H.R. Seiwell
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Ritter, W.E.

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UNIVERSITY OF CALIFORNIA PUBLICATIONS
IN
ZOOLOGY

Vol. 4, No. 1, pp. 1-52, Pls. 1-3 October 26, 1907

1986
R 5147

THE ASCIDIANS COLLECTED BY THE UNITED STATES FISHERIES BUREAU STEAMER *ALBATROSS* ON THE COAST OF CALIFORNIA DURING THE SUMMER OF 1904*

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BY

WM. E. RITTER.

The work of the Albatross from March 1 to June 11, 1904, furnished material for the only bit of information we have concerning the off-shore ascidians of the California region. No shore collections are included in this report. It should be stated, however, that many of the dredging stations, probably more than half, and particularly those in and about Monterey Bay, were in depths of only a few fathoms—100 or less.

The following systematic table of the fourteen species in the collection shows the depths and also the geographic position with reference to Point Conception, from which the species come. Full data as to habitat, so far as the field records furnish them, are given under each species.

Family Molgulidae—	DEPTH.	LOCALITY.
Halomolgula n. gen.		
1. Halomolgula ovoidia n. sp.	1000 fath.	South of Point Conception.
2. Molgula regularis n. sp.	71-67 fath.	South of Point Conception.

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Family Cynthiidae—

3. Halocynthia okai n. sp.	10-80 fath.	North of Point Conception.
4. Boltenia echinata n. sp.	21-48 fath.	North of Point Conception.
5. Culeolus pyramidalis n. sp.	2259 fath.	South of Point Conception.
6. Microcosmus transversus n. sp.	33 fath.	South of Point Conception.
7. Styela milleri n. sp.	2228 fath.	South of Point Conception.
8. Styela gibbsii Stimp.	40 fath.	North of Point Conception.

Family Ascidiidae—

Benthascidia n. gen.

9. Benthascidia michaelseni n. sp.	2182 fath.	South of Point Conception.
10. Ascidia clementea n. sp.	654-111 fath.	South of Point Conception.
11. Ciona mollis n. sp.	1100 fath.	South of Point Conception.

Family Distomidae—

12. Cystodites cretaceous v. Dr.	43-111 fath.	North of Point Conception.

Family Polyclinidae—

13. Psammaplidium spauldingi n. sp.	33 fath.	South of Point Conception.

Family Didemnidae—

14. Didemnum opacum n. sp.	33 fath.	South of Point Conception.

For about 50 miles to the north of Point Conception, or more exactly Point Arguello, the California coast runs almost due north and south, then for about 70 miles south of the Point the course is nearly east and west. The broad, mountainous triangle thus standing out from the general northwest and southeast trend of the coast constitutes apparently as important a geographical barrier for the littoral life of the coast as do the Tehachapi Mountains, of which it is really a part, for the life of the land.

It will be seen that ten of the fourteen species were taken south of the Point. This seeming greater wealth of off-shore species southward is the more striking when it is considered that the stations occupied on each side of the Point were practically the same, there having been 133 to the south and 130 to the north.

Some interesting results are revealed by an examination of the bathymetric distribution of the species. The following table presents the facts:

1. Depth, 2000 fathoms or more; number of stations, 7; number of species, 3.

2. Depth, 2000 to 1000 fathoms; number of stations, 9; number of species, 3.

3. Depth, 100 to 500 fathoms, 41; number of stations, 41; number of species, 0.

4. Depth, 500 to 1 fathoms; number of stations, 206; number of species, 8.

This gives—Depth 1: 1 species to 2 1-3 stations.
Depth 2: 1 species to 3 stations.
Depth 3: 0 species to 41 stations.
Depth 4: 1 species to 25 1-4 stations.

Of the 263 stations occupied only 16 produced ascidians. Two of these, namely, 4420 and 4425, produced two species each; 4420 was in a depth of 33 fathoms and 4425 in 1100 fathoms, both in the vicinity of San Nicolas Island and both on sandy or muddy bottom. Only three species were taken at more than one station, *Halocynthia okai* coming from five stations, all in the Monterey district, in less than 100 fathoms.

The data are too few to permit of much in the way of generalization, but indications in two directions are rather strong. In the first place, the off-shore ascidian fauna is considerably richer south than north of Point Conception, so far as concerns the areas worked over at this time; and, second, that the deep water along and just beyond the continental shelf is more prolific of this form of animal life than is the shallower in-shore water.

Genus HALOMOLGULA.

Test beset with processes each containing *calcareous spicules*. Branchial membrane with nine folds on each side. Infundibula present, large. Branchial stigmata small, irregular in form and distribution, rarely with any curvature. One gonad on each side of the body, the left in the intestinal loop.

Halomolgula ovoida, n. sp.

Pl. 1, figs. 1 to 6.

Superficial Characters.—Form varying from almost perfectly spherical to strongly depressed biscuit-shape with elliptical base. Outline in general very regular and even; surface, except on area

of attachment, wholly free from foreign substances. *Siphons* projecting scarcely at all above the general surface. Attached usually by posterior end, the area of attachment being usually broad and often extended by a flange, more or less regular, of test. *Color* light grey; in some regions, especially about the anterior end, approaching white. *Size*, longest diameter of largest specimens, 4 cm.; short diameter of same specimen, 3.5 cm.; more usual size, longer diameter about 2 cm., shorter about 1.5 cm. *Test* thin and papery, entire surface beset with minute stellate tubercles, each of which contains several short, rod-like *calcareous spicules* (pl. 1, figs. 1, 2 and 3). Except for presence of the opaque white tubercles just mentioned, test quite transparent.

Mantle.—Delicate, easily separating from the test, its muscle bands delicate though numerous, especially in the anterior half of the animal, where they are disposed both meridianally and circularly, with also some fibres running obliquely.

Branchial Apparatus.—Siphons very short or wholly absent. Branchial orifice appearing on the surface usually as a longitudinal slit. Branchial orifice probably with six lobes. *Branchial tentacles* from twelve to fourteen, compound, rather large, with several intervening ones much smaller (pl. 1, fig. 4). *Hypophysis* mouth simple, elliptical, situated slightly to the right side and far removed from the tentacular circlet. *Peripharyngeal* groove distant from the tentacular circlet and pursuing a meandering course by bending in between the anterior ends of the branchial folds, fig. 5.

