

Article VI.—NEW NORTH AND SOUTH AMERICAN ASCIDIANS

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In the following pages, five species of ascidians new to the coasts of North and South America are described, four of them new to science. The remaining form appears to belong to a species recently described from Japan by Professor Oka, though no material of the Japanese form has been available for comparison. Instances of very wide and often discontinuous distribution do not, however, appear to be very uncommon among the ascidians, and the number of such cases is constantly increasing as the group is becoming better known.

The species dealt with are as follows:

Order KRIKOBANCHIA Seeliger

Family Polycitoridæ

Clavelina huntsmani, new species; west coast of North America

Order PTCHYCOBRANCHIA Seeliger

Family Botryllidæ

Botryllus primigenus OKA, 1928; Tortugas, Florida; Japan (Oka)

Family Styelidæ

Polyandrocarpa (Eusynstyela) gravei, new species; Tortugas, Florida

Stolonica zorritensis, new species; Zorritos, Peru

Pyura bradleyi, new species; Zorritos, Peru

The species of *Clavelina* has been described from material in the collection of The American Museum of Natural History. For the specimens from Tortugas, Florida, and for notes on their colors and appearance in life and on their larvæ, I am indebted to Professor Caswell Grave of Washington University, St. Louis, Missouri, while those from Zorritos, northern Peru, a region whose ascidian fauna is very little known, are based on material in the Peabody Museum of Yale University, collected many years ago by Mr. F. H. Bradley, and were placed at my disposal for study through the kindness of Dr. Stanley C. Ball. I wish to acknowledge here my obligations to both of these gentlemen.

Type material of the new species is contained in the collection of The American Museum of Natural History.

ORDER **KRIKOBANCHIA** SEELIGER
(= **APLOUSOBANCHIATA** LAHILLE)

Clavelina huntsmani, new species

Figure 1

Clavelina species, HUNTSMAN, 1912, Trans. Canadian Inst., 1911, p. 115; 1913, Proc. Royal Soc. London, (B) LXXXVI, pp. 440-450; pp. 455-459.

The colonies available for study are all fully adult and consist of dense clusters of club-shaped zooids, each of which has, at least as far as the specimens at hand show, its separate and distinct covering of test throughout its entire length, including a short basal peduncular part into which the body of the zooid does not extend. The lower ends of the zooids converge and join in a small, irregular basal mass of test which is penetrated by stolons or vascular processes from the zooids, and which serves to attach the colony.

These clusters contain, among the larger ones, a few very small zooids branching from the basal mass of stolons or from the peduncular part of older zooids. These are, in most cases, separate and provided with their own distinct covering of test for their whole, or nearly their whole length, even when very small (10 mm. long or less), but it is not certain whether these small ones are really young, or whether they are stunted or arrested in their development by overcrowding or other causes, and I judge it quite possible that in immature stages of colonies, a less complete degree of separation of the zooids may occur, though the material to determine this question is lacking at present.

In the preserved specimens, the largest zooids measure about 40 mm. long and 8 to 9 mm. transversely near the upper and larger end. These are the measurements of the test; in the more or less contracted condition the body of the zooid measures but three-fourths or less of the above length, and its anterior end is drawn back a little way into the enveloping mass of test. The largest cluster contains about twenty-five zooids of various sizes, but is very likely only a part of a larger colony.

In the preserved material, the test is fairly firm, transparent and colorless near the free ends of the zooids, becoming whitish and more opaque near their bases. The bodies of the zooids are yellowish white or pale flesh-color, and may be distinctly seen through the test.

The zooids have the form usual in this family. The thoracic portion is of oval form when contracted but elongate and barrel-shaped in expansion, and bears the very short tubular siphons at the anterior end. The orifices are smoothly rounded with no indication of lobes. Except the sphincters of the tubes, the muscles are mainly longitudinal. The abdomen is elongate oval, tapering anteriorly into the long constricted neck by which it is joined to the thorax. The normal number of tentacles is apparently thirty-two (4+4+8+16) comprising three or four orders distributed with considerable regularity according to the usual scheme (1-3-2-3-1-3-2, etc.). As usual, in this family, the smaller tentacles are inserted a little nearer the distal end of the branchial tube than the larger ones. The dorsal tubercle is longitudinally elongate oval, with an orifice of similar form. There are from sixteen to twenty rows of stigmata with a large number (often about forty) in a row on each side. The transverse vessels each bear an internally projecting membrane attached

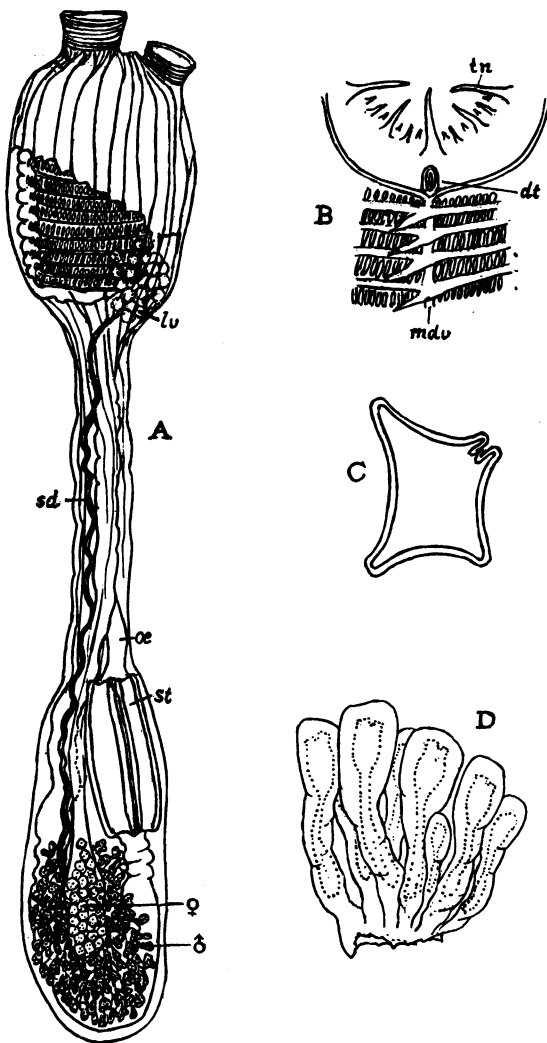


Fig. 1. *Clavelina huntsmani*, new species.

