nevertheless the first to show the typical Araucarioxylon structure associated with the presence of short-shoots. Moreover, the large size of the trunk investigated in the present instance, leaves no doubt as to the persistence of the base of the short-shoot in the successive annual rings of the mother axis. It is clear from a consideration of the present very important genus, that the Araucarian line in its older representatives approximated more and more to the Abietineous type illustrated by *Pinus* and *Prepinus*. Both *Araucariopitys* and *Woodworthia* vouch for the soundness of this general conclusion. The evidence for the primitive presence of short-shoots in the Araucarian line (*Woodworthia* and *Araucariopitys*) as well as in the Abietineous series (*Pinus* and *Prepinus*) seems now to rest on a very firm basis. Moreover, this condition in the vegetative axes of the earlier Conifers affords a most satisfactory support to the conclusions reached by the greater number of morphologists as to the interpretation of the female cone of the Conifers in general. As is well known the present tendency is to regard the

ovuliferous scale of the Conifers as the equivalent of a metamorphosed short-shoot. In the light of recent investigations on the fossil Conifers this hypothetical explanation of the morphology of the seed-bearing appendages of the female cone receives a very satisfactory corroboration. Further, nothing could be more in harmony with present tendencies in morphology, than to find that the short-shoot or its equivalent has persisted at least in a vestigial form, in connection with the reproductive apparatus long after it has disappeared or almost disappeared in the vegetative axis of the living Conifers, with the exception of the very ancient genus *Pinus*. We may then safely assume that the presence of short-shoots was a primitive attribute of the Coniferous stock and that as a consequence we find it present in older representatives of those two Coniferous tribes, *viz.*, the Abietineae and the Araucarineae, which we know to have had the longest geological history.

Another feature of interest connected with the genus described in the present article, is that it adds one more bond to the evidence connecting the Abietineae and Araucarineae. As a result of recent investigations on the woods of the American Lower Cretaceous, we know that the ligneous structure of some of the older Araucarian Conifers more nearly approached the Abietineae than is the case with any of those now living. The proof afforded by the genus *Woodworthia* of the presence of short-shoots in the Araucarian line at so remote a period as the Trias, supplies an additional and very weighty piece of evidence as to the Abietineous origin of the Araucarian Conifers. As far back as the Triassic we find the tendency of the Araucarineae to become more and more like the Abietineae, clearly indicated. Whether this evidence is confirmed by the consideration of the general wood structure of the more ancient Araucarian Conifers, will be discussed in an extensive memoir, now in preparation.

#### SUMMARY.

1. *Woodworthia*, an ancient Araucarian genus from the Triassic forests of Arizona, possessed the wood structure of the living representatives of the Araucarineae.
2. It at the same time was provided with short-shoots of the Abietineous type, which persisted in the wood of the trunk throughout the life of the tree.

3. The leaf-traces of *Woodworthia*, unlike those of the living *Araucarineae*, did not persist in the secondary wood.

4. Persistent leaf-traces cannot be regarded as an ancestral character of the Coniferous stock.

5. *Woodworthia* supplies additional evidence of the approximation of the Abietineous and *Araucarineous* lines in the Mesozoic.

6. The *Abietineae* represent the most primitive living Conifers.

7. The possession of short-shoots was probably a common feature of the older Coniferous stock and such an hypothesis supplies satisfactory evidence for the most generally accepted explanation of the ovuliferous scale in the existing Conifers, as a modified short-shoot or brachyblast.

*Printed July, 1910.*



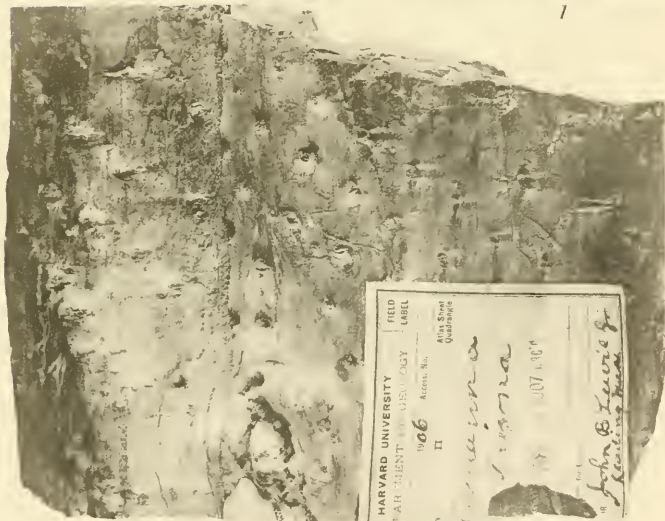
EXPLANATION OF PLATES.

PLATE 31.

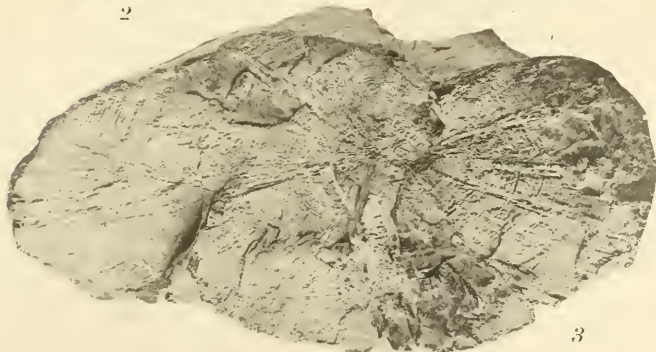
- Fig. 1. Surface of trunk of *Woodworthia arizonica*.  $\times \frac{1}{2}$ .  
Fig. 2. Surface of the opposite side of the same trunk.  $\times \frac{1}{2}$ .  
Fig. 3. End view of the same trunk reduced to one half the natural size.



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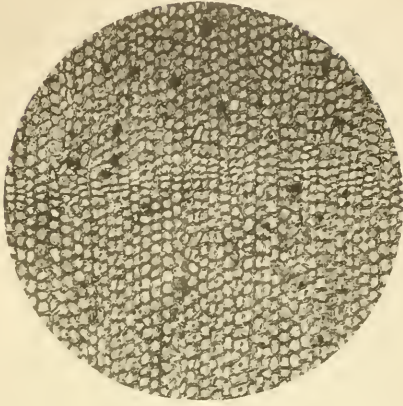
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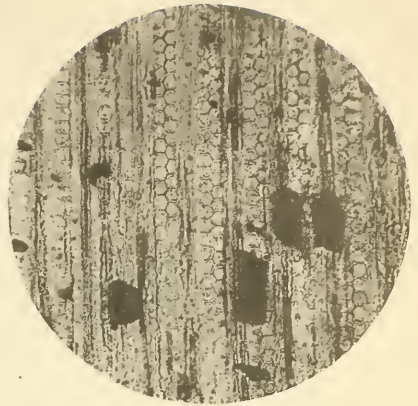


PLATE 32.

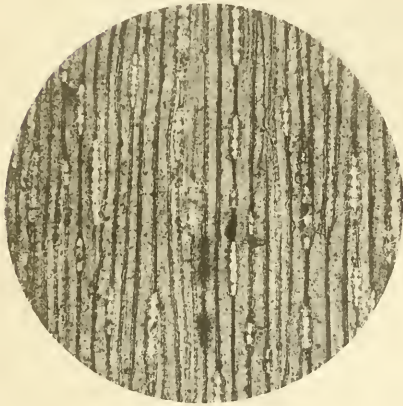
- Fig. 4. Wood of *Woodworthia arizonica* in transverse section.  $\times 40$ .  
Fig. 5. Longitudinal radial section of the same.  $\times 120$ .  
Fig. 6. Longitudinal tangential section of the same.  $\times 120$ .  
Fig. 7. Tangential section of the wood of the same showing a short-shoot and its subtending leaf-trace.  $\times 10$ .  
Fig. 8. Transverse section of short-shoot of the same about four centimeters from the pith.  $\times 40$ .  
Fig. 9. Transverse section of a short-shoot near the surface of the trunk.  $\times 40$ .



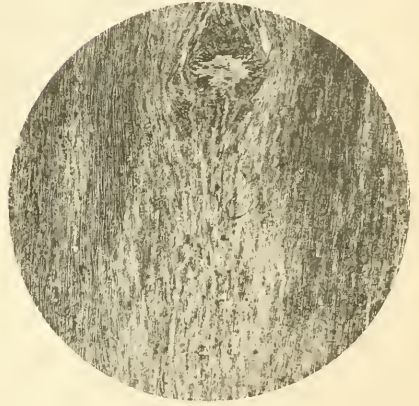
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No. 10.— A NEW PREPINUS FROM MARTHA'S VINEYARD.

BY EDWARD C. JEFFREY.

NOR long since the present writer described remains of short-shoots of a pine-like Conifer, from the Androvetta deposits of Staten Island (Island Cretaceous or Upper Potomac), showing internal structure well preserved. These differed from the brachyblasts of living pines in several important particulars, viz.: by the possession of a very extensive fascicular sheath, resembling that of existing Soft Pines, but more richly developed and not deciduous; by the presence of numerous fascicular leaves not in definite number as in living pines and attached behind a still active growing point; by the complicated transfusion tissue of the fascicular leaves, resembling in its organization most nearly that found in the leaf of Cordaites; and finally, of greatest importance, by the presence of true centripetal wood in the foliar bundles. To this remarkable and interesting genus the name *Prepinus* was assigned ("On the Structure of the Leaf in Cretaceous Pines," *Ann. Bot.*, vol. 22, p. 207-220, pls. 13, 14, 1908).

In the autumn of 1908, two short-shoots of a similar character were found in the Cretaceous clays of Gay Head, Martha's Vineyard, Massachusetts, to the south of the lighthouse. Photographs of these two spur-shoots are shown from opposite sides in Figs. 3, 4, 5, and 6 (Pl. 33), under a three-fold magnification. Practically only the bractigerous region of the short-shoot is present; the terminal portion, bearing the fascicular leaves, has practically disappeared and is present only in some degree in the smaller specimen shown in Figs. 3 and 4 (Pl. 33). The sheathing bracts are of the same type and are marked by the same persistence found in *Prepinus statenensis* Jeffrey. For comparison, a well preserved short-shoot of this species is presented in Figs. 1 and 2 (Pl. 33) under a five-fold magnification. In the Staten Island specimen part of the bractigerous region has been broken off at the time of fossilization, while the fascicular leaves are present and are represented by a considerable portion of their bases. In Fig. 1 (Pl. 13) of the article cited above, is shown, under a magnification of ten diameters, a spur-shoot of *Prepinus statenensis* in the same condition of dilapidation as those of the species at present under considera-

tion represented in Figs. 3, 4, 5, and 6 (Pl. 33). The present species resembles superficially so far as it goes, very closely the *Pinites Solmsi* of Seward (Cat. Mesoz. Plants, Dept. Geol., Brit. Mus. [The Wealden Flora, Pt. 2, Gymnospermae], p. 196, pl. 18, fig. 2, 1900) much more in fact than it does the *Prepinus statenensis* of the present writer.

Of the two short-shoots in the writer's possession the smaller one is much better preserved and moreover has attached to the upper or distal end the bases of a few fascicular leaves. Both the spur-shoots are considerably flattened by the weight supported through a great length of time, which on account of the entire absence of carbonization or petrification, they have not been able to resist. Fig. 9 (Pl. 33), shows a transverse section through the lower portion of the smaller short-shoot. On the left a considerable part of the cortical tissues has been broken away but on the right, as well as above and below, the structure is complete. The woody cylinder of the short-shoot may readily be made out and it is possible to distinguish the presence of two or more rows of resin canals in the ligneous tissues surrounding the pith. This is a feature of contrast to *P. statenensis*, where only a single series of canals has been observed. (See Jeffrey, Ann. Bot., vol. 22, pl. 13, figs. 6, 7, 1908.) Fig. 7 (Pl. 33), represents a portion of the wall of the fibrovascular cylinder as well as a little of the inner cortex from the same specimen. It is obvious from this that the wood represents only one annual ring. The resin canals which are clearly present in the wood are filled with tyloses. The single annual ring containing resin ducts occluded by tyloses, makes it certain that we have really to do with a short-shoot and not with an ordinary twig, in which tyloses would only occur in a rather old specimen with numerous annual rings, showing heartwood. This evidence only confirms that derived from the external aspect. The resin canals of the woody cylinder of the short-shoot are not only vertical but also horizontal. The latter canals join the vertical canals of the wood with one another radially and likewise with similar canals in the cortex. Both horizontal and vertical canals are likewise present in *P. statenensis* (Jeffrey, Ann. Bot., vol. 22, pl. 13, figs. 6, 7, 1908). Fig. 10 (Pl. 33) represents a section through the middle region of the larger specimen. The woody cylinder is here represented where it is of greatest diameter and presents at the same time a thick zone of wood. The pith is cracked as a result of the long continued pressure to which the specimen has been subjected. The wood shows the numerous

resin canals, which also appear in the smaller specimen. Outside the fibrovascular cylinder lies the cortex, in which are likewise present resin canals. In neither of the two specimens examined, could any evidence be found of the presence of sclerotic nests such as exist in the pith of *P. statenensis*. Fig. 10 (Pl. 33) likewise shows the presence of the bases of the ensheathing bracts, which surround the axial portion of the short-shoot. It is clear from the figure that these, unlike the fascicular leaves, are flattened even as they take their origin from the surface of the short-shoot. On their lower or outer surface they are coated with a thick coat of sclerotic cells. They contain but a single leaf-trace and possess two resin canals, one on each side of the trace, communicating with the cortical canals of the short-shoot.

Fig. 8 (Pl. 33) shows the base of one of the fascicular leaves, found attached to the upper portion of the smaller short-shoot. It is at once distinguishable from the bracts, which take their origin lower down by the prominent ridge which marks its outer surface. The leaf-trace is single as in the case of the sheathing bracts described above and is likewise flanked on either side by a resin canal. In Fig. 8 (Pl. 33) the junction of the foliar resin canal with that of the cortex of the short-shoot can clearly be made out on the right, whilst on the left the union of the two resin ducts has not yet taken place. The tyloses are not as well developed in the bases of the fascicular leaves as they are in the sheathing bracts. This is, however, not surprising as even in the woody portion of the short-shoot the resin ducts are less clearly occluded by tyloses in the upper portion. The continuity between the resin canals of the fascicular leaves and those of the cortex of the short-shoots is a feature of great importance in connection with the affinity of the present species with *Prepinus statenensis*. As has been pointed out by Strasburger (Hist. Beiträge, vol. 3, 1891) the resin canals of the leaves of the living species of *Pinus* end blindly in the lower portion of the leaf and do not communicate with the resiniferous tissues of the axis. The same relations have been shown to occur in the case of the resin canals of the leaves of true pines from the Lower Cretaceous (Hollick and Jeffrey, "Studies of Cretaceous Coniferous Remains from Kreischerville, New York," Mem. N. Y. Bot. Garden, no. 3, pl. 22, figs. 1, 2, and 4, 1909).

In transverse sections near the tip of the smaller short-shoot as many as seven leaf-bases of the fascicular type, in contrast to the sheathing bracts, were found attached to the periphery. In the highest obtain-

able planes of section the woody portion of the central cylinder was still present in a marked degree and showed a number of foliar gaps much larger than seven. It may consequently be safely assumed that if our specimens had been complete, it would have been quite apparent that there were numerous fascicular leaves and that these were arranged in a spiral and not verticillate fashion. It follows that the short-shoots under consideration cannot be referred to the genus *Pinus*, but must in the present state of our knowledge at any rate, be attributed to the genus *Prepinus*. The following are the characters which appear to justify this reference: fascicular sheath composed of numerous spirally ranked non-deciduous and non-scarious bracts; leaves numerous, spirally arranged, with resin canals running to the very bases and communicating with those of the axis. The anatomical structure of the fascicular leaves could not be made out in detail, so the comparison with *Prepinus* along this line is excluded. It is difficult to make clear specific distinction between *Prepinus statenensis* and the new species at present under consideration, except on the basis of the anatomical structure of the axis of the short-shoot. As has been pointed out above, in the Martha's Vineyard species there are several rows of vertical resin canals in the wood of the short-shoot in contrast to the single series found in *Prepinus statenensis*. Moreover, there are no apparent sclerotic nests in the medulla of the former species in contrast to the well marked aggregations of sclerenchyma found in the pith of the latter. In accordance with the data furnished in the foregoing paragraphs, it is now possible to state precisely the characters of the new species under consideration:

***Prepinus viticetensis* species nov.**

Short-shoots of large size, sheathed by spirally arranged, numerous, non-deciduous bracts; fascicular leaves numerous, with spiral phyllotaxis, having resin canals decurrent to the base and continuous with similar canals of the axis; *wood of the short-shoots with numerous resin canals in two or more rows; pith without sclerotic nests.*

The italicised portion of the specific description indicates the features of contrast with *Prepinus statenensis*.

## CONCLUSIONS.

It is clear from the foregoing account that there was present in the flora, entombed in the Lower Cretaceous clays of Gay Head, Martha's Vineyard, Massachusetts, a species of the genus *Prepinus*, differing clearly from the similar remains found at Kreischerville, Staten Island, New York. This need supply no argument against the general stratigraphic equivalence of the Cretaceous deposits of the two localities, which has been insisted upon by both Ward and Hollick. There are likewise specific differences between the supposed *Sequoias* and *Dammaras* of the two deposits as is shown in the literature.

It will not be out of place at the present time to discuss the general problem of the relative antiquity of the two main divisions of the Abietineae. It is quite generally assumed that those Abietineae which are without resin canals in their secondary wood are of greater antiquity than those which possess them. Against this view it has been urged by the present writer, that there is clear evidence that those Abietineous Conifers, which are characterized by the possession of short-shoots and both horizontal and ligneous resin canals, are of more ancient origin. The genus *Prepinus*, judged by the criteria universally accepted as demonstrating phylogenetic antiquity must be regarded as a very ancient representative of the Conifers, for it has a type of leaf organization found elsewhere only in the Cordaitales, which became extinct at the end of the Paleozoic period. Moreover, the presence of cryptogamic wood in the leaf-traces of this genus makes its closer affinity with the older Gymnosperms beyond reasonable question, in the present state of our knowledge. The experimental data derived from wounding and the recapitulatory phenomena observed in the first annual ring of growth in the *Abies*-like representatives of the Abietineae further strengthen the position occupied by the writer, by making it clear that the Abietae have come from ancestors possessing the ligneous characters of the Pineae and are consequently of later origin.

If, as seems inevitable from the evidence now at our disposal, we regard the Pineae as the oldest representatives of the Abietineae, the question arises, whether the resin canals which are a constant feature of structure of the wood of this subtribe, originated first in the horizontal or the vertical plane. Gothan has recently expressed himself strongly in opposition to the writer's views as to the antiquity of the

Abietineae and particularly as to the greater age of the Pineae ("Die fossilen Hölzer von König Karls Land," Kong. Svensk. Vetenskaps-Akad. Handlingar, Stockholm, vol. 42, no. 10, 1908). Apropos of a new genus from the Jurassic strata of King Karl's Land, *Protopycoxylon*, which shows normally only vertical resin canals but which gave rise to canals in the horizontal plane as the result of injury, he expresses the view that the vertical canals appeared first and that they were followed by those in the horizontal plane. This view is clearly at variance with the known facts regarding the structure of the older *Pityoxyla*. Penhallow has described a species of *Pityoxylon* from the Permian of the State of Kansas, which has horizontal resin canals only, while Göppert from the Carboniferous of Waldenburg has described another *Pityoxylon* with resin canals confined to the horizontal plane (Penhallow, "North American Species of *Dadoxylon*," Trans. Roy. Soc. Canada, ser. 2, vol. 6, 1900; Göppert, "Revision meiner Arbeiten," Bot. Centralbl., vol. 5, p. 405, 1881). It is thus obvious that so far as the paleobotanical evidence goes, the horizontal resin canal is more ancient in the wood of the Conifers than is the vertical. In view of all the evidence which has been recently accumulated, there appears to be now no doubt, in the present state of our knowledge at any rate, that the type of Conifer with short-shoots and ligneous resin canals is very old and of greater antiquity than the type presented by the living *Abies* and the representatives of the *Sequoiineae* and *Cupressineae*. The short-shoot even figured in the earlier *Araucarineae* as the present writer will show in an article shortly to appear.

#### SUMMARY.

1. There was present in the flora represented in the Lower Cretaceous clays of Martha's Vineyard, Massachusetts, a Coniferous species belonging to the genus *Prepinus* Jeffrey.
2. This shows appreciable differences from the type species, *P. statenensis*, and on that account is named *P. viticetensis*.
3. Those Abietineae with ligneous resin canals are the oldest representatives of the tribe, as is shown both by the organization of the archaic genus *Prepinus* and the structure of the oldest described species of *Pityoxyla*.
4. The Abietineae are the oldest tribe of Conifers.



EXPLANATION OF PLATE 33.

- Fig. 1. Surface view of short-shoot of *Prepinus statenensis*.  $\times 5$ .  
Fig. 2. Same from the opposite side under the same magnification.  
Fig. 3. Short-shoot of *Prepinus viticetensis*.  $\times 3$ .  
Fig. 4. The same from the opposite side under the same magnification.  
Fig. 5. Another specimen of the same under the same magnification.  
Fig. 6. Specimen shown in Fig. 5 from the opposite surface, same magnification.  
Fig. 7. Part of transverse section through the base of specimens shown in Figs. 3 and 4.  $\times 40$ .  
Fig. 8. Base of fascicular leaf of the same specimen.  $\times 40$ .  
Fig. 9. Base of short-shoot shown in Figs. 3 and 4, in transverse section.  $\times 13$ .  
Fig. 10. Section transversely through the lower third of specimen shown in Figs. 5 and 6.  $\times 10$ .



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No. 11.— COMPOUND ASCIDIANS OF THE COASTS OF  
NEW ENGLAND AND NEIGHBORING BRITISH  
PROVINCES.

BY WILLARD G. VAN NAME, PH.D.

INTRODUCTION.

THE compound ascidians, or those that reproduce by budding and form colonies of more or less intimately connected individuals, are no longer regarded as constituting a natural group, since their origin from at least two, and perhaps more different groups of simple ascidians is well established. Yet those ascidians which have acquired this additional method of reproduction, have as a result acquired so many characters in common that the division of the ascidians into simple and compound forms remains a most convenient one, the employment of which is still justifiable if made with the understanding that no natural classification is implied.

In number of genera and species, the compound ascidians are fairly well represented in the New England region, and the abundance of certain of the species, as well as the large size of the colonies they form, would prevent their being overlooked by anyone making a study of its marine fauna. The scanty references to these animals in the earlier accounts of the invertebrates of this region are therefore to be explained chiefly by the difficulty of determining and satisfactorily describing the different forms of this group. In fact, until 1871, although the occurrence of other genera had been mentioned, but three of the species, those called in this paper *Botryllus schlosseri* (Pallas), *Amaroucium pellucidum* (Leidy), and *Tetradidemnum albidum* (Verrill), had been definitely determined and recorded. The earlier records are contained in the accounts of the Mollusca of this region, as the ascidians were then regarded as members of that branch of the animal kingdom.

Couthouy, in 1835 (see list of literature at the end of this article), records *Botryllus schlosseri* under the name *B. stellatus*, and lists also "*Polyclinum* ——" from near Boston. The latter form cannot be definitely determined, but was probably *Amaroucium glabrum* Verrill, as no *Polyclinum* is known from this region.

Gould (1841) in his "Report on the Invertebrata of Massachusetts," again records *Botryllus stellatus*, and mentions the existence of other forms which had not been satisfactorily made out.

Stimpson (1854) in his "Synopsis of the marine Invertebrata of Grand Manan, N. B.," records the occurrence in that locality of a compound ascidian "with the aspect of an *Aplidium*," which in all probability was *Amaroucium glabrum* Verrill, as well as of another which "approximated in character to the genus *Botrylloides*," and was probably really a member of that genus. He also mentions what he regarded as a species of *Clavellina* (see p. 343).

Leidy (1855) described and figured *Amaroucium pellucidum* from the Rhode Island coast, placing it, however, in a totally different group of animals and calling it *Acyonidium? pellucidum*.

Packard (1867) in his "View of the recent invertebrate fauna of Labrador," records a "*Leptoclinum* sp." and (under the name *Dilemnium roscum* Sars) also *Tetradideanum albidum* (Verrill).

Further additions to the list of species were not made until the year 1871, when Professor A. E. Verrill published in the American Journal of Science a series of papers entitled "Descriptions of some imperfectly known and new ascidians from New England." In these he describes again the three species above mentioned as well as seven new ones, and figures a number of them. In these papers, he proposes three new genera, *Macroclinum*, *Lissoclinum*, and *Lioclinum* (see below, p. 384), and establishes apparently for the first time, the almost universally adopted families *Botryllidae*, *Polyclinidae*, and *Didemnidae* (*Amer. Journ. Sci.*, ser. 3, vol. 1, p. 211). Later in the same year, in an article in the same journal, entitled "On the distribution of marine animals on the southern coast of New England," two more compound ascidians are described. The papers subsequently published by Verrill in the course of the general investigation of the marine fauna of the New England region which was then being conducted by the United States Commission of Fish and Fisheries (now the Bureau of Fisheries), and especially the "Report upon the invertebrate animals of Vineyard Sound" by Verrill and Smith, which appeared in 1873, give many facts regarding the distribution and habits of these species, and in the latter work many of them are again described. No additions are made to the list of species, save that the occurrence of another member of the *Botryllidae* is mentioned.

Since that time the compound ascidians of this region have been

greatly neglected by zoologists, the little that has been published being based almost entirely on Verrill's work, though Herdman (1886) described an Aplidium (*A. despectum*) dredged by the Challenger off Nova Scotia, which, without much doubt, is identical with one of Verrill's species, and Whiteaves (1901), in his "Catalogue of the marine Invertebrata of eastern Canada," gives new facts regarding the distribution of some species. Lefevre's work (1898) on the budding of Perophora, Metcalf's (1900) anatomical observations, and Bancroft's (1903) investigations of the variations in the genus Botryllus should receive special mention as contributions to the anatomy and life history of certain forms.

In general, however, the knowledge of this group as far as New England is concerned, stands today very much as Verrill left it more than thirty years ago, and his names for the species have up to this time been employed without any material changes. When these names were given, owing to the lack of good descriptions and figures of European forms, it was not possible to identify the New England species with those of the Old World, but the excellent descriptions and figures furnished by the works of Huitfeldt-Kaas, Hartmeyer, Bjerkan, Redikorzew, and other recent writers on the northern European ascidians, clearly show that a number of the forms are common to both hemispheres, while the strict application of the law of priority in the nomenclature, which has been made possible through the admirably thorough and conscientious work of Hartmeyer, involves additional changes in these names. The species described by Verrill, with the names used by previous New England writers, and those changes in the nomenclature which the writer has adopted are as follows:

<i>Verrill's name.</i>	<i>Name here adopted.</i>
<i>Botryllus gouldii</i> . (= <i>B. stellatus</i> of Couthouy and Gould.)	<i>Botryllus schlosseri</i> (Pallas), 1766.
<i>Botryllus</i> sp..	<i>Botrylloides aureum</i> Sars, 1851.
<i>Perophora viridis</i> .	No change.
<i>Leptoclinum albidum</i> (type). (= <i>Didemnum roseum</i> Sars, of Packard, Bin- ney, and Dall.)	<i>Tetradidemnum albidum</i> (Verrill), 1871.
<i>Leptoclinum luteolum</i> (type).	<i>Tetradidemnum albidum</i> (Verrill), 1871. (Only a color variety.)

<i>Verrill's name.</i>	<i>Name here adopted.</i>
<i>Lissoclinum tenerum.</i>	<i>Didemnopsis tenerum</i> (Verrill), 1871.
<i>Lissoclinum aureum.</i>	No change.
<i>Macroclinum crater.</i>	<i>Macroclinum pomum</i> (Sars), 1851.
<i>Amaroecium pallidum.</i>	<i>Aplidium pallidum</i> (Verrill), 1871.
<i>Amaroecium pellucidum.</i> (= <i>Alcyonidium</i> ? <i>pellucidum</i> Leidy.)	<i>Amaroucium pellucidum</i> (Leidy), 1855.
<i>Amaroecium constellatum.</i>	<i>Amaroucium pellucidum</i> form <i>constellatum</i> (Verrill), 1871.
<i>Amaroecium glabrum.</i>	<i>Amaroucium glabrum</i> (Verrill), 1871.
<i>Amaroecium stellatum.</i>	<i>Amaroucium stellatum</i> (Verrill), 1871.

As shown in the above list, two prove not to be valid species. However, under the term *Leptoclinum albidum* (or *L. luteolum*, if the specimen happened to have a yellowish, orange, or pinkish tint) two very different species, which should be placed in different genera, have been confused. One of these is, as explained below, a well known European form; the other the writer cannot satisfactorily identify, and he has therefore been obliged to describe it as new. Three other forms can now be added to the list of those inhabiting this region, though one is a deep-water species which does not occur near the shore. The list of New England species should therefore be completed as follows:

<i>Verrill's name.</i>	<i>Name here adopted.</i>
<i>Leptoclinum albidum</i> (part) + <i>Leptoclinum luteolum</i> (part).	<i>Didemnum lularium</i> n. sp.
Not recorded by Verrill.	<i>Holozoa clavata</i> (Sars), 1851.
Not recorded by Verrill.	<i>Polycitor küenthali</i> (Gottschaldt), 1894.
Not recorded by Verrill.	<i>Leptoclinides faeröensis</i> Bjerkan, 1905.

This is a total of 15 species, representing 13 genera and 5 families (see synopsis on p. 344-346), and is exclusive of the free-swimming pelagic family Pyrosomidae, which is represented in New England waters, but which is not included in the scope of the present paper. In this connection it should further be mentioned that among the material collected by the steamer Albatross in the deep water off the New England coast, there are a few specimens of compound ascidians in too poor condition to determine whether or not they belong to

forms above listed, and that as already stated (p. 340) Stimpson (1854, p. 19) records finding at Grand Manan in one instance "what appeared to be a *Clavellina* but so mangled by rough usage in the dredge as to be further indistinguishable." The occurrence of a member of this or an allied genus in these waters is not in itself improbable, but as a large amount of collecting has since been done in the above locality without finding any such form, Stimpson's record does not seem sufficiently certain to require further consideration in this paper.

The writer has himself collected and studied in a fresh condition a number of the forms here described, but this account is based chiefly on the extensive collections of New England invertebrates belonging to or deposited in the Peabody Museum of Yale University, comprising those made by Professor A. E. Verrill, S. I. Smith, H. E. Webster, O. Harger, and others, chiefly during the years 1868 to 1870, inclusive, and those made (also largely under the direction of Professor Verrill) by the United States Commission of Fish and Fisheries between the years 1871, when it was first established, and 1887, inclusive. Much of the material collected by the Fish Commission has been removed to the United States National Museum at Washington, but the writer had previously examined most of the specimens of compound ascidians, and he feels reasonably sure that the account presented in the following pages covers all the species that were collected.

Not only did the combined collections, comprising in all hundreds of examples of compound ascidians from the region in question, afford an exceptional opportunity for the study of these animals on account of their richness in specimens and the extent of geographical area they covered, but they included the types of Verrill's species and genera, and a large number of specimens from deep water, collected by the Fish Commission steamer *Albatross*, which could not be duplicated elsewhere. An examination of this material, which evidently contained forms new to the region, before time should play greater havoc with it than it had already done, was therefore very desirable. Naturally a part of these specimens were found in such poor condition that they were of interest chiefly in working out the distribution of the several species. Nearly all of them had simply been put in strong alcohol and kept in it, some of them for forty years, and were probably in many cases badly shrunken to begin with. Yet in the large quantity of material that was examined there were many remarkably well preserved colonies, in which the zooids were well expanded, and in which the

details of the structure could be made out as well as one could hope to do with freshly preserved material, unless enough of it were available to preserve many different lots.

In concluding these preliminary remarks, the writer wishes to express his thanks to Professor Verrill for the use of the collections as well as for much advice and information which have been of service in preparing this paper, and to Miss Katherine J. Bush, Ph.D., of the Peabody Museum, for assistance in looking up the specimens in the large and incompletely catalogued collections.

#### GEOGRAPHICAL DISTRIBUTION.

The region with which this paper deals extends from the Gulf of St. Lawrence and Banks of Newfoundland southward to, and including, Long Island Sound. A brief synopsis of the distribution of the several forms in area and in depth is here given. The species are arranged in families, and in the order in which they are described in the systematic part of this paper, the classification adopted being substantially that of Hartmeyer (1909). In order to diminish as much as possible the inconvenience which the changes in nomenclature must cause for a time, Verrill's names are again repeated, following those adopted in this paper.

#### Family BOTRYLLIDAE Verrill, 1871.

1. *Botryllus schlosseri* (Pallas). [*B. gouldii* Verrill.]  
Coasts of Massachusetts, Rhode Island, Connecticut, and Long Island; Mediterranean and Atlantic coasts of Europe.  
Confined to very shallow situations.
2. *Botrylloides aureum* Sars. [*Botryllus* sp., Verrill.]  
Gulf of St. Lawrence; off Newfoundland; Gulf of Maine; Maine coast; northern waters of Europe.  
Shallow water to 250 meters.

#### Family PEROPHORIDAE Giard, 1872.

3. *Perophora viridis* Verrill.  
Southern Massachusetts, Rhode Island, Connecticut and North Carolina coasts; Bermuda.  
Low-water mark to 12 fathoms.

## Family POLYCITORIDAE Michaelsen, 1904.

4. *Polycitor kükenthalii* (Gottschaldt). [Not recorded by Verrill.]  
Off Newfoundland; Spitzbergen; Murman coast.  
From 15 to 395 meters.
5. *Holozoa clavata* (Sars). [Not recorded by Verrill.]  
Off Newfoundland and Nova Scotia; New England coast north of, and off, Cape Cod; northern European waters.  
Shallow water to 150 fathoms.

## Family DIDEMNIDAE Verrill, 1871.

6. *Didemnum lutarium* sp. nov. [*Leptoclinium albidum* (part.) + *L. luteolum* (part.) Verrill.]  
New Hampshire to Long Island Sound, but local north of Cape Cod.  
Shallow water only.
7. *Leptoclinides faerøensis* Bjerkan. [Not recorded by Verrill.]  
Off Newfoundland and the eastern United States, south to N. lat. 37°; vicinity of Iceland; Faroe Islands; north of Norway.  
Deep water only; 100 to 1582 fathoms.
8. *Tetradidemnum albidum* (Verrill). [*Leptoclinium albidum* (type) + *L. luteolum* (type) Verrill.]  
Davis Strait; Labrador; Banks of Newfoundland; New England coast, chiefly from Cape Cod northward, but locally south to off Martha's Vineyard; northern waters of Europe.  
Low-water mark to 110 fathoms.
9. *Didemnopsis tenerum* (Verrill). [*Lissoclinium tenerum* Verrill.]  
Banks of Newfoundland; New England coast north of, and off, Cape Cod. *Didemnopsis variabile* (Huitfeldt-Kaas), 1896, of northern European and Asiatic waters, is very probably identical.  
From 10 to 75 fathoms.
10. *Lissoclinium aureum* Verrill.  
Banks of Newfoundland, New England coast, chiefly north of Cape Cod, but south locally to off Martha's Vineyard. *Diplosomoides dubium* Hartmeyer, 1903, from the region of Spitzbergen, is a very close ally.  
Shallow water to 100 fathoms.

## Family SYNOICIDAE Hartmeyer, 1908.

11. *Macroclinium pomum* (Sars). [*Macroclinium crater* Verrill.]  
Banks of Newfoundland; waters of northern Europe; near the Faroe Islands; near Iceland.  
Greatest depth, 75 fathoms.

12. *Aplidium pallidum* (Verrill). [*Amaroccium pallidum* Verrill.]  
Newfoundland and the Gulf of St. Lawrence; coast of New England, chiefly north of Cape Cod, but locally to southern Massachusetts and probably Rhode Island. *A. lacteum* Huitfeldt-Kaas, 1896, of northern European waters, is very probably identical with this species.  
Low water to 126 (in one case 471) fathoms.
13. *Amaroccium pellucidum* (Leidy).  
Southern Massachusetts, Rhode Island, and Connecticut. [North Carolina, according to Verrill.]  
Greatest depth, 12 fathoms.
- 13a. *Amaroccium pellucidum* form *constellatum* (Verrill). [*A. constellatum* Verrill.]  
New Hampshire, to Long Island Sound.  
Low water to 18 fathoms.
14. *Amaroccium glabrum* Verrill.  
Newfoundland and the Gulf of St. Lawrence; coast of New England, chiefly north of Cape Cod, but locally to southern Massachusetts and Rhode Island. A very closely allied, if distinct, form (*A. translucidum* Ritter, 1901) occurs in northern European, Asiatic, and Alaskan waters.  
Low water to 80 fathoms.
15. *Amaroccium stellatum* Verrill.  
Southern Massachusetts. [North Carolina, according to Coues and Yarrow.]  
Shallow water.

In this paper seven of these species are considered as identical with previously described European species, while with four of the others subsequently described European species may be identical.

As far as their distribution in the New England and eastern Canadian region is concerned these species may, if we except the deep-water *Leptoclinides faeröensis*, be divided into two groups, a northern one composed of

*Botrylloides aurum* Sars.  
*Polycitor kükenhali* (Gottschaldt).  
*Holozoa clavata* (Sars).  
*Tetradidemnum albidum* (Verrill).  
*Didemnoopsis tenerum* (Verrill).  
*Lissoclinum aureum* Verrill.  
*Macroclinum pomum* (Sars).  
*Aplidium pallidum* (Verrill).  
*Amaroccium glabrum* Verrill.

and a southern one composed of

*Botryllus schlosseri* (Pallas).

*Perophora viridis* Verrill.

*Didemnum lutarium* sp. nov.

*Amaroucium pellucidum* (Leidy).

*Amaroucium stellatum* Verrill.

Cape Cod may be said to be the dividing limit between the areas occupied by these groups, but no exact limit can be laid down, as many of the species extend a considerable distance into the territory of the other group. All the species of the northern group range northward beyond the limits of the region which this paper covers, and if not found in Europe also, are represented there by scarcely distinguishable allies, while of the southern group *Botryllus schlosseri* only is also European, unless future investigation should prove that one or more others are inseparable from European forms.

But little has been recorded concerning the distribution of compound ascidians on the American Atlantic coast south of New England, and the southern limits of the range of the southern group of species remain to be determined. *Perophora viridis* is the only one of them recorded from Bermuda, though a species of *Didemnum* closely allied to *D. lutarium* is also found there. *Amaroucium stellatum* (by Coues and Yarrow), *A. pellucidum* (by Verrill), and *Perophora viridis* (by Lefevre, and Wilson), have been recorded from North Carolina, but from the northern part of New Jersey southward until the region of coral reefs is reached, the shores and bottoms are chiefly of shifting sand, unfavorable for the growth not only of ascidians but of most other marine organisms except the comparatively small percentage which are especially adapted for life in that environment; while the bays, sounds, and harbors are in many cases too brackish to be favorable for organisms so strictly marine as the ascidians. Yet the reports of several zoologists (Stimpson, Coues and Yarrow, Lefevre, Wilson) show that ascidians are abundant about Beaufort, North Carolina, and no doubt investigation would result in finding other favorable localities along this stretch of coast.

#### DISTRIBUTION IN DEPTH.

The species of the first or northern group all occur through a considerable range in depth, being found from a depth of a few fathoms

(or from low-water mark in some cases) to 65 or 100 fathoms or more, according to the species, *Aplidium pallidum* ranging from low water to 471 fathoms. *Leptoclinides faerøensis* stands alone among all our species in being confined to depths of 100 fathoms and over, two small specimens being from 1582 fathoms. The species of the second or southern group are exclusively shallow-water forms, but one of them being recorded from a depth as great as 18 fathoms.

#### DISTRIBUTION ACCORDING TO CHARACTER OF BOTTOM.

A majority of the species are recorded from stations with widely different kinds of bottom. *Didemnopsis tenerum* and *Lissoclinium aureum* prefer mud, but a stony or shelly bottom is usually most favorable on account of affording the best opportunities for attachment. When they occur on sandy or muddy bottom, the smaller species generally grow on large simple or compound ascidians or other large attached animals, not directly on the bottom itself. The species which form large colonies, as those of the genus *Amaroucium*, can grow on soft or loose bottom where there is no large fixed object for attachment, being then anchored by a quantity of fine gravel, sand, or mud, some of it more or less completely included in the basal part of the colony. The existence of tidal currents carrying an abundant supply of food in suspension is a factor of more importance to these animals than the character of the bottom, provided only that the possibility of attaching or anchoring itself is afforded to the colony. In situations so favored it is not uncommon to find three or four kinds of ascidians, simple and compound, attached to the same shell or other object, or growing upon each other. Water that is even slightly brackish is, however, very unfavorable to them, and if much fresh water is received in a harbor or small bay their growth there may be prevented entirely. *Botryllus schlosseri* has the habit of growing on eel-grass (*Zostera*) and upon floating timber or the bottoms of boats, as well as on rocks. *Amaroucium pellucidum* develops into the typical sand-incrusted form on a sandy bottom only. Where it grows on rocks or piles of wharves, the *constellatum* form develops. Besides the last-mentioned species, *Perophora viridis*, *Didemnum lutarium*, *Tetradidemnum albidum*, and *Amaroucium glabrum* grow abundantly on the piles of wharves in some places.

## COMPARATIVE ABUNDANCE.

*Macroclinum pomum* and *Botrylloides aurcum*, though widely distributed and locally abundant in European waters, are poorly represented in the collections, probably because their range lies chiefly to the north and eastward of the region where most of the collecting was done. *Polycitor kükenthalii* also was collected from few localities, and is rare in Europe as well. The deep-water species *Leptoclinides focröensis*, though represented by comparatively few specimens, must grow luxuriantly in some places, judging by the large and flourishing colonies it forms. *Holozoa clavata*, *Didemnopsis tenerum*, *Lissoclinum aurcum*, and *Aplidium pallidum* are widely distributed but local, and can seldom be found in any considerable quantity, *Lissoclinum aureum* being decidedly rare. The remaining seven species are all abundant, locally at least, and may be collected in large quantities in the favorable places and seasons. The extraordinarily luxuriant growth of *Amaroucium pellucidum* and *A. stellatum* in Vineyard Sound is mentioned below (pp. 406 and 418), but considering its wide distribution and the large number of stations where it is very common, *Amaroucium glabrum* is probably really more abundant than any of the others.

## DESCRIPTIONS OF SPECIES.

The numbered dredging and trawling stations mentioned are those of the United States Fish Commission.

The classification and nomenclature is substantially that of Hartmeyer (1908b, 1909). The writer has not departed from it in any case without a full explanation of the reasons for so doing. In Hartmeyer's system, through conformity to the international rules of nomenclature, several of the familiar generic names of compound ascidians are abandoned or applied to other genera. The genus *Didemnum* in the sense hitherto usually employed becomes *Trididemnum* Della Valle, 1881, while the name *Didemnum* Savigny, 1816, is applied to the genus that has been known as *Leptoclinum*. The name *Leptoclinum* Milne-Edwards, 1841, replaces *Diplosoma* Macdonald, 1858. *Distaplia* Della Valle, 1881, becomes *Holozoa* Lesson, 1830. The family names *Distomidae* and *Polyclinidae* are replaced by *Polycitoridae* and *Synoicidae*, respectively. Where the new names seem likely to cause

confusion the writer has adopted the expedient of placing the old name after the new one in brackets, as proposed by Michaelsen and already employed by other writers also, thus: *Holozoa* [*Distaplia*] *clavata* (Sars).

*Abbreviations used in Illustrations.*

<i>at</i> — atrial orifice.	<i>lv</i> — larva.
<i>bp</i> — brood pouch.	<i>mb</i> — muscle band.
<i>br</i> — branchial orifice.	<i>mp</i> — muscular process.
<i>dlg</i> — dorsal languet.	<i>od</i> — oviduct.
<i>en</i> — endostyle.	<i>oe</i> — esophagus.
<i>fp</i> — fecal pellet.	<i>ov</i> — ovary.
<i>g</i> — ganglion.	<i>r</i> — rectum.
<i>gc</i> — gastric caecum.	<i>rep</i> — reproductive glands.
<i>i</i> — intestine.	<i>s</i> — stomach.
<i>ilv</i> — internal longitudinal vessel.	<i>sd</i> — sperm duct.
<i>ing</i> — intestinal gland.	<i>t</i> — testis.
<i>lg</i> — atrial languet.	<i>vp</i> — vascular process.

The illustrations are from drawings and photographs by the author.

Family BOTRYLLIDAE Verrill, 1871.

Genus BOTRYLLUS Gaertner and Pallas, 1774.

Systems simple, circular or elliptical, composed of comparatively few zooids. Colony thin and incrusting in the typical species.

**Botryllus schlosseri** (Pallas).

Text-fig. 1; Pl. 39, fig. 10.

1766. *Acyonium Schlosseri* Pallas, Elench. Zoophyt., no. 208.  
 1816. *Botryllus Schlosseri* Savigny, Mémoires sur les animaux sans vertèbres, pt. 2, p. 200, pl. 20, fig. 5.  
 1838. *Botryllus stellatus* Couthouy, Boston Journ. Nat. Hist., vol. 2, p. 111.  
 1841. *Botryllus stellatus* Gould, Report on Invertebrata of Massachusetts, ed. 1, p. 320.  
 1870. *Botryllus Schlosseri* Binney, Gould's Invertebrata of Massachusetts, ed. 2, p. 3, pl. 23, fig. 319.  
 1870. *Botryllus Schlosseri* Dall, Proc. Boston Soc. Nat. Hist., vol. 8, p. 255.  
 1871. *Botryllus Gouldii* Verrill, Amer. Journ. Sci., ser. 3, vol. 1, pp. 211, 212, fig. 14-19.  
 1872. *Botryllus Gouldii* Verrill, Amer. Journ. Sci., ser. 3, vol. 3, p. 213.

1873. *Botryllus Gouldii* Verrill and Smith, Report on Invertebrate Animals of Vineyard Sound, pp. 702, 375 (378), 389, (393, 483), pl. 33, figs. 252, 253.
1879. *Botryllus Gouldii* Verrill and Rathbun, Proc. U. S. Nat. Mus., vol. 2, p. 231.
1879. *Botryllus Gouldii* Verrill, Preliminary Check-List of Marine Invertebrates, p. 27.
1889. *Botryllus gouldii* McDonald, Rep. Comm. Fish and Fisheries for 1886, p. 858.
1891. *Botryllus Schlosseri* + *B. Gouldii* Herdman, Journ. Linn. Soc. London, Zool., vol. 23, p. 607.
1898. *Botryllus* Davenport, Science, new ser., vol. 8, p. 686.
1900. *Botryllus gouldii* Metcalf, Zool. Jahrbücher, Anat., vol. 13, p. 522, pl. 37, fig. 38-40 (ganglion, neural gland, etc.).
1903. *Botryllus schlosseri* Bancroft, Proc. California Acad. Sci., ser. 3, zool., vol. 3, no. 5.
1909. *Botryllus gouldii* + *B. schlosseri* Hartmeyer, Bronn's Tier-reich, vol. 3, suppl., pp. 1378, 1379.

Bancroft (1903), after a long study of the life history of *Botryllus* colonies, both in America (Wood's Hole and Newport) and Europe (Naples), concludes that "in *Botryllus*, as it occurs in Europe and the Atlantic Coast of North America, color characters cannot be used for separating species; and that, therefore, since none of the described species have been based upon morphological characters, there is no valid reason for recognizing more than the single species *B. schlosseri* (Pallas, 1766, pp. 355-356) Savigny (1816)." He further says: "It might be thought that *B. gouldii* (Verrill, 1871, p. 211) of the Atlantic Coast of North America should be excepted in this general lumping of species; but so far as can be seen at present, there is no ground for making an exception, for *Botryllus* at Wood's Hole and at Newport exactly resembles *Botryllus* at Naples. In the main, even the same color variations are met with; but their relative commonness differs somewhat in the three localities." In the present paper, the writer accepts this view, but will not attempt to cite further the literature or synonyms referring to this species as it occurs in Europe. The following descriptions and remarks upon its growth and distribution refer to it as it occurs in American waters.

Verrill says of this species (Verrill and Smith, 1873, p. 375) that when young it "forms thin, soft, circular or oval incrustations. . . . These young colonies begin to appear in June and grow very rapidly, new individuals being formed by buds that originate from the first

ones in rapid succession, so that in two or three weeks the small colonies will increase from a quarter of an inch in breadth up to three or four inches, if they be situated on a flat surface, and have room to spread. If upon a stem or leaf of the eel-grass they will extend entirely around it, and perhaps several inches along its length, if not opposed by other colonies. At the same time the crusts increase very much in thickness. Thus by the end of the summer, the eel-grass, algae, stems of hydroids, &c., often become completely covered up by the luxuriant growth of this curious compound animal. The colors of this species are extremely variable and often very elegant, and it is seldom that two colonies can be found with precisely the same pattern of color. Growing upon the same leaf of eel-grass, many different colonies may often be found, each showing a different arrangement of the colors."

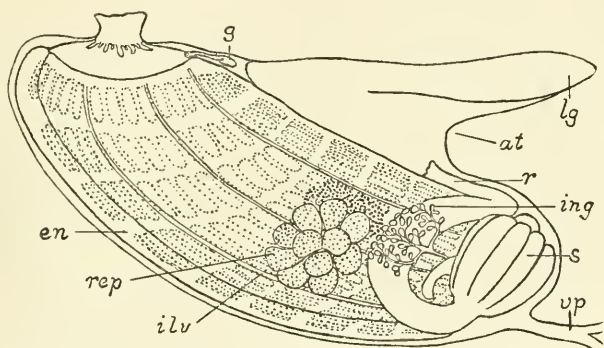
Professor Verrill then goes on to describe the principal color varieties, to seven of which he assigns names: vars. *bicolor*, *farinacea*, *annulata*, *atrox*, *variegata*, *albida*, and *stella*. In nearly all these forms the zooids are dark colored, usually deep purple or purplish brown. This color also pervades the bulbs of the test vessels and suffuses to a greater or less degree the test substance during life, but when the animal dies the test becomes light colored and more transparent. During life, in addition to this dark pigment, the zooids, especially their anterior ends and dorsal portions, and the bulbs of the test vessels, are marked with a light colored pigment, which mostly disappears after death. To the varied shades and distribution of this pigment much of the variation in the color of different colonies is due.

The zooids are of moderate size (the individual figured measuring about 1.75 mm. long). They lie in the colony either on their ventral surface with the anterior end somewhat turned up, or in an inclined position, as shown in the figure. The systems in which they are arranged contain from five to about twenty individuals, rarely more, and are circular or oval in outline, and usually well separated from each other. The posterior ends of the zooids are close together, and extend more or less under the common cloacal chambers which form the centers of the systems.

The branchial aperture is without lobation, or nearly so. The atrial cavity is quite capacious and opens into the common cloacal cavity by the large dorsally situated atrial opening, the upper lip of which is produced into a more or less prominent languet. The tenta-

cles number sixteen, the rows of stigmata about nine (ten in Professor Verrill's figure), the internal longitudinal vessels three on each side. The latter are separated by about four stigmata. Each side of the endostyle there are five or six stigmata before the third internal longitudinal vessel is reached, and each side of the median dorsal vessel six or sometimes seven stigmata.

This is a very abundant species at many points along the coast of southern New England, and probably further south, though Professor Verrill gives no locality south of Brooklyn, N. Y. This is doubtless the *Botryllus* recorded by Davenport (1898) from Cold Spring Harbor,



Text-fig. 1.—*Botryllus schlosseri* (Pallas). Zooid.  $\times 45$ .

Long Island. It extends along the Massachusetts coast north of Cape Cod at least to Salem, being abundant at Boston and Charlestown, Massachusetts, as well as at Provincetown on the extremity of Cape Cod.

It is strictly a shallow-water species and grows in a great variety of situations, but especially on eel-grass (*Zostera*), on floating timber, and on the bottom of boats. The most luxuriant growth of this species that the writer has ever seen was removed from the bottom of a launch kept at the Thimble Islands in Long Island Sound, November 15, 1909. It formed coherent patches up to 20 cm. across, which were produced into dependent lobes often several centimeters long, where the stem of an alga or other growth was present to form a basis for such an extension of the colony. These large patches were, however, not single colonies, but were formed by the more or less complete growing together of a number of originally distinct colonies. In

spite of the luxuriant growth of these examples, the systems remained small, oval or elliptical in outline, and generally with easily distinguishable limits. These colonies reached this development in but little more than three months.

Genus BOTRYLLOIDES Milne-Edwards, 1841.

Differs from *Botryllus* chiefly in having elongated, more or less branching systems instead of small simple ones.

***Botrylloides aureum* Sars.**

Text-fig. 2.

1851. *Botrylloides aurea* Sars, Nyt Mag. Naturvidensk., vol. 6, p. 153.  
 1859. *Botrylloides aurea* Sars, Forh. Videnskabs-Selsk. Christiania, 1858, p. 66.  
 1873-74. *Botryllus*, new species, Verrill, Amer. Journ. Sci., ser. 3, vol. 6, p. 440; vol. 7, p. 413.  
 1874. *Botryllus* sp., Verrill, Proc. Amer. Assoc. Adv. Sci., vol. 22, pp. 348, 352.  
 1879. *Botryllus* Verrill, Preliminary Check-List of Marine Invertebrata, p. 27.  
 1894. *Botrylloides rugosum* Gottschaldt, Jena. Zeitschr., vol. 28, p. 344, pl. 24, fig. 1.  
 1896. *Sarcobotrylloides aureum* Huitfeldt-Kaas, Norske Nordhavs-Exp., Zool., vol. 23, no. 1, p. 25.  
 1896. *Sarcobotrylloides aureum* Bonnevie, Norske Nordhavs-Exp., Zool., vol. 23, no. 2, p. 11.  
 1897. *Sarcobotrylloides aureum* Vanhöffen, Drygalski's Grönland Exp., vol. 2, pt. 1, p. 184.  
 1901. *Botryllus*, species undetermined, Whiteaves, Catalogue of Marine Invertebrata, p. 266.  
 1903. *Sarcobotrylloides aureum* Hartmeyer, in Römer and Schaudinn, Fauna Arctica, vol. 3, p. 263-266, pl. 6, figs. 15, 16, and 20; pl. 11, fig. 13-19.  
 1904. *Sarcobotrylloides aureum* Hartmeyer, Wiss. Meeresunters., Abt. Helgoland, vol. 5, pt. 2.  
 1905. *Sarcobotrylloides aureum* Bjerkan, Bergens Mus. Aarbog, no. 5, p. 13.  
 1906. *Sarcobotrylloides aureum* Redikorzew, in Derjugin, Die murmansche biologische Station, Trav. Soc. Nat. St. Pétersbourg, vol. 37, p. 155.  
 1907. *Sarcobotrylloides aureum* Redikorzew, Ann. Mus. Zool. Acad. Sci. St. Pétersbourg, vol. 11, pp. 138, 151, 152.  
 1908. *Sarcobotrylloides aureum* Bjerkan, Tromsø Mus. Aarsheft, no. 25, pp. 74, 115.  
 1908. *Sarcobotrylloides aureum* Redikorzew, Trav. Soc. Nat. St. Pétersbourg, vol. 39, pp. 20, 27.  
 1909. *Sarcobotrylloides aureum* Hartmeyer, Bronn's Tier-reich, vol. 3, suppl., pp. 1380, 1381.

The genus *Sarcobotrylloides* von Drasche, in which recent authors have placed this species, is distinguished from *Botrylloides* only by the greater thickness of the colony. The writer cannot regard it as worthy of recognition even as a subgenus.

This well known northern European species is represented in the collections by but few specimens, most of them small ones. The following description is based almost entirely on the largest of the specimens, which is from Station 2699 off Newfoundland (see below).

The colony is on what appears to be a section of the stalk of a *Boltenia*, completely surrounding and covering it (as well as many of the branches of a hydroid also growing on the same object) for a length of nearly 8 cm., reaching a width of over 2 cm. and a thickness of nearly 1.5 cm. in some places. Though there are considerable areas of the surface not occupied by zooids at all, in many places the systems are somewhat crowded and their exact limits are often indistinguishable, but there appear to be many small oval or elongated ones, and not many that are extensively branched. In this respect this species is not a typical *Botrylloides*, but approaches somewhat the genus *Botryllus*. Systems occur on all sides of the roughly cylindrical mass of the colony. The color of the colony preserved in alcohol in this, as in the other specimens, is purple, due chiefly to the deep purple zooids. The test is fairly transparent and without much color. It contains the branching vessels universally present in this family.

The zooids are rather large (about 2.3 to 2.7 mm. long, when well expanded) and are nearly as broad as in a typical *Botryllus*.

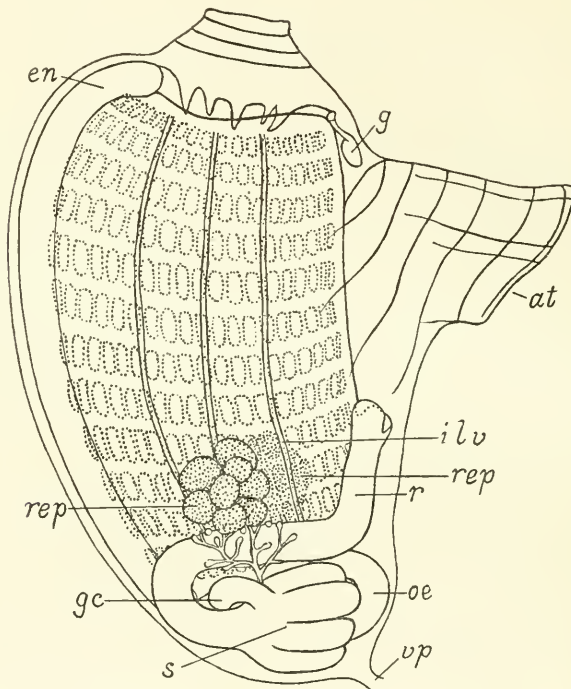
The oral tentacles usually number eight, larger and smaller ones being placed alternately. Huitfeldt-Kaas and Gottschaldt also give this number. Hartmeyer found in addition eight still smaller ones in large zooids, making sixteen in all. Such additional tentacles may sometimes occur in the American specimen, but if so they are very small and rudimentary.

The branchial sac had 12 or 13 rows of stigmata in the individuals in which they could be counted, and three internal longitudinal vessels on each side. Between these vessels about three or four stigmata intervene; between the median dorsal vessel and the first internal longitudinal vessel six or sometimes seven stigmata; between the third internal longitudinal vessel and the endostyle also six or seven stigmata. For a short distance each side of the endostyle there are no stigmata.

The stomach has six or more deep longitudinal folds and a well developed caecum. The rectum has a markedly two-lobed aperture.

The localities from which the specimens came are:

(1) Station 2699 (off Newfoundland, N. lat.  $45^{\circ} 04'$ , W. long.  $55^{\circ} 23'$ , 72 fathoms, August 22, 1886). Two colonies, the one described above, and another more irregular in form and less bulky, growing on a branching hydroid; also several small colonies.



Text-fig. 2.—*Botrylloides aurcum* Sars. Zooid.  $\times 36$ .

(2) Casco Bay, 50 fathoms, August 6, 1873. A small, very flat colony incrusting a simple ascidian.

(3) Stations 55 to 56 B (Cashe's Ledge, Gulf of Maine, 30 to 40 fathoms, gravel, September 5, 1874). A flat colony over 20 mm. across, incrusting a simple ascidian.

(4) Banks of Newfoundland. Several very small and evidently young colonies.

Whiteaves (1901, p. 266) records a "*Botryllus*," the present species with little doubt, from the Gulf of St. Lawrence (half way between Pointe de Monts and the west end of Trinity Bay, 96 fathoms; and 15 miles SSE. of Bonaventure Island, 50 fathoms). Stimpson (1854, p. 19) mentions a bright green compound ascidian from Grand Manan, which "approximated in character the genus *Botrylloides*" and may have been a color variety of this species. The specimens collected by Verrill were purple, if his statement to this effect is meant to apply to the living as well as to the preserved specimens.

According to Hartmeyer (1903), who has carefully described it, this species is very common about Spitzbergen, Bear Island, the northern coast of Norway, and the Murman coast of Russia, occurring in shallow water and to a depth of 100 fathoms. It occurs also off Greenland (Vanhöffen). Bjerkan (1905) reports a specimen from 250 meters depth. Sars's type was from Norway. Hartmeyer's description is based on the study of material from many localities, including the type of *Botrylloides rugosum* Gottschaldt from Spitzbergen, and Vanhöffen's example from Greenland (Karajafiord).

This species is clearly distinct from *Botrylloides nigrum* Herdman, which occurs at Bermuda. *B. nigrum* has considerably smaller zooids, which are arranged in very complex branching systems.

Family PEROPHORIDAE Giard, 1872.

Genus PEROPHORA Wiegmann, 1835.

Body short and wide; both apertures with lobes. Branchial sac with but four rows of stigmata. Transverse vessels with stout papillae bearing anteriorly and posteriorly directed branches, some of which are joined to the branches of papillae of other transverse vessels, forming an incomplete system of internal longitudinal vessels. Median dorsal vessel with three languets, one opposite the origin of each pair of transverse vessels.

*Perophora viridis* Verrill.

Text-fig. 3.

1871. *Perophora viridis* Verrill, Amer. Journ. Sci., ser. 3, vol. 2, p. 359.

1872. *Perophora viridis* Verrill, Amer. Journ. Sci., ser. 3, vol. 3, p. 211.

1873. *Perophora viridis* Verrill and Smith, Report on Invertebrate Animals of Vineyard Sound, pp. 702, 388, 401.

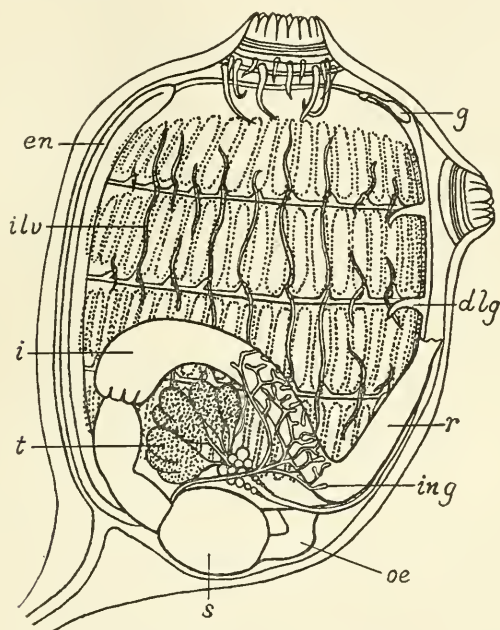
1879. *Perophora viridis* Verrill, Preliminary Check-List of Marine Invertebrata, p. 27.
1889. *Perophora viridis* McDonald, Rep. U. S. Comm. Fish and Fisheries for 1886, p. 858.
1891. *Perophora viridis* Herdman, Journ. Linn. Soc. London, Zool., vol. 23, p. 602.
1898. *Perophora viridis* Lefevre, Journ. Morphology, vol. 14, p. 367.
1898. *Perophora* Davenport, Science, new ser., vol. 8, p. 687.
1900. *Perophora viridis* Metcalf, Zool. Jahrbücher, Anat., vol. 13, p. 508, pl. 34, fig. 14 (ganglion, neural gland, etc.).
1900. *Perophora viridis* Wilson, Amer. Naturalist, vol. 24, p. 354.
1902. *Perophora viridis* Van Name, Trans. Connecticut Acad. Sci., vol. 11, p. 337.
1905. *Perophora viridis* Seeliger, Bronn's Tier-reich, vol. 3, suppl., pp. 979 ff (budding).
1909. *Perophora viridis* Hartmeyer, Bronn's Tier-reich, vol. 3, suppl., p. 1410.

The colony comprises a varying but very often considerable number of distinct and sometimes quite widely separated zooids, each surrounded by a rather thin layer of transparent colorless test substance, which does not unite with that of adjacent zooids to form a common mass, but is continuous at the posterior end of the zooid with that covering the stolon. The stolon is slender and tubular, its outer layer consisting of test substance like that of the zooids, and it grows like a vine over the surface to which the colony is attached, giving off numerous branches which in large and prospering colonies may thickly cover parts of that surface. The zooids are generally nearly sessile on the branches of the stolon. The buds from which the zooids develop are mostly produced on the actively growing terminal portions of the branching stolons, so that in general the zooids are younger and smaller as the terminal parts are approached.

The zooids are, when fully grown, from 2.5 mm. to 3.5 mm. in length or height, but colonies contain many smaller individuals, either immature or undersized from other causes. In a dorso-ventral direction the zooids measure somewhat less than they do in length, while in lateral diameter (from right to left) they are not usually more than one half or two thirds of the length, the larger and older zooids being generally more flattened laterally than the younger ones. The yellowish or yellowish green color of the zooids, which gives the species its name, is chiefly due to corpuscles of that color, which are contained in numerous anastomosing vessels forming a network in the mantle.

The mantle is thin and quite transparent except for the above

mentioned vessels, and the musculature is weak. The sphincters of the apertures consist of numerous very slender circular bands. From the apertures and from the region of the ganglion a rather small number of muscle bands, each consisting of but few fibers, run a short distance in a posterior or oblique direction, those arising about the branchial orifice running straight back, those arising near or around the atrial orifice running toward the ventral side of the body. Their number and length vary in different individuals, but in most cases they



Text-fig. 3.—*Perophora viridis* Verrill. Zooid.  $\times 27$ .

are lost long before the ventral or posterior part of the body is reached, while the branching vessels of the mantle described above are found chiefly on the parts of the body where the muscle bands are wanting. The outline of the mantle seen from the side is more or less elliptical, but that of the test tapers off more gradually into the pedicle. The test is therefore rather thick at the posterior ventral end of the body. The branch of the stolon running in the pedicle enters the body of the zooid at a point a little above the lower or posterior end of the endo-

style. The apertures are generally somewhat protruding, but when the animal is strongly contracted may not project beyond the general contour of the test. They have a very variable number of lobes. The oral tentacles are about 24 in number, of three sizes regularly arranged; those of the smallest size are inserted a little nearer the aperture than the others.

The branchial sac has the four rows of long stigmata characteristic of the genus. The number of stigmata in a row exceeds 20. Those near the endostyle become successively shorter as that organ is approached. The transverse vessels separating the rows of stigmata bear about ten short stout papillae, separated (except next to the median dorsal vessel and the endostyle where the distance is greater) from each other by the width of two stigmata. Practically all the papillae bear two slender branches of varying length, one anterior and one posterior. The extent to which the branches are joined to those of papillae of other rows to form internal longitudinal vessels varies in different individuals and doubtless also in the same individual with its age. Such unions may occur over the greater part of the sac. The writer has observed this in specimens both from New England and from Bermuda.

Some distance beyond the stomach, which is elliptical and smooth-walled, there is a well marked valvular constriction of the intestine, beyond which the intestine is of larger capacity and only gradually tapers down to its former size. Between this valve and the stomach, there is also a fairly constant and conspicuous constriction. The gland surrounding the intestine has tubules which branch repeatedly and end in blunt but not much expanded tips.

There is great individual variation in the number of lobes or of distinct glands into which the testis is divided. It lies in the loop of the intestine, the parts or lobes spreading out in a fan-like manner from the point where the common sperm duct begins. Often the testis is divided up into ten or more small separate pyriform glands, each borne on a branch of the common sperm duct; in other cases there may be only one or two such small separate divisions, the rest of the organ being made up of one or two larger masses only incompletely cleft into lobes by deep fissures extending in toward the commencement of the sperm duct. The ovary is also situated in the loop formed by the digestive canal, along the first part of the common sperm duct.

This species is allied to the widely distributed European form *P.*

*listeri* Forbes and Hanley, 1848, and to *P. banyulensis* Lahille, 1887, of the Mediterranean, but not having had an opportunity to study these species, the writer cannot say how great and how constant the distinctions between them are. It is stated that the production of buds on the older parts of the stolon is more frequent in *P. listeri* than in *P. viridis*, resulting in a somewhat different habit of the colony, that the zooids are practically colorless (they sometimes are so in *P. viridis* also) and further that there are more oral tentacles and that the incomplete longitudinal bars are wanting in *P. listeri*. These latter differences might be due solely to differences in the age of the individuals. Nor can the writer express an opinion as to how far the differences in the accounts of the budding in *P. listeri* by Kowalevsky (1874) and *P. viridis* by Lefevre (1898) are due to different interpretations of the obscure phenomena of this process, though a difference in the orientation of the young buds in relation to the stolon seems to exist between the two species. Lahille's species seems to be still more like *P. viridis*, and Herdman (1891, p. 602; 1906, p. 298) has suggested that it may not be distinct from the American form.

*P. viridis* can be found abundantly in summer at Wood's Hole and Vineyard Haven, Mass., on the piles of wharves, at or below low-water mark, usually growing in company with or upon other ascidians, simple or compound. Verrill gives it as common on algae and ascidians in Vineyard Sound, Mass., 2 to 12 fathoms. It has been recorded from Newport, R. I., and Noank, Conn., Cold Spring Harbor, L. I. (Davenport, 1898), and Beaufort, N. C. (Lefevre, Wilson). Lefevre found it as abundant in summer at Beaufort as at Wood's Hole. This species occurs also about the Bermuda Islands, where the writer has collected it at various points, attached to stones in shallow water, usually, as on the Massachusetts coast, growing in company with other ascidians. In the spring (May) the colonies were not very abundant, nor so large and flourishing as those found at Wood's Hole in summer, but this may be due more to the season than to the locality. Hartmeyer (1908a) in his preliminary report on the ascidians of the Tortugas mentions the occurrence of this genus in that region without indicating the species.

Family POLYCITORIDAE Michaelsen, 1904 [= DISTOMIDAE Giard, 1872].

Genus POLYCITOR Renier, 1804 [= DISTOMA Savigny, 1816].

Colony thick and fleshy, sometimes capitate or pedunculate. Zooids usually not arranged in systems. No calcareous spicules. Branchial and atrial apertures six-lobed, the atrial aperture being situated at the end of a short anteriorly directed tube. Intermediate transverse vessels crossing the middle of the branchial stigmata are not present, nor is a brood pouch developed, as in the following genus (Holozoa). The intestinal loop is (usually at least) twisted, bringing the stomach to the dorsal side and the reproductive organs to the left side of the abdomen.

The species here described belongs to the subgenus *Eudistoma* Caullery, a group which is perhaps deserving of generic rank. Its distinguishing characters are a small number of rows (usually four) of stigmata and a smooth-walled stomach.

***Polycitor kükenthali*** (Gottschaldt).

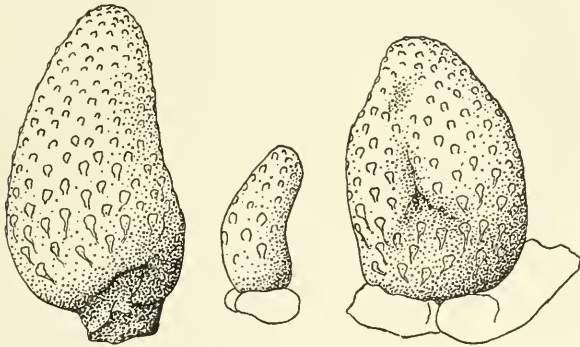
Text-figs. 4, 5.

1894. *Colella kükenthali* Gottschaldt, Jena Zeitschr., vol. 28, p. 363, pl. 24, fig. 6.  
 1903. *Distomus kükenthali* Hartmeyer, in Römer and Schaudinn, Fauna Arctica, vol. 3, p. 311, pl. 14, fig. 6.  
 1907. *Distomus kükenthali* Redikorzew, Ann. Mus. Zool. Acad. Imp. Sci. St. Pétersbourg, vol. 11, pp. 148, 151, 153.  
 1908. *Distomus kükenthali* Redikorzew, Trav. Soc. Nat. St. Pétersbourg, vol. 39, pp. 20, 33.  
 1909. *Polycitor kükenthali* Hartmeyer, Bronn's Tier-reich, vol. 3, suppl., p. 1432.

The colony is commonly greater in height than in breadth, and of more or less ovate, acorn-shaped, or pear-shaped form, and is attached at the larger end by a distinctly narrowed base which may be produced into a short, stout peduncle. A few colonies are so elongated as to be more or less finger-shaped, and in such cases are usually somewhat curved. The two largest colonies in the collection measure 46 mm. in height by 26 mm. in width, and 40 mm. in height by 29 mm. in greatest width respectively. They are shown in text-fig. 4. Another colony was about 60 mm. long, but comparatively slender.

The test is practically free from sand, and though not very transparent, it allows the anterior part of the zooids to be more or less distinctly seen through its substance. It is of a translucent yellowish white or yellowish gray color in the preserved specimens, while the tissues of the zooids are opaque yellowish white. The zooids are evidently not arranged in systems, their atrial orifices opening separately on the outer surface of the colony, yet they are in many cases very regularly distributed, forming evident rows from the base to the apex of the colony. In some of the specimens the anterior ends of the zooids tend to project slightly above the level of the surface of the colony. In the living specimens this no doubt occurred to a much greater extent.

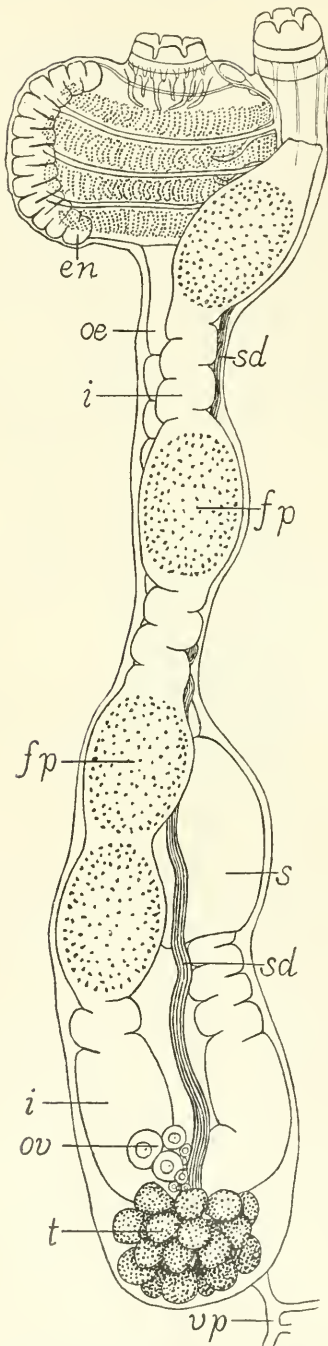
In all the specimens the zooids are violently contracted and contorted, and examples which are approximately straightened out are hard to



Text-fig. 4.—*Polycitor kükenthalii* (Gottschaldt). Three colonies. Natural size.

find. Such examples measure in their shrunken condition only about 5 mm. to 7 mm. in length, but it is very evident that this gives little idea of their natural size, which must have been at least two or three times as great in living, moderately expanded individuals.

The mantle is very muscular, especially on the thorax, where there are numerous strong longitudinal muscle bands, and underlying these, a dense layer of transverse fibers, which, however, form much less distinct bands. As a result of the contraction of the powerful longitudinal muscles the thorax in the preserved specimens is commonly broader in a dorso-ventral direction than it is long, and the long slender abdomen becomes also greatly shortened, the esophagus and intestine becoming irregularly plicated transversely. The branchial  $\bar{\bar{v}}$  and



atrial orifices are similar in appearance, each having six blunt lobes. The branchial orifice is but little produced in the contracted specimens, but the atrial orifice is at the end of a distinct, though short, anteriorly directed tube.

There is a circle of about a dozen slender tapering oral tentacles, longer and shorter ones alternating. In addition there are a number of very much shorter tentacles inserted a little nearer the orifice. In the atrial siphon there are no tentacles. The dorsal languets are long and slender, resembling the tentacles.

The violent contraction of the thoracic muscles renders the walls of the thorax so thick and opaque, and has so crushed and folded the branchial sac that its structure can be made out only with the greatest difficulty, and not without considerable possibility of error, but after examining a large number of zooids, the writer is very decidedly of the opinion that there are but four rows of stigmata, with probably over twenty in a row on each side, and the branchial sac has accordingly been so represented in the figure (text-fig. 5). The transverse vessels are slightly muscular, and moreover bear a narrow inwardly projecting membrane.

The esophagus and ascending part of the intestine are very long, and the intestinal loop beyond the stomach is likewise of considerable length. The stomach is large and

Text-fig. 5. — *Polycitor kükenthalii* (Gottschaldt). Zooid. × 30.

thin-walled. The irregular folds into which its walls are thrown in the preserved specimens are probably entirely due to the contractions incident to preservation.

The testis consists of a group of about twenty pyriform glands in the left posterior part of the abdomen and lies for the most part posterior to the intestinal loop. The ovary (poorly developed in most of the specimens examined) consists chiefly of a group of eggs of various sizes, and is situated just anterior to the testis. A few of the specimens contained one or two large embryos in the anterior part of the abdomen.

The writer identifies the above described specimens with this rare northern European species rather than with the better known *P. crystallinum*, widely distributed in European waters, which forms colonies of similar size and shape, chiefly on account of the structure of the branchial sac, *P. crystallinum* being described as having from 9 to 15 rows of stigmata (Hartmeyer, 1903, p. 310). *P. kükenthali* was described by Gottschaldt (1894) from two specimens from Spitzbergen, 8 to 10 fathoms, and was for a long time not found again, but has recently been recorded by Redikorzew (1907a, 1908a) from the Murman coast. It has been taken at a depth of 395 meters (Hartmeyer, 1909).

The American specimens, about thirty in number, are all from Station 2699 (off Newfoundland, N. lat.  $45^{\circ} 04'$ , W. long.  $55^{\circ} 23'$ , 72 fathoms, Aug. 22, 1886) except two. These also are from localities off Newfoundland: Station 2693 (N. lat.  $46^{\circ} 53'$ , W. long.  $44^{\circ} 39' 30''$ , 78 fathoms, Aug. 11, 1886) and Station 2694 (N. lat.  $46^{\circ} 52' 30''$ , W. long.  $44^{\circ} 54' 30''$ , 86 fathoms, Aug. 11, 1886). The colonies were mostly attached to small stones, gravel, and *Boltenia* stems. A majority of the specimens are small and poorly developed.

Genus HOLOZOA Lesson, 1830 [= DISTAPLIA Della Valle, 1881].

Form of colony very variable, most frequently capitate or club-shaped. Test without spicules. Zooids with a large branchial sac having four rows of stigmata, each row with a delicate intermediate transverse vessel crossing (but without interrupting) all the stigmata.

Digestive canal forming a simple, not twisted, loop. Reproductive glands on the right side of the abdomen. When a zooid contains developing embryos, a long tubular tapering diverticulum of the peri-

branchial cavity (the brood pouch) develops to receive them. The oviduct extends into this nearly to the closed distal end. Apparently the pouch (and the section of the oviduct contained in it) increase in length only so fast as there is need of space to contain more embryos. The youngest embryos are therefore in the distal part, and there is a series of older and older embryos and larvae extending back to the proximal end of the pouch. Owing to the narrow neck connecting the pouch with the peribranchial cavity of the zooid, the larvae cannot pass back into that cavity, but must escape by breaking through the wall of the pouch and the surrounding test.

**Holozoa clavata** (Sars).

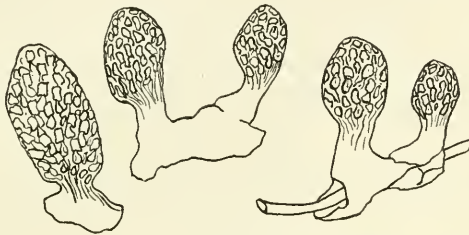
Text-figs. 6, 7.

1851. *Leptoclinium clavatum* Sars, Nyt Mag. Naturvidensk., vol. 6, p. 154.  
 1859. *Leptoclinium clavatum* Sars, Forh. Videnskabs-Selsk. Christiania, p. 66.  
 1892. *Distoma* (?) sp., Herdman, Proc. and Trans. Liverpool Biol. Soc., vol. 6, p. 92.  
 1896. *Distaplia clavata* Huitfeldt-Kaas, Norske Nordhavs-Exp., Zool., vol. 23, no. 1, p. 10, pl. 1, fig. 3.  
 1903. *Distaplia clavata* Hartmeyer, in Römer and Schaudinn, Fauna Arctica, vol. 3, p. 313, pl. 6, fig. 4; pl. 11, fig. 21.  
 1904. *Distaplia clavata* Hartmeyer, Wiss. Meeresunters., Abt. Helgoland, vol. 5, pt. 2.  
 1905. *Distaplia clavata* Bjerkan, Bergens Mus. Aarbog, no. 5, p. 16, pl. 3, fig. 1-3.  
 1907. *Distaplia clavata* Redikorzew, Ann. Mus. Zool. Acad. Sci. St. Pétersbourg, vol. 11, pp. 151, 154.  
 1908. *Distaplia clavata* Redikorzew, Trav. Soc. Nat. St. Pétersbourg, vol. 39, pp. 20, 33.  
 1908. *Distaplia clavata* Bjerkan, Tromsøe Mus. Aarsheft., no. 25, pp. 87, 115.  
 1909. *Holozoa clavata* Hartmeyer, Bronn's Tier-reich, vol. 3, suppl., p. 1437.

Though varying much in shape, well developed colonies of this animal generally have a club-shaped, capitate, or acorn-like form, and are usually raised on a well marked peduncle which expands at its lower end into a broad base by which it adheres. Sometimes a colony may consist of more than one head (text-fig. 6). Young colonies are simple small rounded masses attached by a narrow base. The zooids are confined to the heads, and systems and common cloacal apertures, if present, are hard to demonstrate. Sometimes a tendency of the zooids to be arranged in rows seems apparent, but on the other hand the fact that the zooids often project slightly above the general surface

of the test might be taken to indicate that each zooid is independent. Many vascular processes from the zooids extend down into the peduncle of the colony. In the alcoholic specimens the test is whitish and sufficiently transparent in the heads to allow the zooids to be plainly seen; in the peduncles it is more opaque. There are no notes on the colors of the American specimens during life. The test substance in the heads is of a rather gelatinous consistency, and is easily torn; that in the peduncles is firmer and tougher. The largest colony (of flattened club-shaped form) measures about 35 mm. long.

The zooids are large, when well expanded from 3.4 mm. to 5 mm.



Text-fig. 6.—*Holozoa clavata* (Sars). Three colonies.  $\frac{2}{3}$  natural size.

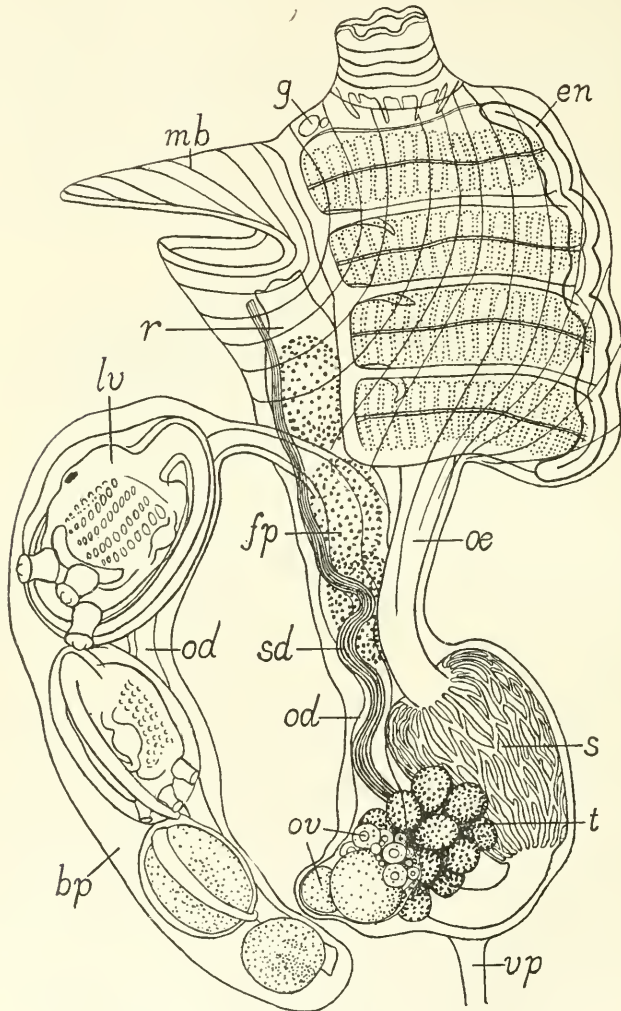
long, and have one or more vascular processes extending from the posterior end of the abdomen. The branchial aperture is six-lobed or sinuate; the atrial may or may not have its anterior border produced into a distinct languet. The oral tentacles are of two sizes placed alternately.

The branchial sac has the usual four rows of stigmata with the inner transverse vessels crossing the stigmata, as described above. There are about 18 stigmata in a row on each side; the last two or three stigmata (those nearest the endostyle) become successively shorter as shown in text-fig. 7. There are three long dorsal languets.

The stomach is ovate with thin walls bearing numerous narrow and not very conspicuous internal ridges, the prevailing course of which is generally longitudinal, but they always exhibit more or less irregularity in their arrangement, and in some individuals curve and anastomose to such an extent as to form merely an irregular network. The number as well as the prominence of the ridges is exceedingly variable. In some specimens they are conspicuous; in others they are so low as easily to escape notice, or the stomach walls may be actually smooth.

The brood pouch is a long curved tapering caecum-like sac, arising

by a constricted neck from the right dorsal part of the thorax posterior to the atrial aperture, and extending out into the common test, curving



Text-fig. 7.—*Holozoa clavata* (Sars). Zooid.  $\times 36$ .

posteriorly so as to lie along near the abdomen of the zooid to which it belongs. It may contain as many as ten or twelve embryos and

exceed in length the body of the zooid, but oftener only from three to six embryos will be found, the length of the pouch and the number of embryos it contains being dependent on the rate at which reproduction is going on.

In European waters this species has been found along the Norwegian and Murman coasts, and at Spitzbergen, in depths from 20 to 150 fathoms (Hartmeyer, 1903; Bjerkan, 1905; Redikorzew, 1907a).

The American specimens are from various localities from Newfoundland to Cape Cod, 90 fathoms being the greatest depth. The stations are as follows:

(1) Station 2456 (off Newfoundland, N. lat.  $47^{\circ} 29'$ , W. long.  $52^{\circ} 18'$ , 86 fathoms, gravel, July 2, 1885). One colony.

(2) Station 2699 (off Newfoundland, N. lat.  $45^{\circ} 04'$ , W. long.  $55^{\circ} 23'$ , 72 fathoms, August 22, 1886). Many small colonies.

(3) Station 100 (off Halifax, N. S., N. lat.  $44^{\circ} 28'$ , W. long.  $63^{\circ} 18'$ , 42 fathoms, September 15, 1877).

(4) Station 44 (off Nova Scotia, N. lat.  $43^{\circ} 06'$ , W. long.  $65^{\circ} 04.5'$ , 90 fathoms, estimated, fine sandy mud, August 21, 1877). Two rather large colonies.

(5) Station 43 (off Nova Scotia, N. lat.  $43^{\circ} 05.5'$ , W. long.  $65^{\circ} 02'$ , 90 fathoms, estimated, August 21, 1877). Three rather large colonies.

(6) Grand Manan, N. B. (Bay of Fundy). Many specimens.

(7) Eastport, Maine. Many specimens.

(8) Station 4 (near Baker's Island, off Salem, Mass., 22 fathoms, gravelly, August 4, 1877). Very poor specimen, doubtful.

(9) Station 371 (12 miles off Chatham, Mass., N. lat.  $41^{\circ} 35.5'$ , W. long.  $69^{\circ} 35'$ , 34.5 fathoms, coarse sand, September 19, 1879). One colony.

The species of this genus described by the writer as *Distaplia bermudensis* in his account (1902) of the ascidians of Bermuda Islands, but which should now be called *Holozoa bermudensis*, appears to be sufficiently distinct from the present one. The colony forms a thick flat crust, or more or less distinct heads, the systems are inconspicuous, and the zooids are decidedly smaller and always have a smooth-walled stomach.

## Family DIDEMNIDAE Verrill, 1871.

Genus DIDEMNUM Savigny, 1816 [= LEPTOCLINUM auct. plur.].

Colony usually thin and expanded; sometimes thick and fleshy. Common test containing stellate spicules, usually in great abundance. Branchial aperture six-lobed; atrial aperture a plain opening without a languet. Four rows of stigmata in the branchial sac. Testis single or more or less completely two-parted. Proximal part of sperm duct coiled about the testis.

*Didemnum candidum* Savigny, 1816, the type of the genus, has four rows of stigmata, and belongs to the group which has usually been called *Leptoclinum* Milne-Edwards, 1841. Therefore, according to the rule of priority *Didemnum* must replace *Leptoclinum* in the sense that the latter term has generally been used.

In the above diagnosis of this genus, there are two points of difference from that given by Hartmeyer (1909, p. 1448). According to him, an atrial languet is present, and the testis is always undivided. Hartmeyer's classification makes no provision for the numerous forms of this group in which there is no atrial languet. The languet is, in fact, lacking in the type species of the genus, as Savigny's (1816) figure clearly shows.

Owing to the numerous species in this family, and the difficulty of satisfactorily classifying them, a subdivision of the group into a larger number of genera than at present will tend to clearness rather than obscurity, and believing that the presence or absence of an atrial languet is a good generic distinction, the writer has in this paper adopted the course of limiting *Didemnum* [*Leptoclinum*] to species which, like Savigny's type, lack the languet. From *Leptoclinides* Bjerkan, 1905, *Didemnum* is sufficiently distinguished by lacking the posteriorly directed tubular atrial siphon, having only a simple aperture.

Hartmeyer's diagnosis also disregards the fact that in this group of genera a two-parted testis is common. The writer does not consider this of importance as a generic character, but has so worded the diagnosis as not to exclude species so provided, and for the forms with an atrial languet, he has adopted, after some hesitation, the name *Tetradidemnum* Della Valle, 1881 (see below).