Ganglion—Extremely long and narrow, extending from in front of the hypophysis backward behind it to a distance three or four times the length of the latter. *Dorsal lamina* a broad, heavy, crenulated membrane beset with numerous conical processes. *Branchial sac*, with nine folds on each side, eight of which are large, the one on each side of the endostyle being small. Internal longitudinal vessels on each side of each fold varying from six on the smaller folds to nine or ten on the larger. *Infundibula* large, quadrilateral, frequently notched at their inner borders, *i.e.*, the borders toward the inner margins of the folds. *Stigmata* small and irregularly distributed, usually short elliptical, but in some regions somewhat curved. Those of the infundibula gener-

ally smaller than those between the folds. *Transverse vessels* limited to the folds, and to the intervals between the infundibula, pl. 1, figs. 5 and 6.

Intestinal Tract.—Wide, simple open loop situated across the posterior dorsal side of the animal, somewhat to the left. Stomach not large, sharply set off from the esophagus but not from the intestine, the wall irregularly folded. Anus bordered by five or six petaloid lobes. *Renal organs* in the form of two or three distinct patches on the inner surface of the mantel in the vicinity of the gonads, the largest patch being lateral to the right gonad. *Gonads* one on each side of the body, the left in the intestinal loop, each long and sausage-shaped.

The dull white, clean-surfaced, egg-shaped habitus of this fine species gives an assemblage of the animals a striking appearance. The coreaceous consistency of the test causes the specimens to keep their form to an unusual degree, in spite of the action of preserving fluids. Nearly all of the hundred and fifty individuals examined were attached to a net-like hexactinellid sponge, and considerable expanses of the sponge are still adhering to the specimens. The minute, close-set, rigid spicule-bearing processes of the test give the surface considerably the nature of the chagrin of some sharks. Examination of the processes with a hand lens discovers them to be arranged about the orifices in quite regular fashion (pl. 1, fig. 2). In perspective the processes are regularly goblet-shaped, with the mouth of the goblet taking the form of the Greek acanthus. Each secondary process, corresponding to the petal of the acanthus flower, contains a rod-like calcareous spicule, the distal end of which is pointed, and corresponds to the tip of the process. The spicules do not occur in interior parts of the animal, excepting on the inner surface of the siphons and over a small, well-defined area on the inside of the branchial and atrial chambers, immediately around the orifices. These areas in all probability mark the inturned portion of the ectoderm. After the spicules are destroyed with acid a considerable cluster of cells is observable in the tubercles containing them. These probably produce the spicules. The question of the lobulation of the orifices in this species is unusually difficult. Pl. 1, fig. 2, shows the branchial orifice as seen in a surface view in a specimen with

far more suggestions of lobes than can be recognized in the majority of the large number of individuals examined. There can be no doubt about the presence of six lobes here. Whether they stand for realities in the living animal, or are merely results of retraction, I am not quite sure, but assume the former. The condition of the atrial orifice is still more dubious. Usually in an ascidian, where the lobes can not be made out by surface examination, separation of the test from the mantle brings out the true state of things. Applying this method here does not help. Indeed the edge of the orifice, when thus freed, is even more lobeless than when viewed from the surface.

As will have been noticed from the diagnosis the branchial sac is peculiar in several respects. The quadrilateral outline of the infundibula is unusual in Molgulids. Frequently the infundibula in this species are quite as broad at the inner end as at the outer, and the notching or forking of many of them is quite a new feature. The branchial folds, excepting the one nearest the endostyle on each side, are broad and thin, and as a consequence the infundibula are unusually flattened. The two folds adjacent to the endostyle are so thin as to be easily overlooked. The small size and irregularity of the stigmata is another peculiarity. One may examine the whole area of a branchial membrane without noticing more than the slightest inclination to curvature among the orifices. In other individuals a pronounced tendency of this sort is seen, some of the stigmata being curved to a quarter or even a half circle. Again, the membrane itself is unusually thick and heavy in the infundibula, and generally the stigmata are here considerably smaller than in other parts of the sac.

What I interpret as the "renal organs" are rather insignificant as compared with these structures in many other Molgulids. As mentioned in the diagnosis, they are situated on the inner surface of the mantle in the vicinity of the gonads. The largest one observed, in a large specimen, was not more than 2 mm. across. It consisted of a peculiar meandered folding of the epithelial layer of the mantle, the cells of which, though somewhat larger than those of the adjacent parts, had seemingly little in common with the tissue characteristic of the renal organ of the Molgulidae. But little coloring matter has been observed in any of these structures in this species, and no vesicles have been seen.

The gonads are practically of the same size on the two sides of the body. Only in the larger individuals are they fully developed. In these the axial part of the sausage-shaped mass is readily seen to be the ovary, and here many of the ova are relatively large. Along this ovarian axis, for its entire length, the pear-shaped testis lobes are disposed on both sides. These lobes are uniform in size and shape, and are placed with their larger ends directed away from the axis. Both gonads converge toward the atrial chamber so that their orifices, as well as the esophageal opening and the anus are near together, and all are near the atrial siphon.

The character, which more than any other, has compelled me to establish a new genus for this species is the calcareous spicules in the test. Starting from this feature, and considering along with it the slight extent to which the stigmata are curved, I have tried to force the species into the genus *Rhabdocynthia*, Herdman. But even relying on the spicules alone, the fact that in our present species they are confined to the test, whereas in *Rhabdocynthia* they are present in other tissues, as the mantel, branchial vessels, etc., makes a quite sharp contrast between the two types. There is, however, an undoubted tendency toward a curvature of the stigmata in *H. ovoidia*. When this is coupled with the well-marked infundibula of the branchial sac it becomes obvious that *Rhabdocynthia* will not receive our species, indeed that it must be associated with the Molgulas rather than with the Cynthias.

After the spicules the characters most seriously in the way of assigning the species to any recognized genus are the two orifices, the number of branchial folds, the position of the gonad of the left side, and probably the structure of the renal organ.

No Molgulid, so far as I am aware, possesses more than seven branchial folds on each side. Since, however, the genus Molgula is allowed six and seven folds (and five if, as Hartmeyer '03 believes, *Pera* should not be separated off), I should not be disposed to permit even the nine folds of *H. ovoidia* to stand in the way of assigning it to an old genus were there no other difficulties in the way.

As regards the relation of the intestinal tract and gonads, *H. ovoidia* has greater resemblance apparently to *Eugyra molgul-*

oides (Sluiter '04) than to any other species. But of course the characters of the dorsal lamina and branchial membrane put *Eugyra* out of consideration for our species.