A.—Zooid, $\times 6$; *oe*, oesophagus; *lv*, larva; *sd*, sperm duct; *st*, stomach. B.—Anterior pharyngeal region, $\times 25$; *dt*, dorsal tubercle; *mdv*, median dorsal vessel; *tn*, tentacle. C.—Cross-section of stomach, $\times 15$. D.—Cluster of individuals, four-fifths natural size.

throughout the length of the vessel. This membrane is continuous at the median dorsal vessel with one of the series of acute triangular languets borne on the latter.

The stomach is rather elongate oblong and is four-sided in cross-section, each angle being marked by a prominent ridge on the exterior. One of these ridges is double, consisting really of two ridges separated by a longitudinal furrow which

forms an internally projecting ridge or typhlosole (that is itself furrowed along its free margin) on the inner surface of the stomach. The intestine forms a rather large loop extending some distance beyond the stomach.

The reproductive organs consist of a saccular ovary containing many small eggs situated in the intestinal loop and a very large number (often several hundred) of small male glands, pear-shaped or elongate, or sometimes cleft into two or more lobes, spread over the surface of the intestinal loop, especially on the left side of the body, but extending through and around the loop onto the right side to some extent. The common sperm duct, formed by the union of the numerous ducts from the testes, and the oviduct, which is of rather large diameter, both accompany the ascending branch of the intestine. In some individuals the atrial cavity contains numerous developing eggs or young larvæ, which evidently pass through their early stages in that location. Body length of the larvæ about 0.42 mm.

LOCALITIES.—Monterey Bay, California, collected by Prof. E. C. Starks (types); Barkley Sound, Vancouver Id., British Columbia. These specimens, including the types, are in The American Museum of Natural History, New York. Huntsman, 1912, records finding it in quantity in Barkley Sound on rocks at low tide and by dredging in 5 to 10 fathoms. Type is A. M. N. H. Catalogue No. 872.

According to the latest classification (Michaelsen, 1930) of this group, this is a member of the typical subgenus or division of the genus *Clavelina* in its broad sense. It bears a considerable resemblance to *Dendroclavella elegans* Oka, 1927, from Japan, but that species is described as having an ovoid, smooth-walled stomach, somewhat smaller zooids than the present species, and a more tree-like manner of branching of the colony. These characters, especially that of the stomach, seem to exclude the specific identity of the Japanese and the western American form. The Japanese species seems, if I understand Michaelsen's classification correctly, to be a member of the genus *Podoclavella* Herdman. It does not appear to require the establishment of the new genus (*Dendroclavella*) which Oka made for it.

I take pleasure in naming this species for Dr. A. G. Huntsman, who has recorded it among the species of the British Columbia regions and made some studies in its development, though without naming it or publishing any description.

ORDER **PTYCHOBANCHIA** SEELIGER)

(= **STOLIDOBANCHIATA** LAHILLE)

Family **Botryllidæ**

Botryllus primigenus Oka

Figures 2 and 3

Botryllus primigenus OKA, 1928, Proc. Imper. Acad. Tokyo, IV, p. 303, Figs. A, B.

In 1928, I received from Prof. Caswell Grave of Washington University, some specimens of the genus *Botryllus* collected at Tortugas, Florida, which were evidently of a species new to American waters.

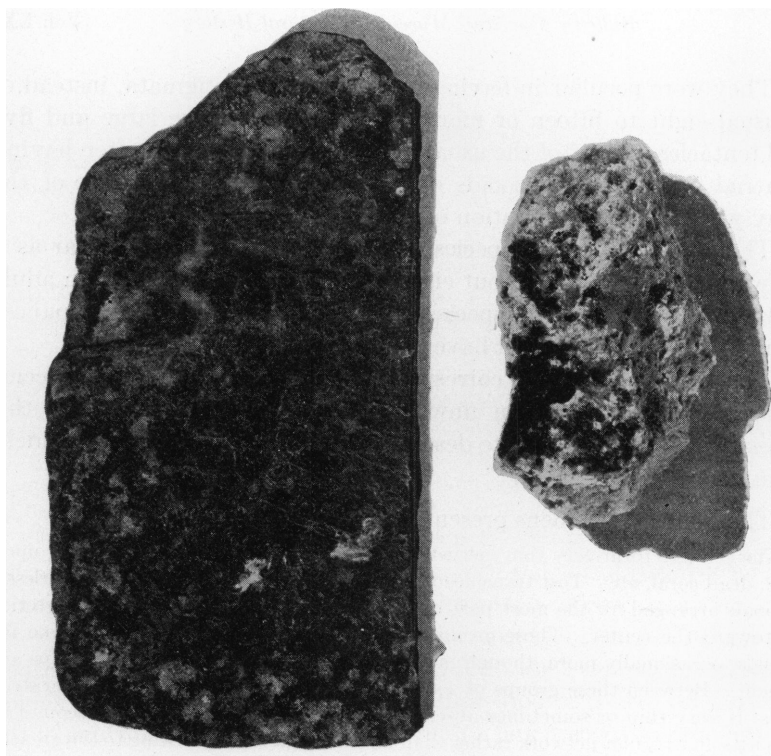


Fig. 2. *Botryllus primigenus* Oka, 1928.
Two colonies, growing on slate and dead coral, respectively, natural size.

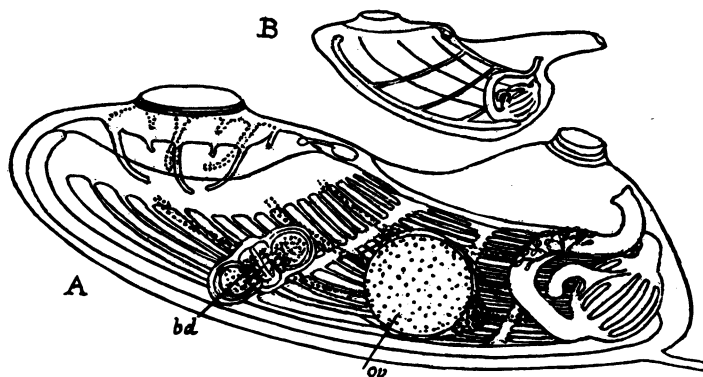


Fig. 3. *Botryllus primigenus* Oka, 1928.
A.—Zoid with atrial aperture opening on the surface of the colony, $\times 45$; *bd*, bud; *ov*, egg. B.—
Outline of a zoid forming part of a system and provided with a long atrial siphon to reach the common
cloacal cavity, $\times$ about 18.