Two species of *Leptoclinum* were described from New England by Professor Verrill (1871a) — *L. albidum* and *L. luteolum*, the latter

distinguished mainly by a reddish or yellow color. In his later works, the last mentioned form is regarded as only a variety of the former. But the type specimens of both are alike in every respect, the colors, of course, having long since faded out. The name *luteolum* must therefore be regarded as strictly synonymous with the name *albidum*, and should be entirely abandoned. The matter is complicated, however, by the fact that two distinct forms have been confused under the name *albidum* (or *luteolum*, if the specimen happened to be of a reddish or yellow color). One of these, the true *albidum* (Verrill's type), is found chiefly north of Cape Cod, and is in this paper placed in the genus *Tetradidemnum* (see p. 377). The other species, more southern in its distribution, is a typical *Didemnum* [*Leptoclinum*]. Until better descriptions and figures of related species of other regions shall be available it seems best to treat it as a distinct and new species, a course which the constancy of its characters may after all eventually justify, even though the differences from related forms are small.

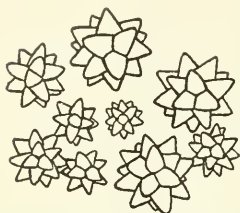
***Didemnum lutarium* sp. nov.**

Text-figs. 8, 9; Pl. 37, fig. 7.

1869. *Didemnum* sp.?, Perkins, Proc. Boston Soc. Nat. Hist., vol. 13, p. 160.  
 1871. *Leptoclinum albidum* (part.) + *Leptoclinum luteolum* (part.) Verrill, Amer. Journ. Sci., ser. 3, vol. 1, p. 446.  
 1872. *Leptoclinum albidum* (part.) + *Leptoclinum luteolum* (part.) Verrill, Amer. Journ. Sci., ser. 3, vol. 3, p. 212.  
 1873. *Leptoclinum albidum* (part.) + *Leptoclinum luteolum* (part.) Verrill and Smith, Report on Invertebrate Animals of Vineyard Sound, pp. 403 (411, 424), 515, 706.  
 1879. *Leptoclinum albidum* + *L. albidum*, var. *luteolum* Verrill and Rathbun, Proc. U. S. Nat. Mus., vol. 2, p. 231.  
 1879. *Leptoclinum albidum* (part.) + *Leptoclinum albidum* var. *luteolum* (part.) Verrill, Preliminary Check-List of Marine Invertebrata, p. 27.  
 1886. *Leptoclinum albidum* (part.) + *L. albidum* var. *luteolum* (part.) Herdman, Report Voyage Challenger, vol. 14, p. 287 and ff.  
 1889. *Leptoclinum albidum* + *L. albidum* var. *luteolum* McDonald, Rep. U. S. Comm. Fish and Fisheries for 1886, p. 858.  
 1900. *Leptoclinum albidum* (in part, at least) Metcalf, Zool. Jahrbücher, Anat., vol. 13, pp. 527, 562, 563, pl. 37, fig. 50 (neural gland, etc.).  
 1902. *Leptoclinum luteolum* Van Name, Trans. Connecticut Acad. Sci., vol. 11, p. 363.

The colony in this species often becomes considerably over 100 mm.

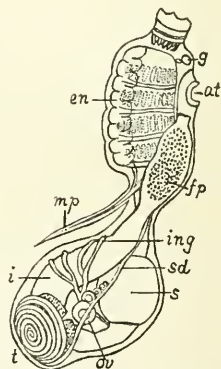
across and from 2 to 4 mm. thick, or even thicker in large specimens. As compared with that of *Tetradidemnum albidum*, the only species of this region with which it is likely to be often confused, the common test substance is softer and much more easily broken, and owing to the minute size of the spicules the surface does not have such a rough, gritty character. It is, however, commonly more wrinkled than in that species, and the furrows often appear to indicate in a rough way the forms of the systems in which the zooids are arranged. The small rounded elevations over the zooids, which are so noticeable on the surface of most specimens of *T. albidum*, are usually not developed in this species, and the branchial orifices are usually conspicuous.



Text - fig. 8. — *Didemnum lutarium*, n. sp. Spicules. × 515.

The color is sometimes a chalky white, but often it is tinged with yellow or reddish. When the colony grows in water that is even slightly muddy it becomes more or less discolored with the mud. The spicules are exceedingly numerous and thickly distributed in most parts of the test in most specimens. They are for the most part under 0.02 mm. in diameter and usually have a rather small number of regularly tapering conical points with moderately acute tips.

The zooids are so minute that their structure is by no means easy to make out. In the contracted state they are often under 1 mm. in length. Their body is short, and sharply constricted between the thorax and abdomen. There are longitudinal muscle bands in the mantle on the thorax, and a stout muscular process of moderate length extending out into the common test from the middle region of the body.



Text - fig. 9. — *Didemnum lutarium*, n. sp. Zooid. × 48.

The branchial orifice has six very short lobes; the atrial orifice is a plain opening without a languet. The tentacles are apparently 16 in number, of two sizes placed alternately. The branchial sac has 10 or 11 stigmata in a row on each side, in the middle rows at least. The posterior row probably has a less number. The stomach is

globular, and the intestine has a constriction or valve some distance beyond the stomach. The tubules of the gland embracing the intestine are clearly visible in some specimens, and are few in number with tapering ends.

The testis is very frequently, if not invariably, divided into two glands, which together form a conical mass about which the sperm duct is coiled, usually making about eight or nine turns.

North of Cape Cod this form is local and for the most part replaced by *Tetradidemnum albidum*. There are specimens in the collection from a tide-pool on Ten Pound Island, near Gloucester, Mass., and others, which if correctly labeled, are from the Isles of Shoals off the New Hampshire coast. Metcalf (1900, p. 563) mentions specimens of this genus from Casco Bay, Maine, which he apparently considered identical with those found at Wood's Hole, and hence with this species, but the writer has seen none from so far north that were of this species.

South of Cape Cod (including also the south shore of the Cape) it is the common, and in most places the only, species of the genus. Probably all the published records of *L. albidum* and *L. luteolum* Verrill from that part of the coast refer to it. It is abundant at Wood's Hole, Edgartown, and Vineyard Haven, Mass., on the piles of wharves, and in Vineyard Sound in 4 to 15 fathoms, and often grows on ascidians of other kinds, as well as on stones, sponges, shells, etc. Other localities are Point Judith, Rhode Island; off Stonington, Conn., 4 fathoms, rocky; Noank, Conn.; Peconic Bay; Thimble Islands near Stony Creek, Conn., 4 to 6 fathoms, rocky.

As compared with the *Didemnum* [*Leptoclinum*] found at Bermuda, which the writer in his account of the ascidians of that region identified after some hesitation with *D. [L.] speciosum* Herdman, 1886, of the Brazilian coast, the test in this species is very much softer and more brittle. The Bermuda form generally has larger spicules with more rays; in those varieties where they are as small as in *D. lutarium*, the rays are slender and very much more numerous. The present species does not, as is the case in the Bermuda species, show a differentiation into varieties differing markedly in the size and shape of the spicules, etc., but is remarkably constant in its characters. The correspondence in the structure of the zooids, however, shows the Bermuda and the New England forms to be very closely allied, so that *D. lutarium* may some time need to be reduced to the rank of a subspecies of *D. speciosum*.

Herdman (1886, p. 287 and following) identifies doubtfully with *L. albidum* Verrill specimens collected by the Challenger Expedition off San Jago, Cape Verde Islands, in 100 to 125 fathoms and 10 to 20 fathoms, and from Simons Bay, Cape of Good Hope, 10 to 20 fathoms. Another specimen, from Tangier Bay, Morocco, he doubtfully identifies with *L. albidum* var. *luteolum* Verrill. Herdman based these determinations upon a comparison of the Challenger specimens with examples of *Leptoclinium albidum* and *L. albidum* var. *luteolum* received from the United States Fish Commission, which sent out sets of labeled specimens of the common New England invertebrates to various foreign museums. But the specimens that were sent out labeled *L. albidum* or *L. albidum* var. *luteolum* were, since they came from Vineyard Sound (Verrill and Rathbun, 1879, p. 231; McDonald, 1889, p. 858), really *D. [L.] lutarium*. Hence, it is to this species, not to *albidum*, that the Challenger specimens are allied. Indeed, Herdman's description and figures would show this, even if the records were wanting.

The Tangier Bay specimen (which he figures, Pl. 11, fig. 10-15) may be left out of account here, as Herdman says its zooids have but three rows of stigmata. In regard to the others, since Herdman after a direct comparison was doubtful as to their identity, it will be better to reserve decision until more material shall have been collected from those regions, and to follow a like course in regard to a large colony collected at the Philippine Islands, which had long-rayed, regularly stellate, sharp-pointed spicules. This colony he describes and figures (Pl. 25, fig. 11-14) as a new variety (*grande*) of *L. albidum*.

Sluiter (1905, p. 103) identifies a specimen of this genus from the Bay of Jibuti, East Africa, with *L. albidum* var. *luteolum* Verrill, apparently largely on account of its orange red color.

#### GENUS LEPTOCLINIDES Bjerkan, 1905.

Resembles *Didemnum* [*Leptoclinium*] in most characters. Four rows of stigmata. Spicules present in the test. Atrial orifice situated far back on the thorax and produced into a funnel-like, more or less posteriorly directed tube, without a languet.

#### *Leptoclinides faeröensis* Bjerkan.

Text-figs. 10, 11, 12; Pl. 39, fig. 14

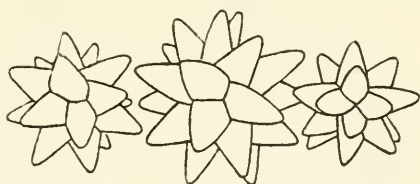
1905. *Leptoclinides faeröensis* Bjerkan, Bergens Mus. Aarbog, no. 5, p. 20, pl. 3, fig. 4-6.

1908. *Leptoclinides faeröensis* Bjerkan, Tromsø Mus. Aarsheft., no. 25, p. 99.

1909. *Leptoclinides faeröensis* Hartmeyer, Bronn's Tier-reich, vol. 3, suppl., p. 1447.

This is exclusively a deep-water species, and aside from the differences in the characters of the zooids, is readily distinguished from *Didemnum* [*Leptoclinium*] *lutarium* by the larger spicules with longer and usually more numerous points, the larger and fewer zooids, and by the great thickness of the colony, the surface of which is generally raised into low elevations and folds of irregular form and considerable extent. In a specimen measuring about 85 mm. across, the thickness is no less than 25 mm. at one point. The interior of the colony is occupied by test substance of firm consistency and yellow color, containing scattered spicules, the zooids occupying the portions near the surface only. The surface layer of test above the zooids and cloacal chambers contains more numerous spicules, and may readily be stripped off.

In its character the surface of the colony is very variable. The apertures of both kinds are conspicuous, and the surface is often slightly raised over the position of each zooid. The surface of the colony is a dull yellowish white color in the alcoholic specimens. The spicules are rather large, usually with long regular conical points. They are usually not much over 0.05 mm. in diameter, and in some specimens they are beautifully regular in the surface layer of test.



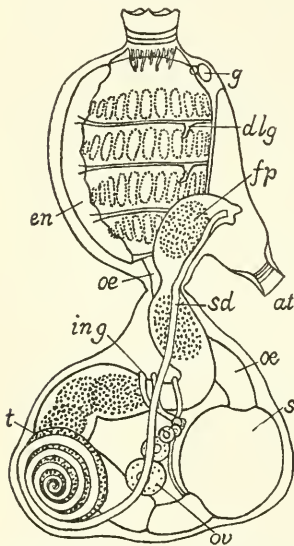
Text-fig. 10. — *Leptoclinides faeröensis* Bjerkan. Typical spicules from a colony from Station 2429 (off Newfoundland, N. lat. 42° 55' 30", W. long. 50° 51', 471 fathoms). × 515.

The zooids of this species are large, the individual figured, which is well expanded, measuring 1.7 mm. long. The body is greatly constricted or strangulated between the thorax and abdomen. The mantle musculature consists of a number of narrow longitudinal bands, beneath which on the thorax are also many transverse fibers. No muscular process extending out into the test was observed, but club-shaped vascular processes resembling those of *Lissoclinium aureum*, described below, are frequently present.

The branchial orifice has six short lobes; the atrial orifice is at the

end of a funnel-like structure arising from the posterior dorsal part of the thorax and directed backward at a greater or less angle. The margin of the orifice is plain or very slightly sinuate. The oral tentacles are numerous (at least 16, if not considerably more) and are of three sizes more or less regularly arranged. Where it was possible to count them, there were 11 stigmata on a side in the three anterior of the four rows, and about nine in the fourth (posterior) row. The two or three stigmata in each row which are nearest the endostyle

become successively shorter as that organ is approached. There is a space without stigmata along each side of the endostyle. The dorsal languets arise from the transverse vessels on the left side of the body about opposite the third stigma from the median dorsal vessel. The stomach is round and the intestine long, forming a wide loop. The intestine has one or more well marked constrictions.



Text-fig. 11.—*Leptoclinides fueröensis* Bjerkan. Zooid.  $\times 42$ .

In those individuals in which the reproductive organs were well developed, the testis, though not in all cases very well preserved, appeared to be always undivided. The sperm duct makes from four to six loose coils about it.

The American specimens (of which there are over a dozen in the collections, all from depths of 100 fathoms or over) agree well with Bjerkan's description of the types, which were from northwest of Iceland, 590 meters, and east of the Faroe Islands, 420 meters. A pair of depressions on the sides of the thorax, occupied by test substance filled with small crowded spicules, is present (in many cases, at least), as described by Bjerkan in the European specimens. A similar condition occurs in some other members of this family, notably in *Echinoclinium verrilli* of Bermuda and the West Indies, and in *Tetralidemnum albidum* of our own coasts.

The majority of the American specimens are from off Newfoundland and Nova Scotia, from depths of 110 to 300 fathoms. A fine

large colony is from Station 2471 (N. lat.  $44^{\circ} 34'$ , W. long.  $56^{\circ} 41' 45''$ , 218 fathoms, gray mud, sand, July 4, 1885). The species ranges, however, much farther south, as there are colonies from Station 2429 (N. lat.  $42^{\circ} 55'$ , W. long.  $50^{\circ} 51'$ , 471 fathoms, gray mud, June 23, 1885); from N. lat.  $42^{\circ} 53'$ , W. long.  $59^{\circ} 04'$ , 100 to 150 fathoms; and from Station 2523 (N. lat.  $41^{\circ} 48'$ , W. long.  $65^{\circ} 44'$ , 111 fathoms, sand, gravel, stones, July 13, 1885).

There are also two small colonies having somewhat fewer and less regular spicules (text-fig. 12) than the other specimens, so that the test is quite translucent, but apparently they are of this species. These are from the great depth of 1582 fathoms (Station 2228, N. lat.  $37^{\circ} 25'$ , W. long.  $73^{\circ} 06'$ , brown mud, September 11, 1884). This depth is more than double that of any previously recorded station for a species of this family.



Text-fig. 12.—*Leptoclinides faeröensis* Bjerkan. Spicules from a colony from Station 2228 (N. lat.  $37^{\circ} 25'$ , W. long.  $73^{\circ} 06'$ , 1582 fathoms).  $\times 515$ .

#### Genus TETRADIDEMNUM Della Valle, 1881.

As already mentioned (p. 370), the writer believes that the species having an atrial languet should be removed from the genus *Didemnum* [*Leptoclinum*]. In two genera of this group, *Polysyncraton* Nott, 1891, and *Tetradidemnum* Della Valle, 1881, the atrial languet is present. It seems best to continue to restrict *Polysyncraton*, as heretofore, to forms having the testis divided into a considerable number (four to ten) of distinct parts. The writer has therefore provisionally referred the species described below to *Tetradidemnum*. The type of the genus, *T. gigas* of the Mediterranean, was figured by Della Valle (1881, pl. 5, fig. 47; pl. 7, fig. 69), but never described. Recently Della Valle (1908) has claimed that *Tetradidemnum* should replace *Didemnum* Savigny, 1816, on the ground that Savigny did not sufficiently characterize his genus. With this view the writer does not agree, but believes that *Tetradidemnum* is available as a name for that subdivision of *Didemnum* which contains Della Valle's type

(*T. gigas*). By taking his original diagnosis and the characters shown in his fig. 69 of the type, it is clear that the genus is distinguished by the following combination of characters:

Atrial languet present: four rows of branchial stigmata; sperm duct spirally coiled about the testis, testis not divided.

In all characters except the last, the species described below would agree with this diagnosis. It has, however, the testis divided into two parts. Division to this limited extent has not usually been treated as of sufficient importance to warrant the establishment of a distinct genus, so that the writer would modify the above diagnosis by adding the qualification "into more than two distinct parts" to the last statement thereof. Should at some future time more information about Della Valle's type be forthcoming and prove that the inclusion of this species in *Tetradidemnum* is not justifiable, it will then be soon enough to burden the nomenclature of this group with a new generic name.

***Tetradidemnum albidum* (Verrill).**

Text-figs. 13, 14, 15; Pl. 35, fig. 2; Pl. 39, fig. 13.

1851. *Didemnum roseum* + *Leptoelinum gelatinosum* Sars, Nyt. Mag. Naturvidensk., vol. 6, pp. 153, 154.
1858. *Didemnum roseum* + *Leptoelinum gelatinosum* Sars, Forh. Videnskabs-Selsk. Christiania, p. 66.
1867. *Didemnum roseum* Packard, Mem. Boston Soc. Nat. Hist., vol. 1, p. 276.
1870. *Didemnum roseum* Binney, Gould's Invertebrata of Massachusetts, ed. 2, p. 4.
1870. *Didemnum roseum* Dall, Proc. Boston Soc. Nat. Hist., vol. 13, p. 255.
1871. *Leptoelinum albidum* (part.) + *Leptoelinum luteolum* (part.) Verrill, Amer. Journ. Sci., ser. 3, vol. 1, p. 446.
1872. *Leptoelinum albidum* (part.) + *Leptoelinum luteolum* (part.) Verrill, Amer. Journ. Sci., ser. 3, vol. 3, pp. 212, 213.
1873. *Leptoelinum albidum* (part.) + *Leptoelinum luteolum* (part.) Verrill and Smith, Report on Invertebrate Animals of Vineyard Sound, pp. 403 (411, 424), 705, 706.
1873. ? *Didemnum roseum* Ehlers, Sitz.-Ber. phys.-med. Soc. Erlangen, no. 5, p. 7.
1874. *Leptoelinum albidum* + *Leptoelinum luteolum* Verrill, Amer. Journ. Sci., ser. 3, vol. 7, pp. 39, 43, 413, 504.
1874. *Leptoelinum albidum* + *Leptoelinum luteolum* Verrill, Proc. Amer. Assoc. Adv. Sci., vol. 22, pp. 352, 355, 359, 363.
1879. *Leptoelinum albidum* (part.) + *L. albidum* var. *luteolum* (part.) Verrill, Preliminary Check-list of Marine Invertebrata, p. 27.

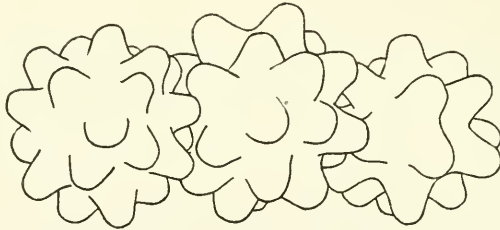
1886. ? *Leptoclinium* sp., von Drasche, Oester. Polarstat. Jan Mayen Beob.-Ergeb., vol. 3, zool., p. 101.
1891. *Leptoclinium albidum* + *L. luteolum* Herdman, Journ. Linn. Soc. London, Zool., vol. 23, p. 631.
1891. *Didemnum roseum* Packard, The Labrador Coast, p. 397.
1892. *Leptoclinium* sp., Herdman, Proc. and Trans. Liverpool Biol. Soc., vol. 6, p. 91.
1894. *Leptoclinium structum* Gottschaldt, Jena. Zeitschr., vol. 28, p. 357, pl. 24, figs. 4a, 4b; pl. 25, fig. 9.
1896. *Didemnum roseum* Huitfeldt-Kaas, Norske Nordhavs-Exp., Zool., vol. 23, no. 1, p. 6.
1897. *Didemnum roseum* Vanhöffen, in Drygalski, Grönland Exp., vol. 2, pt. 1, p. 184.
1901. *Leptoclinium albidum* + *L. albidum* var. *luteolum* Kingsley, Proc. Portland Soc. Nat. Hist., vol. 2, p. 183.
1901. *Leptoclinium albidum* + *L. albidum* var. *luteolum* Whiteaves, Catalogue of marine Invertebrata east. Canada, p. 265.
1902. *Leptoclinium albidum* Van Name, Trans. Connecticut Acad. Sci., vol. 11, p. 363, pl. 52, fig. 41.
1903. *Leptoclinium roseum* Hartmeyer, in Römer and Schaudinn, Fauna Arctica, vol. 3, pt. 2, p. 361, pl. 6, figs. 17, 18; pl. 14, fig. 17.
1906. *Leptoclinium roseum* Redikorzew, in Derjugin, Die murmansche biologische Station, Trav. Soc. Nat. St. Pétersbourg, vol. 37, p. 155.
1906. *Leptoclinium roseum* Redikorzew, Trav. Soc. Nat. St. Pétersbourg, vol. 37, pt. 1, p. 310.
1907. *Leptoclinium roseum* Redikorzew, Ann. Mus. Zool. Acad. Sci. St. Pétersbourg, vol. 11, pp. 150, 151, 153.
1908. *Leptoclinium roseum* Bjerkan, Tromsø Mus. Aarsheft., no. 25, pp. 98, 115.
1908. *Leptoclinium roseum* Redikorzew, Trav. Soc. Nat. St. Pétersbourg, vol. 39, pp. 21, 36.
1908. *Leptoclinium roseum* Redikorzew, Mém. Acad. Imp. Sci. St. Pétersbourg, ser. 8, cl. phys. math., vol. 18, no. 11, p. 52.
1909. *Didemnum structum* + *D. albidum* + *D. albidum* var. *luteolum* Hartmeyer, Bronn's Tier-reich, vol. 3, suppl., pp. 1449, 1451.
- Not *Didemnum roseum* delle Chiaje, Mem. Animali senza Vertebre, vol. 3, 1828.
- Not *Leptoclinium albidum* nor *Leptoclinium albidum* var. *luteolum* Herdman, Report Voyage Challenger, Tunicata, pt. 2, pp. 287 ff., 1886.

As Sars's (1851) name *roseum*, by which this species has usually been known in Europe, was preoccupied by delle Chiaje (1828), Hartmeyer (1909) adopted Gottschaldt's (1894) name *structum* instead. *Leptoclinium albidum* Verrill (1871) as well as *L. luteolum* Verrill are, however, in the writer's opinion identical with Sars's species, and as Verrill's name *albidum* antedates Gottschaldt's it

should be adopted as the specific name. Verrill considered white colonies of this animal as constituting one species (*albidum*) and pinkish or yellowish specimens another species or variety (*luteolum*). Apparently the usual color of colonies of this species in European waters is rosy, though a white variety occurs also. In American waters, white specimens seem to be more common.

The following description is based exclusively on American specimens:

The colonies are of a white, rosy, salmon or yellowish color, generally only 2 mm. to 3 mm. in thickness and of irregular and variable outline, occasionally measuring over 100 mm. across but usually not so much. They incrust stones, shells, sponges, etc., and not infrequently the larger simple ascidians. In consistency, they are generally rather hard and brittle, owing to the great abundance of large spicules.



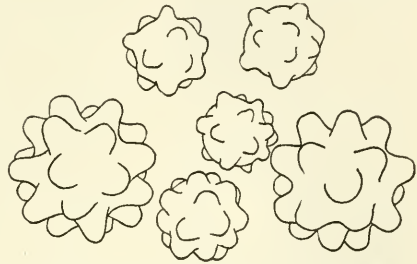
Text-fig. 13.—*Tetradidemnum albidum* (Verrill). Typical spicules from a colony from off Nova Scotia.  $\times 340$ .

These are in most colonies rather thickly distributed throughout the test, but most densely crowded in the upper layers. They render the surface slightly rough and gritty to the touch. The cloacal openings are usually inconspicuous in preserved and contracted examples, and the branchial apertures are also generally not at all prominent. Occasionally their position is marked by small circular areas where the spicules are less abundant; more frequently the surface of the colony is raised into small low rounded elevations which mark the positions of the zooids. Usually the surface is not greatly wrinkled.

The spicules (text-fig. 13) are very characteristic and quite unlike those of typical members of the genus *Didemnum* [*Leptoclinium*]. They are of large size, averaging perhaps 0.08 mm. in diameter in many specimens, but in others, especially in those from more southern localities, not more than 0.05 mm. The colonies with the largest

spicules were from Canadian waters. Redikorzew (1908b, p. 52) mentions spicules of 0.16 to 0.175 mm. diameter in European specimens, but these are probably to be understood as extreme dimensions. Certainly no such average is attained in American examples.

The shape of the spicules is not properly described as stellate, but is that of a sphere studded with numerous short blunt projections which taper slightly and have almost hemispherically rounded ends. When the spicules are abundant their shape as well as their size and distribution are usually beautifully uniform, especially in the upper layers of the colony. Occasional specimens may be met with in which the spicules are much reduced in number and size, and in such cases they often exhibit irregularities in shape also. Some colonies from Station 157 (off Cape Ann, Mass., N. lat. 45° 35', W. long. 70° 30', approximately, 40 fathoms, sand and rocks, August 15, 1878) have these peculiarities to such an extent as to deserve special mention. In them, the spicules are confined chiefly to the upper layers of the colony and are comparatively few, in some cases so few that their presence is not noticeable without



Text-fig. 14.—*Tetradiemnum albidum* (Verrill). Irregular spicules from a colony from U. S. F. C. Station 157 (off Cape Ann, Mass., 40 fathoms).  $\times 340$ .

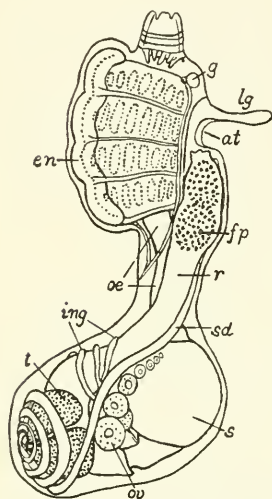
the aid of the microscope. The colony is therefore quite translucent, being more like that of *Didemnoopsis* in consistency. Their spicules (text-fig. 14) are variable in size and but few of them exceed 0.05 mm. or 0.06 mm. in diameter. Many of them, especially the smaller ones, have the points very short and more or less irregularly developed; in extreme cases the points are so reduced that they are mere rounded elevations on the surface of the nearly spherical spicule. With only a small series of specimens at hand, such colonies might be taken for a different species.

Mention should also be made of the fact that in this, as in some other members of this family (*Leptoclinides fueröensis* Bjerkan, for instance), closely crowded groups of small spicules occupying depressions on the sides of the outer wall of the thorax of the zooid may occur.

The zooids in this species measure 1.5 mm. or 1.6 mm. or more in

length when fairly well expanded, and often have club-shaped processes apparently very similar to those of *Lissoclinum aureum* described below (p. 392), but not so well developed as in that species.

The mantle contains a considerable number of slender longitudinal muscle bands, but few transverse fibers. The sphincters, especially that of the atrial orifice, are weak. There are six rounded lobes to the branchial orifice; the atrial orifice is large and is provided with a rather short narrow club-shaped languet arising from its anterior lip.



Text-fig. 15.—*Tetradidmnum albidum* (Verrill). Zoid.  $\times 45$ .

Sometimes the stigma next to the median dorsal vessel is also rather small. The muscles of the branchial sac are poorly developed. A narrow band may be observed along each side of the median dorsal vessel and its fibers may be traced back a short distance into the constricted portion of the body connecting the thorax and abdomen. The dorsal languets arise from the transverse vessels a little way to the left of the median dorsal vessel. The stomach is round and smooth-walled, as usual in this group.

The male reproductive organs consist of two pyriform testes, forming together a conical mass about which the sperm duct makes from four to eight loose spiral turns. The ovary is elongated, lying beside the ascending portion of the sperm duct. The eggs in the posterior portion of the ovary are the furthest advanced in development.

According to Hartmeyer (1903) and Redikorzew (1907a) this species has been found about Spitzbergen, the King Charles Islands, and

Northeast Land; at various points on the Norwegian coast, on the Murman coast, in the White Sea, in Davis Straits, on the coast of Greenland, and (on Packard's authority) on the Labrador coast and at Eastport, Maine. Sixty fathoms (in Davis Straits) is the greatest depth that Hartmeyer records.

On the American coast this species is very common from about the latitude of Boston northward, though Boston is not its southern limit. It is represented in the Yale Collections by numerous specimens from the Banks of Newfoundland and southward along the coast to Cape Cod and beyond, and is recorded by Whiteaves (1901) from Prince Edward Island and the Mingan Islands. At the latter place it was collected also by Verrill. Verrill's types of *albidum* and *luteolum* were from Eastport, Maine. South of Boston it is less common, but a few miles off Chatham, Mass., at the southeastern angle of Cape Cod, it was dredged in quantity at Stations 964 to 979 (10 to 16 fathoms, sand, gravel, stones, August 30, 1881), and Station 371 (34.5 fathoms, coarse speckled sand, September 19, 1879). There is also a colony from Station 2079 (N. lat.  $41^{\circ} 13'$ , W. long.  $66^{\circ} 19' 50''$ , 75 fathoms, white sand); one from Station 751 (nine miles east of Great Point, Nantucket, Mass., 13 fathoms, September 15, 1875), and several from the most southerly of all the localities, Stations 762 to 767 (about 11 miles southwest of Gay Head, Mass., 16.5 to 18 fathoms, gravel and sand, September 20, 1875). In every other case where the writer has examined supposed specimens from points south or west of Chatham, Mass., they have proved to be of another species (*Didemnum lutarium*, see p. 373).

The greatest depths from which any of the specimens came are: Station 54B (off southeastern edge of Cashe's Ledge, Gulf of Maine, 110 fathoms, mud, September 5, 1874) and Station 2459 (off Newfoundland, N. lat.  $46^{\circ} 23'$ , W. long.  $52^{\circ} 45'$ , 88 fathoms, coarse gray sand, July 2, 1885). The specimen from Station 2079 (see above) is from 75 fathoms; another from Station 2699 (off Newfoundland, N. lat.  $45^{\circ} 04'$ , W. long.  $55^{\circ} 23'$ ) is from 72 fathoms. In the Bay of Fundy and about Eastport, Maine, according to Professor Verrill (1871a), it occurs from low-water mark to from 80 to 100 fathoms; in the southern part of its range it appears not to occur along the shore but always in water at least a few fathoms deep.

The specimens identified by Herdman (1886) in the Challenger Reports with *Leptoclinum albidum* Verrill, or considered varieties of

that species, have nothing to do with the present species, but with *Didemnum lularium* (see p. 374).

Genus *DIDEMNOPSIS* Hartmeyer, 1903.

[= *DIDEMNOIDES* Lahille, 1890; not von Drasche, 1883; not Herdman, 1891.]

Colony incrusting, often thick and fleshy. Spicules wanting. Branchial orifice six-lobed; atrial orifice situated on a funnel-like extension of the atrial cavity which is some distance back from the anterior end of the thorax. Three rows of stigmata. Testis single, of conical form. Proximal part of sperm duct coiled about the testis.

Those members of the genus *Trididemnum* [*Didemnum*] which lack spicules in the test were separated for that reason by Lahille (1890) as the genus *Didemnoides*. As the name *Didemnoides* had already been otherwise employed (by von Drasche, 1883), Hartmeyer (1903) substituted the name *Didemnopsis* for the new genus. It appears, however, that both these names are antedated by *Lioclinum*, proposed by Verrill (1871a, p. 444) in a footnote to one of his papers. This footnote reads as follows:

“*Didemnum*, as established by Savigny and adopted by Milne Edwards, includes two distinct groups: the first having calcareous corpuscles in its integument; the second soft and gelatinous throughout. The latter may be called *Lioclinum*. It includes *L. viscosum* (Sav.) and *L. gelatinosum* (Edw).”

The writer does not feel sure that it is justifiable summarily to reject *Lioclinum* in favor of *Didemnopsis*, as Hartmeyer (1909) has done. *Didemnum viscosum* Sav., a form which has not since been identified, is the type of *Lioclinum* as the species first placed in it. Should it be found again, and prove to be, as is very probable, a *Didemnopsis*, there would seem to be no question as to the validity of the name *Lioclinum*, for in this group we must depend on the characters of the type species more than on the generally imperfect diagnosis of the author in deciding the generic characters. But since the nature of Savigny's species remains uncertain, there is as yet no need of abandoning the accepted name *Didemnopsis*. Whether it is really worth while to keep this genus separate from *Trididemnum* [*Didemnum*] may after all be open to question.

***Didemnopsis tenerum* (Verrill).**

Text-figs. 16, 17; Pl. 39, fig. 15.

1871. *Lissoclinum tenerum* Verrill, Amer. Journ. Sci., ser. 3, vol. 1, p. 445.  
 1872. *Lissoclinum tenerum* Verrill, Amer. Journ. Sci., ser. 3, vol. 3, p. 212.  
 1879. *Lissoclinum tenerum* Verrill, Preliminary Check-list of Marine Invertebrata, p. 27.  
 1891. *Lissoclinum tenerum* Herdman, Journ. Linn. Soc. London, Zool., vol. 23, p. 629 (listed as uncertain species).  
 1909. *Lissoclinum tenerum* Hartmeyer, Bronn's Tier-reich, vol. 3, suppl., pp. 1453, 1456 (mentioned as uncertain species).

Professor Verrill's type of *Lissoclinum tenerum* was among the specimens of this animal examined. *Didemnopsis variabile* (Huitfeldt-Kaas), 1896, is very probably identical with this species. Its synonymy is as follows:

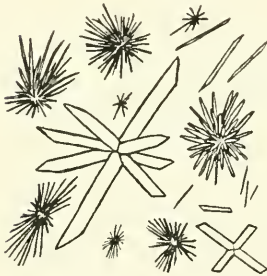
1851. *Didemnum gelatinosum* (err., non Milne-Edwards, 1841) (part) Sars, Nyt Mag. Naturvidensk., vol. 6, p. 154.  
 1858. *Didemnum gelatinosum* Sars, Forh. Videnskabs-Selsk. Christiania, p. 66.  
 1892. ? *Pseudodidemnum* sp., Herdman, Proc. and Trans. Liverpool Biol. Soc., vol. 6, p. 91.  
 1896. *Didemnoïdes variabile* Huitfeldt-Kaas, Norske Nordhavs-Exp., Zool., vol. 23, no. 1, p. 5, pl. 1, figs. 1, 2.  
 1903. *Didemnopsis variabile* Hartmeyer, in Römer and Schaudinn, Fauna Arctica, vol. 3, p. 366, pl. 6, fig. 19; pl. 14, fig. 22.  
 1904. *Didemnopsis variabile* Hartmeyer, Wiss. Meeresunters., Abt. Helgoland, vol. 5, pt. 2.  
 1905. *Didemnopsis variabile* Bjerkan, Bergens Mus. Aarbog, no. 5, p. 22, pl. 3, fig. 9.  
 1906. *Didemnopsis variabile* Redikorzew, in Derjugin, Die murmansche biol. Station, Trav. Soc. Nat. St. Pétersbourg, vol. 37, p. 155.  
 1907. *Didemnopsis variabile* Redikorzew, Ann. Mus. Zool. Acad. Sci. St. Pétersbourg, vol. 11, p. 151.  
 1907. *Didemnopsis variabile* Redikorzew, Zool. Anzeiger, vol. 31, p. 522.  
 1908. *Didemnopsis variabile* Bjerkan, Tromsø Mus. Aarsheft., no. 25, pp. 101, 115.  
 1908. *Didemnopsis variabile* Redikorzew, Trav. Soc. Nat. St. Pétersbourg, vol. 39, pp. 21, 36.  
 1908. *Didemnopsis variabile* Redikorzew, Mém. Acad. Imp. Sci. St. Pétersbourg, ser. 8, cl. phys.-math., vol. 18, no. 11, p. 49, fig. 11.  
 1909. *Didemnopsis variabile* Hartmeyer, Bronn's Tier-reich, vol. 3, suppl., p. 1447.

“Colonies incrusting shells, ascidians, etc., forming thin soft gelatinous crusts, which are translucent and filled with numerous very small

zooids which are nearly uniformly distributed. Cloacal openings small round apertures numerous scattered over the surface" (Verrill, 1871a).

The right of this species to a place in this genus rather than in *Trididemnum* may perhaps be questioned, for on careful search, at least in some colonies, a few small calcareous bodies may be found in the test. The simplest and commonest ones are apparently nothing more than elongated crystals, but two of these may be joined near their middle points, forming a cross, or several or many may radiate from a common point, forming a stellate group (sometimes with rays of very irregular length, sometimes quite regular) which simulates, if indeed it does not sometimes actually become, a real spicule. Such groups are generally minute, usually attaining a diameter of only 0.02 mm. to

0.04 mm., but occasionally much larger ones occur, usually in company with smaller ones. In many specimens no calcareous bodies at all were found. In form the colony is usually expanded and incrusting, frequently not much over 2 mm. thick, but occasionally 8 mm. or 10 mm. in thickness. In outline it may be very irregular, and sometimes measures 60 mm. or more in largest diameter, but usually very much less. Alcoholic specimens are grayish or yellowish white in color.



Text - fig. 16. — *Didemnopsis tenerum* (Verrill). Crystalline bodies from the test of a colony from Eastport, Me.  $\times 515$ .

The zooids vary much in size. As they are found in the preserved specimens, few of them exceed 1.50 mm. to 1.75 mm. in length, and a large majority are much smaller (1.15 mm. to 1.40 mm.), though in many cases such small size appears to be due to immaturity as well as to violent contraction. In many cases the body is violently constricted or strangulated between the thorax and abdomen. The writer has not observed vascular processes extending out into the test, but is not prepared to say that they may not be developed in certain stages of the life history of the colony. Neither is there a long muscular process as in many members of this family (as *Didemnum* [*Leptoclinium*] *lutarium*), but the muscle bands running along the median dorsal vessel and to the posterior end of the endostyle, which are continuous with the muscles of the process in those forms in which it occurs, are visible in some individuals of the present spe-

cies. The muscle fibers in the mantle are comparatively weak and mainly longitudinal.

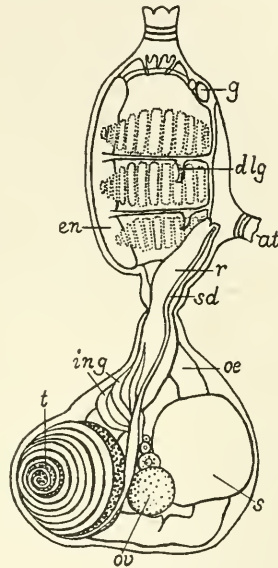
The branchial aperture is obtusely six-lobed; the atrial aperture, which is placed at the end of a somewhat funnel-shaped tubular projection, is situated posterior to the middle of the thorax in adult zooids, though further forward in young ones. It is plain-margined in young zooids, but often conspicuously lobed in older ones. This tube often gets broken off in dissecting out the zooid from the common test.

In many individuals it can be clearly seen that there are but eight tentacles, larger and smaller ones alternating, those opposite the endostyle and median dorsal vessel being larger than any of the others. In other individuals there are additional still smaller ones, or 16 in all. The dorsal tubercle is situated close against the ganglion.

There are three rows of stigmata, with a rather broad space free from stigmata intervening between the anterior end of the thorax and the first row.

In one individual where the stigmata could be accurately counted, there were 12 in the first and 11 in the second and third rows on each side; in another, 11 in the first two rows and 10 or 9 in the last. In others, 10 was the maximum in the anterior rows, though in those cases the zooids were perhaps not mature. The stigmata begin quite close to the endostyle and extend to the median dorsal vessel. At the ventral end of the rows the stigmata become successively shorter as the endostyle is approached, but at the dorsal end only the first, if any, is much shortened. The dorsal languets (two in number) arise from the transverse vessels of the left side of the sac about opposite the second or third stigma from the median dorsal vessel. They are short, curved, and directed posteriorly.

An oblique constriction in the intestine some distance beyond the stomach (which is globular and smooth-walled) is generally noticeable.



Text-fig. 17.—*Didemnoopsis tenerum* (Verrill). Zooid.  $\times 45$ .

The few tubules constituting the glandular organ surrounding the intestine have tapering ends.

The single large testis has the usual position in the left posterior part of the abdomen, and the proximal part of the sperm duct makes usually from eight to ten turns about it. Many of the colonies contain large tailed larvae of the type usual in this group.

Comparing this with the descriptions and figures of the European and Arctic species *D. variabile* (Huitfeldt-Kaas), the chief differences seem to be that *D. variabile* has slightly larger zooids (2 mm. long) and that calcareous bodies in the test have not been observed. These differences do not appear necessarily to indicate that the European form is distinct from *D. tenerum*.

*Didemnum strangulatum* Ritter (1901), from Kadiak Island, Alaska, 20 fathoms, is, from Ritter's description, evidently a close ally of the present species. It also has a few "calcareous stellate bodies" in the test in some colonies; in others none were found (Ritter, 1901, p. 248). Their rays are, however, described as short and blunt. The zooids are about 2 mm. long. The character from which Ritter names his species, the violent constriction of the body between the thorax and abdomen, occurs also in *D. tenerum* and in the European form, as Bjerkan's (1905, Pl. 3, fig. 9) figure clearly shows, and would indicate the identity of all three forms, if it were of any value as a specific character. However, it has no such value, as it may be observed in members of other genera of this family (*Leptoclinides faerøensis* and *Didemnum lutarium*, for instance).

*Didemnopsis tenerum* ranges from the Banks of Newfoundland to off the coast of Cape Cod, in depths of from 10 to 75 fathoms. A muddy bottom seems to be most favorable to it. The European and Arctic species *Didemnopsis variabile* (Huitfeldt-Kaas, 1896), which, as above stated, may be identical with it, is widely distributed and common on the Norwegian coast, and is recorded from Spitzbergen, the Murman coast, and the Siberian Arctic Ocean, occurring in depths of from 40 to 180 meters, on muddy bottoms with scattered stones, shells, etc. A variety of it (*gelatinosum*) described by Huitfeldt-Kaas (1896) from Norway has also been recorded by Redikorzew (1907a, 1908b) from the Murman coast.

The writer has examined specimens of *D. tenerum* from the following localities:

Banks of Newfoundland, collected by Captain T. M. Coffin; Station

2699 (off Newfoundland, N. lat.  $45^{\circ} 04'$ , W. long.  $55^{\circ} 23'$ , 72 fathoms, August 22, 1886); Bay of Fundy; Eastport, Maine (several specimens, including the type); Casco Bay, Maine; Stations 161 to 164 (off Cape Ann, N. lat.  $42^{\circ} 36'$ , W. long.  $70^{\circ} 27'$ , approximately, 54 to 75 fathoms, mud and fine sand, August 16, 1878); Station 222 (off Cape Ann, N. lat.  $42^{\circ} 33'$ , W. long.  $70^{\circ} 31'$ , approximately, 40 fathoms, fine sandy mud, September 21, 1878); Station 184 (off Cape Ann, N. lat.  $42^{\circ} 30'$ , W. long.  $70^{\circ} 38'$ , approximately, 45 fathoms, mud, August 29, 1878); Stations 25 to 31 (Massachusetts Bay, N. lat.  $42^{\circ} 27.5'$ , W. long.  $70^{\circ} 36'$ , 48 to 50 fathoms, mud, August 13, 1877); Station 349 (Massachusetts Bay, N. lat.  $42^{\circ} 10.5'$ , W. long.  $70^{\circ} 29'$ , 26 fathoms, sand and mud); Station 371 (off Chatham, Mass., N. lat.  $41^{\circ} 35.5'$ , W. long.  $69^{\circ} 35'$ , 34.5 fathoms, coarse speckled sand, September 19, 1879); Station 372 (off Chatham, Mass., N. lat.  $41^{\circ} 40'$ , W. long.  $69^{\circ} 28.5'$ , 70 fathoms, sand and pebbles, September 19, 1879).

Genus LISSOCLINUM Verrill, 1871.

Verrill's descriptions of this genus and of the species included, are concerned so largely with external characters and with characters common to many or most genera of the family, that we must depend on an examination of the type to determine the correct diagnosis of the genus. Of the two species, *L. aureum* and *L. tenerum*, the former, being the first described (Verrill, 1871a, p. 444) and the only one figured, is the type.

An examination of Verrill's type specimens shows that while *L. tenerum* is a Didemnopsis, *L. aureum*, the generic type, is closely allied to *Diplosomoides dubium* Hartmeyer, 1903, of the European Arctic region. *Diplosomoides flavescens* Redikorzew, 1907, of the Siberian Arctic Ocean, is also closely allied. All these three species are distinguished by having the testis consisting of four or more separate or nearly separate radially arranged parts, and by having an atrial languet. *Diplosomoides* Herdman was originally defined as differing from *Leptoclinium* Milne-Edwards [= *Diplosoma* MacDonald] only in having calcareous spicules. *Leptoclinium* [*Diplosoma*], however, has the testis consisting of two distinct somewhat hemispherical parts and has no atrial languet. There are species of *Diplosomoides* (*D. fragile* of Bermuda, for instance), which do correspond exactly to *Leptoclinium*, lacking the atrial languet and having a two-parted testis.

In the opinion of the writer, they are the ones that should constitute the genus *Diplosomoides*, but *D. dubium* and *D. flavescens* should be removed from *Diplosomoides* and placed with Verrill's species in the genus *Lissoclinum*, a genus which bears exactly the same relation to *Diplosomoides* that *Polysyncrator* bears to *Didemnum* [*Leptoclinum*]. The same distinctions that have led to the recognition of *Polysyncrator* justify the recognition of *Lissoclinum*. Its characters are as follows:

Colony variable in form, flat and incrusting or of considerable height. Common test often with extensive cavities. Calcareous spicules generally present. Branchial aperture six-lobed; atrial aperture with a languet. Four rows of stigmata. Stomach smooth-walled. Testis divided completely or incompletely into four or more parts. Sperm duct not coiled about the testis.

In this genus, as in the other genera of this family in which the sperm duct is not spirally coiled, *viz.*, *Leptoclinum* [*Diplosoma*] and *Diplosomoides*, and also in *Echinoclinum*, the writer has been unable to find any trace of the branching tubular gland surrounding the intestine, while in those members of the family in which the sperm duct is coiled, *viz.*, *Didemnum* [*Leptoclinum*], *Leptoclinides*, *Didemnoopsis*, *Trididemnum* [*Didemnum*], *Tetradidemnum*, and *Polysyncrator*, it is conspicuous in any fairly well preserved material, consisting of a few (often only three or four) thin-walled tapering tubules without enlarged bulbs at the ends, which clasp the ascending part of the intestine. At their proximal ends they unite, and discharge into the intestine beyond the stomach by a common duct.

In two (*Didemnoopsis*, *Leptoclinides*) of the last-mentioned group of genera, the writer has been able to distinguish clearly the dorsal languets, which are not borne on the median dorsal vessel, but on the transverse vessels of the left side of the branchial sac at some distance from the median dorsal vessel. In *Lissoclinum*, and as far as he has been able to distinguish them in other genera of the *Leptoclinum* [*Diplosoma*] section of the family, they are apparently borne on, or at least close to, the median dorsal vessel.

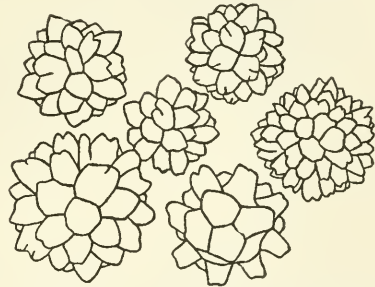
***Lissoclinum aureum* Verrill.**

Text-figs. 18, 19, 20; Pl. 39, figs. 11, 12, 16, 17.

1871. *Lissoclinum aureum* Verrill, Amer. Journ. Sci., ser. 3, vol. 1, p. 444, fig. 26.

1872. *Lissoclinum aureum* Verrill, Amer. Journ. Sci., ser. 3, vol. 3, p. 212.  
 1879. *Lissoclinum aureum* Verrill, Preliminary Check-list of Marine Invertebrata, p. 27.  
 1891. *Lissoclinum aureum* Herdman, Journ. Linn. Soc. London, Zool., vol. 23, p. 629 (listed as uncertain species).  
 1909. *Lissoclinum aureum* Hartmeyer, Bronn's Tier-reich, vol. 3, suppl., pp. 1453, 1456 (listed as uncertain species).

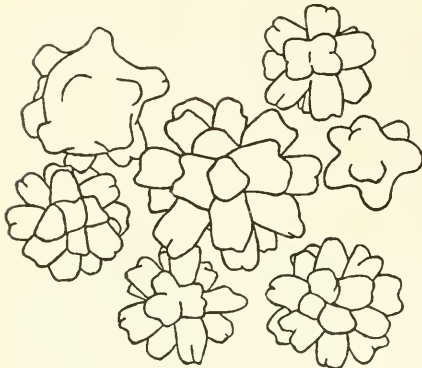
The colony is of more or less irregular outline, flat and incrusting, or more usually somewhat convex above, with thick rounded edges. The largest specimens do not much exceed 30 mm. in greatest diameter; 3 to 6 mm. is the usual thickness, but this may be exceeded in some parts of the colony in the case of large specimens. According to Professor Verrill (1871a), the color in life is light yellow with bright orange zooids. In alcoholic specimens the test is grayish, and often transparent enough to allow the zooids to be distinctly seen. The latter are numerous and apparently arranged in systems of considerable complexity. The test contains large oval cells. The extent of the development of cavities in the common test is very variable in this species. In some colonies (including many of those in which spicules are practically or entirely wanting, as well as those with many spicules) they are well developed, the test in the interior of the colony being reduced to a thin tough capsule surrounding each zooid; in others they are apparently entirely wanting, and the test substance is as solid and continuous as in a *Didemnum*.



Text-fig. 18.—*Lissoclinum aureum* Verrill. Spicules.  $\times 515$ . This figure and fig. 19 are from different colonies.

Professor Verrill mentions no calcareous spicules. Nevertheless a few at least may be found in many colonies by a careful microscopical examination. Not only are they generally insignificant in number, but most of them are far from regular in form, a considerable part being better described as irregular or more or less crystalline deposits of calcareous matter, while the regular ones are of spherical or stellate form, often 0.03 mm. to 0.05 mm. in diameter, and are provided with numerous but short and frequently somewhat notched or broken

rays. Examples of the regular forms are shown in text-figs. 18 and 19. Some colonies seem to lack altogether not only regular spicules, but calcareous deposits; at least the writer found none in the portions examined microscopically. On the other hand, some colonies have the regular spicules so numerous that the specimen acquires something of the opaque white appearance of a *Didemnum* [*Leptoclinium*]. In



Text-fig. 19.—*Lissoclinum aurcum* Verrill. Spicules.  $\times 515$ .

such colonies the surface often shows a small sharply defined area of each zooid in which the spicules are less abundant and the test consequently less white and opaque.

The zooids measure, when expanded, about 2 mm. in length, the comparatively long neck between the thorax and abdomen, and the many divisions of the testis giving them a superficial resemblance to those of the family Polycitoridae. The muscles of the mantle, including the sphincters of the apertures, are very weak and inconspicuous.

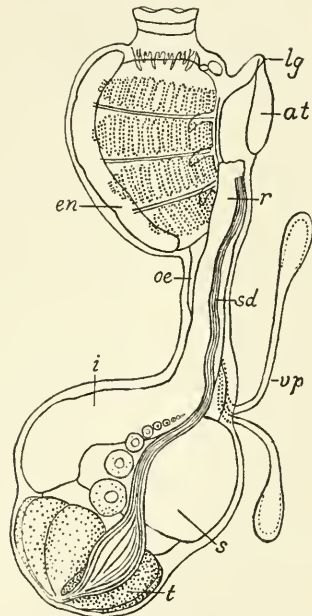
In some colonies, at least, a large majority of the fully developed zooids have two long club-shaped vascular processes extending out into the common test from the region of the esophagus. In some cases one of them forks or divides into two branches. Apparently their wall consists of a single layer of cells, which are flattened, except at the expanded end of the process, where they become high and columnar. Perhaps more carefully preserved material might show a more complex structure. The processes contain a few corpuscles. Inside the body the processes are continued as two narrow thin-walled tubes, which run up (anteriorly) along the esophagus close against its wall. They become gradually smaller and appear to end without communicating with the esophagus or branchial sac.

The branchial aperture is six-lobed; the atrial aperture is large, thin-bordered and without lobes, but with a short languet, which extends but little beyond the margin of the aperture. The tentacles

number 12 in young zooids, and are then of two sizes arranged alternately. Fully adult zooids have 12 more still smaller tentacles between the others, or 24 in all.

The branchial sac has four rows of stigmata with from 12 to 14 stigmata on each side in the anterior rows, but only about ten in the last row. The transverse vessels are provided with a few muscle fibers and a band of muscle fibers runs along each side of the median dorsal vessel. There are three dorsal languets, which, as above noted, appear to arise directly from the median dorsal vessel, though perhaps more from its left than from its right side, so that their bases are in contact with the left transverse vessels. The stomach is oval and smooth-walled. The folds in the stomach wall mentioned by Professor Verrill must evidently have been caused by the contraction incident to preservation. The intestinal loop is twisted through about  $180^\circ$  on its vertical axis, bringing the stomach to the dorsal side, and also bent to the right, so that the reproductive organs appear to have a position posterior to the intestinal loop. There is a distinct constriction or valve in the intestine near the point where it begins to ascend.

The testis is divided into from five to nine or ten pyriform bodies placed radially, with their apices close together and more or less posteriorly directed with reference to the axis of the body. Very short connecting ducts arising from their apices unite to form the common sperm duct or vas deferens, which has a nearly straight course to and then parallel with the rectum. Near its origin it often expands into a large spindle-shaped seminal receptacle. Generally the divisions of the testis are completely or almost completely separated from each other, but there seem to be individual differences in this respect. When the testis becomes large, the parts become closely crowded together,



Text-fig. 20.—*Lissoclinum aureum* Verrill. Zooid.  $\times 42$ .

but the readiness with which they usually break apart on dissecting the zooid shows that this does not necessarily indicate incomplete separation. The structure of the ovary is best made out in those zooids (as that shown in text-fig. 20) in which the eggs are still small. It is then seen to consist of a single series of eggs of different sizes, lying near the common sperm duct. The eggs at the posterior end of the series are the largest. Sometimes the ovary may form a prominent projection on the surface of the body, connected with the body by a somewhat constricted base.

The close relationship of *Diplosomoides dubium* Hartmeyer, 1903, (or *Lissoclinum dubium*, as the writer would call it), to this species has already been alluded to. Indeed, the differences between the two are all, as far as can be judged from Hartmeyer's description and figures, well within the limits of individual variation, except that in the European species the zooids measure 4 mm. long, about double the length of well expanded zooids of the American form, and certainly extraordinarily large for a member of the Didemnidae. Hartmeyer describes the testis as composed of five incompletely separated divisions, while *L. aureum* frequently has more divisions which are often, at least, completely separated. *L. dubium* is found in the Spitzbergen region and off Franz Josef Land, in depths to 85 meters. The other species, *Diplosomoides flavescens* Redikorzew, 1907, which the writer would transfer to *Lissoclinum*, is distinguished by having but four divisions to the testis and extremely large (up to 0.4 mm.) blunt-rayed spicules. It is from the Arctic Ocean north of Siberia.

*Lissoclinum aureum* is found from the Banks of Newfoundland to off the coast of Martha's Vineyard, Mass., both in shallow water and in depths to 100 fathoms. A muddy bottom seems to be preferred. The specimens having but a few spicules, or in some cases apparently none at all, are from these localities:

Station 2699 (off Newfoundland, N. lat. 45° 04', W. long. 55° 23', 72 fathoms, August 22, 1886); Bay of Fundy; Eastport, Maine, and Casco Bay, Maine, in shallow water; Station 46 B (near Jeffrey's Ledge, N. lat. 43° 03', W. long. 70° 04', 51 fathoms, hard sandy mud, September 4, 1873); Stations 170 and 171 (off Cape Ann, N. lat. 42° 33', W. long. 69° 59', 90 fathoms, fine sandy mud and gravel, August 24, 1878); Station 137 (off Cape Ann, N. lat. 42° 32.5', W. long. 70° 23.5', 53 fathoms, rocks, drifting into soft mud, July 29, 1878); off Cape Ann, 48 fathoms; Station 211 (off Cape Ann, N. lat. 42° 38', W.

long.  $70^{\circ} 28.5'$ , approximately, 60 fathoms, mud); Massachusetts Bay, near Stellwagen's Bank, 90 fathoms; Station 264 (off Cape Cod, Race Point Light, S.  $65^{\circ}$  W., 15 miles, N. lat.  $42^{\circ} 10'$ , W. long.  $69^{\circ} 56.5'$ , 80 fathoms, blue mud, July 28, 1879); Station 873 (off Martha's Vineyard, Mass., N. lat.  $40^{\circ} 02'$ , W. long.  $70^{\circ} 57'$ , 100 fathoms, soft sticky mud, September 13, 1880).

The specimens with abundant spicules are not numerous, and are from the vicinity of Eastport, Maine, except one from Station 2455 (off Newfoundland, N. lat.  $47^{\circ} 21'$ , W. long.  $51^{\circ} 38' 30''$ , 81 fathoms, brown sand, June 26, 1885), and one from Station 78 B (near Jeffrey's Ledge, N. lat.  $43^{\circ} 04'$ , W. long.  $70^{\circ} 30'$ , 35 fathoms, September 13, 1873).

Family SYNOICIDAE Hartmeyer, 1908 [= POLYCLINIDAE Verrill, 1871].

Genus MACROCLINUM Verrill, 1871.

Colony massive, usually rounded and attached by a narrow base. Systems small and simple, circular or elliptical, wanting or indistinguishable in some stages of growth of the colony.

Zooids elongated. Post-abdomen sessile and very long when fully developed. Branchial aperture six-lobed; atrial aperture more or less produced into a tubular or funnel-like form and provided with a three-parted languet. Intestinal loop twisted in some individuals, but not in others. Stomach wall smooth or occasionally with distinct but small and shallow areolations.

Of the European writers who have described the following species (with which, as shown by Bjerkan (1905, pp. 17, 18), Verrill's *M. crater* is identical), Alder (1863) and Bjerkan (1908) alone seem to have noted the areolation of the stomach. The latter author suggests that this indicates a relationship to *Synoicum Phipps*. This is a conclusion at which the writer had already arrived before seeing Bjerkan's article. Not only the areolation of the stomach, but the somewhat produced atrial siphon bearing the three-fingered languet and the small circular systems indicate a relationship to the latter genus, but the writer has not had the opportunity of studying any species of *Synoicum* and cannot express any opinion as to whether the relationship with that genus is sufficiently close to make uniting the two genera advisable.

A very close relationship of *Macroclinum* to *Amaroucium* is not apparent to the writer. The areolation of the stomach does not exhibit the slightest indication of having arisen by the breaking up of a system of longitudinal folds such as is present in the stomach wall in that genus.

***Macroclinum pomum* (Sars).**

Text-fig. 21; Pl. 38, fig. 8.

1851. *Amaroucium pomum* Sars, Nyt Mag. Naturvidensk, vol. 6, p. 155.  
 1859. *Amaroucium pomum* Sars. Forh. Videnskabs-Selsk. Christiania, p. 66.  
 1863. *Amaroucium pomum* Alder, Ann. Mag. Nat. Hist., ser. 3, vol. 11, pp. 170, 171.  
 1871. *Macroclinum crater* Verrill, Amer. Journ. Sci., ser. 3, vol. 1, p. 293, fig. 23-25.  
 1872. *Macroclinum crater* Verrill, Amer. Journ. Sci., ser. 3, vol. 3, p. 212.  
 1879. *Macroclinum crater* Verrill, Preliminary Check-list of Marine Invertebrata, p. 27.  
 1891. *Macroclinum crater* + *Amaroucium pomum* (?) Herdman, Journ. Linn. Soc. London. Zool., vol. 23, p. 628 (listed among unrecognizable Polyelinidae).  
 1893. ? *Aplidiopsis pomum* Herdman, Ann. Mag. Nat. Hist., ser. 6, vol. 12, p. 445.  
 1896. *Aplidiopsis pomum* + *Aplidiopsis sarsii* Huitfeldt-Kaas, Norske Nordhavs-Exp., Zool., vol. 23, no. 1, pp. 13, 14, pl. 1, fig. 8-10.  
 1903. *Macroclinum crater* + *Macroclinum pomum* Hartmeyer, in Römer and Schaudinn, Fauna Arctica, vol. 3, p. 319-322, text-fig. 37-39, pl. 6, fig. 5; pl. 13, figs. 6, 7.  
 1904. *Macroclinum pomum* Hartmeyer, Wiss. Meeresunters., Abt. Helgoland, vol. 5, pt. 2.  
 1905. *Macroclinum pomum* Bjerkan, Bergens Mus. Aarbog, no. 5, pp. 17, 18.  
 1906. *Macroclinum pomum* Hartmeyer, Beiträge zur Meeresfauna von Helgoland, in Wiss. Meeresunters., Abt. Helgoland, p. 126.  
 1907. *Macroclinum crater* Redikorzew, Ann. Mus. Zool. Acad. Imp. Sci. St. Pétersbourg, vol. 11, pp. 148, 153.  
 1908. *Macroclinum pomum* Bjerkan, Tromsøe Mus. Aarsheft., no. 25, p. 88.  
 1909. *Macroclinum pomum* Hartmeyer, Bronn's Tier-reich, vol. 3, suppl., p. 1464.

This species forms large rounded masses attached by a narrow area or raised on a very short thick peduncle. Often the surface exhibits large flattened or concave areas. The test in alcoholic specimens is tough, cartilaginous (especially the outer layer), and of a rather opaque yellowish or yellowish white color. The surface is rather smooth and often incrustated with a thin even layer of sand grains, though in other

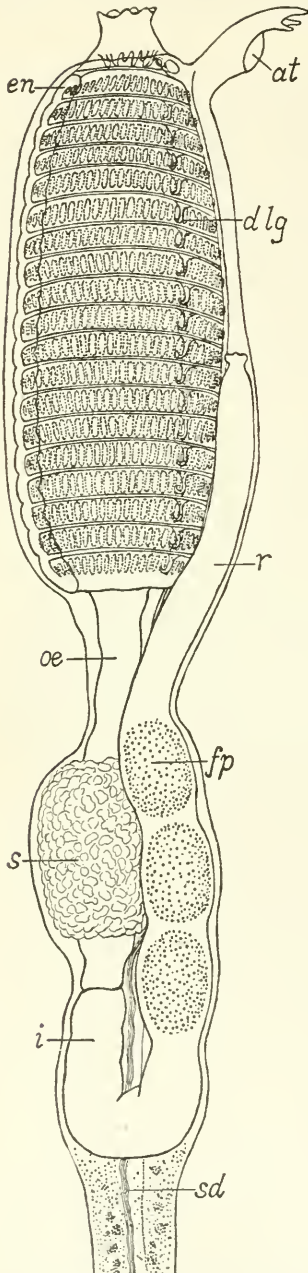
cases this is lacking. The interior of the colony is comparatively free from sand. The zooids are in some specimens arranged in small circular or elliptical systems of from six to eleven zooids (usually about eight); in the center of each system a small roundish common cloacal orifice is more or less distinctly visible. In some colonies no such systems are discernible, the zooids being irregularly distributed. This character probably depends rather on the stage of growth of the colony than on individual variation or poor preservation.

The three colonies of this species (all from the Banks of Newfoundland) which are in the collections have the following dimensions and characters:

The smallest (the type of Verrill's genus *Macroclinum* and species *M. crater*) is of circular outline, about 45 mm. in diameter and 25 mm. in height. It was attached by a small area at the base and has the upper surface conspicuously concave, whence the name *crater*. Another, the most regular in form (Pl. 38, fig. 8), measures about 115 mm. by 95 mm. in its transverse diameters and 95 mm. in height. It is attached to a stone by a very short stout peduncle, if indeed it is proper to apply that term to such a short thick extension of the colony. The third colony is 136 mm. in greatest diameter, though from its irregularity it is not of much greater bulk than the last. It was attached directly by a small area on the lower surface. Still larger colonies are reported by Hartmeyer from European waters.

In one of the larger specimens, the zooids are beautifully expanded. In these, the thorax and abdomen together measure about 10 mm. in length, but in the usual contracted state are of but half that length or less. The post-abdomen (the length of which is less affected by the contraction of the muscles) may itself measure fully 10 mm. in length. The muscles in the mantle form a network in which most of the fibers are longitudinal, but on the thorax a considerable number of oblique fibers and a few transverse fibers occur. The branchial orifice has six obtuse lobes. The atrial orifice is at the end of a short funnel-shaped tube situated well forward on the thorax, and is smooth-margined, with the anterior part of its border produced into a short languet, ending in three small finger-like processes.

The tentacles, which appear to number about 12, are of two sizes placed alternately. The branchial sac has about 20 rows of moderately long stigmata. The number in a row on each side reaches 30 or even more. The stigmata begin close to the median dorsal vessel and ex-



Text-fig. 21. — *Macroclinum pomum* (Sars). Zooid.  $\times 15$ .

tend close to the endostyle, which is narrow and inconspicuous. The stigmata at both ends of the rows are small, but reach their full length at a very short distance from the endostyle, while at the dorsal ends of the rows only the first two stigmata are generally perceptibly shortened. In the first or anterior series, however, the stigmata increase gradually in length to the middle point of the series (see text-fig. 21), and this is also true to some extent of the last series. The transverse vessels are not strongly muscular. The dorsal languets are short and hooked, and directed posteriorly, the recurved point bending toward the ventral side. They appear to have absolutely no connection with the median dorsal vessel, for they are placed about opposite the sixth or seventh stigma on the left side of the body, arising from the transverse vessels of the branchial sac. There are no languets on the right side.

The intestinal loop is little or not at all twisted in most of the well expanded zooids, but in other cases it is (as usual in the genus *Anarocium*) twisted through a full half turn, bringing the stomach, which is oval and longer than broad, to the dorsal side. It has been suggested by Bjerkan (1905) that such twisting, which occurs in most compound ascidians, may be largely due to the contraction of the body walls. It is easy to see that the twisting might admit of a more compact disposal of the parts of the

digestive tract, and hence, when once started, might be increased as the muscles contracted, but unless there was an initial tendency to twist in a given direction, the uniform direction of the twist which prevails in most species would remain to be explained. Possibly the structures lying beside the intestinal loop (the reproductive organs in some groups, the epicardial sac and sperm duct in others) may cause a displacement in one direction to be easier than in the other.

In some specimens the stomach wall, which is very thin and easily thrown into irregular folds by the contraction of the animal, is, as noted by Alder (1863) and Bjerkan (1908), raised into numerous but very small and shallow areolations which show no tendency to be arranged in rows, but are quite irregularly distributed. In other specimens, it is difficult to detect the areolation. To what extent this is due to individual variation rather than to imperfect preservation, the writer will not attempt to decide from the limited material at hand.

All of the three specimens above described were obtained by fishermen on the Banks of Newfoundland, and were probably brought up from the bottom by catching on the fish-hooks or becoming entangled in the lines. The two large colonies were collected by Captain George W. Scott, in July, 1871, in 40 fathoms, Virgin Rock bearing N. E. by N. 30 miles distant.

In northern European waters, this is a quite widely distributed and locally abundant species. Alder (1863) records it from "deep water in Moray Firth." Hartmeyer (1903, 1906) records examples from the Banks of Newfoundland and from various points on the coast of Norway in depths to 40 fathoms; also one from Helgoland. He reports it as abundant and reaching a large size on the Dogger Bank and Great Fisher Bank in the North Sea. Bjerkan (1905, 1908) records other Norwegian and North Sea localities, in depths to 160 meters, as well as east of the Faroe Islands, 110 meters, and off the southeast coast of Iceland, 75 meters. Redikorzew (1907) records it from the Murman coast region.

Genus *APLIDIUM* Savigny, 1816.

Colony sessile, generally cushion-like or forming a thick crust. Systems often unrecognizable (in preserved specimens at least).

Zooids small, the post-abdomen usually short. Branchial orifice six-lobed; atrial orifice with a smooth or lobed border. An atrial

lanquet may be present or wanting (wanting in the New England species). Atrial orifice often some distance posterior to the front end of the thorax. Stomach with longitudinal folds in the wall. Intestinal loop usually if not always twisted, bringing the stomach to the dorsal side, the rectum crossing the esophagus on the left side.

***Aplidium pallidum* (Verrill).**

Text-fig. 22.

1871. *Amouroucium pallidum* Verrill, Amer. Journ. Sci., ser. 3, vol. 1, p. 289.  
 1871. *Amouroucium pallidum* Verrill, Amer. Journ. Sci., ser. 3, vol. 2, p. 362.  
 1872. *Amouroucium pallidum* Verrill, Amer. Journ. Sci., ser. 3, vol. 3, p. 211.  
 1873. *Amarocium pallidum* Verrill and Smith, Report on Invertebrate Animals of Vineyard Sound, pp. 496, 705.  
 1874. *Amaroecium pallidum* Verrill, Amer. Journ. Sci., ser. 3, vol. 7, pp. 40, 43, 504.  
 1874. *Amarocium pallidum* Verrill, Proc. Amer. Assoc. Adv. Sci., vol. 22, pp. 357, 363.  
 1879. *Amaroecium pallidum* Verrill, Preliminary Check-list of Marine Invertebrates, p. 27.  
 1886. ? *Aplidium despectum* Herdman, Report Voyage Challenger, Tunicata, pt. 2, p. 210, pl. 28, fig. 11-13.  
 1891. *Amaroucium pallidum* + (probably) *Aplidium despectum* Herdman, Journ. Linn. Soc. London. Zool., vol. 23, pp. 628, 622.  
 1901. *Amaroucium pallidum* Kingsley, Proc. Portland Soc. Nat. Hist., vol. 2, pt. 5, p. 183.  
 1901. *Amaroucium pallidum* + (probably) *Aplidium despectum*, Whiteaves, Catalogue of Marine Invertebrata, p. 265.  
 1909. *Amaroucium pallidum* + (probably) *Aplidium despectum* Hartmeyer, Bronn's Tier-reich, vol. 3, suppl., pp. 1469, 1477.

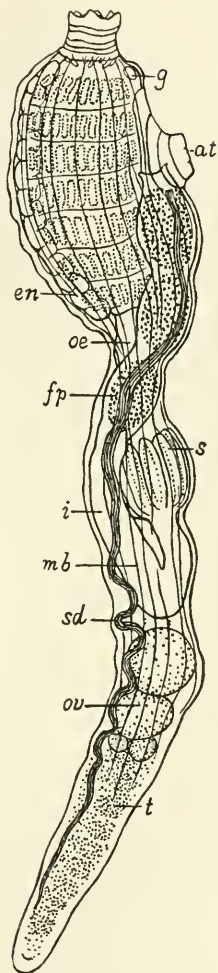
As stated below, *Aplidium lacteum* Huitfeldt-Kaas, 1896, is very probably identical with this species. Its synonymy is as follows:

1896. *Aplidium lacteum* Huitfeldt-Kaas, Norske Nordhavs-Exp., Zool., vol. 23, no. 1, p. 15, pl. 2, fig. 14-16.  
 1903. *Aplidium lacteum* Hartmeyer, in Römer and Schaudinn, Fauna Arctica, vol. 3, p. 338-340, text-figs. 46, 47, pl. 6, fig. 13; pl. 13, fig. 16.  
 1907. *Aplidium lacteum* Redikorzew, Ann. Mus. Zool. Acad. Imp. Sci. St. Pétersbourg, vol. 11, pp. 149, 153.  
 1908. *Aplidium lacteum* Redikorzew, Trav. Soc. Nat. St. Pétersbourg, vol. 29, pp. 21, 34.  
 1909. *Aplidium lacteum* Hartmeyer, Bronn's Tier-reich, vol. 3, suppl., p. 1469.

“Masses sessile, hemispherical or subglobular, usually attached by

a large base. Surface generally evenly rounded, sometimes irregular in large specimens, smoothish, but thinly covered with minute, firmly adherent particles of fine sand which are embedded in the common tissue and scattered throughout its substance. The cloacal openings are few in number and irregularly placed, except in small specimens, which usually have but one large central opening. The animals often form somewhat circular groups of six or eight individuals around the cloacal openings; outside of the circular groups they are usually irregularly scattered, but sometimes form linear series of eight or ten, and in young specimens with but one central opening they often form a larger outer circle, which is near the margin, more or less irregular and composed of numerous individuals. . . . Color of the masses pale yellowish or grayish; stomach dull orange color; ovaries yellowish white. The larger specimens are 15 mm. to 25 mm. in diameter” (Verrill and Smith, 1873, p. 705).

Alcoholic specimens vary much in the shade of color of the common test, which ranges from a milky yellowish white to rather dark brownish gray, but the small closely crowded and usually much contorted zooids are generally visible through the test, though any arrangement of them in systems cannot generally be recognized. The amount of sand in and on the surface of the test is very variable; in some specimens it is insignificant. In form and size, the specimens mostly agree well with Verrill's description, and though there are irregularly shaped colonies among them, as would be expected in large series, it is evident that anything approaching the capitate form characteristic of *A. glabrum* is only infrequently met with in this spe-



Text - fig. 22. — *Aplidium pallidum* (Verrill). Zooid.  $\times 42$ . The longitudinal muscle bands in the mantle are indicated in the figure.

cies, which tends to form a low sessile colony with a rounded or more or less flattened upper surface. Few of the colonies exceed 30 mm. in greatest diameter.

The zooids in preserved specimens vary from pale yellow to brown in color. They are almost invariably violently contorted, so that their natural form is completely obscured. Individuals which remain straightened out, as in text-fig. 22, are few in most specimens. There appears to be a fairly well marked constriction between the thorax and abdomen, but little constriction or none between the abdomen and post-abdomen. The latter of course varies in length and thickness according to the development of the reproductive organs, but is generally decidedly less than the length of the thorax and abdomen together, when the latter are straightened out and moderately relaxed. The total length of most of the zooids is between 2 mm. and 3.5 mm. in the alcoholic specimens. Verrill and Smith give 3 mm. to 4 mm. as the greatest length, probably in fresh specimens. The branchial orifice is six-lobed; the atrial orifice, placed at a varying but often considerable distance from the anterior end of the thorax, is at the end of a low conical projection and has a plain or very slightly lobed or sinuate margin. An atrial languet appears to be entirely wanting. The mantle muscles are mainly longitudinal.

Owing to the minute size and contracted condition of the zooids, the details of the internal structure of the thorax are generally entirely obscured. The oral tentacles appear to be of two sizes placed alternately, and to number about a dozen. Dorsal languets were not distinguishable, but there is no reason to suppose they are not present. The endostyle is broad, with very tortuous margins in the contracted state. In the zooid figured (text-fig. 22) the rows of stigmata numbered seven, with at least a dozen in a row on each side of the sac. Apparently some of the zooids have at least one or two more rows of stigmata than this.

The wall of the stomach has generally from 10 to 12 conspicuous longitudinal folds extending its whole length. The intestine forms a twisted loop, crossing the esophagus on the left side of the latter.

The ovary is situated in the anterior part of the post-abdomen; the testes extend through the greater part of the length of that division of the body.

This is not a very common species, though its distribution is wide. Whiteaves (1901) records it from near Bonaventure Island in the Gulf

of St. Lawrence, 56 fathoms. According to Verrill and Smith (1873, p. 705) it is found "from Martha's Vineyard [Mass.] to the Gulf of St. Lawrence. Off Buzzard's Bay, 25 fathoms, gravel; south of Gay Head, 10 fathoms, stony; Casco Bay, 8 to 40 fathoms; Eastport Harbor and Bay of Fundy, low water to 80 fathoms." Apparently it is found near low-water mark in the more northern localities only. South of the latitude of Boston, it is rare and local. It appears to prefer a stony or gravelly bottom, but grows under a variety of conditions.

Specimens from Station 2698 (off Newfoundland, N. lat.  $45^{\circ} 07'$ , W. long.  $55^{\circ} 09'$ , 90 fathoms, sand and pebbles, August 22, 1886); Station 21B (Cashe's Ledge, 52 to 90 fathoms, rocky); from several stations off Cape Ann; and Station 2525 (N. lat.  $41^{\circ} 49'$ , W. long.  $65^{\circ} 49' 30''$ , 72 fathoms, sand, gravel, and broken shells, July 13, 1885) are also in the collection. Some colonies from Stations 839 to 840 (near the Dumplings, Narragansett Bay, R. I., 20.5 to 27.5 fathoms, gravel and sand, August 31, 1880) appear also to belong to this species, slightly extending its known range to the westward. A record from Watch Hill, R. I., may be correct, but the writer was unable to verify it.

Its range in depth, as given by Verrill and Smith, must be much increased. There are half a dozen colonies from Station 2514 (off Nova Scotia, N. lat.  $43^{\circ} 28' 30''$ , W. long.  $63^{\circ} 57' 30''$ , 126 fathoms, black mud, July 11, 1885). These are large specimens (the largest, of somewhat elongated form, measures 33 mm. in length) and form rounded or irregularly flattened masses attached by a narrow base only, and as would be expected on a soft muddy bottom, they contain little sand in the test. There is also a small but apparently typical colony from Station 2429 (off Newfoundland, N. lat.  $42^{\circ} 55' 30''$ , W. long.  $59^{\circ} 51'$ , June 23, 1885) from the considerable depth of 471 fathoms. There the bottom is gray mud, and this colony also contains little or no sand.

A comparison of this species with the descriptions of *A. lacteum* Huitfeldt-Kaas (1896) (further described and figured by Hartmeyer, 1903) shows that aside from differences in external form, ascribable to individual variation, they agree in nearly every particular, the only important discrepancy being that Huitfeldt-Kaas and Hartmeyer found only five or perhaps six rows of stigmata in the branchial sac, while the writer has not found less than seven in the American form. This is a character which is subject to a good deal of individual varia-

tion in members of this family of ascidians, and the writer is not inclined to attribute great weight to this difference in view of the otherwise close correspondence between the European and American forms. The European form is recorded from the west coast of Norway, 60 to 200 fathoms (Huitfeldt-Kaas), and Spitzbergen, 80 meters (Hartmeyer), and from Nova Zembla, the Murman coast, and the White Sea (Redikorzew, 1907a).

*Aplidium despectum* Herdman (1886) collected by the Challenger Expedition at Le Have Bank off Nova Scotia, 51 fathoms, is probably identical with *A. pallidum*.

#### Genus AMAROUCIUM Milne-Edwards, 1841.

This genus is not sufficiently distinguished from *Aplidium*, from which it differs chiefly in usually having the colony distinctly pedunculated or composed of several or many heads, and in the larger size of its zooids, these having the atrial orifice near the anterior end of the thorax and always provided with a languet, and the post-abdomen, when fully developed, exceeding (sometimes very greatly) the remainder of the body in length.

#### *Amaroucium pellucidum* (Leidy).

Pl. 35, fig. 3; Pl. 37, fig. 6.

This species exists in two very dissimilar forms, which have been considered distinct species (the typical *A. pellucidum*, and *A. constellatum* Verrill), but which are in reality not even true subspecies, as is shown by some colonies which in one part have the typical *pellucidum* characters, while in the remainder of the colony the *constellatum* characters are equally well developed. There are also specimens in which the whole colony has characters intermediate between the two. The second form of this species (the *A. constellatum* of Verrill) will be designated in this paper *A. pellucidum* form *constellatum*, and will be described separately (see p. 406). The synonymy, description, and statements here immediately following apply to the typical form only.

1855. *Alcyonidium* ? *pellucidum* Leidy, Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 3, p. 142, pl. 10, fig. 24.  
 1871. *Amouroucium pellucidum* Verrill, Amer. Journ. Sci., ser. 3, vol. 1, p. 290.  
 1871. *Amouroucium pellucidum* Verrill, Amer. Journ. Sci., ser. 3, vol. 2, p. 359.

1872. *Amoroucium pellucidum* Verrill, Amer. Journ. Sci., ser. 3, vol. 3, p. 211.  
1873. *Amaroccium pellucidum* Verrill and Smith, Report on Invertebrate Animals of Vineyard Sound, pp. 703 (397), 401 (411, 415), 419 (424).  
1879. *Amaroccium pellucidum* Verrill and Rathbun, Proc. U. S. Nat. Mus., vol. 2, p. 231.  
1889. *Amaroccium pellucidum* McDonald, Rep. U. S. Comm. Fish and Fisheries for 1886, p. 858.  
1891. *Amaroucium pellucidum* Herdman, Journ. Linn. Soc. London, Zool., vol. 23, p. 628 (listed under heading "unrecognizable Polyclinidae").  
1900. *Amaroccium pellucidum* Metcalf, Zool. Jahrbücher, Anat., vol. 13, p. 526.  
1909. *Amaroucium pellucidum* Hartmeyer, Bronn's Tier-reich, vol. 3, suppl., pp. 1477, 1481 (listed as uncertain species).

The two most striking characters which serve to distinguish this from the other New England members of the genus are the subdivision of the colony into small lobules and the dense and even coating of sand with which the whole or nearly the whole external surface is generally covered. *Aplidium pallidum* is occasionally conspicuously incrustated with sand, but rarely to such an extent as is usual and normal in the present form, where the sand covers the surface so thickly that the true character of the test is entirely obscured. Where the coating of sand is abraded or wanting, the test is seen to be translucent and gelatinous. In such cases, there is a tendency of the lobules to be more or less fused or united, and the specimen then approaches the form *constellatum* (described below) in its characters. In colonies which are thickly incrustated with sand, the sand grains are often present in great abundance in the deeper portions of the test as well as on the surface, making the test hard and easily broken.

The large rounded masses in which this form is often found exceed in bulk the colonies of the other New England species of the genus. They often reach 160 to 200 mm. in diameter and 70 or 90 mm. in height, being sometimes almost perfectly hemispherical. These large masses are subdivided into or built up of elongated lobules, which arise from the common base of the colony as narrow stalks and increase gradually in diameter as the upper part of the colony is approached, their truncated upper extremities forming the free convex surface of the colony. So closely do these lobules fit together that the clefts between them, although they extend nearly to the base of the colony and are lined with the coating of sand mentioned above, show but slightly unless they are opened out and the lobules separated by

rough handling. Each lobule generally contains a single circular or oval system of zooids with a cloacal orifice in the center, and at the upper and larger end is 5 mm. to 10 mm. or more in diameter, the length depending on the height of the colony. In regularly hemispherical specimens the lobules are often very regular in size and form. In general, those near the edges of the colony are more completely divided off, and tend to diverge from the central mass and from each other, while the central lobules, especially where the coating of sand is more or less imperfect, tend to fuse. The color of the colony depends chiefly on that of the sand with which it is incrustated. The zooids have the stomach of a bright orange or red color, but the remainder of the body is not conspicuously colored.

The zooids do not differ from those of the form *constellatum* (see p. 408), except that they are usually decidedly slenderer and often longer (20 mm. to 25 mm.) including the post-abdomen, accommodating themselves to the form of the long narrow lobules. They appear to have as a general rule two or three more rows of stigmata in the branchial sac (about 12 to 14 instead of 9 to 11) than those of the *constellatum* form.

According to Professor Verrill, this form is found from North Carolina to Vineyard Sound. There are specimens in the collection from Station 775 (near Dutch Island, Narragansett Bay, R. I., 8 fathoms, sand and shells) and from Stonington, Conn. Leidy's type was from Point Judith, R. I., where he found it abundant. This is exclusively a shallow-water form.

It is, however, in Vineyard Sound, in from 6 to 12 fathoms, that it is found in the greatest abundance, and in the largest and most characteristic colonies. The wide extent of sandy bottom which is kept more or less stirred up by the strong tidal currents makes the locality an ideal one for the development of this animal. Over large areas the bottom is so thickly covered with the colonies that the dredge will often come up solidly filled with them.

***Amaroucium pellucidum* form *constellatum* (Verrill).**

Text-fig. 23; Pl. 36, figs. 4, 5; Pl. 38, fig. 9.

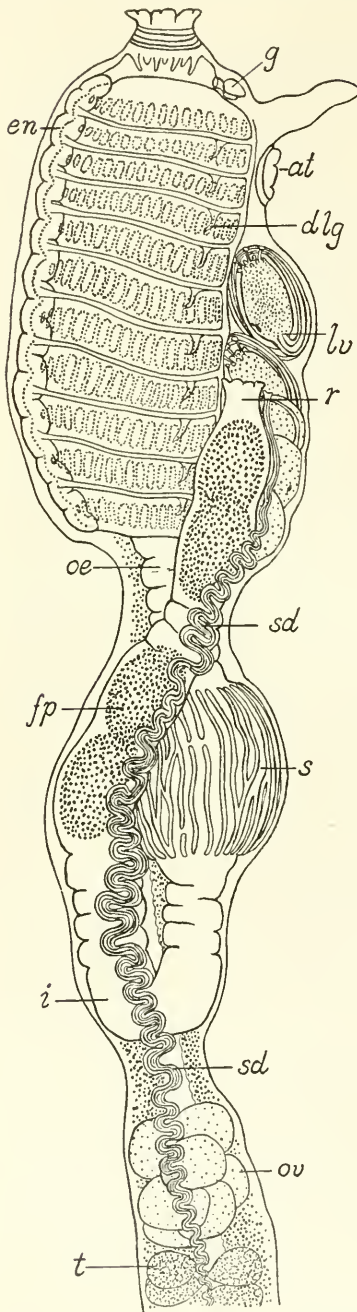
1871. *Amouroucium constellatum* Verrill, Amer. Journ. Sci., ser. 3, vol. 2, p. 359.  
 1872. *Amouroucium constellatum* Verrill, Amer. Journ. Sci., ser. 3, vol. 3, p. 211.

1873. *Amaroccium constellatum* Verrill and Smith, Report on Invertebrate Animals of Vineyard Sound, pp. 704, 388, 393, 403 (411, 424).
1879. *Amaroccium constellatum* Verrill and Rathbun, Proc. U. S. Nat. Mus., vol. 2, p. 231.
1879. *Amaroccium constellatum* Verrill, Preliminary Check-list of Marine Invertebrates, p. 27.
1889. *Amaroccium constellatum* McDonald, Rep. U. S. Comm. Fish and Fisheries for 1886, p. 858.
1891. *Amaroccium constellatum* Herdman, Journ. Linn. Soc. London, Zool., vol. 23, p. 628 (listed under heading "unrecognizable Polyclinidae").
1898. *Amaroccium constellatum* Davenport, Science, new ser., vol. 8, p. 687.
1900. *Amaroccium constellatum* Metcalf, Zool. Jahrbücher, Anat., vol. 13, p. 525, pl. 37, fig. 47 (ganglion, neural gland, etc.).
1909. *Amaroccium constellatum* Hartmeyer, Bronn's Tier-reich, vol. 3, suppl., p. 1466.

In this form, the colony is usually turbinate, tapering to a somewhat narrowed base by which it is attached. The upper surface may be nearly flat and the edges abrupt; in other specimens the upper surface is moderately convex and the edges rounded. Such colonies usually measure from 10 to 25 mm. in height and the same or rather more in width near the summit, the base being more or less contracted (Pl. 38, fig. 9). These dimensions may be considerably exceeded, but more frequently when larger colonies occur, they are made up of several such turbinate masses, united at their bases but separated above by clefts of greater or less depth. Rarely such divisions are wanting, and the colony may form a large hemispherical or somewhat flattened mass (Pl. 36, figs. 4, 5) attached by a broad base and may reach 80 mm. in transverse diameter and 30 to 50 mm. in height.

The surface of the colony is smooth and its texture gelatinous and only moderately firm. Preserved in formaldehyde it becomes quite soft. The test is rather opaque, but the deep color of the zooids renders them conspicuous in spite of this. In life, the color of the test varies from a cream color through various shades of yellow (or more frequently flesh color) to a pale orange or reddish. The branchial orifices often have six radiating white lines.

"Anal orifices often surrounded by a pale or whitish border; zooids generally orange-yellow; the orifices and tubes with upper part of the mantle bright orange, or lemon-yellow; branchial sac usually flesh-color or pale yellow, sometimes bright orange; stomach with bright orange-red longitudinal glandular ribs; intestine light orange; man-



Text-fig. 23. — *Amaroucium pellucidum* (Leidy) form *constellatum* (Verrill). Zooid.  $\times 34$ .

tle with minute opaque white specks. In some specimens the cloacal chamber or 'atrium' contained three or four bright purple tadpole-shaped larvae" (Verrill and Smith, 1873).

The zooids are generally arranged in rather irregular and extensive systems, though small circular or oval groups also occur. The limits of the systems are often difficult to make out. The zooid here figured (text-fig. 23) measured about 4 mm. in length without the post-abdomen, and may be considered as of average size. The post-abdomen may be 10 mm. or more long when the reproductive organs are well developed, but its length and thickness are not specific characters on which any reliance can be placed.

The mantle contains distinct transverse muscle bands on the thorax underlying the more conspicuous longitudinal ones. The latter are not placed very close together, and as usual are most conspicuous on the thorax, gradually disappearing on the post-abdomen. Large rounded dark colored cells occur in the mantle; in some individuals in abundance, in others in only small numbers. The branchial orifice has six short lobes, each of which may be slightly cleft (see text-fig. 23); the atrial orifice has

five slight lobes besides the long simple languet. The ganglion is elliptical and the rounded dorsal tubercle is situated close to it.

The oral tentacles appear to number about 12, of two sizes placed alternately. The endostyle is probably nearly straight when the branchial sac is fully expanded, but in preserved specimens it is almost always more or less sinuous. There are usually 10 or 11 rows of stigmata, though in some colonies only 9, with from 16 to 18 in a row on each side. The three or four stigmata nearest the endostyle are successively smaller as that organ is approached. The transverse vessels are strongly muscular, but the median dorsal vessel is slender and inconspicuous. It does not bear the dorsal languets, these being placed on the transverse vessels of the left side about opposite the fourth or fifth stigma from the dorsal end of the row. The languets are directed posteriorly. There are none on the transverse vessels of the right side.

The wall of the stomach is thick and has usually about 30 or 40 (in a few colonies only 15 to 20) sharply defined narrow longitudinal ridges, which in some individuals are very regular and extend the whole length of the stomach. In other individuals, some of the ridges branch and anastomose, or terminate before the end of the stomach is reached. Sometimes the branching occurs to such an extent as to form a network of ridges over a part of the stomach wall. The writer has not observed this over the whole surface of the stomach; in all cases, on some parts of it the regular longitudinal arrangement of the ridges is preserved. The intestinal loop, as usual in this group, is commonly twisted through a half turn, bringing the stomach to the dorsal side. Often, however, the twisting amounts to only a quarter turn, or even less.