Finally turning to the troublesome orifices, the recently established *Astropera* (Pizon '98), possessing as it does a gonad on each side of the body, holds out at first sight some promise of furnishing a lodging place for our species. But the absence of the peculiar petaloid lobes of *Astropera*, taken with differences in the number of branchial folds, and in the position of the left gonad relative to the intestine, to say nothing of the absence of the spicules in *Astropera*, make it out of the question to seriously consider uniting our species to Pizon's genus.

I conclude, then, that *Halomolgula ovoidia* is a representative of a group of Molgulids that holds some such relation to *Molgula* as that held by *Rhabdocynthia* to *Cynthia*. When, however, one searches through the known species of the family Molgulidae for a species that might have been the parent of *H. ovoidia*, not much success is met with.

In view of the fact, noted by Sluiter '04, that the species of *Rhabdocynthia* are, most of them, inhabitants of seas in which coral reefs abound, it is worth while to point out that such is not the case with *H. ovoidia*. There are very few corals or other calcium carbonate-producing species in the region to which this animal belongs. The collection contains about one hundred and fifty specimens.

Station 4425, 21.8 miles S. 7°E. point of San Nicholas Island, 1000 to 1100 fathoms, bottom green mud and fine sand, and globigerina, associated with much hexactinelid sponge. April 13, 1904.

Molgula regularis, n. sp.

Pl. 1, figs. 7 and 8.

Superficial Characters.—Ellipsoid, very regular in outline, surface entirely covered with foraminiferous shells and sand particles, which cling closely to the great number of filiform processes of the test. No definite area of attachment, though a thin membrane-like substance loosely adhering to one side of some of the specimens may mark the place of contact with the substratum on

which the body rests. No siphon nor orifices visible without removing the covering of foreign particles. Length of longest specimen, 4 cm.; thickness of same, 2.3 cm. Other specimens of the collection but little smaller.

Test.—Thin and leathery after adhering particles are removed; semi-transparent. Filamentous processes very numerous and slender, but little branched, foreign particles clinging to them throughout their length.

Mantle.—No definite muscle bands excepting around the orifices. Here large and strong bands regularly disposed radially around the orifices, uniform in length and terminating abruptly at their distal ends; also a narrow zone of circular fibres around each orifice. The rest of the mantle containing an open meshwork of fine fibres (pl. 1, fig. 7).

Branchial Apparatus.—Siphons entirely wanting. Orifices not far apart, the branchial being well forward, the atrial near the middle of the length of the body. On removal from the test the orifices found to be slightly but unequivocally six-lobed (branchial), and four-lobed (atrial). Branchial *tentacles* about ten, of several sizes, the largest large and copiously branched. *Hypophysis-mouth* a narrow ellipse directed somewhat obliquely to the long axis of the animal. *Peripharyngeal band* running close to the anterior ends of the branchial folds. *Ganglion* a little more than twice as long as broad, less than its length behind the hypophyseal mouth. *Dorsal lamina* a plain-edged rather broad membrane (pl. 1, fig. 8). *Branchial sac* with six prominent folds. Longitudinal vessels of the folds delicate and rather irregular in number and course; about five on each side of each fold, nearly equally spaced from one another. *Infundibula large,* extending full size to the edge of the folds and leaving little space between them along the transverse vessels. *Stigmata* large everywhere; little curved except as they extend around the infundibula.

Intestinal Tract.—Situated on the left side at the extreme posterior end of the animal; loop a close one. *Stomach* not large, nearly twice as long as broad, smooth-walled. *Intestine* very long and thin, of uniform diameter throughout; rectal half forming a wide semi-circle; anus without lobes. *Renal organ* consisting of a large brown, regular elongate central portion, surrounded by a

still larger clear part; situated on the right side of the body, close to the posterior end of the endostyle. *Gonads,* one on each side of the body, that on the left in front of the intestinal loop (pl. 1, fig. 7).

This species, clear-cut in its generic characters and also sharply set off from any other species of the genus, needs little of comment beyond what is brought out by the diagnosis. While it is one of those species so welcome to the systematist because of the positiveness in both its generic traits and in its specific differentiation from other known Molgulas, it is at the same time a good example of those species which present such a combination of specific characters as to make the question of what its closest affinities within the genus are, so difficult, but at the same time so interesting. For example, as regards surface covering, form, hypophysis mouth, number of folds in the branchial sac, and position of left gonad, *M. regularis* has much in common with *M. tenax* Traustedt, and on the whole one may conclude that it is more closely related to this than to any other species. At the same time, as regards the mantel muscles, the form of the gonads and the structure of the so-called liver, the two differ sharply. *M. tenax* has no such development and disposition of mantle muscles about the siphons as *M. regularis* presents us with (pl. 1, fig. 7). The testis of *tenax,* as shown by Hartmeyer '03, is a rounded single mass on each side instead of a whole series of small elongate lobes as in our species; and is situated to one side of the ovary instead of being scattered round it so as to give the latter a central position with reference to it. The liver in *tenax* is, according to Hartmeyer, "very exceptional in its enormous development." Nothing of this sort is found in *M. regularis.* But *M. arctica* Kiaer is a species in which the mantle musculature is very similar to that of *M. regularis.* Likewise the structure and relation of the male and female gonads in this far northern species are much like those of *M. regularis.* In the latter the relatively great elongation of the combined male and female glands, with the testes divided up into distinct and quite widely separated lobes, these being deployed around the ovary and scattered along its whole length, is to be regarded as an extreme expression of the same type as that represented by the glands of *M. arctica.* In this latter species, however,

we seem to have about the opposite extreme of the type, namely, variation in the direction of shortening the axis and concomitant crowding together of the testis lobes. Again, *M. arctica* would appear to conform to the usual Molgula type as regards the liver. But *M. arctica* has seven folds in the branchial sac, and, according to Kiaer, a narrow anus "with a faint indication of four lobes on the margin." Whether, consequently, *M. regularis* shall be regarded as more closely related to *tenax* or *arctica* will depend on the ever-recurring question of the value to be placed on different characters. There appears to be no particular prospect of reaching a generally recognized standard of reference for the question.

The collection contained half a dozen specimens. Station 4309, Point Loma Light N.44°, E. 8.6°, March 3, 1904, 67-73 fathoms, bottom fine sand and shells.

Halocynthia okai, n. sp.

Pl. 1, figs. 9 to 16.