They were peculiar in having but four rows of stigmata, instead of the usual eight to fifteen or more rows; in having five large and five small tentacles instead of the usual four of each size, and in often having the atrial orifices of the zooids opening directly on the surface of the colony without the intervention of common cloacal cavities.

Though no American species has hitherto been found, so far as I am aware, with less than about eight or more rows of stigmata in adult zooids, no less than three species have been recorded from Japanese waters by Professor Oka that have only four rows of stigmata.

The Florida specimens correspond so closely to one of these species (*B. primigenus*), that I am unwilling, at least on the basis of the material thus far available, to describe them as new in spite of the widely separated localities.

The Florida specimens present the following characters:

The colonies form very thin incrusting sheets of irregular outline, growing upon stones, dead coral, etc. Test translucent (in alcoholic material practically colorless), the zooids arranged for the most part in circular or oval groups with their posterior ends toward the center. These groups are usually composed of seven to nine individuals, occasionally more, though in some cases two or more adjacent groups are confluent. Between these groups of zooids, which are usually somewhat separated, the test is very thin or sometimes absent altogether, so that the colony becomes in some parts an irregular network rather than a continuous sheet. Owing to the greatly flattened form of the zooids, the colony, even where thickest (where the zooids are situated) does not greatly exceed 1 mm. in the preserved material. The usual branching vessels connecting the zooids and the different groups or systems of zooids are present in the test. The terminal bulbs which they bear are often of quite elongate form.

In the preserved material, the zooids are olive greenish, the test, as above stated, practically colorless and quite transparent and its branching vessels and thin bulbs pale grayish except where filled with dark-colored corpuscles. The colonies attain considerable size. The largest colony, though not entire, measures 85 mm. across, and appears to have measured even more in the direction transverse to that measurement.

Professor Grave's notes describe living specimens as follows:

"Colonies irregular in outline. Three inches in diameter. Translucent. Composed of zooids in circular or oval groups of 7 to 8 zooids each, except groups apparently undergoing reorganization into two daughter groups. Groups about 5 mm. in diameter; each zooid with individual oral and atrial orifices. A narrow line of grayish granular pigment passes between oral and atrial openings, the remaining part of surface of zooid brownish."

Well-expanded zooids in preserved specimens measure up to about 2 mm. long. They are proportionately rather wide, and are flattened dorso-ventrally. They lie horizontally or very obliquely in the colony, with the ventral surface down and the anterior end sharply bent up. The branchial apertures are round or oval and but

little, if at all, prominent. The atrial apertures are apparently provided with stronger sphincter muscles and are sometimes raised on a slight papilla. Attention should be called to the fact that only a part of the zooids are provided with individual atrial apertures on the surface of the colony, as in many groups the atrial orifices open into a common cloacal cavity which may be incomplete (a mere depression into whose sides the zooids open), or be well formed, with a rather large, but (in the preserved material) not very conspicuous aperture in the center of the group. In such cases the zooids may have a more or less well-developed atrial siphon with the aperture at its end, in order to reach the common cloaca.

Ten tentacles, five larger and five smaller ones alternating, one of the larger ones being in the ventral median position.

Branchial sac very wide and flaring at the anterior end, but much narrowed behind. There are but four rows of stigmata, which are rather long. The usual three internal longitudinal vessels are present. About four stigmata intervene between these vessels. A strip along each side of the endostyle is free from stigmata.

In several zooids the arrangement of the stigmata and vessels was determined to be as follows in the anterior row:

mdv 3 v 4 v 4 v 5 *en*

The stigmata are probably about the same in number in the posterior rows, though narrower, but are less easily accurately counted there on account of the presence of the alimentary and reproductive organs.

The stomach is short and wide and rather regularly elliptical in outline. It is thin-walled, with rather poorly marked longitudinal folds. These folds are narrow and well separated, about eight in number, besides the narrow ridge terminating in the cæcum and an additional incomplete fold beside it. The cæcum is tubular and much curved, and ends in a small enlarged bulb. It is similar to, but not over two-thirds as long as that of *Botryllus planus* (Van Name), a species also occurring in Florida waters. The ridge bearing the cæcum is somewhat oblique to the axis of the stomach, the other folds are parallel to the axis. The rectal part of the intestine is quite short.

In nearly all the zooids in the specimens at hand there is a single, very large egg or developing embryo projecting prominently on each side of the body a little behind the middle. It is inclosed in an evagination of the body wall, which closely invests it. On the posterior median aspect of the egg and closely applied to it, there is a small dome-shaped mass of cells which stain quite darkly and perhaps represent a remnant of the follicle which incloses the egg in earlier stages.

Many zooids bear a bud on each side, farther forward than the egg. These buds, even when very small, bear a group of eggs on each side of their body. Older buds have one large egg on each side inclosed in a thick follicle and close to it a few small cells, probably the degenerating remains of the other eggs.

In regard to the male organs, I can state nothing definite, as none were found in any of the numerous individuals examined, unless possibly rudiments of them may be present in some of the young buds close to the large eggs.

Prof. Grave writes of the larvæ of this species that they "are much smaller than those of *B. schlosseri* and *B. niger* and much more embryonic in the development of the definitive organs of the adult form."

LOCALITIES.—Tortugas Islands, Florida, in very shallow water. Three colonies, collected in 1928 and 1929 by Prof. Caswell Grave, are in the collection of The American Museum of Natural History. Bay of Tateyama, Prov. Awa, Japan (Oka).

The fact that the male reproductive glands are not known makes it difficult to place this species definitely, but it appears to be a true *Botryllus*, not a *Botrylloides* (syn. *Metrocarpa*).