The ovaries are situated in the anterior part of the post-abdomen; the testes, however, extend through the greater part of the length of the post-abdomen. The epicardium is often visible as a tube of large diameter, which extends along in the right side of the abdomen and post-abdomen nearly to the posterior end of the latter. The sperm duct, a very tortuous thick-walled tube of varying diameter, extends along in the left side of the post-abdomen and abdomen, and running beside the rectum, ends near the anus, and the heart, as usual in this family, is situated at the extreme posterior end of the post-abdomen. The eggs develop into tailed larvae in the atrial cavity of the parent. Sometimes as many as a dozen embryos and larvae of different sizes and stages may be seen in the atrial and peribranchial cavity of a zooid.

Though also confined to shallow water, this form is not (as the typical *pellucidum* appears to be) limited in its northward distribution by Cape Cod. The collections contain colonies which, if correctly labeled, are from the Isles of Shoals, N. H., and others from a tide-pool on Ten Pound Island, near Gloucester, Mass. At Barnstable, Mass., in Cape Cod Bay, Professor Verrill found it abundant. It is very abundant in summer at Wood's Hole, Mass., and also at Vineyard Haven, Mass., on the piles of wharves, though colonies growing in such situations do not as a rule attain as large a size as those growing on the bottom. In Vineyard Sound, it is found in from 4 to 12 fathoms and is common on rocky bottoms, forming large and massive colonies sometimes of nearly hemispherical form, as already described. There is also a small colony from Station 2576 (off southern Massachusetts, N. lat.  $41^{\circ} 15' 30''$ , W. long.  $68^{\circ} 16'$ , 18 fathoms, coarse white sand, September 4, 1885); and there are good-sized colonies from Buzzard's Bay, Mass.; Noank, Conn.; off Stonington, Conn., 4 to 5 fathoms; Peconic Bay, Long Island; and others labeled "Long Island Sound." Davenport (1898) records it from Cold Spring Harbor, L. I.

As far as the writer is aware, it has not been recorded from points farther south. It is perfectly distinct from the two species of *Amaroucium* found at Bermuda, though the structure of the zooids shows it to be a near ally of one of them (*A. exile* Van Name). This Bermuda species, however, forms only very small button-shaped colonies, and has a much more transparent test, smaller zooids with more rows of stigmata, and generally fewer (though sometimes over 20) ridges on the stomach wall than the New England species.

***Amaroucium glabrum* Verrill.**

Text-fig. 24; Pl. 35, fig. 2.

1871. *Amouroucium glabrum* Verrill, Amer. Journ. Sci., ser. 3, vol. 1, p. 288, fig. 20-22.  
 1872. *Amouroucium glabrum* Verrill, Amer. Journ. Sci., ser. 3, vol. 3, p. 211.  
 1874. *Amaroccium glabrum* Verrill, Amer. Journ. Sci., ser. 3, vol. 7, pp. 39, 40, 43, 132, 133, 413, 504.  
 1874. *Amaroccium glabrum* Verrill, Proc. Amer. Assoc. Adv. Sci., vol. 22, 1873, pp. 352, 355.  
 1874. *Amaroccium glabrum* Verrill, 6th Ann. Rept. Peabody Acad. Sci., Salem, pp. 59, 60.  
 1875. *Amaroccium glabrum* Verrill, Amer. Journ. Sci., ser. 3, vol. 10, p. 41.

1879. *Amaroccium glabrum* Verrill, Preliminary Check-list of Marine Invertebrates, p. 27.
1891. *Amaroccium glabrum* Herdman, Journ. Linn. Soc. London, Zool., vol. 23, p. 628 (listed under heading "unrecognizable Polyelimidæ").
1901. *Amaroccium glabrum* Kingsley, Proc. Portland Soc. Nat. Hist., vol. 2, pt. 5, p. 183.
1901. *Amaroccium glabrum* Whiteaves, Catalogue of Marine Invertebrata, p. 266.
1909. *Amaroccium glabrum* Hartmeyer, Bronn's Tier-reich, vol. 3, suppl., p. 1477 (listed as uncertain species).

The synonymy of *A. translucidum* Ritter, 1901, which as stated below (p. 415) is closely allied to, if really distinct from this species, is as follows:

1892. *Circinalium pachydermatinum* (part.) Jacobsohn, Trav. Soc. Nat. St. Pétersbourg, vol. 23, pt. 2, pp. 158, 159.
1901. *Amaroccium translucidum* Ritter, Proc. Washington Acad. Sci., vol. 3, p. 249, pl. 30, figs. 29, 30.
1903. *Amaroccium translucidum* Hartmeyer, in Römer and Schaudinn, Fauna Arctica, vol. 3, p. 326, fig. 40-42, pl. 6, figs. 8, 9; pl. 13, fig. 10-12.
1906. *Amaroccium translucidum* Redikorzew, in Derjugin, Die murmansche biologische Station, Trav. Soc. Nat. St. Pétersbourg, vol. 37, p. 155.
1906. *Amaroccium translucidum* Redikorzew, Trav. Soc. Nat. St. Pétersbourg, vol. 37, pp. 309, 310, 366.
1907. *Amaroccium translucidum* Redikorzew, Ann. Mus. Zool. Acad. Imp. Sci. St. Pétersbourg, vol. 11, pp. 149, 151, 153, 154.
1907. *Amaroccium translucidum* Redikorzew, Zool. Anzeiger, vol. 31, p. 522.
1908. *Amaroccium translucidum* Redikorzew, Trav. Soc. Nat. St. Pétersbourg, vol. 39, pp. 20, 23.
1908. *Amaroccium translucidum* Redikorzew, Mém. Acad. Imp. Sci. St. Pétersbourg, ser. 8, cl. phys.-math., vol. 18, no. 11, p. 46.
1909. *Amaroccium translucidum* Hartmeyer, Bronn's Tierreich, vol. 3, suppl., p. 1467.

Ordinarily, colonies of *Amaroccium glabrum* form rounded or more or less flat-topped heads, 10 to 20 mm. in height, usually with rather abrupt sides which contract to a narrow base or short peduncle. A colony may consist of but one or several such heads, which, when small, generally consist of a single system containing rather few irregularly placed zooids surrounding a single cloacal aperture. Larger and broader heads may contain several systems, though in preserved specimens their number and limits are rarely discernible. The amount of common test substance as compared with the bulk and number of the zooids is generally large, so that the zooids are commonly well

separated from each other and from the margin of the colony. The tendency to irregularity and individual variation in the shape of the colony is considerable, but nearly all the shapes are readily recognized as modifications of the capitate form above described.

In localities particularly favorable for its growth this species may develop into turbinate masses or lobes similar in size and appearance to those of the *constellatum* form of *A. pellucidum*, and as in that species these lobes may be aggregated or even completely fused into a hemispherical or flattened mass sometimes 80 mm. in diameter attached by a more or less narrowed base.

In spite of the occasional resemblance in external form between this species and *constellatum*, there are very evident differences in the character of the test substance and size and details of the zooids. In this species, the test is firmer and more transparent, in fresh specimens of a pale translucent bluish white color, allowing the zooids to be distinctly seen. In alcoholic specimens it loses more or less of this transparency, becoming of a yellowish white color or some shade of gray or brownish gray, and varies in consistency from rather firm to decidedly tough and fibrous. The upper part of the colony has usually a smooth glabrous surface comparatively or completely free from adhering or imbedded sand grains or other foreign bodies. The basal parts of the colony are generally firmer and more opaque, and may contain much sand and other foreign matter. In some specimens the majority of the zooids will be found with their long axis perpendicular to the upper surface or parallel to the main axis of the colony; in others they lie in all sorts of positions and directions. In life "the branchiae are light yellow; the stomach dark orange, ovaries yellowish white, the eggs containing embryos bright orange yellow" (Verrill, 1871a, p. 289).

The zooids are small; a length of from 4 to 5 mm. when the post-abdomen is shorter than the thorax and abdomen together, or of from 7 to 8 mm. when the post-abdomen is long, is usually not exceeded in the alcoholic specimens, and in many colonies their average size is smaller. Although a large number of specimens was examined, the zooids were always found in a violent state of contraction. The branchial orifice is six-lobed; the atrial orifice may or may not be noticeably lobed, and is provided with a well developed languet, which, as noted also by Ritter and Hartmeyer in *A. translucidum*, often has a pair of lateral lappets or processes near its base. In some colonies

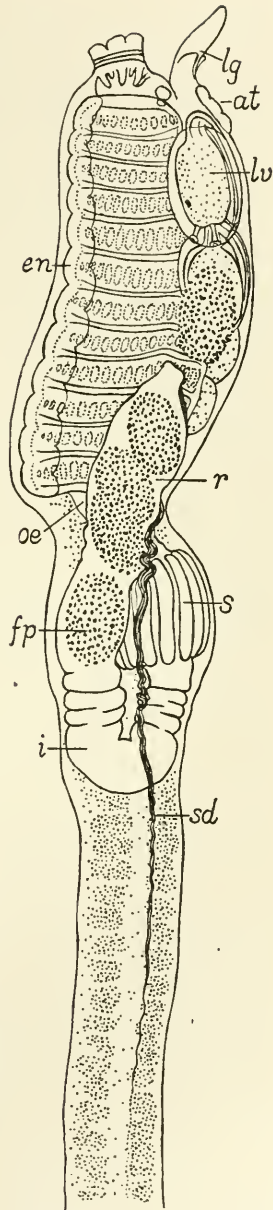
these are nearly as long as the main portion of the languet, in others they are very rudimentary or entirely wanting.

The oral tentacles are distinguished with difficulty, owing to the contracted state of all the specimens, but there appear to be about 12 in all, of two sizes arranged alternately. There are about 11 or 12 rows of stigmata with apparently a maximum of about 18 in a row on each side in the few specimens that were in a condition to show these structures. Dorsal languets are probably present, but were not distinguishable. The transverse vessels are muscular.

The intestinal loop is twisted, bringing the stomach to the dorsal side, the intestine crossing the esophagus to the left of the latter. The stomach has as a rule a rather small number, 12 or 15, of deep longitudinal folds, but in some colonies the number averages higher, about 18 or 20 or even more. Irregularities in the folds sometimes occur, but more often they are quite regular and uniform in width, and extend the full length of the stomach. In respect to the reproductive organs, it resembles the last-described species.

This species is found from the Banks of Newfoundland and the Gulf of St. Lawrence to southern Massachusetts and Rhode Island. It seems to prefer a rocky or gravelly bottom.

To consider its distribution more in detail, it is recorded by Verrill (1872) from Murray Bay in the lower St. Lawrence, and by Whiteaves (1901) from Bonaventure Island, 50 fathoms, Orphan Bank, and Gaspé Bay. It is



Text - fig. 24. — *Amaroucium glabrum* Verrill. Zooid.  $\times 34$ .

abundant along the coast of Nova Scotia and in the Bay of Fundy, where according to Professor Verrill it is found from low water to 80 fathoms. It is also common along the coast of northern New England, and also at considerable distances from the shore where the water is not too deep. In the more southern parts of its range it occurs chiefly in water from 5 to 45 fathoms or more in depth. There are numerous specimens from the vicinity of Cape Ann and of the northern end of Cape Cod. Farther south it becomes more local in its distribution, but there are localities off Chatham, Mass., at the southeastern angle of Cape Cod, where it was found in great abundance and sometimes in large and flourishing colonies. These are: Stations 965 to 979 (a few miles S. E. of Chatham Lights, 15 to 18 fathoms, sand, gravel, and stones, August 30, 1881). Other localities in the same region but farther offshore are: Station 371 (16 miles off Chatham, N. lat.  $41^{\circ} 35.5'$ , W. long.  $69^{\circ} 35'$ , 34.5 fathoms, coarse speckled sand, September 19, 1879); and Station 984 (off Chatham, N. lat.  $41^{\circ} 31'$ , W. long.  $69^{\circ} 28'$ , 33 fathoms, mud and sand, August 30, 1881), and farther to the southeast, Station 2081 (N. lat.  $41^{\circ} 10' 20''$ , W. long.  $66^{\circ} 30' 20''$ , 50 fathoms, sand, September 4, 1883) and Station 2082 (N. lat.  $41^{\circ} 09' 50''$ , W. long.  $66^{\circ} 31' 50''$ , coarse yellow sand, September 4, 1883).

It occurs sparingly in Nantucket and Vineyard Sounds. There are specimens from Station 629 (Nantucket Sound, 5.5 fathoms, sand, July 21, 1875) and Station 1203 (Menemsha Bight, Martha's Vineyard, 8 fathoms, hard sand, August 7, 1887). Still farther south and west, it is more or less rare. There is a small and poor specimen from Station 797 (near Point Judith, R. I., 16.5 fathoms), which is of this species without very much doubt, and the writer feels certain of some from Station 775 (off the north end of Dutch Island, Narragansett Bay, 12 fathoms, gravel, sand, and mud, August 6, 1880), and Station 778 (near Fort Dumpling, Narragansett Bay, 26 fathoms, gravel, sand, and broken shells, August 7, 1880). There is also a jar containing numerous small and badly shrunken colonies, evidently in a degenerated and not actively growing condition when collected, from U. S. F. C. Stations 762 to 767 (off Southwest Ledge, near Martha's Vineyard, Mass., Gay Head N. E. about 11 miles, 16.5 to 18 fathoms, gravel and sand, September 20, 1875). With the last-mentioned colonies are specimens of *Tetradidemnum albidum* (Verrill), a species commonly found in company with *A. glabrum* on the coasts of northern New

England. The presence of this northern *Tetradidemnum*, readily and positively identified even in poor preservation by its characteristic spicules, certainly tends to confirm the opinion that the *Amaroucium* colonies found growing with it are really *A. glabrum*. Verrill (1875) reports *A. glabrum* also from off Block Island, R. I.

The greatest depth from which any of the specimens that the writer has examined, came is Station 2699 (off Newfoundland, N. lat. 45° 04', W. long. 55° 23', 72 fathoms, August 22, 1886).

Ritter (1901) has described a species (*A. translucidum*) evidently very closely allied to the present one from numerous specimens collected on reefs at low tide in Prince William Sound, Alaska. In some respects his specimens differ from *A. glabrum* as it is ordinarily found on the Atlantic coast, notably in the light red color suffusing the test and zooids, the very regular inversely conical colonies, the larger and more crowded zooids, the very transparent test, and the usually larger number of folds in the stomach wall, which folds, judging from his statements, are more subject to irregularity in arrangement than in the New England form. Though his specimens were all from one locality, thus increasing the probability that the above discrepancies may be only manifestations of individual variation or the effect of some particular environment, yet the writer would be disposed to regard Ritter's form as an allied but distinct species were it not that Hartmeyer (1903) and Redikorzew (1906, 1907a, b, 1908b) have identified with Ritter's species, specimens from Spitzbergen and Bear Island, the Murman coast, the White Sea, and Siberian waters, with characters apparently completely bridging over the differences between the Alaskan and New England forms, and indicating that we probably have to deal with a single species of circumpolar distribution, which, however, may be somewhat differentiated into geographical races in the Atlantic and Pacific regions. Should this view be accepted, *glabrum* would be the specific name, while *translucidum* might be employed as a trinomial to designate the Alaskan race or subspecies. The European specimens should, as far as can be judged from the descriptions and figures, be regarded as of the typical *glabrum* form rather than of the *translucidum* form.

**Amaroucium stellatum** Verrill.

Text-fig. 25; Pl. 34, fig. 1.

1871. *Amouroucium stellatum* Verrill, Amer. Journ. Sci., ser. 3, vol. 1, p. 291.  
 1871. *Amouroucium stellatum* Verrill, Amer. Journ. Sci., ser. 3, vol. 2, p. 359.  
 1872. *Amouroucium stellatum* Verrill, Amer. Journ. Sci., ser. 3, vol. 3, p. 211.  
 1873. *Amaroccium stellatum* Verrill and Smith, Report on Invertebrate Animals of Vineyard Sound, pp. 402 (411), 419 (424), 704.  
 1878. ? *Amaroccium stellatum* Coues and Yarrow, Proc. Acad. Nat. Sci. Philadelphia, p. 304.  
 1879. *Amaroccium stellatum* Verrill and Rathbun, Proc. U. S. Nat. Mus., vol. 2, p. 231.  
 1889. *Amaroccium stellatum* McDonald, Rep. U. S. Comm. Fish and Fisheries for 1886, p. 858.  
 1891. *Amaroucium stellatum* Herdman, Journ. Linn. Soc. London, Zool., vol. 23, p. 628 (listed under heading "unrecognizable Polyclimidae").  
 1900. *Amaroccium stellatum* Metcalf, Zool. Jahrbücher, Anat., vol. 13, p. 526.  
 1909. *Amaroucium stellatum* Hartmeyer, Bronn's Tier-reich, vol. 3, suppl., p. 1477 (listed as uncertain species).

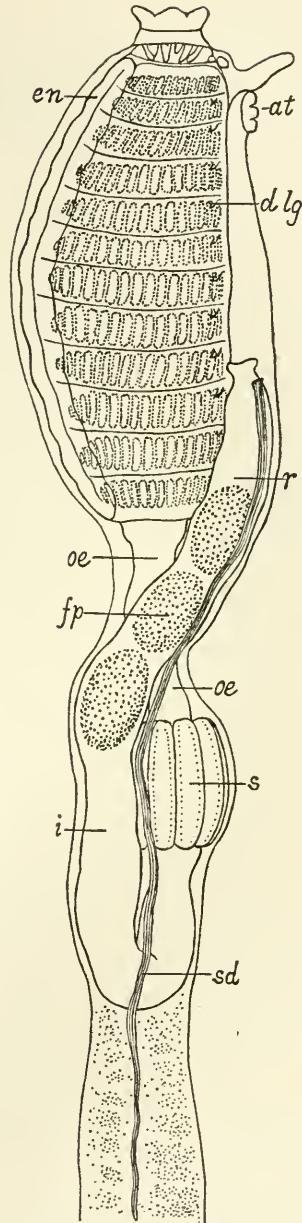
In this species the zooids closely resemble those of *A. glabrum*, but the character of the colony is very different.

"It forms large, smooth, irregular plates, or crest-like lobes and masses, which are attached by one edge to the stones and gravel. These plates are sometimes one to two feet long, six inches high, and about an inch thick, and, owing to their smooth surface and whitish color, look something like great slices of salt-pork, and in fact it is often called 'sea pork' by the fishermen. Other specimens will be four or five inches high, and only one or two inches broad at the base, and perhaps half an inch in thickness, and the summit often divides into broad flat, blunt lobes; various other shapes also occur, some of them very irregular. The larger specimens of this species are generally of a pale bluish or sea-green color by reflected light when first taken from the water, but pale salmon or flesh-color by transmitted light. The zooids are much elongated and arranged in more or less regular circular groups over the whole surface, with a small cloacal orifice in the center of each circle. If kept in water, when they grow sickly the zooids will be forced partially or wholly out of their cavities by the contraction of the tissues around them — a peculiarity seen also in other species of this genus. These zooids have the branchial tube prominently six-lobed, and of a bright orange color, this color also extending over the upper

or outer end of the body, between the tubes, and more or less over the branchial sac, which is pale yellow or whitish below. The stomach is longitudinally sulcated, with bright orange-red ribs or glands; intestine bright orange or yellow.

"This species is devoured by sharks, skates, and the tautog, although it would seem difficult for them to digest it, or get much nutriment from it. The supply is certainly sufficiently abundant" (Verrill and Smith, 1873, p. 402).

Though sometimes found attached to large stones, the colonies are more often anchored by a mass of small stones, shells, or gravel, some of which become completely imbedded in the lower part of the colony. Rarely the base of the colony is simply buried in the sand. As already stated, the zooids are grouped in small circular or oval systems. These groups are separated from each other by a considerable amount of test substance. In preserved specimens, the areas occupied by these systems become depressed below the surrounding surface, for the zooids shrink more than the rather tough and resistant test in the intervening spaces. In fresh examples, however, the surface is quite smooth. The longest, though perhaps not the most bulky colony in the collections is 580 mm. long in the preserved and somewhat shrunken condition, although not over 30 mm. wide at any point, but such long and narrow colonies are exceptional.



Text-fig. 25.—*Amaroucium stellatum* Verrill. Zooid.  $\times 34$ .

The zooids are rather small, the example figured measuring less than 4 mm. without the post-abdomen, though as can be seen in the figure, it was expanded to an extent unusual in preserved specimens. The post-abdomen often exceeds the rest of the body in length. The muscle bands in the mantle are mostly longitudinal and are narrow and quite numerous.

The branchial orifice is six-lobed; the atrial orifice is usually more conspicuously lobed than in *A. glabrum* and has a rather short simple languet. There are about a dozen tentacles in all, of two sizes placed alternately. The branchial sac has about 12 rows of stigmata with a maximum number of about 17 or 18 in a row on each side. Near the endostyle the stigmata become successively shorter, but maintain their full length at the dorsal end of the row. The stigmata begin quite near the endostyle and extend to the median dorsal vessel, which is slenderer and inconspicuous, though the transverse vessels are muscular. The dorsal languets are very short, stout, somewhat curved, and directed posteriorly. They arise from the transverse vessels of the left side about opposite the second stigma from the median dorsal vessel.

The wall of the stomach has about a dozen deep and regular longitudinal folds. There appears to be nothing unusual in the structure of the reproductive organs.

All the specimens unquestionably of this species in the collection are from Vineyard Sound, Mass., and vicinity, which is also the only place where the writer has collected it. The most favorable situation for its growth is where there is a stony or gravelly bottom and a strong current. Such places exist at many points in Vineyard Sound and especially in the channel at Wood's Hole, where, in summer at least, the bottom is literally covered with the plate-like masses or colonies over large areas, and in dredging the dredge often becomes completely filled with them. Though it is a shallow-water species, the writer has never found it near low-water mark, but always in water at least a couple of fathoms in depth. Coues and Yarrow (1878) report its occurrence on the North Carolina coast as follows:

"Very abundant on rocks and stones near Beaufort, and on the piles of the wharf at Fort Macon. This species attains a large size and the rapidity of its growth is surprising; new clean piles used to repair a wharf were in less than four months well covered with large clusters of this ascidian." The writer has not found it growing on piles on the New England coast, and does not feel certain that their specimens

were correctly identified with this species. A number of Dr. Yarrow's original specimens are in the Yale Museum, and though they are in a very poor state of preservation, it is safe to say that most of them are not *A. stellatum*. There is one colony which may be of this species, but its condition is too poor to be certain of it.

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*Printed September, 1910.*

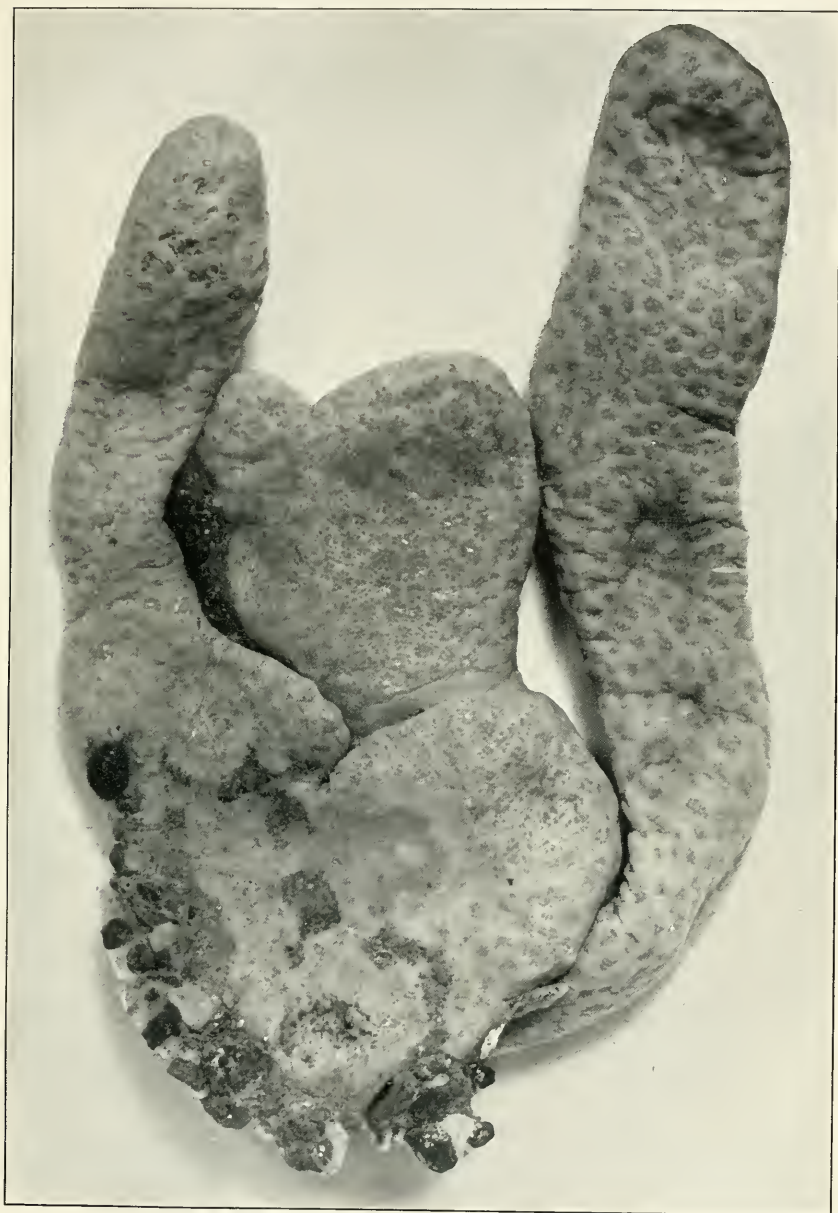


EXPLANATION OF PLATES.

The photographs were taken from alcoholic specimens except where otherwise mentioned.

PLATE 34.

Fig. 1. *Amaroucium stellatum* Verrill. Colony from Wood's Hole, Mass., Slightly less than natural size.



1



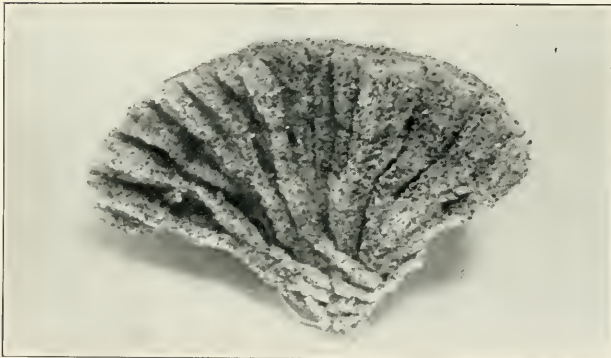


PLATE 35.

- Fig. 2. Mussel shell bearing colonies of *Amaroucium glabrum* Verrill and *Tetradidemnum albidum* (Verrill). From Station 2577 (off Massachusetts, N. lat.  $41^{\circ} 17'$ , W. long.  $68^{\circ} 21'$ , 32 fathoms). Natural size.
- Fig. 3. *Amaroucium pellucidum* (Leidy). Piece of a colony from Vineyard Sound, Mass., seen from one side, to show the form of the lobules. Natural size.



2



3





PLATE 36.

- Fig. 4. *Amaroucium pellucidum* form *constellatum* (Verrill). Colony from Peconic Bay, Long Island, New York, seen from one side. Natural size.
- Fig. 5. *Amaroucium pellucidum* form *constellatum* (Verrill). Another colony from Peconic Bay, Long Island, New York, seen from above. Natural size.



4



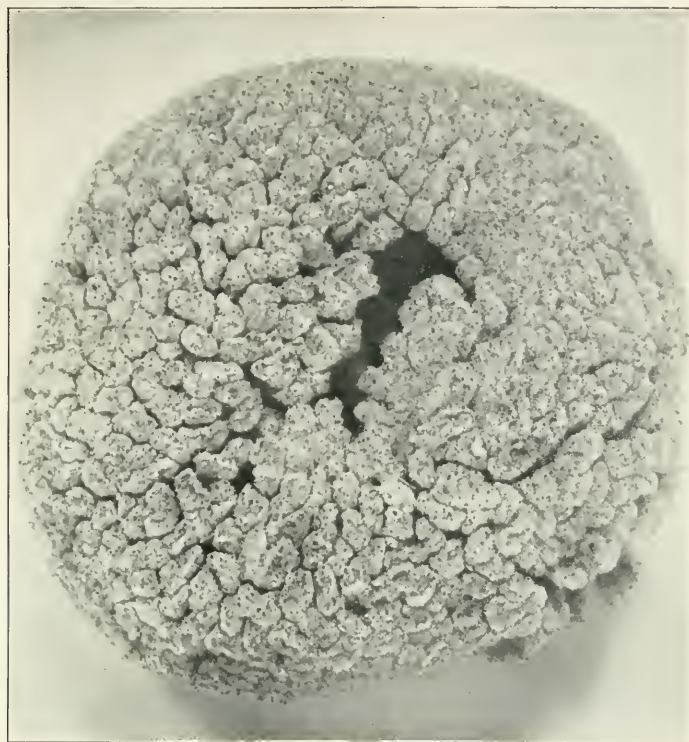
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PLATE 37.

- Fig. 6. *Amaroucium pellucidum* (Leidy). Colony from Vineyard Sound, Mass., seen from above. Natural size.
- Fig. 7. *Didemnum lutarium* n. sp. Colony from Wood's Hole, Mass. Natural size.



6



7





PLATE 38.

- Fig. 8. *Macroclinum pomum* (Sars). Colony from the Banks of Newfoundland. Natural size.
- Fig. 9. *Amaroucium pellucidum* form *constellatum* (Verrill). Colony from the piles of a wharf at Vineyard Haven, Mass. The specimen is partly overgrown with a colony of *Perophora viridis* Verrill. Preserved in formaldehyde. Natural size.



8



9





PLATE 39.

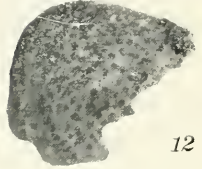
- Fig. 10. *Botryllus schlosseri* (Pallas). Colony from Wood's Hole, Mass.  
Natural size.
- Figs. 11, 12. *Lissoclinum aureum* Verrill. Two colonies containing numerous spicules in the test substance. From Eastport, Maine.  $\times 2.5$ .
- Fig. 13. *Tetradidemnum albidum* (Verrill). Small colony from Eastport, Maine.  $\times 2.5$ .
- Fig. 14. *Leptoclinides fueröensis* Bjerkan. Colony from off Newfoundland. Natural size.
- Fig. 15. *Dilemnopsis tenerum* (Verrill). Colony from the Bay of Fundy.  $\times 2.5$ .
- Figs. 16, 17. *Lissoclinum aureum* Verrill. Two colonies (one of them broken) containing very few spicules in the test substance. From the Bay of Fundy.  $\times 2.5$ .



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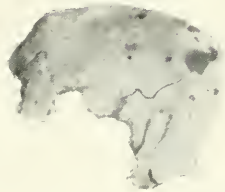
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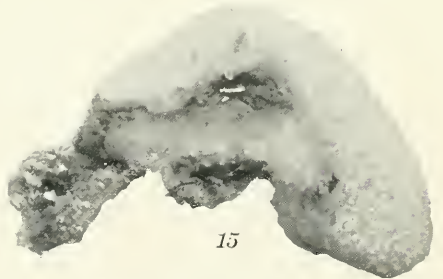
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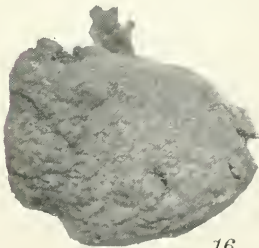
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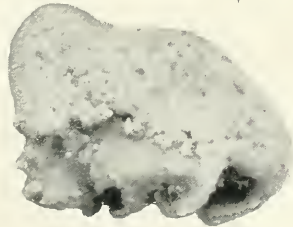
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425,

# No. 12.—THE SUTTON JURASSIC OF THE VANCOUVER GROUP, VANCOUVER ISLAND.<sup>1</sup>

BY C. H. CLAPP AND H. W. SHIMER.

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## INTRODUCTION.

THE fossils described here were collected by C. H. Clapp in the summers of 1908 and 1909, while making a reconnaissance geological survey of southern Vancouver Island for the Geological Survey of Canada.

The beds in which the fossils occur have been named the Sutton formation from Sutton Creek which empties into the Cowichan Lake, on the southern shore of which the fossils were found. The Sutton formation is a member of the Vancouver Group as defined by George M. Dawson.<sup>2</sup>

The fossils as determined by both authors prove to be a unique fauna. It has few or no affinities, so far as known, in North America, but is more closely related to the Rhaetic of central Europe, the Jurassic of western and central Europe, and Cutch Jurassic of India.

## LOCATION AND OCCURRENCE.

The fossils described below were found on the shore of Cowichan Lake, Vancouver Island. Cowichan Lake is one of the larger lakes of Vancouver Island situated in the center of the southern part, about sixty miles northwest of Victoria. The fossil-bearing beds occur on the south shore of the lake, about eight miles from the eastern end. They are almost directly south of Cottonwood Creek,

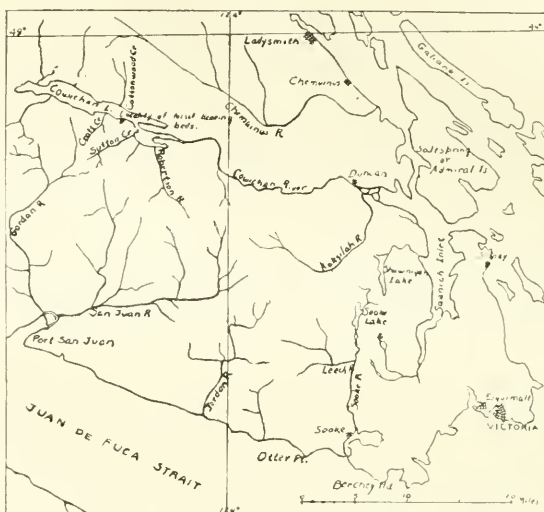
<sup>1</sup> Published by permission of the Director of the Geological Survey of Canada.

<sup>2</sup> G. M. Dawson. Report on a Geological Examination of the Northern Part of Vancouver Island and Adjacent Coasts. Ann. Rep. Geol. Surv. Canada, 1886, p. 10 B.

and between Croft Creek, two miles to the west, and Sutton<sup>1</sup> Creek, three miles to the east.

The formation has been named the Sutton formation after Sutton Creek. No fossils have been found on Sutton Creek, but similar limestones to those which contain the fossils occur both to the northwest and southeast of the creek so that it is probable that the formation crosses it.

The fossil-bearing beds form one of the so called "lenses" of limestone which occur intercalated with the very thick lavas, principally



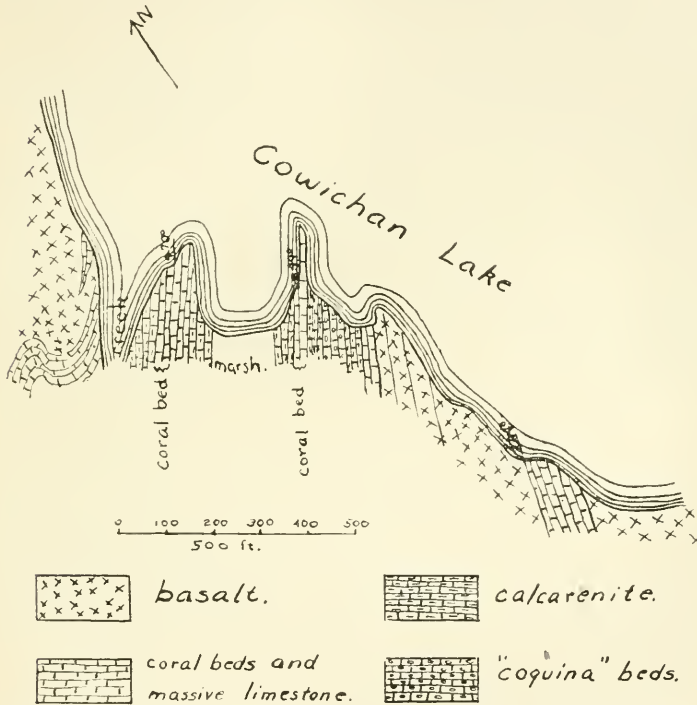
Text-fig. 1.— Sketch map showing occurrence of fossil-bearing limestone beds intercalated with basalt.

basaltic, which make up the bulk of the Vancouver group. The lens in which the fossils were found is about 500 feet across the outcrop. The strike of the beds is about N. 35° E. and the dip from 50° to 70° to the northwest. The thickness is therefore about 400 feet. The general strike of the whole Vancouver group, and probably that of the Sutton formation, is about N. 55° W.

The limestones were evidently formed by the accumulation of organic material. Two beds occur which are formed entirely of corals and are doubtless old coral reefs. Between the coral beds are strata composed almost entirely of small fragments of calcareous

organisms, that is, they are typical calcarenites. Interstratified with the calcarenites are layers, one very thick, composed chiefly of pelecypod shells, which form a veritable coquina.

Although it is probable that in all of the limestone lenses, fossils were originally very abundant, in the great majority of cases at the present time all traces of the original organisms have been destroyed. Even in the known fossil-bearing beds, the limestone has been re-



Text-fig. 2.—Sketch map of southern Vancouver showing location of the fossil-bearing beds of the Sutton formation.

crystallized into a fine-grained to compact marble, and on the fresh fracture only, traces of the very abundant fossils can be detected. As the fossils have not been silicified, or even converted to dolomite, it is only very rarely that they have been weathered out so as to be identifiable. At the locality where the determinable fossils have been collected the beds are covered by the lake during seasons of

high water, and are exposed during seasons of low water. The constant repetition of this process has dissolved out the matrix in which the fossils were embedded, and which was only very slightly more soluble, and has left the fossils in relief. Although many of the fossils are well preserved, the majority are very poorly preserved and cannot be determined with any assurance.

From the nature of the Sutton limestone it is seen that it is of marine origin, and formed largely from the remains of various calcareous organisms, chiefly corals and pelecypods. Such, doubtless, is the origin of the other numerous limestone lenses of the Vancouver group. It is to be presumed, therefore, that the volcanic rocks were largely submarine, and the rarity of tuffs and agglomerates, and of interbeds of terrestrial material adds weight to this conclusion. It is probable that some of the old vents were above sea level since a few conglomerates composed of rounded volcanic fragments and interstratified with tuffs are known. The old vents were probably islands and it was on these volcanic islands, far removed from the mainland to the east, that the organisms which built the coral reefs and coquina beds lived.

## DESCRIPTION OF FOSSILS.

***Isastrea whiteavesi* n. sp.**

Pl. 40, figs. 9, 10.

Corallum encrusting; calices irregularly hexagonal, nearly all compressed; united to one another directly by thick walls or by a coenenchyma across which extend and unite the produced costae of the corallites. In the latter case the corallites are less crowded, as on the sides where the polyps probably got less food. Calices deep; when united their walls are about one millimeter thick.

Septa, 24 in three cycles; there are indications of a fourth cycle. Septal margins apparently granulated. No appearance of a columella.

Diameter of calices 4 to 7 mm., averaging 6 mm.; depth 2 to 3 mm.

That portion of the coral (*i. e.*, the side) where the corallites are embedded in coenenchyma is apparently perfectly continuous with the main mass in which the corallites are crowded to a polygonal cross-section; the coenenchyma becomes less in amount and the corallites more crowded as the upper surface of the coral mass is approached.

Named after Dr. J. F. Whiteaves who alone up to the present has described lower Mesozoic fossils from northern Vancouver Island.

*Comparison.*—It agrees with *I. oblonga* (Fleming)<sup>1</sup> from the Portland series (Upper Jura) of England in diameter of calices, arrangement of septa, apparent absence of columella, and resembles it in general in shape of corallites, thick walls, and strong lateral granulations of septa. It differs in the apparently taller corallites, shallower calices, thicker walls, and less regular hexagonal or pentagonal outline of corallites, some being subcircular in cross-section, thus indicating a more primitive species.

***Isastrea cowichanensis* n. sp.**

Pl. 41, fig. 11.

Corallum encrusting, calices irregularly hexagonal, united to one another by relatively thick walls with evidences of coenenchyma upon the sides as in *I. whiteavesi*. Calices rather deep (1.5 to 2 mm.), diameter about 3 mm.; walls about 0.8 mm. thick.

<sup>1</sup> J. Fleming. British Fossil Corals, 1850, pt. 1, p. 73, pl. 12.

Septa, 24 in three cycles, the third rudimentary. There is a tendency for the first two cycles to be irregularly developed so that the symmetry is apparently quadrameral. Columella rudimentary.

Named from Cowichan Lake, upon the southern shore of which the fossil was found.

*Comparisons.*—This species agrees very closely with *I. parva* Gregory of the Upper Putschum Beds (upper Middle Jurassic) of India<sup>1</sup> in forming encrusting sheets of polygonal, rather deep and small corallites. The number of septa is similar but in our species they are more rudimentary in having the third cycle very poorly developed and with no indications of a fourth cycle. The walls of our species are also thicker.

It also agrees very closely with *I. richardsoni* Edwards and Haime of the Inferior Oolite (lower Middle Jura) of England<sup>2</sup> differing principally in its more rudimentary third cycle of septa, and its thicker walls.

***Isastrea vancouverensis* n. sp.**

Pl. 40, fig. 8; Pl. 42, fig. 17.

Corallum massive; closely crowded corallites irregularly hexagonal or rounded, united directly by their relatively thin walls. Calices exceedingly deep, with average diameter of about 2 mm. In the best preserved corallites the septa reach almost to the center. The septa are very poorly preserved, seldom appearing except as vertical ridges on the inner walls. They are apparently from 20 to 30 in number and there are indications of two cycles. There is a suggestion of the presence of a spongy columella and of tabulae.

Named from the group in which the Sutton formation occurs.

*Comparison.*—In its tall corallites and deep calices it resembles *I. oblonga* (Fleming) from the Portland series (Upper Jura) of England.<sup>3</sup> It differs mainly in its much smaller size (diameter of calyx, 2 as against 4 to 5 mm.) and is less regularly hexagonal or pentagonal, many being semicircular in cross-section, thus indicating a more primitive species.

<sup>1</sup> J. W. Gregory. The Jurassic Fauna of Cutch. The Corals. Mem. Geol. Surv. India, Paleontol. Indica, ser. 9, 1900, vol. 2, pt. 2, p. 129.

<sup>2</sup> Edwards and Haime. A Monograph on British Fossil Corals. Paleontogr. Soc. London, 1850, vol. 1, p. 138, pl. 29, figs. 1, 1a.

<sup>3</sup> J. Fleming. British Fossil Corals, 1850, pt. 1, p. 73, pl. 12.

**Calamophyllia suttonensis** n. sp.

Pl. 40, figs. 5, 7; Pl. 41, fig. 15.

Corallum bushy, consisting of cylindrical tubular corallites which grow nearly parallel to one another but slightly diverging. Corallites at intervals of from 2 to 4 cm. divaricating at an acute angle and usually separated from one another by about a third of their diameter but connected by narrow horizontal processes. Exterior surface marked by longitudinal costae of three sizes, corresponding to the septa and by occasional knobby proliferations from all sides. Epitheca apparently absent.

Septa, 48 arranged in four cycles, produced outward forming the alternating costae; the first two cycles are equally developed. Columella apparently wanting. Dissepiments are present but rarely preserved. Diameter of calyx, 6 mm.

Named from the formation.

*Comparison*.—This species agrees very closely with *C. clathrata* Emmerich from the Rhaetic of central Europe (Juravischen province).<sup>1</sup> It differs, however, in having the first two cycles of septa more strongly developed towards the center of the calyx so that fusion of adjoining septa frequently occurs; in the latter species the septa become much attenuated toward the center, apparently a more primitive condition. The thecal proliferations are apparently also more numerous and better developed in the former.

**Calamophyllia dawsoni** n. sp.

Pl. 40, fig. 1; Pl. 42, fig. 16.

Similar to *C. suttonensis* in number and cycles of costae and presumably of septa (the septa are not sufficiently well preserved to be made out with certainty). The corallites are smaller (3 to 3.5 mm. in diameter), branch more frequently, are more irregularly diverging, and are separated by about their diameter.

Named in honor of Dr. George M. Dawson who first described and defined the Vancouver group of which the Sutton formation is a member.

<sup>1</sup> F. Frech. Die Korallen der juravischen Triasprovinz. Palaeontographica, 1891, vol. 37, p. 15, pl. 4, fig. 1-11.

*Comparison.*—This species somewhat resembles *C. delicatula* Frech from the Rhaetic of central Europe (Juravischen province)<sup>1</sup> in size, angle of branching, and strength of costae. It differs in the much greater distance between the individual corallites and in the stronger and more abundant proliferations.

***Terebratula suttonensis* n. sp.**

Pl. 40, figs. 2, 3.

Elongate biconvex, truncate anteriorly; pedicle valve broadly convex toward the beak, becoming flattened toward the front, forming there a broad sinus in which is a low median ridge with a shallow depression on either side. The outer side of the prominent ridges bordering the median sinus flattened, giving to this portion of the shell a somewhat depressed appearance. Brachial valve regularly convex from beak to front, with a shallow, median depression anteriorly, bounded by rather prominent folds on either side. Laterally from each of these folds is a broad sinus corresponding to the prominent ridges of the pedicle valve. Surface smooth except for low concentric growth lines. Length about three centimeters, breadth about two centimeters. Our single specimen is rather badly crushed.

Named from the formation.

*Comparisons.*—Our species differs from *T. globata* Sowerby from the Inferior Oolite of England<sup>2</sup> in its less globulose form, being narrow in proportion to its length and comparatively less thick. The fold at the anterior end of the brachial valve is broader as is likewise its included sinus. In proportion of length, breadth, and thickness and character of anterior fold and sinus it is more like *T. phillipsi* Morris of the European Middle Jurassic but does not have this species' long straight sides extending from beak more than half-way to the front of the shell. Our species differs from *T. hypsogonia* Kitchin of the lower Upper Jurassic (Upper Charee) fauna of Cutch<sup>3</sup> in having fold and sinus much less strongly developed and in having a much less vertical thickness. The lateral sinuses on the brachial valve are

<sup>1</sup> F. Frech. Die Korallen der juravischen Triasprovinz. Palaeontographica, 1891, vol. 37, p. 19, pl. 3, fig. 1A-C.

<sup>2</sup> T. Davidson. British Fossil Brachiopoda. Palaeontogr. Soc. Monogr., 1851-'52, vol. 1, p. 54, pl. 13, fig. 2-7.

<sup>3</sup> F. L. Kitchin. The Jurassic Fauna of Cutch. The Brachiopoda. Mem. Geol. Surv. India, Palaeontol. Indica, ser. 9. 1900, vol. 3, pt. 1, pl. 6, fig. 1-4.

somewhat more broadly depressed causing a less angular junction of the two valves at this place. The general proportion in the older part of the shell is similar.

**Myophoria suttonensis** n. sp.

Pl. 41, fig. 12-14.

Shell trigonal, inequilateral with rounded anterior, and produced and angular posterior margin. Breadth and height about equal. Beaks situated slightly anterior to middle. Surface marked with a radial ridge extending from the umbos to the posterior border, separating from the rest of the shell the posterior dorsal area which bears a different ornamentation. Main body of shell ornamented with from 17 to 19 radiating ribs; these ribs are much broader than the interspaces and are broadly rounded on top; they are strongly but minutely crenulated by crowded concentric striae. In the sinus bounding the radial ridge anteriorly there are two smaller radial ribs; from there, however, the ribs at once become strong and prominent and thence slowly decrease in strength toward the anterior portion of the shell where they become very weak or are wholly absent. Numerous concentric striae are prominent upon the ribs, but become especially strong at the anterior margin. The radial ribs are much smaller on the umbonal area where they are crossed by three or four Trigonion-like, strong, transverse ridges.

Posterior dorsal area nearly smooth. The ornamentation consists of concentric growth lines, most prominent over a broad, low medial rib.

Cardinal teeth typical of other *Myophorias*,—that is, two in the right valve, with vertical striations upon their outer and inner edges. These fit into corresponding socket-like teeth on the left valve, that are striated only upon their inner edges.

Named after the formation.

*Comparison*.—Closely similar to *M. goldfussi* Münster in the group of *M. costata*, a group which, as given by Waagen in *Die Lamellibranchiaten der Pachycardientuffe*<sup>1</sup> is characterized by “numerous, rather blunt, radial ribs and thick, often sharp, concentric growth lines.”

<sup>1</sup> L. Waagen. *Die Lamellibranchiaten der Pachycardientuffe der Seiser Alm*. Abhandl. k. k. geol. Reichsanstalt, Wien, 1907, vol. 18, pt. 2, p. 146.

Our species agrees with *M. goldfussi* in the greater posterior prolongation of the shell, and the rounded anterior portion which does not advance much beyond the beak; the numerous concentric growth lines give it a roughened appearance. It differs from the figures given of that species in the stronger and broader posterior radial ridge, with two instead of one radial rib in the sinus, and in the absence of prominent radial ribs from the flattened area, posterior to the radial ridge, where *M. goldfussi* has about three strong radial ribs.

The figures<sup>1</sup> of *M. goldfussi* show from 14 to 16 ribs, much narrower than their interspaces, and apparently continuous to the anterior edge of the shell, while our species bears from 17 to 19 ribs which are wider than the interspaces and do not continue to the anterior edge of the shell, representing thus a less primitive form for the latter species. Our species differs also in having three or four strong Trigonía-like ridges extending transversely across the umbo. These growth ridges die out upon all portions of the shell except the extreme anterior area where they may be traced almost half-way down the shell.

*M. goldfussi* is characteristic of the Upper Trias (uppermost Muschelkalk through Rhaetic) of the Alps and Carpathians.

It is interesting to note the apparent close relationship between Trigonía and Myophoria, for the Sutton specimens have the shape and radial markings of Myophoria and at the umbo have the strong, transverse ridges similar to Trigonía; added to this, the continuance of the radial ribs to the beak suggests the derivation of both from the same ancestor rather than the descent of one from the other.

**Choristoceras suttonensis** n. sp.

Pl. 40, figs. 4, 6.

Whorls laterally compressed, but little or not at all embracing as evidenced by the absence of any impressed zone, and increasing very slowly in size. Cross-section oval with breadth about four fifths of the height; sides broadly rounded; venter slightly flattened.

Surface ornamented with strong simple ribs that cross the umbilical region, though there much weaker, increase in strength up the sides

<sup>1</sup> A. Bittner. Lamellibranchiaten der alpinen Trias. Abhandl. k. k. geol. Reichsanstalt, Wien, 1895, vol. 18, pt. 1, pl. 11, fig. 24-27.

to the ventral shoulders and run straight across the venter. On the venter the ribs are depressed by a slight furrow; this depression of the ribs accentuates their height on the ventral shoulders into the appearance of low knobs bordering the furrow.

Lobes and saddles entire, except that the ventral lobe is divided by a small siphonal notch. There are two narrow lateral lobes, the second lateral being about two thirds the depth of the first. The three saddles are much broader than the lobes, the first saddle being very deep. Internal antisiphonal lobe not as deep as the second lateral.

Height of cross-section, 4.7 mm.; breadth of cross-section, 3.5 mm.

Unlike the type, *C. marshi* Hauer, from the Rhaetic, but like most of the other species placed in this genus, this species lacks the slight division in the first lateral lobe, all the lobes except the siphonal being entire.

Named from the formation.

*Comparison*.—This species is apparently most closely related to *C. subrhaeticum* Mojsisovics.<sup>1</sup> It agrees with this in size and proportion, in its loose coiling, in having strong, simple ribs interrupted on the venter by a furrow leaving knobs on each side. Its suture is likewise similar. It differs in having the saddles proportionally somewhat broader and the antisiphonal lobe deeper. This latter is almost as long as the adjoining second lateral lobe, instead of being only one third its length as in this species (as shown in Fig. 8d, Tafel 134). It differs likewise in not having fine striae parallel to the ribs. *C. subrhaeticum* is found in the Rhaetic formation of Central Europe (Hallstätter Kalke).

Externally this species agrees closely with *Polycycylus nodifer* Hyatt and Smith.<sup>2</sup> That species, however, is more closely coiled and the second lateral lobe is exceedingly small and the first lateral lobe is sometimes ceratitic. The third lateral saddle is likewise minute. *P. nodifer* occurs in the Upper Triassic, zone of *Tropites subbullatus*, Shasta Co., California.

The fauna includes besides the species described above many very poorly preserved fossils,—simple cup corals ( $r^3$ ), other encrusting

<sup>1</sup> E. Mojsisovics. Die Cephalopoden der Hallstätter Kalke. Abhandl. k. k. geol. Reichsanstalt, Wien, 1893, vol. 6, pt. 2, p. 563.

<sup>2</sup> A. Hyatt and J. P. Smith. The Triassic Cephalopod Genera of America. U. S. Geol. Surv., Prof. Paper 40, 1905, p. 201.

<sup>3</sup> C = very common; c = common; r = rare; R = very rare.

corals (*c*) somewhat similar to *Isastrea*, and *Thamnastrea* sp. (*r*). Some other poorly preserved forms, apparently Bryozoa, are rather common.

Pelecypods belonging apparently to the families Tellinidae (*C*), Pectinidae (*C*), Ostreidae (*r*), Pinnidae (*r*), and others.

Gastropods probably of the families Naticidae (*r*), Capulidae (*Platyceras*, *r*), and others.

Vegetation is present both as thin bands of carbonaceous material and as stem impressions.

#### CONCLUSIONS AS TO AGE.

Since all species are new and the field relations obscure, for the region is one of great metamorphism, the determination of age must rest upon comparison with the nearest related species. This comparison is summarized in the table on page 437.

The closest comparison of species is thus with the uppermost Triassic (Rhaetic) and the Middle and Upper Jurassic. All of the Jurassic species, with one possible exception, show less primitive characteristics when compared with the Sutton species, or the Sutton species are more primitive, indicating an age prior to that of Middle and Upper Jurassic. All of the Rhaetic species are slightly more primitive than those from the Sutton formation, indicating for the latter less primitive forms a later period of development. This would place the age in the lower part of the Lower Jurassic, or Lower Lias.

This fauna has apparently nothing in common with the Liassic faunas of Nevada, Oregon, and California noted by Hyatt.<sup>1</sup> The latter as noted by J. P. Smith<sup>2</sup> has no European relatives, except for the almost universal *Arietites* group, but is probably a northward extension of the South American type. The Sutton fauna, on the other hand, is rather closely related to the European and Indian faunas, and thus gives for North America a second type of Liassic fauna, though this Eurasian type has not yet been recognized from Alaska.

<sup>1</sup>A. Hyatt. Trias and Jura in the Western States. Bull. Geol. Soc. Amer., 1894, vol. 5, p. 395-434.

<sup>2</sup>J. P. Smith. Periodic Migrations between the Asiatic and the American Coasts of the Pacific Ocean. Amer. Journ. Sci., ser. 4, 1904, vol. 17, p. 221.

Choristoeras suttonensis ( <i>r</i> ) . . .	{ C. subrhaeticum* Polychelus nodifer	Rhaetic Upper Trias	Europe California	Slightly more primitive
Myophoria suttonensis ( <i>C</i> ) . . . . .	{ M. goldfussi*	Upper Trias thro' Rhaetic	Centr. Europe	Slightly more primitive
Terebratula suttonensis ( <i>R</i> ) . . . . .	{ T. globata T. phillipsi* T. hypsogonia*	Lower Middle Jura Middle Jura Lower Upper Jura	England Europe India	Less primitive Slightly more primitive?
Isastrea vancouverensis ( <i>C</i> ) . . . . .	{ I. oblonga	Upper Jura	England	Less primitive
I. cowichanensis ( <i>r</i> ) . . . . .	{ I. parva* I. richardsoni*	Upper Middle Jura Lower Middle Jura	India England	Less primitive " "
I. whiteavesi ( <i>r</i> ) . . . . .	{ I. oblonga	Upper Jura	England	" "
Calamophyllia suttonensis ( <i>C</i> )	{ C. clathrata*	Rhaetic	Centr. Europe	More primitive
C. dawsoni ( <i>C</i> ) . . . . .	{ C. delicatula	Rhaetic	Centr. Europe	

\* Comparison indicates a fairly close relationship with the Sutton species.  
*C* = very common; *c* = common; *r* = rare; *R* = very rare.

The rarity of cephalopods is a notable feature of the fauna. The absence of such characteristic West Coast pelecypods as *Daonella lommeli*, *Halobia superba*, and *Pseudomonotis subcircularis* would make its reference to any portion of the Triassic exceedingly improbable; similarly none of the cephalopods so abundant in the western Triassic was found here.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY.

*Printed January, 1911.*



EXPLANATION OF PLATES.

PLATE 40.

- Fig. 1. *Calamophyllia dawsoni* n. sp. A portion of the type specimen, showing method of branching and the stout proliferations.  $\times 1\frac{1}{2}$ .
- Fig. 2. *Terebratula suttonensis* n. sp. Brachial valve of type specimen, somewhat deformed, showing median and lateral sinuses.  $\times 1$ .
- Fig. 3. Same. Front view with pedicle valve above showing undulating junction of the two valves and displacement of median fold to the right.  $\times 1$ .
- Fig. 4. *Choristoceras suttonensis* n. sp. Suture.  $\times 4$ .
- Fig. 5. *Calamophyllia suttonensis* n. sp. Transverse section.  $\times 1\frac{1}{2}$ .
- Fig. 6. *Choristoceras suttonensis* n. sp. Portion of a coil of the type specimen; surface view showing the strong ribs.  $\times 2\frac{1}{2}$ .
- Fig. 7. *Calamophyllia suttonensis* n. sp. A portion of the type specimen showing method of branching, costae, and knobby proliferations.  $\times 1$ .
- Fig. 8. *Isastraea vancouverensis* n. sp. A portion of the type specimen showing the deep calices.  $\times 1\frac{1}{2}$ .
- Fig. 9. *Isastrea whiteavesi* n. sp. The type specimen.  $\times 1\frac{1}{2}$ .
- Fig. 10. The same. Corallites embedded in coenenchyma. This is at the sides of the type specimen and is apparently continuous with that of Fig. 9.  $\times 1\frac{1}{2}$ .

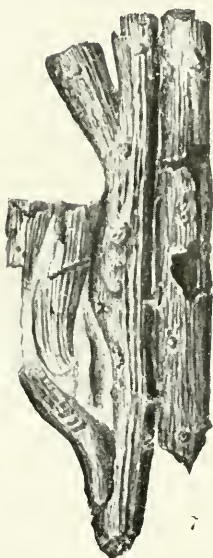
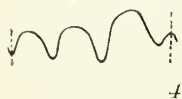
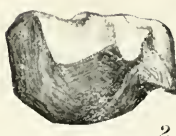
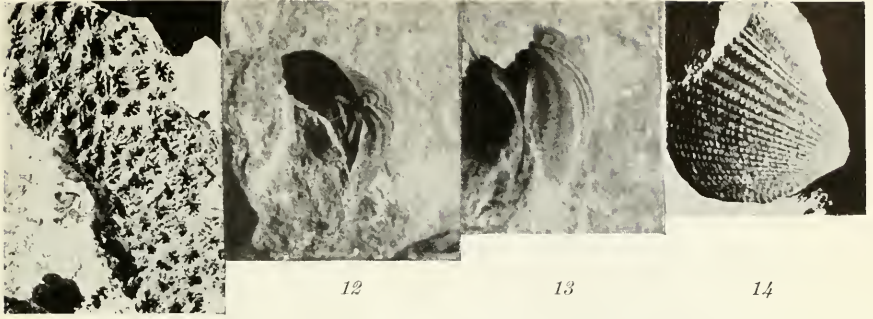






PLATE 41.

- Fig. 11. *Isastrea cowichanensis* n. sp. Photograph of the type specimen.  $\times 1$ .
- Fig. 12. *Myophoria suttonensis* n. sp. Photograph of the type specimen, right valve. Umbonal view showing striated teeth, Trigonialike transverse ridges upon umbo and the strong radial ridge extending from umbo to posterior border of valve separating the ribbed portion from the posterior dorsal area.  $\times 1\frac{1}{3}$ .
- Fig. 13. The same; posterior dorsal area showing the broad low medial rib upon which the growth lines show as low folds.  $\times 1\frac{1}{3}$ .
- Fig. 14. The same; surface view showing radial ribs crossed by concentric ridges, the disappearance of the former upon the anterior portion of the shell where the transverse ridges occur.  $\times 1\frac{1}{3}$ .
- Fig. 15. *Calamophyllia suttonensis* n. sp. Photograph of a mass, showing the loose arrangement of corallites, the prominent costae, and strong horizontal proliferations.  $\times 1\frac{1}{3}$ .



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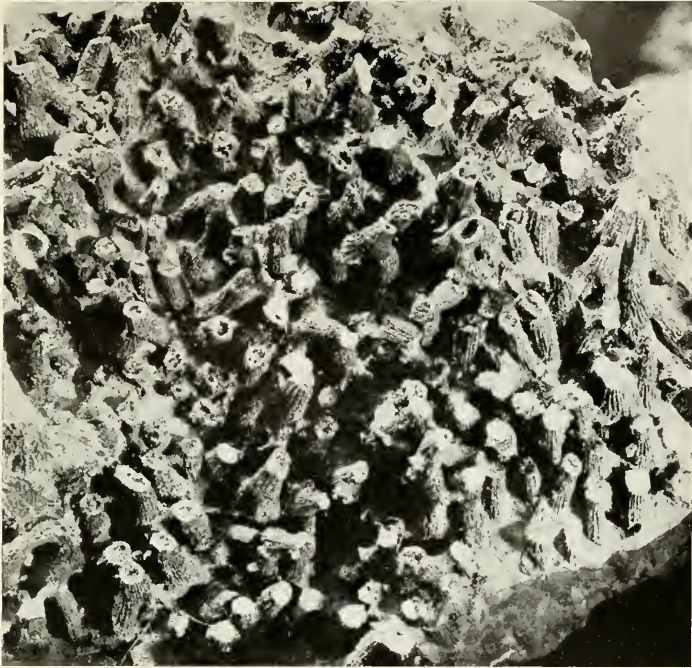
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PLATE 42.

- Fig. 16. *Calamophyllia dawsoni* n. sp. Photograph of a mass partly weathered from the limestone. The weathering has taken place from the under side of the corallites.  $\times 1\frac{1}{3}$ .
- Fig. 17. *Isastrea vancouverensis* n. sp. Photograph of a mass showing closely crowded corallites, their great length, and usually sub-circular cross-section. In the natural longitudinal sections the septa appear as ribs giving to the corallites a longitudinally striated appearance.  $\times 1\frac{1}{3}$ .



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SIMPLE ASCIDIANS OF THE COASTS OF NEW ENGLAND  
AND NEIGHBORING BRITISH PROVINCES.

BY WILLARD G. VAN NAME, PH. D.

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No. 13.—SIMPLE ASCIDIANS OF THE COASTS OF NEW ENGLAND AND NEIGHBORING BRITISH PROVINCES.

BY WILLARD G. VAN NAME, PH. D.

IN a previous paper the writer has given an account of the compound ascidians of the region from the Gulf of Saint Lawrence to Long Island Sound, inclusive. In the present paper the simple ascidians of the same region are dealt with and, as before, the account is based chiefly on a study of the extensive collections belonging to and deposited in the Peabody Museum of Yale University.

As this is practically a continuation of the paper dealing with the compound ascidians, it will be unnecessary to repeat all the preliminary statements there made concerning the work, and it will suffice to state that the collections studied were made chiefly by Professor A. E. Verrill, Professor S. I. Smith, H. E. Webster, O. Harger, and others associated with them, during 1868 and 1870, and by the United States Commission of Fish and Fisheries from 1871 to 1887 inclusive, and include specimens from deep water as well as from near the shore. Much of the material is the property of the United States National Museum. Smaller lots of specimens from various sources, including some collected by the writer himself, have also been studied, so that the geographical area dealt with in this paper has been well covered. Advantage has also been taken of this opportunity to describe and figure several deep-water forms collected by the steamer *Albatross* at stations too far from the coast to justify considering them as belonging to the New England fauna. The specimens from which the figures and descriptions were prepared were all, as far as the writer is aware, collected in summer, or not later than September. While collecting at other seasons might not result in finding other species, it would be likely to disclose facts regarding the development, growth, and reproduction of these animals which the summer specimens do not show.

The curators of the Peabody Museum, Professor W. R. Coe and Miss Katharine J. Bush, Ph.D., have kindly allowed the writer the advantage of every facility afforded by the Museum for the preparation of this paper, and by their interest and readiness to assist have

incurred the writer's deepest obligation. The writer is also indebted to Dr. R. Hartmeyer of Berlin, for much important information regarding European species, and for specimens of many of the latter for comparison, and to Professor A. G. Huntsman of Toronto for information concerning the collections he has made in Canadian waters.

#### REVIEW OF LITERATURE.

The earliest work known to the writer that requires consideration here is that of Lesueur (1823, see list of literature at end of paper). He describes and figures several simple ascidians from the Atlantic coast of the United States, two of which, *Ascidia plicata*, sp. nov., *Ascidia ovalis*, sp. nov., were found on a ship's bottom at Philadelphia. Though Lesueur's descriptions and figures show external characters only, his *Ascidia plicata* is doubtless the animal described in this paper as *Tethyum plicatum*. The *Ascidia ovalis*, the writer does not venture to identify with any species here described. The types of these species do not appear to have been preserved, as a letter of inquiry addressed to the Philadelphia Academy of Natural Sciences, (where, according to Lesueur, the types were kept), brought out the information that nothing was known of the specimens.

Couthouy (1838) lists the following from Massachusetts:

<i>Ascidia rustica</i> Linnaeus	= <i>Caesira manhattensis</i> . <sup>1</sup>
<i>Ascidia microcosmus</i> Cuvier	= <i>Tethyum partitum</i> (probably).
<i>Ascidia intestinalis</i> Linnaeus	= <i>Ciona intestinalis</i> var. <i>tenella</i> .
<i>Ascidia pedunculata</i> Lamarek	= <i>Pyura ovifera</i> .

Gould (1841) in his "Report on the Invertebrata of Massachusetts," lists:

<i>Ascidia rustica</i> Linnaeus	= <i>Caesira manhattensis</i> .
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DeKay (1843) in the Zoology of New York, part 5, describes:

<i>Boltenia reniformis</i> Macleay	= <i>Pyura ovifera</i>
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and records and figures:

<i>Ascidea manhattensis</i> , sp. nov.	= <i>Caesira manhattensis</i>
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both species from New York Harbor, where, however, the former has never since been found. DeKay also lists as "extra-limital" forms

<sup>1</sup> In listing the species recorded by the several authors, the names adopted in this paper are given in the second or right-hand column.

some of the species recorded by Lesueur, Couthouy, and Gould (see above).

Agassiz (1850) describes seven new species from the shores of Massachusetts. His descriptions are very brief and unsatisfactory, and his types are not known to the writer to be in existence. Professor Verrill, who was one of Agassiz's students, has informed the writer that these types were probably never preserved at all. Agassiz had colored drawings of them prepared by an artist (Mr. Burkhardt), but did not publish these drawings. They were used years afterward (1870) by Binney to illustrate the second edition of Gould's "Report on the Invertebrata of Massachusetts," and with their aid it has been possible to determine what Agassiz's species are. The list is as follows:

<i>Ascidia amphora</i> , sp. nov.	= <i>Caesira manhattensis</i> .
" <i>psammophora</i> , sp. nov.	= " <i>arenata</i> .
" <i>ocellata</i> , sp. nov.	= <i>Ciona intestinalis</i> var. <i>ocellata</i> .
" <i>carnea</i> , sp. nov.	= <i>Dendrodoa carnea</i> .
" <i>hirsuta</i> , sp. nov.	= <i>Pyura echinata</i> .
" <i>rugosa</i> , sp. nov.	= <i>Tethyum partitum</i> (probably).
<i>Boltenia microcosmus</i> , sp. nov.	= <i>Pyura ovifera</i> .

Two of Agassiz's specific names are still retained, while four of the others are synonyms of previously described species. The remaining name (*Ascidia psammophora*) the writer, following Verrill, rejects on the ground that it is insufficiently described. The species is determinable only by Burkhardt's drawing, while long before the drawing was published, Stimpson (1852) had published a recognizable description of the species as *Molgula arenata*.

Stimpson (1851) described as a new species from Massachusetts Bay:

<i>Pelonaia arenifera</i> , sp. nov.	= <i>Pelonaia corrugata</i> .
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In 1852 he described from the Bay of Fundy region:

<i>Ascidia callosa</i> , sp. nov.	= <i>Phallusia prunum</i> .
" <i>tenella</i> , sp. nov.	= <i>Ciona intestinalis</i> var. <i>tenella</i> .'
" <i>geometrica</i> , sp. nov.	= <i>Chelyosoma macleayanum</i> .
<i>Glandula fibrosa</i> , sp. nov.	= <i>Pandocia fibrosa</i> .
" <i>mollis</i> , sp. nov.	= <i>Tethyum molle</i> .
<i>Boltenia rubra</i> , sp. nov.	= <i>Pyura ovifera</i> .

From George's Bank:

<i>Pera pellucida</i> , sp. nov.	= <i>Caesira crystallina</i> .
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From Massachusetts:

- Molgula producta*, sp. nov. Doubtful.  
 " *arenata*, sp. nov. = *Caesira arenata*.  
*Cynthia partita*, sp. nov. = *Tethyum partitum*.  
 " *gutta*, sp. nov. = *Dendrodoa carnea*.

Also two "Cynthias" from North Carolina.

In this article Stimpson established two new genera, *Glandula* (for *G. fibrosa* and *G. mollis*) and *Pera* (for *P. pellucida*). The chief characters distinguishing *Glandula* from *Cynthia* (as Stimpson used the names) were that in *Glandula* the body was unattached and covered with sand or mud. Owing to an error by Traustedt (1880) who redescribed *Glandula mollis*, and stated that the stigmata were curved, *Glandula* was for a long time considered a valid genus, but as shown by Hartmeyer (1909a) it has no claims to recognition. *Pera* also long had recognition on account of its pedicel, but the writer follows Hartmeyer in considering that it has no anatomical characters requiring its separation from *Caesira* [*Molgula*].

In 1854, Stimpson, in his "Synopsis of the Marine Invertebrata of Grand Manan," records the following simple ascidians, most of them the same as in his last work:

- |                                  |   |
|----------------------------------|---|
| <i>Ascidia callosa</i> Stimpson  | = <i>Phallusia prunum</i> .                       |
| " <i>tenella</i> Stimpson        | = <i>Ciona intestinalis</i> var. <i>tenella</i> . |
| " <i>geometrica</i> Stimpson     | = <i>Chelyosoma macleayanum</i> .                 |
| <i>Glandula fibrosa</i> Stimpson | = <i>Pandocia fibrosa</i> .                       |
| " <i>mollis</i> Stimpson         | = <i>Tethyum molle</i> .                          |
| <i>Cynthia pyriformis</i> Rathke | = <i>Pyura aurantium</i> .                        |
| " <i>echinata</i> (Linnaeus)     | = " <i>echinata</i> .                             |
| <i>Boltenia rubra</i> Stimpson   | = " <i>ovifera</i> .                              |
| " <i>reniformis</i> Macleay      | = " "   |

Packard (1863) recorded the following species from southern Labrador:

- |                                    |                               |
|------------------------------------|-------------------------------|
| <i>Ascidia callosa</i> Stimpson    | = <i>Phallusia prunum</i> .   |
| <i>Cynthia pyriformis</i> Rathke   | = <i>Pyura aurantium</i> .    |
| <i>Cynthia</i> sp.                 | Doubtful.                     |
| <i>Pelonaia arenifera</i> Stimpson | = <i>Pelonaia corrugata</i> . |
| <i>Boltenia oviformis</i> Savigny  | = <i>Pyura ovifera</i> .      |

In a later work (1867) entitled "View of the Recent Invertebrate Fauna of Labrador" he revised and increased the list of species from that region so that it stood as follows:

<i>Ascidia callosa</i> Stimpson	=	<i>Phallusia prunum</i> .
<i>Glandula glutinans</i> (Möller)	=	<i>Eugyra glutinans</i> .
<i>Cynthia pyriformis</i> Rathke	=	<i>Pyura aurantium</i> .
“ <i>condylomata</i> sp. nov.	=	<i>Tethyum rusticum</i> .
“ <i>echinata</i> (Linnaeus)	=	<i>Pyura echinata</i> .
“ <i>placenta</i> , sp. nov.	=	<i>Tethyum coriaceum</i> .
<i>Pelonaia arenifera</i> Stimpson	=	<i>Pelonaia corrugata</i> .
<i>Boltenia bolteni</i> (Linnaeus)	=	<i>Pyura ovifera</i> .

Perkins (1869) in his “Molluscan Fauna of New Haven” (Connecticut), records two simple ascidians from that vicinity:

<i>Ascidia manhattensis</i> DeKay	=	<i>Caesira manhattensis</i> .
<i>Molgula arenata</i> Stimpson	=	“ <i>arenata</i> .

Binney (1870) in editing the second edition of Gould’s “Report on the Invertebrata of Massachusetts” gives a compilation of the information contained in the works of Agassiz, Stimpson, Packard, etc., but having no familiarity with the ascidians himself, he took most of the names and descriptions just as he found them, and in several cases gave two descriptions and names for the same species, or fell into other similar errors. The species he includes are those of the above mentioned authors with one addition, for he added one more to the numerous synonyms of *Pyura ovifera* (Linnaeus) by describing, from a colored drawing by Burkhardt (see p. 441), *Boltenia Burkhardti*, as a new species.

It is, however, the colored plates that give Binney’s work its chief importance as far as the ascidians are concerned. These comprise reproductions of drawings by Morse from Packard’s alcoholic specimens collected at Labrador and elsewhere, and the drawings mentioned above (p. 441) made by Burkhardt for Agassiz, but never before published. Seven type specimens are shown among these illustrations, those of the following species:

Fig. 322. <sup>1</sup>	<i>Cynthia placenta</i> Packard	=	<i>Tethyum coriaceum</i> .
“ 327.	<i>Boltenia Burkhardti</i> Binney	=	<i>Pyura ovifera</i> .
“ 330.	<i>Ascidia psammophora</i> Agassiz	=	<i>Caesira arenata</i> .
“ 332.	“ <i>ocellata</i> Agassiz	=	<i>Ciona intestinalis</i> var. <i>ocellata</i> .
“ 333.	“ <i>amphora</i> Agassiz	=	<i>Caesira manhattensis</i> .
“ 334.	“ <i>carnea</i> Agassiz	=	<i>Dendrodoa carnea</i> .
“ 336.	“ <i>hirsuta</i> Agassiz	=	<i>Pyura echinata</i> .

The part of Binney’s work dealing with the ascidians was reviewed

<sup>1</sup> Binney’s figures.

and criticised by Verrill (1870b) and the identity of some of the forms appearing there as distinct species was pointed out.

Dall (1870), in his "Revision of the Classification of the Mollusca of Massachusetts," took his list of Ascidians from Binney's work.

In 1871 the important series of papers by Verrill entitled "Descriptions of some imperfectly known and new Ascidians from New England," appeared in the American Journal of Science. The simple ascidians described in them are as follows:

<i>Molgula manhattensis</i> (DeKay)	=	<i>Caesira manhattensis</i> .
" <i>pannosa</i> , sp. nov.	=	" <i>pannosa</i> .
" <i>retortiformis</i> , sp. nov.	=	" <i>retortiformis</i> .
" <i>littoralis</i> , sp. nov.	=	" <i>citrina</i> .
" <i>papillosa</i> , sp. nov.	=	" <i>papillosa</i> .
" <i>pilularis</i> , sp. nov.	=	<i>Bostrichobranchus pilularis</i> .
<i>Cynthia stellifera</i> , sp. nov.	=	<i>Tethyum partitum</i> .
" <i>monoceros</i> (Möller)	=	" <i>rusticum</i> .
" <i>carnea</i> (Agassiz).	=	" <i>coriaceum</i> + <i>Dendrodoa carnea</i> .
" <i>echinata</i> (Linnaeus)	=	<i>Pyura echinata</i> .
" <i>pyriformis</i> (Rathke)	=	" <i>aurantium</i> .
" <i>pulchella</i> , sp. nov.	=	<i>Dendrodoa aggregata</i> var. <i>pulchella</i> .
<i>Ascidia complanata</i> Fabricius	=	<i>Phallusia prunum</i> .
<i>Ciona tenella</i> (Stimpson).	=	<i>Ciona intestinalis</i> var. <i>tenella</i> .

Figures of most of these species are given. These figures and descriptions (as was also the case with those of the other authors so far reviewed) deal almost exclusively with external characters, though unlike those of the earlier authors, they are very detailed, and leave little to be desired in so far as information regarding the external appearance is concerned.

In the latter part of the same year, Verrill (1871b) published another paper recording many facts about the above species, and in the following year (1872b, p. 209-214), one giving a list of ascidians from the New England region not included in Binney's work, and recording the changes in the nomenclature of various species which his studies of this group had shown to be necessary. That same year (1872b, p. 281-290) two more simple ascidians were described by him:

<i>Glandula arenicola</i> , sp. nov.	=	<i>Tethyum molle</i> .
<i>Molgula pellucida</i> , sp. nov.	=	<i>Bostrichobranchus pilularis</i> (var.?).

In other papers (1873-'74, 1874a) on the explorations and dredging operations on the New England coast, many additional facts about

the distribution of the ascidians are recorded by Verrill, one more species being added by him during this period:

*Ascidia mollis*, sp. nov. = *Phallusia obliqua*.

In 1873, the first copies of the important "Report upon the Invertebrate Animals of Vineyard Sound" by Verrill and Smith, were distributed. This contains much information about the habits and distribution of the ascidians, redescribing and figuring some of them. An undetermined species of "Glandula" from "Vineyard Sound and off Martha's Vineyard, in 10 to 20 fathoms, sand," is recorded.

In 1874, Tellkamp's "Notes on the *Ascidea Manhattensis*, De Kay" though not correct in some important respects, practically marks the beginning of the study of the anatomy and development of the ascidians of this region.

In the years following this period the systematic study of this group of animals in this region advanced but slowly. Many of Verrill's later papers contain scattering notices of them, and his "Preliminary Check-list of the Marine Invertebrates of the Atlantic Coast, from Cape Cod to the Gulf of St. Lawrence" (1879a) contains a list of the species recorded from that region. In this list *Molgula sordida* Stimpson was inadvertently added to the list of New England ascidians.

The *Challenger* expedition, 1873 to 1876, dredged at several stations off the Atlantic coast, and the three simple ascidians obtained were described by Herdman (1880, 1881, 1882) as new. These were:

*Boltenia elegans*, sp. nov. = *Pyura ovifera*.  
*Ascidia falcigera*, sp. nov. = *Phallusia obliqua*.  
*Culeolus suhmi*, sp. nov.

the last being the only one actually a new species. It is a deep-sea form, not a member of the New England fauna. Afterward it was obtained by the *Albatross* and described by Verrill (1885a) as *Culeolus Tanneri*, sp. nov. (see p. 543).

Traustedt dealt with two New England species in two papers on ascidians of other regions. In the first (1880) he redescribed *Tethyum molle* (Stimpson) from original specimens; in the second (1883a) he established for a species that proves to be Verrill's *Molgula* or *Eugyra pilularis* the new genus *Bostrichobranchus* on account of its peculiar branchial sac, and calls it *B. manhattensis* in the belief that it was DeKay's species. The genus is a valid one. What appears to

be the same species was described as new by Metcalf (1900) (see p. 464) in an important paper dealing chiefly with points on the anatomy and histology of various ascidians.

The lists of ascidians given among those of other invertebrates by Packard (1891) and Kingsley (1901) are compilations from some of the above works, but Whiteaves' (1901) list of Canadian Invertebrata contains new matter concerning this group. The last mentioned writer did much collecting in Canadian waters, and some of his earlier papers (notably that of 1874b) also record facts about ascidians of that region, all of which, however, are summarized in his list of 1901.

Recently Michaelsen (1908b, 1912) has described a new species (*Pyura pectenicola*) and a new variety (*Dendrodoa kükenthali* var. *pectenicola*) from the Banks of Newfoundland, but the writer cannot regard them as distinct from previously described forms.

It is not within the scope of this review to mention papers of a purely anatomical or embryological nature, nor those of European writers dealing with species common to America and European waters, but the work of Hartmeyer (1903) on the Arctic ascidians in Römer and Schaudinn's "Fauna Arctica" cannot be passed without mention, as it gives so much information about many species found in the New England region that it has taken a place of the very first importance in the literature of the New England ascidians.

As in the case of the compound ascidians, the published facts concerning the simple ascidians of the Atlantic coast south of New England are few and scattering and the specimens at hand so few that it has not seemed best to attempt to cover that region in the present paper.

#### GENERAL NOTES.

Leaving out of account all uncertain forms, 34 species of simple ascidians, distributed in 6 families and 12 genera, are here recorded from the region this paper deals with. All the more important families of simple ascidians are represented. The region cannot, however, be called unusually rich in number of species, neither are there many whose structural characters present any striking peculiarities. The most interesting of them is Traustedt's genus *Bostrichobranchus*. This is evidently derived from the genus *Eugyra* Alder and Hancock (1870), from which it differs in the multiplication of the infundibula of the branchial sac. It is, in the writer's opinion, the most highly special-

ized genus of ascidians. The peculiarities of the branchial sac and their development from the simpler type characteristic of *Eugyra* are described at length in the systematic part of this paper. One species of *Tethyum* [*Styela*], *T. mortenseni* Hartmeyer, is unusual in the degree of reduction of the folds of the branchial sac, but aside from this, the only form whose peculiarities call for special mention here is a small species of the family *Caesiridae* [*Molgulidae*], *Caesira singularis* sp. nov., in which the gonads are of a peculiar form, the folds of the branchial sac are reduced to an unusual degree, and the tentacles are unbranched. The last mentioned character is unique in that family, as far as the writer is aware.

The family best represented is the *Caesiridae* [*Molgulidae*] with 13 species, 12 of them in the genus *Caesira* [*Molgula*], which is thus by far the best represented genus in the region. The *Pyuridae* [*Cynthiidae* or *Halocynthiidae*] are few, but the *Tethyidae* [*Styelidae*] are well represented, having 11 species in the region, of which 7 are included in the typical genus *Tethyum* [*Styela*]. The extensive genus *Pandocia* [*Polycarpa*] of the same family has, however, but one representative, and the important family *Phallusiidae* [*Asciidiidae*] but two or three. Omitting doubtful forms and varieties, but adding the 15 species of compound ascidians described by the writer in a previous paper, there are 49 species of ascidians recorded from the region. Pelagic Tunicata (*Pyrosomidae*, *Salpidae*, etc.) are not included in the scope of either of these papers, and the writer will not attempt an estimate of the number of species represented.

The writer has taken advantage of this opportunity to describe also three deep-sea forms found off the Atlantic coast of the United States as well as one which is not known to range as far north as New England.

The list of new species from New England and eastern Canada described in this paper is as follows:

- Caesira lutulenta.*
- “ *robusta.*
- “ *intumescens.*
- “ *singularis.*
- Tethyum atlanticum.*

The following new deep-sea species are also described:

- Caesira verrilli.*
- Pandocia albatrossi.*

## DISTRIBUTION.

The region with which this paper deals, extends from the Gulf of Saint Lawrence and the Banks of Newfoundland southward to, and including, Long Island Sound. In the brief synopsis of distribution of the several species here given, the species are numbered consecutively from 16 onward, numbers 1 to 15 inclusive being compound ascidians described by the writer in a previous paper (1910). Deep-sea or extra-limital forms that are described in this paper are included in this synopsis, but are not numbered, and to prevent confusion, the names used by Verrill and other American writers are often given in brackets following the name here adopted. The records of the Peabody Museum give many localities for some of these species which the writer could not verify. They have not been quoted in this paper, nor have they been depended on in working out the distribution of the species, for they were generally made out after merely superficial examination of the specimens and contain many errors of identification.

Family CAESIRIDAE Hartmeyer, 1908.

[= MOLGULIDAE auct. plur.].

Genus BOSTRICHORANCHUS Traustedt, 1883.

16. *Bostrichobranchus pilularis* (Verrill), 1871. [*Eugyra pilularis* + *Molgula pellucida* Verrill].  
Gulf of Saint Lawrence to North Carolina.  
 $\frac{1}{2}$  to 120 fathoms.

Genus CAESIRA Fleming, 1822.

[= MOLGULA auct. plur.].

17. *Cacsira lutulenta*, sp. nov.  
Off the coast of southern New England and the Middle States.  
67 to 142 $\frac{1}{2}$  fathoms.
18. *Caesira manhattensis* (DeKay), 1843. [*Molgula Manhattensis* Verrill].  
Vicinity of Cape Ann, Mass., to North Carolina.  
Shallow water only (near low-water mark, occasionally to 16 fathoms).
19. *Caesira septentrionalis* (Traustedt), 1882.  
Northern waters of Europe, and Greenland. One specimen from the Banks of Newfoundland.  
Greatest depth 50 fathoms.
20. *Caesira intumescens*, sp. nov.  
Two specimens from the Banks of Newfoundland.  
Depth of 39 fathoms recorded for one specimen.

21. *Caesira pannosa* (Verrill), 1871. [*Molgula pannosa* Verrill].  
Gulf of Saint Lawrence; Bay of Fundy region; Casco Bay; George's Bank.  
10 to 80 fathoms.
22. *Caesira citrina* (Alder and Hancock), 1848. [*Molgula littoralis* Verrill].  
Northern and western Europe; Gulf of Saint Lawrence; Saint Peter's Bank (south of Newfoundland); Bay of Fundy region; southward to off Martha's Vineyard, and Narragansett Bay.  
Littoral to 126 fathoms.
23. *Caesira crystallina* (Möller), 1842. [*Pera pellucida* Stimpson; *P. crystallina* Verrill].  
Arctic seas; Norway; Iceland; Greenland; etc. Nearly circumpolar.  
Gulf of Saint Lawrence; George's Bank.  
10 to 180 meters.
24. *Caesira papillosa* (Verrill), 1871. [*Molgula papillosa* Verrill].  
Arctic seas (Bear Island, Hope Island, Farøe Islands, Greenland).  
Gulf of Saint Lawrence and Bay of Fundy to off Martha's Vineyard.  
10 to 100 fathoms.
25. *Caesira arenata* (Stimpson), 1852. [*Molgula arenata* Verrill; *Ascidia psammophora* Agassiz].  
Nantucket, Vineyard Sound, and Buzzards Bay to Long Island Sound (near New Haven, Conn.).  
3 to 15 fathoms.
26. *Caesira robusta*, sp. nov.  
Region about Wood's Hole and Martha's Vineyard, Mass.  
Shallow water.
27. *Caesira retortiformis* (Verrill), 1871. [*Molgula retortiformis* Verrill].  
Waters of northern Europe and Asia, Iceland and Greenland, Alaska.  
On the American Atlantic coast south to the southeastern angle of Cape Cod.  
Shallow water to 150 fathoms.
- *Caesira verrilli*, sp. nov.  
Deep water. One specimen only, from N. lat. 40° 24', W. long. 66° 04',  
1,769 fathoms.
28. *Caesira singularis*, sp. nov.  
Off Race Point, Cape Cod, to Long Island Sound.  
14 to 27 fathoms.
- *Caesira producta* (Stimpson), 1852. Uncertain species.  
Massachusetts Bay to east of Block Island, R. I.  
Low water to 29 fathoms.

NOTE.—*Caesira sordida* (Stimpson), 1852, has been attributed to the New England fauna through an oversight only.

Family PYURIDAE Hartmeyer, 1908.

[= CYNTHIIDAE s. HALOCYNTHIIDAE auct. plur.].

Genus PYURA Molina, 1782.

[= CYNTHIA s. HALOCYNTHIA auct. plur.].

29. *Pyura echinata* (Linnaeus), 1767. [*Cynthia echinata* Verrill + *Ascidia hirsuta* Agassiz].  
 Circumpolar in the Arctic Seas; northern waters of Europe; Iceland, Greenland; on the American Atlantic coast south to off southern Massachusetts and Rhode Island.  
 Low water to 109 fathoms.
30. *Pyura ovifera* (Linnaeus), 1767. [*Boltenia bolteni* + *B. rubra* + *B. reniformis*, etc., auct.]. Sometimes called stemmed sea peach.  
 Circumpolar in the Arctic seas; on the American coast ranging south to Nantucket Shoals (DeKay gives a record from New York Harbor).  
 Shallow water to 100 fathoms.
31. *Pyura aurantium* (Pallas), 1787. [*Cynthia* or *Halocynthia pyriformis* Verrill]. Popularly called sea peach.  
 Nearly circumpolar in the Arctic seas; on the American coast south to Massachusetts Bay.  
 Low water to 120 fathoms.

Genus MICROCOSMUS Heller, 1877.

32. *Microcosmus nacreus*, sp. nov.  
 Between Nova Scotia and Sable Island, also on Grand Bank.  
 26 to 36 fathoms.

Genus CULEOLUS Herdman, 1881.

- . *Culeolus suhmi* Herdman, 1881. [*Culeolus Tanncri* Verrill].  
 Deep water off the eastern United States.  
 1,608 to 2,620 (probably to 2,919) fathoms.

Family TETHYIDAE Hartmeyer, 1908.

[= STYELIDAE auct. plur.].

Genus PELONAIA Goodsir and Forbes, 1841.

33. *Pelonaia corrugata* Goodsir and Forbes, 1841. [*Pelonaia arenifera* Stimpson].  
 Nearly circumpolar in the Arctic seas; northern Europe, including the British Islands; Iceland; Greenland; Labrador; Gulf of Saint Lawrence; once recorded from Massachusetts Bay.  
 6 to 100 fathoms.

## Genus TETHYUM Bohadsch, 1761.

[= STYELA auct. plur.].