Superficial Characters.—Nearly spherical, though some specimens distinctly elongated antero-posteriorly. Attached by posterior end, area of attachment usually small. Except on area of attachment, *thickly covered with long straight spines,* these bearing numerous small secondary spines. Each spine bearing a *radial tuft* of from four to six or eight spinelets at its tip. In addition to the long spines, numerous sessile whorled spinelets on the test between the bases of the large spines (pl. 1, figs. 9, 11, 12 and 13). *Siphons* short and often so hidden by spines as to be found with difficulty. *Color* brown to light gray. *Length* of largest specimens, 80 mm.; thickness of same, 55 mm. *Length* of spines of full-grown individuals, 10 mm. and more. *Test* strong and leathery, rarely more than 1 or 1.5 mm. thick. *Mantle* rather thick, not separating readily from the test; mantle musculature consisting of evenly-spaced bands radiating from each siphon, the crossing of the two series giving the mantle the appearance of closely woven cloth. The muscles extending over the entire body, but somewhat weaker in the intestinal regions.

Branchial Apparatus.—Siphons very short and broad, the branchial somewhat larger. Both four-lobed, the lobes distinct and tumid. *Tentacles* about sixteen in number, large and much branched, the branches arranged rather constantly in pairs of nearly uniform size, and bearing numerous secondary and tertiary branchlets (pl. 1, fig. 14). *Hypophysis* mouth horseshoe-shaped, somewhat broader than long, the ends turned in but not produced into spirals, the two horns of equal length. *Dorsal tanquets short*, slender and numerous. *Branchial* membrane with ten large folds on the left side and nine on the right, with suggestion of an additional fold on each side next to the endostyle. Each of the largest folds with ten prominent longitudinal vessels on each side, making twenty in all (pl. 1, fig. 16). Transverse vessels distinctly of two sizes. *Stigmata* small, uniform in size, extending lengthwise with reference to the folds. *Endostyle*, large and tortorous. *Ganglion* long and narrow, in some specimens extending nearly the entire distance between the two siphons.

Digestive Tract.—Situated on the left side, the loop about one and one-half times as long as broad, the rectal bend short; stomach small, not clearly set off from the intestine; anus with a distinct rim.

Gonads.—Consisting of about five cylindrical masses on the left side and four on the right, those of the left within the intestinal loop.

In the collection are a number of young specimens that are no larger than the largest specimens of *H. villosa* that I have seen, yet the spines are nearly as long and closely crowded in these as in the largest individuals. In no case are they scattered as they are in *villosa*. This species adds another to the considerable number of spiny Cynthias. It belongs to the *hilgendorfi* section of this group of species, *i. e.*, to the section having the branchial stigmata extending lengthwise with reference to the branchial folds instead of crosswise, as they do in *H. echinata* and its congeners. Oka (1906) has recently described two other species from the coast of Japan which in all probability belong to the same group, though the important point of the position of the stigmata he does not mention. Oka's species are *H. owstoni* and *H. ritteri*. *H. okai* appears to resemble *H. owstoni* more closely than any of the other

species, but from this it differs in the absence of the spirally inrolled horns of the hypophysis mouth; in the less number of tentacles, *owstoni* having thirty; and in the larger number of longitudinal vessels on the branchial folds, *owstoni* having seventeen or eighteen of these.

As our information now stands, the distribution of these Cynthias presents an interesting problem. There can be no doubt, as it appears, that *H. hilgendorfi* Traustedt, *H. owstoni* Oka, *H. ritteri* Oka, of Japan, and *H. okai*, of the Pacific Coast of the United States, are very close of kin. Furthermore, *H. echinata L.*, *H. arctica* Hartmr., *H. villosa* Stimp., and probably *H. castaneiformis* v. Dr., constitute another group of closely related forms that is, however, sharply separated from the *hilgendorfi* group by the difference in the stigmata already indicated. The *echinata* group seems to be well represented in the Arctic regions, the Bering Sea and Alaskan waters, but thus far is unknown south of Puget Sound on the American coast (*H. villosa* Stimp, Herdman 1898, Ritter 1901), or south of northern Japan (*H. arctica* Hartmeyer 1906). On the other hand, none of the *hilgendorfi* group are yet known from the region intervening between northern Japan and northwestern United States. (On re-examining certain specimens from Puget Sound which I (Ritter 1901) formerly assigned to *H. villosa*, I now find to be undoubtedly the same as those from the coast of Southern California which I am naming *H. okai*). In other words, the *hilgendorfi* group seems to be replaced at the north on both east and west shores of the Pacific by the rather distinct *echinata* group. Of course farther collecting may bring to light members of the *hilgendorfi* group in the Bering Sea and other Alaskan waters. It is desirable that a closer study, both as to structure and as to distribution, should be made of all these forms.

About twenty-five specimens were taken from five stations, as follows: 4552 Point Pinos light, S. 73°E., 4 miles, June 9, 1904, 73 fathoms, green mud and rocks; 4554 Point Pinos light, S. 76°E., 3 miles, June 9, 1904, 60 to 80 fathoms, green mud and rocks; 4555 (practically same as 4554); 4557 Point Pinos light, S. 25°W., 3.1 miles, June 9, 1904, 53 fathoms, rock bottoms.

Boltenia echinata, n. sp.

Pl. 2, figs. 17 to 19.

Superficial Characters.—Body ovate to elongate, surface beset with simple, slender, sharp, rather remote spines. Siphons distinct or not, at nearly opposite ends of body. Peduncle slender, of nearly uniform diameter throughout, slightly thicker at junction with the body; attached to dorsal side somewhat nearer the branchial orifice, starting off at a sharp angle with the long axis of the body. *Color* brownish white, body and peduncle nearly the same. Greatest length of body 1.75 cm. to 2 cm., greatest thickness 1 cm. to 1.5 cm. Length of peduncle two to three times that of body, greatest thickness of peduncle not more than 4 mm.

Test, very thin but firm and parchment-like, of uniform thickness, semi-transparent; entire body spiny, the spines of several lengths, slender, sharp, usually unbranched, but an occasional long one with one or more secondary processes. Each spine situated on a raised, clearly delimited area of test, the larger ones on larger areas, the smaller on smaller areas. No spines on proximal half of peduncle.

Mantle, very thin and closely adherent to the test, musculature consisting of a set of small, moderately numerous, regularly arranged and evenly spaced radial and circular bands, the radials of both orifices distinctly stronger than the circulars; and in addition a felt-work of much finer fibres.