Oka (1927) has named, though without giving any actual descriptions, two other species of Botryllidæ from Japanese waters besides *B. primigenus* that have four rows of stigmata.

About one of these, "*Leptobotrylloides dubium*, new genus, new species," Oka (1927b, p. 608) gives us no information except that it "occupies an intermediate position" between the genera *Botryllus* and *Botrylloides*, the zooids resembling those of the former, the systems those of the latter genus, though small, "star-shaped" systems as well as long ones occur. Regarding the zooids, he states only that they are short and obliquely placed and that they have only four rows of stigmata, but at the end of the article, he states that all the species mentioned in it except one (*B. communis*, see below) have eight tentacles, four large and four small, so that we must assume that eight is the number in *L. dubium*.

In the same paper, Oka gives the name *B. communis* to what he says is the common species of the family on the Japanese coasts, growing usually in band-shaped colonies on eel grass (*Zostera*). It has ten tentacles, five large and five small, but "agrees with the European *B. schlosseri* in other anatomical characters."

In this last statement, Oka is apparently mistaken, for he places this species in his key as having four rows of stigmata, while *B. schlosseri* has eight or nine rows. The development of this species which he names *communis* in 1927, had, moreover, been the subject of an excellent article by Professor Oka published many years previously (1892), though in it the species is referred to only as a "*Botryllus*" without any specific designation. But although the article deals chiefly with young stages, it is evident from the statements on page 530 that there are four or, more seldom, five rows of stigmata, and his figure 36 on plate xxii indicates five rows, certainly no more. The number of tentacles is ten, as in his later (1928) described *B. primigenus*.

Of these species (*B. communis* and "*Leptobotrylloides*" *dubium*), the former at least seems very close to *primigenus* and it should be noted that if they cannot all be maintained as distinct species, both the former names have priority over *primigenus*, and *communis* has page precedence over *dubium*.

This is the fifth species of this family (Botryllidæ) known from the eastern coast of North America. There has been much confusion in

regard to certain of them. For a discussion of these species see Van Name 1930, pp. 474-482, Figs. 45-49.

Family **Styelidæ**

Polyandrocarpa (*Eusynstyela*) *gravei*, new species

Figures 4 and 5

This species is a very near ally of *P. (E.) tinca* (see Van Name, 1921, p. 414, Figs. 84-86) which is also found on the Florida coast.

The two colonies at hand for description are of flat incrusting form; the larger (the type), attached to a piece of slate, is of elliptical outline and measures about 55

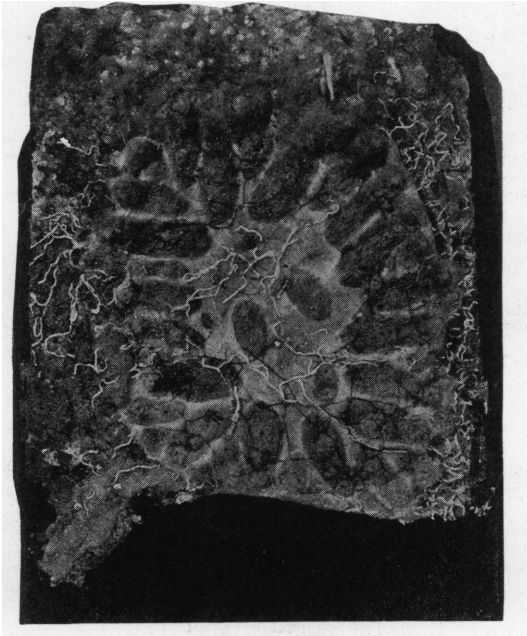


Fig. 4. *Polyandrocarpa (Eusynstyela) gravei*, new species.
Type colony, attached to a piece of slate, natural size.

mm. by 48 mm. across. It contains about twenty large zooids arranged around the marginal part of the colony with their long axes directed radially and their anterior ends outward, leaving a considerable space in the middle without zooids except for two large ones and two small ones which lie rather widely apart in it. A few additional small zooids in the intervals between the large zooids of the marginal row bring the total number of zooids up to about thirty.

The smaller colony is apparently not complete. It measures about 25 mm. by 30 mm. across and contains about a dozen zooids arranged without much regularity except that their long axes lie in somewhat parallel directions. It is attached to a

rather rough stone. The colonies form a tough, flat, incrusting sheet, in most places not much over 1 to 2 mm. thick in the preserved condition, not including the small papillæ on which the apertures are situated.

In the preserved specimens, the test is whitish, opaque and rather smooth, except over the zooids, where it is finely wrinkled in a direction corresponding to the long

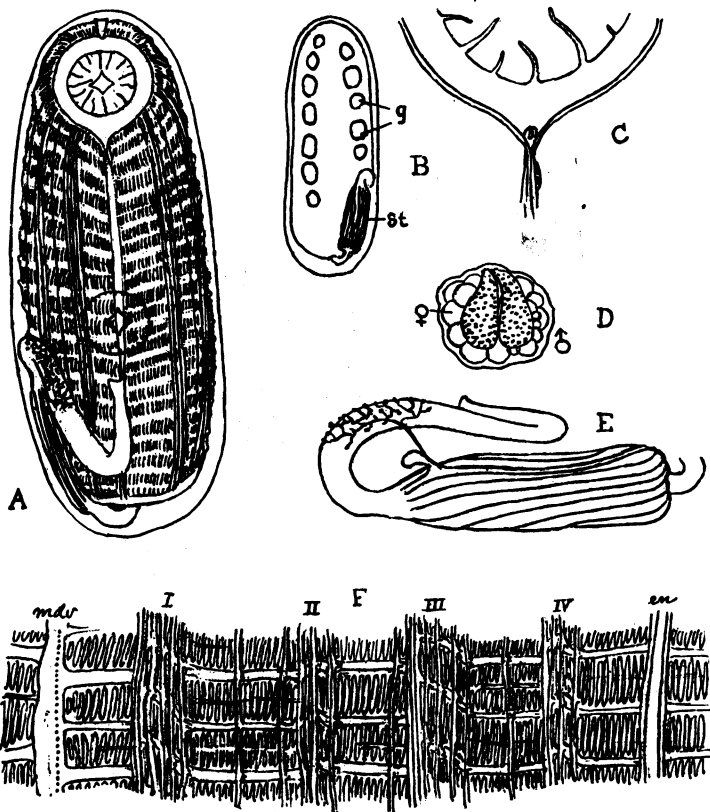


Fig. 5. *Polyandrocarpa (Eusynstyela) gravei*, new species.