34. *Tethyum rusticum* (Linnaeus), 1767. [*Halocynthia rustica* Verrill].  
Nearly circumpolar in the Arctic Seas; northern Europe; Farøe Islands, Iceland, Greenland; on the American coasts south only to the Gulf of Saint Lawrence and Banks of Newfoundland.  
2 to 432 meters.
35. *Tethyum atlanticum*, sp. nov.  
Off the coast of New England and the Middle States.  
62 to 202 (in one case 327) fathoms.
36. *Tethyum partitum* (Stimpson), 1852. [*Cynthia* or *Styela partita* auct.].  
Cape Verde Islands, western Europe, Mediterranean, Adriatic. Massachusetts Bay to North Carolina. Represented at Bermuda by a subspecies.  
Shallow water (low water to 15 fathoms only, on the American coast).
37. *Tethyum coriaceum* (Alder and Hancock), 1848. [*Cynthia placenta* Packard, 1867; *Cynthia carnea* Verrill, 1871 in part; and *Halocynthia tuberculum* Verrill, 1879, in part].  
Of wide distribution in northern European waters; Siberian Arctic Ocean; Greenland; Davis Straits. In American waters from Labrador and the Banks of Newfoundland to Massachusetts Bay.  
10 fathoms to 400 meters.
38. *Tethyum mortenseni* Hartmeyer, 1912.  
At two American stations only, off Nova Scotia and off Cape Ann, Mass.; one European station (near Norway).  
45 fathoms to 660 meters.
39. *Tethyum finmarkiense* (Kiaer), 1893.  
Off Norway. One specimen from the Banks of Newfoundland.  
20 meters to 67 fathoms.
- . *Tethyum plicatum* (Lesueur), 1823.  
Philadelphia to the West Indies and South America; the Mediterranean and Adriatic Seas; Indian and parts of the Pacific Oceans; Australia.  
Shallow water (at least on the American coast).
40. *Tethyum molle* (Stimpson), 1852. [*Glandula mollis* Stimpson, 1852. *Glandula arenicola* Verrill, 1872].  
Gulf of Saint Lawrence to Long Island Sound. *Tethyum vestitum* (Stanger), 1860, of the British coasts is a very closely allied, if distinct species.  
10 (or less) to 150 fathoms. (The writer has seen specimens from shallow water only.)

## Genus PANDOCIA Fleming, 1822.

[= POLYCARPA auct. plur.].

41. *Pandocia fibrosa* (Stimpson), 1852. [*Glandula fibrosa* Stimpson, 1852].

From the Gulf of Saint Lawrence (authority of Whiteaves), Nova Scotia, and the Bay of Fundy region to off Nantucket (perhaps to N. lat. 39°).

30 (or less) to 134 fathoms; probably to 238 fathoms.

—. *Pandocia albatrossi*, sp. nov.

Deep water off the middle Atlantic States.

1,420 to 2,033 fathoms.

Genus DENDRODOA MacLeay, 1824.

42. *Dendrodoa aggregata* (Rathke), 1806, var. *pulchella* (Verrill), 1871. [*Cynthia pulchella* Verrill, 1871].

Banks of Newfoundland; Nova Scotia; Maine Coast. (The typical *D. aggregata* is widely distributed in the Arctic regions, Norway, Greenland, Iceland, etc.)

10 to 40 fathoms.

43. *Dendrodoa carnea* (Agassiz), 1850. [*Ascidia carnea* Agassiz, 1850; *Cynthia carnea* or *Halocynthia tuberculum* Verrill (part)].

Banks of Newfoundland and Bay of Fundy to Long Island Sound. Shallow water to 39 fathoms.

44. *Dendrodoa grossularia* (Van Beneden), 1846.

Waters of northern Europe and adjacent Arctic seas, including Great Britain and Iceland; Greenland; Gulf of Saint Lawrence; Eastport, Maine.

Greatest depth 80 meters.

Family RHODOSOMATIDAE Hartmeyer, 1908.

Genus CHELYOSOMA Broderip and Sowerby, 1830.

45. *Chelyosoma macleayanum* Broderip and Sowerby, 1830. [*Ascidia geometrica* Stimpson, 1852].

Circumpolar in the Arctic seas; Grand Manan, New Brunswick and Casco Bay, Maine.

10 to 99 meters.

Genus CORELLA Alder and Hancock, 1870.

46. *Corella borealis* Traustedt, 1886.

Spitzbergen, Kara Sea, Davis Straits, and east coast of Greenland; off Cape Ann, Mass.

66 meters to 250 fathoms.

Family PHALLUSIIDAE Traustedt, 1883.

[= ASCIDIIDAE auct. plur.].

Genus PHALLUSIA Savigny, 1816.

[= ASCIDIA auct. plur.].

47. *Phallusia obliqua* (Alder), 1863. [*Ascidia mollis* Verrill].

Waters of northern Europe; Greenland, Labrador to Cape Cod (off Chatham, Mass.); Jeffrey's Bank, Cashe's Ledge, etc.

33 fathoms to 600 meters (chiefly in 50 fathoms or more).

48. *Phallusia prunum* (Müller), 1776. [*Ascidopsis complanatus* Verrill].  
Waters of northern Europe; Iceland; Greenland; Labrador and Banks of Newfoundland to Cape Cod, and slightly farther south at stations off the coast.  
Low water to 150 fathoms (commonest in shallow water).
- . *Phallusia inornata* (Verrill), 1872. Uncertain species (not Hancock, 1870). Near Eastport, Maine (one specimen only).  
12 fathoms.

## Family CIONIDAE Lahille, 1887.

## Genus CIONA Fleming, 1822.

49. *Ciona intestinalis* (Linnaeus), 1767.  
Found in most parts of the world. On the American Atlantic coast occurs from the Gulf of Saint Lawrence to southern Massachusetts and Rhode Island, and still farther south at stations off the coast. Those from north of Cape Cod [= *Ascidia tenella* Stimpson, 1852] are said by Verrill to differ in external characters from those from south of Cape Cod [= *Ascidia ocellata* Agassiz, 1850] and one or both forms may deserve recognition as varieties. Greatest depth recorded in New England region, 127 fathoms.

The simple ascidians of this region cannot be as satisfactorily divided into northern and southern groups as the compound ascidians, for three of them range throughout the whole or nearly the whole region. These are: *Bostrichobranchus pilularis*, *Tethyum molle*, *Dendrodoa carnea*. Of the remainder, the following 23 are northern species whose range lies wholly or chiefly north of Cape Cod:

<i>Caesira septentrionalis</i> .	<i>Tethyum coriaceum</i> .
“ <i>intumescens</i> .	“ <i>mortenseni</i> .
“ <i>pannosa</i> .	“ <i>finmarkiense</i> .
“ <i>citrina</i> .	<i>Pandocia fibrosa</i> .
“ <i>papillosa</i> .	<i>Dendrodoa aggregata</i> var. <i>pulchella</i> .
“ <i>retortiformis</i> .	“ <i>grossularia</i> .
<i>Pyra echinata</i> .	<i>Chelyosoma macleayanum</i> .
“ <i>ovifera</i> .	<i>Corella borealis</i> .
“ <i>aurantium</i> .	<i>Phallusia obliqua</i> .
<i>Microcosmus nacreus</i> .	“ <i>prunum</i> .
<i>Pelonaia corrugata</i> .	<i>Ciona intestinalis</i> var. <i>tenella</i> .
<i>Tethyum rusticum</i> .	

Nearly all of these forms either extend their range into the waters of northern Europe (some are circumpolar), or have very close European allies.

The following eight are southern forms found mainly or wholly south of Cape Cod. As in the case of the compound ascidians of similar distribution, but little is yet known about the southern limits of their range:

<i>Caesira lutulenta.</i>	<i>Caesira singularis.</i>
“ <i>manhattensis.</i>	<i>Tethyum atlanticum.</i>
“ <i>arenata.</i>	“ <i>partitum.</i>
“ <i>robusta.</i>	<i>Ciona intestinalis</i> var. <i>ocellata.</i>

The data in regard to many of the species are insufficient for satisfactory generalization in regard to their distribution in depth. A majority of the species of the northern group range in depth from a few fathoms, or from low-water mark, to a considerable depth, generally 100 to 200 fathoms. Only three of them are not recorded from depths of 50 fathoms or more.

With the southern group of species this is not the case. Excepting two which are exclusively confined to moderately deep water some distance off the coast, they are shallow-water forms.

In their habits, the species may be divided into two main classes: those which attach themselves to some more or less solid object, and those which live free, buried in the sand or mud, in which they are often anchored by fibrous processes of the test. The first class includes the larger proportion of the species. A rocky, shelly, or other hard bottom is generally most favorable for these, for the reason that there they are more likely to find firm objects for attachment, but provided such objects are present, the character of the bottom itself is a secondary matter. The species which habitually bury themselves are necessarily inhabitants of sandy or muddy bottoms. It should be noted, however, that such species are often found lightly attached to some object, or to each other.

Of this latter group the following eight may be regarded as members:

<i>Bostrichobranchus pilularis.</i>	<i>Caesira singularis.</i>
<i>Caesira lutulenta.</i>	<i>Pelonaia corrugata.</i>
“ <i>papillosa.</i>	<i>Tethyum molle.</i>
“ <i>arenata.</i>	<i>Pandocia fibrosa.</i>

Also of this group are the deep-sea species *Pandocia albatrossi* and *Caesira verrilli*, though these do not properly belong to the New England fauna.

*Caesira manhattensis* is peculiar in very often growing upon eel-grass (*Zostera*). The period of growth and life of individuals which so

attach themselves is evidently limited by that of the plant, which grows up during the summer months and dies down as cold weather comes on.

#### DESCRIPTIONS OF SPECIES.

The numbered dredging and trawling stations mentioned are those of the United States Commission of Fish and Fisheries, (now the Bureau of Fisheries) and further data in regard to them (dates, temperatures, etc.) can be found in the Report of the Commissioner for 1886 (Washington, 1889).

In classification and nomenclature the writer has followed the system of Hartmeyer as employed by that author in Bronn's Tier-reich, vol. 3, supplement, 1909. As a matter of convenience the order of families and genera employed in that work is followed here in nearly every case. Where this nomenclature involves the substitution of less known names for those which have long been commonly employed, the old name has in many instances been included in brackets after the new one thus: *Caesira* [*Molgula*] *manhattensis* (DeKay).

The considerable number of species to be dealt with has made it necessary to restrict the discussion of the variations due to age, individual peculiarity, and many other factors, and to select for description and illustration adult and moderately large specimens exhibiting what appear to be average characters. But the reader should bear in mind that individual peculiarities are of frequent occurrence in these animals, which though of complex structure, have no hard parts, and that in attempting to identify specimens, complete correspondence with the descriptions in every particular will be the exception rather than the rule. Such differences from the specimen described, as a differently shaped body, difference in coloration, a greater or less number of internal longitudinal vessels on the branchial sac, a smooth exterior in a species usually coated with sand or débris, or the opposite, must be expected to occur not only in single specimens but sometimes in all of a lot of individuals which are collected at the same time and place.

The synonyms and literature of the several species that are given are chiefly those of American authors, those having some reference to the occurrence of the species in the waters of northeastern North America, or those of the original describer. For others having reference to their occurrence in foreign waters the reader is referred to the

extensive lists given by Hartmeyer (1903). Many important references that are of too recent date to appear in the above work of Hartmeyer have, however, been inserted.

Owing to the difficulty frequently encountered in identifying ascidians, even with lengthy descriptions and good figures, the value of analytical keys and synopses of characters for the purpose is doubtful. If those here offered occasionally give a hint that is of assistance, it will be all that is expected.

*Abbreviations used in Illustrations.*

<i>at</i> — atrial aperture.	<i>mdv</i> — median dorsal vessel.
<i>br</i> — branchial aperture.	<i>od</i> — oviduct.
<i>dl</i> — dorsal lamina.	<i>oe</i> — esophagus.
<i>en</i> — endostyle.	<i>ov</i> — ovary.
<i>fd</i> — fold.	<i>r</i> — rectum.
<i>g</i> — gonad.	<i>rep</i> — reproductive glands.
<i>gc</i> — gastric caecum.	<i>s</i> — stomach.
<i>i</i> — intestine.	<i>sd</i> — sperm duct.
<i>ilv</i> — internal longitudinal vessel.	<i>sg</i> — stigmata.
<i>k</i> — kidney.	<i>t</i> — testis.
<i>l</i> — liver.	<i>tv</i> — transverse vessel.

The illustrations are from drawings and photographs by the author. The photographs are from alcoholic specimens. The text-figures show the outline of the body after removal from the test (except text-fig. 12).

Family CAESIRIDAE Hartmeyer, 1908.

[= MOLGULIDAE auct. plur.].

Branchial aperture usually with six lobes; atrial aperture usually with four lobes. Body frequently not permanently attached, the animal living buried in the sand or mud of the sea bottom.

Tentacles almost always branched (simple in one New England species).

Branchial sac with internal longitudinal vessels and generally with longitudinal folds and inwardly projecting conical elevations or infundibula, whose walls are pierced with curved, spirally arranged stigmata, straight stigmata being the exception in this family. Intestine always on left side of body. Reproductive organs sometimes on one, but more frequently on both sides of body.

An excretory organ or kidney consisting of a large completely

closed sac in which concretions develop, is usually situated on the inner wall of the mantle on the right side of the body.

*Key to New England Genera of Caesiridae.*

Branchial sac with six or seven (rarely but five) curved longitudinal folds bearing several or many internal longitudinal vessels; reproductive organs on both sides of body . . . . . *Caesira*.

Branchial sac without folds; seven stout widely separated internal longitudinal vessels on each side; reproductive organs on left side only.

*Bostrichobranchus*.

Genus *BOSTRICHOBANCHUS* Traustedt, 1883.

Branchial sac without folds. Five transverse and seven stout internal longitudinal vessels on each side. Wall of sac raised into internally projecting conical infundibula, numerous and irregular in distribution in old individuals, but showing more or less regularity in arrangement in young specimens. Two long stigmata form a perfect double spiral on the wall of each infundibulum.

Reproductive organs on the left side only, in and beside the intestinal loop.

The genus is evidently derived from the genus *Eugyra* Alder and Hancock, 1870, from which it differs chiefly in the development of numerous secondary infundibula in the wall of the branchial sac, *Eugyra* having regularly but a single vertical row of large infundibula (or two in the ventral region) in each of the spaces marked off by the transverse vessels. This is probably the most highly specialized genus of ascidians. It is known only from the American Atlantic coast, from the Gulf of Saint Lawrence to North Carolina, and though several species have been described, the writer after a study of many specimens has been unable to divide it into species distinguished by definite and constant characters. In this paper therefore its members will be treated provisionally as belonging to a single variable species.

The related genus *Eugyra* Alder and Hancock, 1870, has not been recorded from the region covered by this paper, though Packard (1867, p. 279) reports *Eugyra glutinans* (Möller), under the name "*Glandula glutinans* Möller" from Labrador, "Henley Harbor, 6f. sand," (subsequent records, Packard, 1891, p. 396, and Whiteaves, 1901, p. 271, the latter under the name *Eugyra glutinans*, are based only on Packard's original record). *Eugyra glutinans* is widely

distributed in northern Europe, and occurs about Greenland, so that its occurrence on the Labrador coast or even farther south would not be strange, but as its resemblance to *Bostrichobranchnus pilularis* is very close, not only externally, but internally also in the case of young specimens, a confirmation of Packard's record would be desirable.

***Bostrichobranchnus pilularis* (Verrill).**

Pl. 43, fig. 1-4; Pl. 44, figs. 5, 6; Pl. 69, fig. 137; text-fig. 1.

1871. *Molgula pilularis* Verrill, Amer. Journ. Sci., ser. 3, vol. 1, p. 58, fig. 4c.  
 1871. *Molgula pilularis* Verrill, Amer. Journ. Sci., ser. 3, vol. 2, p. 361.  
 1872. *Eugyra pilularis* Verrill, Amer. Journ. Sci., ser. 3, vol. 3, p. 211, pl. 8, fig. 3.  
 1873. *Eugyra pilularis* Verrill, Amer. Journ. Sci., ser. 3, vol. 6, p. 440.  
 1873. *Eugyra pilularis* Verrill and Smith, Rept. on Invertebrate Animals of Vineyard Sound, pp. 509, 700, pl. 33, fig. 249.  
 1874. *Eugyra pilularis* Verrill, Proc. Amer. Assoc. Adv. Sci., vol. 22, pp. 348, 352, 368.  
 1874. *Eugyra pilularis* Whiteaves, Amer. Journ. Sci., ser. 3, vol. 7, p. 7.  
 1874. *Eugyra pilularis* Verrill, Amer. Journ. Sci., ser. 3, vol. 7, pp. 40, 46, 413.  
 1879. *Eugyra pilularis* Verrill, Preliminary Check-list of Marine Invertebrates, p. 27.  
 1883. *Bostrichobranchnus manhattensis* Traustedt, Vidensk. Meddel. Naturhist. For. Kjobenhavn, 1882, pp. 109, 128.  
 1891. *Eugyra pilularis* + *Bostrichobranchnus manhattensis* + *Molgula pilularis* Herdman, Journ. Linn. Soc. London, Zool., vol. 23, pp. 564, 569.  
 1898. *Eugyriopsis manhattensis* Pizon, Ann. des Sci. Nat., Zool., ser. 8, vol. 7, p. 318.  
 1898. *Eugyriopsis manhattensis* Pizon, Comptes Rendus Acad. Sci. Paris, vol. 126, p. 1816.  
 1898. *Eugyriopsis manhattensis* Pizon, Bull. Mus. d'Hist. Nat. Paris, vol. 4, p. 273.  
 1900. *Eugyra pilularis* + *Herdmania bostrichobranchnus* (also *Bostrichobranchnus molguloides*) Metcalf, Zool. Jahrbücher, Anat., vol. 13, pp. 520, 521, 583ff, pl. 36, fig. 33-37.  
 1901. *Eugyra pilularis* Whiteaves, Geol. Survey Canada, pub. no. 722, p. 271.  
 1901. *Eugyra pilularis* Kingsley, Proc. Portland Soc. Nat. Hist., vol. 2, p. 182.  
 1907. *Bostrichobranchnus manhattensis* Seeliger, Bronn's Tier-reich, vol. 3, suppl., p. 1192, text-fig. 218.  
 1909. *Eugyra pilularis* + *Bostrichobranchnus manhattensis* + *B. molguloides* Hartmeyer, Bronn's Tier-reich, vol. 3, suppl., pp. 1319, 1320.  
 1912. *Bostrichobranchnus molguloides* Michaelsen, Mitth. Naturhist. Mus. Hamburg, no. 28, p. 155.

The following form may be inseparable from this species or it may deserve recognition as a variety or subspecies. (See p. 464.)

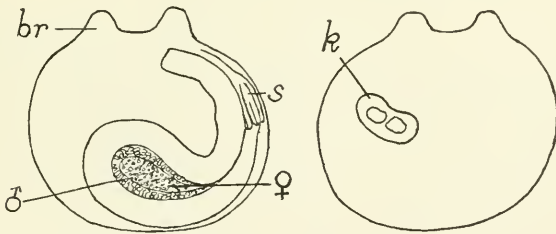
1870. *Molgula producta* Binney, Gould's Invertebrata of Massachusetts, ed. 2, pl. 22, figs. 315, 316 (but not the description in text).  
 1872. *Molgula pellucida* Verrill, Amer. Journ. Sci., ser. 3, vol. 3, pp. 211, 289, pl. 8, fig. 2.  
 1873. *Molgula pellucida* Verrill and Smith, Rept. on Invertebrate Animals of Vineyard Sound, pp. 699, 426, 429.  
 1878. *Molgula pellucida* Coues and Yarrow, Proc. Acad. Nat. Sci., Philadelphia, 1878, p. 303.  
 1891. *Molgula pellucida* Herdman, Journ. Linn. Soc. London, Zool., vol. 23, p. 569 (listed as uncertain species).  
 1909. *Caesira pellucida* Hartmeyer, Bronn's Tier-reich, vol. 3, suppl., p. 1324 (listed as uncertain species).

The writer cannot say whether or not the *Molgula pellucida* Verrill (?) of Metcalf (1900, p. 589) is this animal.

Not *Molgula pellucida* Macdonald, 1859.

Verrill (1871a, p. 58) and Verrill and Smith (1873, p. 700) give a detailed description of the external characters of the typical form of *B. pilularis* which is here quoted:

"Body unattached, globular, covered with a thin layer of mud, and, when the tubes are retracted looking like a small soft ball of mud.



Text-fig. 1.—*Bostrichobranchus pilularis* (Verrill).  $\times 4$ .

Integument of the body, when cleaned, very thin, soft, nearly transparent, thickly covered with minute granules, and minutely fibrous, usually concealed by the adhering particles of mud and fine sand, but this can be easily removed. The tubes are naked, nearly transparent, subconical, slender, as long as the diameter of the body, originating close together and but slightly divergent, both of them nearly straight; they can be wholly retracted and their bases are surrounded and connected by a narrow, naked, oval, or oblong band, which is

usually conspicuous when the tubes are withdrawn; in partial contraction the tubes are conical, subpellucid, reticulated with white lines. The branchial tube is a little shorter than the anal, the aperture surrounded by six acute, conical papillae, and twelve small dark brownish spots. Anal tube a little smaller, slightly longer, a little tapering, with a small square aperture, surrounded by four small lobes and four small, reddish brown eye-spots.

"In life the body when cleaned is transparent grayish, the dark intestine showing through very distinctly; tubes greenish at base.

"Diameter usually about 5 mm., seldom more than 6 mm. or 8 mm."

In the last mentioned of the two works (p. 509) the following further account of this species is given:

"The most abundant [on muddy bottoms of the Massachusetts coast] is *Eugyra pilularis*, which in contraction looks like a round ball of mud, for it completely covers itself with a thick coating of fine sand or mud, which is held in place partly by delicate fibrous processes from the integument, those from the base being longer, and serving to anchor the little creature in the sand by attaching a considerable quantity of sand to themselves. When the sand is removed the integument is found to be thin and quite transparent, the tubes when extended, are long and transparent, close together and inclosed by a naked band which surrounds the base of both."

The species is a variable one, and appears to be considerably affected by the environment in which it happens to grow. Individuals from certain localities may be nearly free from sand or mud and have a fairly smooth, sometimes quite transparent test. The size attained is also apparently much influenced by the locality. In some places it does not exceed the dimensions given by Verrill, although, as the reproductive organs show, the animals are adult. In exceptionally favorable places it becomes 28 mm. to 35 mm. long, and 24 mm. or 25 mm. in dorso-ventral diameter. The animal can generally be recognized among New England forms by the area on the surface of the body, usually free from sand or mud, which surrounds the base of the siphons and is bordered by a definite line. This area is elliptical, somewhat oblong, or more or less figure S-shaped. In many preserved specimens the siphons will be found entirely retracted and projecting but little, if at all, above the general contour of the body, which though often of approximately globular form is nevertheless usually somewhat longer than deep and more or less

compressed laterally. In other cases the siphons may remain extended, in which case the modified area about their bases described above is often inconspicuous.

Transverse muscle fibers prevail in the mantle and are for the most part gathered into very slender bands which are not at all conspicuous on most parts of the body. But in the vicinity of the siphons strong bands spread out in a radial manner over the body surface becoming abruptly slender after a certain distance, and near each side of the mid-ventral line (though not extending across that line) there are many stout transverse muscle bands. The circular muscles about the bases of the siphons are also well developed.

The tentacles are numerous and of about four different sizes or orders arranged with some regularity, the largest numbering about eight. The largest tentacles are irregularly bipinnately or to some extent tripinnately branched. Those of intermediate size are once or twice pinnate with a few rather irregular branches; the smallest are entirely unbranched. The branches terminate in blunt, scarcely enlarged tips.

The orifice of the dorsal tubercle is C-shaped or horseshoe-shaped with the open interval directed toward the left. In large specimens the horns are generally more or less irregularly incurved or bent. The dorsal lamina is plain-edged.

The branchial sac is entirely without folds, but has in their place seven very stout internal longitudinal vessels on each side which are crossed by five transverse vessels, dividing the sac into 48 fields on each side of the body. The stigmata are very long and arranged in chains of double spirals, and the part of the wall of the branchial sac occupied by each well developed spiral becomes raised into an internally projecting infundibulum or cone, upon whose surface one of the long stigmata winds from the base to the apex and terminates there. Another stigma winding down to the base between the coils of the first stigma, crosses to an adjacent infundibulum upon which it forms the ascending spiral, terminating at the apex. Thus the spirals of a number of infundibula form a connected series or chain, and would, were it not for the interruptions at the apices of the infundibula, consist of one continuous long stigma. The infundibula, which are often very long, forming somewhat curved finger-shaped projections into the branchial cavity of various sizes and lengths, are numerous and show no noticeable regularity in their arrangement in large indi-

viduals. Each of the two spiral stigmata which wind around the wall may in a long infundibulum make ten or more complete turns between the base and the apex, but every intermediate stage between such a condition and a very low conical infundibulum with only a few turns can be seen on the same individual; and here and there rudimentary or incipient spirals in which each stigma makes only a part of a turn, are scattered among the fully developed ones. Apparently it is only in localities exceptionally well adapted to the growth of this animal that great complexity of the branchial sac is attained. In other environments the growth of the body is more or less stunted and the number of infundibula developed is much fewer. In such specimens and in young individuals it can be seen that there is a definite system in the arrangement of the infundibula and in the way their spirals are connected together. The infundibula (and the spirals formed by their stigmata) may in such individuals be seen to be of two kinds, here called *primary* and *secondary*. The primary spirals appear first in the young animals, have a definite situation and direction of twist, and for a long time are conspicuous for their greater number of turns, and it is only in large and old individuals that the secondary spirals and infundibula afterward developed attain numbers and dimensions sufficient entirely to obscure this regularity.

In describing the arrangement, the spirals alone will be alluded to, it being understood that as a spiral becomes well developed, that part of the wall of the sac which it occupies becomes raised into an infundibulum. Leaving out of account for the present the spirals in the spaces dorsal to the first internal longitudinal vessel and those bridged over by the seventh (most ventral) internal longitudinal vessel, the apex of each primary spiral is nearly or directly under (bridged over by) an internal longitudinal vessel, and is situated at a point midway along one of the segments into which that vessel is divided by the transverse vessels. Thus, although the vessels divide the surface of the sac into conspicuous fields, the systems of connected spirals do not correspond to these fields, since the primary spirals lie partly in one field and partly in the field next dorsal to it. In young individuals, the primary spirals may be the only ones. But as the individual grows, other spirals (*secondary* spirals) begin to develop. Usually the two first secondary spirals form ventral to the primary one with which they are connected. As the animal grows other secondary spirals (all forming part of the same chain or series) develop

anterior and posterior to the primary spiral, but usually do not form on the area dorsal to it except in old and large individuals when the secondary spirals are already numerous. As far as the writer has observed, the system of connected spirals of which one primary spiral is the center, is in normal cases totally distinct from those connected with any other primary spiral. In large individuals, independent systems of spirals form in the interspaces of the principal chain, and increase the complication of the arrangement. Delicate radial vessels, usually four in number, crossing without interrupting the stigmata strengthen and support each infundibulum.

Not only the distribution, but the direction of twist of the spirals is subject to a definite scheme in young individuals. Those primary infundibula (with the exception of those dorsal to the first, and those bridged over by the seventh internal longitudinal vessel) which are situated in the same vertical row have the same direction of twist. The direction is different in alternate vertical rows. Assuming that the twist is from the base toward the apex, the stigmata curve in the dorsal half of each such primary infundibulum toward the odd-numbered transverse vessels, and the free ends of the stigmata which extend from them (or from the chain of stigmata of which they form a part) lie close to the transverse vessels having odd numbers. This is shown in figs. 3 and 5 (Pls. 43, 44) where comparatively simple arrangements of the spirals are represented. The secondary spirals first developed in each chain and a majority (but not all) of those formed later generally twist in the opposite direction to their primary spiral.

Save for occasional irregularities and individual peculiarities, the above described arrangement prevails throughout the greater part of the sac. The seventh or most ventral internal longitudinal vessel differs in having two primary spirals under (bridged over by) each of its segments. These spirals twist in opposite directions curving toward each other in the dorsal half of each spiral, as in the ordinary primary spirals separated by an odd-numbered transverse vessel. These spirals are connected together through the secondary spirals, lying ventral to them and other secondary spirals develop dorsal to them even in young animals.

In some individuals merely irregularly curved and hooked stigmata occur in some of the fields along the median dorsal vessel. In other individuals well formed spirals exist, often having a direction of twist opposite to that normal in the vertical column in which they are situated.

The alimentary canal forms a small but moderately wide open loop. The stomach walls have longitudinal folds. These are usually few in number (often only about eight or ten) near the esophageal end, but most of them fork, or incomplete folds arise between them, so that at the pyloric end they are more numerous and more irregular. A liver appears to be wanting. The gland surrounding the intestine is well developed and covers the outer surface of the intestine for some distance on the inside of the bend of the loop. It consists of a complex network of crossing and anastomosing tubules whose small branches bear minute bulbs. These bulbs lie close against if not partly buried in the intestinal walls while the tubules bearing them are more superficial. The margin of the anus is smooth.

The kidney is a rather small transparent bean-shaped sac in the right posterior part of the body, attached to the mantle. It generally contains two or three large dark colored concretions.

The reproductive organs are situated on the left side of the body only, and lie in the bend of the intestine. There is a large, central, somewhat flask-shaped ovary, about the border of which (and following the curve of the intestine) the male organ is situated, the latter consisting of numerous small glands which are themselves cleft into from two to five or six or more lobes.

As already stated the writer cannot divide this genus into satisfactorily distinguishable species. The type of the genus *Bostrichobranchnus*, *B. manhattensis* Traustedt, 1883, from Cape Cod, and a species subsequently described by Metcalf (1900) from Buzzards Bay, 9 fathoms, named *Herdmania bostrichobranchnus* (which name he changed to *Bostrichobranchnus molgulooides* in the latter part of the same article) were both described from preserved specimens, and do not seem to have any important features distinguishing them from *Eugyra pilularis* Verrill (1871a) or from each other. It is possible, however, that *Molgula pellucida* Verrill (1872b), which proves upon examination of Professor Verrill's specimens also to belong to this genus, should eventually receive recognition as a subspecies. *Molgula pellucida* is described by Verrill as follows (1872b, p. 289):

"Body subglobular with a smooth, thin, pellucid test. Tubes terminal, contiguous, much swollen at base, long, divergent, tapering, reticulated within by longitudinal and circular white lines (muscular fibers). Branchial aperture with six small papillae. Intestine conspicuously visible through the test; stomach covered by deep

orange colored hepatic glands. Ovaries large, whitish. Color of test, pale hyaline bluish; tubes toward the end, dull neutral tint, diameter of the largest specimens about 1 inch.

“Mass. Bay,—L. Agassiz; Long Island — Coll. Peabody Academy of Science; Bird Shoal near Beaufort, N. C.—Dr. H. C. Yarrow.”

The chief distinguishing characters are evidently the thin transparent test, nearly or quite free from incrusting material and the non-retractile siphons. There are specimens in the collection labeled *Molgula pellucida* from Huntington Bay, Long Island, which were collected by Dr. Tellkamp. They may be Professor Verrill's types. There are also examples apparently intermediate between them and the ordinary *pilularis* from many localities along the New England coast. Specimens from North Carolina, collected by Dr. Yarrow are also in the collection, and differ more from the typical *pilularis* than Tellkamp's specimens do, having long, tapering, very tough non-retractile siphons, and the thin but tough test practically free from incrusting sand, which is characteristic of this variety.

Assuming provisionally that these forms are all of one variable species, *B. pilularis* ranges from the Gulf of Saint Lawrence (Mingan Islands, 50 fathoms, Whiteaves, 1901) if not from still farther north, to North Carolina, and is found in depths from  $\frac{1}{2}$  to 120 fathoms. It is very abundant in many localities, though from its habit of lying buried in the sand or mud it is readily overlooked. In other parts of its range it does not appear to grow as large as near Cape Cod, in Buzzards Bay, and Vineyard Sound. Off Race Point, Cape Cod, is perhaps the most favorable locality. There Professor Verrill found very large specimens cast up on the beach in immense numbers after a storm. Often several large individuals would be found attached together.

The localities of specimens examined by the writer are as follows:

10 miles north of Shediac, N. B. (collected by J. F. Whiteaves).

Stations 85, 86 (off Chebucto Head, Nova Scotia, 101 fathoms).

Stations 56-58, 72, 73, 97 (in and about Halifax Harbor, Nova Scotia, 16 to 18 fathoms, sand).

Bay of Fundy, off Grand Manan (soft mud).

Eastport, Me., and South Bay, Lubec, Me.

Casco Bay (collected by M. M. Metcalf).

Baker's Island, Salem, Mass.

Race Point, Cape Cod (many very large specimens, as above noted).

- Station 920 (off Martha's Vineyard, N. lat. 40° 13', W. long. 70° 41' 54'', 63 fathoms, green mud), many rather large specimens.
- Station 873 (off Martha's Vineyard, N. lat. 40° 02', W. long. 70° 57', 100 fathoms, soft sticky mud).
- Station 876 (off Martha's Vineyard, N. lat. 39° 57', W. long. 70° 56', 120 fathoms, soft sticky mud).
- Station 860 (Vineyard Sound, Cuttyhunk Light N.  $\frac{1}{2}$  W., 3 miles, 17 $\frac{1}{2}$  fathoms, sand and mud).
- Station 788 (off Newport, R. I., 6 miles SSE. of Brenton's Reef Lightship, 18 fathoms, fine sandy mud).
- Station 793 (off Newport, R. I., Point Judith WNW.  $\frac{1}{2}$  W., 6 miles, 19 fathoms, sand and broken shells).
- Off Block Island (specimens covered with very coarse sand).
- Noank, Conn.
- Fisher's Island Sound (off Sea Flower Reef, 7 fathoms).
- Long Island Sound (off New London, 6 to 9 fathoms).
- Huntington Bay, Long Island (collected by T. A. Tellkamp; labeled *Molgula pellucida* as above noted).
- Fort Macon, North Carolina (collected by Dr. H. C. Yarrow; labeled *Molgula pellucida* as above noted, and differing considerably from the typical form).

Traustedt gave this species the specific name *manhattensis* in the belief that it was identical with *Caesira* [*Molgula*] *manhattensis* (DeKay), 1843. There is often considerable superficial resemblance between large specimens of this species and *C. manhattensis*, and an error in Tellkamp's (1874) description of the latter has contributed to the confusion. Tellkamp stated that the branchial sac of *Caesira manhattensis* had no folds, from which one might suspect that his specimens were *Bostrichobranchnus* and not *Caesira*, but neither the rest of his description, nor his figures, nor the localities of his specimens bear out this supposition, and Metcalf (1900) therefore concluded that the statement was an error. This conclusion the writer is able to confirm, having examined some of Tellkamp's specimens which are in the Yale Museum. They are typical *C. manhattensis* with the usual folds in the branchial sac.

Genus CAESIRA Fleming, 1822.

[= MOLGULA auct. plur.].

Branchial sac with five to seven longitudinal folds on each side which, if rudimentary, are at least indicated by a row of infundibula and by a group of closely placed internal longitudinal vessels (rarely by only one or two of the latter).



Test cartilaginous, transparent and smooth externally; stigmata very long and narrow, mostly in spirals; kidney broad but very short (Grand Banks only).

*intumescens.*

Body rounded, with diverging siphons; surface usually more or less covered with débris; intestinal loop bent in a very regular curve; stigmata long, forming many irregular curves and spirals in the spaces between as well as on the folds; six branchial folds, internal longitudinal vessels few..... *manhattensis.*

Body longer than deep, thickly coated with débris; seven high branchial folds with many internal longitudinal vessels; stigmata long and fairly straight between the folds; kidney of moderate size, rather elongated.

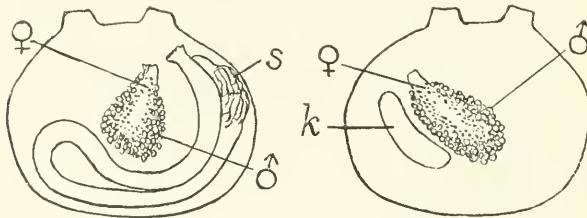
*pannosa.*

Body covered with débris; seven branchial folds; stigmata short and rather irregular in arrangement between the folds; kidney elongated, very large (Grand Banks) ..... *septentrionalis.*

**Caesira lutulenta, sp. nov.**

Pl. 45, fig. 7-10; Pl. 73, fig. 168; text-figs. 2, 3.

Body unattached, of elliptical outline, noticeably longer than deep, and not much compressed laterally, the largest specimen measuring



Text-fig. 2.— *Caesira lutulenta*, sp. nov. × 3.

about 15 mm. long by 12 mm. deep, and 8 mm. or more from side to side. Apertures rather near together on the dorsal surface and in the contracted preserved specimens generally projecting little if at all beyond the general outline of the body, though occasionally they are raised on small papillae. Branchial aperture with six, the atrial with four lobes. Test rather thin and soft though tough, of a deep greenish gray color in the alcoholic specimens and more or less translucent, covered externally with vast numbers of fine soft moss-like branching processes which are best developed on the ventral portions

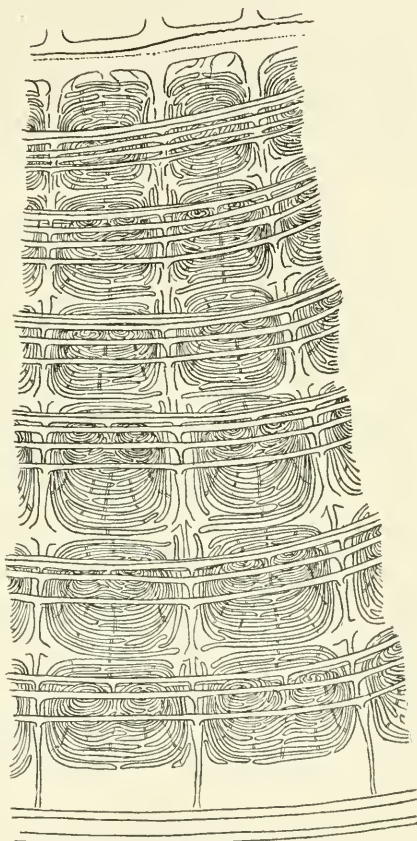
of the body. To these processes a great quantity of mud and very fine sand adheres, giving the animal the appearance of a ball of mud.

Mantle exceedingly delicate, so that it is difficult to remove it entire from the test. Mantle muscles poorly developed. The bands radiating from the bases of the siphons are neither numerous nor stout, and the circular bands underlying them are slender, irregular, and usually not closely placed. Some short transverse bands occur along either side of the mid-ventral region.

Tentacles chiefly of three sizes or orders, quite regularly arranged, those of the first two orders apparently usually numbering six each, and those of the third order twelve. Tentacles of the fourth and fifth orders (the last merely small unbranched papillae) occur in the spaces between the larger ones, but are neither very numerous nor very regularly placed. The large tentacles have rather short branches, and only those on the basal half or two thirds of the main trunk bear small branches. Tips of the branchlets not at all enlarged.

Dorsal tubercle clearly seen in one specimen only. In this it had an elongated very slightly curved slit-like orifice placed almost transversely.

Dorsal lamina plain-edged anteriorly, but the margin of its posterior portion is, in some individuals at least, obscurely denticulate.



Text-fig. 3. — *Caesira lutulenta*, sp. nov. Part of branchial sac of right side of a specimen from Station 921.  $\times 12$ .

Branchial sac of very delicate structure with six fairly prominent folds on each side, each of which bears a row of well developed infundibula, six in number. These are separated by the five principal transverse vessels, and each divides more or less completely into an anterior and a posterior apex separated by a short transverse vessel of the second order confined to the summit of the fold. The internal longitudinal vessels are confined to the folds. In a fairly large individual their total number was as follows:

*mdv.* 0 (7) 0 (8) 0 (7) 0 (6) 0 (5) 0 (4) 0 *en.*

In the respects just described the branchial sac resembles that of our other species of *Caesira*, but in the arrangement of the stigmata there is in this species an approach to the condition prevailing in the genus *Eugyra* and in young specimens of the genus *Bostrichobranchnus*. As in those genera, the spirals in alternate vertical columns of infundibula have opposite directions, and the free ends of the spirals terminate near the odd-numbered principal transverse vessels (nos. 1, 3, and 5). The two spirals on the two apices of an infundibulum often, if not regularly, have opposite directions of twist. A very few slender radial vessels strengthen the infundibula, crossing without interrupting the stigmata.

Intestinal loop fairly widely open for some distance from its reflected end. The whole loop is much less bent than in many of the other New England species, the reflected part being only slightly turned up toward the dorsal side of the body. Stomach wall with rather numerous irregular glandular folds.

Kidney rather small, sausage-shaped, and only moderately wide. It has an oblique position against the body wall in the right posterior ventral part of the body.

The gonads, which have the usual positions dorsal to the intestinal loop and the kidney respectively, are unusually wide and short. Each consists of a central flask-shaped ovary (containing in all the specimens studied very numerous small eggs) bordered, except at and near the small open end, with the numerous small lobed or pyriform testes.

This species, readily distinguished by the fine moss-like processes on the outer surface and by the long spirally arranged stigmata and the short, broad, gonads, seems to be confined to moderately deep water (67 to 142½ fathoms) off the coast of southern New England

and the States farther south. It inhabits muddy bottoms, burying itself in the mud.

The localities of the specimens are as follows:

- Station 921 (N. lat.  $40^{\circ} 07' 48''$ , W. long.  $70^{\circ} 43' 54''$ , 67 fathoms, green mud).  
 Station 871 (N. lat.  $40^{\circ} 02' 54''$ , W. long.  $70^{\circ} 23' 40''$ , 115 fathoms, mud and fine sand).  
 Stations 941 (N. lat.  $40^{\circ} 01'$ , W. long.  $69^{\circ} 56'$ , 79 fathoms, hard sand and mud).  
 Station 878 (N. lat.  $39^{\circ} 55'$ , W. long.  $70^{\circ} 54' 15''$ ,  $142\frac{1}{2}$  fathoms, mud).  
 Station 2559 (N. lat.  $39^{\circ} 48'$ , W. long.  $71^{\circ} 48' 30''$ , 120 fathoms, brown mud and sand).

**Caesira manhattensis** (DeKay).

Pl. 45, fig. 11-13; Pl. 71, figs. 151, 152; text-figs. 4, 5.

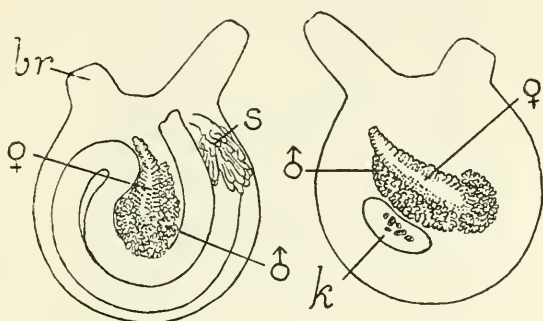
1838. *Ascidia rustica* Couthouy, (non Linnaeus), Boston Journ. Nat. Hist., vol. 2, p. 111.  
 1841. *Ascidia rustica* Gould (non Linnaeus), Rept. Invertebrata of Mass., ed. 1, p. 319.  
 1843. *Ascidea manhattensis* + *A. rustica* Gould (non Linnaeus), DeKay, Rep. Nat. Hist. New York, Mollusca, p. 259.  
 1850. *Ascidia amphora* Agassiz, Proc. Amer. Assoc. Adv. Sci., vol. 2, p. 159.  
 1860. *Ascidia Manhattensis* Stimpson, Smithsonian Check-list, p. 2.  
 1869. *Ascidia Manhattensis* Perkins, Proc. Boston Soc. Nat. Hist., vol. 13, p. 160.  
 1870. *Ascidia Manhattensis* + *A. amphora* Binney, Gould's Invertebrata of Mass., ed. 2, pp. 23, 25, pl. 24, fig. 333.  
 1870. *Ascidia amphora* + *A. manhattensis* Dall, Proc. Boston Soc. Nat. Hist., vol. 13, p. 255.  
 1871. *Molgula Manhattensis* Verrill, Amer. Journ. Sci., ser. 3, vol. 1, p. 54, fig. 1.  
 1871. *Molgula Manhattensis* Verrill, Amer. Journ. Sci., ser. 3, vol. 2, p. 359.  
 1871. *Ascidia Manhattensis* Perkins, Proc. Boston Soc. Nat. Hist., vol. 13, p. 160.  
 1872. *Molgula Manhattensis* Verrill, Amer. Journ. Sci., ser. 3, vol. 3, p. 213.  
 1873. *Molgula Manhattensis* Verrill and Smith, Rept. on Invertebrate Animals of Vineyard Sound, pp. 699, 311, 445, etc., pl. 32, fig. 250.  
 1874. *Ascidia Manhattensis* Tellkampf, Ann. Lyceum Nat. Hist. N. Y., vol. 10, p. 83-91, pl. 3.  
 1879. *Molgula Manhattensis* Verrill, Preliminary Check-list of Marine Invertebrates, p. 27.  
 1879. *Molgula Manhattensis* Verrill and Rathbun, Proc. U. S. Nat. Mus., vol. 2, p. 231.  
 1882. *Molgula manhattensis* Kingsley, Proc. Boston Soc. Nat. Hist., vol. 21, p. 441-451, pl. 9. (Development.)  
 1889. *Molgula Manhattensis* McDonald, Rept. U. S. Comm. Fish and Fisheries for 1886, p. 858.

1894. *Molgula Manhattensis* Willey, Amphioxus and Ancestry of the Vertebrates. New York & London.
1897. *Molgula manhattensis* Crampton, Ann. New York Acad. Sci., vol. 10, p. 50-57, pls. 4, 5.
1898. *Molgula manhattensis* Hunter, Journ. Comp. Neurol., vol. 8, p. 202. (Notes on peripheral nervous system.)
1900. *Molgula manhattensis* Metcalf, Zool. Jahrbücher, Anat., vol. 13, pp. 519, 584, 588, pl. 36, figs. 29, 30, 2 text-figs. p. 581.
1900. *Molgula manhattensis* Wilson, Amer. Naturalist, vol. 34, p. 354.
1900. *Molgula manhattensis* Willey, Quart. Journ. Micr. Sci., vol. 44, p. 141-160, pl. 9.
1903. *Molgula (Bostrichobranchus) manhattensis* Bancroft and Esterly, Univ. of California Publications, Zool., vol. 1, p. 105.
1902. *Molgula manhattensis* Hunter, Anat. Anz., vol. 21, p. 241-243, 3 text-figs. (Structure of heart.) Abstracts in Journ. Roy. Mic. Soc., 1902, p. 548; Zool. Jahrb., 1902.
1903. *Molgula manhattensis* Hunter, Amer. Journ. Physiol., vol. 10, p. 1-27. (Notes on heart action.)
1909. *Caesira manhattensis* Hartmeyer, Bronn's Tier-reich, vol. 3, suppl., p. 1323.
1912. *Caesira manhattensis* Hartmeyer, Sitzungsber. Ges. Naturforsch. Freunde, 1912, no. 1, p. 14.
1912. *Caesira manhattensis* Hartmeyer, Denkschr. K. Akad. Wiss. Wien, cl. math.-nat., vol. 88, p. 209.  
Probably not *Molgula manhattensis* Kingsley (1901, p. 182).

Body normally nearly globular except for some degree of lateral compression. Siphons diverging and usually more or less curved, originating from the dorsal surface a little way apart or, less often, quite close together. The atrial siphon is tapering and may equal half the body diameter in length; it has a square aperture. The branchial siphon is shorter, stouter and more truncate, and has a six-lobed aperture. Attachment of body frequently by a rather small area on the left ventral surface, but several or many individuals often grow together in a cluster, and the position of the area of attachment as well as its extent, is very variable.

Test firm, tough, and moderately thick, with a finely but irregularly roughened surface. This roughness commonly develops on or near the bases of the siphons into more or less noticeable papillae, and on various parts of the body into an irregular coat of short, uneven, hair-like processes, which would not be particularly conspicuous were it not that they generally serve to catch and attach sand grains, shell fragments, bits of eel-grass and other débris, the fragments being

often of such size and attached in such abundance as completely to disguise the form and appearance of the animal. Occasionally specimens have a fairly smooth even coating of sand grains. In living specimens the test has a pale greenish yellow or olive color. "The branchial orifice is sometimes surrounded within by a ring of dull reddish brown, the 6 lobes have each a spot of dark brown with smaller ones between. The anal orifice is greenish yellow" (Verrill, 1871a, p. 55). The mantle, when the test is removed, is greenish, the intestine and gonads showing through it.

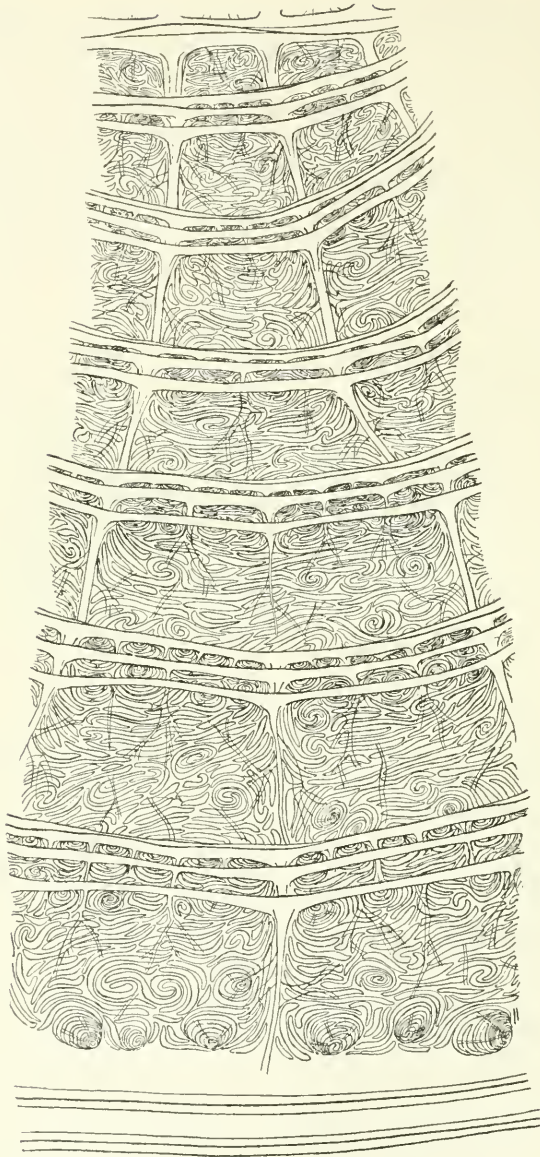


Text-fig. 4.—*Caesira manhattensis* (DeKay).  $\times 1.7$ .

Large specimens measure 20 mm. to 25 mm. in antero-posterior or dorso-ventral diameter, the lateral diameter being somewhat less.

Mantle musculature rather weak. Muscle bands radiating from siphons not very numerous. Over most of the body the musculature consists of rather weak and not very closely placed bands of different sizes. They cross each other in various directions, the greater number having a transverse or somewhat oblique direction.

Branched tentacles of about four orders are present in addition to a variable, but often considerable, number of minute simple or rudimentary ones. The larger tentacles are arranged with some approximation to regularity and numbered in several specimens studied about four of the first, four of the second, and eight of the third order, but there is much individual variation. Largest tentacles three times compound; ultimate branchlets borne numerously on the trunk and larger branches as well as on the smaller ones; their tips not at all swollen.



Text-fig. 5.— *Caesira manhattensis* (DeKay). Part of right side of branchial sac.  $\times 15$ .

Dorsal tubercle C-shaped or horseshoe-shaped, open interval to the right or rear; horns usually strongly incurved.

Dorsal lamina plain.

Branchial sac with six folds on each side, which are not very prominent but are conspicuous on account of the internal longitudinal vessels they bear, these being wanting on the interspaces. Maximum number of vessels on any fold usually six, sometimes seven in the dorsal part of the sac diminishing to four and three on the two ventrally situated folds. (One or two vessels on the larger folds are generally concealed in the normal position of the fold.) Five large transverse vessels. In their intervals are several orders of smaller transverse vessels, which are for the most part confined to the folds and do not extend across the interspaces. Some of those of the second order become thicker in the ventral parts of the sac (where, on account of the curvature of the folds, the transverse vessels of the first order are widely separated) and continue across the interspaces between the folds assuming the rôle of vessels of the first order. The smallest transverse vessels occur only on the summits of the folds. The summit of each fold is occupied by a longitudinal series of small infundibula, upon which the stigmata are narrow and form single or double spirals of many turns. They are bridged over by the internal longitudinal vessels borne on the summit of the fold. Along the sides of the folds are less regular rows of infundibula. On the interspaces the stigmata are wider but still mostly very long and narrow. Though a majority are longitudinal in direction, many of them are curved or hooked at one end, and here and there they assume a spiral arrangement, a more or less perfect infundibulum being formed. Along each side of the endostyle there is a somewhat irregular row of large infundibula. The considerable length of most of the stigmata, and the fewness of the transverse vessels in the broad interspaces between the folds, all tend to make the walls of the branchial sac very delicate. This weakness is in part overcome by a rather extensive system of delicate branching vessels (for the most part of flattened section so that they are but slightly prominent on the wall of the branchial sac) which lie upon the inner wall of the sac, especially on the interspaces between the folds, and cross the stigmata in various directions without interrupting them.

Digestive tract forming a narrow loop whose branches are in close contact for most of their length. The whole loop is bent in a very

regular circular curve approximating three fourths of a circle, a character serving to distinguish this from the other New England species. Wall of the anterior part of the stomach plicated with irregular convolutions so as to suggest the appearance of the human brain. Posterior part smooth-walled, tapering gradually off into the intestine.

Kidney of moderate size with a slightly elongated bean-shaped outline.

The ovary, forming the central part of each gonad, has an elongated flask-shaped outline; its walls have transverse plications which deeply constrict the interior cavity. The eggs are small and are mostly imbedded in or attached to the thick glandular walls of the ovary. That part of the wall lying against the mantle is, however, thin and bears few or no eggs. About the margins of the ventral portion of the ovary the testis is situated. It consists of dense masses of small, distinct, mostly two- or three-lobed glands. These glands extended farther on the anterior than the posterior margin of the left ovary in the individuals studied, and the long axis of the left gonad is nearly vertical (see text-fig. 4). The right gonad has an inclined portion, and is somewhat narrower and longer than the left, the male glands extending along the ventral margin of its ovary (between the latter and the kidney) but reaching also around its anterior (closed) end and a little way along the dorsal margin. The difference in the shape of the two gonads is less pronounced than in *C. lutulenta*.

The range of this species, as far as the writer can give it from specimens actually examined, is from Cape Ann (Annisquam, Mass.) to Beaufort, N. C. Verrill and Smith (1873) record it from Casco Bay, Me., though less common there than farther south, but a bottle of Verrill's specimens, in all probability the very ones upon which the record was based, prove on examination to be a different species. Nor were any specimens found in the extensive collections made at other points on the coast of Maine.

A long list of localities where it is found in greater or less abundance might be given. Among those of specimens which the writer has himself dissected are: Annisquam, near Boston, Wood's Hole, and Vineyard Haven, as well as other localities about Vineyard Sound, and Buzzards Bay, on the Massachusetts coast; off Newport (6 fathoms), and Point Judith  $12\frac{1}{2}$  (fathoms), Rhode Island; Stonington, Noank, and New Haven, Connecticut; Bay Shore and Fire Island on the south shore of Long Island, New York City (the type

locality); Beesley's Point, New Jersey; the mouth of Patapsco River, Maryland; and Beaufort, North Carolina.

Although the Yale collection contained specimens of ascidians from various stations to depths of 85 fathoms labeled "*Molgula manhattensis*" those from deeper water proved on dissection to be of other species, and as far as the writer can ascertain from the series of specimens available, this species is confined to shallow water, 16 fathoms or less, and it is certainly most plentiful in the shallowest situations.

Along the coast of southern New England (as far north as the vicinity of Boston), Long Island, New Jersey, and doubtless also farther southward, this is the most abundant and conspicuous of the simple ascidians. This great abundance is largely due to its habit of growing upon eel-grass (*Zostera*) as well as attached to stones, piles of wharves, etc., for the extensive shallow flats on which a luxuriant growth of the above mentioned plant develops every summer in the bays and harbors of these coasts, afford almost unlimited opportunity for the increase of an animal adapted to that particular environment. In favorable situations it grows in clusters of several or many individuals of different sizes. This species has been the subject of a number of anatomical and embryological studies.

Tellkamp (1874) published some notes on the distribution, anatomy, growth, and development of this species, which, however, require some correction. He stated that the branchial sac was not plicated, and supposed that this species developed with an alternation of generations, the eggs developing into a so called "Mammaria" instead of into the parent form. Just what this "Mammaria" was, is difficult to say. His description somewhat suggests a young colony of the genus *Botryllus*.

Kingsley (1882) also made a study of this species, and flatly denies that any such alternation takes place, saying that the tailed larvae develop into the adult in the usual manner.

*C. ampulloides* (Van Beneden), 1846, widely distributed in the waters of western and northern Europe and Asia, and recorded also from Greenland, is a littoral form closely allied to *C. manhattensis*, and *C. socialis* (Alder), 1863, is also a closely allied western European form. Through the kindness of Dr. Hartmeyer the writer has been enabled to make a direct comparison of specimens of these species with *C. manhattensis*, but is not inclined to regard the European species as identical with each other or with *C. manhattensis*. Of the two

*C. socialis* appears to be the most closely allied to the American species.

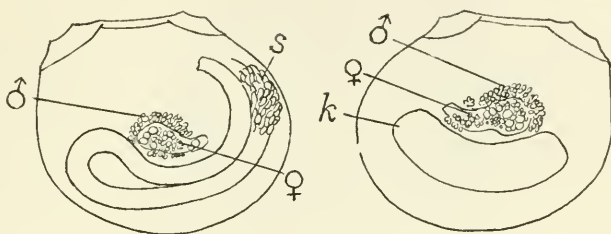
**Caesira septentrionalis** (Traustedt).

Pl. 46, fig. 14-16; Pl. 73, fig. 160; text-figs. 6, 7.

1842. *Ascidia conchilega* Möller, Naturhist. Tidsskr., vol. 4, p. 95 (non Müller, 1788).
1883. *Molgula septentrionalis* + *M. boreas* Traustedt, Vidensk. Meddel. Naturhist. For. Kjøbenhavn, pp. 111, 112.
1891. *Molgula septentrionalis* + *M. boreas* Herdman, Journ. Linn. Soc. London, Zool., vol. 23, p. 56S.
1892. *Molgula septentrionalis* Herdman, Proc. and Trans. Liverpool Biol. Soc., vol. 6, p. 91.
1892. *Molgula septentrionalis* Jacobsohn, Trav. Soc. Nat. St. Pétersbourg, vol. 23, pt. 2, pp. 9, 13.
1896. ? *Molgula norvegica* Kiaer, Norske Nordhavs-Exped., vol. 23, no. 3, p. 15, pl. 5, fig. 8-12.
1901. *Molgula septentrionalis* Hartmeyer, Meeresfauna Bergens, p. 53, figs. 19, 20.
1903. *Molgula septentrionalis* Hartmeyer, in Römer and Schaudinn, Fauna Arctica, vol. 3, p. 152, pl. 4, figs. 7, 8; pl. 7, fig. 12-16; pl. 8, fig. 18.
1906. *Molgula septentrionalis* Redikorzew, Trav. Soc. Nat. St. Pétersbourg, vol. 37, pt. 1, p. 310.
1907. *Molgula septentrionalis* Redikorzew, Ann. Mus. Zool. Acad. St. Pétersbourg, vol. 11, pp. 129, 151-153.
1908. *Molgula septentrionalis* Redikorzew, Trav. Soc. Nat. St. Pétersbourg, vol. 39, pp. 20, 22.
1908. *Molgula septentrionalis* Bjerkan, Tromsø Mus. Aarshefter, no. 25, pp. 56, 57.
1909. *Caesira septentrionalis* Hartmeyer, Bronn's Tier-reich, vol. 3, suppl., p. 1324.
1910. *Caesira septentrionalis* Hartmeyer, Danmark-Expeditionen, vol. 5, p. 229.
1912. *Caesira septentrionalis* Hartmeyer, Sitzungsab. Ges. Naturforsch. Freunde, 1911, no. 10, p. 439.
1912. *Caesira septentrionalis* Hartmeyer, Sitzungsab. Ges. Naturforsch. Freunde, 1912, no. 1, p. 17.
1912. *Caesira septentrionalis* Hartmeyer, Vidensk. Meddel. Naturhist. For. Kjøbenhavn, vol. 63, p. 264.

The only specimen in the collection measures about 19 mm. by 19 mm. by 13.5 mm. None of these diameters, however, corresponds to any principal axis of the animal, as it is flattened in a somewhat oblique direction. The surface is rough and irregularly incrustated with sand and shell fragments (some of considerable size) and bears

scattered irregular hair-like processes, most of which are very short. The apertures are not raised on tubes or papillae, and are difficult to discern from the exterior. The branchial aperture is well forward at the anterior end of the body, the atrial some distance back. Test in the preserved specimens yellowish gray, somewhat transparent when



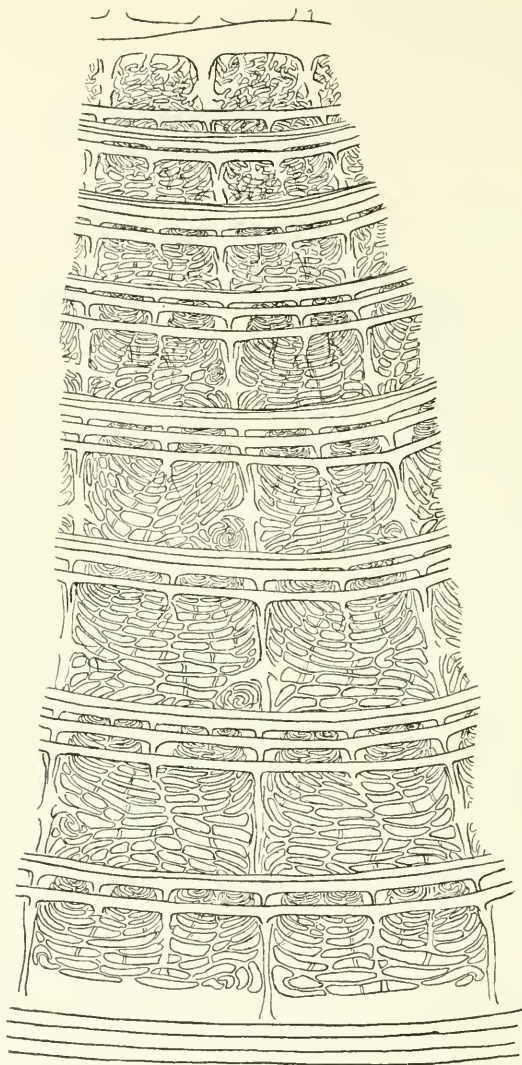
Text-fig. 6.—*Caesira septentrionalis* (Traustedt).  $\times 2.2$ .

the foreign bodies incrusting it are removed, and of a tough, cartilaginous consistency.

Musculature of the mantle strong. It corresponds exactly with that described in European specimens by Hartmeyer (1903). From the bases of the siphons (if that term can be applied to such low projections) strong muscle bands radiate upon the surface of the body extending some distance except upon the area between the siphons. A strong ring muscle lies externally upon these radial muscles at the base of each siphon. Along each side of the region of the endostyle, and transversely or somewhat obliquely placed, are spindle-shaped bands, which are more conspicuous on the left side than on the right and form in places more or less noticeable longitudinal rows.

Oral tentacles stout, with broad membranes, but very scantily branched. There are about a dozen large tentacles probably representing two orders, and some branched tentacles of a smaller (third) order in the intervals. Still smaller tentacles also occur, but are rather few, and the usual scheme of arrangement is not very strictly adhered to. The branching of the larger tentacles is to some extent irregularly bipinnate, those of the third order are only once pinnate; the tips of the stout short branchlets are rounded and often slightly enlarged.

Dorsal lamina with a smooth straight rather thick margin; endostyle unusually stout.



Text-fig. 7.—*Caesira septentrionalis* (Traustedt). Part of right side of branchial sac.  $\times 9$ .

Owing to an injury to that part of the specimen, the dorsal tubercle was not clearly seen. (According to Hartmeyer it is always simply C-shaped with the opening directed to the left rear.)

Branchial sac with seven folds on each side, of which all but the seventh or most ventral fold are well developed. There are five principal transverse vessels extending from the median dorsal vessel to the endostyle. On the summit of each fold, in each of the spaces marked off by these transverse vessels there are two well developed infundibula, many of which divide more or less completely into an anterior and a posterior apex. The infundibula of a pair are separated by a short transverse vessel of a second order confined in most cases entirely to the fold in which it is situated. Where the infundibula divide into two apices the latter may be separated from each other by short transverse vessels of a third order. The internal longitudinal vessels are stout and are confined to the folds except that one vessel of the first fold on one side lies a little removed from the base of the fold. The vessels number about as follows:

Left side	0	(5)	0	(6)	0	(7)	0	(6)	0	(5)	0	(4)	0	(4)	0
	<i>mdv.</i>												<i>en.</i>		
Right side	0	(6)	0	(5)	0	(6)	0	(6)	0	(5)	0	(5)	0	(4)	0

Stigmata mostly small and short, arranged rather irregularly in straight or curved longitudinal rows on the interspaces between the folds, their arrangement becoming concentric or irregularly spiral on the infundibula. They also occasionally have a tendency to assume a spiral or concentric arrangement (indicating the development of rudimentary infundibula) on some of the interspaces between the folds, usually in the immediate vicinity of one of the large transverse vessels, also along the extreme ventral part of the sac each side of the endostyle. Irregular branching vessels lying on the inner surface of the sac and crossing usually without interrupting the stigmata are extensively developed, especially in the dorsal part of the sac. In the spaces each side of the median dorsal vessel they are so numerous as largely to cover and conceal the stigmata. They bear small rounded papillae on the ends of many of their branches.

Stomach wall very glandular, with very numerous irregular folds and small rounded or irregular projections. The intestine forms a loop whose position is mainly horizontal, bending only very slightly upward (dorsally) at the reflected end. The branches of the loop approach each other a short distance from the reflected end and run nearly parallel for some distance.

Kidney very large and long, quite decidedly curved, with the concavity dorsal.

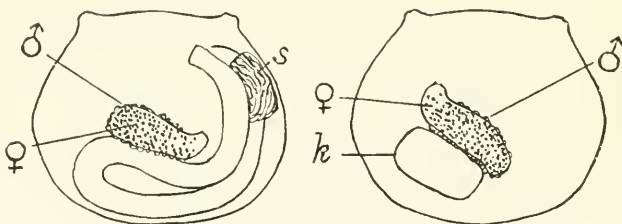
Gonads in the usual situations, dorsal to the intestinal loop on the left side and dorsal to the kidney on the right. That of the right side is the largest. Each gonad consists of a central moderately wide phial-shaped ovary having a slight S-shaped curvature, bordered especially on the dorsal and anterior edge by the testes, which are mostly cleft into several lobes and are fairly large and not very numerous. The eggs contained in the ovaries are also rather large and few.

This well characterized species is represented by only a single specimen from the Banks of Newfoundland. It has been collected, according to Hartmeyer (1903), about Spitzbergen, on the Norwegian coast, the Murman coast, in the White Sea, and on the Greenland coast, 50 fathoms being the greatest depth recorded for it.

***Caesira intumescens*, sp. nov.**

Pl. 46, fig. 17-20; text-fig. 8.

In the better preserved of the two specimens in the collection, the body is of fairly regular rounded form measuring 12 mm. long, 10 mm. deep, and 8 mm. from side to side. The apertures are widely sepa-



Text-fig. 8.— *Caesira intumescens*, sp. nov.  $\times 3$ .

rated (about 5.5 mm. apart) and do not project above the surface. They are in fact so strongly contracted that the number of their lobes is not evident. The test is quite transparent and practically colorless, and of a rather firm cartilaginous consistency, moderately thick in some places, but thin in others. The outer surface is not entirely smooth, having numerous slight wrinkles, but is free from processes of the test substance and from adhering foreign matter.

The specimen had evidently adhered to hydroid stems by an area on its lower surface.

The other specimen is larger (22 mm. by 18 mm.), but less regular in form. It also grew on a hydroid.

Mantle thin, the musculature rather slight but extended over a large part of the surface of the body, though over the region of the kidney it disappears almost completely. Musculature composed mainly of very slender crooked bands forming a very loose extremely irregular network. On the area about the apertures it consists as usual of radiating and circular bands, but these are neither stout nor numerous, nor very regular in their arrangement. The majority of the circular bands lie superficial to the radiating ones.

About six large, pinnately branched, two or three times compound tentacles, and several orders of smaller and simpler ones arranged according to the usual scheme, but with frequent irregularities.

Dorsal tubercle simply C-shaped, with the horns neither inrolled nor strongly incurved. Open interval turned toward the right.

Owing to mutilation of the specimen not much of the dorsal lamina or the dorsal part of the branchial sac could be seen; the branchial folds could not be satisfactorily counted, but it seems not improbable that there were but six. The internal longitudinal vessels are stout. They number on the last three folds on the right side (the fourth, fifth, and sixth, if the above total is correct) five, four, and three respectively. Apparently there was a total of not more than about six or seven on any of the folds. The principal transverse vessels, extending from the median dorsal vessel to the endostyle appear to be of the usual number (five). Along the summits of the folds in each of the spaces marked off by these vessels one large infundibulum is present (on the last fold sometimes two). These usually divide into an anterior and a posterior apex. Between these apices a small transverse vessel is usually present.

Stigmata very long and narrow and arranged spirally on the infundibula. These spirals are, however, not continuous, the stigmata ending at intervals, often without being directly continued by another, but the general spiral arrangement is maintained by the adjacent stigmata, which close nearer together when the one between them terminates. In the great length and narrowness of the stigmata the branchial sac of this species resembles that of *C. lutulenta*, but the

arrangement of the spirals is less regular and they do not appear to commence near particular transverse vessels as in that form. Elsewhere than on the infundibula the stigmata are usually irregularly (often very irregularly) curved, and frequently rather short. They often tend to form rudimentary spirals and infundibula. This is particularly the case between the last fold and the endostyle.

Intestinal loop not much bent up toward the dorsal side. Its branches are not widely open, but come together only gradually and at a considerable distance from the reflected end. The stomach walls are developed by means of very narrow and deep irregular plications into a glandular organ of large bulk.

Kidney a short broad sac of somewhat oblong form in the usual position on the right side.

Gonads placed as usual dorsal to the intestinal loop and the kidney respectively. Each contains a moderately elongated phial-shaped ovary which is densely crowded with small eggs. The male portion of the organ consists of small lobed glands of the usual type which do not extend out much beyond the border of the ovary, but lie between it and the mantle.

The only good specimen of this species in the collection was collected at Station 2449 (N. lat.  $46^{\circ} 37'$ , W. long.  $49^{\circ} 50' 30''$ , 39 fathoms, broken shells) at the extreme eastern edge of the Grand Banks. Another but poorly preserved specimen also comes from the Banks of Newfoundland, but doubtless from some other place, having been brought in by fishermen.

**Caesira pannosa** (Verrill).

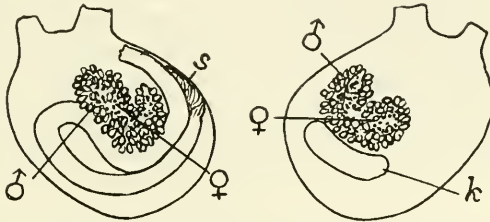
Pl. 47, fig. 21-24; Pl. 48, fig. 25; Pl. 71, fig. 148; text-fig. 9.

1871. *Molgula pannosa* Verrill, Amer. Journ. Sci., ser. 3, vol. 1, p. 55, fig. 2.  
 1872. *Molgula pannosa* Verrill, Amer. Journ. Sci., ser. 3, vol. 3, p. 211.  
 1874. *Molgula pannosa* Whiteaves, Amer. Journ. Sci., ser. 3, vol. 7, p. 5.  
 1874. *Molgula pannosa* Verrill, Proc. Amer. Assoc. Adv. Sci., vol. 22, pp. 352, 355, 363, 368.  
 1874. *Molgula pannosa* Verrill, Amer. Journ. Sci., ser. 3, vol. 7, pp. 39, 43, 46, 413.  
 1891. *Molgula pannosa* Herdman, Journ. Linn. Soc. London, Zool., vol. 23, p. 569.  
 1901. *Molgula pannosa* Kingsley, Proc. Portland Soc. Nat. Hist., vol. 2, p. 182.  
 1901. *Molgula pannosa* Whiteaves, Geol. Survey Canada, pub. no. 722, p. 270.

1909. *Caesira pannosa* Hartmeyer, Bronn's Tier-reich, vol. 3, suppl., p. 1324.  
 1912. *Caesira pannosa* Hartmeyer, Sitzungsber. Ges. Naturforsch. Freunde,  
 1912, no. 1, p. 17.

Verrill's description of this species deals exclusively with the external appearance and is here quoted in full:

"Body subglobular, or a little elongated, somewhat compressed laterally, entirely covered, except the ends of the tubes, with a firm and thick covering, composed of fragments of shells, echini, zoö-



Text-fig. 9.—*Caesira pannosa* (Verrill).  $\times 3$ .

phytes, worm-tubes, foraminifera, grains of sand, pieces of sea-weed, and other debris. The surface of the integument, when the foreign matter is removed, is densely covered with small granule-like papillae, which give rise to very abundant, long, fine fibrous processes, by which the foreign matters are entangled; the basal portion of the tubes is covered with similar processes, though less numerous, which decrease toward the end, leaving the terminal portion nearly smooth. The tubes, which arise close together, are short conical, a little divergent. The anal tube is a little longer than the branchial, swollen at base, tapering and rounded at the end, which has a very small square aperture. The branchial tube is about the same in size, but a little shorter, subcylindrical, scarcely tapering, with six, small, prominent, acute lobes or papillae; alternating with these are six smaller ones. In contraction the tubes can be wholly withdrawn, and then the body looks like a more or less irregular ball of dirt.

"In life the color of the clean integument is a dull, dark, grayish green; the tubes lighter, or dull olive-green.

"A large specimen, when expanded, was 1 inch in length; .75 broad; .50 thick."

In the alcoholic specimens examined by the writer the color of the

test both without and within was generally decidedly more brown than gray or greenish. Many of the specimens have on one side an area where the test processes are few and short and the adhering material scanty, looking as if the body had been attached by that area or at least pressed against some other object. In a few specimens the siphons arise a considerable distance apart. The largest specimen examined measured 24 mm. in length, 16 mm. in dorso-ventral diameter, and still less in transverse diameter, but the usual dimensions are not more than two thirds as great as in this specimen.

Mantle musculature slight, muscle bands conspicuous chiefly near the siphons, from whose bases stout closely placed radiating bands extend for some distance, then taper abruptly and either end or become very narrow and inconspicuous. These radiating bands are overlaid by a layer of circularly placed fibers. Short thick oblique muscle bands occur also in considerable numbers near the mid-ventral line on each side of the body, but do not extend across the region of the endostyle.

Tentacles of at least four orders fairly regularly arranged. Large tentacles few, irregularly bipinnately (to some extent tripinnately) branched. The branchlets, which have the tip rounded but not perceptibly enlarged, are borne on the main stem (between the origins of the larger branches) as well as upon the large branches. The smallest tentacles are nearly or quite simple.

In the specimens examined the orifice of the dorsal tubercle was simply C-shaped or horseshoe-shaped with the open interval directed obliquely (sometimes forward, oftener backward) to the left.

Dorsal lamina very broad and stout, with a smooth, somewhat rolled margin.

Branchial folds well developed, seven on each side. Internal longitudinal vessels numerous and fairly stout; they are well developed both on the dorsal and on the ventral of the two leaves forming each fold and generally occur only on the folds, though sometimes one may lie in an interspace but close along the base of a fold. In a very large individual these vessels numbered as follows:

*mdv.* 0 (10) 0 (12) 0 (12) 0 (11) 0 (9) 0 (7) 0 (6) 0 *en.*

but this is a somewhat greater number than occur in most specimens, and in the normal more or less dorsally directed position of the folds some of the vessels are of course concealed from view.

Principal transverse vessels of the sac five in number. Short transverse vessels of the second order (confined, except in the ventral region, to the folds themselves and not extending on to the interspaces) occur midway between the principal ones, and in the intervals still smaller and shorter vessels of a third order are present, especially in large specimens, their presence depending upon whether or not the infundibula fork or divide a second time, as described just below.

Stigmata short and arranged on the interspaces between the folds in longitudinal rows, which, as a transverse vessel is approached, curve toward and extend on to the nearest fold. The summit of each fold is formed by a series of large low infundibula, only one generally occupying each of the spaces marked off by the principal transverse vessels, and on these infundibula, the stigmata gradually assume a concentric and irregularly spiral arrangement. Each infundibulum divides into two cones (a posterior and an anterior) separated by a short transverse vessel of the second order, and some of them (in very large individuals most of them) divide a second time so that there is a series of four small cones along the summit of the folds between each principal transverse vessel. On the cones the stigmata become very narrow and are separated only by slender vessels. These infundibula are bridged over by the internal longitudinal vessels running along the summit of the fold. Infundibula do not develop elsewhere and only rarely is there any tendency to a spiral arrangement of the stigmata except on the upper parts of the infundibula just described. Fig. 22 shows the arrangement of the folds, vessels, and stigmata in an adult individual of medium size. In very large individuals both the longitudinal and the concentric or spiral rows of stigmata will usually be found more numerous; the stigmata remain short even in the largest specimens.

The stomach wall is either very delicate or, in the specimens examined, had been injured by digestion after death, so that its structure could be made out only imperfectly. The wall of the proximal part of the organ has many deep plications which are more or less irregular and variable in length and direction. In one specimen at least, these folds appeared to form a rather conspicuous glandular mass on the posterior aspect of the stomach. The intestine forms a loop whose sides are separated fairly widely for a short distance near the reflected end but elsewhere are close and overlapping. The whole loop forms a somewhat angular curve, widely open dorsally. Margin of anus sinuate.

Kidney a rather elongated sausage-shaped sac of considerable size, situated against the mantle in the right postero-ventral part of the body. Its concave border is directed dorsally and somewhat forward.

Gonads proportionally rather short and broad, consisting of a central elongated ovary abruptly bent or curved dorsally, bordered by the numerous small, irregularly disposed, pyriform or lobate testes. The testes extend also to a considerable extent in between the ovary and the mantle partially concealing the ovary when the gonad is looked at through the mantle. On the left side the gonad lies dorsal to the intestine, the testes in its lower portion, however, extending down to some extent between the intestine and the mantle. On the right side it lies dorsal and somewhat anterior to the renal organ.

Most of the specimens in the collection came from Eastport, Me., and Grand Manan, N. B., and other places in that vicinity, where the species is common, occurring, according to Professor Verrill (1871a) on muddy and shelly bottoms in depths from 10 to 80 fathoms. It is also represented by large specimens from Casco Bay, where it occurs on muddy bottoms in from 2 to 64 fathoms (Verrill, 1874a) and by several of various sizes from near the eastern edge of George's Bank (Station 2525, N. lat.  $41^{\circ} 49'$ , W. long.  $65^{\circ} 49' 30''$ , 72 fathoms, sand, gravel, and broken shells). Two examples from Murray Bay, Gulf of Saint Lawrence, collected by J. W. Dawson, incrustated with coarse sand, were poorly preserved, but apparently of this species. Whiteaves (1874, 1901) records it from Orphan Bank, Gulf of Saint Lawrence. This species is evidently a close ally of *C. septentrionalis* (Traustedt) described above (p. 478).

**Caesira citrina** (Alder and Hancock).

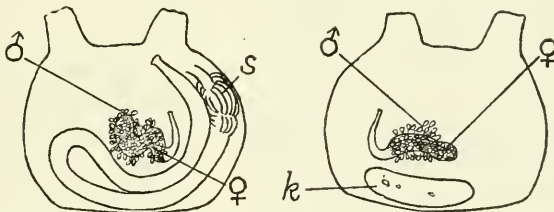
Pl. 48, fig. 26-30; Pl. 73, fig. 163; text-figs. 10, 11.

1848. *Molgula citrina* Alder and Hancock, Trans. Tyneside Nat. Field Club, vol. 1, p. 198.  
 1850. *Molgula citrina* Cocks, Rept. Cornwall Polyt. Soc. for 1849, p. 73.  
 1869. *Molgula citrina* Norman, Rept. British Assoc. Adv. Sci. for 1868, p. 303.  
 1871. *Molgula littoralis* Verrill, Amer. Journ. Sci., ser. 3, vol. 1, p. 56, fig. 4a.  
 1871. *Molgula nana* Kupffer, Berichte Komm. d. Meere, 1871, p. 136.  
 1872. *Molgula littoralis* Verrill, Amer. Journ. Sci., ser. 3, vol. 3, p. 211.  
 1874. *Molgula littoralis* Whiteaves, Amer. Journ. Sci., ser. 3, vol. 7, p. 7.  
 1879. *Molgula littoralis* Verrill, Preliminary Check-list of Marine Invertebrates, p. 27.

1891. *Molgula nana* + *M. nuda* + *M. littoralis* Herdman, Journ. Linn. Soc. London, Zool., vol. 23, pp. 568, 569.
1901. *Molgula littoralis* Whiteaves, Geol. Survey Canada, pub. no. 722, p. 270.
1903. *Molgula nana* Hartmeyer, in Römer and Schaudinn, Fauna Arctica, vol. 3, p. 157.
1906. *Molgula nana* Redikorzew, Trav. Soc. Nat. St. Pétersbourg, vol. 37, pt. 1, pp. 308, 310.
1907. *Molgula citrina* Alder and Hancock, British Tunicata, vol. 2, p. 62, pl. 26, fig. 5-9; pl. 27, fig. 6-8; pl. 28, fig. 3-5; pl. 40, fig. 4; pl. 47, fig. 3; text-figs. 46, 47.
1907. *Molgula nana* Redikorzew, Ann. Mus. Zool. Acad. Sci. St. Pétersbourg, vol. 11, pp. 129, 132, 133.
1908. *Molgula nana* Redikorzew, Trav. Soc. Nat. St. Pétersbourg, vol. 39, pp. 20, 22, 42.
1909. *Caesira citrina* + *C. littoralis* + *C. nana* Hartmeyer, Bronn's Tierreich, vol. 3, suppl., pp. 1323, 1324.
1912. *Caesira citrina* Hartmeyer, Sitzungsab. Ges. Naturforsch. Freunde, 1912, no. 1, p. 17.

Verrill's (1871a) description is here quoted:

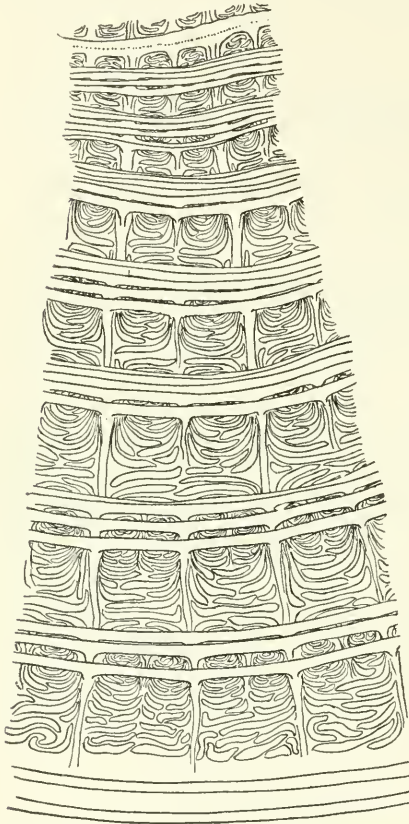
"Body transversely oblong-oval, somewhat flattened laterally, and attached obliquely by a part of one side (usually the right) to the under side of stones; when young subglobular. Integument firm and



Text-fig. 10.—*Caesira citrina* (Alder and Hancock).  $\times 4$ .

tough, but translucent, the tubes similar to the body; the surface smoothish in young specimens, in older ones slightly wrinkled, not fibrous, but somewhat roughened by sparse granule-like papillae, to which a thin, imperfect coating of foreign substances is sometimes attached; in contraction the surface is reticulated with wrinkles, with more elevated interstices. Tubes short and stout, arising from the upper side, and separated by a distance about equal to or exceeding their diameters, quite divergent, the anal tube most so, not wholly retractile. The anal tube is about twice as long as the branchial and usually swollen in the middle, rounded at the end, with a simple square

orifice, which in full expansion often becomes roundish. The branchial tube has about the same diameter, and is short cylindrical, with six short papillae around the orifice. In contraction the tubes form low verrucae.



Text-fig. 11.—*Caesira citrina* (Alder and Hancock). Part of branchial sac.  $\times 15$ .

“When living the color of the body is translucent dull greenish or olive, between the tubes usually more or less ferruginous brown or russet; on the sides the viscera show through as dull orange-colored and darker blotches.

“One of the larger specimens was, when living .45 of an inch long; height .35; length of branchial tube .10; diameter .10; distance between bases of tubes .08.”

There are specimens in the collection exceeding these dimensions. One from Casco Bay, Me., measures 16 mm. long, 13 mm. dorso-ventrally (excluding the siphons), and 11 mm. from side to side. The specimens vary greatly in their external appearance and shape, some being attached by a

broad area and considerably flattened, others are more nearly round. Some are very smooth externally, others quite rough and with much adhering sand and foreign matter. Often the siphons bear on their outer surface a few short spiny processes. Some of these may also occur on other parts of the body.

Musculature of mantle weak, and on most parts of the body diffuse, consisting of fibers more or less isolated or grouped into only the nar-

rowest bands, which cross each other in various directions. Radiating and circular muscles about the bases of the siphons not strongly developed, the radiating bands being of loose structure and not very stout, and tapering off quite abruptly at some distance from the origin of the siphons. Along each side of the endostyle there are some distinct though narrow bands disposed in oblique and transverse directions to the course of the endostyle.

Tentacles moderately numerous and of at least four or five sizes and degrees of complexity as regards their branching, which in the large tentacles is of the bipinnate type (though a few branches may bear incipient branchlets of a third order), while the smallest are entirely simple, often mere papillae. Large tentacles comparatively few (about six or eight). They vary so much in size that it is probable that they represent more than one order. They bear as usual in this group broad membranes on the stem and branches; the branchlets have blunt and rounded, though little if at all enlarged, tips.

Dorsal tubercle large; its orifice C-shaped with the open interval to the right; horns not strongly incurved or inrolled.

Dorsal lamina a broad thick membrane, its border sometimes slightly sinuous.

Branchial sac with rather slight folds on each side, which are rendered conspicuous by the groups of stout internal longitudinal vessels which run along them and by the series of infundibula along their summits. The folds being slight, all or most of the internal longitudinal vessels are visible without disturbing the normal position of the folds. These vessels numbered on a medium-sized specimen as follows:

Left side    0 (5) 0 (5) 0 (4) 0 (4) 0 (4) 0 (2) 0 (2) 0

*mdv.*

*en.*

Right side   0 (5) 0 (5) 0 (5) 0 (4) 0 (4) 0 (3) 0 (2) 0

In large individuals they are more numerous, eight or nine occurring on some of the folds. The transverse vessels in most parts of the sac are of two orders placed alternately, those of the first order numbering five. Those of the second order are frequently not continuous from the median dorsal vessel to the endostyle, but are interrupted on the spaces between the folds and limited, except in the ventral part of the sac, to the latter; in that part of the sac they may extend across the spaces also. In an interval between transverse vessels of

the first order there are normally two infundibula except in the ventral part of the sac (on the seventh fold or sometimes also the sixth or sixth and fifth) where there are four. Transverse vessels of a third order are developed on the folds having additional infundibula. Generally the infundibula fork at the summit into two more or less perfectly separated cones, an anterior and a posterior one, or at least the stigmata at their summit form an anterior and a posterior spiral, indicating a tendency to such forking.

Stigmata mostly quite long, and wide in proportion to the distance between the folds. Between the folds their direction is mainly longitudinal, though scarcely any of them are straight, and strongly curved or hooked forms occur here and there. On the infundibula they assume a concentric arrangement, and as the apex is approached they become ordered in more or less perfect spirals, as already mentioned, becoming here much narrower and closer together than on the spaces between the folds. Ventral to the last fold the stigmata may form a few incipient and rudimentary spirals. For a more perfect understanding of these details the reader is referred to text-fig. 11 which represents a part of the sac of a rather large individual.

The cardiac portion of the stomach has several large shallow sac-like expansions whose walls are thrown into numerous deep glandular folds mainly longitudinal in direction, or approximately so, forming a secreting organ of considerable extent. The pyloric portion is smooth-walled and tapers gradually off into the intestine. The latter forms a loop whose course is mainly horizontal, the reflected part of the loop being, however, somewhat turned up toward the dorsal side of the body. The branches of the loop are separated for some distance from the end. The anal orifice has a smooth, thickened margin, and is often more or less distinctly two-lipped.

Kidney large, sausage-shaped and nearly straight. It occupies a posterior ventral position on the right side.

Left gonad dorsal to the horizontal part of the intestinal loop; right gonad just dorsal to the kidney. They differ in form, the left having the ovary, which is elongated, bent in an S-shaped curve, the right having the ovary much straighter. In each case the ovary is prolonged at the posterior end into a rather long oviduct, which bends dorsally. Its walls are very delicate. It is apparently accompanied by the sperm duct, a tube of much smaller diameter but thicker-walled; this appears to terminate in a narrowed orifice with a thickened border

after extending dorsally a little way. The testes themselves are small pyriform or two-lobed glands lying against the free surface of the ovary and against the inner surface of the mantle about the border of, but not always very close to the ovary.

In the specimens studied (all collected during the summer months), there was generally a group of embryos and tailed larvae in various stages in the peribranchial cavity anterior to the gonad on each side. These larvae appear to average several hundredths of a millimeter less in length than those of *C. papillosa* (see p. 500) and the eggs also appear to be slightly smaller than in that species.

Recorded by Professor Verrill from shallow water and along the shore ("under stones near low water mark") in the region about Eastport, Maine, and Grand Manan, N. B., but apparently of very much wider distribution, since the writer believes specimens from the following localities also to belong to this species:

Gulf of Saint Lawrence, between Pictou Island and Cape Bear (collected by J. F. Whiteaves).

Station 2699 (N. lat. 45° 04', W. long. 55° 23', 72 fathoms).