Branchial Apparatus.—Siphons so short as to be unrecognizable in preserved specimens, or but little projecting from the surface of body, both regularly four-lobed. *Tentacles* about twenty, of unequal sizes, the largest long and copiously branched, the few strong primary branches carrying a great number of secondary branches. *Hypophyseal mouth* simple horse-shoe shaped, about as long as broad. *Branchial membrane* with twelve folds of very unequal size; internal longitudinal vessels, five or six on each face of the largest folds with one or two between the folds, small and all nearly of same size. *Stigmata* directed *transversely* to the longitudinal vessels, in general regularly elongate but in some regions shorter and with long

axes in various directions (pl. 2, fig. 18). *Dorsal languets* rather long, close together, no membrane.

Digestive Tract.—Situated on left side of body, loop regular, rather wide; stomach not large nor clearly set off from intestine; a short pedunculate pouch with shallow lobulated surface projecting from ventral edge of the stomach. *Gonads* two, one on each side of body, the left within the intestinal loop, both elongate and tortuous. The *ovary* constituting the main axial portion of each mass; the *testis* consisting of a double row of somewhat lighter colored elevations, along the outer side of each ovary.

There are two specimens of this species in the collection; one (fig. 17) from station 4558 Point Pinos Light, S. 79°, W. 2 miles, June 9, 1904, 40 to 48 fathoms, rock bottom; the other from station 4303 (fig. 18), Point Loma Light, N. 12°, W. 6.1 miles, March 1, 1904, 21 fathoms, gray sand bottom.

Cursory comparison of figs. 17 and 19 suggests that the two are quite different animals. This conjecture gains strength when it is noted that the first station mentioned is near Monterey and the other near San Diego. The diagnosis is given almost wholly from the specimens shown in figs. 17 and 19. I am inclined to believe the two to be distinct species; nevertheless the differences between them are not sufficiently great nor of a kind to warrant the separation on the strength of the single specimen of each available for examination. Although differences exist in some of the internal features as well as in their superficial ones, these differences are still more of a kind that may well be supposed to be individual. Should it in the future be found necessary to separate them, *Boltenia echinata* would be the name of the Monterey form, and a new name would have to be given the San Diego one.

Attention may be called to the apparently branched condition of the peduncle of the San Diego specimen. This probably comes from the peduncles of several individuals having fused together during growth, as the parts are now inseparable.

The transverse direction of the branchial stigmata is an especially noteworthy characteristic of the species. This recalls the same peculiarity in the *echinata* group of Halocynthias referred to under *H. okai* of this paper. Of the other Boltenias that pos-

sess the same character, *B. elegans* Herdman, has more in common with *B. echinata* than has any other species, but *elegans* is wholly devoid of surface spines. *B. bouvetensis* Michaelsen (Michaelsen, 1904) is interesting in this connection as furnishing a sort of intermediate condition between longitudinal and transverse stigmata. According to Michaelsen the stigmata in this species are very irregular, some being long, some short, some curved, some longitudinal, and some transverse.

Culeolus pyramidalis, n. sp.

Pl. 2, figs. 20 and 21.

Superficial Characters.—Body rather regularly pyramidal, slightly compressed, peduncle attached at apex of the pyramid close to the branchial orifice and on its ventral side, fig. 20. Base of the pyramid marked by the atrial orifice dorsally, the papillary band laterally, and by a pronounced patch of longer test papillae ventrally. Outline of base elliptical with long axes of ellipse dorso-ventral; base strongly convex, fig. 21. Siphons none. Surface in general even, but a series of not well defined grooves radiating from the atrial orifice. Entire surface thickly beset with minute papillae, and a distinct, sinuous *papillary band* marking off the base of the pyramid. Peduncle very long and slender, of nearly uniform diameter throughout, terminating in a disc provided with strong holdfasts. *Color* of body yellowish gray; peduncle blue gray. Greatest length of body 2.5 cm., long axis of elliptical base 2 cm., short axis of same 1.5 cm. Length of peduncle 19 cm.

Test thin, scarcely 1 mm. thick, firm and leathery, bearing a great number of low, conical papillae, each of which is situated in a definite area of clear test; blood ampullae in the test substance, and extending into the longer test papillae of the band.

Mantle thin and transparent except for the muscle bands, which are, especially on the atrial portion of the body, rather strong though not close together, the circular and longitudinal running at nearly a right angle to one another, producing a large-meshed network.

Branchial Apparatus.—No siphons nor lobes for either orifice,

branchial orifice close to the insertion of the peduncle and dorsal to this, much smaller than atrial, slightly elliptical, elongate crosswise of body, with a low but definite and even lip. Atrial orifice very large and wide open, distinctly elliptical, elongation crosswise of the body, the ventral border somewhat more arched than the dorsal; edge of the test bordering the opening so even as to give the impression that the orifice has been cut with a die. *Tentacles* of unequal sizes very long and strong, but branches neither numerous nor large. *Branchial membrane* without stigmata, composed of very loose wide-meshed netting of blood vessels, the whole so crumpled and distorted in specimens available as to make the true structure impossible of determination. A few spicules, mostly unbranched, in branchial vessels; more spicules, these irregularly branched, in tentacles. *None of the spicules calcareous*, they giving no evolution of gas when treated with acids.

Digestive Tract.—On left side, stomach not clearly set off from intestine, thin walled, and not (?) provided with coeca. Intestinal loop simple, narrow, irregular, the two limbs close together, the rectal being ventral to the stomach and running nearly parallel with and close to the endostyle for some distance. *Gonads* not determined.

There is not sufficient material in the collection to enable me to adequately describe this species. Enough can, however, be made out to warrant the conclusion that it is unidentifiable with any *Culeolus* hitherto described. The external characters, upon which I have chiefly to rely, which appear to differentiate the species, are: the position of the papillary band with reference to the atrial orifice. In most other species possessing the band it is continuous around the orifice instead of, as here, being interrupted by it (pl. 2, fig. 21). *C. quadrula* Sluiter 1904 approximates *C. pyramidalis* in this particular more closely, perhaps, than does any other species, but *quadrula* appears to be without the tuft of larger papillae at the lateral ends of the atrial opening, and the especially prominent patch at the ventro-posterior angle or prominence of the body. Furthermore the surface of the test of *pyramidalis* is not laid off into any such quadrangular areas as is that of *quadrula*. The radiating plicae and shallow

grooves around the atrial opening appear to be without a counterpart in any other species (fig. 21). It might be conjectured that these are artifacts. Their regularity, however, and particularly the sharpness of the grooves preclude, I believe, the possibility of their being accounted for in this way when the firmness of the test is considered. There is little doubt that they are structural. Again *C. pyramidalis* seems to outdo all other species in the great size and wide-openness of its atrial orifice.