A.—Dorsal view of zooid, $\times 6$. B.—Outline of ventral surface, to show position of gonads, $\times 3$; g, gonad; st, stomach. C.—Region of dorsal tubercle and part of circle of tentacles, $\times 18$. D.—Gonad, exterior aspect, $\times 14$. E.—Alimentary tract, $\times 10$. F.—Part of branchial sac, $\times 16$.

axis of the zooid and of a gray color. In life the color of the colony is, according to a letter from Professor Grave, "scarlet, glistening smooth in young colonies, but in the older colonies the zooids becoming fuzzy, either from the outgrowth of hairlike papillæ or from the attachment of algæ, etc. My impression is that *P. tinctoria* is a darker red than the new species." Professor Grave further states regarding the colonies that they are more glossy than those of *P. tinctoria*, though difficult to distinguish from the latter in the adult form, and that the arrangement of the zooids in a circular or

oval pattern (as described above in the type colony) was found in only two of his specimens, the usual arrangement being in an irregular compact group. He believes that the oval or circular arrangement develops only when a smooth, even surface permits of symmetrical growth.

In the preserved specimens at least, the outlines of the zooids are easily discernible as oblong or elliptical areas on the surface of the colony, from the difference in the character and color of the surface above described. This is not the case in *P. tincta*, where indications of the location and size of the zooids are usually furnished only by the small papillæ on which the apertures are borne. The apertures (which are four-sided) are raised on small papillæ in the present species also, the branchial papillæ being larger and higher than the atrial. Both of them bear, or are surrounded by, small nodules or verrucæ, making them appear rough and irregular.

The zooids lie upon their ventral surfaces and are greatly flattened dorso-ventrally, much more than is usual in *P. tincta*. The largest ones measure about 17 mm. long by 5 mm. wide in the type colony, though most of them are not more than 10 to 12 mm. long. The papilla bearing the branchial orifice is on the dorsal aspect only a little removed from the anterior end of the body; the atrial orifice is sometimes nearly half the body length from the posterior end.

In their internal structure, the zooids resemble those of *P. tincta* very closely. The mantle muscles form, as in that species, a thin sheet in which distinct bands are not recognizable in most places.

In a zooid 8.5 mm. long, about twenty oral tentacles were found, about sixteen of them of good size, larger and smaller usually alternating, with still smaller third-order tentacles in several of the intervals. Very small slender atrial tentacles are also present, inserted in a large circle about the interior of the base of the short conical papilla that bears the atrial orifice. They apparently number at least thirty.

The dorsal tubercle was examined in but one individual. In that it was found to be C-shaped with the open interval to the right.

The branchial sac corresponds closely to that of *P. tincta*. The dorsal lamina is wide and smooth-edged. The four longitudinal folds usual in this family are present on both sides of the sac. Of these, the first and third are best developed, and bear more internal longitudinal vessels than the other two. Arrangement of internal longitudinal vessels in an individual 11 mm. long:

Right side: *mdv* 0 (9) 2 (5) 1 (10) 1 (5) 0 *en*

Left side: *mdv* 0 (10) 2 (5) 0 (8) 0 (5) 0 *en*

An individual about 8.5 mm. long had the following arrangement on the right side and a closely similar one on the left:

mdv 0 (8) 2 (3) 1 (8) 1 (3) 0 *en*

As usual in this family, the first fold on the right side is farther from the median dorsal vessel than on the left side, about twelve or fourteen stigmata sometimes intervening in large individuals on the right, but only eight or nine on the left. Ordinarily eight or nine stigmata are present in the meshes in the flat parts of the sac. The individual 11 mm. long had about twenty-five transverse vessels, larger and smaller alternating with fair regularity. In a few places intermediate third-order vessels extend for short distances, and in many parts of the sac there are very delicate parastigmatic vessels crossing the stigmata half-way between the transverse vessels.

The stomach is elongate-oblong and lies with its axis in an antero-posterior direction in the left ventral region, ventral to the branchial sac. It has about fourteen

longitudinal folds in its wall, which are but little prominent on the outer surface, and a very small curved cæcum a little way from the pyloric end. The duct of the gland that surrounds the intestine communicates with the cæcum. The intestine is quite long. From the pyloric (anterior) end of the stomach it curves around to the dorsal side of the body along which it extends back parallel to and nearly to the posterior (cardiac) end of the stomach, but more or less separated from it by the left marginal part of the branchial sac, then it bends abruptly forward to form the rectum. The orifice of the latter is two-lipped.

The gonads are small rounded sacs attached to the inner surface of the mantle or body wall and not connected by any common sperm duct or oviduct. They resemble those of *P. tincta*, each containing a pair of ovate male glands and a number of eggs, the latter occupying chiefly that part of the sac which is next to the branchial sac. The gonads form a longitudinal row on each side of the median line and, as in *P. tincta*, they project as rounded evaginations on the ventral surface of the body, occupying corresponding cavities in the test substance. The individual gonads of the same row are sometimes so crowded as to be difficult to count, and to appear confluent, though they are probably merely in close contact. About five to nine gonads is apparently the usual number in a row. The row on the left side is normally shorter and composed of fewer gonads, because it ends just anterior to the alimentary organs, while the right-hand row may extend farther back.

Professor Grave finds that there is the following difference in size in the larvæ of the two species:

Length of larva of *P. tincta*.....1.16 mm.

Length of larva of present species.....1.32 mm.

LOCALITY.—This species is thus far known only from Tortugas, Florida, where it was found attached to stones in shallow water by Professor Caswell Grave, for whom I have named it. The type is A. M. N. H. Catalogue No. 879. The two colonies above described, collected in the summers of 1929 and 1930 respectively, are the only ones I have seen.