Station 2514 (N. lat. 43° 28' 30'', W. long. 63° 57' 30'', 126 fathoms, black mud).

Casco Bay, Me. (large specimen).

Baker's Island, near Salem, Mass.

Station 159 (Gloucester Harbor, Mass., off Freshwater Cove, 8 fathoms, sand).

Station 33 (off Cape Ann, N. lat. 42° 30', W. long. 70° 20', 90 fathoms, mud).

Vineyard Sound, Mass., 14 fathoms.

Off Gay Head, Mass.

Station 848 (Narragansett Bay, R. I., 15½ fathoms, mud).

The writer finds that Verrill's species agrees so closely with the description of *C. citrina* (Alder and Hancock), 1848, that there is no doubt of their identity. *C. citrina* is recorded from various points on the British coasts (Northumberland, Durham, Isle of Man, Cornwall, and Shetland). *C. nana* Kupffer, 1871, from Norway, the White Sea, the German and Danish coasts, etc., and *C. echinosiphonica* (Lacaze-Duthiers), 1877, of western Europe, are also identical according to Dr. Hartmeyer's view, with which the writer fully agrees.

**Caesira crystallina** (Möller).

Pl. 48, fig. 31-33; text-figs. 12, 13.

1842. *Clavelina crystallina* Möller, Naturhist. Tidsskr., vol. 4, p. 95.  
 1852. *Pera pellucida* Stimpson, Proc. Boston Soc. Nat. Hist., vol. 4, p. 232.  
 1860. *Pera pellucida* Stimpson, Smithsonian Check-list, p. 1.  
 1870. *Pera pellucida* Binney, Gould's Invertebrata of Massachusetts, ed. 2, p. 17.  
 1872. *Pera crystallina* Verrill, Amer. Journ. Sci., ser. 3, vol. 3, pp. 213, 290, pl. 8, fig. 9.  
 1879. *Pera crystallina* Verrill, Preliminary Check-list of Marine Invertebrates, p. 27.  
 1891. *Pera ekrystallina* Herdman, Journ. Linn. Soc. London, Zool., vol. 23, p. 565.  
 1901. *Pera crystallina* Whiteaves, Geol. Survey Canada, pub<sup>l</sup>. no. 22, p. 271.  
 1903. *Molgula crystallina* Hartmeyer, in Römer and Schaudinn, Fauna Arctica, vol. 3, p. 137.  
 1905. *Molgula crystallina* Bjerkan, Bergens Mus. Aarbog, 1905, no. 5, p. 4.  
 1906. *Molgula crystallina* Redikorzew, Trav. Soc. Nat. St. Pétersbourg, vol. 37, pt. 1, p. 309.  
 1907. *Molgula crystallina* Redikorzew, Ann. Mus. Zool. Acad. St. Pétersbourg, vol. 11, pp. 128, 151-153.  
 1907. *Molgula crystallina* Redikorzew, Zool. Anzeiger, vol. 31, p. 521.  
 1908. *Molgula crystallina* Redikorzew, Trav. Soc. Nat. St. Pétersbourg, vol. 39, pp. 20, 22, 42.  
 1908. *Molgula crystallina* Bjerkan, Tromsø Mus. Aarshefter, no. 25, pp. 56, 114.  
 1908. *Molgula crystallina* Redikorzew, Mém. Acad. Imp. Sci. St. Pétersbourg, cl. phys.-math., vol. 18, no. 11, p. 11, pl. 1, fig. 2.  
 1909. *Caesira crystallina* Hartmeyer, Bronn's Tier-reich, vol. 3, suppl., p. 1323.  
 1912. *Caesira crystallina* Hartmeyer, Sitzungsab. Ges. Naturforsch. Freunde, 1912, no. 1, p. 14.

The following notes on the structure and the illustrations were made from only two specimens, but one of which was dissected.

Body ovoidal, tapering more or less abruptly at one end into a narrow pedicel (which may be nearly as long as the body) by which the animal is attached. Apertures not very prominent; branchial situated on one side of the body, six-lobed; atrial situated at end opposite origin of pedicel, four-lobed. Surface of body fairly smooth, with a few slight wrinkles but no processes or adhering foreign matter. Neither specimen much exceeded 20 mm. in length including the pedicel, which was 6 mm. to 8 mm. long. The species attains, how-

ever, a considerably larger size. Test of moderate thickness and firm consistency, very transparent, allowing much of the internal structure to be seen.

Musculature of mantle slight, consisting of very slender, rather widely separated bands, forming on parts of the body a fairly regular network with more or less rectangular meshes.

Tentacles of several sizes quite regularly arranged. Even the large ones have comparatively few branches and are not more than twice pinnate. Tips of branchlets blunt and slightly swollen.

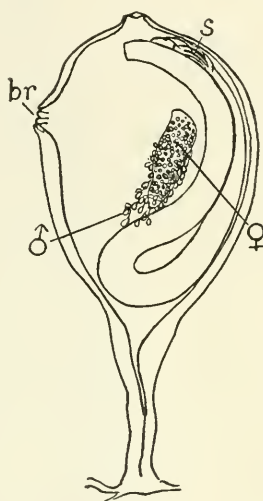
Dorsal lamina plain-edged.

Dorsal tubercle C-shaped, the horns decidedly incurved, opening directed to right rear.

Branchial sac with five moderately prominent folds on each side. Apparently but five principal transverse vessels, but more or less complete intermediate ones may develop in some of the intervals. Internal longitudinal vessels stout and confined to the folds: three on the first four folds, two on the fifth (most ventral) fold. One or two infundibula on the summit of each fold in each space marked off by the principal transverse vessels. Also a series of spirally arranged stigmata representing rudimentary infundibula between the median dorsal vessel and the first fold, and some more or less irregularly disposed ones ventral to the last fold.

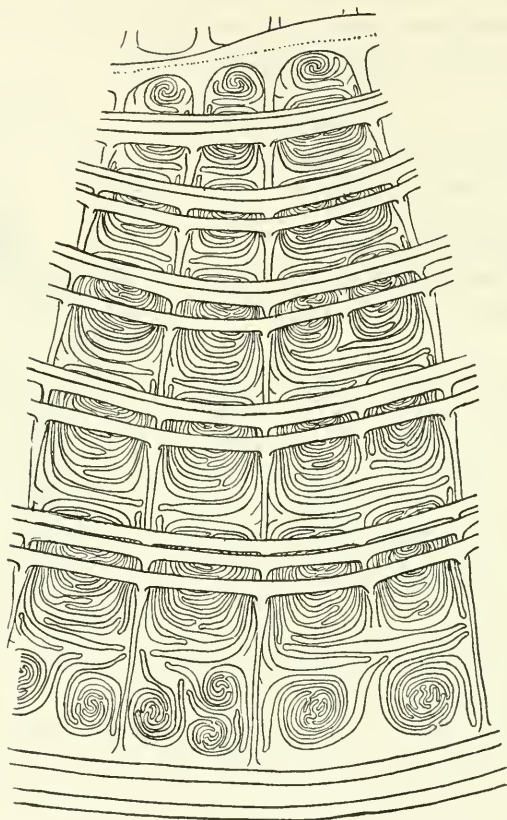
Stigmata mostly wide and long, not very numerous; arranged in fairly distinct double spirals on the infundibula. Free ends of the spirals mostly come out of the spirals near the odd-numbered principal transverse vessels.

But two small specimens of this species are in the collection. They were obtained at Murray Bay, Gulf of Saint Lawrence, by Dr. J. W. Dawson. Stimpson had the species from George's Bank, 30 fathoms. Professor Verrill informed the writer that he had never found it in all the extensive collecting that he had done, and the species is evidently



Text-fig. 12.—*Caesira crystallina* (Möller). (Outline of test shown.)  $\times 5.2$ .

uncommon in the New England region and extends its range only into the northern part of it. It is nearly circumpolar in distribution (Redikorzew, 1908b, p. 12) being recorded from the coast of Norway, Spitz-



Text-fig. 13.—*Caesira crystallina* (Möller). Part of right side of branchial sac.  $\times 16$ .

bergen, between Bear Island and Hope Island, Franz Josef Land, Barents Sea, Murman Coast, White Sea, Siberian Arctic Ocean, Davis Straits, Cape Arton, Greenland, and Iceland, and attains in some of these localities a much larger size than the specimens above described. Redikorzew (1908b, p. 12) says, "It prefers a stony bottom, but occurs also on sandy and muddy bottoms ranging from 10 to 180 meters." He describes in the same article (p. 13) a variety (*tuberculata*) from the New Hebrides Islands (11-26 meters).

**Caesira papillosa** (Verrill).

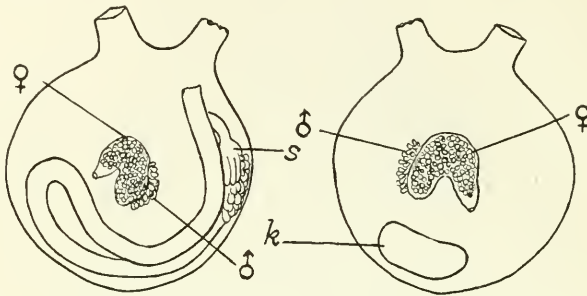
Pl. 49, fig. 34-38; Pl. 73, fig. 167; text-fig. 14.

1871. *Molgula papillosa* Verrill, Amer. Journ. Sci., ser. 3, vol. 1, p. 57, fig. 4, b.  
 1871. *Molgula papillosa* Verrill, Amer. Journ. Sci., ser. 3, vol. 2, p. 362.  
 1872. *Molgula papillosa* Verrill, Amer. Journ. Sci., ser. 3, vol. 3, p. 211, pl. 8, fig. 4.  
 1873. *Molgula papillosa* Verrill and Smith, Rept. on Invertebrate Animals of Vineyard Sound, pp. 699, [495].  
 1874. *Molgula papillosa* Verrill, Proc. Amer. Assoc. Adv. Sci., vol. 22, p. 363.  
 1874. *Molgula papillosa* Whiteaves, Amer. Journ. Sci., ser. 3, vol. 7, p. 7.  
 1874. *Molgula papillosa* Verrill, Amer. Journ. Sci., ser. 3, vol. 7, p. 43.  
 1879. *Molgula papillosa* Verrill, Preliminary Check-list of Marine Invertebrates, p. 27.  
 1883. *Molgula tenax* Traustedt, Vidensk. Meddel. Naturhist. For. Kjobenhavn, p. 110.  
 1891. *Molgula papillosa* + *M. tenax* Herdman, Journ. Linn. Soc. London, Zool., vol. 23, pp. 567, 569.  
 1901. *Molgula papillosa* Kingsley, Proc. Portland Soc. Nat. Hist., vol. 2, p. 182.  
 1903. *Molgula tenax* Hartmeyer, in Römer and Schaudinn, Fauna Arctica, vol. 3, p. 137, pl. 4, fig. 3; pl. 7, fig. 4-9.  
 1909. *Caesira papillosa* + *C. tenax* Hartmeyer, Bronn's Tier-reich, vol. 3, suppl., p. 1324.  
 1912. *Caesira papillosa* Hartmeyer, Vidensk. Meddel. Naturhist. For. Kjobenhavn, vol. 63, p. 263.  
 1912. *Caesira papillosa* Hartmeyer, Sitzungsber. Ges. Naturforsch. Freunde, 1912, no. 1, p. 16.

Professor Verrill's description of the external appearance is as follows:

"Body free, nearly globular, or transversely suboval, usually slightly compressed laterally. Integument rather thin, translucent, the surface, both of the tubes and body, entirely covered by particles of sand, broken shells, foraminifera, etc., which adhere firmly. When cleaned the whole surface is thickly covered with prominent granule-like papillae and numerous slender fibrous processes; the granules are most conspicuous on the tubes, where they usually have a rusty color. The tubes are long, subequal, and their bases are separated by a space usually greater than their diameters; they are quite divergent, both of them curving outward, the anal tube most abruptly. The branchial tube is cylindrical, somewhat longer than the anal, equal to or exceeding the diameter of the body, the orifice surrounded by six, rather long and slender, conical, divergent papillae. The anal tube often bends suddenly outward, tapers slightly, and has a small

square aperture, surrounded by a circle of dull reddish brown. In contraction the tubes are not retracted but are usually shortened to about one-half their length. In life the body, when cleaned, is pale grayish, with an almost transparent integument, through which the convolutions of the dark intestine are conspicuous.



Text-fig. 14.—*Caesira papillosa* (Verrill).  $\times 4$ .

“The largest specimens are about .40 of an inch in diameter.”

The largest specimen in the collections examined by the writer was 14.5 mm. long, 9 mm. high, and about 7 mm. transversely across the body, but most of the specimens were of less than two thirds of these dimensions. The fact that even in a strongly contracted state the siphons, though much shortened, are not retracted, is somewhat characteristic of this species. In many individuals the siphons, though divergent, arise rather near together from a common base or low extension of the dorsal region of the body. Some of the specimens appear to have been attached to rocks, shells or other objects.

Musculature of mantle weak and for the most part diffuse. Circular and radiating bands about the bases of the siphons comparatively weak, and though numerous transverse bands are present in the region along each side of the endostyle they are very slender (usually only the width of three or four fibers).

Tentacles of several sizes or orders arranged according to the usual scheme but not without some irregularities. Smallest ones unbranched, the others irregularly branched in a pinnate or more or less bipinnate manner. Tips of the branchlets ending bluntly, and often perceptibly swollen.

Orifice of the dorsal tubercle longitudinally elongated and slit-like.

Dorsal lamina a comparatively narrow membrane, smooth-edged

on the anterior part but with small triangular teeth rather widely spaced on the posterior part.

Branchial sac provided with well marked but rather low folds, seven on each side, each bearing three internal longitudinal vessels along its summit, except the most dorsal fold, which is rudimentary, and bears but one or two. The most ventral fold may also be reduced and bear but one or two vessels. There are none of these vessels in the intervals between the folds. In most parts of the sac there are two orders of transverse vessels placed alternately, those of the first or largest order numbering five on each side of the body. In addition there are very slender tubules which cross the stigmata and pass to the summits of the infundibula described below. There is on each fold one large infundibulum between each pair of transverse vessels of the first order, except on the fold next to the endostyle where there are two, each transverse vessel of the second order here becoming of the size of, and assuming the character of one of the first order while one of the slender tubules mentioned above, situated midway in each interval assumes the size and character of a vessel of the second order. Each of the above described infundibula divides in its upper portion into an anterior and a posterior apex, separated by a transverse vessel of the second order.

Stigmata mostly elongated, and wide in proportion to the vessels separating them. They are straight or nearly so only in the case of a few situated between folds, becoming curved on the infundibula and spiral on the summits of the latter. Sometimes the spirals on the two summits of an infundibulum curve in the same way, in other cases in opposite ways.

Stomach with few irregular longitudinal folds in its cardiac portion, the pyloric portion being smooth-walled and tapering off gradually into the intestine. Over a considerable portion of its surface, however, especially on the posterior side, there is a thick glandular mass of small rounded or short fold-like caeca opening into the stomach and constituting an hepatic organ of greater bulk than is usually present in this genus. The intestinal loop has a course which is mainly horizontal, the reflected end being but little bent up dorsally.

Kidney sausage-shaped, rather wide for its length and situated, as in related species, against the right posterior part of the body wall. It usually contains a few small concretions.

In the specimens dissected (all collected during the summer months)

the ovaries were greatly developed and distended with eggs of various sizes, while the testes were comparatively small, in respect to both the number and the size of the pyriform or lobed glands which composed them. The eggs when ready to be laid are rather large, 0.26 mm. or more. They develop into tailed larvae in the peribranchial cavity. A group of these tailed larvae was usually present in the peribranchial cavity on each side of the body near the gonad. The larvae in these groups generally measured about 0.36 mm. long exclusive of the tail, but larger, more advanced ones were also sometimes present, generally in other parts of the cavity.

Left gonad situated dorsal to the intestine (nearer the reflected part of the loop than to the rectum); the right, dorsal and anterior to the kidney. The ovary is elongated, bent in an inverted U-shaped curve. The opening is downwardly directed and at the anterior end, and is not produced into an oviduct. The testis consists of a series of small pyriform or more or less lobed glands bordering the posterior margin of the ovary or overlapping and covering it in part.

In the New England region this species occurs from the Gulf of Saint Lawrence (Whiteaves, 1874, 1901, identification by Verrill) and Bay of Fundy to off Martha's Vineyard, chiefly in depths of 10 fathoms or more (70 fathoms being the maximum recorded), preferring stony, shelly, or sandy bottoms. Verrill (1871a) reports it from Eastport, Me., at low-water mark under stones, and off the northern side of Treat's Island, in 10 to 20 fathoms in shelly bottom. Verrill and Smith (1873) give its distribution as follows:

"Off Martha's Vineyard, 10 fathoms, stony; Casco Bay and Bay of Fundy, 10 to 20 fathoms."

The writer has examined specimens from

Eastport, Me. (including Professor Verrill's types).

Casco Bay, Me.

George's Bank, 50 fathoms.

Station 372 (21 miles east of Chatham, Mass., N. lat. 41° 40', W. long. 69° 28' 30'', 70 fathoms, sand and pebbles).

Station 2080 (N. lat. 41° 13', W. long. 66° 21' 50'', 55 fathoms, gray sand).

Its distribution is really much wider, for there can be no doubt of the identity of Traustedt's (1883) *Molgula tenax* with the present species. Examination of a specimen of *C. tenax* kindly sent by Dr. Hartmeyer, confirms this conclusion. The largest specimen mentioned by Hartmeyer is 16 mm. long, somewhat larger than any the writer has exam-

ined. *C. tenax* has been collected near Bear Island and Hope Island, the Farøe Islands, and Greenland, in from 6 to 100 fathoms. It was not correctly reported from the West Indies, Herdman's statement to that effect being the result of a misunderstanding.

**Caesira arenata** (Stimpson).

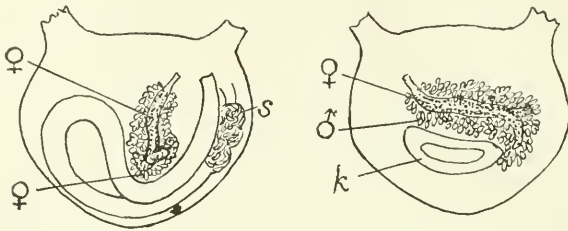
Pl. 50, fig. 39-42; Pl. 52, figs. 48, 49; Pl. 71, fig. 150; text-fig. 15.

1850. *Ascidia psammophora* Agassiz, Proc. Amer. Assoc. Adv. Sci., vol. 2, p. 159 (description insufficient).
1852. *Molgula arenata* Stimpson, Proc. Boston Soc. Nat. Hist., vol. 4, p. 230.
1860. *Molgula arenata* Stimpson, Smithsonian Check-list, p. 2.
1869. *Molgula arenata* Perkins, Proc. Boston Soc. Nat. Hist., vol. 13, p. 160.
1870. *Molgula arenata* + *Ascidia psammophora* Binney, Gould's Invertebrata of Massachusetts, ed. 2, pp. 21, 24, pl. 24, figs. 330, 331.
1870. *Ascidia psammophora* + *Molgula arenata* Dall, Proc. Boston Soc. Nat. Hist., vol. 13, p. 255.
1870. *Molgula arenata* Verrill, Amer. Journ. Sci., ser. 2, vol. 49, p. 424.
1871. *Molgula arenata* Verrill, Amer. Journ. Sci., ser. 3, vol. 2, p. 362.
1872. *Molgula psammophora* Verrill, Amer. Journ. Sci., ser. 3, vol. 3, p. 213.
1872. *Molgula arenata* Verrill, Amer. Journ. Sci., ser. 3, vol. 3, pl. 8, fig. 5.
1873. *Molgula arenata* Verrill and Smith, Rept. on Invertebrate Animals of Vineyard Sound, pp. 699, 502.
1889. *Molgula arenata* McDonald, Rept. U. S. Comm. Fish and Fisheries for 1886, p. 858.
1891. *Eugyra arenata* Herdman, Journ. Linn. Soc. London, Zool., vol. 23, p. 569.
1909. *Caesira arenata* + *C. psammophora* Hartmeyer, Bronn's Tier-reich, vol. 3, suppl., p. 1324 (listed as uncertain species).
1912. *Caesira arenata* Hartmeyer, Sitzungsber. Ges. naturforsch. Freunde, 1912, no. 1, p. 15.
1912. *Caesira arenata* Hartmeyer, Denkschr. K. Akad. Wiss. Wien, cl. math.-nat., vol. 88, p. 209.

Agassiz (1850) in naming the species *Ascidia psammophora* gave no description sufficient to enable it to be recognized, saying merely: "whose body is surrounded all over with fine sand. Found around Cape Cod" — a statement applicable to four or five different species. That he referred to the present one was not discoverable until Binney (1870) published two drawings of Agassiz's specimens made by Mr. Burkhardt, under Agassiz's direction. Though these illustrations quite clearly represent this species, in the meantime Stimpson (1852) had published a brief but clear description of the species, enabling

it to be readily recognized, and the writer follows the course already adopted by Verrill and others of rejecting Agassiz's name and adopting that of Stimpson.

Externally this species is commonly of very regular and symmetrical form, having an approximately circular outline when seen from one



Text-fig. 15.— *Caesira arenata* (Stimpson).  $\times 3$ .

side except that between the apertures the outline is nearly straight, and the body is strongly flattened from side to side, often to such an extent as to be disk-like. The apertures are widely separated, their distance apart usually about equaling one fifth of the circumference of the body, and in the contracted alcoholic specimens they often project but little, sometimes scarcely at all, beyond the general outline of the body. Generally the body is smooth and evenly covered with a close coat of sand grains, which extends to the lobes surrounding the apertures. Occasionally shell fragments, minute pebbles, etc., also adhere to the body. The branchial aperture has as usual six lobes, the atrial four. This species does not appear to attach itself, but to live free, buried in the sand. Occasionally two individuals adhere loosely together. The largest specimens in the collections measure 18.5 mm. to 20 mm. in length and scarcely less in depth, but often not more than 7 mm. in transverse diameter.

Test transparent or translucent, grayish or brownish in alcoholic specimens when the sand is removed, and moderately thick and tough in large specimens. When removed from the test, the body, owing to the widely separated and very short siphons has a more or less triangular outline with the apertures at two of the angles. The mantle is quite transparent, allowing the viscera to be clearly seen. On the sides of the body the musculature of the mantle is for the most part diffuse and very slight. The bands which radiate from the

siphons are few in number and extend but a little way on the sides, though farther on the dorsal region of the body between the siphons and along the mid-ventral region. Slenderer and less regular circular bands cross the radiating bands, and between the siphons and along the ventral region near the endostyle slender, more or less irregular transverse bands are numerous and quite closely placed.

At least five orders of oral tentacles are present, the largest of which are extensively branched in an irregular tripinnate manner and usually number six, while those of the second and third orders are also much branched; those of the remaining orders are small and comparatively or entirely simple. Their arrangement is fairly regular according to the usual scheme (1, 5, 4, 5, 3, 5, 4, 5, 2, 5, etc.).

Dorsal tubercle generally with a plain C-shaped opening; the horns not spirally rolled. They usually turn to the right.

Dorsal lamina plain for much of its length. Posteriorly it becomes very broad and bears small triangular teeth. Similar but longer and narrower teeth (only four or five in number) occur on the extreme posterior end of some of the internal longitudinal vessels.

Branchial sac of delicate structure with six folds on each side. These folds are but slightly prominent and each might perhaps be better described as a row of infundibula bridged over longitudinally from a group of internal longitudinal vessels. Except as noted below, these vessels are confined to the folds and numbered on the right side of two fairly large individuals of average characters about as follows:

*mdv.* 0 (7) 0 (6) 0 (6) 0 (5) 0 (4) 0 (4) 0 *en.*  
*mdv.* 0 (7) 0 (8) 0 (7) 0 (6) 0 (5) 0 (4) 0 *en.*

Owing to the slight prominence of the folds nearly all these vessels are visible as the folds lie in their normal position. In some specimens one of the vessels of the group belonging to a fold often lies on the interspace somewhat removed from, and to the dorsal side of the base of the fold. This was observed in the case of the four first (most dorsal) folds in one individual. In other individuals these isolated vessels, if any are present, are fewer and very rudimentary and irregular. The large transverse vessels of the sac, extending from the median dorsal vessel to the endostyle apparently represent two sizes or orders, the normal number of the largest ones being five. There is, however, often so little difference between those of the first and the second order that they are hard to distinguish, and in the ventral part of the sac

the large transverse vessels may be more numerous, through the development of others which do not originate from the median dorsal vessel. Midway between these large vessels there are vessels of a third order, but these are delicate except on the folds and near the endostyle where they become stouter.

Between each two large vessels (first or second order) there is a single large infundibulum on each fold. It divides more or less completely into anterior and posterior cones separated by a vessel of the third order. Stigmata between and on the basal portion of the infundibula long and often exceeding in width the vessels separating them; this makes the sac very delicate, a condition which is to some extent compensated for by slender vessels radially arranged on the walls of the infundibula, crossing without interrupting the stigmata. There are but few straight stigmata; most of them are arranged in a concentric manner extending half or quarter way around the infundibula. On the upper portion of the latter the stigmata become narrow and are irregularly arranged in curves and small spirals in marked contrast to their regular arrangement on the basal portions. Dorsal to the first fold, and ventral to the last fold, the stigmata are also irregularly arranged and curved.

Stomach wall with a few shallow widely separated folds in addition to numerous small convoluted glandular folds which completely occupy most of the surface of its cardiac portion and form a fairly extensive secreting organ of a green color. The intestine forms a loop whose branches are rather widely separated for some distance from the reflected end, which owing to the bending of the whole loop is turned upward (dorsally). The margin of the anus is apparently plain or nearly so.

Kidney large, somewhat narrowed toward the ends, and very slightly curved with the concavity dorsal. It lies against the body wall in the right ventral region and generally contains one very large concretion.

Gonads in the usual position in the concavity dorsal to the intestinal loop and dorsal to the kidney. They each consist of an elongated tubular ovary (constricted at the end which is directed toward the atrial siphon, but not produced sufficiently to make it proper to speak of an oviduct) bordered nearly all around by the small pyriform, or two- or three-lobed testes. The left ovary has a nearly dorso-ventral direction and is often somewhat bent posteriorly at the ventral end;

the right ovary lies more nearly horizontal and its closed end bends abruptly down around the anterior end of the kidney. This last character appears to be one of the most constant and striking peculiarities of this species.

This animal inhabits sandy bottoms in shallow water (to 15 fathoms depth) from the southern shore of Cape Cod and Nantucket to and including Long Island Sound. It appears to live buried in the sand and does not attach itself to solid objects. It is local in distribution, but occasionally abundant in some places.

Agassiz (1850) who first recorded this species said it was found "around Cape Cod" a statement that should perhaps not be taken too broadly, as the writer is not aware of its occurrence on the northern shore of Cape Cod. Stimpson (1852) gave its distribution as "the region of Nantucket and Martha's Vineyard." Verrill and Smith (1873) record it from "Long Island Sound near New Haven, [Conn.] 3 fathoms, sand; Vineyard Sound and Buzzards Bay, [Mass.] 5 to 15 fathoms, sand and gravel."

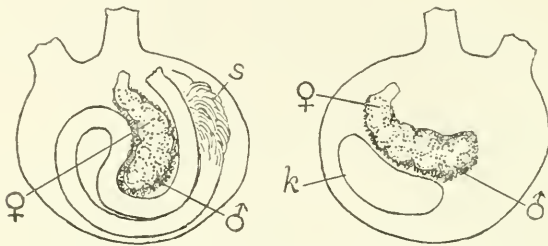
In the Peabody Museum collections it is represented by specimens from Vineyard Sound; off Montauk Point; Gardner's Bay; Long Island Sound, off New Haven (Conn.) Harbor, where it was once found abundantly over a small area. The writer has also received a specimen from Dr. Hartmeyer, which was collected in Buzzards Bay by Mr. G. M. Gray, and has also received from Mr. Gray a series of specimens from the Wood's Hole region. According to Hartmeyer, *Molgula arenosa* Metcalf (1900) is probably not this species but the European *Caesira oculata* Forbes, 1848.

***Caesira robusta*, sp. nov.**

Pl. 51, fig. 43-47; Pl. 73, fig. 161; text-figs. 16, 17.

The larger of the two well preserved specimens in the collection measures 38 mm. long, 29 mm. in height, and about 18 mm. from side to side, though being flattened in a somewhat oblique direction it is difficult to determine the exact thickness in that direction. The other measures 26 mm. long, 23 mm. high, and is strongly compressed laterally, measuring only about 7 mm. in that direction. The siphons, which in the large specimen project about 5 mm., in the small one somewhat less, are placed quite near together, and have six prominent conical lobes to the branchial aperture and four lobes to the atrial

aperture. The specimens appear to have been attached only to loose sand and gravel, and their exterior, which is rough and irregular, is coated with a thick layer of firmly attached coarse sand and has some rather large pebbles firmly imbedded in it. The test is rather thick and firm and its inner surface is whitish.



Text-fig. 16.—*Caesira robusta*, sp. nov.  $\times 1.8$ .

Mantle musculature weak for such large specimens. Some stout bands radiate from the base of the siphons and are underlaid by less regular circular bands. On the sides of the body the muscles are slender, inconspicuous, and irregularly disposed; as the region of the endostyle is approached short stout muscle bands become numerous but are irregular in their arrangement, lying in various oblique directions and crossing each other irregularly.

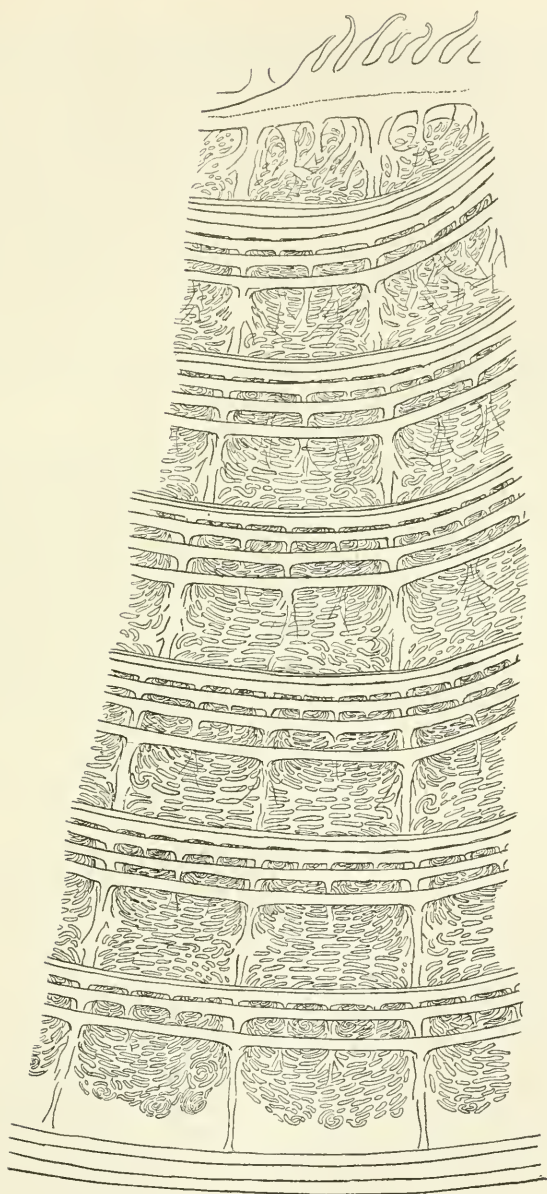
Tentacles mostly of three sizes or orders, six of the first, six of the second, and twelve of the third order arranged in the usual way (1, 3, 2, 3, 1, 3, 2, 3, etc.). Some smaller tentacles are present in the intervals but they are few and irregularly distributed. The largest tentacles are three times compound in a rather more regularly pinnate manner than usual in this genus, their branches and branchlets are not very numerous, and the tips of the branchlets are moderately tapered.

Dorsal lamina broad with long, narrow, sharply pointed teeth on the posterior part. Some of the internal longitudinal vessels (one or two on a fold) bear on their extreme posterior part a few similar teeth. (See Pl. 51, fig. 45.)

Dorsal tubercle C-shaped in both specimens (in one rather irregularly so) with the horns directed to the right and spirally incurved.

Branchial sac with six well developed folds on each side. In the smaller of the two specimens the distribution of the internal longitudinal vessels is about as follows:

*mdv.* 0 (11) 0 (10) 0 (10) 0 (S) 0 (7) 0 (5) 0 *en.*



Text-fig. 17.— *Caesira robusta*, sp. nov. Part of branchial sac of right side.  $\times 20$ .

The transverse vessels of the sac, as would be expected in such large and evidently old individuals, are rather irregular. Five appears to be the number of those of the first order. In the ventral part of the sac some of those of the second order become nearly as stout, and assume the character of vessels of the first order. Transverse vessels of a third, fourth, and (in some places) fifth order are developed only on the folds, and separate the small infundibula which are developed along the summit of each fold. These small infundibula may be regarded as the cones formed by the forking (two or more times) of the large infundibula occupying the spaces between the larger transverse vessels, but these large infundibula are in this species only poorly marked, and are indicated chiefly by the more or less concentric arrangement of the stigmata.

Stigmata small, very short and very numerous. They do not form regular rows but between the folds are nevertheless mostly longitudinally, and on the basal portion of the folds more or less concentrically arranged, so as to indicate, as just mentioned, large infundibula. On the upper part of the folds they are quite irregular, becoming more or less spiral in the small infundibula on the summit, and forming other spirals, usually irregular and imperfect, on the sides of the folds. Many of the stigmata are so small and short as to be merely oval openings. Next to the endostyle there is an irregular row of imperfect infundibula with irregularly spiral stigmata. The wall of the sac, especially in the dorsal part is strengthened by irregular branching vessels lying upon its inner surface, and crossing, usually without interrupting, the stigmata which lie in their path.

Stomach wall with rather numerous irregular glandular folds. Intestinal loop open (but not very widely) for a considerable distance from its reflected end; the whole loop is bent in fairly regular curve as in *C. manhattensis*, though not so much as in that species. Margin of the anus sinuate and slightly flared.

Kidney large, wide, sausage-shaped and slightly curved; placed against the body wall of the posterior ventral part of the right side in an oblique position with the posterior end more dorsal.

Gonads very large in both the specimens, the ovaries being particularly well developed and containing a great number of small eggs. There is a hermaphroditic gonad in the usual position on each side of the body; on the left side in the concavity dorsal to the intestinal loop, on the right dorsal and somewhat anterior to the kidney. The

axial part of each gonad consists of an elongated flask-shaped, slightly curved ovary, whose walls are more or less evidently thrown into transverse plications. The opening for the discharge of the eggs is at the smaller and more dorsally situated end and is not at all produced into an oviduct. The axis of the ovary of the left side is nearly dorso-ventral in direction, that of the right much less inclined to the horizontal. The blind end of the right gonad is not bent down around the end of the kidney as in *C. arenata* (Stimpson). The numerous lobate testes surround almost the entire border of the ovaries.

The only two good specimens of this animal in the collections came, if correctly labeled, from the channel at Wood's Hole, Massachusetts, and hence from water of very moderate depth, disturbed by strong tidal currents. They were collected by the U. S. Fish Commission in 1875. Two other specimens, about the size of the smaller of the two just described, labeled Martha's Vineyard, 1871, and Vineyard Sound, respectively, are also apparently of the same species, but the internal organs are in a very poor state of preservation, and the branchial sac and gonads not in a condition to show anything of their structure. The species is evidently very closely allied to *C. arenata* (Stimpson), described on page 501 yet with the material at hand, it does not seem justifiable to consider the two identical.

**Caesira retortiformis** (Verrill).

Pl. 52, fig. 50-52; Pl. 69, figs. 139, 140; text-figs. 18, 19.

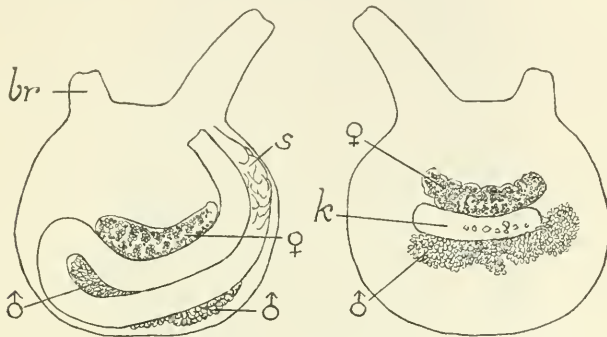
1871. *Molgula retortiformis* Verrill, Amer. Journ. Sci., ser. 3, vol. 1, p. 56, fig. 3.  
1872. *Molgula retortiformis* Verrill, Bull. Essex Inst., vol. 3, p. 5 (no description).  
1872. *Molgula retortiformis* Verrill, Amer. Journ. Sci., ser. 3, vol. 3, p. 211.  
1873. *Molgula retortiformis* Verrill, Amer. Journ. Sci., ser. 3, vol. 6, pp. 435, 440.  
1874. *Molgula retortiformis* Verrill, Proc. Amer. Assoc. Adv. Sci., vol. 22, pp. 352, 363.  
1874. *Molgula retortiformis* Verrill, Amer. Journ. Sci., ser. 3, vol. 7, pp. 43, 413, 504.  
1879. *Molgula retortiformis* Verrill, Preliminary Check-list of Marine Invertebrates, p. 27.  
1879. *Molgula retortiformis* Verrill and Rathbun, Proc. U. S. Nat. Mus., vol. 2, p. 231.

1880. *Molgula groenlandica* Traustedt, Vidensk. Meddel. Naturhist. For. Kjobenhavn, p. 425.
1882. *Molgula retortiformis* Baird, Rept. U. S. Comm. Fish and Fisheries for 1879, pp. S0S, S29.
1883. *Molgula groenlandica* Traustedt, Vidensk. Meddel. Naturhist. For. Kjobenhavn, p. 112.
1889. *Molgula retortiformis* McDonald, Rept. U. S. Comm. Fish and Fisheries for 1886, p. S58.
1891. *Molgula groenlandica* + *M. retortiformis* + *Pera longicollis* Herdman, Journ. Linn. Soc. London, Zool., vol. 23, pp. 565, 568, 569.
1901. *Molgula retortiformis* Kingsley, Proc. Portland Soc. Nat. Hist., vol. 2, p. 182.
1901. *Molgula retortiformis* Whiteaves, Geol. Survey Canada, pub. no. 722, p. 270.
- ? 1901. *Molgula graphica* Ritter, Proc. Washington Acad. Sci., vol. 3, p. 230, pl. 27, fig. 6-9.
1903. *Molgula retortiformis* Hartmeyer, in Römer and Schaudinn's Fauna Arctica, pp. 145, 373, text-figs. 1, 2.
1905. *Molgula retortiformis* Bjerkan, Bergens Mus. Aarbog, 1905, no. 5, p. 5.
1906. *Molgula retortiformis* Redikorzew, Trav. Soc. Nat. St. Pétersbourg, vol. 37, pt. 1, pp. 308, 309.
1907. *Molgula retortiformis* Redikorzew, Ann. Mus. Zool. Acad. St. Pétersbourg, vol. 11, pp. 129, 151, 154.
1907. *Molgula retortiformis* Redikorzew, Zool. Anzeiger, vol. 31, p. 521.
1908. *Molgula retortiformis* Redikorzew, Trav. Soc. Nat. St. Pétersbourg, vol. 39, pp. 20, 22.
1908. *Molgula retortiformis* Redikorzew, Mém. Acad. Imp. Sci. St. Pétersbourg, ser. 8, cl. phys.-math., vol. 18, no. 11, p. 14, pl. 1, figs. 9, 11, text-figs. 3a, 3b.
1909. *Caesira retortiformis* Hartmeyer, Bronn's Tier-reich, vol. 3, suppl., p. 1324.
1910. *Caesira retortiformis* Hartmeyer, Danmark-Expeditionen, vol. 5, p. 229.
1912. *Caesira retortiformis* Hartmeyer, Sitzungsber. Ges. Naturforsch. Freunde, 1912, no. 1, p. 18.

For a description of the external features of this species Verrill's original description is here quoted. It should be emphasized, however, that the siphons are very retractile and in preserved specimens generally appear only as low papillae, or do not project at all.

"Body subglobular or more or less oval, generally higher than broad and a little compressed laterally, destitute of a disk, though generally adhering. The integument is thick and firm, but translucent, usually covered, together with the tubes, by various zoöphytes, ascidians, fragments of shells, etc., which form a coarse, rough, and rather

loosely adherent coating but this is usually incomplete or thin and the surface more or less exposed. When cleaned the surface is roughened by small, scattered, granule-like papillae, and irregular rough processes, while in large specimens it is more or less rudely wrinkled. The large tubes arise from the upper part, a short distance apart, and are widely



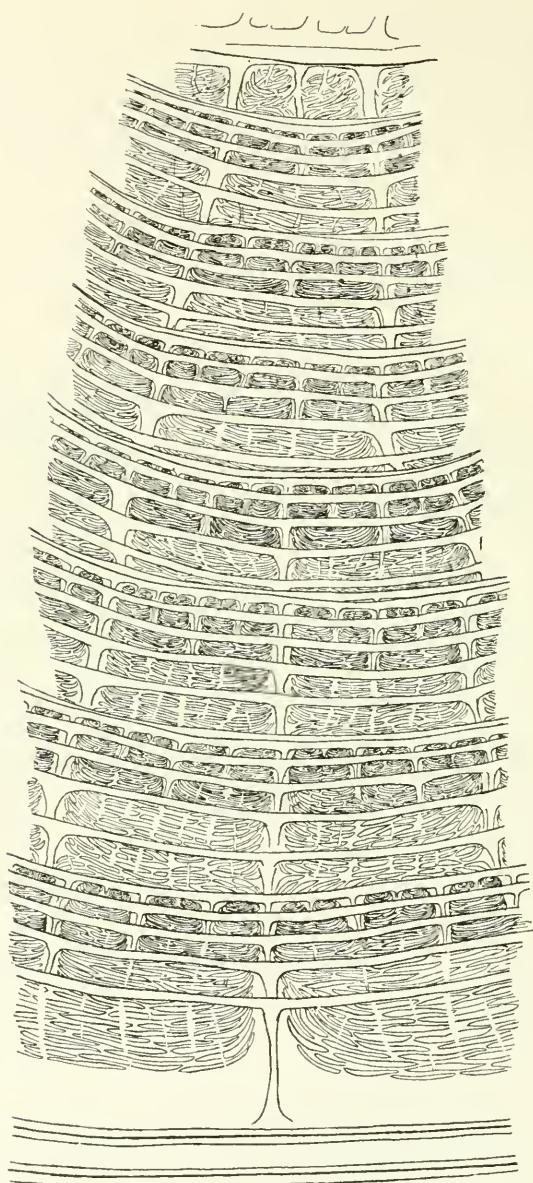
Text-fig. 18.— *Cuesira retortiformis* (Verrill).  $\times 1.5$ .

divergent and very unequal. The anal tube is much the longest, usually equaling in length the diameter of the body, very large and swollen at the base, curving outward and tapering to the end, which is blunt with a small square aperture, its surface is often roughened with irregular processes and in partial contraction is often sulcated. The branchial tube is usually about one-fourth as long, much smaller at the base, curved outward, the aperture surrounded with six, short, conical, acute, papillae or tentacular lobes, its surface below often rough with irregular verrucae. In contraction the tubes form large, low and rough verrucae, or may be wholly retracted and invaginated, together with a portion of the integument of the body around their bases.

“When living the color is uniform light olive or grayish green.

“The young have essentially the same characters as the adults, but are smoother” (Verrill, 1871a, p. 56).

Hartmeyer (1903, p. 147) says of this species that it is the largest of the family known to him from the Arctic or Subarctic regions, and one of the largest Arctic ascidians. The largest specimen that he had seen was 75 mm. long and 60 mm. in height and came from Newfoundland; from the vicinity of Bear Island he also records specimens



Text-fig. 19.—*Catesira retortiformis* (Verrill). Part of left side of branchial sac.  
× 12.

65 mm. long and 54 mm. in height and equally large ones from West Spitzbergen, Greenland, and the northern North Pacific. Wagner records much larger specimens (90 mm. long) from the White Sea. In the Bay of Fundy region the individuals do not usually exceed 30 mm. or 40 mm. in length, but occasional larger ones occur.

Mantle musculature well developed, siphons very muscular. Strong bands radiating from the siphons extend for a distance on the sides of the body. A rather close network of slender muscle bands crossing each other in various directions (though transverse bands predominate) covers most of the body.

Oral tentacles of four or five orders, the larger ones very complex in their branching, being three or four times compound, and notable for the great number of small simple or nearly simple, often rudimentary and nodule-like branchlets which are borne on the trunk and larger branches as well as on the smaller ones. These branchlets end in blunt, rounded, often slightly swollen tips. In a number of specimens examined there were usually five very large (but not all equally large), complex, branched tentacles alternating with a like number of considerably smaller ones, and between these several other orders of smaller and less complex ones arranged more or less conformably to the usual scheme (1, 4, 3, 4, 2, 4, 3, 4, 1, etc.). Very small simple or slightly branched tentacles were also present in the intervals, but not in large numbers, at least in the specimens studied.

Dorsal tubercle large, C-shaped with the open interval toward the right and the horns spirally incurved.

Dorsal lamina plain-edged.

Branchial sac with seven well developed folds on each side. It is difficult to say whether the internal longitudinal vessels should be regarded as confined to these folds or whether the two vessels at the base of each fold should be reckoned as belonging to the interspaces dorsal and ventral to it, since they usually lie a little removed from the fold, though clearly belonging to the group borne on the fold. The largest folds bear (including their outlying ones) about twelve vessels.

Transverse vessels of sac of four or five orders, seven of them of the first order. As these diverge from each other in the ventral parts of the sac, a few of the vessels of the next smaller or second order become stouter and assume the rôle of vessels of the first order in that part of the sac. The smaller transverse vessels are in general well developed

only on the folds (the smallest only on the summit portion of them) and become slender, inconspicuous, or lost entirely on the interspaces, though many of them are continued in those spaces as very narrow vessels limiting the ends of the stigmata or crossing the latter without interrupting them.

Development of a spiral arrangement of the stigmata and of infundibula confined to a row along the summit of each fold (indeed the whole upper portion of each fold may be described as composed of a row of infundibula), elsewhere the stigmata are straight or moderately curved and for the most part rather short, being more or less frequently interrupted or crossed by the transverse vessels already described. In general the direction of these stigmata is longitudinal (parallel to the length of the folds) though a tendency to curve toward the base of the nearest fold is conspicuous as the large transverse vessels are approached. The row of small infundibula along the ridge of each fold may be regarded as formed by the forking (twice) of larger infundibula of which there are generally two between adjacent transverse vessels of the first order. There are therefore generally eight of the small infundibula between two such vessels, but sometimes less or more. The spirals formed by the stigmata on these infundibula are more or less interrupted, and there does not appear to be any strict rule governing their direction; those of adjacent infundibula often but not always curve in opposite directions. Generally but one of the stigmata reaches the apex of an infundibulum. The internal longitudinal vessels are raised on high plate-like supports to bridge over these infundibula.

The irregular network of internal supporting vessels which strengthen the sac in many species of this genus is not much developed in this form, perhaps because from the shortness of the stigmata the sac is fairly strong without such support. In some individuals, however, such supporting vessels are fairly numerous in the dorsal part of the sac, and arise chiefly as branches of the regular transverse vessels.

Stomach walls very thick, containing numerous comparatively small hepatic crypts or follicles which are visible on the exterior only as very low irregular prominences, somewhat suggesting the convolutions of the brain in their appearance.

Intestinal loop very narrow, and nearly horizontal in position, the stomach and rectum forming nearly a right angle with the other part.

Kidney sausage-shaped, its long axis nearly horizontal; situated about the middle of the right side.

An ovary and a testis, entirely separated from each other are present on each side. Each ovary is an elongated sac usually somewhat larger at the blind end than at that where the opening is situated. The eggs, which are comparatively large, develop in its walls (except in that wall which lies against the mantle). The walls have deep transverse plications, which cause the eggs to look as if arranged in irregular columns extending part way across the cavity of the ovary. In the left side, the ovary lies outside of the intestinal loop, dorsal to and along the middle part of the upper branch of the loop. On the right side it has a similar position along the dorsal border of the kidney. The testis is an elongated mass of minute pyriform glands which are often incompletely two-cleft, or three-cleft. On the left side it lies against the inner side of the lower branch of the intestinal loop (on that side which lies against the branchial sac). It projects a little beyond the ventral border of the intestine, and likewise is visible in the small open portion of the loop. On the right side the testis lies ventral to the kidney, extending also somewhat around its anterior end. This separation of the male and female glands is unique, at least among the New England species of this family.

*C. retortiformis* is widely distributed in the northern waters of Europe, Asia, and America, having been recorded from Spitzbergen, the White Sea, etc., the Siberian Arctic Ocean, the northern North Pacific (Sitka), Iceland, Greenland, Newfoundland, etc. It ranges southward along the American Atlantic coast to the southeastern angle of Cape Cod, being fairly common about Eastport, Me. It is recorded from depths between 1 meter and 150 fathoms, and grows chiefly on rocky or other hard bottoms.

The localities of the specimens examined by the writer are as follows:

Eastport, Me., and vicinity, many specimens from less than 10 mm. up to 50 mm. long.

Station 2699 (N. lat.  $45^{\circ} 04'$ , W. long.  $55^{\circ} 23'$ , 72 fathoms), several specimens, the largest 45 mm. long.\*

Casco Bay, Me., one large specimen, 45 mm. long.

Station 8 (off Baker's Island, Cape Ann, Mass., 20 fathoms, rocky).

Station 21 (off Baker's Island, Cape Ann, Mass., 26 fathoms, hard gravel and stones).

Station 4 (off Salem, Mass., 22 fathoms, gravelly).

Off Cape Cod, Mass., locality not specified; one large specimen (51 mm. long).

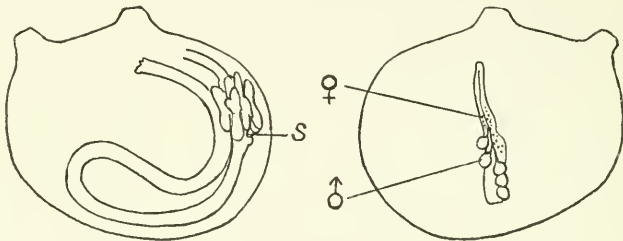
Station 364 (off Cape Cod, N. lat.  $41^{\circ} 58\frac{1}{2}'$ , W. long.  $69^{\circ} 44'$ , 70 fathoms, hard sand and broken shells).

Station 371 (16 miles off Chatham, Mass., N. lat.  $41^{\circ} 35\frac{1}{2}'$ , W. long.  $69^{\circ} 35'$ ,  $34\frac{1}{2}$  fathoms, coarse sand).

**Caesira verrilli**, sp. nov.

Pl. 53, fig. 53-57; text-fig. 20.

The only specimen in the collection is of rather regular form, measuring about 9 mm. long, 7 mm. deep, and 5.5 mm. transversely across the body. The siphons, which are drawn in almost even with the surface of the body, arise rather near together on the anterior part of the dorsal surface. The atrial siphon has the orifice distinctly



Text-fig. 20.— *Caesira verrilli*, sp. nov.  $\times 4$ .

four-lobed; the lobes of the branchial siphon cannot readily be counted in its strongly contracted condition. Test of moderate and even thickness; it would be somewhat transparent were it not quite thickly and evenly covered with foraminifera, sand grains, etc.

Musculature of the mantle rather weak and composed entirely of very slender muscle fibers. These bands are quite regularly arranged on most parts of the body, forming a network of transverse and longitudinal fibers with rather small square or somewhat wedge-shaped meshes. One set of bands arises in a radiating manner from about the bases of the siphons and reaches quite to, in some cases apparently across, the mid-ventral line.

Tentacles of at least four orders, placed quite regularly according to the usual scheme of arrangement. They are provided with the broad membranes attached along the stem and branches that are usual in this group. The largest tentacles number about eight and are bipinnately branched, as are also those of the second order. The

smaller ones are simply pinnate with a few branches, or if very small, are entirely unbranched. The tips of the branchlets are not swollen.

Dorsal tubercle with an oval orifice.

Dorsal lamina rather narrow, plain-edged.

Branchial sac with six approximately equal folds on each side. These folds do not actually represent much plication of the wall of the sac, but the group of internal longitudinal vessels which are borne on them (and, except for two or three very slender irregular and rudimentary ones, not elsewhere) gives them the appearance of having considerable height, for these vessels are raised up on tall supports considerably above the level of the summit of the fold on which they are borne. Transverse vessels of two orders placed alternately, numbering ten in all.

The stigmata are rather few, broad and short, and between the folds are longitudinal or only slightly oblique in direction. As the summit of a fold is approached they become more oblique until they lie at an angle of about 45 degrees to the transverse vessels, becoming at the same time smaller and shorter, and assuming an arrangement in spirals whose centers lie at the summit of the folds midway between the transverse vessels. The spiral is, however, an angular one, made up of straight stigmata successively shorter as the center is approached, and each placed at right angles to the preceding one of the series; the stigmata do not in this species exhibit the tendency to curve that is usual in the genus *Caesira*. These spirals are raised into low pyramidal infundibula having a square base.

The esophagus is unusually long and slender, the stomach wall is dark brown in color and is expanded into a number of capacious sac-like caeca of irregular form and arrangement, but the plications forming these caeca tend to a longitudinal rather than a transverse arrangement. The intestinal loop has its branches open for some distance from the reflected end; they then lie nearly parallel and close together. The whole loop forms a curve widely open dorsally. Margin of anus sinuate.

No kidney and no left gonad were discovered, but the writer is not prepared to say that they were wanting.

The gonad on the right side contains an elongated tapering tubular ovary with a few eggs in various stages of development. Its smaller end, where the orifice is situated, is directed dorsally toward the base of the atrial siphon. The male part of the organ consists of only five

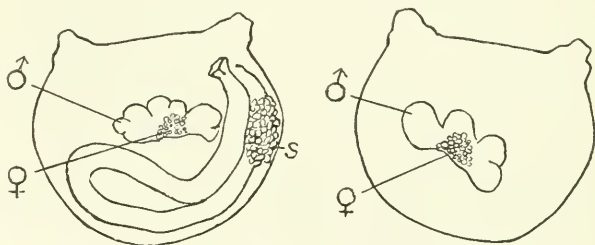
large rounded glands lying beside the ventral part of the ovary. Their efferent ducts unite to form a common sperm duct running along beside the ovary and apparently reaching nearly to the dorsal end of that organ.

This is a deep-sea species not properly belonging to the New England fauna. The only specimen was dredged in the deep water off the eastern edge of George's Bank at Station 2572 (N. lat.  $40^{\circ} 29'$ , W. long.  $66^{\circ} 04'$ , 1769 fathoms, gray ooze).

*Caesira singularis*, sp. nov.

Pl. 54, fig. 58-60; Pl. 73, fig. 166; text-figs. 21, 22.

In its external appearance this species resembles a small *Caesira arcuata* (Stimpson), having the same general form, though the body appears to average a trifle longer in proportion to its depth and to be usually less compressed laterally. As in *Caesira arcuata* the apertures are widely separated and the surface of the body is completely covered



Text-fig. 21.—*Caesira singularis*, sp. nov.  $\times 4$ .

with sand. The apertures were so tightly contracted in the specimens studied that the lobes surrounding them could not be satisfactorily counted either from the outside or on the mantle after removal from test. The testis is rather thin yet of firm, more or less rigid consistency; its interior surface when dry exhibits a whitish, somewhat nacreous luster. The largest specimen measures 11.5 mm. long, 9 mm. dorsoventrally, and 7 mm. from side to side.

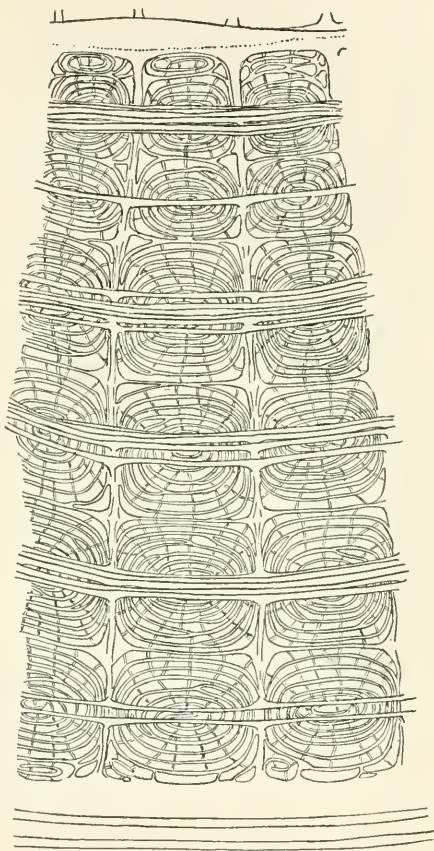
After removing the animal from the test there is, however, no more occasion for confusing this species with *C. arcuata*. The mantle is very thin and transparent, so that the peculiar form of the gonads is readily visible through it, and the musculature of the mantle is likewise totally different from that of the last named species, consisting of a

regular network with almost rectangular meshes covering practically the entire body, formed by long slender bands radiating from the siphons, crossed at right angles by other bands placed at quite regular intervals.

Tentacles of three sizes, arranged according to the usual scheme (1, 3, 2, 3, 1, 3, 2, 3, etc.). There are about eight of the first and eight of the second order. The tentacles are peculiar in being all entirely unbranched, but they are provided, as in other members of the *Caesiridae*, with a broad membrane extending along their whole length. Dorsal lamina a rather narrow membrane whose free edge is plain or very obscurely and minutely sinuate.

Dorsal tubercle small, with a simple C-shaped orifice the horns of which are neither inrolled nor strongly incurved. The open interval was toward the left in two out of three specimens, and toward the right in the third. The endostyle is narrow.

The branchial sac is of very delicate structure, and has no true folds, though six folds on each side are indicated by six longitudinal rows, each of eight large flattened infundibula, bridged over by one or more longitudinal vessels (see text-fig. 22). The infundibula show little if any of the tendency to divide into two apices that is common in this



Text-fig. 22.— *Caesira singularis*, sp. nov. Part of left side of branchial sac.  $\times 12$ .

family. On the basal or outer portion of the infundibula the stigmata are concentric; toward the center or apex they form a single, occasionally interrupted spiral, and are crossed and supported by some slender radial vessels. The surface of the sac is crossed by seven transverse vessels situated between the vertical rows of infundibula. Small imperfect or rudimentary infundibula occur along the dorsal and ventral edges of the sac next to the median dorsal vessel and the endostyle. The bars or vessels separating adjacent stigmata are slender and usually narrower than the stigmata, giving the infundibula an appearance suggesting a spider's web.

Stomach provided with a great number of small papilla-like caeca; the intestinal loop narrow and comparatively little bent; anus with a square or somewhat two-lipped opening.

A kidney is apparently wanting.

The gonads have the usual positions. They are hermaphroditic and each consists of three or more large rounded testes arranged in a longitudinal row and apparently more or less fused together by their ventral portions but separated by clefts above (dorsally). The ovary appears to consist of a mass of small eggs grouped together at the lower (ventral) middle part of the gonad.

There are but a few specimens of this peculiar species in the collections, all from four localities, as follows:

Station 333 (off S. end of Stellwagen's Bank, Race Point Light S. 18° E., 5¼ miles, 27 fathoms, fine yellow sand).

Station 281 (on Stellwagen's Bank, Race Point Light S. 12° E., 8½ miles, 14 fathoms, fine yellow sand and broken shells).

Station 828 (north of Block Island, 15 fathoms, sand).

Long Island Sound (no further particulars on label).

It is evidently an inhabitant of sandy bottoms in water of moderate depth, and probably buries itself in the sand without becoming attached to any solid object.

NOTE. Verrill (1879a, p. 27) lists *Caesira sordida* (Stimpson), 1852, (type locality Charleston, S. C.), among the New England ascidians, but it appears to have been included simply through an oversight.

#### UNCERTAIN SPECIES.

##### *Caesira producta* (Stimpson).

1852. *Molgula producta* Stimpson, Proc. Boston Soc. Nat. Hist., vol. 4, p. 229.

1860. *Molgula producta* Stimpson, Smithsonian Check-list, p. 2.

1870. *Molgula producta* Binney, Gould's Invertebrata of Massachusetts, ed. 2, p. 21 (not pl. 22, figs. 315, 316).
1870. *Molgula producta* Dall, Proc. Boston Soc. Nat. Hist., vol. 13, p. 255.
1872. *Molgula producta* Verrill, Amer. Journ. Sci., ser. 3, vol. 3, pp. 211, 288, pl. 8, fig. 6.
1873. *Molgula producta* Verrill and Smith, Rept. on Invertebrate Animals of Vineyard Sound, pp. 502, 510, 699.
1879. *Molgula producta* Verrill, Preliminary Check-list of Marine Invertebrates, p. 27.
1891. *Molgula producta* Herdman, Journ. Linn. Soc. London, Zool., vol. 23, p. 569 (listed as uncertain species).
1909. *Caesira producta* Hartmeyer, Bronn's Tier-reich, vol. 3, suppl., p. 1324 (listed as uncertain species).
1912. *Caesira producta* Hartmeyer, Sitzungsab. Ges. Naturforsch. Freunde, 1912, no. 1, p. 19.

Probably not *Molgula producta* Whiteaves (1874, 1901) as some of Whiteaves' specimens from the Gulf of Saint Lawrence labeled "*Molgula producta*" (identified as such by Professor Verrill) are *Bostrichobranchus pilularis*.

Stimpson's (1852) description of *Molgula producta* is as follows:

"This is usually perfectly globular, while the apertures are on tubes often equal in length to the diameter of the body, which originate close together and diverge. The test is rather thin, pellucid, usually of a pale rose tint, and covered, the tubes included, with a thin coating of sand. The branchial aperture is rounded, with six short cirri within, the anal is square. Diameter half an inch.

"It occurred on a sandy bottom, in six fathoms in Boston Bay; and also at low water on Bird Island. The tadpole-like young were ejected in August, and were of a bright vermilion color, which continued for a long time after their final detachment."

Localities, Boston Bay, sandy bottom, 6 fathoms, and at low water on Bird Island also near Boston.

Verrill and Smith (1873) give the following:

(p. 502) "The *Molgula producta* was dredged in some numbers on a bottom of fine sand, with some mud. The integument is thin, translucent, closely covered with a layer of fine sand; the tubes are transparent, whitish or flesh-color, sometimes pink at the ends; anal tube with four, and branchial with six, flake-white, longitudinal stripes and often with a circle of flake-white spots at the base outside, and other spots within. The anal orifice is square, but the branchial is either subcircular or squarish, in expansion, and destitute of distinct lobes or papillae, in this respect differing from all the other species of

the genus. The branchial tube is generally a little the longest, and both of them are somewhat tapered, with a swollen base."

(p. 510) "The *Molgula producta* also occurred on the sandy mud at the 29-fathom locality [about 15 miles east of Block Island, Rhode Island]."

(p. 699) "Off Buzzard's Bay, 25 fathoms, sandy. Massachusetts Bay, low-water to 6 fathoms, (Stimpson)."

No specimens of this animal were found in the collection, or at least none were recognized as such. (It will be observed that the distinguishing characters are largely those which could hardly be recognized except in living or very fresh specimens.) The only specimens found labeled *Molgula producta* were those from the Gulf of Saint Lawrence alluded to above, and evidently were nothing more than a case of mistaken identification, as they are *Bostrichobranchnus pilularis*. There is no reason to suppose that this animal, whatever it may be, occurs in that region. The writer does not venture to identify it with any of the other species here described. Were it possible to do so, the name *producta*, owing to the early date of its description (1852) would probably have priority over the name here employed.

Family PYURIDAE Hartmeyer, 1908.

[= CYNTHIIDAE s. HALOCYNTHIIDAE auct. plur.].

Body usually attached. Test generally tough, opaque, and of leathery consistency. Both apertures four-lobed in most forms, but exceptions are frequent.

Tentacles almost always branched.

Branchial sac usually with more than four (most commonly six to eight) longitudinal folds. Stigmata never spirally arranged.

Intestine always on left side; stomach generally not definitely marked off from the beginning of the intestine, into which it tapers off gradually.

Reproductive organs on both sides of body.

Genus PYURA Molina, 1782.

[= CYNTHIA s. HALOCYNTHIA auct. plur.].

Body of variable form, sometimes with a long stalk.

Test tough, leathery or cartilaginous.

Tentacles branched.

Dorsal lamina broken up into a series of tongue-like processes.

Branchial sac usually with six or more folds on each side. Stigmata straight, placed longitudinally, or in a few species transversely to the body axis.

Intestine on left side forming a widely open loop. Stomach tapering gradually into the intestine. A liver generally present.

Reproductive organs developed on both sides of body.

Verrill (1879b) proposed the name *Halocynthia* as a substitute for the preoccupied but generally used name *Cynthia*. Both are, however, long antedated by *Pyura* Molina, 1782, as shown by Michaelsen (1904). As above defined, this genus includes *Boltenia* Savigny, 1816, which has generally been kept distinct on account of its long stalk.

*Key to New England Species of Pyura.*

- Body with a long slender stalk. Stigmata elongated transversely to the body axis.....*ovifera*.  
 Body not stalked.  
 Surface of the body with large branched processes. Stigmata elongated transversely to the body axis.....*echinata*.  
 Surface of body evenly covered with very small tubercles, each bearing one or more minute points. Stigmata elongated in a direction parallel to the body axis.....*aurantium*.

***Pyura echinata*** (Linnaeus).

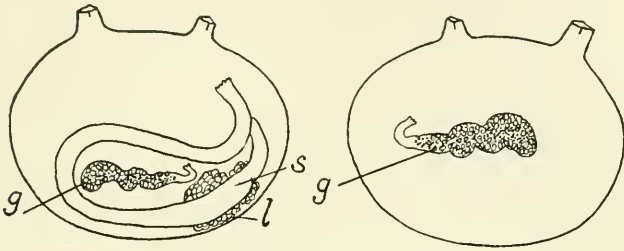
Pl. 54, fig. 61-65; Pl. 70, figs. 143, 144; text-fig. 23.

1767. *Ascidia echinata* Linnaeus, Syst. Nat., ed. 12, vol. 1, pt. 2, p. 1087, no. 6.  
 1850. *Ascidia hirsuta* Agassiz, Proc. Amer. Assoc. Adv. Sci., vol. 2, p. 159.  
 1854. *Cynthia echinata* Stimpson, Smithsonian Contr., vol. 6, p. 20.  
 1867. *Cynthia echinata* Packard, Mem. Boston Soc. Nat. Hist., vol. 1, p. 277.  
 1870. *Cynthia echinata* + *C. hirsuta* Binney, Gould's Invertebrata of Massachusetts, ed. 2, pp. 18, 20, pl. 23, fig. 326; pl. 24, fig. 336.  
 1870. *Cynthia* (?) *echinata* + *C.* (?) *hirsuta* Dall, Proc. Boston Soc. Nat. Hist., vol. 13, p. 255.  
 1871. *Cynthia echinata* Verrill, Amer. Journ. Sci., ser. 3, vol. 1, p. 96.  
 1871. *Cynthia hirsuta* Verrill, Amer. Journ. Sci., ser. 3, vol. 2, p. 362.  
 1872. *Cynthia echinata* Verrill, Bull. Essex Inst., vol. 3, p. 5.  
 1872. *Cynthia echinata* Verrill, Amer. Journ. Sci., ser. 3, vol. 3, p. 213.  
 1873. *Cynthia echinata* Verrill and Smith, Rept. on Invertebrate Animals of Vineyard Sound, pp. 495, 702.  
 1874. *Cynthia echinata* Verrill, Proc. Amer. Assoc. Adv. Sci., vol. 22, pp. 352, 363.  
 1874. *Cynthia echinata* Verrill, Amer. Journ. Sci., ser. 3, vol. 7, pp. 43, 413.  
 1879. *Halocynthia echinata* Verrill, Bull. U. S. Nat. Mus., no. 15, p. 148.

1879. *Halocynthia echinata* Verrill, Proc. U. S. Nat. Mus., vol. 2, p. 197.
1879. *Halocynthia echinata* Verrill, Preliminary Check-list of Marine Invertebrates, p. 27.
1879. *Halocynthia echinata* Verrill and Rathbun, Proc. U. S. Nat. Mus., vol. 2, p. 231.
1889. *Halocynthia echinata* McDonald, Rept. U. S. Comm. Fish and Fisheries for 1886, p. 858.
1891. *Cynthia echinata* Packard, Labrador Coast, chap. 15, p. 396.
1899. *Cynthia arctica* + *C. echinata* Hartmeyer, Zool. Jahrbücher, Syst., vol. 12, p. 468, fig. C; pl. 22, fig. 3; pl. 23, figs. 3, 11, 18.
1900. *Cynthia echinata* Metcalf, Zool. Jahrbücher, Syst., vol. 13, p. 511.
1901. *Cynthia (Halocynthia) echinata* Kingsley, Proc. Portland Soc. Nat. Hist., vol. 2, p. 183.
1901. *Cynthia echinata* Whiteaves, Geol. Survey Canada, pub. no. 722, p. 268.
1903. *Halocynthia arctica* + *H. echinata* Hartmeyer, in Römer and Schaudinn, Fauna Arctica, vol. 3, pt. 2, pp. 190, 373, pl. 11, figs. 10, 11.
1906. *Halocynthia arctica* Redikorzew, Trav. Soc. Nat. St. Pétersbourg, vol. 37, pt. 1, pp. 154, 308, 310.
1907. *Halocynthia arctica* Redikorzew, Ann. Mus. Zool. Acad. St. Pétersbourg, vol. 11, pp. 130, 151-153.
1907. *Halocynthia arctica* Redikorzew, Zool. Anzeiger, vol. 31, p. 521.
1908. *Halocynthia arctica* Bjerkan, Rept. Second Norwegian Arctic Exped., no. 14, p. 5.
1908. *Halocynthia arctica* Redikorzew, Trav. Soc. Nat. St. Pétersbourg, vol. 39, pp. 20, 23.
1908. *Halocynthia arctica* Redikorzew, Mém. Acad. Imp. Sci. St. Pétersbourg, ser. 8, cl. phys.-math., vol. 18, no. 11, p. 26.
1908. *Halocynthia arctica* Bjerkan, Tromsø Mus. Aarshefter, no. 25, pp. 60, 115.
1909. *Pyura arctica* + *Microcosmus echinatus* Hartmeyer, Bronn's Tierreich, vol. 3, suppl., pp. 1339, 1445.
1910. *Pyura echinata* Hartmeyer, Sitzungsab. Ges. Naturforsch. Freunde, 1910, no. 5, p. 231-240, pl. 8.
1910. *Pyura echinata* Hartmeyer, Danmark-Expeditionen, vol. 5, p. 233.
1911. *Pyura arctica* Redikorzew, Ann. Mus. Zool. Acad. Sci. St. Pétersbourg, vol. 16, p. 216.
1912. *Pyura echinata* Hartmeyer, Sitzungsab. Ges. Naturforsch. Freunde, 1911, no. 10, p. 439.
1912. *Pyura echinata* Hartmeyer, Vidensk. Meddel. Naturhist. For. Kjøbenhavn, vol. 63, p. 266.

Body of elliptical outline when seen from one side, the antero-posterior diameter exceeding the others. Attachment usually by a comparatively small area on the ventral surface; body often slightly compressed in a dorso-ventral direction. Apertures four-lobed, on small conical papillae on the dorsal surface of the body; rather

widely separated. The body surface bears numerous and very characteristic large spinous processes, which at once serve to distinguish the species from all other ascidians of the New England region. Each process has the form of a stout tapering column at the summit of which an irregular circle of tapering branches, usually four



Text-fig. 23.—*Pyura echinata* (Linnaeus).  $\times 3$ .

to eight in number, arises. Some of the branches may fork once. One of them may have a central position, the others extending out radially from around the base, or all may extend out radially or obliquely. Both the main stem and these branches are studded with slender hair-like spines of varying length (see fig. 65). These spinous processes exceed the siphons in length in the contracted specimens. The largest specimens examined measured about 22 mm. long, 14 mm. high, dorso-ventrally, and 15 mm. from side to side.

Color "usually deep salmon, often more or less tinged with pink or flesh-color, and sometimes of a delicate flesh-color throughout. The apertures are red, often bright red with a lighter red ring; the tubes frequently have eight alternate light and deep red longitudinal stripes extending from the edge to the base of the tubes, or four light stripes extending from the angles of the apertures down their sides" (Verrill, 1871a, p. 96). Test of moderate thickness and very tough.

Mantle very thin and generally so closely adherent to the test that it can be removed in small fragments only. Musculature not greatly developed. About the origin of the siphons the radial and circular muscles form distinct though rather narrow bands, the circular ones being the more superficial.

Tentacles of four or five orders, arranged with some degree of regularity; the largest extensively branched in an irregularly pinnate manner, twice compound (to a small extent three times), the main

branches coming out alternately on opposite sides of the stem. Stem and branches bear narrow membranes. Branchlets short and blunt, often reduced to mere nodules. Smallest tentacles merely small simple papillae. In medium-sized specimens there are about six large, six second order, and a dozen third order tentacles in addition to the numerous small ones.

Dorsal lamina broken up into a series of long narrow tapering languets.

Dorsal tubercle C-shaped with irregularly incurved horns; open interval to the right.

Branchial sac with six to eight folds on each side, two of which, the second and the last, are so rudimentary as scarcely to deserve the name, being represented chiefly by a few closely grouped internal longitudinal vessels. Transverse vessels few, of different sizes, but not regularly arranged. In the anterior and middle parts of the sac they are usually separated by about 12 to 24 of the transversely placed stigmata. Small transverse vessels developed only on the folds and disappearing in the interspaces are often present about midway between the larger ones.

Stigmata placed (except as noted below) with their long diameter transverse to the body axis, forming regular longitudinal rows separated by longitudinal vessels not to be confounded with the internal longitudinal vessels which are also present. On the interspaces the stigmata are moderately long and narrow, they become shorter and the longitudinal rows of them closer together as the summit of a fold is approached. On most of the interspaces one of the longitudinal vessels separating the rows is broader than the others and is pierced by a few longitudinally placed stigmata.

Internal longitudinal vessels generally corresponding in number to the longitudinal rows of stigmata; one vessel crossing all the stigmata of a given row. At the summit of the folds, however, the vessels become more numerous than the rows of stigmata. Their distribution in several moderately large specimens was about as follows:

*mdv.* 1 (18) 2 (5) 4 (14) 5 (16) 5 (16) 5 (10) 2 (3) 3 *en.*

Digestive tract forming a rather long widely open loop. Stomach elongated, thin-walled, but having on the side toward the branchial sac a large irregular glandular mass composed of many small short blunt-ended caeca. Margin of anus lobed.

One elongate, somewhat sinuously curved, longitudinally placed gonad on each side of the body, that of the left side lying entirely within the intestinal loop. The posterior end of each gonad is produced into a short recurved oviduct ending in a somewhat enlarged aperture with a lobed margin. In the specimens examined the ovary was in all cases greatly developed, and the entire gonad closely packed with eggs of various sizes. The testes were not distinguishable with certainty. In most cases the peribranchial cavities contained numerous tailed larvae.

*Ascidia hirsuta* Agassiz, 1850, is the young of this species (Verrill, 1872b). *Pyura echinata* is widely distributed in the Arctic seas and in the waters of northern Europe, including Iceland and Greenland. In American waters it is recorded from Labrador and Newfoundland, George's Bank and along the coast to Massachusetts and Rhode Island. It ranges in depth from low-water mark (in northern localities) to 109 fathoms (324 meters in European waters). It is common in the Bay of Fundy region, but rare south of Cape Cod.

The specimens studied by the writer are from these localities:

Banks of Newfoundland.

Bay of Fundy, and vicinity of Eastport, Me. (many specimens).

Casco Bay.

Stations 972 and 976-984 (Crab Ledge, off Chatham, Mass., 16-33 fathoms, sand, gravel, stones), few specimens.

Off Block Island, R. I., September 2d and 3d, 1874, three small specimens.

#### *Pyura ovifera* (Linnaeus).

Pl. 55, fig. 66; Pl. 56, fig. 68-70; Pl. 67, fig. 133; Pl. 70, fig. 145; text-fig. 24.

1767. *Vorticella ovifera* Linnaeus, Syst. Nat., ed. 12, vol. 1, pt. 2, p. 1319, no. 14.

1816. *Boltenia ovifera* + *B. fusiformis* Savigny, Mém. Anim. s. Vert., vol. 2 pp. 88, 140, pl. 1, fig. 1; pl. 5, fig. 1, and pp. 89, 141.

1838. *Ascidia pedunculata* Couthouy, Boston Journ. Nat. Hist., vol. 2, p. 111.

1841. *Boltenia reniformis* Gould, Rept. on Invertebrata of Massachusetts, p. 319.

1843. *Boltenia reniformis* DeKay, Zool. New York, Mollusca, p. 260, pl. 34, fig. 324.

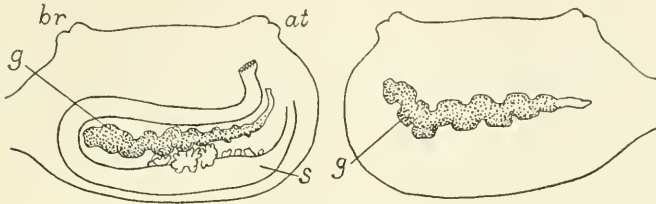
1850. *Boltenia microcosmus* Agassiz, Proc. Amer. Assoc. Adv. Sci., vol. 2, p. 159.

1852. *Boltenia rubra* Stimpson, Proc. Boston Soc. Nat. Hist., vol. 4, p. 232.

1854. *Boltenia rubra* + *B. reniformis* (?) Stimpson, Smithsonian Contr., vol. 6, art. 5, p. 20.

1860. *Boltenia clavata* + *B. rubra* Stimpson, Smithsonian Check-list, p. 1.
1863. *Boltenia oviformis* Packard, Canadian Naturalist and Geologist, vol. 8, p. 412.
1867. *Boltenia Bolteni* Packard, Mem. Boston Soc. Nat. Hist., vol. 1, p. 277.
1870. *Boltenia clavata* + *B. microcosmus* + *B. rubra* + *B. Burkhardti* Binney, Gould's Invertebrata of Massachusetts, ed. 2, p. 14-16, pl. 24, figs. 325, 327, 337, 338.
1870. *Boltenia clavata* + *B. microcosmus* + *B. rubra* + *B. Burkhardti* Dall, Proc. Boston Soc. Nat. Hist., vol. 13, p. 255.
1870. *Boltenia clavata* + *B. microcosmus* Verrill, Amer. Journ. Sci., ser. 2, vol. 49, p. 424.
1871. *Boltenia reniformis* Verrill, Bull. Essex Inst., vol. 3, pp. 3, 6.
1873. *Boltenia* sp. Verrill and Smith, Rept. on Invertebrate Animals of Vineyard Sound, p. 702.
1874. *Boltenia Bolteni* Verrill, Proc. Amer. Assoc. Adv. Sci., vol. 22, p. 363.
1874. *Boltenia Bolteni* Verrill, Amer. Journ. Sci., ser. 3, vol. 7, p. 43.
1874. *Boltenia ciliata* Whiteaves, Amer. Journ. Sci., ser. 3, vol. 7, p. 5.
1879. *Boltenia Bolteni* Verrill and Rathbun, Proc. U. S. Nat. Mus., vol. 2, p. 231.
1881. *Boltenia elegans* Herdman, Proc. Roy. Soc. Edinburgh, vol. 11, p. 80.
1882. *Boltenia elegans* Herdman, Challenger Rept., Zool., vol. 6, p. 86, pl. 7, fig. 1-5.
1882. *Boltenia Bolteni* Baird, Rept. U. S. Comm. Fish and Fisheries for 1879, pp. 791, 795, 796, etc.
1885. *Boltenia Bolteni* Verrill, Rept. U. S. Comm. Fish and Fisheries for 1883, p. 529.
1886. *Boltenia Bolteni* Whiteaves, Catalogue Colonial and Indian Exhibition, p. 39, text-fig.
1889. *Boltenia bolteni* McDonald, Rept. U. S. Comm. Fish and Fisheries for 1886, p. 858.
1891. *Boltenia bolteni* Packard, Labrador Coast, chap. 15, p. 397.
1891. *Boltenia ovifera* + *B. Bolteni* + *B. fusiformis* + *B. reniformis* + *B. ciliata* + *B. microcosmus* + *B. rubra* + *B. Burkhardti* + *B. elegans* Herdman, Journ. Linn. Soc. London, Zool., vol. 23, p. 571.
1900. *Boltenia reniformis* Metcalf, Zool. Jahrbücher, Anat., vol. 13, p. 512, 2 text-figs.
1901. *Boltenia bolteni* Kingsley, Proc. Portland Soc. Nat. Hist., vol. 2, p. 183.
1901. *Boltenia Bolteni* + *B. ciliata* + *B. elegans* Whiteaves, Geol. Survey Canada, pub. no. 722, pp. 269, 270.
1903. *Boltenia ovifera* Hartmeyer, in Römer and Schaudinn, Fauna Arctica, vol. 3, p. 173, pl. 4, figs. 11, 12; pl. 10, fig. 1-4.
1907. *Boltenia ovifera* Redikorzew, Ann. Mus. Zool. Acad. St. Pétersbourg, vol. 11, pp. 130, 152, 153.
1908. *Boltenia ovifera* Redikorzew, Trav. Soc. Nat. St. Pétersbourg, vol. 39, pp. 20, 23.
1909. *Pyura ovifera* Hartmeyer, Bronn's Tier-reich, vol. 3, suppl., p. 1340.
1910. *Pyura ovifera* Hartmeyer, Danmark-Expeditionen, vol. 5, p. 231.

At once distinguishable from the other ascidians of this region (except the rare deep-sea *Culcolus suhmi*, which the ordinary collector would not obtain) by having the body raised on a long slender stem. It was formerly made the type of a separate genus (*Boltenia*) on this account, but as shown by Hartmeyer (1903) the internal structure



Text-fig. 24.—*Pyura ovifera* (Linnaeus).  $\times \frac{2}{3}$ .

is that of a *Pyura* closely allied to *P. echinata*. This species is widely distributed, and very variable in form and appearance, and several species have been established based upon these external differences. Hartmeyer (1903) after a careful study of many specimens came to the conclusion that these differences were individual peculiarities only, or due to age, and the writer after examining many specimens from different parts of the New England and Canadian regions has also failed to find differences indicating that more than one species is represented.

Body of variable form, kidney-shaped, egg-shaped, or even spindle-shaped, sometimes decidedly compressed laterally, sometimes very little so, if at all. Apertures on widely separated papillae on the dorsal surface, both four-lobed, or the atrial aperture more or less like a transverse cleft. Stem arising from the anterior end or anterior ventral region of the body, generally about two to four times as long as the body; proportionately longer in rather small than in very large individuals. Its basal end is expanded for attachment to the rock or other object on which the animal grows. Its surface is usually transversely wrinkled. The test is very variable, sometimes thin, and but little if at all wrinkled on the surface, in other cases it is thick and deeply wrinkled or thrown into irregular elevations. In small and medium-sized specimens the surface both of the body and stem is often thickly covered with small thorn-like tapering processes, which, however, are soft and flexible, and not prickly to the touch. They

may arise directly from the surface, or each spine from a rounded protuberance on the surface. They may be so numerous and minute as to give the surface a velvety appearance or large enough to be individually conspicuous to the naked eye. As the animal grows older and larger they disappear more or less completely, though some probably always persist. The species attains a large size; body length 50 mm. to 80 mm. or often more; stem, often 150 mm. to 200 mm. additional. In alcoholic specimens the color of the body is yellowish white or more or less brownish; in life the body is sometimes deep red, in other cases yellowish, often tinged with red. In internal structure the American specimens correspond very accurately with the description given by Hartmeyer (1903).

Mantle musculature mainly of two layers, the deep layer (deficient on the ventral region) formed by the bands which radiate from the siphons; the superficial layer of those which encircle the body and the bases of the siphons. Each layer consists of distinct rather widely separated bands; together they form a network with nearly square meshes.

Oral tentacles rather few; about a dozen large ones, which differ much in size among themselves and show some tendency to alternate in size, and a few smaller ones in the intervals. The largest are very complex in their branching (irregularly five or six times pinnate); the ultimate branchlets have rounded somewhat swollen tips.

Dorsal tubercle C-shaped with inrolled horns; open interval to the right.

Dorsal lamina cleft into numerous narrow teeth.

Branchial sac with nine or ten folds (the last of which is rudimentary) on each side. The first fold is the highest; the others diminishing in height in quite regular succession except the second, which is lower than its place in the series would indicate. Internal longitudinal vessels very numerous in large specimens. In a moderately large one they were distributed as follows:

*mdv.* 3 (30) 7 (16) 6 (24) 7 (22) 6 (20) 5 (17) 5 (14) 5 (14) 3 (9) 3 (4) 1 *en.*

Stigmata placed with their long diameter transverse to the length of the folds, as in *P. echinata*. They are arranged in longitudinal rows, separated by vessels of varying width. In general these rows correspond in number to the internal longitudinal vessels, one of the latter passing over the middle of all of the stigmata of a row, but

whether this arrangement is carried out on the upper part of the folds where the vessels are crowded, is doubtful.

Transverse vessels of sac numerous and of various sizes, the largest generally separated by 20 to 40 stigmata. The smaller ones occur at varying intervals and are rather closely and irregularly distributed.

Stomach elongated, tapering, not abruptly distinguished from either the esophagus or the intestine. It bears a number of lobed hepatic glands, those toward the pyloric end being the largest in the specimens studied. Loop formed by stomach and intestine almost U-shaped, the branches being nearly parallel. Margin of anus with many lobes.

Gonads elongated, somewhat sinuous, with projecting masses or lobes along the sides. Ovary central, covered more or less completely by the very numerous small, mostly rounded or pyriform, testes. Position of gonads nearly longitudinal, the posterior end turned up toward the base of the atrial siphon. That of the left side lies between the branches of the loop formed by the alimentary tract.

This is chiefly an Arctic species, known from Bering Sea, the Arctic American archipelago, Greenland and Labrador. Its range extends along the American Atlantic coast much farther south than in any other part of the world. In the northern part of the region covered by this paper it is common and is represented in the Peabody Museum collections by numerous specimens, from various localities from the Gulf of Saint Lawrence and the Grand Banks and George's Bank to off Nantucket, especially from the Banks of Newfoundland, Nova Scotia, and the Bay of Fundy. There are more specimens, probably, than its relative abundance would account for, since its large size, peculiar appearance, and the frequency with which its stem causes it to be caught and brought up by the hooks of fishermen cause it to be noticed and preserved, when more abundant but less conspicuous forms are overlooked or thrown away. DeKay (1843) records what is presumably this species from New York Harbor. No other record from anywhere near New York seems to exist, but DeKay is quite positive in his statement of the locality of the specimen, and from his description of its colors, seems to have examined it while still in a fresh state. The most southern specimens that the writer has seen were some from near Chatham, Mass., at the southeastern angle of Cape Cod (Stations 981 and 982, 42, 43 fathoms, gravel), and a few (one of them of medium size) from Nantucket Shoals.

This species prefers a rocky or other hard bottom and occurs to

depths of 100 fathoms, though more numerous in shallow water (4 to 50 fathoms).

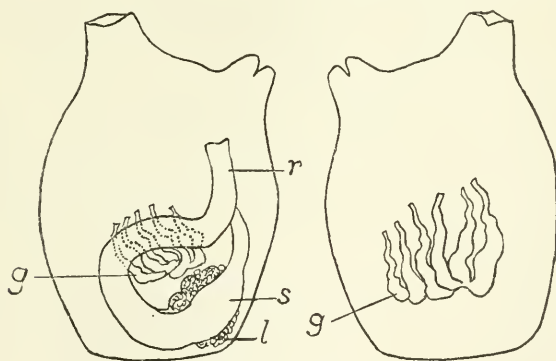
**Pyura aurantium** (Pallas).

Pl. 55, fig. 67; Pl. 56, fig. 71-74; Pl. 67, fig. 134; text-fig. 25.

1787. *Ascidia aurantium* Pallas, Nova Acta Acad. Petrop., vol. 2, p. 240, pl. 7, fig. 38.
1806. *Ascidia pyriformis* Rathke, Zool. Danica, vol. 4, p. 41, pl. 156.
1854. *Cynthia pyriformis* Stimpson, Smithsonian Contr., vol. 6, p. 20.
1860. *Cynthia pyriformis* Smithsonian Check-list, p. 1.
1863. *Cynthia pyriformis* Packard, Canadian Naturalist and Geologist, vol. 8, p. 412.
1867. *Cynthia pyriformis* Packard, Mem. Boston Soc. Nat. Hist., vol. 1, p. 277.
1870. *Cynthia pyriformis* Binney, Gould's Invertebrata of Massachusetts, ed. 2, p. 17, pl. 23, figs. 320, 321.
1870. *Cynthia pyriformis* Dall, Proc. Boston Soc. Nat. Hist., vol. 13, p. 255.
1871. *Cynthia pyriformis* Verrill, Bull. Essex Inst., vol. 3, pp. 3, 5.
1871. *Cynthia pyriformis* Verrill, Amer. Journ. Sci., ser. 3, vol. 1, p. 97, fig. 10.
1872. *Cynthia pyriformis* Dall, Amer. Journ. Conchology, vol. 7, p. 157.
1874. *Cynthia pyriformis* Verrill, Proc. Amer. Assoc. Adv. Sci., vol. 22, pp. 359, 363.
1874. *Cynthia pyriformis* Whiteaves, Amer. Journ. Sci., ser. 3, vol. 7, p. 5.
1874. *Cynthia pyriformis* Verrill, Amer. Journ. Sci., ser. 3, vol. 7, p. 43.
1879. *Halocynthia pyriformis* + *H. villosa* Verrill, Bull. U. S. Nat. Mus., no. 15, p. 148.
1879. *Halocynthia pyriformis* Verrill, Proc. U. S. Nat. Mus., vol. 2, p. 197.
1879. *Halocynthia pyriformis* Verrill and Rathbun, Proc. U. S. Nat. Mus., vol. 2, p. 231.
1880. *Cynthia papillosa* Traustedt, Vidensk. Meddel. Naturhist. For. Kjobenhavn, p. 407.
1885. *Cynthia pyriformis* Verrill, Rept. U. S. Comm. Fish and Fisheries for 1883, p. 529.
1886. *Halocynthia pyriformis* Whiteaves, Catalogue Colonial and Indian Exhibition, p. 39.
1889. *Halocynthia pyriformis* McDonald, Rept. U. S. Comm. Fish and Fisheries for 1886, p. 858.
1900. *Cynthia pyriformis* Metcalf, Zool. Jahrbücher, Anat., vol. 13, p. 510.
1901. *Halocynthia pyriformis* Whiteaves, Geol. Survey Canada, pub. no. 722, p. 268.
1901. *Cynthia (Halocynthia) pyriformis* Kingsley, Proc. Portland Soc. Nat. Hist., vol. 2, p. 183.
1903. *Halocynthia aurantium* Hartmeyer, in Römer and Schaudinn, Fauna Arctica, vol. 3, p. 195.
1906. *Halocynthia aurantium* Redikorzew, Trav. Soc. Nat. St. Pétersbourg, vol. 37, pt. 1, pp. 154, 308, 310.