The one character of internal structure that seems to be unique is the spicules. In other species these are spoken of as being calcareous. If they are actually of this nature in all other cases, then *pyramidalis* stands alone in possessing spicules of some other substance. What they are I do not know, but they are unaffected by hydrochloric acid.

There are three specimens of *Culeolus* in the collection, from two stations, *viz.*, 4394 and 4396, only a few miles apart. I am not sure that all belong to the same species. Two of the specimens, much smaller than the one here figured and described, have some important peculiarities of their own. One has a sacculated stomach wall and in this particular resembles *C. murrayi* Herdman and *C. thysonatus* Shiter. The number of specimens is not sufficient to enable me to decide what the significance of these diversities may be. I consequently prefer to leave the matter for the present without an attempt to more definitely assign the smaller individuals to their species. Since the animals come from a great depth, over 2,000 fathoms, the question here raised is of special interest, and it is greatly to be hoped that more material may be secured before long.

Station 4394, 32° 54′ N., 121° 15′ W. (just at the foot of the continental slope west of San Diego), March 30, 1904, 2,259 fathoms, soft gray mud. Station 4396, 33° 01′ N., 121° 32′ W., March 31, 1904, 2,228 fathoms, red mud.

Microcosmus transversus, n. sp.

Pl. 2, figs. 22 and 23.

Superficial Characters.—Cylindrical, axis transverse making the orifices at nearly opposite ends; attached by less than middle half of ventral side, the branchial end turning up somewhat more

than the atrial, and considerably narrower at the end, making an ill-defined branchial siphon. Surface very uniform and entirely free of foreign bodies. *Color* milk-white, uniform throughout. *Test* semi-cartilaginous, opaque, from one to two or more mm. thick; from its inner surface a filmy, half gelatinous, irregularly areolated layer readily separates. *Mantle* rather thick and heavy, its musculature consisting of especially large, regular, slightly separated muscle bands, the circular bands being largest. Both mantle proper and its muscles much reduced on the ventral side making the viscera, the gonads in particular, distinctly visible through the mantle.

Branchial Apparatus.—Branchial orifice distinctly four-lobed, atrial situated at the large posterior end of the cylindrical body, making a siphon scarcely recognizable. The test duplicature turned into the branchial siphon of considerable thickness and remaining with the test when the latter is removed from the animal. *Tentacles* unequal in size, sparsely and irregularly branched, few in number, about ten or twelve. *Peripharyngeal* band strong, very close to the tentacular circle. *Hypophysis* horse-shoe shaped, longer than broad, opening turned outward for about one-fourth of a circle; horns not spirally coiled but bent slightly inward. Dorsal lamina a broad area scarcely projecting into the branchial chamber though its two edges are raised into slight folds. *Branchial membrane* with six folds on each side, the second to fourth incluse very large; about five or six longitudinal vessels on each face of each of the prominent folds. *Stigmata* rather narrow, regular, longitudinal.

Digestive Tract.—Intestinal loop long, narrow, simple, situated on left side of body, both esophagus and anus near the atrial siphon, and the axis of the loop placed nearly parallel to the endostyle. *Esophagus* short and narrow, forming nearly a semicircle. *Stomach* but little thicker than intestine and not clearly set off from latter (less so than figure indicates). Wall with many inconspicuous longitudinal folds. A peculiar bulb-like inflation in the rectum near the anus.

Gonads two, one on each side, the left within the intestinal loop. *Ovary* cylindrical, regular, constituting an axial part, around which the uniformly sized, crowded *testis* lobes are dis-

posed. Right gonad close to the endostyle and extending parallel with it.

A single specimen from station 4420, east point of San Nicolas Island, S. 77°, W. 5.7 miles, April 12, 1904, 33 fathoms, bottom fine gray sand.

Judging from certain other species of simple ascidians that present considerable variability in the distance apart of the orifices, we may suppose that acquaintance with more specimens of *M. transversus* will find the unusual form of this particular individual not to be wholly constant for the species. We may be quite sure, however, that an exceptionally wide separation of the siphons is characteristic of the species.

As to general form *M. transversus* is approached in the remoteness of its siphons by *M. arenaceous* Sluiter (Sluiter 1904), but this latter species lacks considerable of being so nearly a cylinder with orifices at opposite ends, as is the particular specimen of *M. transversus* under observation. Furthermore *M. arenaceous* has a thin leathery test bearing numerous processes, and is covered more or less completely with sand. *M. transversus* is peculiarly smooth surfaced and free from sand. When note is taken of the fact that the animal comes from a sandy bottom, this trait as distinguishing it from *M. arenaceous* becomes of special weight. Another equally important distinction between the two species is found in the hypophysis month. This in *M. arenaceous* is broken up into a number of wholly distinct parts.

On the whole *M. transversus* appears to be a specially well defined species. It should be said, however, that in a few particulars of internal structure a more careful examination of more specimens may somewhat modify the diagnosis. For example, I am considerably in doubt about the number of tentacles. It is not impossible that a minute branchial fold may be present on each side next to the endostyle. The dorsal lamina should also receive more study. Again attention ought to be called to the fact that the stomach is not in reality so positively folded as fig. 23 gives the impression that it is. The folds are very small and may be easily overlooked.

Styela milleri, n. sp.

Superficial Characters.—Cylindric-ovoid, attached by a small area at posterior end; orifices both branchial the atrial somewhat toward the dorsal side. No siphons, but orifices distinct, both regularly four-lobed. Surface broken by a few irregular low wrinkles anteriorly, by large patches of indurated or warty thickenings posteriorly; the area of attachment bearing many short filamentous processes. *Color* yellowish brown, the warty areas darker. Length 22 cm., thickness 1.2 cm. *Test* very thin but parchment-like, readily detachable from the mantle; dull white on inner surface. *Mantle* thin, muscle fibers uniformly distributed, longitudinal and circular, not disposed in definite bands, the longitudinal generally somewhat stronger.

Branchial Apparatus.—Siphons entirely wanting, both orifices with clear-cut lobes. *Tentacles* of several lengths, about thirty long and slender ones of nearly equal length, and probably as many more shorter, but of unequal lengths. *Dorsal tubercle* prominent, bearing the broad simple horse-shoe shaped *hypophysis mouth*. *Branchial membrane* with four folds on each side, all broad except the one next the endostyle on the right side, two of the folds on each side next the endostyle drawn out anteriorly into long processes. Internal *longitudinal* vessels numerous and large, the largest folds having eighteen or twenty on each face. *Transverse* vessels consisting of a series of large and strong ones of nearly but not quite equal size, and between many of these, others very delicate, usually crossing the stigmata. *Stigmata* long and slender, with the intervening vessels also very narrow. *Dorsal lamina* a broad thin membrane not thin nor toothed, but closely crimped. *Endostyle* heavy, irregularly tortuous throughout.