***Stolonica zorritensis*, new species**

Figure 6

The colonies consist of more or less closely crowded masses or clusters of club-shaped zooids of various sizes, arising from a basal tangled mass of branching and root-like stolons, which evidently serve to anchor the colony in the sand of the sea bottom. The zooids are enclosed in an individual covering of test; though toward the posterior or basal ends the tests of adjacent individuals may be more or less adherent, they are actually in connection with each other only by means of the stolons in the base of the colony.

The groups or clusters of zooids in the collection are mostly small, some containing only a dozen or twenty well-developed zooids, but they appear to be only parts or fragments of one or more much larger colonies, the size of which it is now impossible to determine. The test covering the zooids and basal stolons is not thick, but tough and resistant. Its substance is everywhere densely crowded with sand grains which also thickly incrust its surface, giving it the color and appearance of the sand.

Individual zooids are club-shaped, of oval cross-section (being slightly compressed from side to side), larger at the free or anterior end, and tapering posteriorly,

the narrow posterior part being composed of test only, except that it is traversed by the stolon connecting the zooid with its neighbors. The anterior end is rounded or more or less truncated, and bears the two apertures which are near together and either almost even with the surface (in strongly contracted specimens) or raised on papillæ. The zooids in the colonies at hand are of various sizes, but only the larger ones have the reproductive organs developed. The maximum length of the largest zooids is about 20 mm., the greatest dorso-ventral diameter about 3.8 mm., but most of them are considerably less, and a considerable part (sometimes about one half) of

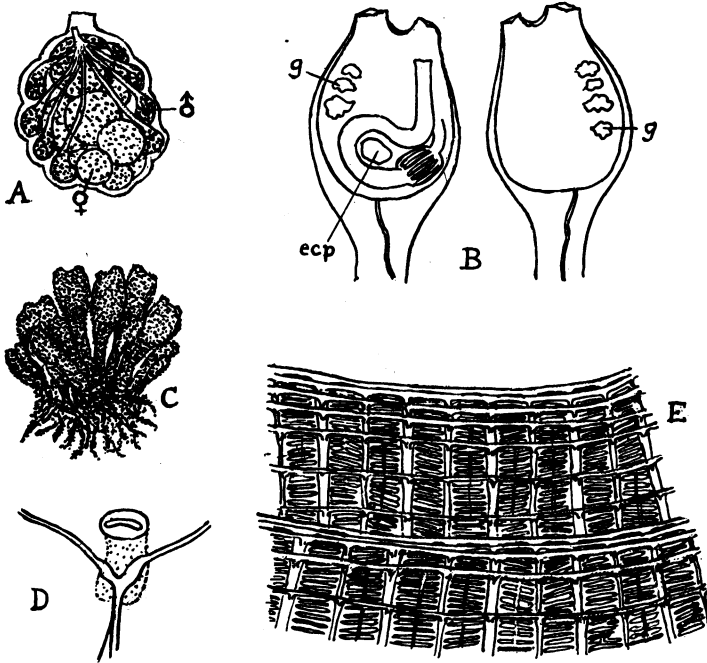


Fig. 6. *Stolonica zorritensis*, new species.

A.—Gonad, $\times 32$. B.—Left and right sides of a zooid showing positions of gonads and alimentary organs, $\times 4.5$; ecp, endocarp; g, gonad. C.—Group of zooids, natural size. D.—Dorsal tubercle, $\times 38$. E.—Part of branchial sac, $\times 32$.

the length is occupied by a more or less narrowed basal extension of the test, traversed only by the stolon by which connection with the rest of the colony is made.

When removed from the test, the body is of oval or oblong outline and, for the reason just given, it often measures only one half or even less of the total external length. The apertures are square or four-lobed. The mantle is thin and semi-transparent, with thin, even, muscular layers, longitudinal and transverse (the latter outside), composed for the most part of very slender threads which in many cases appear to be only a single fiber in thickness. They are, however, very numerous (the transverse threads more so than the longitudinal ones) and form minute meshes, very regular on the anterior parts of the body but less regular and somewhat larger on the posterior parts.

The tentacles are numerous and proportionately large and long, and form a crowded circle quite close in front of the peripharyngeal bands. There are probably normally about thirty-two larger ones representing two if not three orders and arranged with more or less regularity. In many of the intervals, there are additional small tentacles of a higher order; the extent to which these are developed, and therefore the total number of tentacles, is subject to much variation and is probably dependent more or less on the age and size of the zooid.

The dorsal tubercle has an orifice that is usually of transversely directed slit-like form and slightly curved.

The dorsal lamina is plain-edged and rather wide in the anterior part.

Branchial sac with four folds on each side. In adult, sexually mature zooids, and even in somewhat smaller ones having no reproductive organs developed, these folds are usually all fairly well developed. The fourth (or ventral) fold may, however, be very low or incomplete. The higher folds bear from five to seven closely grouped, very slender, internal longitudinal vessels; on the intervals between folds, there are generally one or two vessels, but these may be very narrow and poorly developed. A satisfactory scheme of the internal longitudinal vessels is, however, hard to make out, for the vessels on the intervals may lie so close to a fold that one is in doubt whether or not they should be counted as belonging to the fold, or they may be so slender and incompletely developed that it is doubtful whether they deserve to be counted at all. In two large zooids their distribution was about as follows:

A.—Right side: *mdv* 0 (6) 1 (7) 2 (5) 2 (3) 1 *en*

Left side: *mdv* 1 (6) 1 (6) 2 (5) 1 (4) 0 *en*

B.—Right side: *mdv* 1 (6) 2 (5) 2 (5) 2 (3) 1 *en*

Left side: *mdv* 0 (5) 1 (6) 2 (5) 2 (2) 1 *en*

The principal transverse vessels number about eighteen in the larger zooids and are of two sizes placed alternately. In a smaller zooid, the smaller transverse vessels were often found incomplete and interrupted. Still smaller vessels crossing the stigmata are present in some places. Except near the endostyle, there are usually only about six or seven stigmata between the more widely spaced internal longitudinal vessels on the unfolded parts of the sac.