1907. *Halocynthia aurantium* Redikorzew, Ann. Mus. Zool. Acad. St. Pétersbourg, vol. 11, pp. 132, 151, 154.
1908. *Halocynthia aurantium* Bjerkan, Report Second Norwegian Arctic Exped., no. 14, p. 5.
1908. *Halocynthia aurantium* Redikorzew, Trav. Soc. Nat. St. Pétersbourg, vol. 39, pp. 20, 24.
1908. *Halocynthia aurantium* Bjerkan, Tromsø Mus. Aarshefter, no. 25, pp. 60, 115.
1908. *Pyura pectenicola* Michaelsen, Jahrb. Wiss. Anstalt. Hamburg, no. 25, suppl. 2, p. 262, pl. 2, fig. 16-19.
1909. *Pyura aurantium* Hartmeyer, Bronn's Tier-reich, vol. 3, suppl., p. 1339.
1912. *Pyura aurantium* Hartmeyer, Denkschr. K. Akad. Wiss. Wien, cl. math.-nat., vol. 88, p. 182.

Body stout and generally of rather regular more or less egg-shaped, barrel-shaped or pear-shaped form, attached by the smaller end. Siphons generally short and stout, like large papillae, the branchial (the larger) being almost terminal in position, the atrial on the dorsal surface, more or less oblique in direction, and removed a varying



Text-fig. 25.—*Pyura aurantium* (Pallas).  $\times 2.4$ .

distance from the branchial siphon. Elongated clavate specimens attached by a narrow base also occasionally occur. Both apertures generally four-lobed, but in the case of the atrial, two pairs of these lobes are often practically fused, so that the aperture has the form of a transverse cleft. One specimen with a five-lobed branchial aperture was found. Testis thin but tough and leathery. External surface of the body usually smooth and even, often practically free from wrinkles even in preserved specimens, sometimes slightly wrinkled with shallow circularly disposed furrows. It has, however, a granular

appearance and feeling, like fine sandpaper, due to very minute short stiff spines abundantly distributed over the surface, singly or in small groups of from two to six or even more, each single spine, or each group, being raised on a small rounded elevation. On some specimens single spines, on other groups predominate. About the orifices the spines are longer but rarely sufficiently so as to be very conspicuous. The spines do not branch but (especially in the case of the larger ones) there may be slightly projecting points along the sides or at the base.

"Color generally yellowish white, more or less tinged on the upper part and one side with peach-red; frequently yellowish white throughout, or merely tinged with orange in certain parts, especially between the tubes. Not unfrequently the color is deep orange-red or peach-red over most of the surface, except the lower part of the sides, which are flesh-color or salmon-color, and a band of light orange bordered with darker orange-red, which passes from each tube down the sides to the base; a similar band or spot generally exists between the bases of the tubes. The apertures are salmon-color inside, often surrounded by a delicate circle of red, or in the darker specimens with a pale orange circle" (Verrill, 1871a, p. 97-98). This vivid coloring together with its velvety appearing surface, has caused the animal to receive the popular name "sea peach." It attains a large size. The largest specimen measured was 75 mm. high and 54 mm. wide. The following description of the internal anatomy was prepared from specimens of moderate size, 30 to 40 mm. in height from the base to the end of the branchial siphon.

Mantle usually readily separable from the test in preserved specimens. Musculature well developed over practically the whole body, consisting of an inner layer of stout closely placed bands originating from the siphons and running to the opposite (attached) end of the body. Overlying these bands is a superficial layer or sheet of slenderer, less well defined bands, which cross the first mentioned bands at right angles, surrounding the body like the hoops of a barrel. This layer extends up on the siphons and forms their sphincters.

Oral tentacles comparatively few. Not more than three or four orders somewhat regularly arranged according to the usual scheme (1, 4, 3, 4, 2, 4, etc.). Those of the first two orders apparently normally number altogether eight, those of the third order eight, while the fourth-order tentacles are few and scattered. Even the largest tentacles are only simply pinnate with short stump-like but tapering

branches arising alternately from each side of the stem. A few of the largest of these branches may bear slight projections along their side indicating incipient second-order branches. The third- and fourth-order tentacles can hardly be called branched; they have merely a few slight protuberances along the sides. The tentacles bear fairly well developed membranes.

Dorsal tubercle large, C-shaped with spirally inrolled horns. The open interval was turned obliquely anteriorly and to the left in the specimens examined.

Dorsal lamina broken up into a series of long tapering languets. The median dorsal vessel broadens out posteriorly and on the right side of the series of languets above mentioned there are smaller additional languets (on the posterior portions sometimes as many as three or four abreast). Endostyle stout and often thrown into lateral undulations in the preserved specimens.

Branchial sac with eight folds on each side. The folds are very high, far exceeding in height the width of the interspaces, especially in large specimens, except the eighth fold, which is more or less rudimentary. The first fold is rather low, the second higher; the third, fourth, and fifth are highest. Transverse vessels very numerous, about five orders being recognizable in the ventral part of the sac, the smallest merely crossing the stigmata. In the dorsal part of the sac the fifth-order vessels are wanting and the fourth-order vessels are small and merely cross the stigmata. Internal longitudinal vessels rather close together, being generally separated on the interspaces between the folds by eight to twelve stigmata, while on the upper part of the folds they are closely crowded. A large number of stigmata (12 to 16) intervene between the endostyle and the nearest internal longitudinal vessel. Many of these vessels terminate before the posterior end of the sac is reached; those that extend the whole length end in a conspicuous recurved hook. They are almost as numerous on the dorsal as on the ventral leaves of the folds. The following is the approximate distribution of the vessels in a specimen about 35 mm. in height.

*mdv.* 2 (16) 3 (18) 4 (22) 4 (24) 4 (22) 4 (14) 3 (10) 2 (3) 1 *en.*

Smaller individuals usually have a less number. Stigmata placed longitudinally (their long diameter parallel to the internal longitudinal vessels).

Stomach rather wide, with a very large hepatic gland consisting of numerous closely placed short tubular or rounded diverticula covering that surface of the stomach which is turned toward the branchial sac. The rest of the stomach wall may exhibit irregular plications. Intestinal loop short and rather wide.

Gonads clongate, flask-shaped or tubular, more or less sinuously curved, ending in a short oviduct at the dorsal end. They vary in number, generally four to seven on a side, the right side usually having more than the left. In contracted preserved specimens they often appear to be more or less fused together at the blind (ventral) end, sometimes apparently forming a single branching mass, but an oviduct can be distinguished at the dorsal end of most, if not all, of the branches, so that it seems questionable if much actual fusion takes place. On the left side the intestine passes between the oviducts and the mantle. In the specimens examined the ovaries were very well developed and occupied most of the gonad, the testes being few and visible only at the posterior end of the ovary where they spread out irregularly beyond the border of the latter. Their ducts, however, appeared to unite, and running along the ovary, to open on a papilla at one side of the oviduct, as in many other ascidians.

This species is of wide distribution in the waters of northern Europe and the Arctic Seas, including Iceland, Greenland and northern Japan. In the Puget Sound region it is represented by allied species. On the American Atlantic coast it ranges from Labrador and the Gulf of Saint Lawrence southward to Massachusetts Bay, being common as far south as the Bay of Fundy, and Eastport, Me.

It prefers a hard bottom affording firm places of attachment, and ranges from low-water mark to 120 fathoms in depth. Stimpson reports that though occurring at low-water mark at Grand Manan it is more common in four or five fathoms.

The form occurring in the Mediterranean is a distinct species, *P. papillosa* (Linnaeus).

The specimens examined by the writer were from:

Labrador coast (collected by J. A. Allen and B. S. Barrow, 1882, and by A. S. Packard).

Bay of Fundy and Eastport, Me.

Station 2445 (N. lat.  $46^{\circ} 09' 30''$ , W. long.  $49^{\circ} 48' 30''$ , 39 fathoms, broken shells).

George's Bank.

Though regretting to differ from so experienced an observer as Professor Michaelsen, the writer believes that *Pyura pectenicola* Michaelsen, 1908b, should be included among the synonyms of this species. *P. pectenicola* was described from two small shrunken and poorly preserved specimens from the Banks of Newfoundland, which were insufficient, as Professor Michaelsen himself says, to make the internal structure entirely clear. The writer has found just such spines on *P. aurantium* as are illustrated for *P. pectenicola*, and in stunted shrunken specimens of the former he has found the gonads apparently, if not actually, fused into an irregularly branching body such as Michaelsen illustrates, though most of the branches at least, have their own oviducts. The supplementary dorsal languets mentioned as especially characteristic of the new species occur in *P. aurantium*, and no other sufficient distinctions between the two species appear to exist.

Genus *MICROCOSMUS* Heller, 1877.

Differs from *Pyura* in having the dorsal lamina a continuous, usually plain-edged membrane, and usually in having the intestinal loop much narrower. Stigmata always elongated in a direction parallel to the body axis.

***Microcosmus nacreus*, sp. nov.**

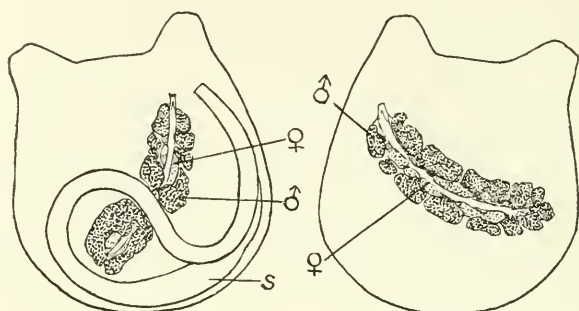
Pl. 56, fig. 75-77; Pl. 57, fig. 82; Pl. 73, fig. 162; text-fig. 26.

Body of unsymmetrically oval outline when seen from one side, the part between the widely separated apertures forming nearly a straight line. Apertures four-lobed, on short, stout, conical siphons, or when retracted, level with the surface. Body usually thick from side to side in the anterior and dorsal part, but it narrows to a thin wedge-like border in the posterior ventral region.

Length of largest specimen 40 mm., depth 35 mm., width 19 mm. Siphons separated by 22 mm. at their ends.

Test cartilaginous, thicker in the ventral region, its substance densely crowded with coarse sand grains. External surface of body even, but covered with coarse sand and small pebbles except immediately about the orifices. Inner surface rough with small papillae due to these sand grains, and provided with a thick nacreous lining.

Musculature of mantle very well developed; composed of rather thick closely placed bands. Those which radiate from the siphons extend to about the middle on the sides of the body, and along the endostyle to a still greater distance. The circular muscles of the siphons underlie these bands. On all parts of the median line except



Text-fig. 26.— *Microcosmus nacreus*, sp. nov. Slightly enlarged.

where the siphons arise, stout closely placed transverse bands, extending well on to the sides of the body, overlie the above mentioned radiating bands.

There are eight large, twice (to a small extent three times) compound tentacles, irregularly arranged. A considerable number of smaller tentacles of different sizes in the intervals but it is difficult to recognize distinct orders or a regular scheme of arrangement. Tentacles provided with moderately wide membranes. Their branching is of the pinnate type with short lateral branches. Tips of branchlets not enlarged.

Dorsal tubercle horseshoe-shaped; open interval directed anteriorly; horns incurved.

Dorsal lamina a membrane whose edge has numerous low obtusely triangular denticulations.

Branchial sac with five well developed folds on each side of the body. The second and third folds are highest, though the number of internal longitudinal vessels borne on the folds decreases from the first to the fifth. Folds higher in anterior part of sac. Details of structure of sac practically alike on both sides. Transverse vessels of four orders (the larger ones bearing narrow membranes) cross the sac and are quite regular in their arrangement according to the scheme 1, 4, 3, 4,

2, 4, etc. They number all told about sixty. In the intervals between them are slender vessels of a fifth order crossing without interrupting the stigmata but these are often wanting or intermittent, extending only over a few stigmata before they terminate. About midway on the interspaces between the first and second folds there are on each side of the sac two internal longitudinal vessels close together. Except for these, the internal longitudinal vessels are all borne on the folds or so near the bases of the latter (either dorsal or ventral to a fold) that they clearly belong to a group borne on one of the folds. They are distributed as follows in the largest specimen:

*mdv.* 0 (19) 2 (18) 0 (14) 0 (13) 0 (11) 0 *en.*

The stigmata are longitudinal in direction and are separated by very narrow vessels. They are very numerous, thirty or forty or more on the interspaces between folds (counting from the actual beginning of the plications, not from the outlying internal longitudinal vessels above mentioned). They are about equally as numerous dorsal to the first fold, and ventral to the last fold as on the interspaces between folds. On the folds the stigmata are narrower than on the interspaces and also very numerous, but difficult to count because of the closely placed internal longitudinal vessels. The above numbers of stigmata apply to the anterior and middle parts of the sac. Posteriorly they are fewer and less regular as the folds come nearer together.

Stomach elongated, with thick glandular walls. It is not conspicuously distinguished externally from the intestine into which it gradually tapers off. Intestinal loop widely open for a short distance; the intestine then approaches the stomach along which it lies, somewhat overlapping it.

Gonads elongated, hermaphroditic. One on each side of the body. That on the left partly in the open space of the intestinal loop, crossing the dorsal branch of the loop at right angles. The ovary, consisting of a rather large oviduct with masses of small eggs along its sides, occupies the axial part of each gonad. The main sperm duct accompanies the oviduct giving off lateral branches to large masses of small pyriform or lobed testes which surround and almost conceal the eggs from view and spread out over the mantle considerably beyond the borders of the ovary. The oviduct extends but a short distance beyond the end of the gonad, terminating with a large irregularly lobed

orifice. The sperm duct does not extend quite as far as the oviduct and terminates on a small papilla.

The only specimen of this species was according to its label brought up on a fish hook "near 2501." Station 2501 is north of Sable Island (N. lat.  $44^{\circ} 27'$ , W. long.  $60^{\circ} 20' 15''$ , 26 fathoms, sand and gravel). Aside from its different external form, the structure of the branchial sac appears to distinguish it sufficiently from *M. glacialis* (Sars) of Norway (see Kiaer, 1893) that species having four or five internal longitudinal vessels on the interspaces between folds and but four to six stigmata separating these vessels.

Genus CULEOLUS Herdman, 1881.

Body more or less egg-shaped, and attached by a very long slender stalk. Apertures large, rounded or cleft-like. Branchial sac reduced to a framework of transverse and internal longitudinal vessels, the resulting meshes not divided into stigmata by interstigmatic vessels. Dorsal lamina reduced to a series of languets. Reproductive organs consisting of one or more hermaphroditic gonads on each side of the body.

Chiefly a deep-sea genus, several species, however, being recorded from water of moderate depth (204 to 924 meters). Greatest depth recorded for any species, 4,636 meters.

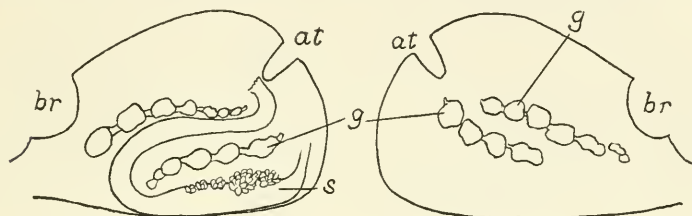
*Culeolus suhmi* Herdman.

Pl. 56, fig. 78-81; Pl. 57, fig. 83; text-figs. 27, 28.

1881. *Culeolus suhmi* Herdman, Proc. Roy. Soc. Edinburgh, vol. 11, p. 86.  
 1882. *Culeolus perlatus* Herdman, Challenger Rept., Tunicata, pt. 1, p. 115, pl. 11, figs. 8, 9; pl. 13, figs. 1, 2.  
 1885. *Culeolus Tanneri* Verrill, Rept. U. S. Comm. Fish and Fisheries for 1883, p. 529, pl. 31, figs. 144, 145.  
 1885. *Culeolus Tanneri* Verrill, Proc. U. S. Nat. Mus., vol. 8, p. 447.  
 1904. *Culeolus perlatus* Michaelsen, Wiss. Ergebn. Deutschen Tiefsee-Exped. "Valdiva", vol. 7, p. 183.  
 1909. *Culeolus suhmi* + *C. tanneri* Hartmeyer, Bronn's Tier-reich, vol. 3, suppl., p. 1347.

Body between wedge-shaped and ovate, deeper near the posterior than near the anterior end, the apertures widely separated, the branchial on the anterior dorsal part, the atrial on the posterior dorsal part; dorsal margin of the body between the apertures, and also the posterior margin convex, the ventral margin straighter. Oral aper-

ture exceptionally large, nearly round; atrial aperture smaller yet still of large size, and of the form of a transverse cleft. Ventral to the branchial aperture the anterior part of the body tapers rapidly off into the stem which arises from the anterior ventral part. (Its origin is continued as a ridge along the ventral margin of the body to near



Text-fig. 27.—*Culeolus sukmi* Herdman.  $\times \frac{2}{3}$ .

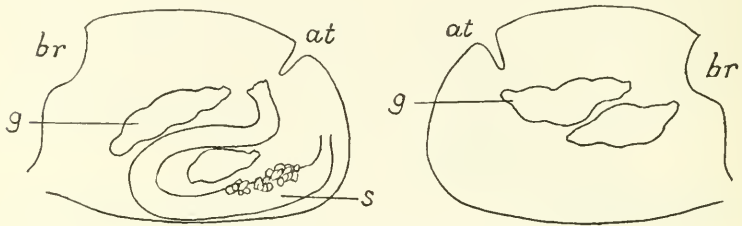
the middle of the latter, where it ends abruptly.) Stem very slender, cylindrical, with minute longitudinal furrows; it ends in a slightly expanded base which breaks up into root-like fibers.

Test moderately thin, tough, not wrinkled externally but thickly and evenly covered with minute rounded semitransparent tubercles each of which bears at its summit a still more minute nipple-like projection. The tubercles are so abundant and evenly distributed that the surface of the body resembles sandpaper, but it is soft to the touch. On a few parts of the body closely crowded, slender irregular soft papillae are borne, some of them 1 mm. or even more in height. The larger of these papillae bear pointed yet soft projections or points along the sides. The points of the body where these papillae chiefly occur are about the margins of the apertures, and along a narrow line on each side which starts from a point on the dorsal surface near the middle of the body and passing obliquely downward and backward meets its fellow of the opposite side on the posterior ventral part of the body, where there is a considerable tuft or area of these papillae. A few papillae are also scattered along the median ventral region. The alcoholic specimens are of a light yellowish brown color, the stems darker.

Dimensions of three specimens: (1) body 60 mm. long, 37 mm. deep; stem 165 mm. long and about 1.5 mm. thick; apertures 45 mm. apart; (2) body 24 mm. long, 18 mm. deep, stem 100 mm. long, and .7 mm. thick; (3) immature, 14 mm. long, 11.5 mm. deep, stem 82 mm. long.

The stem, though practically cylindrical, nevertheless increases somewhat in diameter toward the ends, the narrowest part being nearer to the body than to the base.

Mantle thin, with distinct muscle bands which are neither very numerous nor closely placed. Radial and circular bands about the



Text-fig. 28.—*Culeolus suhmi* Herdman.  $\times 2$ .

apertures rather poorly developed, the most conspicuous muscles being somewhat irregular bands crossing the ventral region transversely.

Large tentacles twice compound, the branchlets few in number and somewhat pointed at the tip. There are ten or twelve of the largest tentacles and about an equal number of second-order tentacles alternating with them. Third-order tentacles (simply branched) appear to be present only in some of the intervals; still smaller ones if present are few and inconspicuous.

Dorsal tubercle (distinguished in only one specimen) small and rounded, though prominent, with a simple pit-like aperture.

Dorsal lamina broken up into a series of large leaf-like languets corresponding in number to the transverse vessels. They arise irregularly, with their broad surfaces transverse, oblique, or occasionally even almost parallel to the course of the median dorsal vessel.

Branchial sac with six folds on each side, very delicate, consisting only of transverse vessels and internal longitudinal vessels. The transverse vessels are apparently about forty in number in the largest specimens, and except for a few short irregular smaller vessels here and there, are all of one order. The internal longitudinal vessels generally are so spaced that they form square or nearly square meshes on the interspaces between folds; on the folds they are closer. They present nothing peculiar in their appearance or distribution, which

was about as follows in the medium-sized of the three specimens whose dimensions are given above:

*mdv.* 2 (9) 3 (8) 2 (10) 3 (8) 3 (6) 2 (4) 1 *en.*

The largest of the three specimens had more vessels (at least twelve on some folds and four on some interspaces) but the branchial sac was not dissected out for a careful study.

The alimentary tract forms a loop of moderate length and width, the rectum bending abruptly dorsally. The stomach is long, tapering gradually into the intestine, and is provided with a row of many-lobed yellowish hepatic glands along each side. The anus was conspicuously though irregularly lobed in one specimen, but only slightly so in another.

Gonads were found well developed only in the two larger specimens whose measurements are given above. There are two on each side of the body. On the left side one of them lies within the space surrounded by the intestinal loop, the other dorsal to the intestine. In the largest individual the gonads were all greatly elongated, and constricted at intervals so as to form a chain of rounded masses, at least six in number, connected like a string of beads. In the smaller individual the gonads were only moderately elongated and exhibited but little tendency to constriction into segments, though this is perhaps largely due to their being greatly distended with the sexual products. The ovary occupies the whole length of the organ on the side attached to the mantle, including the constricted portions; the small, usually two- or three-lobed testes are chiefly found in the superficial parts of the enlarged segments. The sexual ducts were not satisfactorily traced, but apparently the ovary terminates in a narrow neck with a lobed terminal orifice at the posterior end of the whole gonad.

This is a deep-sea species and does not properly belong to the New England fauna, but as Professor Verrill's description of *C. tanneri* dealt only with the external characters, it seemed best to take this opportunity to record something in regard to its internal structure. The writer finds no sufficient grounds for regarding Verrill's species as distinct from Herdman's, which was based on a small specimen taken by the *Challenger* in N. lat. 37° 25', W. long. 71° 40' (1700 fathoms, bottom temperature 1.7° C., gray ooze).

The specimens studied, which included Verrill's types of *C. tanneri*, were from:

Station 2041 (N. lat. 39° 22' 50", W. long. 68° 25', 1608 fathoms, Globigerina ooze), one large specimen (type).

Station 2714 (N. lat. 38° 22', W. long. 70° 17' 30", 1825 fathoms, brown ooze), two rather small specimens (also labeled types).

Station 2713 (N. lat. 38° 20', W. long. 70° 08' 30", 1859 fathoms, brown ooze), seven small specimens; not dissected.

Station 2566 (N. lat. 37° 23', W. long. 68° 08', 2620 fathoms, gray ooze).

The records in the Peabody Museum mention this species also from two other stations, which the writer gives without having examined the specimens:

Station 2099 (N. lat. 37° 12' 20", W. long. 69° 39', 2919 fathoms, Globigerina ooze).

Station 2226 (N. lat. 37° 00', W. long. 71° 54', 2045 fathoms, Globigerina ooze).

Family TETHYIDAE Hartmeyer, 1908.

[= STYELIDAE auct. plur.].

(This includes two subfamilies of simple ascidians, Pelonaiinae Seeliger, 1907, and Tethyinae Hartmeyer, 1908 [Styelinae], with characters as below, and Polyzoinae Hartmeyer, 1903, consisting of compound ascidians which reproduce by budding and form colonies. The latter subfamily has not been found in the New England region).

Test usually tough, opaque, and leathery; apertures as a rule both four-lobed.

Tentacles simple.

Branchial sac regularly with four longitudinal folds on each side (rarely with a rudimentary fifth fold), but some or even all of these may be reduced, rudimentary, or entirely wanting. Stigmata usually straight, never arranged in spirals.

Intestine on the left side of body (posterior to branchial sac in the genus *Pelonaia* only). Stomach usually clearly differentiated from the intestine; no liver.

Reproductive organs sometimes on one, but much more frequently on both sides of body.

Subfamily *Pelonaïinae* Seeliger, 1907.

Contains only the genus *Pelonaia*.

Genus *PELONAIA* Goodsir and Forbes, 1841.

Body much elongated, club-shaped, tapering anteriorly and provided at the posterior end with root-like processes. Both apertures close together at the anterior end.

Branchial sac shorter than the body, without folds. Alimentary tract lying chiefly posterior to the branchial sac. Gonads elongated, present on each side of body.

***Pelonaia corrugata*** Goodsir and Forbes.

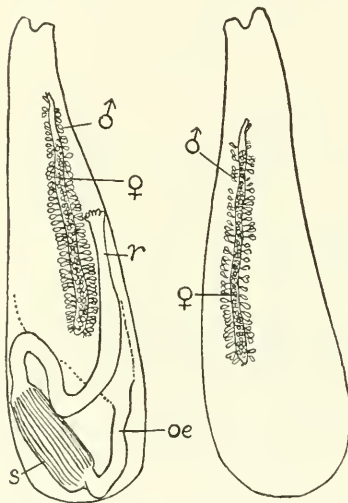
Pl. 58, figs. 84, 85; text-fig. 29.

1841. *Pelonaia corrugata* Goodsir and Forbes, Rept. British Assoc. Adv. Sci., vol. 10, p. 137.
1848. *Pelonaia corrugata* + *P. glabra* Forbes and Hanley, History of British Mollusca, vol. 1, p. 43, pl. E, figs. 3, 4.
1851. *Pelonaia arenifera* Stimpson, Proc. Boston Soc. Nat. Hist., vol. 4, p. 49.
1858. *Pelonaia villosa* Sars, Forh. Vidensk. Selsk. Christiania, p. 66.
1860. *Pelonaia arenifera* Stimpson, Smithsonian Check-list, p. 2.
1863. *Pelonaia arenifera* Packard, Canadian Naturalist and Geologist, vol. 8, p. 412.
1867. *Pelonaia arenifera* Packard, Mem. Boston Soc. Nat. Hist., vol. 1, p. 277.
1870. *Pelonaia arenifera* Binney, Gould's Invertebrata of Massachusetts, ed. 2, p. 26.
1870. *Pelonaia arenifera* Dall, Proc. Boston Soc. Nat. Hist., vol. 13, p. 255.
1874. *Pelonaia arenifera* Whiteaves, Amer. Journ. Sci., ser. 3, vol. 7, p. 7.
1879. *Pelonaia arenifera* Verrill, Preliminary Check-list of Marine Invertebrates, p. 27.
1886. *Pelonaia arenifera* Whiteaves, Catalogue Colonial and Indian Exhibition, p. 39.
1891. *Pelonaia arenifera* Packard, Labrador Coast, p. 397.
1895. *Pelonaia* sp. Rodger, Proc. Roy. Soc. Edinburgh, vol. 20, pp. 157, 158.
1901. *Pelonaia arenifera* Whiteaves, Geol. Survey Canada, pub. no. 722, p. 269.
1903. *Pelonaia corrugata* Hartmeyer, in Römer and Schaudinn, Fauna Arctica, vol. 3, p. 203.
1906. *Pelonaia corrugata* Hartmeyer, Beiträge zur Meeresfauna von Helgoland, no. 25, p. 122.
1906. *Pelonaia corrugata* Redikorzew, Trav. Soc. Nat. St. Pétersbourg, vol. 37, pt. 1, p. 310.

1907. *Pelonaia corrugata* Redikorzew, Ann. Mus. Zool. Acad. St. Pétersbourg, vol. 11, pp. 132, 151, 152, 154.  
 1908. *Pelonaia corrugata* Bjerkan, Tromsø Mus. Aarshefter, no. 25, pp. 61, 114.  
 1909. *Pelonaia corrugata* Hartmeyer, Bronn's Tier-reich., vol. 3, suppl., p. 1356.

The external appearance of the New England specimens is thus described by Stimpson (1851), who called the species *P. arenifera*:

"The body is elongated, clavate, of a brownish color, and covered with grains of sand; the apertures are placed on two small white mammilliform protuberances at the smaller extremity. It inhabits deep water; the specimens were obtained from eighteen fathoms about ten miles east of the Boston Lighthouse."



Text-fig. 29.—*Pelonaia corrugata* Good-  
 sir and Forbes.  $\times 5$ .

The only good specimens that the writer has had the opportunity of examining are a few small ones collected by J. F. Whiteaves, in the Gulf of Saint Lawrence (Whiteaves, 1874, gives these localities: west side of Cape Breton Island, and in Northumberland Straits). A poorly preserved specimen from Murray Bay, Gulf of Saint Lawrence, is also in the collection.

These all agree well with Stimpson's description, being of a red-brown color, and have numerous fine transverse wrinkles, especially on the anterior part of the surface, as well as a thin external coating of sand. The largest are 20 mm. to 30 mm. long and 6 mm. to 8 mm. in greatest width. The species attains, however, a considerable size in some regions. Hartmeyer mentions a specimen from Iceland 110 mm. long.

The following notes on the anatomy were made from a small specimen about 14 mm. long which was not entirely mature.

Mantle strongly muscular, numerous stout bands extending from

the siphons to the attached end of the body. Superficial to these is a weaker layer of muscles encircling the body.

Oral tentacles of two or three sizes, not very numerous, about thirty in number.

Dorsal tubercle C-shaped, the horns incurved, and the open interval directed obliquely forward and to the left.

Dorsal lamina rather wide, plain-edged, but its margin laterally plicated in contraction.

Branchial sac without folds, the internal longitudinal vessels quite regularly placed and but seventeen on a side in this specimen, though perhaps they would be found more numerous in older individuals. But two or three stigmata, which are of short oval form, generally intervene between these vessels, though there are four or five in the spaces along the median dorsal vessel and endostyle. Transverse vessels of three orders regularly arranged, very numerous; those of the first order exceeding thirty in number.

Alimentary tract lying mostly posterior to the branchial sac. Stomach elongated, with about twenty longitudinal folds; esophagus and intestine long, thin-walled, also with longitudinal plications. No pyloric caecum observed. Margin of anus with many short rounded lobes.

Gonads one on each side, consisting of a central ovary of elongated tubular form bordered on each side with a row of small, simple pyriform or, less often, two-lobed male glands. These communicate by short ducts with the common sperm duct which accompanies the ovary and ends on a papilla beside the neck into which the ovary narrows at the anterior end.

This species is of wide distribution. In the Arctic seas it is nearly, if not completely, circumpolar, occurring in the Siberian Arctic Ocean, the White Sea, about Iceland, Greenland, etc., and at many points on the coasts of northern Europe, including Scotland and England.

On the American Atlantic coast it has been reported by Packard (1867, 1891) from Labrador (Straits of Belle Isle, Salmon Bay, 15 fathoms, sandy bottom), by Whiteaves (1901) from the Gulf of Saint Lawrence between Cape Breton and Prince Edward Island, and Northumberland Straits, and by Stimpson from Massachusetts (10 miles east of Boston Light).

It occurs on sandy, less often on muddy bottoms or on those partly stony, but rarely on hard rocky bottoms, and ranges from 6 to 100 fathoms.

No specimens were found in the collections from the New England coast made by the U. S. Fish Commission, and it is evidently very rare there.

Subfamily *Tethyinae* Hartmeyer, 1908.

Characters approximately those given for the family. Comprises simple ascidians only, which never reproduce by budding.

Genus TETHYUM Bohadsch, 1761.

[= STYELA auct. plur.].

Apertures both four-lobed.

Branchial sac regularly with four folds on each side, but one or more may be rudimentary or wanting, or a rudimentary fifth fold may occur (not in any New England species).

Tentacles simple.

Dorsal lamina usually plain, sometimes slightly toothed.

Ovaries phial-shaped or tubular with one end closed; one or more on each side of the body. The small testes generally arranged along the border of the ovary, either close to it, forming a compact gonad, or separated a little way from it.

This genus, which is one of the largest and most widely distributed genera of ascidians, is second only to *Caesira* in the number of species represented in the New England region. Seven from this region are here described in addition to one from the North Carolina coast.

*Key to the Species.*

1. Gonads each consisting of a crooked tubular ovary and a varying number of small testes, the latter attached to the mantle at a little distance from the margin of the ovary.
  - A. Gonads usually one on each side.
    - Body surface coarsely wrinkled, usually a pointed projection between the orifices.....*rusticum*.
    - Body surface with many very minute rounded semitransparent tubercles, body usually dorso-ventrally flattened.....*coriaceum*.
  - B. Gonads usually two on each side.
    - Testes chiefly grouped about the ventral ends of the ovaries. Inhabits moderately deep water.....*atlanticum*.
    - Testes of irregular, often more or less branching form, arranged along each side of the ovaries as well as about their ventral ends. Inhabits shallow water.....*partitum*.
2. Gonads each consisting of a flask-shaped or elongated ovary overlying or closely bordered by a number of small pyriform or lobed testes, the whole forming a compact mass.

- A. Branchial sac with but one fold on each side; two gonads on right and one on left side. . . . . *mortensenii*.
- B. Branchial sac with four folds on each side; gonads rather numerous (often six or eight on one side).
- a. Internal longitudinal vessels chiefly confined to folds of branchial sac; body sand-covered. . . . . *molle*.
- b. Internal longitudinal vessels numerous on interspaces as well as on folds.
- Body flattened dorso-ventrally; surface smooth; gonads numerous on both sides of body. (Northern in distribution.)  
*finmarkiense*.
- Body elongated, attached by posterior part; surface much wrinkled; gonads two on left side, five or more on the right. (North Carolina, etc., not known from New England.)  
*plicatum*.

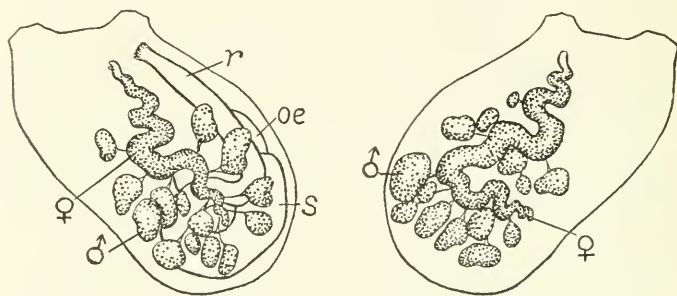
**Tethyum rusticum** (Linnaeus).

Pl. 59, fig. 89-91; Pl. 69, fig. 138; text-fig. 30.

1767. *Ascidia rustica* Linnaeus, Syst. Nat., ed. 12, vol. 1, pt. 2, p. 1087, no. 5.
1842. *Ascidia rustica* + *A. monoceros* Möller, Naturhist. Tidsskr., vol. 4, p. 95.
1867. *Cynthia condylomata* Packard, Mem. Boston Soc. Nat. Hist., vol. 1, p. 277.
1870. *Cynthia condylomata* Binney, Gould's Invertebrata of Massachusetts, p. 19, pl. 23, fig. 324.
1870. *Cynthia condylomata* Dall, Proc. Boston Soc. Nat. Hist., vol. 13, p. 255.
1871. *Cynthia monoceros* Verrill, Amer. Journ. Sci., ser. 3, vol. 1, p. 93.
1872. *Cynthia monoceros* Verrill, Amer. Journ. Sci., ser. 3, vol. 3, p. 213.
1874. *Cynthia monoceros* Whiteaves, Amer. Journ. Sci., ser. 3, vol. 7, p. 5.
1879. *Halocynthia rustica* Verrill, Bull. U. S. Nat. Mus., no. 15, p. 147.
1879. *Halocynthia rustica* Verrill, Proc. U. S. Nat. Mus., vol. 2, p. 197.
1891. *Cynthia monoceros* Packard, Labrador Coast, p. 396.
1901. *Halocynthia rustica* Whiteaves, Geol. Survey Canada, pub. no. 722, p. 268.
1903. *Styela rustica* Hartmeyer, in Römer and Schaudinn, Fauna Arctica, vol. 3, pt. 2, p. 217, pl. 5, figs. 2, 3.
1906. *Styela rustica* Redikorzew, Trav. Soc. Nat. St. Pétersbourg, vol. 37, pt. 1, pp. 154, 308, 310.
1907. *Styela rustica* Redikorzew, Ann. Mus. Zool. Acad. St. Pétersbourg, vol. 11, pp. 134, 151-153.
1907. *Styela rustica* Redikorzew, Zool. Anzeiger, vol. 31, p. 521.
1908. *Styela rustica* Redikorzew, Trav. Soc. Nat. St. Pétersbourg, vol. 39, pp. 20, 25, 42.
1908. *Styela rustica* Bjerkan, Rept. Second Norwegian Arctic Exped., no. 14, p. 6.
1908. *Styela rustica* Redikorzew, Mém. Acad. Imp. Sci. St. Pétersbourg, ser. 8, cl. phys.-math., vol. 18, no. 11, p. 29, pl. 2, fig. 28.

1908. *Styela rustica* Bjerkan, Tromsø Mus. Aarshefter, no. 25, pp. 63, 115.  
 1909. *Tethyum rusticum* Hartmeyer, Bronn's Tier-reich, vol. 3, suppl., p. 1360.  
 1910. *Tethyum rusticum* Hartmeyer, Danmark-Expeditionen, vol. 5, p. 234.  
 1912. *Tethyum rusticum* Hartmeyer, Vidensk. Meddel. Naturhist. For. Kjobenhavn, vol. 63, p. 266.  
 1912. *Tethyum rusticum* Hartmeyer, Sitzungsab. Ges. Naturforsch. Freunde, 1911, no. 10, pp. 439, 440.  
 Not *Ascidia rustica* Couthouy, 1838; Gould, 1841; DeKay, 1843; Binney, 1870.

Ordinary form of the body in well developed individuals elongated, larger at the anterior than at the posterior (attached) end. Apertures situated on small (often inconspicuous) elevations; the branchial aperture terminal, the atrial a little back from the end. Yet low rounded individuals attached by a broad base also occur, and some



Text-fig. 30.—*Tethyum rusticum* (Linnaeus).  $\times 1.4$ .

are even greatly flattened dorso-ventrally so that they have the form of a very flat cone, the test spreading out over the surface on which they are attached beyond the border of the body proper. A more or less conspicuous pointed projection of the test, sometimes 5 mm. or more long, is very frequently present between the apertures and appears to be characteristic of the species when present, but it is often entirely wanting. Surface of the body very strongly wrinkled in a transverse direction. These wrinkles generally break up on the anterior part of the body into irregular rounded prominences.

Test thick, especially near the apertures, and of tough leathery consistency. Color reddish or brownish, especially on the anterior part of the body, retaining this even in many preserved specimens. Measurements of largest specimens studied: 46 mm. to 55 mm. long and 25 mm. in dorso-ventral diameter. The species is generally

distinguishable externally from *T. partitum* (Stimpson) by its larger size, thicker test, and more coarsely and deeply wrinkled surface, even when the pointed process is wanting.

Mantle very thick and muscular. There are numerous bands radiating from the siphons and extending to or toward the attached end of the body, overlaid by a thick layer of fibers crossing them at about right angles and encircling the body.

Oral tentacles rather few. In a large individual fourteen large-sized tentacles (probably representing two orders) were present, and some smaller ones in the intervals, making a total of thirty or more.

Dorsal tubercle of some modification of the U form (often with one horn inrolled) with the open interval directed forward or more or less to the left.

Dorsal lamina a plain membrane.

Branchial sac with four folds on each side, the first usually the highest and the fourth lowest of all. The folds are narrow in comparison with the interspaces. Transverse vessels very numerous, of at least four orders in the dorsal and five in the ventral part of the sac. Fifth-order vessels for the most part merely cross the stigmata. Internal longitudinal vessels very numerous, stout on the interspaces and narrow and closely crowded on the upper part of the folds. They are separated by from five to eight stigmata on the interspaces between folds (by more near the endostyle). The following was the distribution of the vessels on the right side of the sac in a rather large specimen:

*mdr.* 7 (19) 8 (17) 6 (18) 6 (14) 3 *en.*

On the left side there were fewer between the median dorsal vessel and the base of the first fold than on the right side.

Stomach rather long, wide at the cardiac end, and curved nearly to a right angle, tapering gradually into the intestine, which forms a rather wide short loop. Stomach wall with minute, rather irregular longitudinal wrinkles. Rectum long and nearly straight; margin of anus with about a dozen rounded lobes.

Ovaries (one on each side of the body) elongated tubes tapering toward each end and bent in deeply sinuous curves; placed in a direction more or less nearly coincident with the long axis of the body, except that the posterior part of the right ovary is sharply bent in a ventral direction, often so as to form less than a right angle with the rest of the organ. The testes are rounded, oval, or bean-shaped bodies, each composed of a number of closely crowded lobes of irregular

shape. The testes are variable in size, number, and position. Some lie close to the ovary, some at a distance from it. Sperm ducts may be traced leading from them to or toward the ovary, and probably unite to a common duct following that organ. A small papilla on the side of the ovary near the anterior end of the latter is noticeable in some cases and is probably, as in related species, the termination of the sperm duct.

This is a widely distributed species in the high latitudes (Redikorzew, 1908b, p. 32) recorded it from the coast of Norway, Spitzbergen, Barents Sea, Murman Coast, Nova Zembla, White Sea, Siberian Arctic Ocean, Baffin's Bay, Davis Strait, Greenland, Iceland, Farøe Islands, and the coast of Denmark and Germany. It inhabits bottoms of various characters in depths of from 2 to 432 meters.

There are numerous specimens of this species in the collections from the Banks of Newfoundland and a few small ones from Murray Bay, Gulf of Saint Lawrence, and Labrador. It is abundant at Murray Bay according to Whiteaves (1901). There is also a small lot of specimens from the Gulf of Saint Lawrence between Pictou Island and Cape Bear, collected by Dr. Whiteaves, which are peculiar in their dorso-ventrally flattened form, small size, and finely wrinkled surface. They have the low conical shape (in two cases almost disk-like), common in *Tethyum coriaceum* and *Dendrodia carnea* described elsewhere in this article, yet the constant presence of the pointed processes of the test, and the close correspondence of their internal anatomy with that of the specimens from the Grand Banks appears sufficiently to prove their identity with this species. The largest of them measures about 22 mm. across the upper surface. On the New England coast the species has not been found.

***Tethyum atlanticum*, sp. nov.**

Pl. 59, figs. 92, 93; Pl. 60, fig. 96; Pl. 68, fig. 135; text-fig. 31.

1885. *Cynthia partita* ("apparently") Verrill, Rept. U. S. Comm. Fish and Fisheries for 1883, p. 529.

In form, size, and character of the test often practicably indistinguishable from *T. rusticum* except that the pointed process between the apertures which is frequently present in that species does not occur in this one. The lining of the test is whitish or bluish white in many specimens.

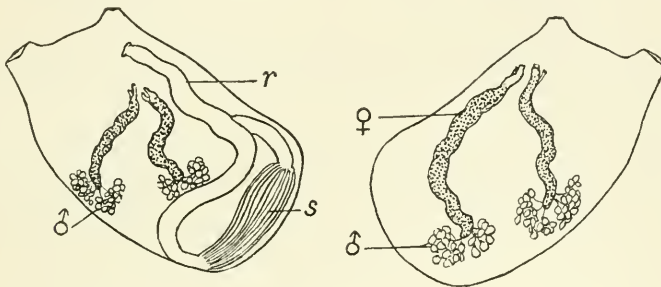
Mantle thin and musculature comparatively weak, although the same layers are present as in *T. rusticum*.

Tentacles comparatively few, as in that species.

Dorsal tubercle inconspicuous, often difficult to distinguish, and of unsymmetrical form, C-shaped or horseshoe-shaped with one horn inrolled, at least in some individuals.

Dorsal lamina plain-edged and rather narrow.

Branchial sac with four folds which are narrow in comparison with intervening spaces. The first two folds are the widest, the last one



Text-fig. 31.— *Tethyum atlanticum*, sp. nov.  $\times 1.4$ .

narrowest of all. Transverse vessels and stigmata less regular in their arrangement than in the other New England species of this genus. At rather wide but not very regular intervals the sac is crossed by fairly stout transverse vessels. In the intervals between them are from 4 to 12 slender vessels which are often more or less irregular in their course and sometimes vary much in size among themselves, in other cases, however, are nearly equal. These narrow vessels separate the transverse rows of stigmata. They often show some tendency to converge toward that point on each fold which lies midway in the interval marked off by the large transverse vessels, and the stigmata conform more or less to this oblique direction of the vessels so that an appearance suggestive of the curved rows of stigmata characteristic of the Caesiridae results. This condition prevails, however, only on the folds, and close to their bases. On most of the wide interspaces the stigmata form rows which are regular except for occasional anastomoses or forking of the slender vessels above described. Very slender transverse vessels crossing without interrupting the stigmata are present only here and there where the stigmata

are long. If followed ventrally they are generally seen to become stouter and separate rows of stigmata after a little distance. Internal longitudinal vessels very numerous and closely placed, especially in the anterior and middle parts of the sac. On the interspaces they are generally separated by two or four stigmata; on the folds they are closely crowded. Their number in the anterior part of the sac of a rather large specimen was:

Left side	8 (40)	8 (40)	9 (27)	11 (22)	5	
	<i>mdv.</i>					<i>en.</i>
Right side	8 (36)	10 (36)	11 (28)	13 (18)	6	

Small stunted, though fully adult individuals have a considerably smaller total number of vessels, though they are as closely placed as in the larger ones.

Stomach rather elongated, tapering in the pyloric portion, yet distinctly marked off from the intestine, which forms a rather large loop. Stomach wall with about twenty regular longitudinal plications. Rectum long and sinuous; margin of the anus more or less distinctly lobed.

Gonads two on each side. The tubular, sinuously curved ovaries are placed obliquely with their closed ends diverging and the open ends (contracted to a narrow neck with a terminal orifice with serrated margin) near together and directed toward the atrial siphon. The testes of each gonad consist of a cluster of pyriform or slightly lobed glands of different sizes attached to the mantle about the closed end of the ovary. Their ducts apparently unite to a common sperm duct accompanying the ovary and ending on a rather large papilla having an orifice with a serrated margin, which is situated on the side of the neck of the ovary.

Aside from inhabiting deeper water than *Tethyum partitum* (Stimpson), this species is readily distinguished by its rougher, thicker, and more wrinkled test, larger size, less prominent and less regularly shaped dorsal tubercle and by the gonads. The testes form moderately compact groups about the blind (ventral) end of the ovaries instead of being arranged along the greater part of the sides of the latter. The individual testes are, moreover, of simpler form than in *T. partitum*; the branched forms common in the latter species rarely if ever occur.

This species scarcely belongs to the New England fauna, all the

specimens coming from rather deep water (62 to 202 fathoms, in one case 397 fathoms) far to the southward of the coasts of southern New England. In many of these stations it grows in large clusters or masses and was dredged in considerable quantities, so that it is evidently an exceedingly abundant species. It occurs on both sandy and muddy bottoms, but prefers compact sand and gravel. The following are the localities of the specimens examined:

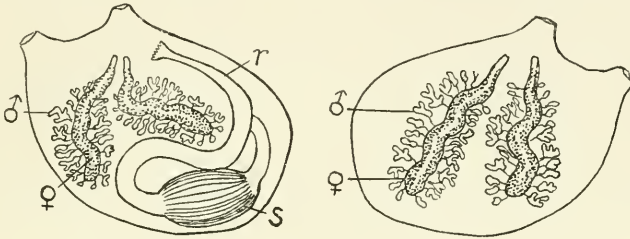
- Station 1157 (N. lat.  $40^{\circ} 14'$ , W. long.  $70^{\circ} 29' 15''$ , 62 fathoms, soft mud), small specimens.
- Station 950 (N. lat.  $40^{\circ} 07'$ , W. long.  $70^{\circ} 32'$ , 71 fathoms, sand, shells and mud), small specimens.
- Station 872 (N. lat.  $40^{\circ} 05' 39''$ , W. long.  $70^{\circ} 23' 52''$ , 86 fathoms, sand, gravel, shells and\* sponge), large specimens.
- Stations 865-867 (N. lat.  $40^{\circ} 05'$ , W. long.  $70^{\circ} 22'$ , 64-65 fathoms, sand, mud and shells), many specimens.
- Station 949 (N. lat.  $40^{\circ} 03'$ , W. long.  $70^{\circ} 31'$ , 100 fathoms, yellow mud), many specimens.
- Station 871 (N. lat.  $40^{\circ} 02' 54''$ , W. long.  $70^{\circ} 23' 40''$ , 115 fathoms, mud and fine sand), many rather small specimens.
- Station 1117 (N. lat.  $40^{\circ} 02'$ , W. long.  $70^{\circ} 45'$ , 89 fathoms, fine sand), many specimens.
- Station 1110 (N. lat.  $40^{\circ} 02'$ , W. long.  $70^{\circ} 35'$ , 100 fathoms, green mud and fine sand), many specimens.
- Station 874 (N. lat.  $40^{\circ} 00'$ , W. long.  $70^{\circ} 57'$ , 100 fathoms, soft sticky mud), small specimens.
- Station 1030 (N. lat.  $39^{\circ} 58' 30''$ , W. long.  $69^{\circ} 15'$ , 337 fathoms, yellow mud), rather small specimens.
- Station 1039 (N. lat.  $39^{\circ} 59'$ , W. long.  $70^{\circ} 06'$ , 130 fathoms, sand and mud, shells), one rather large specimen.
- Station 1038 (N. lat.  $39^{\circ} 58'$ , W. long.  $70^{\circ} 06'$ , 146 fathoms, sand and shells), one specimen.
- Station 1092 (N. lat.  $39^{\circ} 58'$ , W. long.  $69^{\circ} 42'$ , 202 fathoms, gray sand), small specimen.
- Station 940 (N. lat.  $39^{\circ} 54'$ , W. long.  $69^{\circ} 51' 30''$ , 134 fathoms, hard sand and sponges), many specimens.
- Station 1097 (N. lat.  $39^{\circ} 54'$ , W. long.  $69^{\circ} 44'$ , 158 fathoms, fine sand).
- Station 1046 (N. lat.  $38^{\circ} 33'$ , W. long.  $73^{\circ} 18'$ , 104 fathoms, sand), small specimens.

Verrill (1885a, p. 529) refers to this species but considers it probably identical with *Tethyum partitum* (Stimpson).

**Tethyum partitum** (Stimpson).

- Pl. 59, figs. 94, 95; Pl. 60, fig. 97; Pl. 69, fig. 141; Pl. 71, fig. 153; text-fig. 32.
- ? 1838. *Ascidia microcosmus* Couthouy, Boston Journ. Nat. Hist., vol. 2, p. 111.
- ? 1843. *Ascidea microcosmus* DeKay, Zool. New York, Mollusca, p. 259.
- ? 1850. *Ascidia rugosa* Agassiz, Proc. Amer. Assoc. Adv. Sci., vol. 2, p. 159.
1852. *Cynthia partita* Stimpson, Proc. Boston Soc. Nat. Hist., vol. 4, p. 231.
1860. *Cynthia partita* Stimpson, Smithsonian Check-list, p. 1.
1870. *Cynthia partita* + (probably) *C. rugosa* Binney, Gould's Invertebrata of Massachusetts, ed. 2, pp. 18, 20.
1871. *Cynthia partita* + (probably) *C. rugosa* Dall, Proc. Boston Soc. Nat. Hist., vol. 13, p. 255.
1871. *Cynthia stellifera* Verrill, Amer. Journ. Sci., ser. 3, vol. 1, p. 93, figs. 5, 6.
1871. *Cynthia partita* Verrill, Amer. Journ. Sci., ser. 3, vol. 2, p. 362.
1872. *Cynthia partita* Verrill, Amer. Journ. Sci., ser. 3, vol. 3, p. 213, pl. 8, fig. 7.
1873. *Cynthia partita* Verrill and Smith, Rept. on Invertebrate Animals of Vineyard Sound, pp. 311, 701, etc., pl. 33, fig. 246.
1878. *Cynthia partita* Coues and Yarrow, Proc. Acad. Nat. Sci. Philadelphia, 1878, p. 304.
1879. *Halocynthia partita* Verrill, Bull. U. S. Nat. Mus., no. 15, p. 148.
1879. *Halocynthia partita* Verrill, Proc. U. S. Nat. Mus., vol. 2, p. 197.
1879. *Halocynthia partita* Verrill, Preliminary Check-list of Marine Invertebrates, p. 27.
1879. *Halocynthia partita* Verrill and Rathbun, Proc. U. S. Nat. Mus., vol. 2, p. 231.
1885. *Cynthia partita* (part) Verrill, Rept. U. S. Comm. Fish and Fisheries for 1883, p. 529.
1889. *Halocynthia partita* McDonald, Rept. U. S. Comm. Fish and Fisheries for 1886, p. 858.
1891. *Cynthia partita* + *C. stellifera* Herdman, Journ. Linn. Soc. London, Zool., vol. 23, p. 586 (listed as uncertain species).
1898. *Cynthia partita* Hunter, Zool. Bull., vol. 2, no. 3.
1900. *Styela aggregata* var. *americana* (?) Metcalf, Zool. Jahrbücher, Anat., vol. 13, pp. 516, 588.
1901. *Styela partita* Verrill, Trans. Connecticut Acad. Sci., vol. 11, pl. 9, figs. 8a, 8b, 8c.
1902. *Styela partita* VanName, Trans. Connecticut Acad. Sci., vol. 11, p. 388, pl. 55, fig. 69; pl. 56, fig. 76-78; pl. 64, figs. 147, 148.
1903. *Styela partita* Hartmeyer, in Römer and Schaudinn, Fauna Arctica, p. 216, pl. 11, fig. 1-5.
1909. *Tethyum canopoides* + *T. partitum* + *T. variabile* Hartmeyer, Bronn's Tier-reich, vol. 3, suppl., p. 1358-1360.
1912. *Tethyum partitum* Hartmeyer, Denkschr. K. Akad. Wiss. Wien, cl. math.-nat., vol. 88, p. 18-20.

Form largely dependent on whether the animal is attached singly or, as is a common habit in this species, in a crowded group of several or many individuals of different sizes. In the former case the body may be attached by much of the ventral surface and the branchial aperture situated on the dorsal surface slightly back from the anterior



Text-fig. 32.— *Telhyum partitum* (Stimpson).  $\times 3$ .

end; in the latter case the body is usually attached by only a small area near the posterior end, and the branchial aperture is situated at the anterior end, with the atrial aperture a short distance from it on the dorsal surface. When so attached as to grow symmetrically, the body is somewhat elongated, tapering anteriorly, and the apertures are on low rough prominences, not always conspicuous in contracted preserved specimens among the rough excrescences which are commonly found on that part of the body. These may have the form of transverse wrinkles which break up into irregular prominences. The posterior part of the body is usually less rough. Frequently algae, bryozoans, etc., grow upon the surface.

Color yellowish posteriorly, becoming brown, purplish, or red anteriorly, especially about the apertures, which frequently exhibit the striping mentioned in Stimpson's original description. "The tubes are very beautifully marked exteriorly by alternating triangular areas of white and purple arranged as in the shell of a *Balanus*; the white ones having their bases, and the purple ones their apices, on the margin of the apertures" (Stimpson, 1852, p. 231). These colors and markings of course fade out in alcoholic specimens.

Verrill (1871a) thus describes the colors of "*Cynthia stellifera* sp. nov." which was based on flattened specimens of this species from New Haven, Conn. "Color of body when living, reddish brown, ferruginous or purplish brown, often yellowish toward the margin, the median ridge yellowish brown; apertures sometimes bright orange within,

in the area immediately around the openings purplish with minute radiating streaks of flake-white; the four large lobes are brownish, with numerous small specks and streaks of flake-white, which often predominate over the ground color."

Test very variable in thickness, but thicker near the siphons; tough and leathery, smooth internally, rough and more or less fibrous externally. Length of largest specimens 25 mm. to 30 mm.

Mantle rather thin but strong, not adherent to the test in preserved specimens. Musculature light, the superficial layer an almost continuous sheet of fibers, the deeper muscles gathered into imperfect bands which radiate from the bases of the siphons.

Tentacles rather numerous (forty to fifty in large specimens) of several sizes arranged with a variable degree of regularity.

Dorsal tubercle very variable in form, but usually of a modified U-shape (often with one horn much incurved), the open interval pointing anteriorly or more or less to the left.

Dorsal lamina plain and rather narrow.

Branchial sac with four folds which are narrow in comparison to the intervening spaces. The first fold is highest, the fourth lowest of all. Transverse vessels numerous and slender, of at least four orders, arranged with some regularity. Those of the third order merely cross the stigmata in the dorsal part of the sac (those of the fourth order are wanting there) but become stout and separate the stigmata in the ventral region, and fourth-order vessels appear in the intervals there. Internal longitudinal vessels slender and not very numerous, generally separated by from eight (in the ventral region) to five or six (in the dorsal region) stigmata on the interspaces, but quite close together on the upper part of the folds. A medium-sized individual of average characters had them distributed thus on the right side:

*mdv.* 5 (18) 4 (13) 4 (14) 5 (9) 2 *cn.*

On the left side the first fold began nearer the median dorsal vessel and but two vessels intervened instead of five.

Stomach somewhat elongated, with 18 to 30 longitudinal folds in the wall. Intestinal loop moderately large. Margin of anus with a variable number (often about a dozen) rounded lobes, but in some individuals the lobes are not greatly developed, the margin being merely sinuous and more or less plicated.

Gonads two on each side. Each comprises an elongated sinuously

curved ovary having the end with the orifice directed toward the atrial siphon but not produced into an oviduct. The ovary is bordered along each side by a comparatively small number of testes which are of varying shape, often with several irregular branches. These lie a little distance from the ovary; their ducts run to the ovary, upon whose free surface they unite to form the common sperm duct, which extends along on the middle line of the ovary, ending a little short of the termination of the latter. The testes become smaller, of simpler form, and fewer toward the dorsal ends of the ovaries, and are sometimes wanting altogether along that part of them.

Recorded distribution from Massachusetts Bay (type locality, Boston Harbor, 4 fathoms, Stimpson, 1852) to North Carolina. (The writer has not seen specimens from North Carolina.) Along the southern New England coast (Vineyard Sound, Buzzards Bay, Narragansett Bay, Long Island Sound) it is next to *Caesira manhattensis*, the most familiar, if not also the commonest, of the larger simple ascidians. In the harbors of Wood's Hole and Vineyard Haven, Mass., it can be found in summer in large masses on the piles of the wharves, growing in company with *Perophora viridis* Verrill, *Amaroucium pellucidum* form *constellatum* (Verrill), and *Didemnum lutarium* Van Name.

Range in depth from low water to 15 fathoms.

*Cynthia stellifera* Verrill (1871a, p. 93) is only a depressed variety of this species as Verrill himself afterward concluded (1871a, p. 359).

This species is very widely distributed. Rennie and Wiseman (1906) report it from the Cape Verde Islands, and the writer of the present paper has described (1902) a variety of this species (var. *bermudense*) from the Bermuda Islands, which is distinguished by smaller size, brighter colors (often almost entirely red) and by having a test of cartilaginous rather than coreaceous character. The internal characters do not differ from the typical *T. partitum*. The latter is apparently not found at Bermuda. Dr. Hartmeyer has recently informed the writer of his belief that *T. variabile* (Alder), 1863, from the Channel Islands and west coast of France (see Lacaze-Duthiers and Delege, 1892, and Alder and Hancock, 1907) and also *T. canopoides* (Heller), 1877, from the Adriatic and Mediterranean, are identical with each other and with *T. partitum*. *T. canopoides* has also been reported by Traustedt from the West Indies. One of Heller's type specimens of *canopoides* from the Adriatic, kindly sent to the

writer by Dr. Hartmeyer, does not appear to differ in any important respect from *T. partitum* from New England.

**Tethyum coriaceum** (Alder and Hancock).

Pl. 58, fig. 86-88; Pl. 73, figs. 164, 165; text-fig. 33.

1848. *Cynthia coriacea* Alder and Hancock, Trans. Tyneside Nat. Field Club, vol. 1, p. 196.
1851. *Ascidia loveni* Sars, Nyt Mag. Naturvidensk., vol. 6, p. 157, no. 101.
1867. *Cynthia placenta* Packard, Mem. Boston Soc. Nat. Hist., vol. 1, p. 277.
1870. *Cynthia placenta* Binney, Gould's Invertebrata of Massachusetts, ed. 2, p. 19, pl. 23, fig. 322.
1870. *Cynthia placenta* Dall, Proc. Boston Soc. Nat. Hist., vol. 13, p. 355.
1870. *Cynthia placenta* (part) Verrill, Amer. Journ. Sci., ser. 2, vol. 49, p. 424.
1871. *Cynthia carnea* (part) Verrill, Amer. Journ. Sci., ser. 3, vol. 1, p. 94, figs. 7, 8 (not fig. 9).
1872. *Cynthia carnea* (part) Verrill, Amer. Journ. Sci., ser. 3, vol. 3, p. 213.
1873. *Cynthia carnea* (part) Verrill and Smith, Rept. on Invertebrate Animals of Vineyard Sound, p. 701, pl. 23, fig. 248 (not fig. 247).
1874. *Cynthia carnea* (part?) Verrill, Proc. Amer. Assoc. Adv. Sci., vol. 22, pp. 352, 363.
1874. *Cynthia carnea* (part?) Verrill, Amer. Journ. Sci., ser. 3, vol. 7, pp. 43, 413, 504.
1879. *Halocynthia tuberculum* (part) Verrill, Preliminary Check-list of Marine Invertebrates, p. 27.
1879. *Halocynthia tuberculum* (part) Verrill, Bull. U. S. Nat. Mus., no. 15, p. 148.
1879. *Halocynthia tuberculum* (part) Verrill, Proc. U. S. Nat. Mus., vol. 2, p. 197.
1891. *Cynthia carnea* Packard, Labrador Coast, p. 396.
1901. *Cynthia (Halocynthia) tuberculum* Kingsley, Proc. Portland Soc. Nat. Hist., vol. 2, p. 183.
1901. *Halocynthia tuberculum* (part?) Whiteaves, Geol. Survey Canada, pub. no. 722, p. 269.
1903. *Styela loveni* + *Dendrodoa aggregata* (part) Hartmeyer, in Römer and Schaudinn, Fauna Arctica, vol. 3, pp. 210, 235, pl. 5, fig. 4-6; pl. 11, fig. 6-9; text-fig. 6-11.
1905. *Styela loveni* Bjerkan, Bergens Mus. Aarbog, no. 5, p. 8.
1906. *Styela loveni* Redikorzew, Trav. Soc. Nat. St. Pétersbourg, vol. 37, pp. 154, 308, 310.
1907. *Styela loveni* Redikorzew, Ann. Mus. Zool. Acad. Sci. St. Pétersbourg, vol. 11, pp. 133, 151-153.
1907. *Styela coriacea* Alder and Hancock, British Tunicata, vol. 2, p. 109, pl. 37, fig. 1-4; pl. 39, figs. 2, 3; pl. 41, figs. 4, 5.
1907. *Styela loveni* Redikorzew, Zool. Anzeiger, vol. 31, p. 521.

1908. *Styela loveni* Redikorzew, Trav. Soc. Nat. St. Pétersbourg, vol. 39, pp. 20, 24.
1908. *Styela loveni* Redikorzew, Mém. Acad. Sci. St. Pétersbourg, ser. 8, cl. phys.-math., vol. 18, p. 28.
1908. *Styela loveni* Bjerkan, Tromsø Mus. Aarshefter, no. 25, p. 62.
1909. *Tethyum loveni* + *Dendrodoa aggregata* (part) Hartmeyer, Bronn's Tier-reich, vol. 3, suppl., pp. 1359, 1361.
1912. *Tethyum loveni* Hartmeyer, Vidensk. Meddel. Naturhist. For. Kjøbenhavn, vol. 63, p. 267.
1912. *Tethyum coriaceum* Hartmeyer, Sitzungsab. Ges. Naturforsch. Freunde, 1911, no. 10, p. 440.

Both Alder and Hancock (1905-1907) and Verrill (1871a) agree in regard to this species, that when alive it is very contractile and able to change its shape greatly. Aside from this it is subject to great individual variation in form. Living extended specimens are often rather tall and cylindrical with the four-lobed apertures on fairly



Text-fig. 33.— *Tethyum coriaceum* (Alder and Hancock).  $\times 2.2$ .

prominent divergent tubes arising from the upper part of the body. This condition will rarely be found in preserved specimens, which are generally much contracted and have a low dome-shaped or flattened form of circular or oval outline when seen from above, or they may be of a low conical or pyramidal shape attached by a broad expanded base, and the apertures may be but little raised above the surface. The test commonly spreads out a little over the object to which the animal is attached. Alcoholic specimens are usually of a dirty gray or brown color. When alive it is "dark reddish brown, or orange brown, darker below, the wrinkles lighter than the interstices and often salmon colored; the upper parts especially the summit between the apertures, are deep salmon. The apertures are orange red within, and surrounded by a ring of bright red" (Verrill, 1871a).

The most easily recognizable external character of the species is that the upper surface is more or less thickly and evenly studded with very minute tubercles which are generally translucent and of rounded form, resembling in size and appearance grains of smooth

waterworn sand projecting from the test. These minute projections are additional to (and often borne upon) the coarser wrinkles and rounded elevations of the surface of the test which are present in this as in most related species to a varying degree in different individuals. Inner surface of test smooth and more or less whitish or bluish, at least in alcoholic specimens. Size of largest specimens 18 mm. to 20 mm. by 13 mm. to 15 mm. across the upper surface, but only from 5 mm. to 9 mm. high (dorso-ventrally) in the contracted preserved specimens.

Mantle musculature moderately developed on the dorsal and very weak on the ventral part of body. Irregular and imperfect bands radiating from the apertures form a deep layer and are overlaid by a more or less continuous sheet of circular fibers.

Tentacles exceeding fifty in number in large specimens, of four or five sizes (the smallest mere tubercles) arranged with some regularity.

Dorsal lamina plain-edged and rather wide.

Dorsal tubercle horseshoe-shaped with the open interval turned toward the left or somewhat forward in the individuals studied.

Branchial sac with four well developed folds. Transverse vessels not very numerous, of three sizes in the dorsal, and four in the ventral part of the sac, the vessels of the fourth order merely crossing the stigmata. Internal longitudinal vessels placed quite close together on the folds and usually separated only by the width of two, three, or four stigmata, even on the interspaces. They are much more numerous in large individuals than in small ones though separated by about the same number of stigmata. In a rather large specimen they are distributed thus:

*mdr.* 3 (14) 4 (9) 5 (12) 4 (6) 3 *en.*

In a still larger specimen growing attached to the same shell the number is still greater:

*mdr.* 4 (22) 6 (14) 5 (18) 6 (10) 8 *en.*

but such large numbers do not occur in most specimens.

Stomach rather broad, its pyloric end plainly differentiated from the commencement of the intestine; its wall with 20 or more longitudinal folds arranged in the usual manner. Intestinal loop fairly large, but the parts of the intestine become somewhat crowded together and displaced from their usual relations by the flattening of the body.

Margin of anus with numerous lobes. A slight rudiment of a pyloric caecum is present.

Gonads one on each side, each consisting of an elongated, very sinuously curved ovary, and a number of small male glands gathered into more or less compact groups along one or both sides of the ovary (especially along its ventral side). The general direction of the ovaries is horizontal with the open end bent up toward the atrial orifice; that of the right side bends very abruptly, often doubling forward almost parallel to the main portion for a little distance (see Pl. 58, fig. 88). The ducts from the groups of testes run to and follow the ovary, uniting to a common duct ending in the usual way beside the oviduct.

With this British species, originally described by Alder and Hancock in 1848, and well figured in their later work (1905-1907), the writer identifies Packard's *Cynthia placenta* (1867) from Labrador. Packard states it is also common in the Bay of Fundy. Verrill (1871a, p. 94) states that he examined Packard's specimens and found among them one of a different (papillose and sand-covered) species. This, however, is immaterial to the discussion of the present species. The important fact is that it shows that Verrill had an opportunity to compare and determine the identity of his Eastport specimens with Packard's types. One of Packard's types is figured by Binney (1870, pl. 23, fig. 322). Verrill, however, did not employ Packard's name *placenta*, for he believed incorrectly that *Ascidia carnea* Agassiz (1850) was the young of this species, hence he employed the name *carnea*, and his statements in his several papers refer partly to Agassiz's and partly to Packard's species. Subsequently he concluded that Agassiz's species was identical with the *Ascidia tuberculum* of Fabricius (1780) and he then adopted the latter specific name in place of *carnea*. Fabricius' species is, however, probably *Dendrodoa aggregata* (Rathke) according to Hartmeyer (1903, 1909), and, if so, has nothing to do with Packard's *placenta* or Agassiz's *carnea*.

Alder and Hancock (1905-1907) record *T. coriaceum* from Northumberland, the Dogger Bank, Falmouth, and Shetland. It is said to inhabit "deep water, usually on shells." Dr. Hartmeyer has recently informed the writer that he believes *Tethyum loveni* (Sars), 1851, to be also identical with the species, a conclusion with which the writer agrees after examining a specimen of *T. loveni* kindly sent by Dr. Hartmeyer. The species is therefore widely distributed in the northern regions, *Tethyum loveni* having been recorded from Spitz-

bergen, Norway, the White Sea, the Siberian Arctic Ocean, Davis Straits, and Greenland, etc., as well as on the Danish and German coasts. *T. granulatum* (Alder), 1863, of the British coast is also identical, and *T. compressum* Redikorzew (1911) from the Japan Sea is evidently an allied form.

*T. coriaceum* occurs from Labrador and the Gulf of Saint Lawrence, and the Banks of Newfoundland to Massachusetts Bay, and is common about the Bay of Fundy region, also in Casco Bay. Packard (1867) gives the following localities:—Straits of Belle Isle, 40 fathoms, hard bottom; Henley Harbor, 10 to 20 fathoms; Chateau Harbor, 15 fathoms, sand; Bay of Fundy, common. Whiteaves (1901) records it from the Gulf of Saint Lawrence between Pictou Island and Cape Bear, and from 15 miles SSE. of Bonaventure Island, 50 fathoms.

The usual range in depth appears to be between 10 and 50 fathoms. One of the specimens is from 150 fathoms. From the Norwegian coast it is recorded from 400 meters (Kiaer, 1893). Whether the specimens mentioned by Verrill (1871a) from extreme low-water mark were really this species the writer has not been able to find out. Stony or other hard bottoms are most favorable for it.

The localities of American specimens the writer has examined are as follows:

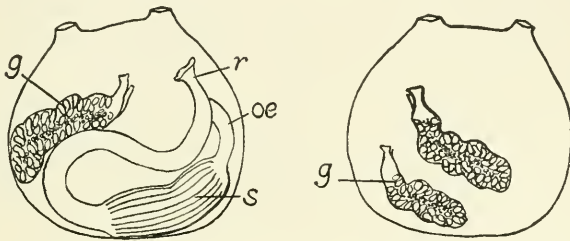
- Station 2466 (N. lat. 45° 29', W. long. 55° 24', 67 fathoms, coral), several small specimens.
- Station 2488 (N. lat. 44° 35', W. long. 57° 13' 30'', 150 fathoms, sand and gravel), one rather large specimen.
- Station 2513 (N. lat. 43° 34', W. long. 63° 56' 30'', 134 fathoms, gray ooze), one small specimen.
- Station 2432 (N. lat. 43° 04', W. long. 50° 45', 64 fathoms, fine gray sand), many specimens, some large attached to shells, etc.
- Eastport, Me., and Bay of Fundy, many specimens, mostly small.
- Station 55B-56B (Cashe's Ledge, 30 to 40 fathoms), one specimen attached to stones.
- Station 21 (off Baker's Island, near Salem, Mass., 26 fathoms, hard gravel and stones).
- Station 236 (off Cape Ann, Mass., N. lat. 42° 28', W. long. 70° 31', 28 fathoms, rocky, coarse sand and pebbles).

**Tethyum mortenseni** Hartmeyer.

Pl. 61, fig. 98-100; text-fig. 34.

1912. *Tethyum mortenseni* Hartmeyer, Vidensk. Meddel. Naturhist. For. Kjobenhavn, vol. 63, p. 268, text-fig. 3.

The largest specimen (from Station 184, see below) is nearly globular except for a flattened area on the ventral surface by which it was attached. Diameter 15 mm. Apertures on dorsal surface, small, four-lobed, 6 mm. apart; scarcely raised above the general surface in the preserved specimen. Test (except attached area) very thin,

Text-fig. 34.—*Tethyum mortenseni* Hartmeyer.  $\times 2.4$ .

but tough. Surface not smooth, yet practically free from incrusting material and without any conspicuous folds or wrinkles. Color of preserved specimens yellowish.

The two other specimens (from Station 2506) are slightly smaller (13.5 mm. and 11 mm. in greatest diameter, apertures 5 mm. apart), somewhat darker colored and a little more compressed laterally, but otherwise very similar.

Mantle thin and musculature slight.

Tentacles arranged with a considerable degree of regularity. There are about 28 larger ones which, on some parts of the circle at least, show some alternation in size and must represent two orders, and between these there are one or more smaller ones in most of the intervals.

Dorsal tubercle in the largest specimen horseshoe-shaped, the horns coming almost together; open interval directed obliquely forward and to the right. In one of the others, there appears to be no open interval at all, the horns coming completely together at the anterior end. On the third specimen, the open interval, if any (that which is present may be only an accidental break) is decidedly toward the left.

Dorsal lamina rather broad, plain-edged.

Branchial sac with but one fold on each side. This apparently represents the first fold; on the left side it is quite close to the median dorsal vessel, on the right side it is a little farther removed, an unusually wide space (15 stigmata) intervening between the median dorsal vessel and the first internal longitudinal vessel. Except for this the sac is similar on the two sides of the body. This fold bears a total of 14 internal longitudinal vessels on the right side in the large specimen and a little larger number on the left side. In the smaller specimens the fold is even better developed and bears more (16 to 20) internal longitudinal vessels. Ventral to this fold the internal longitudinal vessels are for the most part fairly regularly disposed, being separated by from two to four stigmata. Traces of the third (perhaps also of the second) fold are probably indicated by a slightly closer placing of a varying number of vessels in the regions where these folds should be. Total number of vessels on one side of the sac varies from about 39 to 46 in the several specimens. Transverse vessels of two sizes arranged alternately in the dorsal region of the sac. In other parts additional vessels of a third order cross without interrupting the stigmata.

The stomach is elongated, bent at an obtuse angle and has a comparatively small number (about 16 to 18) rather indistinct longitudinal folds. Intestinal loop rather large; margin of anus with indistinct lobes.

Gonads flask-shaped, somewhat curved, with a central ovary and small testes of simple form arranged around its border. The sperm ducts unite and open on a papilla on the neck of the ovary as usual in this group. There are two gonads on the right side and one on the left side, all placed in an oblique position with the neck directed toward the atrial orifice. The gonad of the left side is situated above and anterior to, and close against the bend of the intestinal loop. When the ovaries are well developed the testes become crowded into the part of the gonad which lies against the mantle, their ducts embracing the ovary and uniting to form the common sperm duct on the side of the ovary next to the branchial sac.

The above described specimen is from Station 184 (off Eastern Point Light, N. lat.  $42^{\circ} 30' 15''$ , W. long.  $70^{\circ} 38'$  approximately, 45 fathoms, mud). The two smaller specimens are from Station 2506 (N. lat.  $44^{\circ} 26'$ , W. long.  $62^{\circ} 10'$ , 127 fathoms, dark brown mud). Hartmeyer (1912a) describes this species from a specimen from the Skagerrak,

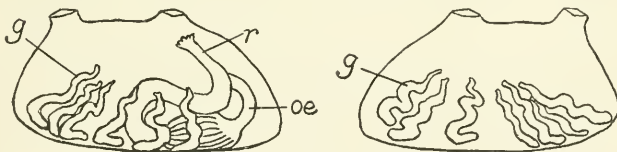
between Denmark and Norway (N. lat.  $58^{\circ} 06'$ , W. long.  $9^{\circ} 0'$ , 660 meters). It has not been reported elsewhere.

**Tethyum finmarkiense** (Kiaer).

Pl. 61, fig. 101-103; Pl. 73, fig. 159; text-fig. 35.

1851. *Ascidia* sp. Sars, Nyt Mag. Naturvidensk., vol. 6, p. 156.  
 1858. *Cynthia gutta* (err., non Stimpson, 1852) Sars, Forh. Vidensk. Selsk. Christiania, p. 65.  
 ? 1860. *Cynthia gutta* Lütken, Vidensk. Meddel. Naturhist. For. Kjøbenhavn, no. 9, p. 7.  
 1893. *Polycarpa finmarkiensis* Kiaer, Forh. Vidensk. Selsk. Christiania, p. 60, pl. 2, fig. 20-25.  
 1896. *Polycarpa finmarkiensis* Kiaer, Norske Nordhavs-Exped., vol. 23, no. 3, p. 12.  
 1903. *Styela finmarkiensis* Hartmeyer, in Römer and Schaudinn, Fauna Arctica, vol. 3, p. 224.  
 1908. *Styela finmarkiensis* Redikorzew, Trav. Soc. Nat. St. Pétersbourg, vol. 39, pp. 20, 25, 42.  
 1908. *Styela finmarkiensis* Bjerkan, Tromsøe Mus. Aarshefter, no. 25, p. 66, fig. 2.  
 1909. *Tethyum finmarkiense* Hartmeyer, Bronn's Tier-reich, vol. 3, suppl., p. 1359.

The single specimen in the collection is dome-shaped, 26 mm. long, 17 mm. wide, and about 10 mm. high, attached to a shell by the entire ventral surface. The substance of the test spreads out over the sur-



Text-fig. 35.— *Tethyum finmarkiense* (Kiaer).  $\times 1.6$ .

face of the shell to which the specimen is attached for a considerable width (at one point over 10 mm.) beyond the edge of the body. Apertures both four-lobed, situated on low papillae about 10 mm. apart on the dorsal surface. Outer surface of test smooth but not shining, pale yellowish white in the alcoholic specimen, free from all foreign materials, and scarcely at all wrinkled. Test rather thin yet firm and rigid.

Mantle rather thin; its musculature not greatly developed.

Tentacles rather large, and not very numerous; at least two sizes, arranged with some regularity.

Dorsal tubercle small, horseshoe-shaped, the open interval directed forward.

Dorsal lamina a broad membrane whose margin is raised into small, quite regular, narrow teeth.

Branchial sac with four well developed folds on each side and very numerous internal longitudinal vessels. The first folds are a little the highest, the second and third about equal, the fourth decidedly lower. It is impossible to decide just how many vessels should be reckoned as belonging to the folds or to the interspaces as the folds begin so gradually, but the following schemes show their approximate distribution:

Left side	5	(23)	5	(18)	3	(16)	3	(11)	5
	<i>mdv.</i>								<i>en.</i>
Right side	3	(24)	5	(19)	5	(17)	5	(10)	5

There are four orders of transverse vessels even in the dorsal part of the sac. The smallest merely cross the stigmata. On the interspaces from five to seven stigmata intervene between the internal longitudinal vessels; close to the endostyle and median dorsal vessel a greater number (ten or more) intervene.

Stomach short and rounded, with a rather small number of longitudinal folds. No pyloric caecum was observed. Intestinal loop small and short; margin of anus with about ten rounded lobes.

Gonads consisting of irregularly curved tubes somewhat constricted into a neck at the dorsal end, having a central ovary and peripheral testes, the latter small but generally cleft into several lobes. Their ducts unite and run along the ovary, ending in a papilla beside the opening of the ovary. The ovarian opening is lobed. The gonads are rather numerous on each side of the body, seven or eight on the right and at least six on the left.

There is but one specimen in the collection, from Station 2466 (N. lat.  $45^{\circ} 29'$ , W. long.  $55^{\circ} 24'$ , 67 fathoms, coral).

Its identity with *Polycarpa finmarkiensis* Kiaer (1893) seems clear. This rare European form, said to be blood red when alive, is known only from the Norwegian coast. Sars (1851) first called it *Ascidia* sp. and later (1858) *Cynthia gutta* Stimpson. Sars's specimens were

examined by Kiaer and identified with his species. This form might almost equally well be placed in *Pandocia* [*Polycarpa*], as was done by Kiaer. *Tethyum joanae* (Herdman), 1898, and *T. stimpsoni* (Ritter), 1900, are closely allied forms from Puget Sound.

***Tethyum plicatum* (Lesueur).**

Pl. 62, figs. 104, 105; Pl. 63, fig. 108; Pl. 68, fig. 136; text-fig. 36.

1823. *Ascidia plicata* Lesueur, Journ. Acad. Nat. Sci. Philadelphia, vol. 3, p. 5, pl. 3, fig. b.  
 1843. *Ascidea plicata* DeKay, Zool. New York, Mollusea, p. 259.  
 1877. *Styela gyrosa* Heller, Sitzungsab. Akad. Wiss. Wien, vol. 37, p. 255, pl. 3, fig. 7-12; pl. 4, fig. 1-8.  
 1883. *Styela plicata* Traustedt, Vidensk. Meddel. Naturhist. For. Kjobenhavn for 1882, p. 123, pl. 5, figs. 6, 16.  
 1883. *Styela plicata* Traustedt, Mitt. Zool. Stat. Neapel, vol. 4, p. 478, pl. 36, fig. 12.  
 1891. *Styela plicata* Herdman, Journ. Linn. Soc. London, Zool., vol. 23, p. 581.  
 1900. *Styela plicata* Metcalf, Zool. Jahrbücher, Anat., vol. 13, p. 516, pl. 36, figs. 24, 25.  
 1900. *Styela* sp. Wilson, Amer. Naturalist, vol. 34, p. 354.  
 1905. *Styela plicata* Hartmeyer, Zool. Jahrbücher, Suppl., vol. 8, p. 384.  
 1909. *Tethyum plicatum* Hartmeyer, Bronn's Tierreich, vol. 3, suppl., p. 1359.  
 1912. *Tethyum plicatum* Hartmeyer, Denkschr. K. Akad. Wiss. Wien, cl. math.-nat., vol. 88, p. 20.  
 Apparently not *Cynthia vittata* Stimpson, 1852, p. 230, as that has "about fourteen branchial folds," and is probably one of the *Pyuridae*.

The following description was made from several large specimens growing in a closely crowded group or cluster, which no doubt affected their shape.

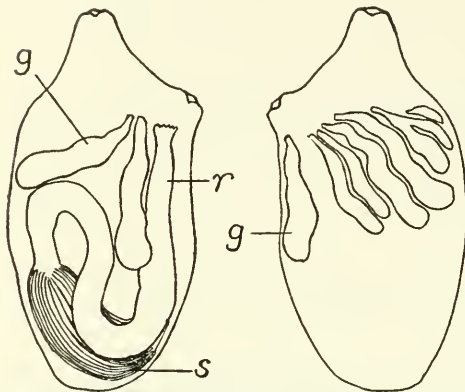
Body irregularly clavate, 58 mm. long, by 25 mm. wide, in the largest specimen, with the branchial aperture at the larger end and the atrial aperture a little way back on the dorsal side. Body attached by the smaller end, or more or less obliquely by one side. Apertures both four-lobed on rather prominent projections.

Test moderately thick and very tough, the surface thrown into coarse deep wrinkles (mainly longitudinal) and irregular prominences. Alcoholic specimens of a dirty brownish white color. It is said to be whitish in life also.

Mantle of only moderate thickness. It contains a layer of closely

placed muscle bands radiating from the siphons and extending toward the attached end of the body. This layer is best developed anteriorly, and is overlaid by a layer of slenderer but also closely placed bands encircling the body.

Tentacles of at least four orders, the larger ones moderately numerous and placed with considerable regularity.



Text-fig. 36.— *Tethyum plicatum* (Lesueur).  $\times 2.2$ .

Dorsal tubercle C-shaped with inrolled horns; the open interval directed forward.

Dorsal lamina plain but often thrown into lateral undulations.

Branchial sac with four well developed folds on each side, of which the three first are about equally high and bear 20 to 24 internal longitudinal vessels, while the fourth is lower and has fewer vessels. Folds

sharply defined, arising abruptly from the interspaces, the two leaves of each fold being closely pressed together. Interspaces between folds generally wide, with numerous (six to nine) internal longitudinal vessels. The following scheme shows about the average condition in the specimens studied:

*mdv.* 5 to 6 (20) 7 (20) 7 (22) 8 (15) 5 to 6 *en.*

Six to eight stigmata, occasionally nine, usually intervene between the internal longitudinal vessels on the interspaces. Transverse vessels of four, in some parts of the sac apparently of five orders; the smallest merely cross the stigmata without interrupting them.

Stomach large, elongated, somewhat curved and abruptly distinguished from the beginning of the intestine. Its walls are thin, with 30 to 40 narrow but distinct longitudinal folds. Intestinal loop large but narrow, the middle part of the intestine extending down (posteriorly) so as to lie beside the stomach. Margin of anus irregularly lobed.

Gonads compact, hermaphroditic, flask-shaped or elongate, and

more or less sinuously (often very irregularly) curved, ending in a very short neck with a slightly lobed terminal aperture for the ovary. Beside the ovarian aperture there is a small rounded projection on which the common sperm duct opens. In each gonad the ovary is central and is bordered by the numerous small simply formed testes. There are two gonads on the left side of the body, one anterior to the bend of the intestinal loop, the other between the loop and the rectum. Their necks converge to near the base of the atrial siphon. On the right side there is an irregular group of gonads (five to eight in the specimens examined). Their necks are directed toward the atrial siphon. Some of the gonads may be divided into two branches.

This is a species of very wide distribution in tropical and warm-temperate regions according to Heller (1877) and Hartmeyer (1905) but it does not appear to occur in the New England region. Its range comprises the Atlantic coast of America from Philadelphia, Penn., to Rio Janeiro, Brazil, including various points in the West Indies; Montevideo; some of the Pacific Islands; points on the coast of Australia; Japan; and Mauritius. The above description and figures are from specimens from Fort Macon, N. C., where it is abundant. The Philadelphia record (Lesueur, 1823) was based on a specimen from a ship's bottom, and may hence have been brought there from some more southern locality.

**Tethyum molle** (Stimpson).

Pl. 62, fig. 106; Pl. 63, fig. 109; Pl. 71, fig. 149; text-fig. 37.

1852. *Glandula mollis* Stimpson, Proc. Boston Soc. Nat. Hist., vol. 4, p. 230.  
 1854. *Glandula mollis* Stimpson, Smithsonian Contr., vol. 6, p. 30.  
 1860. *Glandula mollis* Stimpson, Smithsonian Check-list, p. 2.  
 1870. *Glandula mollis* Binney, Gould's Invertebrata of Massachusetts, ed. 2, p. 22, pl. 22, fig. 317; (but not pl. 24, figs. 328, 329).  
 1870. *Glandula mollis* Verrill, Amer. Journ. Sci., ser. 2, vol. 49, p. 424.  
 1870. *Glandula mollis* Dall, Proc. Boston Soc. Nat. Hist., vol. 13, p. 255.  
 1871. *Glandula mollis* Verrill, Amer. Journ. Sci., ser. 3, vol. 2, p. 361.  
 1872. *Glandula arenicola* Verrill, Amer. Journ. Sci., ser. 3, vol. 3, pp. 211, 288.  
 1872. *Glandula mollis* Verrill, Amer. Journ. Sci., ser. 3, vol. 3, p. 213.  
 1873. *Glandula arenicola* Verrill, Amer. Journ. Sci., ser. 3, vol. 5, pp. 6, 10.  
 1873. *Glandula arenicola* Verrill and Smith, Rept. on Invertebrate Animals of Vineyard Sound, pp. 502, 701.  
 1874. *Glandula arenicola* Verrill, Proc. Amer. Assoc. Adv. Sci., vol. 22, pp. 352, 355.  
 1874. *Glandula arenicola* Verrill, Amer. Journ. Sci., ser. 3, vol. 7, pp. 39, 413.

1879. *Glandula arenicola* Verrill, Preliminary Check-list of Marine Invertebrates, p. 27.
1879. *Glandula arenicola* Verrill and Rathbun, Proc. U. S. Nat. Mus., vol. 2, p. 231.
1880. *Glandula mollis* Traustedt, Vidensk. Meddel. Naturhist. For. Kjobenhavn for 1879-1880, p. 420.
1889. *Glandula arenicola* McDonald, Rept. U. S. Comm. Fish and Fisheries for 1886, p. 858.
1891. *Glandula arenicola* + *G. mollis* Herdman, Journ. Linn. Soc. London, Zool., vol. 23, p. 582.
1901. *Glandula arenicola* + *G. mollis* Whiteaves, Geol. Survey Canada, pub. no. 722, p. 267.
1901. *Glandula arenicola* Kingsley, Proc. Portland Soc. Nat. Hist., vol. 2, p. 183.
1909. *Tethyum arenicolum* + *T. molle* Hartmeyer, Zool. Anzeiger, vol. 34, p. 144, text-fig. 1-3.
1909. *Tethyum arenicolum* + *T. molle* Hartmeyer, Bronn's Tier-reich, vol. 3, suppl., pp. 1358, 1360.

[NOTE. The "*Glandula*, species undetermined," recorded by Verrill and Smith (1873, pp. 502, 701) and Hartmeyer (1909a), from Vineyard Sound, 10 to 20 fathoms, sand, may have been the young of this species. If not, it is uncertain what their species is. No specimens were found in the collections which were recognized as the ones referred to by Verrill and Smith.]