Intestinal Tract.—On the left side of the animal. *Stomach* regular, elongate-melon shaped, the wall thrown into numerous close, regular ridges or folds. A short duodenal section of the intestine bent closely back upon the stomach, and from this a much longer rectal section having at about the middle of its length a short flexure extending forward along the dorsal side of the body almost to the atrial orifice.

Gonads.—Ovaries consisting of a single, much elongated cylindrical mass on each side, extending from antero-dorsal to postero-ventral. *Testes* consisting of closely crowded nodular masses grouped around the posterior ends of the ovaries.

Although this species is a typical Styela quite devoid of striking specific characters, I still find it impossible to assign it to any hitherto described species. On the whole it seems to have more in common with a Straits of Magellan form described by Michaelsen, and regarded by him as a variety of *S. canopus* (Sav.), which he names *magalhaensis*, than with any other known form. This variety, however, usually has distinct siphons, and two ovaries on each side, though according to Michaelsen, 1900, the siphons are occasionally wanting, and in a few instances but a single ovary on each side is present. Were both these variations to occur in the same specimen, the resemblance to our species would be close indeed. However, it seems that the long free ends of the branchial folds in *S. milleri* are without a counterpart in *S. canopus* var. *magalhaensis*. Probably also the test of this latter form is thicker and more uneven than it is in *S. milleri*.

It is interesting to note that this Styela shares with other deep-sea species the trait of possessing nothing distinctive of its remarkable habitat as contrasted with shallow water or even littoral species of the genus. Going upon the testimony of *Culeolus* in particular, but of other deep-sea genera as well, the generalization might be reached that deep-sea life causes degeneration of the branchial membrane. The abyssal Styelas exhibit no evidence of such effects. In the present species, for example, the membrane is if anything rather stronger than usual. It might be conjectured, I suppose, that these particular deep-sea species have not been subjected to this unusual environment long enough to produce the change. But what is the evidence of their being new arrivals in the great depths? There are now eight species, namely, *bathybia* Bonnevie, *bythia* Herd., *flava* Herd., *pusilla* Herd., *squamosa* Herd., *glans* Herd., *oblonga* Herd., and *milleri* Ritter, known from great depths, and it seems as though some of them should show the beginning of reduction of the sac if it is true that an effect of this sort is an inevitable

consequence of such an environment. This does not always seem to be the case. In fact the sacs of two of the species coming from the greatest depths of all are if anything rather stronger than the average. Concerning *S. bythia*, which was dredged by the Challenger in 2,600 fathoms, Herdman remarks that the branchial sac "looks rather thick and opaque," and that this is due to the "large number of internal longitudinal bars present," Herdman '82, p. 152. The sac of *S. milleri* may likewise be said to be rather thick and opaque for a Styela, and from the same circumstance.

A single specimen, station 4396, Long. 33° 01′ N., Lat. 121° 32′ W., March 31, 1904, 2,228 fathoms, bottom red mud.

Styela gibbsii Stimp.

Two specimens of this species were obtained at station 4558, and four at station 4431. The largest of these is 16 mm. long, and all the others, excepting one which is obviously young, are but little smaller. Since these come from two localities and are so nearly uniform in size they may be taken as fully grown. The average length of a hundred or more specimens from Puget Sound, now before me, is 35 or 40 mm., these likewise being quite uniform in size.

As the species has not been found in Alaskan waters, nor in any abundance on the Southern California coast, it is justifiable to assume that Puget Sound is near its metropolis, and that Southern California is near the southern limit of its range. At Puget Sound it lives in abundance on shore rocks above low-water mark.

Station 4431, Brockway Point, Santa Rosa Island, S. 43° W., 5.2 miles, April 15, 1904, 41 fathoms, yellow mud bottom. Station 4558, Point Lobos Light, S. 79° W., 2 miles, June 9, 1904, 40 fathoms, rock bottom.

Benthascidia, n. gen.

Long pedunculate; no siphons and no lobes to the apertures; the branchial orifice very large and not closable. Tentacles simple, short, very numerous, and many short papillae on the inner surface of the intratentacular circlet. Branchial membrane very delicate and *without true stigmata.*

Benthascidia michaelseni, n. sp.

Pl. 2, figs. 24 to 30.

The two specimens secured were both too much mutilated to permit clear recognition of what the general form of the body was. Unfortunately too a number of important anatomical points could not be made out with certainty. The description must consequently be understood to be incomplete. The specimens were curiously broken in almost exactly the same way.

External Characters.—Long pedunculate, the peduncle being smooth and column-like, thickest at base, gradually diminishing in diameter for about a third of its entire length, then as gradually increasing again to pass insensibly into the body (pl. 2, fig. 24). Length of the peduncle to where body thickening begins about 220 mm. Base of peduncle rising abruptly from a mass of fine short roots, or hold-fasts by which the animal was undoubtedly anchored to the bottom. Thickness of the peduncle immediately above the roots about 30 mm.

Form of the body undetermined, but quite certainly no projecting siphons. Whole animal, both body and peduncle hyaline to transparent, without pigment, the visceral mass showing through distinctly. Test for the most part very thin and soft, though thickened to 3 or 4 mm. on portions of the body, this thickening not uniform but producing low nodulations in nearly circular areas of sizes varying from a few mm. to 15 or 20 mm.

Mantle very thin and delicate, separating readily from the test. Muscle fibers of the mantle arranged in delicate though definite bands running generally in the same direction, hence parallel with one another (fig. 26). These considerably stronger and closer together in some portions of the animal than others, though distribution of the heavier portions not determined.

Branchial Apparatus.—Branchial orifice (without siphon) very large, 35 mm. in diameter, circular and without lobes or markings of any sort so far as ascertained. Atrial orifice not found (apparently far remote from the branchial orifice). Branchial *tentacles* minute and very numerous, three or four hundred, simple but irregular in shape, many larger at the free end and somewhat flattened. A great number of minute pro-

cesses projecting from the inner surface of the tentacular area (fig. 29). *Branchial Sac* exceedingly delicate, so much so as to be found with considerable difficulty in the mutilated specimens. No stigmata present but the sac composed of an irregular network of delicate vessels all in the same plane, through which at intervals run larger vessels of more regular course, *p.v.* (pl. 2, fig. 30). The direction of these large vessels with reference to the sac as a whole not determined since no part of the sac in situ has been seen. From the larger vessels other vessels of considerable size and length pass off to the mantle, *b.m.v.* No folds or internal papillae present.