The digestive tract forms a loop in the posterior part of the body; the rather long, straight rectum extends forward and ends in an orifice whose margin is smooth or nearly so. The stomach is short, larger at the pyloric than at the cardiac end, and well marked off from both esophagus and intestine. It has about fifteen deep longitudinal plications, which in some individuals are interrupted and broken so as to result in a condition approaching areolation on parts of the stomach. No pyloric cæcum was found. The esophagus, which is rather long, has its walls longitudinally folded. Often a large endocarp is present in the loop formed by the digestive tract.

Many of the larger zooids contain gonads in the ventral region each side of the endostyle, usually about four or five gonads on the right side, and three on the left side, where they lie in front of the stomach and intestine. Normally the gonads are of saccular form, fairly large, and are hermaphroditic, containing a small number of eggs and several pairs of pyriform male glands; the ducts of the latter curve around the more or less centrally located ovary and unite upon the inner aspect of the latter (the side toward the branchial sac) to form a very short common sperm duct which lies close beside the short neck that bears the opening for the discharge of the eggs, the structure of the gonad being that usual in the genus *Polycarpa*. In later stages

the eggs become quite large in proportion to the size of the gonad, and may so distend its wall, pushing out of place the testes and sperm ducts, that no regular arrangement of the structures such as has just been described can be recognized. Occasionally small but apparently functional gonads containing only one pair of testes and perhaps only a single large egg may be found. I was not able to satisfactorily demonstrate that any gonads that are not hermaphroditic occur in this species, but cannot be certain, as after discharge of the eggs a truly hermaphroditic gonads may simulate a unisexual male gonad. Some large single eggs may often be found attached to the walls of the peribranchial cavity and encysted there, but these I regard as probably eggs that have been discharged from the gonads, not as presenting unicellular female gonads. Their apparently entirely fortuitous distribution does not favor the latter supposition.

Locality.—Zorritos, Peru, collected by F. H. Bradley.

Type colony in the Peabody Museum of Yale University, pieces of it in The American Museum of Natural History, New York (Catalogue No. 870).

While it does not conform to Michaelsen's (1922) restricted definition, yet in its general form, structure and manner of growth, this species appears to belong in the genus *Stolonica*, though peculiar in the small number of its gonads and in their being apparently all hermaphroditic. In the latter respect it agrees with *Polyandrocarpa* Michaelsen, 1904, and might be placed in the latter genus, were the gonads only to be taken into account, as some might claim to be the correct course to follow. Such species as this emphasize the difficulty of dividing the family Styelidae, and especially the members of it that, like the present one, reproduce by budding, into satisfactorily definable genera.

Family Pyuridae

Pyura bradleyi, new species

Figures 7 and 8

The body in this species, as in *P. stolonifera* and its doubtfully distinct ally, *P. præputialis*, described by Heller (1878) from South Africa and Australia respectively, has the test of the upper surface bearing the two tubes somewhat soft and flexible and bordered by a raised rim of harder, stiffer test. Below this rim, the body has, in the two specimens available for study, the form of an inverted cone, greatly compressed from side to side, and sessile by the narrower end, which expands and runs out into rootlike processes for attachment.

The soft upper part of the body within the rim with the tubes it bears can be pushed down into and more or less invaginated within the lower part, but the tubes themselves are not retractile. They arise a little way apart and extend almost or quite vertically, the atrial tube being two or more times the length of the branchial tube.

The surface of the body in general is smooth, that of the tubes also, except for four furrows which extend down on their outer surfaces from the corners of the four-sided apertures on their summits, and both body and tubes are covered with a smooth, dense coating of sand grains, which gives them a brownish color.

The largest specimen measures about 18 mm. high to the edge of the hard rim and 26 mm. dorso-ventrally at the top; the atrial tube is about 11 mm. high, the branchial tube little over one-third that height. In both specimens, a ridge (dorso-ventral in direction) connects the bases of the two tubes. The lateral (right to left) diameter of the body varies according to the state of distension; when not inflated, it is not over 11 mm. in the upper and widest part. The other specimen is a little smaller but quite similarly shaped and proportioned.

The test is thin but rather tough, densely permeated with sand grains and has a smooth pearly lining. Calcareous spicules (see below) are few and small, if normally present in it at all.

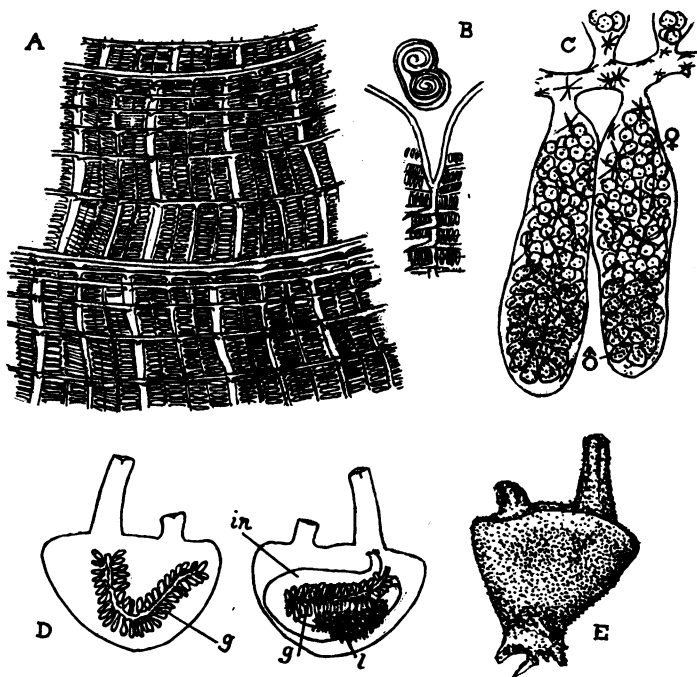


Fig. 7. *Pyura bradleyi*, new species.

A.—Part of branchial sac, $\times 16$. B.—Dorsal tubercle and adjacent structures, $\times 16$. C.—Two sacs from one of the gonads, $\times 18$. D.—Left and right sides of body, somewhat enlarged; g, gonad; in, intestine; l, liver. E.—External view of type, about natural size.