Body ellipsoidal, sometimes nearly spherical, the small apertures (both square) situated rather near together on the anterior dorsal portion, either raised on conical papillae, or nearly level with the surface in contracted specimens. Test thin but tough, thickly and evenly coated with sand grains which adhere firmly. A few hair-like processes from the ventral region assist in anchoring the animal in the sand in which it lies buried, but it is not otherwise attached. Size of an average specimen: 9 mm. long, 7 mm. deep, and 5 mm. to 6 mm. from side to side. Largest specimen about 14 mm. long.

Musculature of mantle rather diffuse, transverse fibers predominating.

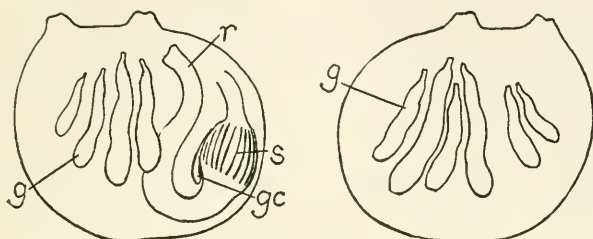
Tentacles, 32 or more, quite regularly arranged; 8 of the first, 8 of the second, and 16 of the third order. Fourth-order tentacles in a few of the intervals only.

Dorsal tubercle C-shaped with the open interval directed to the left. Horns not incurved.

Dorsal lamina plain, rather narrow.

Branchial sac with four rather slight folds on each side, of which the second is more or less rudimentary. Internal longitudinal vessels

confined to the folds or lying so close to their bases as to make it evident that they should be counted as belonging to a certain fold. Between the second and third folds, however, there is usually one stout vessel on the interspace nearly midway between the folds on each side of the



Text-fig. 37.— *Tethyum molle* (Stimpson).  $\times 5.3$ .

sac. Counting all the other vessels as belonging to the nearest fold, the scheme in several specimens studied was about as follows:

*mdv.* 0 (8 to 10) 0 (4) 1 (8 to 11) 0 (6 to 7) 0 *en.*

Transverse vessels of three orders, the smallest merely crossing the stigmata and incomplete in many parts of the sac. About thirty rows of stigmata in a good-sized specimen; 12 to 25 stigmata on the interspaces between folds in the widest part of the sac.

Stomach rather broad, well differentiated from the esophagus and intestine, with a small curved pyloric caecum and about 25 longitudinal folds in its wall. Intestinal loop small; anus with a sinuate margin, or somewhat two-lipped.

Gonads phial-shaped, tapering to a short neck with a terminal aperture for the discharge of the eggs at the dorsal end. Testes small pyriform or somewhat lobed, occupying the part of the gonad adjacent to the mantle. Their ducts embrace the ovary (which occupies the part of the gonad adjacent to the branchial sac) and unite to a common sperm duct running along the free side of the ovary (next to the branchial sac) and opening on a papilla at the side of the neck of the gonad. Gonads placed so that their orifices are directed toward the base of the atrial siphon, those of the left side usually four in number, situated anterior to the alimentary tract. On the right side, the gonads are more numerous, usually six in number, sometimes seven.

Described by Stimpson (1852) from specimens dredged off Cheney's Head, Grand Manan, N. B., in 10 fathoms, sandy bottom. Rede-

scribed by Verrill under the name *Glandula arenicola* from specimens from Murray Bay, Gulf of Saint Lawrence. This species and *Pandocia fibrosa* are those for which Stimpson (1852) constituted the new genus *Glandula* (see p. 442). Traustedt (1880) redescribed this species from some of Stimpson's specimens, but erroneously stated that it had spiral stigmata. This supposed peculiarity caused *Glandula* to be recognized as a valid genus by many writers, until Hartmeyer (1909a) again studied the species, proving that its branchial sac was of the ordinary structure and that the genus *Glandula* should no longer be recognized.

*Cynthia vestita* Stanger (1860) of the British coasts (Northumberland and Durham), described and figured by Alder and Hancock (1905-1907) as *Styela vestita*, appears to be identical with this species. It was wrongly identified with *Microcosmus glacialis* (Sars) by Alder (1863).

*Tethyum molle* is found from the Gulf of Saint Lawrence to Long Island Sound, inclusive, and according to Verrill (1874a, p. 352) down to depths of 150 fathoms though the writer has seen specimens only from rather shallow water. Verrill and Smith (1873) give the distribution as follows: "Murray Bay, Gulf of Saint Lawrence (Dr. J. W. Dawson). Saint George's Bank, 28 fathoms, sand, abundant (S. I. Smith). Off Cuttyhunk Island and Buzzards Bay (T. H. Prudden)." Verrill (1874a) records it from off Casco Bay, on muddy bottoms in from 50 to 95 fathoms and from east of Seguin Island, 23 fathoms (hard bottom with spots of mud).

The writer has examined specimens from the following localities:

Murray Bay, Gulf of Saint Lawrence (coll. by Dr. J. W. Dawson).

Station 279 (Stellwagen's Bank, Race Point Light S.  $6\frac{1}{4}$  miles, 13-13 $\frac{1}{2}$  fathoms, sand).

Station 281 (Stellwagen's Bank, Race Point Light S. 12° E., 8 $\frac{1}{2}$  miles, 14 fathoms, sand and broken shells).

Vineyard Sound.

Buzzards Bay.

Off Cuttyhunk Island.

Station 788 (off Newport, R. I., 6 miles SSE. from Brenton's Reef Lightship, 18 fathoms, fine sandy mud).

Station 799 (off Point Judith, R. I., 13 fathoms, sand, gravel and stones).

Fisher's Island Sound (off Sea-flower Reef, 7 fathoms, sand and shells).

Long Island Sound (off New London, Conn., 6 to 9 fathoms, sand).

## Genus PANDOCIA Fleming, 1822.

[= POLYCARPA auct. plur.].

Distinguished from *Tethyum* [*Styela*] chiefly by the structure of the reproductive organs, which consist of a number (often of very numerous) small, rounded or bottle-shaped, generally hermaphroditic gonads, attached to the inner wall of the mantle on both sides of the body. This genus is none too well distinguished from *Tethyum* as intermediate species occur. Although one of the largest genera of ascidians, it is represented in the New England region proper by but one species. Another occurs in the very deep water off the shore.

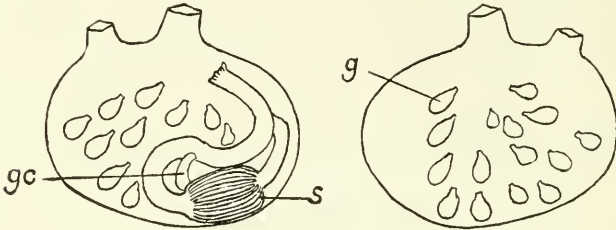
***Pandocia fibrosa*** (Stimpson).

Pl. 63, figs. 107, 110; Pl. 64, fig. 112; Pl. 70, fig. 147; text-fig. 38.

1852. *Glandula fibrosa* Stimpson, Proc. Boston Soc. Nat. Hist., vol. 4, p. 230.  
 1854. *Glandula fibrosa* Stimpson, Smithsonian Contr., vol. 6, p. 20.  
 1860. *Glandula fibrosa* Stimpson, Smithsonian Check-list, p. 2.  
 1870. *Glandula fibrosa* Binney, Gould's Invertebrata of Massachusetts, ed. 2, p. 22, [not pl. 23, fig. 323, which is *Eugyra glutinans* (Möller)].  
 1870. *Glandula fibrosa* Dall, Proc. Boston Soc. Nat. Hist., vol. 13, p. 255.  
 1873. *Glandula fibrosa* Verrill, Amer. Journ. Sci., ser. 3, vol. 6, p. 440.  
 1874. *Glandula fibrosa* Verrill, Proc. Amer. Assoc. Adv. Sci., vol. 22, pp. 348, 352.  
 1874. *Glandula fibrosa* Whiteaves, Amer. Journ. Sci., ser. 3, vol. 7, p. 7.  
 1874. *Glandula fibrosa* Verrill, Amer. Journ. Sci., ser. 3, vol. 7, pp. 409, 413.  
 1891. *Glandula fibrosa* Herdman, Journ. Linn. Soc. London, Zool., vol. 23, p. 582.  
 1901. *Glandula fibrosa* Kingsley, Proc. Portland Soc. Nat. Hist., vol. 2, p. 183.  
 1901. *Glandula fibrosa* Whiteaves, Geol. Survey Canada, publ. no. 722, p. 267.  
 1909. *Tethyum fibrosum* Hartmeyer, Zool. Anzeiger, vol. 34, p. 145.  
 1909. *Tethyum fibrosum* Hartmeyer, Bronn's Tier-reich, vol. 3, suppl., p. 1360.  
 Not *Glandula* sp. (*fibrosa*?) Knipovitsch, 1893 (= *Caesira wagneri* Hartmeyer).

Body rounded, somewhat longer than broad, and more or less noticeably compressed in a dorso-ventral direction in many individuals. Siphons rather near together, forming papillae on the dorsal surface of the body; the branchial, which is the smaller, near the anterior end of the body; the anal near the middle. Both orifices four-lobed. Surface of test rough and granular, a large part of the ventral region bearing an abundant growth of long fine branching hairs along whose

length grains of sand and mud become attached, and which form with this foreign matter a matted and tangled mass which covers not only the ventral region of the animal but extends up around and incloses the body, except the part of the dorsal surface which bears the siphons. The body is thus more or less completely enveloped in a



Text-fig. 38.—*Pandocia fibrosa* (Stimpson).  $\times 2.4$ .

compact mass of mud and long tangled hairs, making it appear like a ball of mud of about double the size that it actually is. The test is exceedingly strong and tough. The largest specimens measure (when the above mentioned mass of mud and hair is removed) about 18 mm. long and somewhat less in the other diameters.

Musculature of mantle well developed on nearly all parts of the body. The superficial layer consists mainly of a sheet of closely placed fibers which are not gathered into bands. The deeper layer consists of rather loose and irregular bands radiating from about the bases of the siphons. The mantle generally adheres firmly to the test.

Tentacles numbering at least fifty or sixty, of various sizes arranged with little appearance of regularity, so that it is difficult to say how many orders are represented, but probably at least four. Very small tentacles, which, however, have the same tapering elongated form as the large ones, are present here and there in the intervals between the larger ones, but they are not very numerous. No atrial tentacles were observed.

Dorsal lamina a plain-edged, rather narrow membrane. In preserved specimens it will generally be found thrown into lateral undulations by the contraction of the tissues. The same is usually the case with the internal longitudinal vessels of the branchial sac.

Dorsal tubercle conspicuous, C-shaped, horns neither inrolled nor

much incurved; open interval turned squarely toward the left in all of a number of specimens examined.

Branchial sac with four well marked folds on each side of the body. Of these the first and third are the highest, and the fourth the least well developed. Transverse vessels of four orders quite regularly arranged according to the scheme: 1, 4, 3, 4, 2, 4, 3, 4, 1, etc. Those of the first three orders number forty or more in large specimens. Those of the fourth order generally cross without interrupting the stigmata. The transverse vessels do not bear conspicuous membranes. Internal longitudinal vessels numerous and borne on the interspaces as well as upon both dorsal and ventral leaves of the folds. Their distribution is, however, difficult to state exactly as there is no way of determining at what points the folds should be considered to begin. At the summits of the folds the vessels are crowded while on the interspaces between folds they are separated by the width of four, five, or six stigmata (only occasionally more). The vessels are more numerous on the ventral than on the dorsal leaf of each fold and the vessels adjacent to the median dorsal vessel and the endostyle are separated from these organs by a considerable interval. The total number of vessels in a rather large specimen was as follows:

*mdv.* 1 (25) 4 (13) 5 (17) 5 (9) 3 *en.*

Smaller individuals have a somewhat less number.

The stomach has numerous (30 to 35) longitudinal folds, and a long pyloric caecum. The intestine forms a rather short wide loop. The anus has its margin provided with numerous rounded lobes.

Gonads (as well as numerous endocarps) irregularly distributed over the inside of the mantle on both sides of the body. Well developed gonads may number a dozen or more on each side. They are small oval sacs tapering at one end to a narrow neck through which the eggs are discharged. Beside this neck is the opening of the common sperm duct upon a small papilla. The eggs occupy the portion of the gonad which lies against the branchial sac, the small pyriform or two- or three-lobed testes the portion which lies against the mantle. The ducts leading from them are long and do not all unite to a common sperm duct until close to the base of the papilla upon which the common duct opens.

It is perhaps worthy of mention that in many specimens of this species there are deposits of irregular calcareous granules in the larger

vessels of the branchial sac, sometimes in such quantities as perceptibly to distend them and render the branchial sac rather rigid.

This animal should be considered the type of Stimpson's (1852) genus *Glandula* (see pp. 442 and 574), as it is the species first described under that genus, and no other way is apparent for distinguishing which of the two species is the type.

Whiteaves (1874) records this species from the Gulf of Saint Lawrence (off the east point of Prince Edward Island, 15 to 20 fathoms, sandy bottom). It ranges south to off Nantucket. Type locality, Hake Bay, Grand Manan, N. B., 35 fathoms, muddy bottom. Range in depth from 30 fathoms or less (in northern localities) to 134 fathoms (probably to 238 fathoms).

This species is represented in the Peabody Museum by numerous specimens from the following localities. At some of them a large number of specimens were obtained and the species is evidently an abundant one.

? Station 2471 (N. lat. 44° 34', W. long. 56° 41' 45'', 218 fathoms, gray sand and mud), one doubtful specimen, test only preserved.

Stations 85, 86 (off Chebucto Head, N. S., N. lat. 44° 04', W. long. 63° 27', 101 fathoms, fine sand).

Grand Manan, N. B. (collected by H. E. Webster).

Casco Bay, Me. (60-105 fathoms).

Station 95 (Halifax Harbor, N. S., depth not stated).

Station 2513 (off Nova Scotia, N. lat. 43° 34', W. long. 63° 56' 30'', 134 fathoms, gray ooze).

Station 2514 (off Nova Scotia, N. lat. 43° 28' 30'', W. long. 63° 57' 30'', 126 fathoms, black mud, broken shells) very abundant.

Station 67B (N. lat. 43° 25', W. long. 69° 34', 86 fathoms, brown mud).

Station 13B (Jeffrey's Bank, N. lat. 43° 23', W. long. 68° 30', 105½ fathoms, brown mud).

Station 12B (Jeffrey's Bank, N. lat. 43° 20', W. long. 68° 33', 60 fathoms, brown mud).

Station 16B (Jeffrey's Bank, N. lat. 43° 19', W. long. 68° 49', 79 fathoms, brown mud).

Station 2522 (N. lat. 42° 20', W. long. 65° 07' 30'', 104 fathoms, sand, gravel).

Station 2525 (eastern edge of George's Bank, N. lat. 41° 49', W. long. 65° 49' 30'', 72 fathoms, sand, gravel, and broken shells).

Station 2580 (east of Nantucket, N. lat. 41° 25' 30'', W. long. 69° 01', 83 fathoms, sand).

? Station 895 (N. lat. 39° 56' 30'', W. long. 70° 59' 45'', 238 fathoms, soft mud), one small specimen apparently of this species.

It seems not unlikely that *Pandocia libera* Kiaer, 1893 (see also Hartmeyer, 1903) is identical with this species, but Michaelsen (1912)

unites *P. libera* with *P. comata* (see below). It is recorded from about Norway and Spitzbergen, in from 65 to 836 meters.

A closely allied but distinct species is *P. comata* (Alder), 1863 (see also Alder and Hancock, 1905-1907, and Lacaze-Duthiers and Delage, 1892), found on the French and British coasts. It has very few (generally but one) internal longitudinal vessels on the interspaces between folds, and a very narrow intestinal loop. *Pandocia fibrillata* (Alder and Hancock), 1907, is evidently also one of this group; the description and figures given are, however, very insufficient.

***Pandocia albatrossi*, sp. nov.**

Pl. 63, fig. 111; Pl. 64, fig. 113; Pl. 70, fig. 146.

The supposed *Caesiras* [Molgulas] from deep water mentioned by Verrill (1885a, p. 529) were mostly of this species, which in spite of its deep-sea habitat differs little from littoral forms.

Body not attached, considerably flattened dorso-ventrally, so that it has an oblate spheroidal form. Orifices (both four-lobed) on very low conical elevations rather near together on the dorsal surface. Ventral portion of body covered with a thick growth of long tangled branching hairs to which fine sand, Globigerina shells, etc., adhere. These materials also cover the dorsal surface except close to the orifices. The ventral hairs are, however, not so long and numerous as in *P. fibrosa*. Largest specimens about 14 mm. long, the same in width, and 10 mm. in dorso-ventral diameter. Mantle musculature weaker than in *P. fibrosa*, the transverse and radiating bands narrower though more numerous, and the outer longitudinal fibrous layer less compact.

Tentacles at least 40 to 50, of several sizes or orders. They are fewer, longer, and distributed with more approach to regularity according to the usual scheme (1, 4, 3, 4, 2, 4, etc.) than in *P. fibrosa*.

Dorsal tubercle small and difficult to distinguish; apparently simply C-shaped with a small open interval whose direction is very variable in different individuals.

Dorsal lamina a plain membrane, commonly found thrown into lateral undulations by the contraction incident to preservation.

Branchial sac similar to that of *P. fibrosa* except that there are but two folds developed on each side, the first and third. The second and fourth are merely rudimentary, or absolutely wanting and their

position is indicated only by a few more closely grouped internal longitudinal vessels. This condition was found constant in a number of specimens examined.

Transverse vessels of only three orders (arranged 1, 3, 2, 3, 1, etc.) are generally recognizable, though the large ones vary in size. The smallest generally cross without interrupting the stigmata. The number of internal longitudinal vessels on one side of the sac in a fairly large and typical example is about as follows:

*mdv.* 1 (16) 0 (4) 4 (12) 4 (3) 2 *en.*

Number of transverse rows of stigmata between thirty and forty. Usually not more than four (sometimes in a few spaces six or seven) stigmata between internal longitudinal vessels where the latter are most widely separated, but between the median dorsal vessel and first internal longitudinal vessel six or eight, between the last vessel and endostyle eight or ten stigmata. These statements apply to the widest part of the sac of rather large individuals.

Stomach with fewer longitudinal folds (20 to 25) than in *P. fibrosa*. Gastric caecum present.

Intestinal loop rather wide and short. Margin of anus with a number of small but irregular lobes.

Gonads and endocarps similar to those of *P. fibrosa*, but not very numerous in the specimens dissected.

Exclusively a deep-water species which does not belong to the fauna of the New England region. The specimens examined are from the following stations, all at depths over 1400 fathoms:

Station 2221 (N. lat. 39° 05' 30'', W. long. 70° 44' 30'', 1525 fathoms, gray ooze).

Station 2038 (N. lat. 38° 30' 30'', W. long. 69° 08' 25'', 2033 fathoms, Globigerina ooze).

Station 2718 (N. lat. 38° 24', W. long. 71° 52', 1569 fathoms, brown ooze).

Station 2714 (N. lat. 38° 22', W. long. 70° 17' 30'', 1825 fathoms, brown ooze), many specimens collected.

Station 2229 (N. lat. 37° 38' 40'', W. long. 73° 16' 30'', 1420 fathoms, Globigerina ooze).

Genus DENDRODA MacLeay, 1824.

Distinguished from *Tethyum* by having the reproductive organs developed on the right side only.

Folds of branchial sac generally more or less reduced.

Stomach always with a pyloric caecum; margin of anus smooth or with but two lips.

*Key to Species.*

1. Gonad branched.  
Gonad 3-branched. Body rounded or ovoid, attached by a small area.  
*aggregata* var. *pulchella*.
2. Gonad unbranched, tubular and nearly straight. Body usually much flattened dorso-ventrally. One branchial fold on right side, none on left. Internal longitudinal vessels very few (only 4 or 5 on left side)... *carnea*. Internal longitudinal vessels more numerous (a dozen or more on a side in large individuals) ..... *grossularia*.

***Dendrodoa aggregata* (Rathke), var. *pulchella* (Verrill).**

Pl. 65, fig. 120-122; Pl. 70, fig. 142; text-fig. 39.

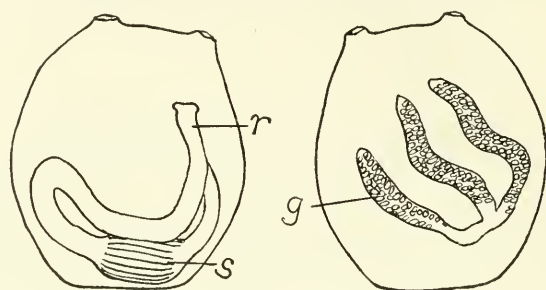
1871. *Cynthia pulchella* Verrill, Amer. Journ. Sci., ser. 3, vol. 1, p. 98.  
 1872. *Cynthia pulchella* Verrill, Amer. Journ. Sci., ser. 3, vol. 3, p. 211.  
 1879. *Halocynthia pulchella* Verrill, Preliminary Check-list of Marine Invertebrates, p. 27.  
 1879. *Halocynthia pulchella* Verrill, Bull. U. S. Nat. Mus., no. 15, p. 148.  
 1879. *Halocynthia pulchella* Verrill, Proc. U. S. Nat. Mus., vol. 2, p. 197.  
 1891. *Cynthia pulchella* Herdman, Journ. Linn. Soc. London, Zool., vol. 23, p. 586 (listed as uncertain species).  
 1903. (Probably.) *Dendrodoa aggregata* (part) Hartmeyer, in Römer and Schaudinn, Fauna Arctica, vol. 3, p. 199.  
 1909. *Pyura aurantium* (part) Hartmeyer, Bronn's Tier-reich, vol. 3, suppl., p. 1341.  
 1912. *Dendrodoa kükenthalii* var. *pectenicola* Michaelsen, Jahrb. Wiss. Anst. Hamburg, vol. 28, suppl. 2, p. 132.

Body of very regular form in most specimens, generally nearly globular or only a little higher or a little lower than broad. Attachment usually by a contracted area, sometimes by a short pedicel; apertures (both small and four-lobed) situated a little way apart on the region opposite to the point of attachment, either on low elevations or little if at all raised above the surface in the contracted specimens. Surface of body even, usually without deep folds, wrinkles, or adhering foreign matter, but with minute regularly disposed wrinkles, transverse and longitudinal, dividing the surface into minute, more or less square fields which become smaller near the apertures and are occupied by low irregular flattened elevations. These are occasionally so small, that the surface has merely a granular appearance to the naked eye, especially on the upper part of the body (near the apertures), but on the lower part they are coarser and their square outline

is readily seen. The largest specimens range from 18 mm. to 25 mm. in height.

Mantle rather thin, with rather slight musculature; generally adherent to the test in alcoholic specimens.

Tentacles of four orders quite regularly arranged except that those of the fourth (smallest) order are few and irregularly distributed. The total number in a good-sized specimen was about forty.



Text-fig. 39.—*Dendrodoa aggregata* var. *pulchella* (Verrill).  $\times 2.2$ .

Dorsal tubercle horseshoe-shaped; open interval forward and to the left, horns not incurved.

Dorsal lamina plain and of moderate width.

Branchial sac with four folds on each side. Of these folds, the first is well developed and the third also, though not so high, while the fourth is low, and generally flattens out before the posterior end of the sac is reached, and the second is generally still less developed, being prominent only at the anterior end, while posteriorly it is represented only by a small group of internal longitudinal vessels. Yet in some individuals all the folds reach the posterior end of the sac. The number of internal longitudinal vessels is very variable in different specimens, as the following schemes will show. The counts were made in the anterior region of the sac.

Specimen 18 mm. high. Station 2445.

Right side	1 (15) 2 (4) 2 (8) 2 (5) 1	
	<i>mdv.</i>	<i>en.</i>
Left side	1 (12) 2 (5) 2 (7) 2 (5) 1	

Specimen 18 mm. high. Station 59.

Right side	<i>mdv.</i> 1 (15) 2 (5) 3 (8) 3 (5) 2	<i>en.</i>
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Largest specimen in the collection, about 25 mm. high. Station 2449.

Right side 1 (19) 2 (10) 2 (13) 3 (11) 1  
*mdv.* *en.*  
 Left side 1 (30) 2 (7) 3 (11) 3 (7) 1

Small specimen 8 mm. high. Stations 53, 54.

Right side *mdv.* 1 (13) 2 (5) 1 (8) 1 (3) 1 *en.*

Total number of vessels greater in large than in small specimens. The vessels are confined to the folds except that one vessel dorsal and one or two ventral to each fold lie on the interspace, removed a varying distance from the base of the fold. That these really belong to the groups on the folds is shown by their often approaching and joining the groups on the nearest folds as one end of the sac is approached. In young individuals all or nearly all the vessels may lie upon the folds. The stigmata are numerous and in large individuals 15 to 25 of them often intervene between internal longitudinal vessels on the interspaces between folds, but these numbers vary much according to the number and position of the above mentioned outlying vessels. The transverse vessels are of four sizes, the smallest merely crossing the stigmata.

The stomach is oblong, of moderate size, with a very small or rudimentary pyloric caecum and twenty or more longitudinal folds. The intestinal loop is narrow and generally so bent that the intestine lies close against the stomach for the whole length of the latter organ, but the exact course and form of the intestinal loop are very variable and often influenced by the indentations of the body caused by the pressure of external objects. The margin of the anus is reflected and nearly plain.

The gonad had three nearly parallel obliquely or nearly horizontally placed branches in all the specimens examined. The details of its structure could not be very well made out in the specimens studied. In each branch the ovary appears to occupy a central position and the testes seem to border it as is usual in this family. In the typical *D. aggregata* the gonad usually has five branches.

Verrill (1871a) described this species from small specimens from Eastport, Me. The types were not found in the collection, but there were other specimens which he had labeled *C. pulchella*. Later, however, he seems to have become doubtful whether this was really

a distinct species from *Pyura aurantium*. An examination of the internal anatomy would of course have proved the two species to be entirely distinct, since they belong to different families.

The writer has so little confidence in the constancy and reliability of the characters by which species of this group have been distinguished, that he considers it sufficient to treat the present form as a variety of *D. aggregata* Rathke, 1806, which is widely distributed in the northern regions of the Old World and has already been recorded from Greenland. *D. kükenthalii* Hartmeyer, (1899, 1903) from the Spitzbergen region has many characters in common with the American specimens, though it has fewer internal longitudinal vessels. If it is not distinct from the American form, the name *pulchella*, whether regarded as a species or subspecies name, has priority. *Dendrodoa kükenthalii* var. *pectenicola* Michaelsen (1912) from the Banks of Newfoundland seems unquestionably identical with the var. *pulchella* here described, and probably also the Casco Bay and Newfoundland specimens of *D. aggregata* recorded by Hartmeyer (1903, pp. 239, 240) are to be referred to this variety. The conclusions drawn by Hartmeyer that *Ascidia carnea* Agassiz, 1850, and *Cynthia placenta* Packard, 1867, are identical with *Dendrodoa aggregata* Rathke are wholly disproved by an examination of the specimens in the Peabody Museum.

Distribution of the variety *pulchella*: Banks of Newfoundland and coasts of Nova Scotia to Eastport, Me., and probably Casco Bay. 10 to 40 fathoms. Shelly or stony bottom, preferred. Type locality, Eastport, Me.

Localities of specimens examined:

Banks of Newfoundland.

Station 2444 (N. lat. 45° 59', W. long. 49° 45' 30'', 39 fathoms, white sand, broken shells), one small specimen.

Station 2445 (N. lat. 46° 09' 30'', W. long. 49° 48' 30'', 39 fathoms, broken shells), three large specimens.

Station 2446 (N. lat. 46° 20', W. long. 49° 52', 40 fathoms, broken shells), one poor specimen apparently of this species.

Station 2449 (N. lat. 46° 37', W. long. 49° 50' 30'', 39 fathoms, broken shells), four large specimens.

Stations 53, 54 (Bedford Basin, north of Halifax, N. S., 35 fathoms, mud), several small and medium-sized specimens.

Station 59 (Halifax, N.S., Outer Harbor,  $\frac{1}{4}$  mile SSW. Rock Head bouy, 25 fathoms, gravel), several large specimens.

The two following species belong in the genus *Styelopsis* Traustedt, 1883, distinguished by the reduction of the folds and vessels of the branchial sac, and the tubular unbranched gonad. It is not recognized as distinct from *Dendrodoa* in Hartmeyer's classification which is adopted in this paper.

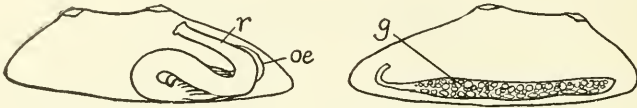
***Dendrodoa carnea*** (Agassiz).

Pl. 64, fig. 114-117; Pl. 72, fig. 15S; text-fig. 40.

1850. *Ascidia carnea* Agassiz, Proc. Amer. Assoc. Adv. Sci., vol. 2, p. 159.  
 1852. *Cynthia gutta* Stimpson, Proc. Boston Soc. Nat. Hist., vol. 4, p. 231.  
 1870. *Cynthia placenta* (part) + (probably) *Cynthia gutta* Verrill, Amer. Journ. Sci., ser. 2, vol. 49, p. 424.  
 1870. *Cynthia gutta* + *Ascidia carnea* Binney, Gould's Invertebrata of Massachusetts, pp. 19, 25, pl. 24, figs. 334, 335.  
 1870. *Ascidia carnea* + *Cynthia gutta* Dall, Proc. Boston Soc. Nat. Hist., vol. 13, p. 255.  
 1871. *Cynthia carnea* (part) Verrill, Amer. Journ. Sci., ser. 3, vol. 1, p. 94, fig. 9 (not figs. 7, 8).  
 1871. *Cynthia carnea* Verrill, Amer. Journ. Sci., ser. 3, vol. 2, p. 362.  
 1872. *Cynthia carnea* Verrill, Bull. Essex Inst., vol. 3, p. 5.  
 1872. *Cynthia carnea* (part) Verrill, Amer. Journ. Sci., ser. 3, vol. 3, p. 213.  
 1873. *Cynthia carnea* (part) Verrill and Smith, Rept. on Invertebrate Animals of Vineyard Sound, pp. 495, 701, pl. 33, fig. 247 (not 248).  
 1874. *Cynthia carnea* Verrill, 6th Ann. Rept. Peabody Acad. Sci., p. 60.  
 1879. *Halocynthia tuberculum* Verrill, Preliminary Check-list of Marine Invertebrates, p. 27.  
 1879. *Halocynthia tuberculum* (part) Verrill, Bull. U. S. Nat. Mus., no. 15, p. 148.  
 1879. *Halocynthia tuberculum* (part) Verrill, Proc. U. S. Nat. Mus., vol. 2, p. 197.  
 1891. *Cynthia carnea* Herdman, Journ. Linn. Soc. London, Zool., vol. 23, p. 586 (listed as uncertain species).  
 1900. *Cynthia carnea* Metcalf, Zool. Jahrbücher, Anat., vol. 13, p. 511, pl. 35, figs. 16, 17.  
 1901. *Halocynthia tuberculum* (part) Whiteaves, Geol. Survey Canada, publ. no. 722, p. 269.  
 1901. *Cynthia (Halocynthia) tuberculum (C. carnea)* Kingsley, Proc. Portland Soc. Nat. Hist., vol. 2, p. 183.  
 1903. *Dendrodoa aggregata* (part) Hartmeyer, in Römer and Schaudinn, Fauna Arctica, vol. 3, p. 235.  
 1909. *Dendrodoa aggregata* (part) Hartmeyer, Bronn's Tier-reich, vol. 3, suppl., p. 1361.

Body greatly flattened dorso-ventrally, having the form of a very depressed cone, or often almost disk-like, attached by the entire

ventral surface, and having the small square apertures on low elevations a little way apart on the upper surface. Outline of body when seen from above rounded or elliptical, 11 mm. long by 9.5 mm. broad in the largest specimen studied. Test thin and parchment-like, often nearly smooth to the naked eye, though finely wrinkled under mag-



Text-fig. 40.— *Dendrodoa carnea* (Agassiz). × 4.2.

nification, generally free from attached foreign material. (In old and large specimens the surface often is rougher and more or less coarsely wrinkled.) The test spreads out beyond the margin of the body on the surface to which the animal is attached forming a border often 2 mm. wide. This part of the test is penetrated by club-shaped vascular processes of the mantle. Color, when alive, pinkish to bright red, often appearing like a drop of blood; in alcohol pale yellow or whitish.

Mantle thin, with slight musculature.

Tentacles mostly of two orders, arranged alternately with considerable regularity and numbering about 32; additional third-order tentacles are represented by minute tubercles in the intervals but are generally not sufficiently developed to deserve counting as tentacles.

Dorsal lamina plain-edged.

Dorsal tubercle small, oval, with an oval or elongated aperture whose long axis lies antero-posteriorly.

Branchial sac with only one fold (the first) on the right side of the body and none on the left side. The fold on the right side usually bears four internal longitudinal vessels. Ventral to the fold are three more widely separated vessels each of which may represent a fold that has disappeared. On the left side of the sac there are generally only four widely spaced vessels. Assuming that they each represent the rudiment of a fold, the scheme of these vessels may be written as follows:

Right side	0 (4) 0 (1) 0 (1) 0 (1) 0	
	<i>mdv.</i>	<i>en.</i>
Left side	0 (1) 0 (1) 0 (1) 0 (1) 0	

In some large specimens, one or two additional vessels were found on each side, thus:

Right side	0	(5 or 6)	0	(1)	0	(1)	0	(1)	0
	<i>mdv.</i>							<i>en.</i>	
Left side	0	(1 or 2)	0	(1)	0	(1)	0	(1)	0

These vessels, of course excepting the group of the first fold, are separated by an average of about 15 stigmata in the middle part of the sac in large individuals; toward the ends of the sac, and in small individuals everywhere, by fewer stigmata. Transverse vessels of sac of three sizes regularly arranged, the smallest merely crossing the stigmata. Those of the first and second orders together totaled about 22 in a fair-sized specimen.

Stomach short and wide, with a small number (about 12 to 16) of deep longitudinal plications and a small narrow curved pyloric caecum. Intestinal loop small; margin of anus reflected but not lobed, often somewhat two-lipped.

Gonad a slender antero-posterior tube in the right ventral part of the body. It is produced posteriorly into a short curved oviduct. The small oval testes occupy the part against the mantle, the elongated ovary the part against the branchial sac. Specimens collected from July to September often contain numerous tailed larvae in the peribranchial cavity.

This small species is unquestionably the *Ascidia carnea* of Agassiz, as, although his description is totally inadequate to distinguish it from the young of other species such as *Tethyum partitum* Stimpson, his statement that it is not immature serves to determine that this is the species referred to. Verrill considered this to be the young of the species called *Tethyum coriaceum* in this paper [*Cynthia placenta* Packard] and hence employed the name *carnea* for both species, or in his later papers the specific name *tuberculum*, for he had concluded that both were identical with the *Ascidia tuberculum* of Fabricius. Bjerkan (1908a, p. 9) expresses the belief that this species (*D. carnea*) is identical with *D. grossularia*, an opinion with which the present writer cannot agree.

*D. carnea* is found from the Banks of Newfoundland and Bay of Fundy to Long Island Sound and is rather common in many localities, attached to stones and shells in water of moderate depth (39 fathoms or less). Type locality, Boston Harbor.

The specimens studied by the writer were from these localities:

Station 2444 (Banks of Newfoundland, N. lat. 45° 59', W. long. 49° 45' 30'',  
39 fathoms, white sand and broken shells).

Eastport, Me.

Vineyard Sound, 14 fathoms.

Off Block Island, 8-21 fathoms, rocky.

Long Island Sound.

**Dendrodoa grossularia** (Van Beneden).

Pl. 64, figs. 118, 119.

1846. *Ascidia grossularia* Van Beneden, Mém. Acad. Roy. Belgique, vol. 20,  
p. 61, pl. 4, fig. 7.
1883. *Styelopsis grossularia* Traustedt, Vidensk. Meddel. Naturhist. For.  
Kjobenhavn, p. 15.
1892. *Styelopsis grossularia* Julin, Bull. Sci. France et Belgique, vol. 24, p.  
208.
1892. *Styelopsis grossularia* Lacaze-Duthiers and Delage, Mém. Prés. Acad.  
France, vol. 45, no. 1, p. 178, pls. 10, 11.
1902. *Styelopsis grossularia* Riedlinger, Nova Acta Acad. Leop.-Carol.,  
Halle, vol. 81, no. 1, pl. 1-6.
1903. *Styelopsis grossularia* Hartmeyer, in Römer and Schaudinn, Fauna  
Arctica, vol. 3, p. 253, pl. 5, figs. 12, 13.
1905. *Styelopsis grossularia* Bjerkan, Bergens Mus. Aarbog, no. 5, p. 12.
1906. *Dendrodoa grossularia* Hartmeyer, Beiträge zur Meeresfauna von  
Helgoland, no. 15, p. 122.
1906. *Styelopsis grossularia* Redikorzew, Trav. Soc. Nat. St. Pétersbourg,  
vol. 37, pt. 1, p. 310.
1907. *Styelopsis grossularia* Redikorzew, Ann. Mus. Zool. Acad. St. Péters-  
bourg, vol. 11, pp. 138, 151-153.
1908. *Styelopsis grossularia* Bjerkan, Rep. Second Norwegian Arctic Exped.,  
no. 14, p. 9.
1908. *Styelopsis grossularia* Redikorzew, Trav. Soc. Nat. St. Pétersbourg,  
vol. 39, pp. 20, 26.
1908. *Styelopsis grossularia* Bjerkan, Tromsø Mus. Aarshefter, no. 25, p. 71.
1909. *Dendrodoa grossularia* Hartmeyer, Bronn's Tier-reich, vol. 3, suppl.,  
p. 1361.
1912. *Dendrodoa grossularia* Hartmeyer, Vidensk. Meddel. Naturhist. For.  
Kjobenhavn, vol. 63, p. 273.
1912. *Dendrodoa grossularia* Hartmeyer, Sitzungsber. Ges. Naturforsch.  
Freunde, 1911, no. 10, p. 440.

A few specimens in the collection agree in practically all characters, external and internal, with the species last described (*D. carnea*), but differ in having a much greater number of internal longitudinal

vessels on the branchial sac. One fold is present on the right and none on the left side as in *D. carnea*. The fold bears a group of six to nine closely placed vessels; the remaining vessels of that side and those of the right side may be somewhat unequally spaced, or gathered into poorly defined groups, these groups probably indicating folds that have disappeared. They total (including those on the fold) about 12 on the left and 13 or 14 on the right side in two of the larger specimens. In the largest specimen of all, their number and distribution may be written as follows, if we assume the grouping of the vessels to indicate rudiments of folds:

Right side	0	(7)	0	(3)	0	(4)	0	(3)	0
	<i>mdv.</i>								<i>en.</i>
Left side	0	(4)	0	(4)	0	(4)	0	(4)	0

One small specimen appears to have fewer (perhaps only ten) on the left side. Five to eight stigmata generally separate the vessels in the wider spaces. The transverse vessels of the sac are somewhat more numerous than in *D. carnea*, but the description of the rest of the anatomy of that species would apply equally well to these specimens so far as was observed, except that the folds in the stomach wall are more numerous, and only eighteen tentacles were counted in one individual in addition to a few small rudimentary ones. The dorsal tubercle is usually similar to that of *D. carnea* (in one specimen it was slightly crescent-shaped); the anus has two lips.

The writer believes that these specimens belong to this well known species, which is widely distributed in the waters of northern Europe and the adjacent parts of the Arctic seas, including the coasts of Great Britain and Ireland, Iceland and Greenland in depths down to 80 meters, and which may therefore be expected to reach the northern part of our coasts. It is a variable species, occurring both solitary and aggregated into groups, and has been described in more or less detail by many writers. The reader is referred especially to the works of Julin (1892), Lacaze-Duthiers and Delage (1892), and Riedlinger (1902) for further details.

The American specimens are from these localities:

Gulf of Saint Lawrence, between Pictou Island and Cape Bear. Collected by J. F. Whiteaves. One specimen of very low flattened conical form, 12 mm. across, exclusive of the border of test substance

which spreads out over the shell to which it is attached. Apertures moderately prominent; surface of test nearly smooth.

Gulf of Saint Lawrence, locality illegible. Collected by J. F. Whiteaves. Two specimens having the dorsal surface finely wrinkled; the largest 14 mm. long by 10 mm. wide, exclusive of the border of test substance which spreads out over the surface to which the body is attached.

Eastport, Me., six specimens of oval outline when seen from above and of a low, more or less flattened dome-like form. Apertures not prominent or only slightly so; surface of test wrinkled. None exceeds the above dimensions.

These specimens, collected during the summer, contained tailed larvae in the peribranchial cavity.

Family RHODOSOMATIDAE Hartmeyer, 1908.

Tentacles simple.

Branchial sac without folds but with internal longitudinal vessels (sometimes incomplete or rudimentary) which bear no papillae.

Dorsal lamina broken up into a series of languets.

Intestine variable in position, more commonly on the right side. Middle part of intestine passes below the stomach instead of above as in most ascidians.

Subfamily *Chelyosomatinae* Hartmeyer, 1908.

Stigmata curved, sometimes spiral in arrangement.

*Key to Genera.*

Upper surface of body protected by regularly arranged horny plates.

*Chelyosoma.*

Body unprotected, often stalked, test thin and transparent. Stigmata in spirals; well developed internal longitudinal vessels present. . . . . *Corella.*

Genus CHELYOSOMA Broderip and Sowerby, 1830.

Body flattened and protected above with regularly arranged horny plates connected by short muscles. Both orifices six-lobed.

This peculiar genus can be at once recognized by the above characters. The species found in the New England region was described by Stimpson (1852) as distinct from that of Europe, but as Hartmeyer (1903) has pointed out, no reasons for considering them distinct seem to exist.

**Chelyosoma macleayanum** Broderip and Sowerby.

1830. *Chelyosoma macleayanum* Broderip and Sowerby, Zool. Journ., vol. 5, p. 46, pl. 3, fig. 4-6.
1852. *Ascidia geometrica* Stimpson, Proc. Boston Soc. Nat. Hist., vol. 4, p. 229.
1854. *Ascidia geometrica* Stimpson, Smithsonian Contr., vol. 6, p. 20.
1860. *Chelyosoma geometrica* Stimpson, Smithsonian Check-list, p. 1.
- ? 1864. *Chelyosoma* sp. Stimpson, Proc. Acad. Nat. Sci. Philadelphia, 1863, p. 161.
1870. *Chelyosoma geometricum* Binney, Gould's Invertebrata of Massachusetts, ed. 2, p. 26.
1870. *Chelyosoma geometricum* Dall, Proc. Boston Soc. Nat. Hist., vol. 13, p. 255.
1874. *Chelyosoma geometricum* Verrill, Amer. Journ. Sci., ser. 3, vol. 7, p. 43.
1874. *Chelyosoma geometricum* Verrill, Proc. Amer. Assoc. Adv. Sci., vol. 22, pp. 361, 363, pl. 1, fig. 6.
1879. *Chelyosoma geometrica* Verrill, Preliminary Check-list of Marine Invertebrates, p. 27.
1898. *Chelyosoma macleayanum* Bancroft, Proc. California Acad. Sci., ser. 3, vol. 1, p. 309.
1899. *Chelyosoma macleayanum* Hartmeyer, Zool. Jahrbücher, Syst., vol. 12, p. 498, fig. j; pl. 23, figs. 9, 17.
1901. *Chelyosoma geometricum* Whiteaves, Geol. Survey Canada, publ. no. 722, p. 267.
1901. *Chelyosoma geometrica* Kingsley, Proc. Portland Soc. Nat. Hist., vol. 2, p. 183.
1903. *Chelyosoma macleayanum* Hartmeyer, in Römer and Schaudinn, Fauna Arctica, vol. 3, p. 269.
1905. *Chelyosoma macleayanum* Bjerkan, Bergens Mus. Aarbog, no. 5, p. 13.
1906. *Chelyosoma macleayanum* Redikorzew, Trav. Soc. Nat. St. Pétersbourg, vol. 37, pp. 155, 309, 310.
1907. *Chelyosoma macleayanum* Redikorzew, Ann. Mus. Zool. Acad. St. Pétersbourg, vol. 11, pp. 141, 151, 152, 154.
1907. *Chelyosoma macleayanum* Redikorzew, Zool. Anzeiger, vol. 31, p. 521.
1908. *Chelyosoma macleayanum* Bjerkan, Tromsø Mus. Aarshefter, no. 25, pp. 75, 76, figs. 3, 4.
1908. *Chelyosoma macleayanum* Redikorzew, Trav. Soc. Nat. St. Pétersbourg, vol. 39, pp. 21, 29.
1908. *Chelyosoma macleayanum* Redikorzew, Mém. Acad. Imp. Sci. St. Pétersbourg, ser. 8, cl. phys.-math., vol. 18, no. 11, p. 39.
1909. *Chelyosoma macleayanum* Hartmeyer, Bronn's Tier-reich, vol. 3, suppl., p. 1392.

Though Verrill (1874a) reports having found this species, no specimen was discovered in the collections examined. The following details

are therefore taken from Hartmeyer (1903) and are not based on American specimens.

Body much flattened; surface with eight horny plates (seven marginal, one central) besides six surrounding each siphon.

Tentacles of several sizes, over 100 in number.

Dorsal tubercle crescent-shaped, horns not spirally inrolled, open interval directed forward.

Dorsal lamina with sickle-shaped languets.

Stigmata curved; internal longitudinal vessels present.

Intestine ventral and on the left side; loop broad; stomach with diverticula.

Reproductive organs spreading in a net-like manner over the intestinal loop.

Stimpson's (1852) description is as follows:

"Body adhering by a broad base, depressed, oval. Test thin, smooth, transparent, very pale greenish, with an almost peripheric, narrow, dark-colored line or ridge, like a fibre, from which other lines of the same character proceed, dividing the surface into ten irregular polygons, two of which, separated from each other by a third, contain the apertures. These two polygons are wheel-like, being radiated with six spokes from a centre, which is the sessile aperture. Proceeding from, and perpendicular to each of the dark lines, are bright straw-colored fibres, extending toward the centres of the polygons but not reaching them. Length, half an inch.

"Dredged in forty fathoms on a muddy bottom off Long Island, Gr. Manan. One specimen only was found, which was adhering to a dead valve of *Pecten Magellanicus*."

According to Redikorzew (1908b, p. 40) this species is known from Norway, Spitzbergen, Murman Coast, White Sea, Siberian Arctic Ocean, the northern North Pacific, Greenland, Jan Mayen, and Iceland. Apparently it is nowhere common. It inhabits stony or muddy bottoms when containing also stones, in depths from 10 to 99 meters.

On the American coast it was collected by Stimpson (1852) near Grand Manan as above stated, and by Verrill (1873) in Casco Bay, Maine (off Witch Rock, 18 fathoms, stony). It is evidently exceedingly rare, and confined to the northern part of the region.

Genus *CORELLA* Alder and Hancock, 1870.

Body often raised on a stalk, branchial aperture with eight lobes; atrial aperture with six lobes.

Test transparent, without horny plates.

Branchial sac without folds but with internal longitudinal vessels. Stigmata arranged in spirals.

Dorsal lamina with teeth or languets.

Digestive canal on right side.

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

***Corella borealis*** Traustedt.

Pl. 65, fig. 123.

1886. *Corella borealis* Traustedt, *Dijmphna Zool.-bot. Udb.*, p. 423, pl. 36, figs. 1, 2; pl. 38, fig. 22; pl. 39, fig. 28.
1891. *Corella borealis* Herdman, *Journ. Linn. Soc. London, Zool.*, vol. 23, p. 588.
1903. *Corella borealis* Hartmeyer, in Römer and Schaudinn, *Fauna Arctica*, vol. 3, p. 271.
1909. *Corella borealis* Hartmeyer, *Bronn's Tier-reich*, vol. 3, suppl., p. 1393.

There is but one small and mutilated specimen of this genus in the collection. It is insufficient for making a satisfactory identification or description, but such characters as can be made out, especially the greatly reduced mantle musculature, indicate that it belongs to this species, rather than to the better known *C. parallelogramma* which is widely distributed on the coasts of northwestern Europe.

The body is oblong and may have tapered at one end into a stalk or pedicel, but if so, this has been broken off. The portion that remains is about 9 mm. long and 6.5 mm. deep, and appears to have been somewhat compressed laterally. Test thin, transparent, and practically colorless, its surface smooth except for some fine wrinkles and folds due to contraction.

Musculature of mantle very slight, developed almost exclusively about the siphons and on the left side where it consists of a few (about a dozen) narrow bands extending transversely about halfway around the body. Several of these bands fork or divide into two branches in the ventral region.

Tentacles numerous (perhaps fifty), slender and closely placed, of three sizes arranged quite regularly.

Branchial sac without folds, but with many transverse and longitudinal vessels dividing the wall of the sac into square meshes. Each mesh more or less irregularly subdivided into stigmata by slender vessels. One of these forms a spiral (though not usually of over  $1\frac{1}{2}$  to  $2\frac{1}{2}$  turns) arising from a transverse vessel and winding toward the center of the mesh. It is supported by a few irregular radial vessels, which at the same time divide the space up into separate stigmata. Spirals arise only from alternate transverse vessels. Those arising from the same vessel opposite each other (hence in adjacent vertical rows but in the same horizontal row) curve in opposite directions; in the same vertical row all curve alike, either in a right- or left-handed direction. In many of the meshes the spiral is so rudimentary or distorted that its spiral nature is practically lost, the mesh being apparently occupied only by a few irregularly placed vessels. Internal longitudinal vessels present, corresponding in number to the rows of meshes, but they are very slender and often interrupted midway between the supporting papillae (see Pl. 65, fig. 123). These supporting papillae are very long and slender and taper to the upper end where the vessel is attached.

The intestine and stomach are too much mutilated to permit of tracing their course. The stomach is short and wide with numerous short irregular convolutions or areolations in its walls. The proximal part of the intestine is much curved and of large diameter; the rectum straight and the margin of the anus has a number of irregular rounded lobes.

The gonad is likewise too much mutilated to determine its form and extent, though portions of both the ovary and the testis remain in the bend of the intestinal loop. The ovarian part which remains consists of a rather large irregular mass of eggs, the male part of several rather compact though much branched masses which divide into numerous very small lobules in an irregular manner.

The animals of this genus are generally highly colored during life, but these colors do not persist in preserved specimens.

This species has hitherto been recorded only from the Arctic Seas, and though widely distributed, appears to be quite rare. Hartmeyer (1903) gives the following localities: Spitzbergen, Kara Sea, Davis Straits, and the east coast of Greenland. Depths, 66 meters to 250 fathoms.

The single New England specimen, which the writer has identified

with it provisionally, is from Station 236 (near Cape Ann, Massachusetts, N. lat.  $42^{\circ} 28'$ , W. long.  $70^{\circ} 31'$ , 28 fathoms, rock, coarse sand, and pebbles).

Family PHALLUSIIDAE Traustedt, 1883.

[= ASCIDIIDAE auct. plur.].

Branchial aperture usually with eight (or seven) lobes; atrial aperture usually with six lobes.

Tentacles simple.

Dorsal lamina plain-edged or toothed, but not broken up into separate languets.

Branchial sac without large longitudinal folds but generally exhibiting a minute plication or fluting. Internal longitudinal vessels present and usually provided with papillae at the intersections with the transverse vessels and in some species also at intermediate points. Stigmata straight.

Alimentary tract on left side of body.

Reproductive organs in and spreading over the intestinal loop.

Genus PHALLUSIA Savigny, 1816.

[= ASCIDIA auct. plur.].

This is the only genus of the family occurring in the New England region and apparently also the only very well characterized genus of the family. The above family characters will suffice for its recognition.

It is represented in the collection by a very large number of specimens, but though many of them were dissected, no other species were recognized than the two next following, both of which were recorded by Verrill, though under other names. A third species was described by Verrill from a single specimen, but is of doubtful validity.

*Key to Species.*

Internal longitudinal vessels with papillae at intersections with transverse vessels only.....*obliqua*.  
 Internal longitudinal vessels with papillae at intersections with transverse vessels and also midway between the intersections.....*prunum*.

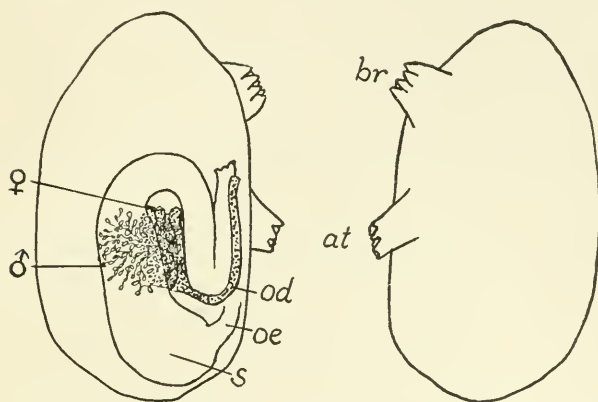
**Phallusia obliqua** (Alder).

Pl. 65, fig. 127; Pl. 66, figs. 128, 131; Pl. 72, figs. 154, 155; text-fig. 41.

1863. *Ascidia obliqua* Alder, Ann. Mag. Nat. Hist., ser. 3, vol. 11, p. 154.  
 1873. *Ascidia* n. sp. Verrill, Amer. Journ. Sci., ser. 3, vol. 6, p. 440.  
 1874. *Ascidia mollis* Verrill, Amer. Journ. Sci., ser. 3, vol. 7, pp. 409, 413, 499, 504.  
 1874. *Ascidia mollis* Verrill, Proc. Amer. Assoc. Adv. Sci., vol. 22, pp. 390, (348, 352), pl. 1, fig. 5.  
 1879. *Ascidia mollis* Verrill and Rathbun, Proc. U. S. Nat. Mus., vol. 2, p. 231.  
 1880. *Ascidia falcigera* Herdman, Proc. Roy. Soc. Edinburgh, vol. 10, p. 469.  
 1882. *Ascidia falcigera* Herdman, Challenger Rept., Zool., vol. 6, p. 211, pl. 32, fig. 1-6.  
 1882. *Ascidia mollis* Baird, Rept. U. S. Comm. Fish and Fisheries for 1879, p. 805.  
 1889. *Ascidia mollis* MacDonal, Rept. U. S. Comm. Fish and Fisheries for 1886, p. 856.  
 1891. *Ascidia falcigera* + *A. mollis* + *A. obliqua* Herdman, Journ. Linn. Soc. London, Zool., vol. 23, pp. 592, 594, 596.  
 1901. *Ascidia falcigera* Whiteaves, Geol. Survey Canada, publ. no. 722, p. 267.  
 1901. *Ascidia mollis* Kingsley, Proc. Portland Soc. Nat. Hist., vol. 2, p. 183.  
 1903. *Ascidia obliqua* Hartmeyer, in Römer and Schaudinn, Fauna Arctica, vol. 3, pt. 2, p. 280, pl. 5, fig. 18; pl. 12, fig. 7-12.  
 1905. *Ascidia obliqua* Bjerkan, Bergens Mus. Aarbog, 1905, no. 5, p. 14.  
 1906. *Ascidia obliqua* Redikorzew, Trav. Soc. Nat. St. Pétersbourg, vol. 37, pp. 154, 309, 310.  
 1907. *Ascidia obliqua* Redikorzew, Ann. Mus. Zool. Acad. St. Pétersbourg, vol. 11, pp. 142, 151-153.  
 1907. *Ascidia obliqua* Redikorzew, Zool. Anzeiger, vol. 31, p. 522.  
 1908. *Ascidia obliqua* Redikorzew, Trav. Soc. Nat. St. Pétersbourg, vol. 39, pp. 22, 29, 42.  
 1908. *Ascidia obliqua* Redikorzew, Mém. Acad. Imp. Sci. St. Pétersbourg, ser. 8, cl. phys.-math., vol. 18, no. 11, p. 41.  
 1908. *Ascidia obliqua* Bjerkan, Tromsø Mus. Aarshefter, no. 25, pp. 79, 114, 115.  
 1909. *Phallusia obliqua* Hartmeyer, Bronn's Tier-reich, vol. 3, suppl., p. 1403.  
 1912. *Phallusia obliqua* Hartmeyer, Vidensk. Meddel. Naturhist. For. Kjøbenhavn, vol. 63, p. 276.  
 Not *Ascidia obliqua* Heller, 1874. Not *Ascidia mollis* Hancock, 1870.

Body oval, elliptical, or more or less oblong in outline, usually attached by a considerable area on the left ventral region, sometimes by the whole side; not usually as much flattened as in the case of the

next following species (*P. prunum*). Apertures on low conical projections some distance apart, the branchial larger and more prominent with eight or seven lobes, the atrial with six lobes (nearly rounded in expansion according to Verrill). Test of moderate thickness on the ventral region, but quite thin above, the outer surface varying from



Text-fig. 41.— *Phallusia obliqua* (Alder).  $\times 1.7$ .

smooth to somewhat wrinkled, with or without some adhering material (mud, algae, hydroids, etc.). In general the test substance is of a softer and more flabby consistency than in the next species, and varies from transparent or translucent to nearly opaque; it is of a greenish or olive tint in life, becoming a dirty gray or brown in alcohol. Size of largest specimen studied: length 57 mm.; width (obliquely) 42 mm. Hartmeyer mentions specimens over 70 mm. long, from Norway, Spitzbergen, etc.

Mantle very thin on the left side but with fairly well developed musculature on the right side; the muscle bands, though slender, are numerous and cross each other in various directions. About the siphons they have the usual circular and radial directions.

Tentacles in a moderately large individual 32, of two sizes placed alternately. In addition, a minute third-order tentacle occurred in two or three of the intervals.

Dorsal tubercle with a crescent-shaped or U-shaped aperture with the open interval directed forward. One horn of the U is often irregularly bent (Pl. 66, fig. 131).

Dorsal lamina broad, its border minutely denticulate in the posterior part of the body but nearly even anteriorly.

Minute plication or fluting of branchial sac moderately well developed. Seen from the inner side the ridges, which are usually at distances equal approximately to twice that separating the internal longitudinal vessels, are narrower than the intervening hollows. The transverse vessels take part in the plication to a considerable extent and are of two orders, three vessels of the second (smaller order) generally intervening between those of the first order. Internal longitudinal vessels, where they cross the transverse vessels, bearing rather stout, somewhat curved papillae, which bend in a dorsal direction and bear a narrow membrane along the dorsal side which is continuous with a narrow membrane borne on the transverse vessel. No papillae on the internal longitudinal vessels at intermediate points as in the next species, and these vessels are, moreover, often interrupted about midway between the transverse vessels (see fig. 128). About four or five stigmata generally intervene between the internal longitudinal vessels but sometimes as few as three. A specimen 47 mm. long had between 60 and 70 internal longitudinal vessels on one side of the sac, and about 90 transverse vessels.

Alimentary tract smaller and less bent than in the next species. Stomach with internal ridges but smooth externally. Margin of anus irregular.

Ovary forming a broad irregular more or less branched mass lying chiefly between the stomach and proximal part of the intestine and the branchial sac. It also encroaches a little upon the side of the stomach which lies against the mantle. The oviduct accompanies the rectum and ends near the anus. The male reproductive organ consists of numerous small rounded lobed or pyriform glands connected by branching ducts, and ramifies over the ovary and over a greater or less extent of the stomach, especially near the pyloric end.

Although living chiefly in comparatively deep water, so that it is less frequently found by the ordinary collector than the next species (*P. prunum*), this species is both widely distributed and very common. In the Old World it occurs in the Siberian Arctic Ocean, on the Murman coast, in the White Sea, about Spitzbergen, Norway; Great Britain, etc., and even on a part of the French coast (Roscoff).

In American waters it occurs in Davis Straits, on the coasts of Greenland and Labrador, in the Gulf of Saint Lawrence, and south-

ward to Cape Cod (Stellwagen's Bank and off Chatham), especially in the deeper waters and on the banks (Jeffrey's Bank, Cashe's Ledge, etc.), off the coast. In the Gulf of Maine it occurs, according to Verrill, in from 48 to 175 fathoms, and in the Bay of Fundy from 40 fathoms downward. Station 371 (off Chatham, Massachusetts, Chatham Lights N.  $72^{\circ}$  W., 16 miles,  $34\frac{1}{2}$  fathoms, coarse sand) is the most southern locality from which the writer has seen this species. This is also somewhat shallower water than usual for the species, as it occurs chiefly in depths of over 50 fathoms and ranges to 244 fathoms (Station 2470, N. lat.  $44^{\circ} 47'$ , W. long.  $56^{\circ} 33' 05''$ , gray mud), 289 fathoms (Davis Straits), and 600 meters (off Norway). Among the localities of specimens examined are:

Station 2520 (south of Cape Sable, Nova Scotia, N. lat.  $42^{\circ} 41'$ , W. long.  $64^{\circ} 55' 30''$ , 62 fathoms, rocky), many large specimens.

Station 29B (off Cape Ann, N. lat.  $42^{\circ} 47' 30''$ , W. long.  $70^{\circ} 20' 30''$ , 33 fathoms, gravel and stones).

Rennie and Wiseman (1906) report this species from the Cape Verde Islands, where, however, one would not expect it to occur. Though found in a variety of situations, a stony bottom is much the most favorable for its growth.

#### **Phallusia prunum** (Müller).

Pl. 65, fig. 124-126; Pl. 66, figs. 129, 132; Pl. 72, figs. 156, 157; text-fig. 42.

1776. *Ascidia prunum* Müller, Prodr. Zool. Dan., p. 225, no. 2730.

1780. *Ascidia complanata* Fabricius, Fauna Groenlandica, p. 332, no. 320.

1791. *Ascidia prunum* Gmelin, Syst. Nat., ed. 13, vol. 1, pt. 6, p. 3124, no. 9.

1852. *Ascidia callosa* Stimpson, Proc. Boston Soc. Nat. Hist., vol. 4, p. 228.

1854. *Ascidia callosa* Stimpson, Smithsonian Contr., vol. 6, p. 19.

1860. *Ascidia callosa* Stimpson, Smithsonian Check-list, p. 2.

1863. *Ascidia callosa* Packard, Canadian Naturalist and Geologist, vol. 8, p. 412.

1867. *Ascidia callosa* Packard, Mem. Boston Soc. Nat. Hist., vol. 1, p. 276.

1870. *Ascidia callosa* Binney, Gould's Invertebrata of Massachusetts, ed. 2, p. 26, pl. 23, fig. 318.

1870. *Ascidia* ? *callosa* Dall, Proc. Boston Soc. Nat. Hist., vol. 13, p. 255.

1870. *Ascidia callosa* Verrill, Amer. Naturalist, vol. 3, p. 383.

1871. *Ascidia complanata* Verrill, Amer. Journ. Sci., ser. 3, vol. 1, p. 98, fig. 11.

1872. *Ascidia complanata* Verrill, Bull. Essex Inst., vol. 3, pp. 3, 5.

1872. *Ascidiopsis complanatus* (or *complanata*) Verrill, Amer. Journ. Sci., ser. 3, vol. 3, pp. 214, 289, pl. 8, fig. 8.

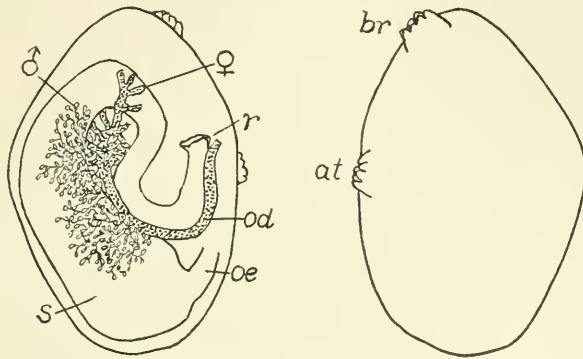
1873. *Ascidiopsis complanata* Verrill, Amer. Journ. Sci., ser. 3, vol. 5, p. 101.

1874. *Ascidioopsis complanatus* Verrill, Proc. Amer. Assoc. Adv. Sci., vol. 22, pp. 352, 355, 358, 363, 370.
1874. *Ascidioopsis complanatus* Verrill, Amer. Journ. Sci., ser. 3, vol. 7, pp. 39, 43, 413, 504.
1874. *Ascidioopsis complanatus* Whiteaves, Amer. Journ. Sci., ser. 3, vol. 3, p. 5.
1879. *Ascidioopsis complanata* Verrill and Rathbun, Proc. U. S. Nat. Mus., vol. 2, p. 231.
1879. *Ascidioopsis complanata* Verrill, Bull. U. S. Nat. Mus., no. 15, p. 147.
1882. *Ascidioopsis complanatus* Baird, Rept. U. S. Comm. Fish and Fisheries for 1879, p. 806.
1885. *Ascidioopsis complanata* Verrill, Rept. U. S. Comm. Fish and Fisheries for 1883, p. 529.
1889. *Ascidioopsis complanata* McDonald, Rept. U. S. Comm. Fish and Fisheries for 1886, p. 856.
1891. *Ascidia prunum* + *A. complanata* Herdman, Journ. Linn. Soc. London, Zool., vol. 23, pp. 592, 594.
1891. *Ascidia callosa* Packard, Labrador Coast, p. 396.
1901. *Ascidia (Ascidioopsis) complanata (A. callosa)* Kingsley, Proc. Portland Soc. Nat. Hist., vol. 2, p. 183.
1901. *Ascidia complanata* Whiteaves, Geol. Survey Canada, publ. no. 722, p. 266.
1903. *Ascidia prunum* Hartmeyer, in Römer and Schaudinn, Fauna Arctica, vol. 3, p. 285, pl. 5, figs. 16, 17; pl. 13, fig. 1-5.
1905. *Ascidia prunum* Bjerkan, Bergens Mus. Aarbog, 1905, no. 5, p. 15.
1906. *Ascidia prunum* Redikorzew, Trav. Soc. Nat. St. Pétersbourg, vol. 37, pp. 154, 310.
1907. *Ascidia prunum* Redikorzew, Ann. Mus. Zool. Acad. St. Pétersbourg, vol. 11, pp. 142, 151-153.
1908. *Ascidia prunum* Bjerkan, Rep. Second Norwegian Arctic Exped., no. 14, p. 10.
1908. *Ascidia prunum* Redikorzew, Trav. Soc. Nat. St. Pétersbourg, vol. 39, pp. 20, 30.
1908. *Ascidia prunum* Bjerkan, Tromsø Mus. Aarshefter, no. 25, p. 83.
1909. *Phallusia prunum* Hartmeyer, Bronn's Tier-reich, vol. 3, suppl., p. 1403.
1910. *Phallusia prunum* Hartmeyer, Danmark-Expeditionen, vol. 5, p. 234.
1912. *Phallusia prunum* Hartmeyer, Sitzungsab. Ges. Naturforsch. Freunde, 1911, no. 10, pp. 439, 440.

Not greatly different from the last described species (*P. obliqua*) in external appearance though generally more regularly oval in outline, especially when young, and more flattened in a direction perpendicular to the surface of attachment, with the apertures less prominent and with a thicker, firmer, more cartilaginous test, which in young individuals is very transparent, with a smooth surface, though in older specimens it becomes wrinkled, and often covered with hydroids,

worm tubes, etc. It averages a little larger than the last species, and very large specimens 90 mm. long are not infrequent from northern localities.

Regarding its color Verrill (1871a, p. 99) says: "Color of the younger specimens pale, translucent greenish or yellowish gray, or light horn-



Text-fig. 42.—*Phallusia prunum* (Müller). × 1.7.

color, the mantle and dark intestine distinctly visible through the test; large specimens are darker greenish or olive-color, generally becoming more or less rusty brown or russet. Mantle finely speckled with raised yellowish points."

This species having been carefully described by a number of writers (see Hartmeyer, 1903) it will suffice here to note some of the important characters and the most conspicuous differences distinguishing it from *P. obliqua*.

Tentacles forty or more, of three sizes (in large individuals four sizes) arranged with considerable regularity.

Orifice of dorsal tubercle crescent-shaped, U- or V-shaped, or some simple modification of these forms. In one individual it was distinctly Y-shaped.

Dorsal lamina with distinct teeth corresponding in position to the origin of the transverse vessels. In the posterior region these teeth are of considerable size and themselves bear small slender teeth on their edges.

Branchial sac more conspicuously fluted or plicated than in *P. obliqua*. As the larger transverse vessels do not take much part in this plication a series of hollows or cavities often results, rather than a

continuous groove or furrow. The ridges as seen from the inside of the sac are narrow, and generally separated by about twice the distance of the internal longitudinal vessels. They become wider as the larger transverse vessels are approached, so that the stigmata on their sides have an oblique position (fig. 129). This peculiarity led Verrill (1872b) to form a distinct genus (*Ascidiopsis*) for this species; the character is, however, but an exaggeration of the plication which occurs in most species of *Phallusia*. The transverse vessels are narrow and of four orders arranged according to the scheme (1, 4, 3, 4, 2, 4, 3, 4, 1, etc.) The internal longitudinal vessels bear a rather long, nearly straight papilla at each intersection with a transverse vessel and a similar but smaller one midway between each intersection. An individual 40 mm. long had between 60 and 65 internal longitudinal vessels on one side of the sac, and about 80 transverse vessels.

Stomach and intestine are very large, often covering almost the whole left side of the body. The stomach and proximal part of the intestine are, moreover, more bent than in the last species; the stomach has internal longitudinal ridges as in that form though smooth internally. The anus margin is irregularly two-lipped.

The ovary, at least in the specimens studied, was more ramified than in *P. obliqua* and one or more branches of it may spread over the side of the stomach or proximal part of the intestine which lies against the mantle. The testis is composed of small pyriform or lobed glands borne on branching ducts, and also extends over much of the same side of the stomach. The oviduct is large and accompanies the rectum.

Geographical distribution about the same as that of *P. obliqua* except that this inhabits shallow or comparatively shallow water. It is abundant and widely distributed in the waters of northern Europe (White Sea, Nova Zembla, Murman coast, Norway, Spitzbergen, etc.), Iceland, Greenland, Davis Straits, Baffin's Bay; and Labrador. In the region covered by this paper it occurs in the Gulf of Saint Lawrence, on the Banks of Newfoundland, the Nova Scotian coast, Bay of Fundy, Casco Bay, Cashe's Ledge, Jeffrey's Ledge, Massachusetts Bay, and Stellwagen's Bank, being exceedingly abundant in the northern part of the region. The most southern localities are some distance off the coast:

Station 2524 (N. lat. 41° 48' 45", W. long. 65° 47', 85 fathoms, sand, gravel, stones).

Station 2526 (N. lat. 41° 40' 45", W. long. 65° 46', 121 fathoms, pebbles).  
Station 2580 (N. lat. 41° 25' 30", W. long. 69° 01', 83 fathoms, yellow sand).

It ranges from low-water mark to 150 fathoms but appears to be commoner in less than 50 fathoms, and though a stony or shelly bottom is most favorable to it, it grows in a great variety of situations. Other species of ascidians as well as other animals attach themselves to large individuals.

UNCERTAIN SPECIES.

**Phallusia inornata** (Verrill).

1879. *Ascidia inornata* Verrill, Proc. U. S. Nat. Mus., vol. 2, p. 196.  
Not *Ascidia inornata* Hancock, 1870.

"In expansion the body is upright cylindro-conical, about twice as high as broad; the base is about the same in diameter as the middle portion, and but very little expanded. The oral tube is much longer than the other, subterminal, swollen at base, tapering, the upper part cylindrical, the opening surrounded by seven low, rounded, thin lobes or crenulations, between which are seven orange-colored ocelli; corresponding with the ocelli there are seven thickened, pointed lobes or folds of the test, which run down from them along the tube as slightly prominent costae, with transverse wrinkles between them. The anal tube is subterminal, shorter and smaller, situated to one side, and only about half as long as the oral. Its orifice is surrounded by six lobes and ocelli, like those of the other. Test moderately thick and firm, somewhat wrinkled, nearly glabrous, translucent, dull yellowish, blotched more or less with russet-brown. The internal organs show through faintly as yellow and dark markings. Height, in expansion, 32 mm.; greatest diameter, 17 mm.; length of oral tube, 12 mm.; of anal, 4 mm. to 5 mm.

"Johnson's Bay, near Eastport, Me., 12 fathoms, stony, August 8, 1872."

It was described as a new species by Professor Verrill, and is not *Ascidia inornata* Hancock, 1870. Therefore if the discovery of more specimens proves it to be a good species it will require a new name, as pointed out by Hartmeyer (1909b). The type was not found in the collection. There is, however, one specimen, labeled "Eastport, Me., 1870," which may be this animal, although the writer is more inclined to consider it merely an abnormal specimen of *P. prunum*. The body is obliquely flattened, 21 mm. long and 12.5 mm. wide, and has fairly

prominent siphons which are 11 mm. apart (measuring to centers of apertures). The body is attached by the posterior end which extends into a rather narrow prolongation about 7 mm. long. The test is smooth and semitransparent; the branchial sac has intermediate papillae, and the alimentary tract is large, the intestine being strongly curved and the rectum ascending close to the descending part of the intestine.

Family CIONIDAE Lahille, 1887.

Body elongated; branchial aperture regularly with eight lobes; atrial with six lobes.

Conspicuous parallel longitudinal muscle bands on each side of the body.

Tentacles simple.

Dorsal lamina broken up into a series of languets.

Branchial sac without folds, but with internal longitudinal vessels bearing papillae.

Stigmata straight.

Intestine largely posterior to the branchial sac.

Reproductive organs in the intestinal loop.

Genus CIONA Fleming, 1822.

This is the only genus of the family. It is of wide distribution but is very difficult to divide into well marked species, and recent writers treat most of those which have been described as merely synonyms of the well known and abundant European species *Ciona intestinalis* (Linnaeus) which is thus given an almost world-wide distribution. This solution of the question is, however, not entirely satisfactory, for the species certainly exhibits considerable local variation.

The two species described from the New England region, *C. tenella* (Stimpson), type locality, Grand Manan, N. B., and *C. ocellata* (Agassiz), type locality, New Bedford, Mass., are among those which Hartmeyer (1903, 1909b) reduces to the category of synonyms of *C. intestinalis*. In favor of this course the writer must admit that he is not aware of any anatomical differences separating *tenella* and *ocellata* from the European *intestinalis* or from each other, and that differences in external characters are very likely to be merely the direct effect of local conditions and not necessarily a proof of differences of race. On the other hand, though many specimens of both *tenella* and *ocel-*

*lata* are in the collections, they are for the most part so poorly preserved that anatomical differences might easily escape notice, and the writer is familiar only with the southern form (*ocellata*) in a fresh state, never having himself collected the northern form (*tenella*). Professor Verrill assures the writer that when fresh there is a noticeable difference between the two, *tenella* though occasionally as large as the other form, averaging of smaller size (usually not over 30 mm. or 40 mm. long) and being of softer and more flaccid consistency than *ocellata*, which often becomes 60 mm. or more long and has a firmer, more rigid test. Even in alcoholic specimens these differences are often noticeable, though the circumstances of collection and preservation may greatly alter the character of the test. The writer would not attribute the weight of specific characters to these differences, yet under the circumstances he does not feel justified in ignoring them entirely, and in giving the synonymy and the distribution of this genus in the New England region will distinguish between the northern and the southern forms by using the names *tenella* and *ocellata* for varieties. The relations of these forms to those of the other parts of the world cannot be determined without the comparison of more material than has yet been available, and the writer must leave that part of the question unsettled.

In both forms the body is elongated oblong and generally somewhat tapering toward the anterior end, and compressed laterally, adhering by the larger (posterior) end; the orifices on short tubes, near together, the branchial the larger and terminal, the atrial smaller and more to one side. Most specimens are, however, more or less distorted and unsymmetrical, and in preserved specimens this is further increased by the unequal contraction of the muscles. The test is of varying thickness, more or less transparent, showing clearly the mantle (which is pale yellowish during life) with its muscle bands, as well as the alimentary and reproductive organs. The branchial orifice has eight, and the anal orifice six red or orange spots (ocelli) about its margin, but these fade out in preserved specimens.

The musculature of the mantle is one of the most conspicuous characters. There are a number of broad strong longitudinal bands on each side extending nearly the whole length of the body. Outside these are fairly numerous but very narrow circular muscles, not gathered into definite bands. The sphincters of the siphons are well developed.

Tentacles simple, rather numerous and of three sizes arranged with some regularity.

Dorsal tubercle C-shaped with incurved or inrolled horns.

Dorsal lamina replaced by a row of numerous narrow tentacle-like languets.

Branchial sac without folds, though a slight degree of minute fluting or plication is sometimes noticeable. Transverse vessels numerous, of two sizes placed alternately, the smaller ones crossing without interrupting the stigmata. Internal longitudinal vessels numerous but slender; they bear long curved papillae at the intersections with all of the transverse vessels. The papillae at the intersections with the smaller vessels are slightly smaller than the others. A membrane is borne on the concave side of each papilla. The number of stigmata intervening between adjacent internal longitudinal vessels is very variable in different individuals as well as in different parts of the sac of the same one, but averages greater in large than in small or immature specimens. It varies from four or six in the latter, to six, seven, or occasionally eight in the former.

Stomach small and short with a small number of moderately distinct longitudinal folds in its wall. Intestinal loop small, the rectum long.

Ovary a pear-shaped mass, sometimes partly cleft into a few lobes, occupying the space in the loop of the intestine. At its narrow (dorsal) end it tapers off into the long, wide, tubular oviduct which accompanies the rectum, lying along its left dorsal side. The oviduct often becomes greatly distended with eggs, these apparently remaining in it some time. The testis consists of a great number of small pyriform or more or less lobed glands connected by branching ducts, and ramifies over more or less of the surface of the intestinal loop and stomach, its duct uniting to form a common sperm duct which lies along the dorsal edge of the oviduct.

***Ciona intestinalis* (Linnaeus).**

Pl. 66, fig. 130; text-fig. 43.

1767. *Ascidia intestinalis* Linnaeus, Syst. Nat., ed. 12, pt. 2, p. 1087, no. 3.

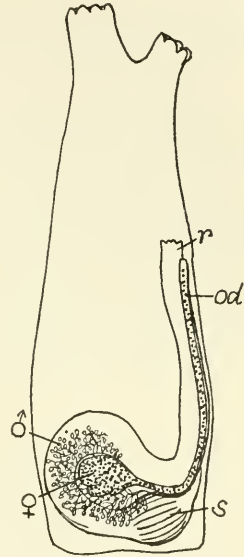
1828. *Ciona intestinalis* Fleming, British Animals, p. 468.

Said to be found in most parts of the world. In the Arctic regions replaced by an elongated pediceled variety (var. *longissima* Hartmeyer,

1899). The following notes and references refer only to the two above-mentioned forms of this animal which occur in the New England region.

Var. *tenella* (Stimpson).

1838. *Ascidia intestinalis* Couthouy, Boston Journ. Nat. Hist., vol. 2, p. 111.
1843. *Ascidia intestinalis* DeKay, Zool. New York, Mollusca, p. 259.
1852. *Ascidia tenella* Stimpson, Proc. Boston Soc. Nat. Hist., vol. 4, p. 228.
1854. *Ascidia tenella* Stimpson, Smithsonian Contr., vol. 6, p. 20.
1860. *Ascidia tenella* Stimpson, Smithsonian Check-list, p. 2.
1870. *Ascidia tenella* Binney, Gould's Invertebrata of Massachusetts, ed. 2, p. 24.
1870. *Ascidia tenella* Dall, Proc. Boston Soc. Nat. Hist., vol. 13, p. 255.
1870. *Ascidia tenella* (part) Verrill, Amer. Journ. Sci., ser. 2, vol. 49, p. 424.
1871. *Ciona tenella* Verrill, Amer. Journ. Sci., ser. 3, vol. 1, p. 99, figs. 12, 13.
1872. *Ciona tenella* Verrill, Bull. Essex Inst., vol. 3, p. 6.
1872. *Ciona tenella* (part) Verrill, Amer. Journ. Sci., ser. 3, vol. 3, p. 213.
1873. *Ciona tenella* Verrill, Amer. Journ. Sci., ser. 3, vol. 6, p. 435.
1873. *Ciona tenella* (part) Verrill and Smith, Rept. on Invertebrate Animals of Vineyard Sound, p. 698.
1873. *Ciona tenella* Verrill, Amer. Journ. Sci., ser. 3, vol. 6, p. 440.
1874. *Ciona tenella* Verrill, Proc. Amer. Assoc. Adv. Sci., vol. 22, pp. 352, 363.
1874. *Ciona tenella* Verrill, Amer. Journ. Sci., ser. 3, vol. 7, pp. 413, 504.
1880. *Ciona tenella* Verrill, Amer. Journ. Sci., ser. 3, vol. 20, p. 251.
1891. *Ascidia tenella* Herdman, Journ. Linn. Soc. London, Zool., vol. 23, p. 599.
1896. *Ciona intestinalis* (part) Castle, Bull. Mus. Comp. Zool., vol. 27, no. 7, p. 203.
1901. *Ciona tenella* Kingsley, Proc. Portland Soc. Nat. Hist., vol. 2, p. 183.
1901. *Ciona tenella* Whiteaves, Geol. Survey Canada, publ. no. 722, p. 267.
1903. *Ciona intestinalis* (part) Hartmeyer, in Römer and Schaudinn, Fauna Arctica, vol. 3, p. 298.
1909. *Ciona intestinalis* (part) Hartmeyer, Bronn's Tier-reich, vol. 3, suppl., p. 1414.



Text-fig. 43.—*Ciona intestinalis* (Linnaeus)  $\times 2$ .

Verrill (1871a, p. 99) thus describes the colors from Eastport specimens:

“Branchial orifice — with eight light orange eye-spots; from the angles between the eyes, light conspicuous white lines pass down the sides. Anal orifice — with six conspicuous eye-spots, like those of the branchial orifice.

“Color transparent whitish, with flake-white lines; mantle transparent, with whitish dendritic markings, not spotted, pale yellowish, deeper above.”

Distribution from Massachusetts Bay northward. Gulf of Saint Lawrence; off Nova Scotia (Station 2506, N. lat.  $44^{\circ} 26'$ , W. long.  $62^{\circ} 10'$ , 127 fathoms, dark brown mud); Grand Manan, N. B.; Eastport, Me.; Casco Bay, Me., 8 to 64 fathoms; Isles of Shoals, N. H.; Station 23 (off Eastern Point, Mass., 35 fathoms, mud and clay nodules).

Type locality, Grand Manan, N. B.

Var. *ocellata* (Agassiz).

1850. *Ascidia ocellata* Agassiz, Proc. Amer. Assoc. Adv. Sci., vol. 2, p. 159.  
 1870. *Ascidia ocellata* Binney, Gould's Invertebrata of Massachusetts, ed. 2, p. 24, pl. 24, fig. 332.  
 1870. *Ascidia ocellata* (part) Proc. Boston Soc. Nat. Hist., vol. 13, p. 255.  
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 1873. *Ascidia tenella* (part) Verrill and Smith, Rept. on Invertebrate Animals of Vineyard Sound, p. 698.  
 1880. *Ciona ocellata* Verrill, Amer. Journ. Sci., ser. 3, vol. 20, p. 251.  
 1889. *Ciona ocellata* MacDonald, Rept. U. S. Comm. Fish and Fisheries for 1886, p. 858.  
 1891. *Ascidia ocellata* Herdman, Journ. Linn. Soc. London, Zool., vol. 23, p. 599.  
 1896. *Ciona intestinalis* (part) Castle, Bull. Mus. Comp. Zool., vol. 27, no. 7, p. 203.  
 1900. *Ciona tenella* Metcalf, Zool. Jahrbücher, Anat., vol. 13, p. 499.  
 1903. *Ciona intestinalis* (part) Hartmeyer, in Römer and Schaudinn, Fauna Arctica, vol. 3, p. 298.  
 1909. *Ciona intestinalis* (part) Hartmeyer, Bronn's Tier-reich, vol. 3, suppl., p. 1414.

Verrill (1880) says of this variety:

“Occurs in abundance at Newport, both on the rocks and on the piles of wharves, at low water, and on dead shells to the depth of 20 fathoms . . . It grows to a length of four or five inches, and about an inch in diameter. It is very translucent, allowing the internal organs

to be well seen through the pale greenish or yellowish-white test. It is generally attached by the base and lower part of one side. The apertures are surrounded by a circle of bright lemon-yellow, and the ocelli are bright red. There are also two bright red spots connected with the nervous ganglia. The *Ciona tenella* (Stimpson) which is common in the Bay of Fundy has the circle around the aperture bright red."

*Distribution.*—Region about Wood's Hole, Mass., New Bedford, Mass. (type locality), Newport, R. I., and other points in Narragansett Bay. It is worthy of mention that Professor Verrill never found it near Wood's Hole, and it may now be more common than formerly in that region.

The writer is at a loss to which of the two New England varieties to refer specimens from Station 872 (N. lat.  $40^{\circ} 05' 39''$ , W. long.  $70^{\circ} 23' 52''$ , 86 fathoms, sand, gravel, shells, and sponge) and Station 1109 (N. lat.  $40^{\circ} 03'$ , W. long.  $70^{\circ} 38'$ , 89 fathoms, gray sand).

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EXPLANATION OF PLATES.

PLATE 43.

- Fig. 1. *Bostrichobranchnus pilularis* (Verrill). Tentacles.  $\times 40$ .  
Fig. 2. *Bostrichobranchnus pilularis* (Verrill). Dorsal tubercle.  $\times 28$ .  
Fig. 3. *Bostrichobranchnus pilularis* (Verrill). Part of branchial sac of immature individual from Station 72.  $\times 43$ .  
Fig. 4. *Bostrichobranchnus pilularis* (Verrill). Intestinal loop and gonad.  $\times 20$ .

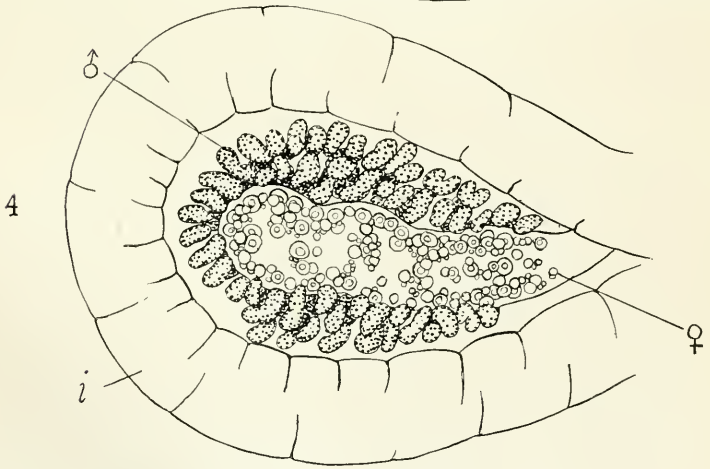
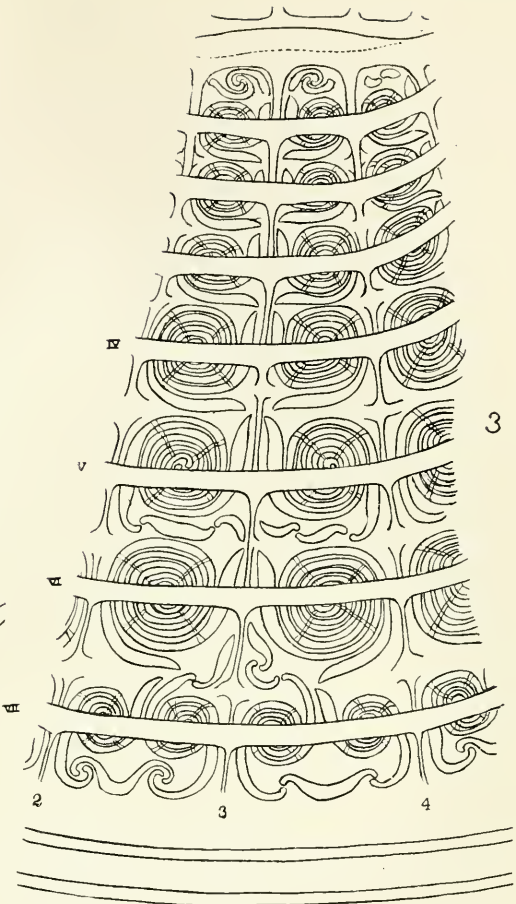
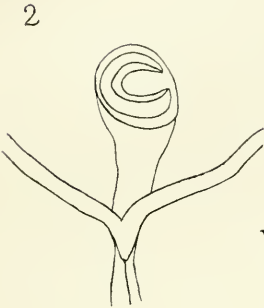






PLATE 44.

- Fig. 5. *Bostrichobranchus pilularis* (Verrill). Camera-lucida drawing of part of the branchial sac of an individual of moderate size from Casco Bay, Maine.  $\times 38$ .
- Fig. 6. *Bostrichobranchus pilularis* (Verrill). One field of the branchial sac of a very large individual from off Race Point, Massachusetts.  $\times 23$ .

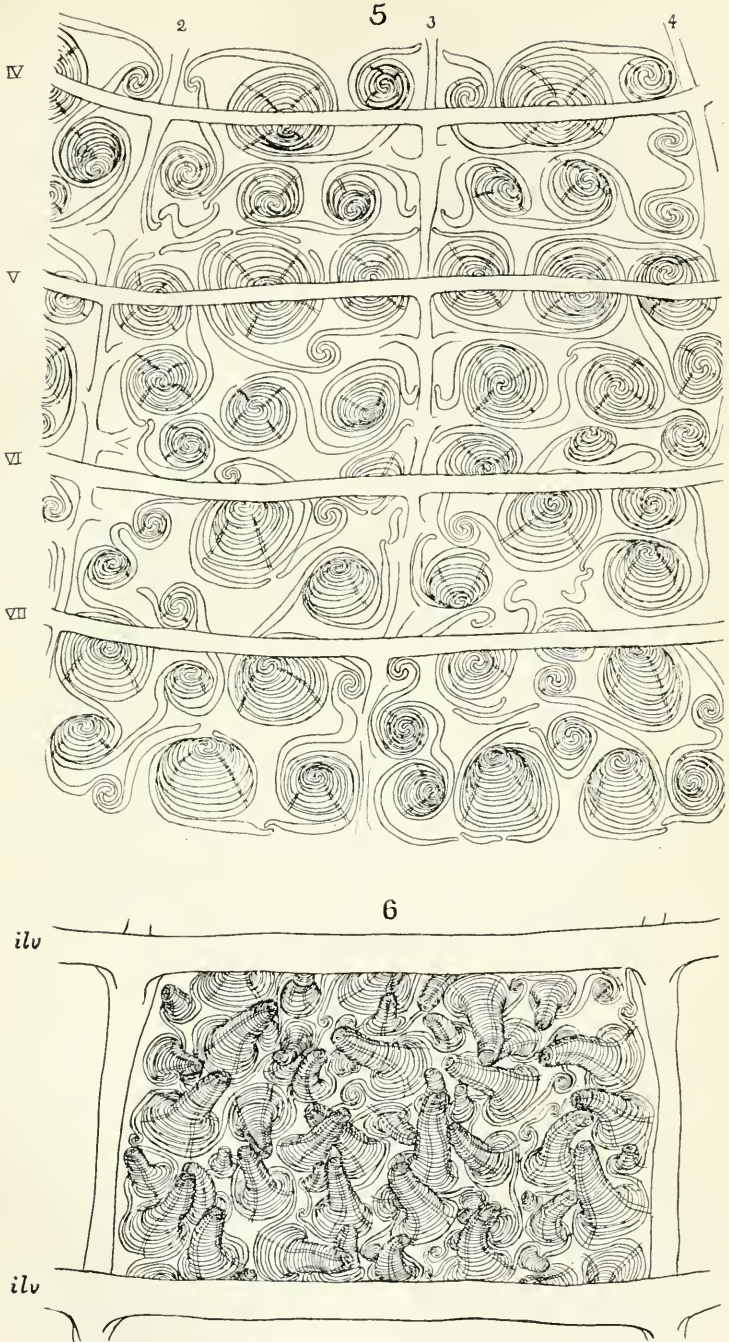






PLATE 45.

- Fig. 7. *Caesira lutulenta*, sp. nov. Tentacles.  $\times 25$ .  
Fig. 8. *Caesira lutulenta*, sp. nov. Right gonad and outline of kidney.  
 $\times 9$ .  
Fig. 9. *Caesira lutulenta*, sp. nov. Left gonad.  $\times 9$ .  
Fig. 10. *Caesira lutulenta*, sp. nov. Dorsal tubercle.  $\times 22$ .  
Fig. 11. *Caesira manhattensis* (DeKay). Right gonad (side next to mantle).  
 $\times 14$ .  
Fig. 12. *Caesira manhattensis* (DeKay). Tentacles.  $\times 25$ .  
Fig. 13. *Caesira manhattensis* (DeKay). Dorsal tubercle.  $\times 22$ .

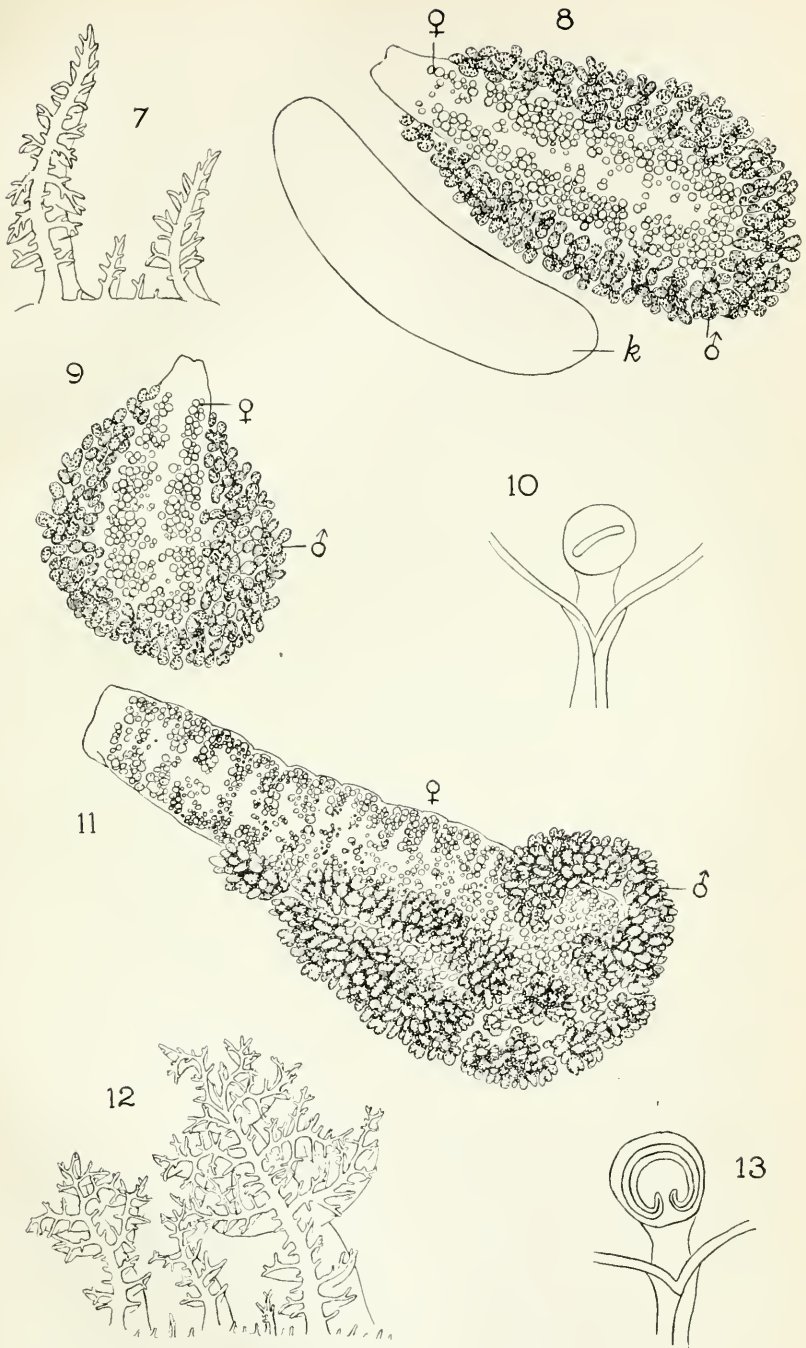






PLATE 46.

- Fig. 14. *Caesira septentrionalis* (Traustedt). Left gonad and outline of intestinal loop.  $\times 7$ .
- Fig. 15. *Caesira septentrionalis* (Traustedt). Right gonad and outline of kidney.  $\times 7$ .
- Fig. 16. *Caesira septentrionalis* (Traustedt). Tentacles.  $\times 23$ .
- Fig. 17. *Caesira intumescens*, sp. nov. Tentacles.  $\times 18$ .
- Fig. 18. *Caesira intumescens*, sp. nov. Right gonad and outline of kidney.  $\times 8$ .
- Fig. 19. *Caesira intumescens*, sp. nov. Dorsal tubercle.  $\times 17$ .
- Fig. 20. *Caesira intumescens*, sp. nov. Part of branchial sac. Ventral region.  $\times 14$ .

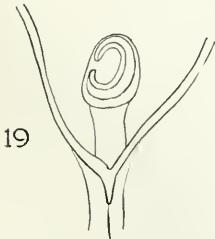
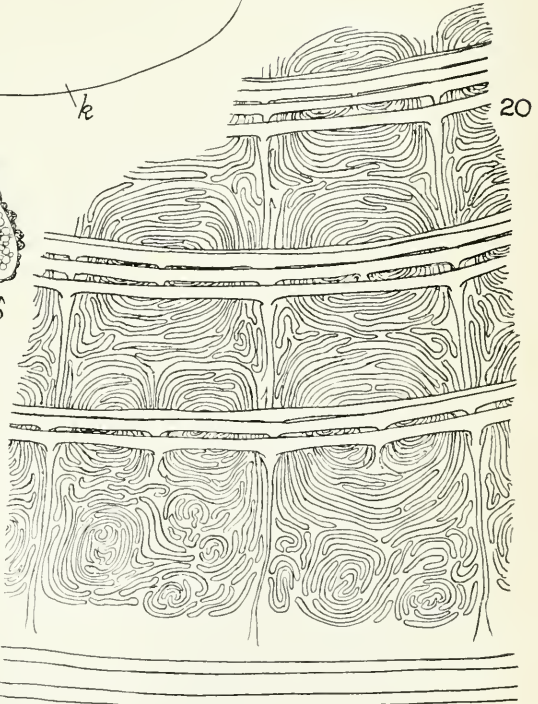
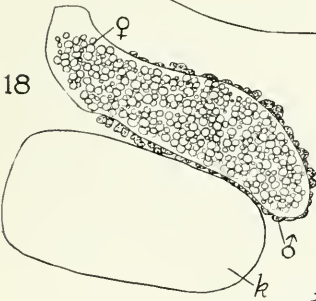
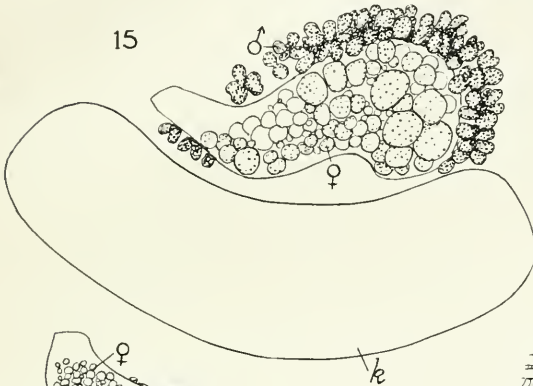
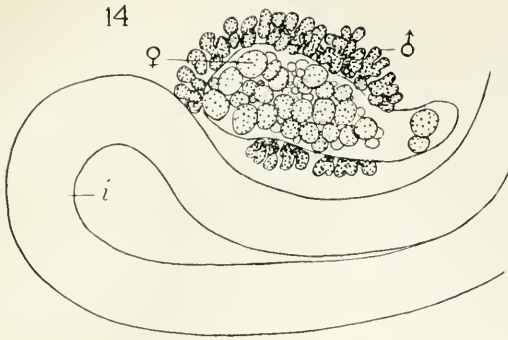






PLATE 47.

- Fig. 21. *Caesira pannosa* (Verrill). Large tentacle from a large specimen.  
× 28.
- Fig. 22. *Caesira pannosa* (Verrill). Part of branchial sac. × 21.
- Figs. 23 and 24. *Caesira pannosa* (Verrill). Dorsal tubercles of two individuals. × 21.

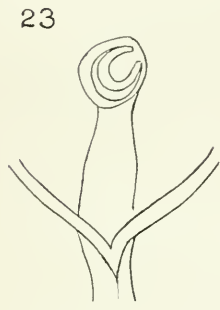
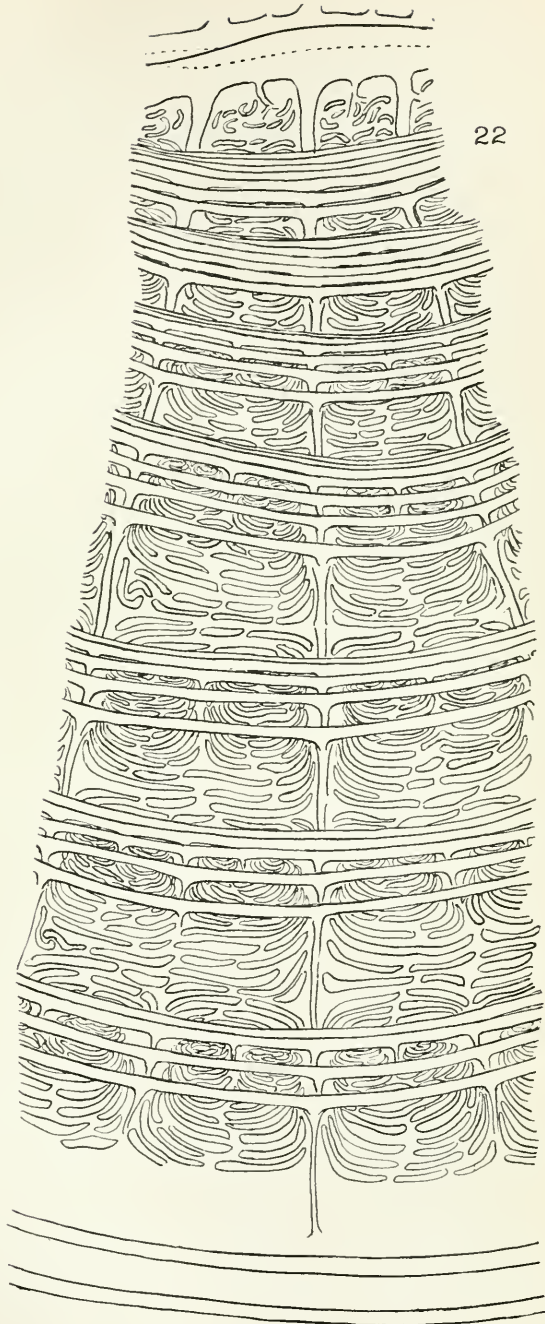






PLATE 48.

- Fig. 25. *Caesira pannosa* (Verrill). Left gonad and outline of intestinal loop, from rather small individual.  $\times 5$ .
- Fig. 26. *Caesira citrina* (Alder and Hancock). Dorsal tubercle.  $\times 25$ .
- Fig. 27. *Caesira citrina* (Alder and Hancock). End of intestine.  $\times 25$ .
- Fig. 28. *Caesira citrina* (Alder and Hancock). Left gonad and outline of intestinal loop.  $\times 15$ .
- Fig. 29. *Caesira citrina* (Alder and Hancock). Right gonad and outline of kidney.  $\times 15$ .
- Fig. 30. *Caesira citrina* (Alder and Hancock). Large tentacle.  $\times 35$ .
- Fig. 31. *Caesira crystallina* (Möller). Tentacles.  $\times 57$ .
- Fig. 32. *Caesira crystallina* (Möller). Dorsal tubercle.  $\times 13$ .
- Fig. 33. *Caesira crystallina* (Möller). Right gonad and outline of kidney.  $\times 13$ .

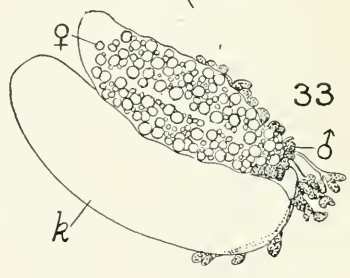
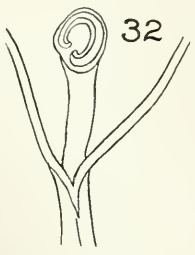
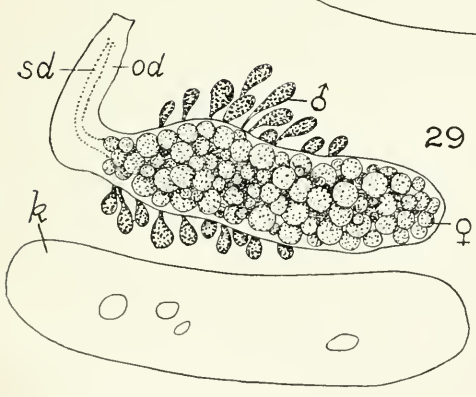
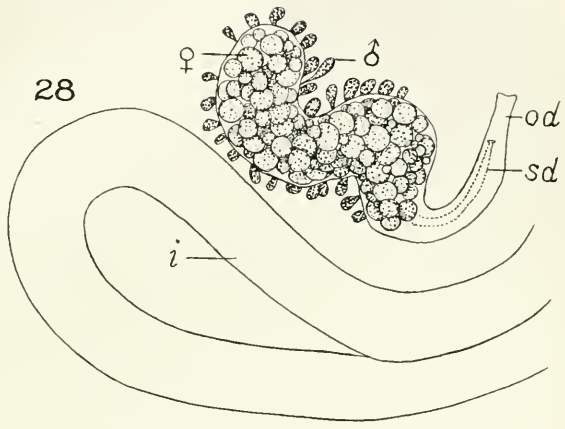
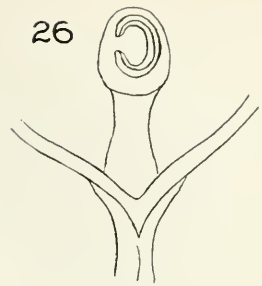
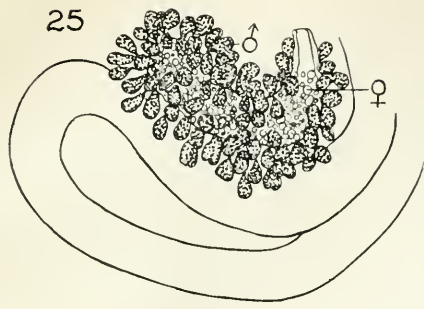






PLATE 49.

- Fig. 34. *Caesira papillosa* (Verrill). Left gonad of specimen from Station 372.  $\times 21$ .
- Fig. 35. *Caesira papillosa* (Verrill). Dorsal tubercle of specimen from Station 2080.  $\times 25$ .
- Fig. 36. *Caesira papillosa* (Verrill). Part of branchial sac (right side) of specimen from Station 372.  $\times 21$ .
- Fig. 37. *Caesira papillosa* (Verrill). Tentacles from specimen from Station 372.  $\times 38$ .
- Fig. 38. *Caesira papillosa* (Verrill). Outline of stomach and hepatic gland of specimen from Station 2080.  $\times 17$ .

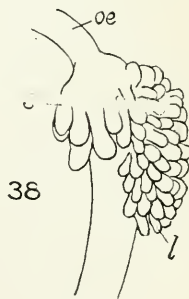
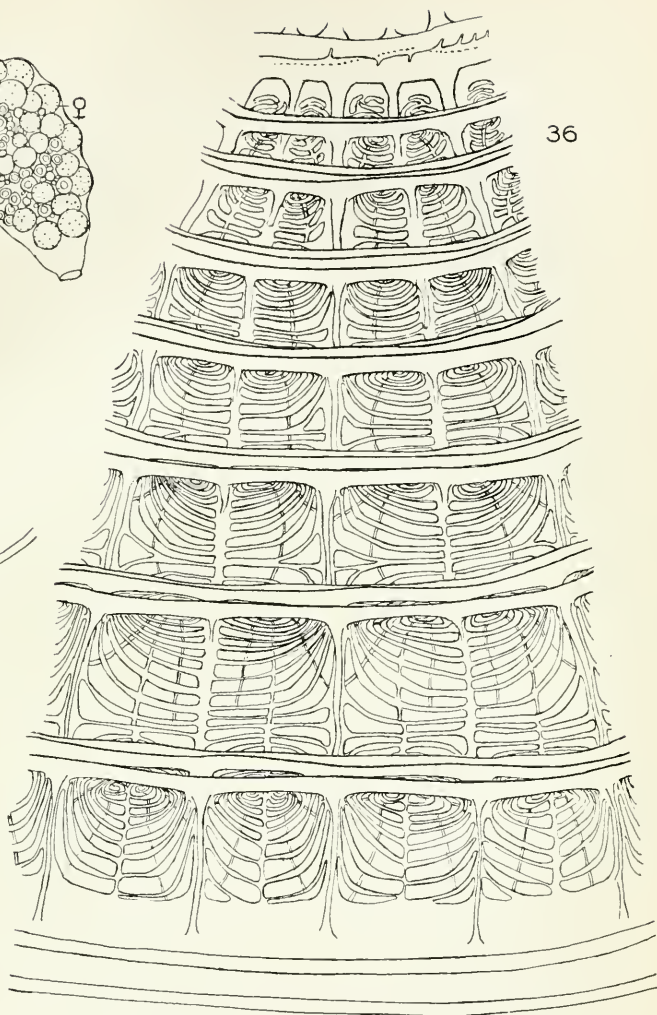
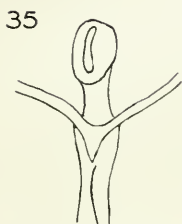






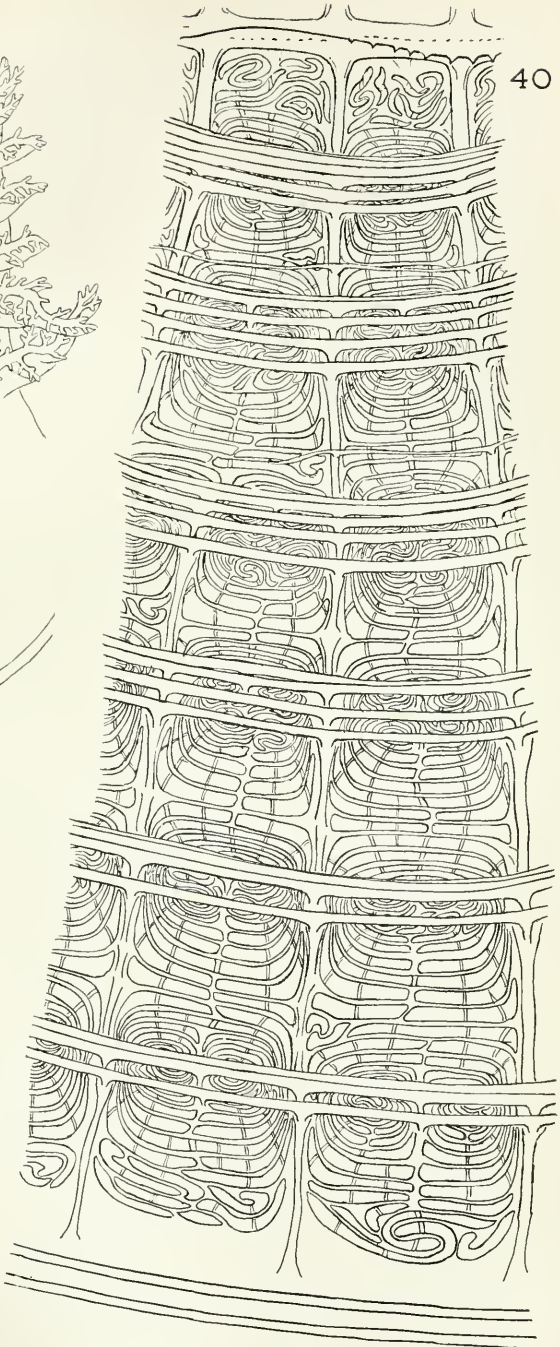
PLATE 50.

- Fig. 39. *Caesira arenata* (Stimpson). Large tentacle from rather large individual.  $\times 17$ .
- Fig. 40. *Caesira arenata* (Stimpson). Part of right side of branchial sac.  $\times 19$ .
- Figs. 41 and 42. *Caesira arenata* (Stimpson). Dorsal tubercles of two individuals. Fig. 42 shows the usual form.  $\times 19$ .

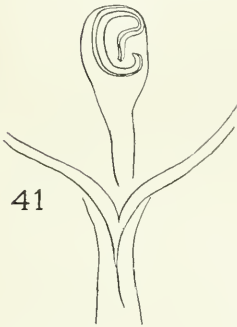
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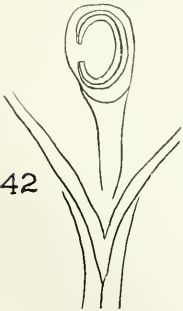






PLATE 51.

- Fig. 43. *Caesira robusta*, sp. nov. Large tentacle.  $\times 18$ .  
Fig. 44. *Caesira robusta*, sp. nov. Dorsal tubercle of large specimen.  $\times 10$ .  
Fig. 45. *Caesira robusta*, sp. nov. Posterior ends of several internal longitudinal vessels showing teeth.  $\times 18$ .  
Fig. 46. *Caesira robusta*, sp. nov. Left gonad of large specimen with outline of intestinal loop.  $\times 6$ .  
Fig. 47. *Caesira robusta*, sp. nov. Right gonad of large specimen with outline of kidney.  $\times 6$ .

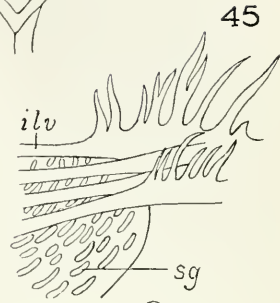






PLATE 52.

- Fig. 48. *Caesira arenata* (Stimpson). Left gonad and outline of intestinal loop.  $\times 9$ .
- Fig. 49. *Caesira arenata* (Stimpson). Right gonad and outline of kidney.  $\times 9$ .
- Fig. 50. *Caesira retortiformis* (Verrill). Dorsal tubercle of medium-sized individual.  $\times 10$ .
- Fig. 51. *Caesira retortiformis* (Verrill). Large tentacle from rather large individual.  $\times 17$ .
- Fig. 52. *Caesira retortiformis* (Verrill). Left gonad and intestinal loop as seen from side next to branchial sac.  $\times 6$ .

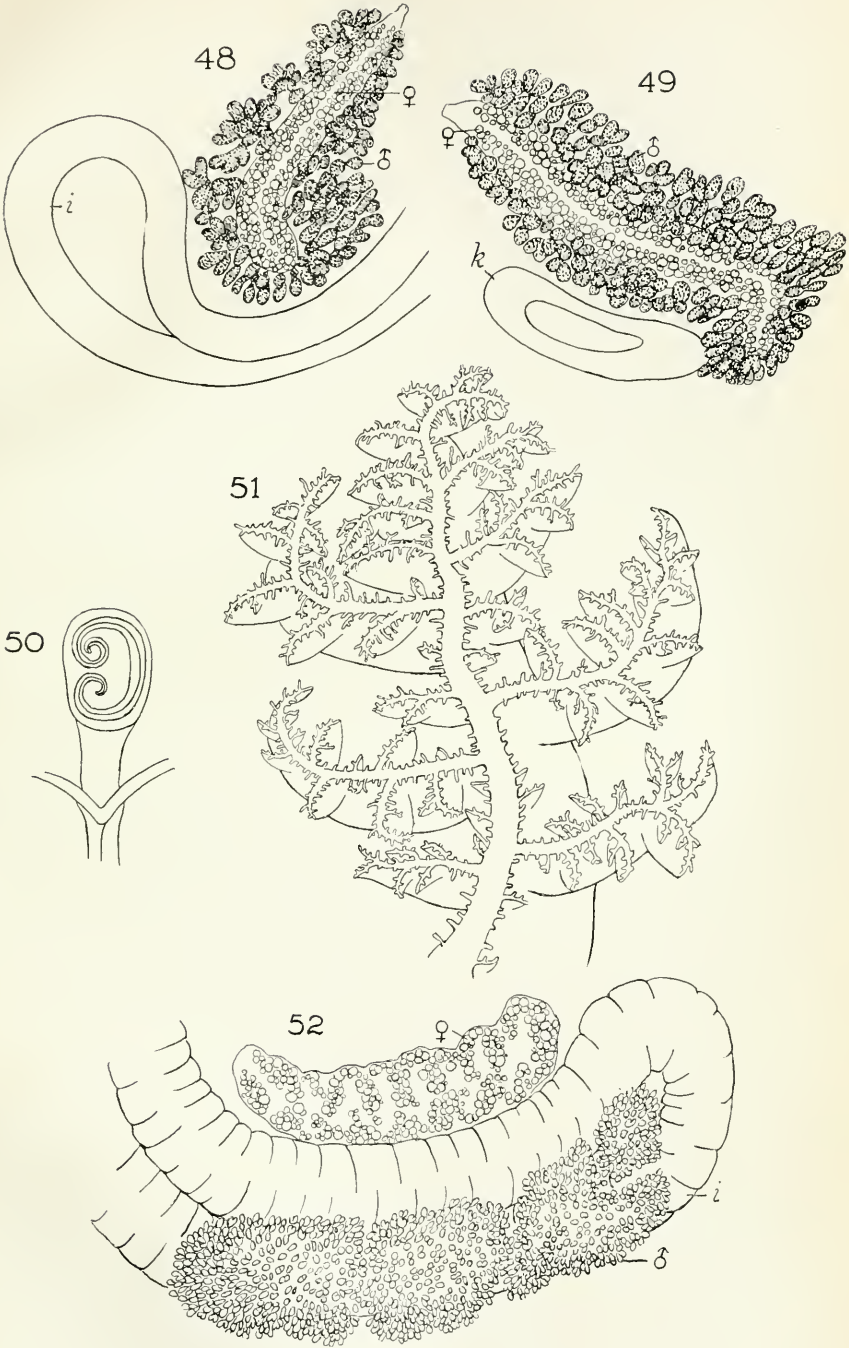






PLATE 53.

- Fig. 53. *Caesira verrilli*, sp. nov. Part of branchial sac.  $\times 23$ .  
Fig. 54. *Caesira verrilli*, sp. nov. Tentacles.  $\times 26$ .  
Fig. 55. *Caesira verrilli*, sp. nov. Dorsal tubercles.  $\times 26$ .  
Fig. 56. *Caesira verrilli*, sp. nov. Right gonad.  $\times 17$ .  
Fig. 57. *Caesira verrilli*, sp. nov. Diagram showing arrangement of stigmata at summit of fold.

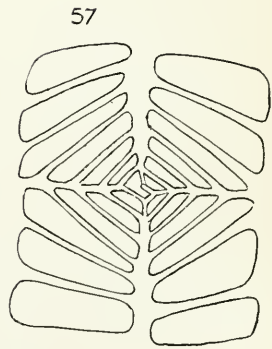
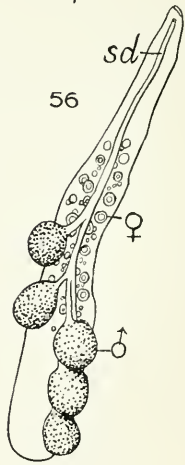
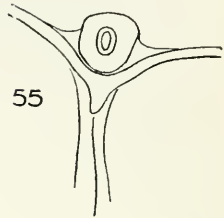
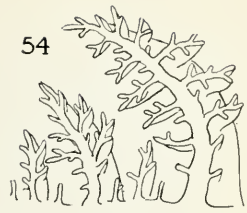
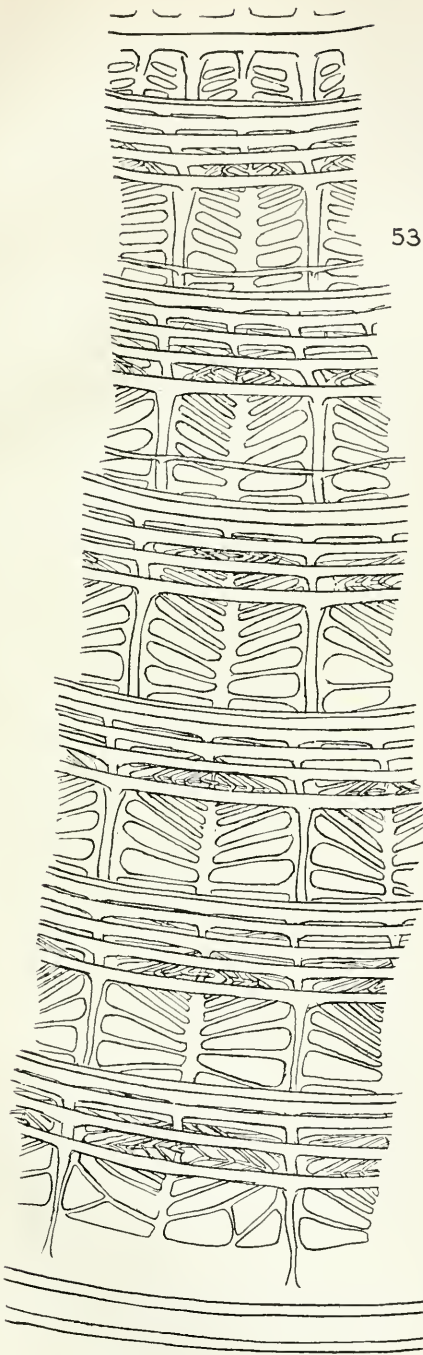






PLATE 54.

- Fig. 58. *Caesira singularis*, sp. nov. Right gonad as seen from side next to mantle.  $\times 14$ .  
Fig. 59. *Caesira singularis*, sp. nov. Dorsal tubercle.  $\times 14$ .  
Fig. 60. *Caesira singularis*, sp. nov. Oral tentacles.  $\times 11$ .  
Fig. 61. *Pyura echinata* (Linnaeus). Dorsal tubercle.  $\times 14$ .  
Fig. 62. *Pyura echinata* (Linnaeus). Oral tentacles.  $\times 8$ .  
Fig. 63. *Pyura echinata* (Linnaeus). Left gonad.  $\times 8$ .  
Fig. 64. *Pyura echinata* (Linnaeus). Part of branchial sac.  $\times 12$ .  
Fig. 65. *Pyura echinata* (Linnaeus). Spinous processes of body.  $\times 9$ .

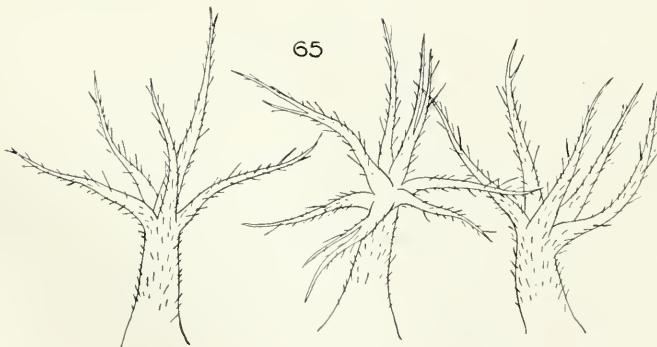
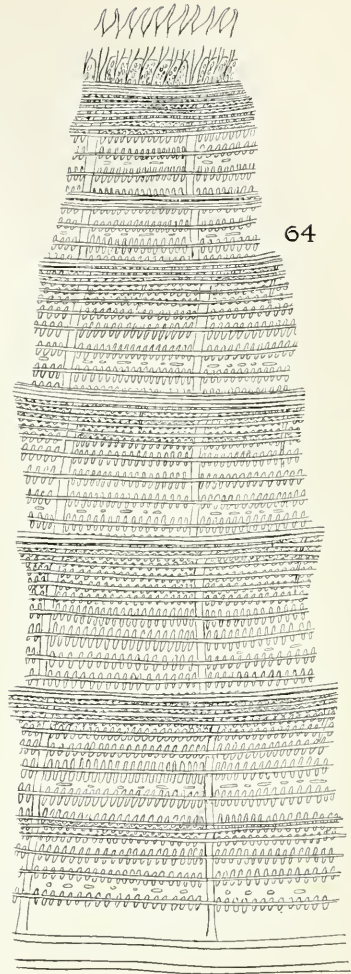
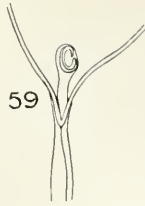
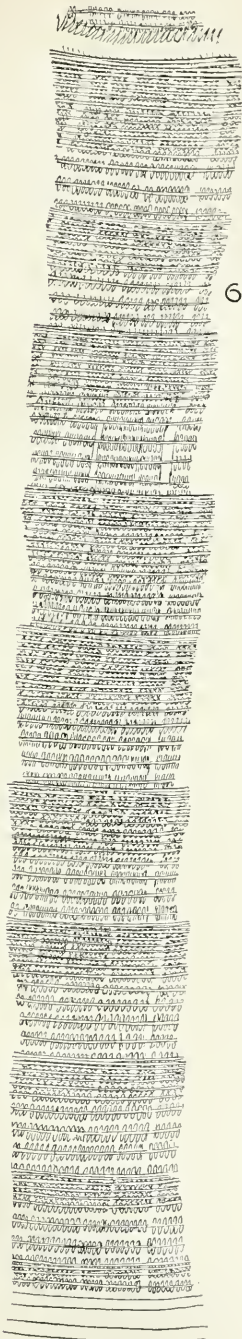






PLATE 55.

- Fig. 66. *Pyura ovifera* (Linnaeus). Part of branchial sac.  $\times 5$ .  
Fig. 67. *Pyura aurantium* (Pallas). Part of branchial sac.  $\times 8$ .



66



67





PLATE 56.

- Fig. 68. *Pyura ovifera* (Linnaeus). One of the smaller (third order) branches of a large tentacle. The numerals show the fourth, fifth, and sixth order branches which it bears.  $\times 37$ .
- Fig. 69. *Pyura ovifera* (Linnaeus). Dorsal tubercle.  $\times 7$ .
- Fig. 70. *Pyura ovifera* (Linnaeus). Part of external surface of a rather small individual showing spines.  $\times 11$ .
- Fig. 71. *Pyura aurantium* (Pallas). Oral tentacles.  $\times 9$ .
- Fig. 72. *Pyura aurantium* (Pallas). Part of external surface of body.  $\times 10$ .
- Fig. 73. *Pyura aurantium* (Pallas). Dorsal tubercle.  $\times 7$ .
- Fig. 74. *Pyura aurantium* (Pallas). Gonad.  $\times 21$ .
- Fig. 75. *Microcosmus nacreus*, sp. nov. Dorsal tubercle.  $\times 8$ .
- Fig. 76. *Microcosmus nacreus*, sp. nov. Oral tentacle.  $\times 9$ .
- Fig. 77. *Microcosmus nacreus*, sp. nov. Left gonad and part of intestinal loop.  $\times 2$ .
- Fig. 78. *Culeolus suhmi* Herdman. Dorsal tubercle.  $\times 8$ .
- Fig. 79. *Culeolus suhmi* Herdman. Processes from border of branchial aperture.  $\times 9$ .
- Fig. 80. *Culeolus suhmi* Herdman. Part of external surface of body.  $\times 7$ .
- Fig. 81. *Culeolus suhmi* Herdman. Oral tentacles.  $\times 9$ .

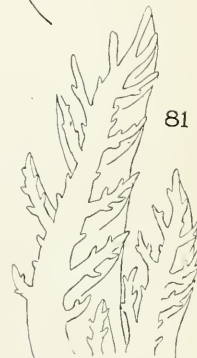
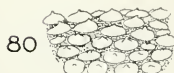
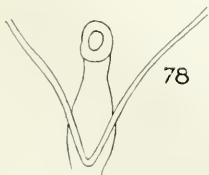
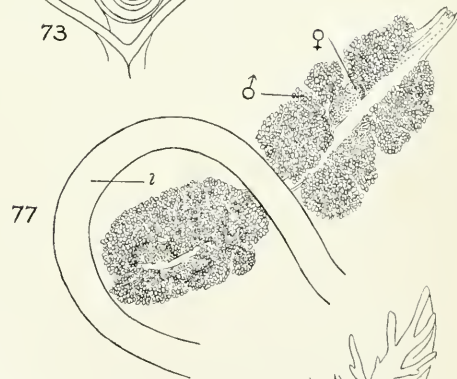
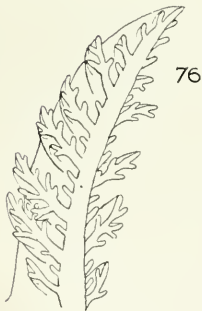
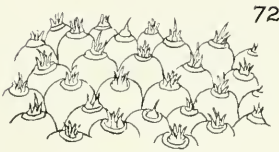
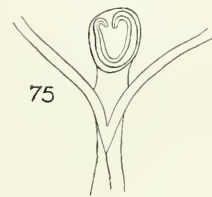
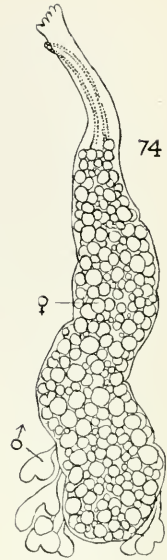
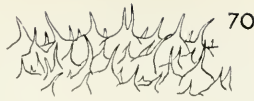






PLATE 57.

- Fig. 82. *Microcosmus nacreus*, sp. nov. Part of branchial sac.  $\times 7$ .  
Fig. 83. *Culeolus suhmi* Herdman. Part of branchial sac.  $\times 8$ .

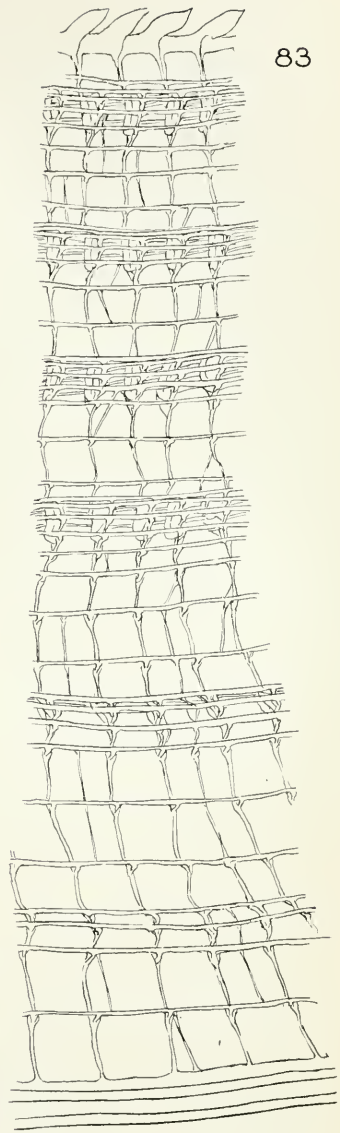
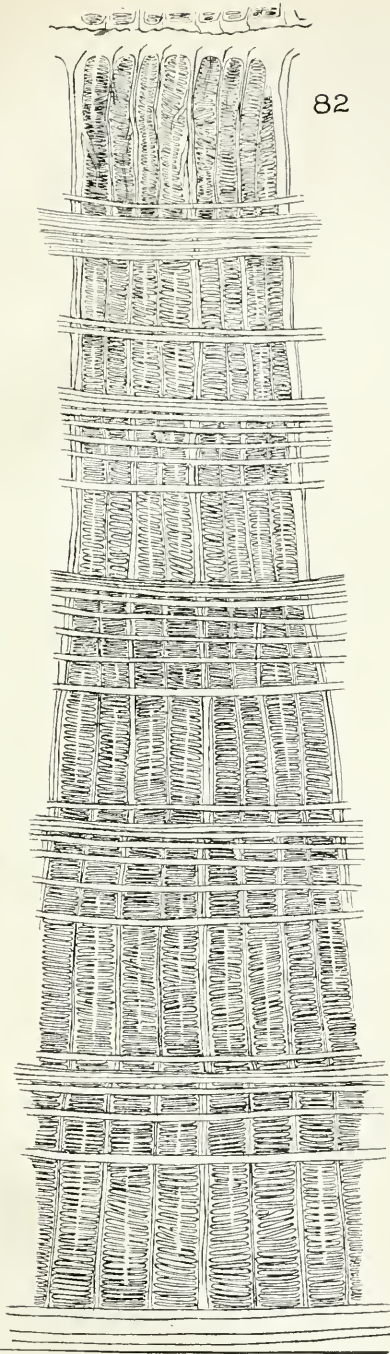






PLATE 58.

- Fig. 84. *Peloniaia corrugata* Goodsir and Forbes. Part of branchial sac.  
× 26.
- Fig. 85. *Peloniaia corrugata* Goodsir and Forbes. Small part of gonad as  
seen from side next to mantle. × 26.
- Fig. 86. *Tethyum coriaceum* (Alder and Hancock). Dorsal tubercle. × 15.
- Fig. 87. *Tethyum coriaceum* (Alder and Hancock). Part of branchial sac.  
× 20.
- Fig. 88. *Tethyum coriaceum* (Alder and Hancock). Right gonad as seen  
from side lying against branchial sac. × 5.

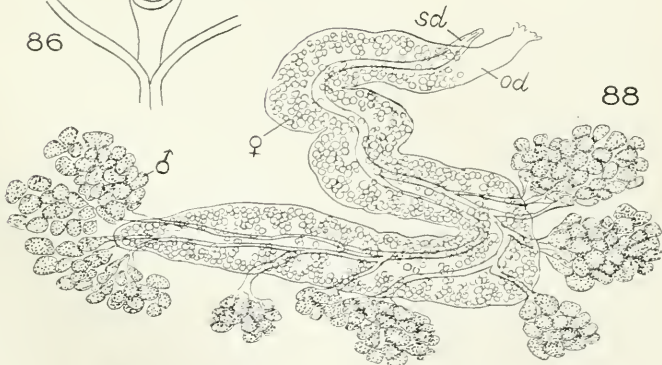
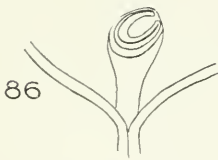
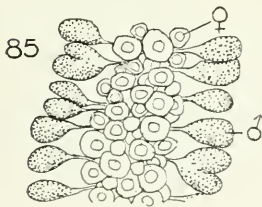
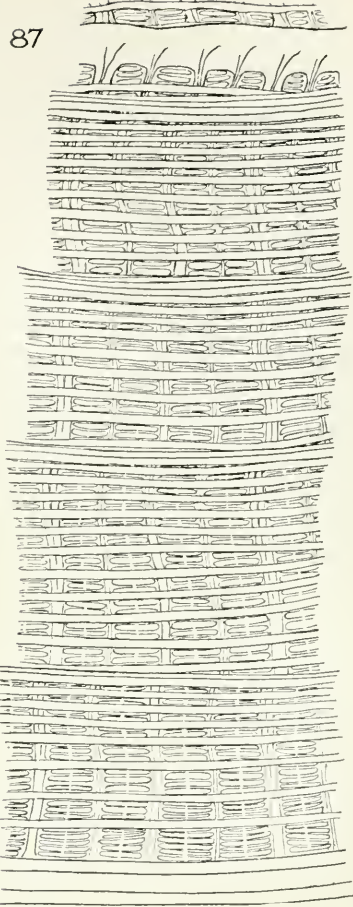
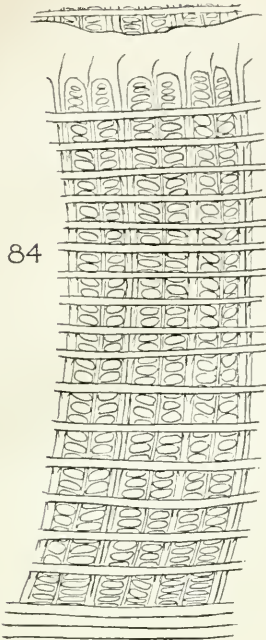






PLATE 59.

- Fig. 89. *Tethyum rusticum* (Linnaeus). Part of branchial sac.  $\times 10$ .  
Fig. 90. *Tethyum rusticum* (Linnaeus). Part of gonad.  $\times 9$ .  
Fig. 91. *Tethyum rusticum* (Linnaeus). Dorsal tubercle.  $\times 11$ .  
Fig. 92. *Tethyum atlanticum*, sp. nov. One of the gonads as seen from side next to mantle.  $\times 6$ .  
Fig. 93. *Tethyum atlanticum*, sp. nov. Dorsal tubercle.  $\times 9$ .  
Fig. 94. *Tethyum partitum* (Stimpson). Dorsal tubercle.  $\times 9$ .  
Fig. 95. *Tethyum partitum* (Stimpson). One of the right gonads as seen from side next to mantle.  $\times 8$ .

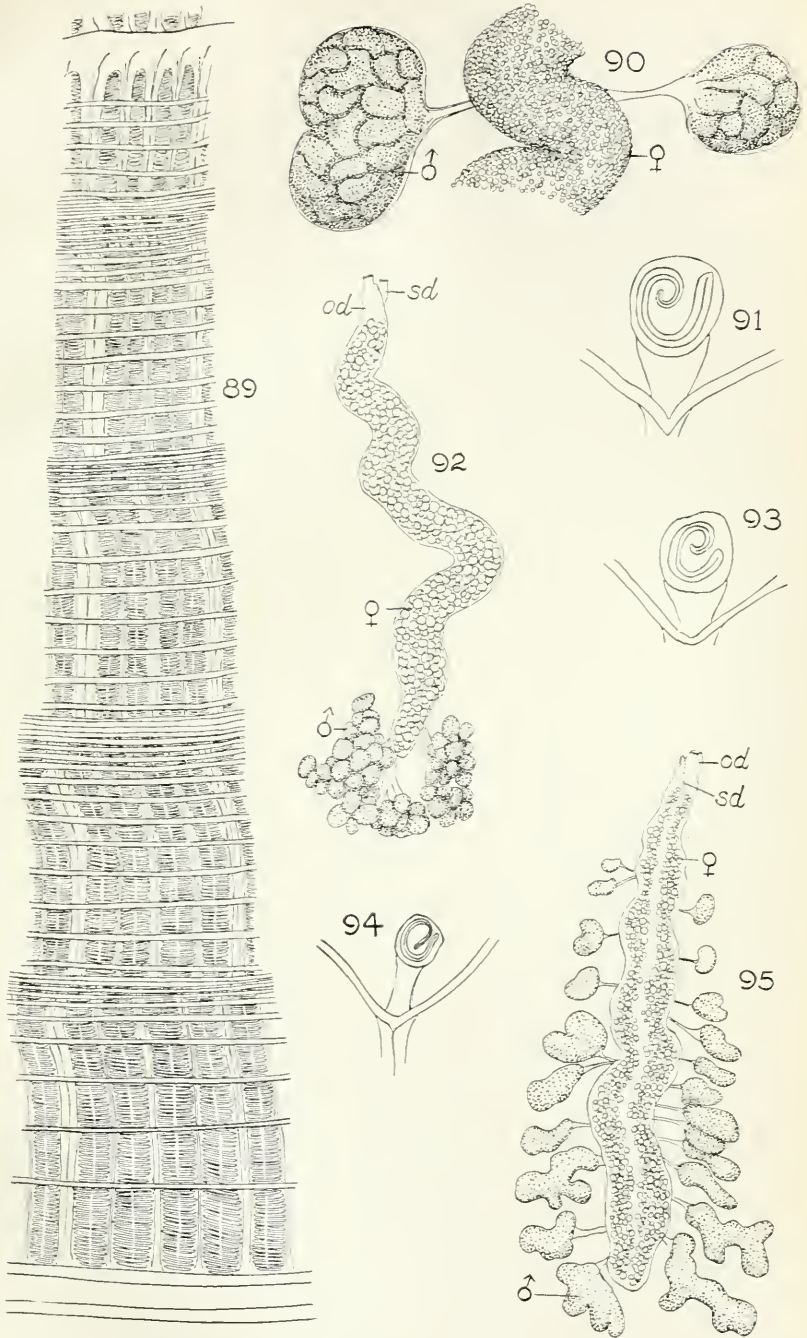






PLATE 60.

- Fig. 96. *Tethyum atlanticum*, sp. nov. Part of branchial sac.  $\times 14$ .  
Fig. 97. *Tethyum partitum* (Stimpson). Part of branchial sac.  $\times 14$ .

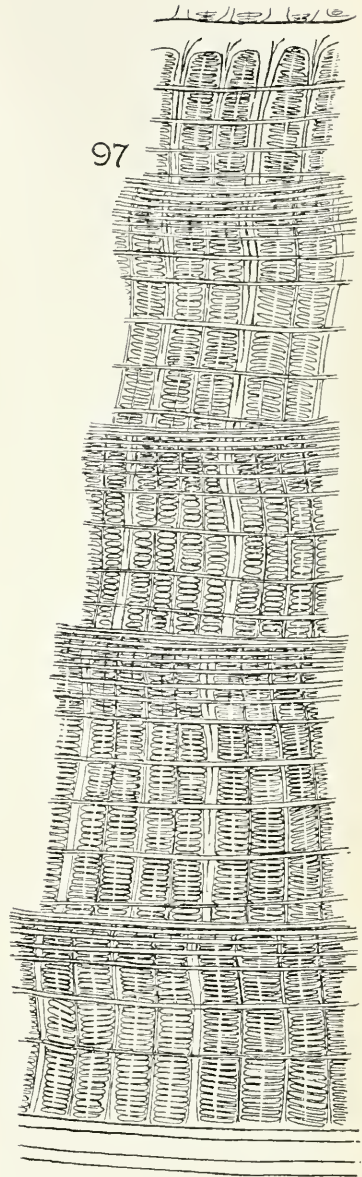
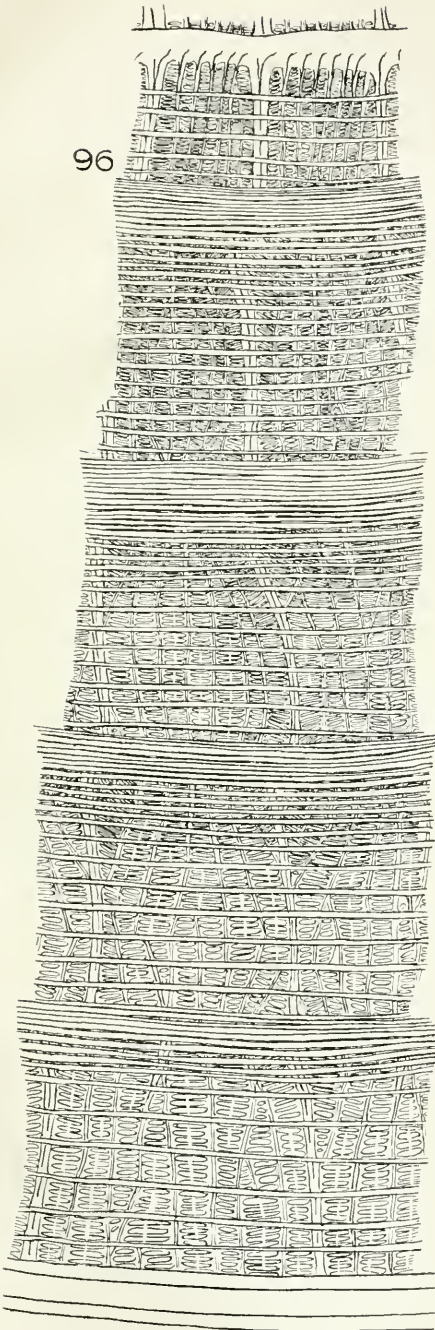
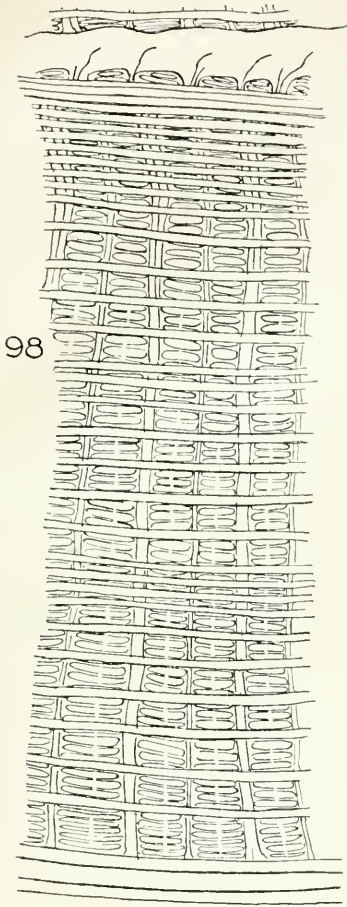




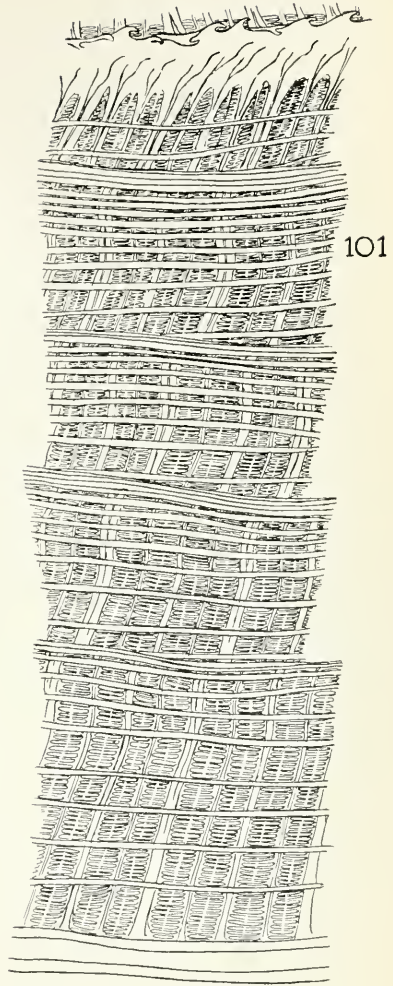


PLATE 61.

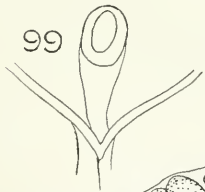
- Fig. 98. *Tethyum mortenseni* Hartmeyer. Part of branchial sac.  $\times 15$ .  
Fig. 99. *Tethyum mortenseni* Hartmeyer. Dorsal tubercle.  $\times 26$ .  
Fig. 100. *Tethyum mortenseni* Hartmeyer. Gonad as seen from side next to  
branchial sac.  $\times 20$ .  
Fig. 101. *Tethyum finmarkiense* (Kiaer). Part of branchial sac.  $\times 15$ .  
Fig. 102. *Tethyum finmarkiense* (Kiaer). Dorsal tubercle.  $\times 12$ .  
Fig. 103. *Tethyum finmarkiense* (Kiaer). Gonad as seen from side next to  
mantle.  $\times 15$ .



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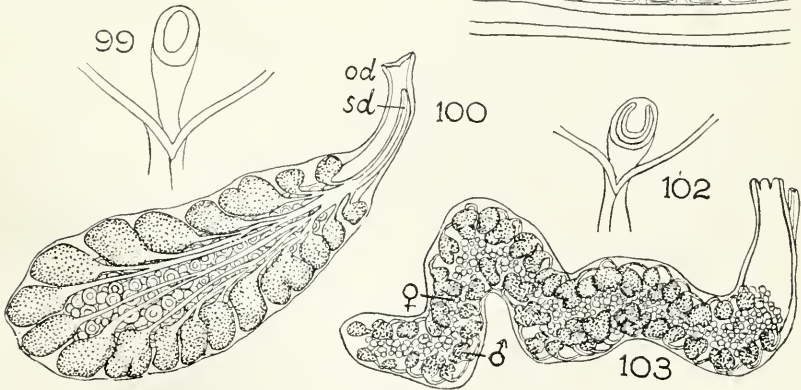
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103





PLATE 62.

- Fig. 104. *Tethyum plicatum* (Lesueur). Part of branchial sac.  $\times 13$   
Fig. 105. *Tethyum plicatum* (Lesueur). Dorsal tubercle.  $\times 13$ .  
Fig. 106. *Tethyum molle* (Stimpson). Part of branchial sac.  $\times 25$ .

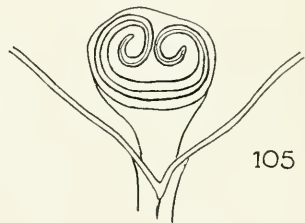
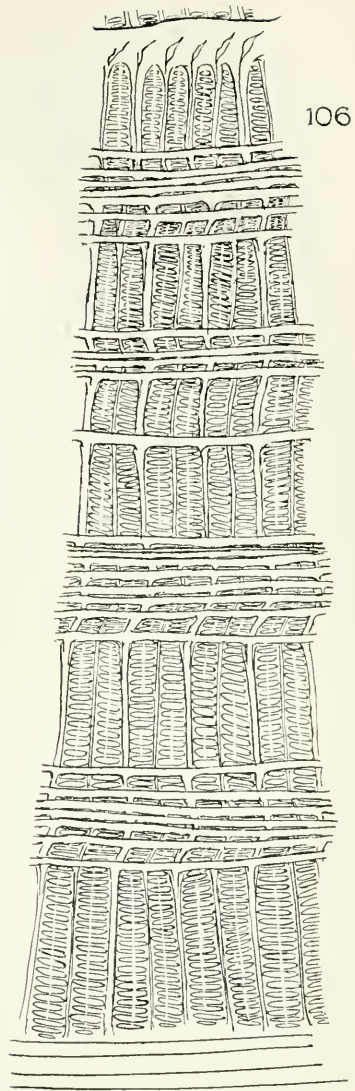
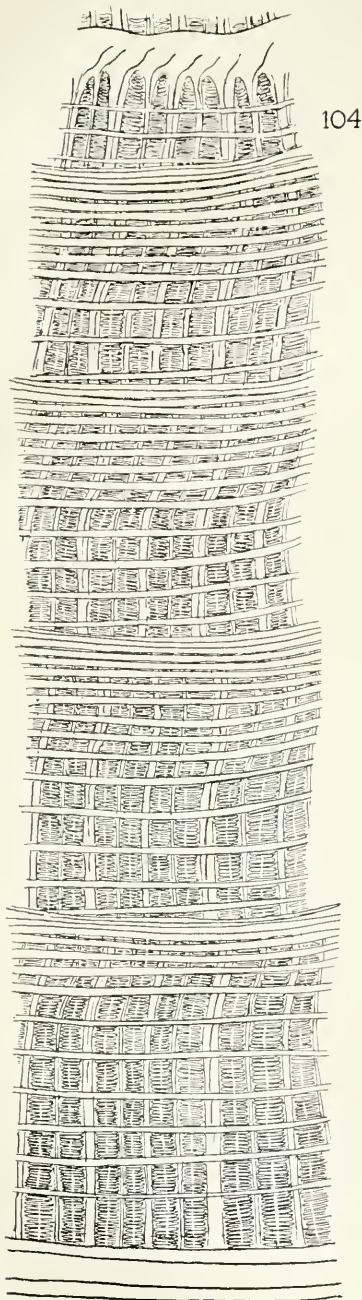






PLATE 63.

- Fig. 107. *Pandocia fibrosa* (Stimpson). Part of branchial sac.  $\times 18$ .  
Fig. 108. *Tethyum plicatum* (Lesueur). Gonad as seen from side attached to mantle.  $\times 7$ .  
Fig. 109. *Tethyum molle* (Stimpson). Gonad as seen from side next to branchial sac.  $\times 20$ .  
Fig. 110. *Pandocia fibrosa* (Stimpson). Gonad as seen from side next to branchial sac.  $\times 26$ .  
Fig. 111. *Pandocia albatrossi*, sp. nov. Part of branchial sac.  $\times 20$ .

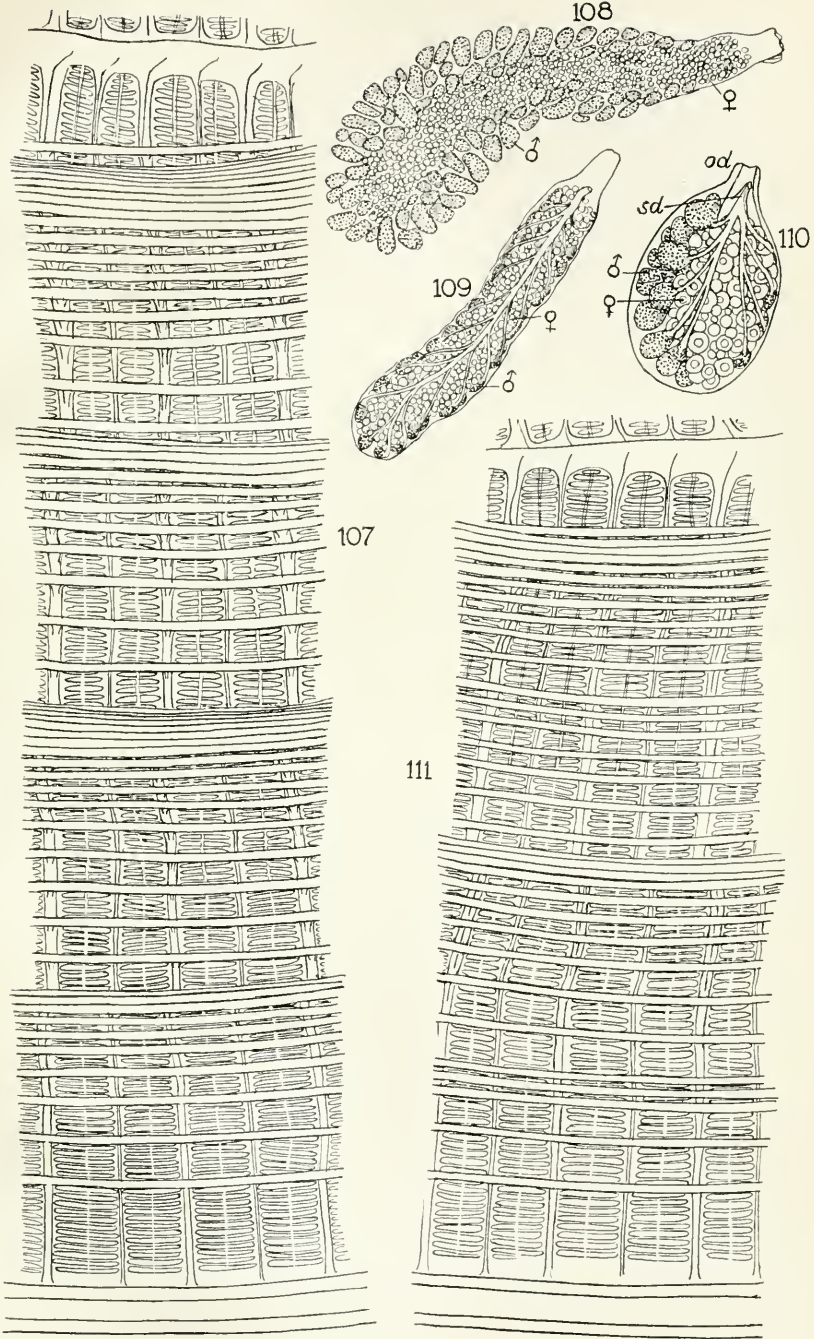






PLATE 64.

- Fig. 112. *Pandocia fibrosa* (Stimpson). Tentacles and dorsal tubercle.  $\times 14$ .
- Fig. 113. *Pandocia albatrossi*, sp. nov. Dorsal tubercle.  $\times 16$ .
- Fig. 114. *Dendrodoa carnea* (Agassiz). Circle of tentacles and dorsal tubercle.  $\times 22$ .
- Fig. 115. *Dendrodoa carnea* (Agassiz). Gonad.  $\times 10$ .
- Fig. 116. *Dendrodoa carnea* (Agassiz). Part of left side of branchial sac.  $\times 13$ .
- Fig. 117. *Dendrodoa carnea* (Agassiz). Part of right side of branchial sac.  $\times 13$ .
- Fig. 118. *Dendrodoa grossularia* (Van Beneden). Part of right side of branchial sac.  $\times 10$ .
- Fig. 119. *Dendrodoa grossularia* (Van Beneden). Part of left side of branchial sac.  $\times 10$ .

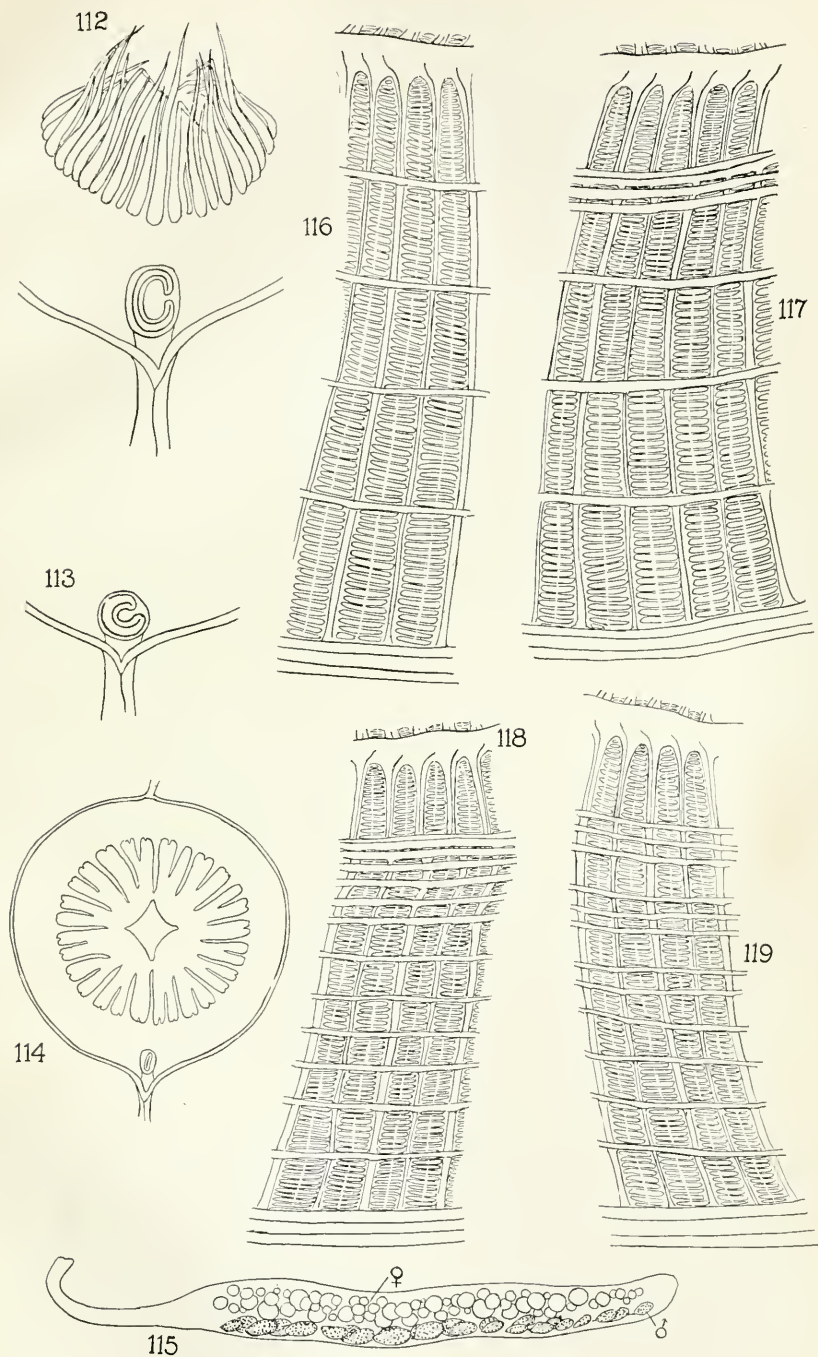






PLATE 65.

- Fig. 120. *Dendrodoa aggregata* var. *pulchella* (Verrill). Part of branchial sac.  $\times 11$ .
- Fig. 121. *Dendrodoa aggregata* var. *pulchella* (Verrill). Piece of one of the branches of the gonad as seen from side lying against the mantle.  $\times 25$ .
- Fig. 122. *Dendrodoa aggregata* var. *pulchella* (Verrill). Circle of tentacles and dorsal tubercle.  $\times 7$ .
- Fig. 123. *Corella borealis* Traustedt. Part of branchial sac.  $\times 31$ .
- Fig. 124. *Phallusia prunum* (Müller). Piece of ovary.  $\times 25$ .
- Fig. 125. *Phallusia prunum* (Müller). Piece of testis.  $\times 25$ .
- Fig. 126. *Phallusia prunum* (Müller). Piece of posterior portion of dorsal lamina and adjacent stigmata.  $\times 31$ .
- Fig. 127. *Phallusia obliqua* (Alder). Piece of posterior portion of dorsal lamina and adjacent stigmata.  $\times 31$ .

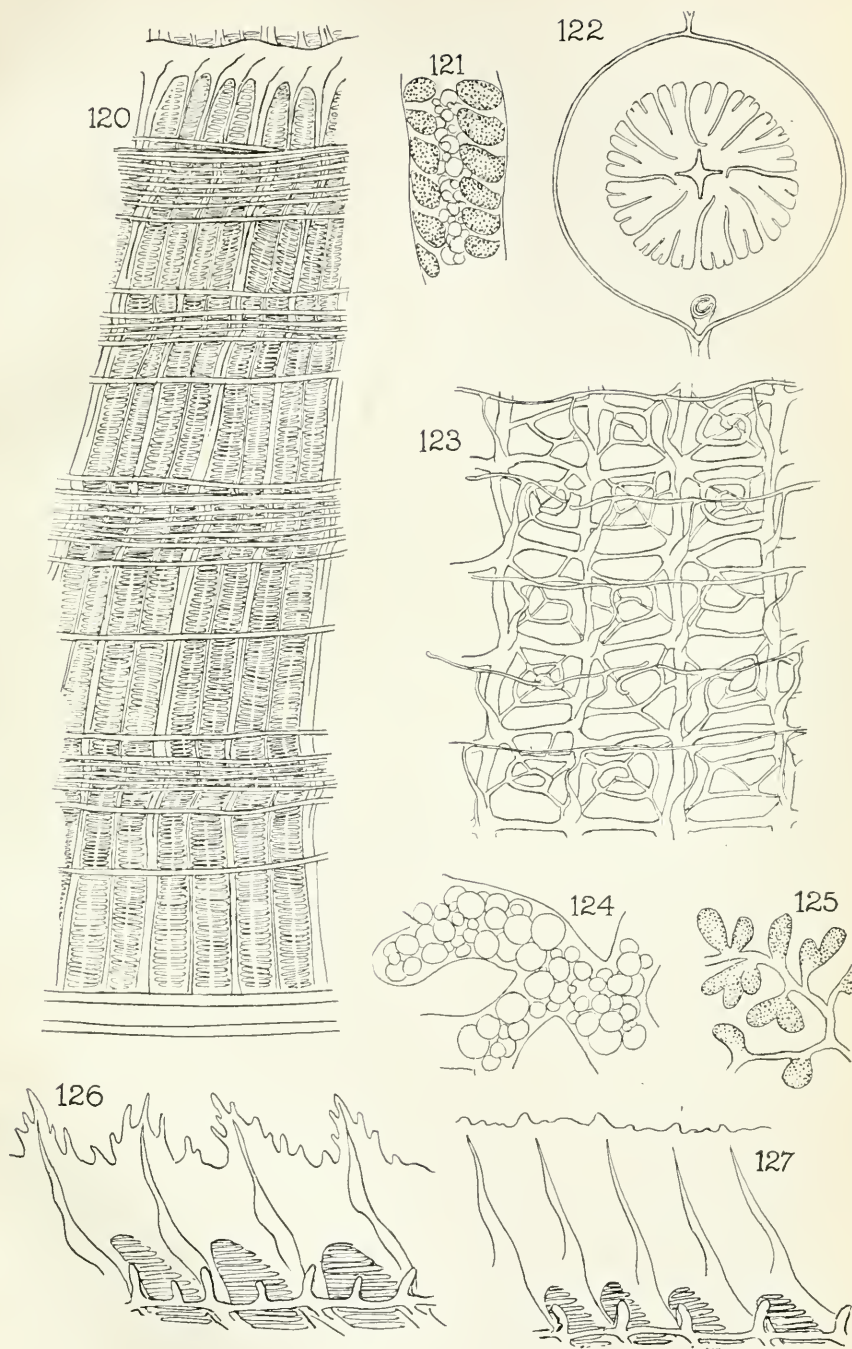


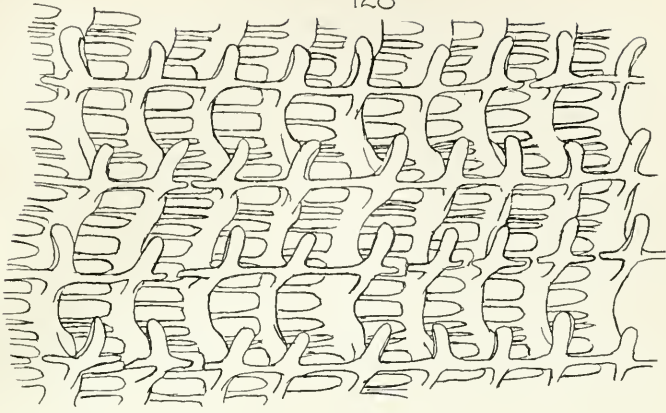




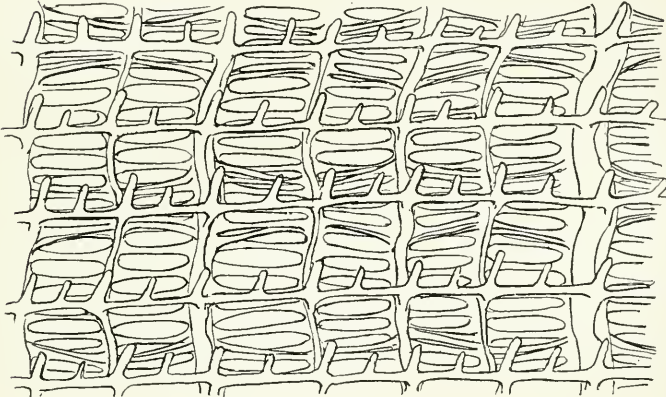
PLATE 66.

- Fig. 128. *Phallusia obliqua* (Alder). Part of branchial sac.  $\times 29$ .  
Fig. 129. *Phallusia prunum* (Müller). Part of branchial sac.  $\times 29$ .  
Fig. 130. *Ciona intestinalis* (Linnaeus). Part of branchial sac from specimen from Newport, R. I.  $\times 36$ .  
Fig. 131. *Phallusia obliqua* (Alder). Dorsal tubercle.  $\times 11$ .  
Fig. 132. *Phallusia prunum* (Müller). Dorsal tubercle.  $\times 11$ .

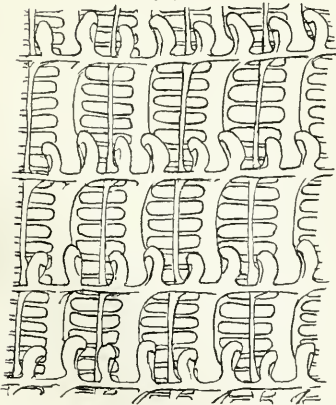
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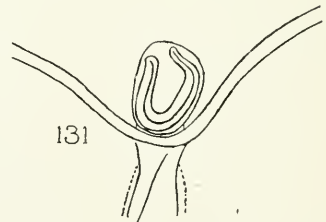
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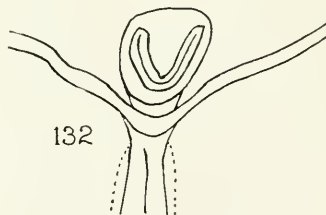






PLATE 67.

- Fig. 133. *Pyura ovifera* (Linnaeus). George's Bank, 41 fathoms. Nat. size.  
Fig. 134. *Pyura aurantium* (Pallas). Labrador. Nat. size.



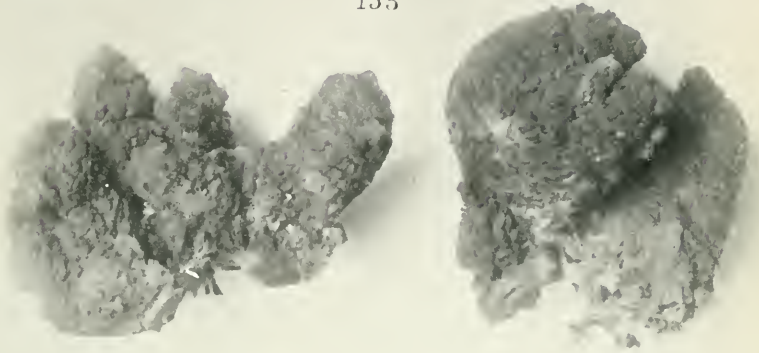




PLATE 68.

- Fig. 135. *Tethyum atlanticum*, sp. nov. Two groups of individuals. Station 940 (N. lat. 39° 54', W. long. 69° 51' 30'', 134 fathoms). Nat. size.
- Fig. 136. *Tethyum plicatum* (Lesueur). Four individuals. Fort Macon, N. C. Nat. size.

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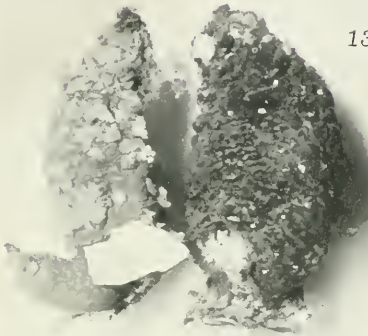
PLATE 69.

- Fig. 137. *Bostrichobranchus pilularis* (Verrill). Two large specimens free from incrusting sand and mud. Vineyard Sound. Nat. size.
- Fig. 138. *Tethyum rusticum* (Linnaeus). Specimens from the Grand Banks. Nat. size.
- Fig. 139. *Caesira retortiformis* (Verrill). Station 2699 (N. lat.  $45^{\circ} 04'$ , W. long.  $55^{\circ} 23'$ , 72 fathoms). Nat. size.
- Fig. 140. *Caesira retortiformis* (Verrill). Eastport, Me. Nat. size.
- Fig. 141. *Tethyum partitum* (Stimpson). Two groups of individuals. Newport, R. I. Nat. size.

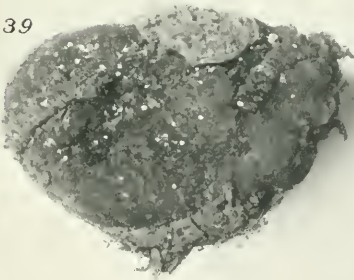
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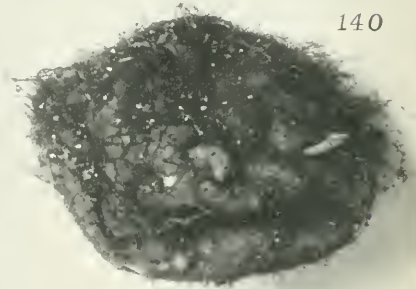
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PLATE 70.

- Fig. 142. *Dendrodoa aggregata* var. *pulchella* (Verrill). Three individuals from the Grand Banks. Nat. size.
- Fig. 143. *Pyura echinata* (Linnaeus). Three individuals from Eastport, Me. Nat. size.
- Fig. 144. *Pyura echinata* (Linnaeus). Labrador. Nat. size.
- Fig. 145. *Pyura ovifera* (Linnaeus). Young individual from Grand Banks. Nat. size.
- Fig. 146. *Pandocia albatrossi*, sp. nov. Specimens from Station 2714 (N. lat.  $38^{\circ} 32'$ , W. long.  $70^{\circ} 17' 30''$ , 1825 fathoms). Nat. size.
- Fig. 147. *Pandocia fibrosa* (Stimpson). Specimens from Station 2056 (N. lat.  $42^{\circ} 01' 30''$ , W. long.  $68^{\circ} 01'$ , 97 fathoms). Nat. size.

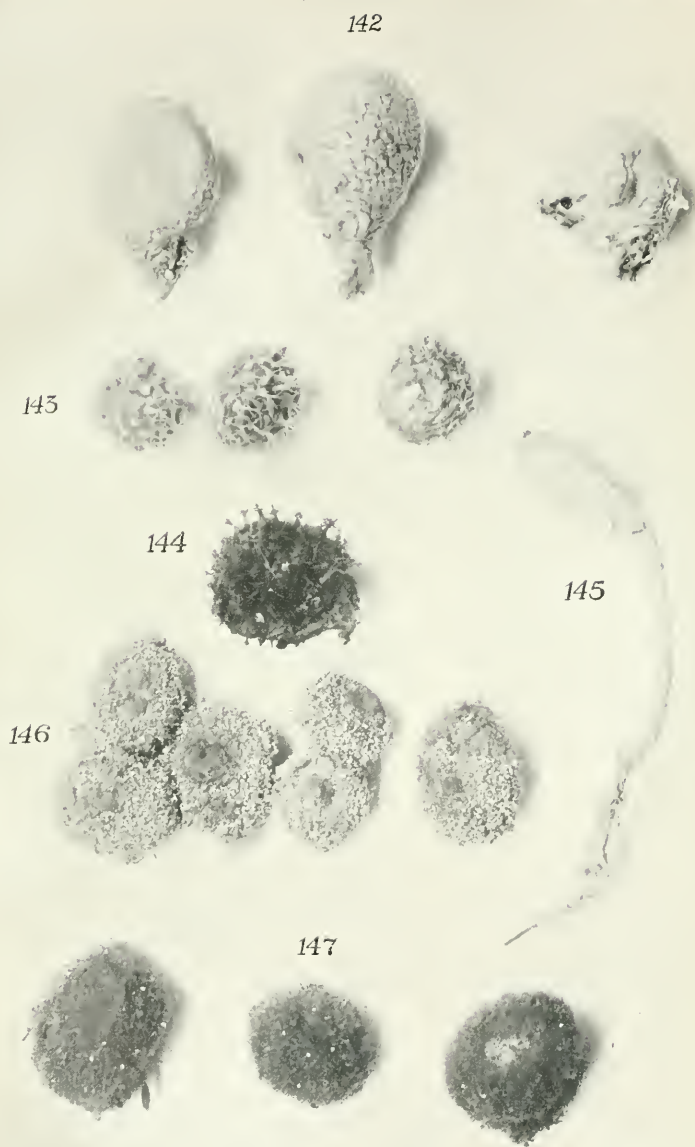






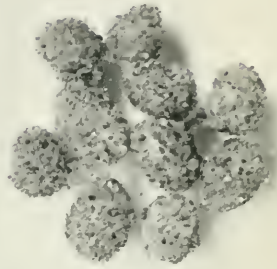
PLATE 71.

- Fig. 148. *Caesira pannosa* (Verrill). Specimens from the Bay of Fundy.  
Nat. size.
- Fig. 149. *Tethyum molle* (Stimpson). Specimens from Vineyard Sound,  
Mass. Nat. size.
- Fig. 150. *Caesira arenata* (Stimpson). Specimens from Long Island Sound  
near New Haven, Conn. Nat. size.
- Fig. 151. *Caesira manhattensis* (DeKay). Vineyard Sound, Mass. Nat.  
size.
- Fig. 152. *Caesira manhattensis* (DeKay). Three individuals from Vineyard  
Sound, Mass. Nat. size.
- Fig. 153. *Tethyum partitum* (Alder). Two specimens from Vineyard  
Sound, Mass. Nat. size.

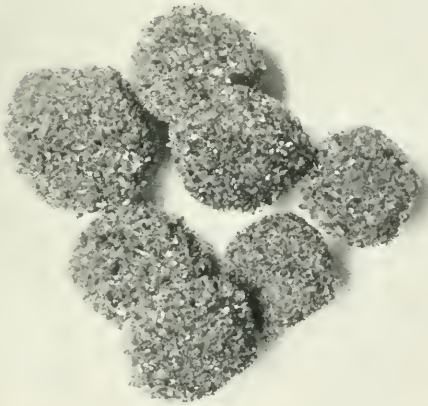
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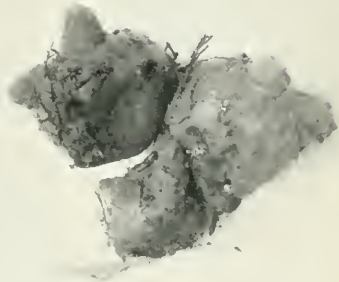
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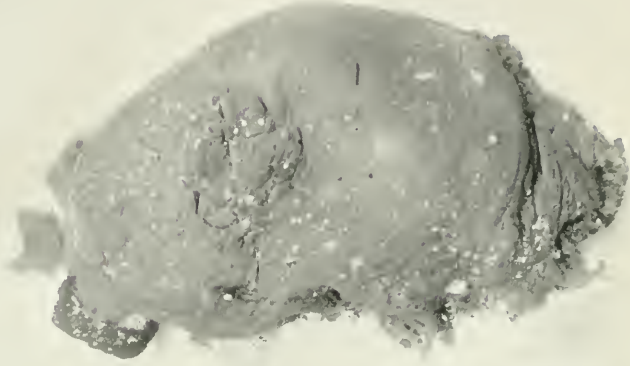




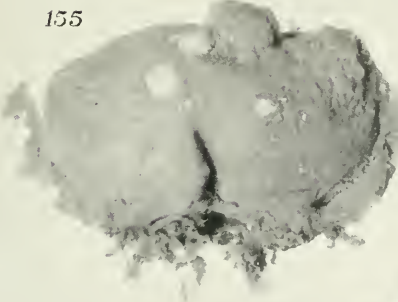
PLATE 72.

- Fig. 154. *Phallusia obliqua* (Alder). Station 371 (off Chatham, Mass.,  
34½ fathoms). Nat. size.
- Fig. 155. *Phallusia obliqua* (Alder). Station 371 (see above). Nat. size.
- Fig. 156. *Phallusia prunum* (Müller). Station 2490 (N. lat. 45° 27' 30'', W.  
long. 58° 27' 45'', 50 fathoms). Nat. size.
- Fig. 157. *Phallusia prunum* (Müller). Eastport, Me. Nat. size.
- Fig. 158. *Dendrodoa carnea* (Agassiz). Individual attached to a pebble.  
Long Island Sound. Nat. size.

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PLATE 73.

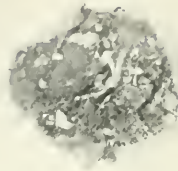
Figures all natural size.

- Fig. 159. *Tethyum finmarkiense* (Kiaer). Specimen attached to broken shell. Station 2466 (N. lat.  $45^{\circ} 29'$ , W. long.  $54^{\circ} 24'$ , 67 fathoms).
- Fig. 160. *Caesira septentrionalis* (Traustedt). Banks of Newfoundland.
- Fig. 161. *Caesira robusta*, sp. nov. Type. Wood's Hole, Mass.
- Fig. 162. *Microcosmus nacreus*, sp. nov. Type. Near Station 2501 (N. lat.  $44^{\circ} 27'$ , W. long.  $60^{\circ} 20' 15''$ , 26 fathoms).
- Fig. 163. *Caesira citrina* (Alder and Hancock). Specimen seen obliquely from one side. Off Cape Ann, Mass., 45 fathoms.
- Fig. 164. *Tethyum coriaceum* (Alder and Hancock). Specimen seen from above.
- Fig. 165. *Tethyum coriaceum* (Alder and Hancock). Specimen seen from one side.
- Fig. 166. *Caesira singularis*, sp. nov. Off south end of Stellwagen's Bank, 27 fathoms.
- Fig. 167. *Caesira papillosa* (Verrill). Station 2080 (N. lat.  $41^{\circ} 13'$ , W. long.  $66^{\circ} 21' 50''$ , 55 fathoms).
- Fig. 168. *Caesira lutulenta*, sp. nov. Station 921 (N. lat.  $40^{\circ} 07' 48''$ , W. long.  $70^{\circ} 43' 54''$ , 67 fathoms).

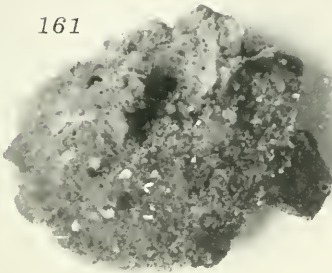
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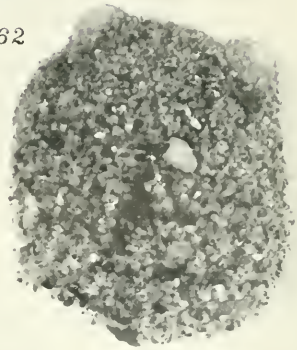
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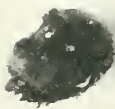
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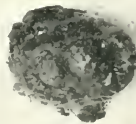
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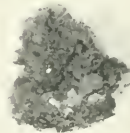
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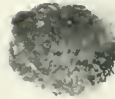
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