When removed from the test, the body exhibits a corresponding raised, but soft, flexible rim about the upper surface bearing the tubes. On the tubes, closely placed circular bands are developed, but (in conformity with their non-retractile character) scarcely any longitudinal muscles. Longitudinal bands commence, however, on the bases of the tubes and spread out on the upper body surface, curving down over the rim, where they become quite wide and strong, but tapering off and ending on the sides a little below the rim. Lower down, the mantle is thin and transparent, allow-

ing the internal organs to show through plainly, and is practically devoid of muscle bands.

The tissues of the mantle and the internal organs (even the tentacles) contain calcareous spicules in varying numbers; in some places very abundantly. In most of these tissues and organs they are of stellate or elongate branched forms with slender, sharply pointed branches. In the walls of the vessels composing the branchial sac, along with these branching spicules there also occur many long, straight, needle-like forms, unbranched or nearly so. The stellate spicules range up to 0.30 to 0.40 mm. in diameter to the ends of the rays and often have the form of quite regular five- or six-pointed stars with straight, slender, smooth, sharply pointed rays, but when the rays are more numerous they do not usually all converge to one center. Often the spicules consist of a more or less elongate axis with two or three rays or branches springing from each end and sometimes at one or more intermediate points. Such

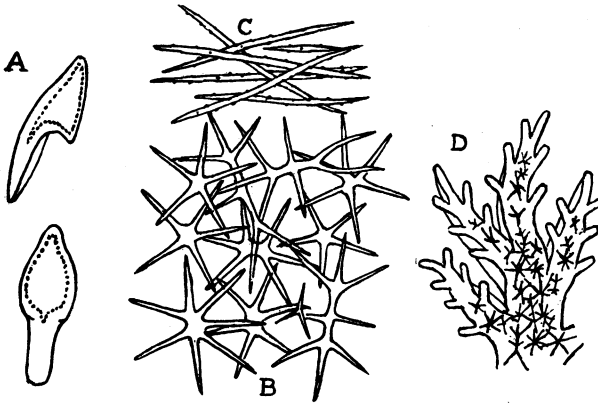


Fig. 8. *Pyura bradleyi*, new species.

A.—Minute spine from the lining of the branchial tube, lateral and upper aspects, $\times 900$. B.—Calcareous spicules of the type found in the mantle and most of the internal organs, $\times 54$. C.—Spicules from the walls of the branchial vessels, $\times 54$. D.—Part of large compound tentacle, $\times 70$.

forms as those just described usually have the rays or branches slender, quite straight, and sharply pointed; occasionally the rays are somewhat curved. The nearly straight needle-like spicules (which often reach 0.60 or 0.70 mm. long) found in the walls of the small branchial vessels are not smooth but somewhat nodular on their surface. Smaller, more or less imperfectly formed spicules of various forms occur in some places. Only small and few spicules, inconspicuous among the numerous sand grains, were found in fragments of the test that were examined.

The thin lining of test substance which extends a little way into the branchial tube is covered with extremely minute, very closely placed curved spines or sharp scales whose free apical part appears to be thin, flattened and somewhat hollowed on the lower or concavely curved aspect, and bluntly rounded off at the tip.

The oral tentacles form a crowded circle, the largest ones (of which about seven or eight seem to deserve to be considered as of the first order) are four or five times compound and end in minute branchlets whose tips are not swollen nor bulbous. There are some smaller, extensively branched tentacles in the intervals, but owing

to the way in which large branches arise at the base of the larger tentacles it is hard (at least in the contracted preserved specimens) to determine whether some of these should be counted as a smaller tentacle or as a branch. The dorsal tubercle in the type specimen is C-shaped with inrolled horns and with the open interval to the animal's left.

Owing to the form of the body, the median dorsal vessel is very short. It bears a series of pointed languets at its junctions with the transverse vessels. The latter are of three or four orders in respect to size and are arranged in the usual manner.

The branchial sac has six well-developed folds on each side which decrease in height with a fair degree of regularity from the dorsal to the ventral part of the sac.

Approximate distribution of the internal longitudinal vessels in the large (type) specimen:

Right side: *mdv* 1 (19) 2 (19) 3 (18) 3 (17) 3 (14) 2 (10) 2 *en*

Left side: *mdv* 2 (17) 1 (17) 1 (17) 2 (16) 3 (14) 2 (11) 2 *en*

On the flat parts of the sac the meshes may contain twelve to fifteen stigmata.

The stomach is little more than a somewhat enlarged part of the intestine into which it gradually tapers off. It bears large masses of branching hepatic tubules on its dorsal aspect. The intestinal loop is large, extending the whole length of the body. The rectum is short with an irregularly lobed aperture.

One gonad on each side. Each consists of a long tubular duct bearing along each side a series of elongate-oval or sausage-shaped sacs, about fifty in the gonad of the right side where the whole gonad is curved in an unequal-sided U-form, and somewhat fewer on the left where it is much straighter and is inclosed by the intestinal loop. The small sacs contain both eggs and small oval testes; the latter chiefly in the distal parts of the sacs.

LOCALITY.—The two specimens were collected at Zorritos, Peru, by Mr. F. H. Bradley, for whom the species is named. They were found with *Polyandrocarpa zorritensis*, described above in this paper, and grew on a sandy bottom attached to calcareous worm tubes. The type is in the Peabody Museum of Yale University; the cotype in The American Museum of Natural History, New York (Catalogue No. 871).

In its internal structure and in the character of the spicules, this species shows close relationship to *P. pachydermatina* (Herdman, 1881) and allied species or subspecies of the Australian region which, however, have the body borne on a more or less well-developed, often elongate, stalk; also to *P. antillarum* Van Name, 1921, of the West Indies, a deep-water species. But unlike those species it combines these characters with the peculiar hard rim surrounding the tube-bearing region that, as already mentioned, is found in *P. stolonifera* (Heller), 1878, and *P. præputialis* (Heller), 1878, of South Africa and Australia respectively, which are not described as possessing spicules.

It does not show any close relationship to *Pyura momus* (Savigny), 1816, and the allied forms constituting the subgenus *Rhabdocynthia* Herdman, 1891, either in its spicules, which show no signs of the rings of minute spinules present in that group, or in the structure of the gonads, which resemble those of typical *Pyuras* in consisting of hermaphroditic sacs arranged along an elongated duct.

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