Digestive Tract.—As a whole consisting of a single loop, the esophageal opening and anus being near together (pl. 2, fig. 29). Length of entire loop 5 cm., width of loop in broadest part 4 cm. Esophagus rather thick, more than half as long as stomach. *Stomach* somewhat cask shaped though slightly curved, about two-thirds as broad as long; wall thrown into a large number of fine folds running lengthwise of the organ, those most pronounced at the anterior end where the wall is of a brownish color. Intestine from stomach on diminishing slightly and uniformly in diameter to the anus which is somewhat inconspicuously four-lobed.

Reproductive Organs.—Male and female, situated alongside of and within the intestinal loop. The *ovary* a large curved sac, containing ova of about 2 mm. in diameter,—giant size for tunicate eggs. *Testes* irregular band shape, situated within the loop of the ovary and somewhat beneath it (pl. 2, fig. 27). Sperm duct consisting of half a dozen or more vasa efferentia, as they might be called, running together at a common center. From this center the sperm duct proper arises and takes a nearly direct course parallel with the rectal portion of the intestine, but extending some distance beyond the anus. The sperm duct pronouncedly club-shaped, the narrow end being proximal. (Probable that the expansion of the distal part pertains only to the period of sexual activity.)

I am considerably puzzled over my inability to find a second, presumably atrial orifice. In view of the dilapidated condition of the specimens it would be unwarranted to suppose the creature

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possesses but a single orifice. Nevertheless, unless the size of the body is enormous, no considerable portion of the test can be actually lacking, and it is surprising, to say the least, that the same orifice should have been lost in both specimens. A large expanse of test surrounds the orifice present, the branchial in each case, and this it is that leads to the conclusion that the two orifices are widely separated. If this be true, there would be a distinct similarity here between the present species and *Corynascidia.*

The structure of the peduncle deserves more attention than it gets in the diagnosis. I have labeled the core (pl. 2, fig. 24) *b.c.*, "body portion of the column." This I do not from evidence furnished by its structure, that it is an extension of the body wall. I have failed to discover either epithelium or muscle fibers anywhere in the column. The whole core is a firm, gelatinous, transparent material with spherical cells scattered uniformly, but by no means numerously, through it. My chief reason for supposing it to be in reality a portion of the body is that it is from this that the roots, or hold-fasts take their origin (see figure). Assuming these structures to be essentially the same as the hold-fasts occurring in other rooted ascidians, *e.g.*, *Rhizomolgula* and *Octacnemus*, the mantle must have been implicated in their production. There is no lumen, nor yet an axial strand of any sort discoverable in the core.

The outer sheath, fig. 24 *tst.*, is with little doubt entirely testicular. Its matrix does not differ perceptibly from that of the body, but it contains a far greater number and variety of cells than does the body test. Many of these cells are spherical, but many are long and narrow, almost to the extent of deserving to be called fibrous. These extend in all directions and are without regular arrangement.

One might expect to find stiffening or supporting elements of some sort in a stalk of the length of this, but none such exist so far as I have observed. It may perhaps be supposed that the organ serves as an anchor chain rather than as a supporting column.

The test of the body is noteworthy for its extreme transparency and the spareness of the cells contained in it. It is so

transparent that fragments, even after having been in preserving fluids for many months, can be seen in a glass of water only with considerable difficulty. I do not recall having examined the test of any other ascidian in which so few cells are present. Furthermore their regularity of form and size is exceptional. They present almost none of the elongations, stellations, and other irregularities common in most ascidians.

In addition to the general statement about the course of the muscle bundles of the mantle, it should be mentioned that in limited areas, probably though not certainly, in the vicinity of the orifices, bundles at right angles or nearly so, to those already described, are present.

In the diagnosis I have neglected to mention the tuft of tentacles situated within the branchial sac between the esophageal and anal orifices (pl. 2, fig. 28). My reason for this was my doubt about the nature of the organs. The most probable suggestion that can be made is that they are dorsal languets. Their closely grouped condition, their restriction to the small area near the esophageal orifice, and their slenderness, make, however, their interpretation by no means certain. But a still greater difficulty in the way of the suggestion is their position *between* the esophageal and anal appertures. Assuming them to be dorsal languets would involve the supposition that the median dorsal line of the animal passes between these orifices. This assumption I make on the evidence furnished by Corynascidia in this particular. I recognize, however, that the evidence is far from sufficient to establish finally the truth of such an assumption. In the one known species of Corynascidia, *C. Suhmi* Herdman, the "esophagus opens," according to Herdman's description, "on the dorsal edge," and the rectum "runs anteriorly in close contact with the stomach and intestine." Thus the dorsal line in this species is near enough to the two orifices to warrant the assumption I have made. The tentacles are not only very slender but they are also very thin walled and delicate.

Of the several other remarkable features about this ascidian, I may next speak of the dorsal tubercle and hypothesis. Pl. 2, fig. 29, shows the region where these structures seem quite certainly to have been situated. As a matter of fact, however, I

have been unable to find anything that can be identified as these parts. A peculiar knot, with no definiteness of organization, was present at the apex of the cone-shaped muscular body shown in the figure with its apex truncated. This was connected by tattered portions of tissue with the branchial membrane; but I have tried in vain to find anything in it that I could call gland, nerve ganglion, or duct. I must therefore leave the question of these parts almost as vague as that of the endostyle. The difference is that I have not even found where the endostyle *ought to be.*

The muscle bands in the figure are considerably stronger here than elsewhere in the vicinity, and I have not been able to trace the circular ones entirely around the circle of which they appear to be a segment. As little have I been able to follow out the entire course of the circular groove, *g.i.f.*, beyond the tentacles shown in the figure. No doubt can be entertained, however, that this is a piece of the peripharyngeal band. It is laid off as the figure shows into quite regular nodes by radiating cross grooves. Whether these exist in nature or not, I do not know, but am inclined to believe they do. The complete circle of tentacles I have not been able to find, the total number being calculated from the segment of the circle present. The great number of minute processes on the inner surface within the pharyngeal area, seen in the figure, *p.i.f.*, will not escape the notice of the reader, nor will they fail to excite curiosity as to their significance. I know of nothing comparable to them in any other ascidian.

I have spoken of the branchial sac as being without stigmata, but as consisting of a network of delicate vessels. The criteria applied in affirming that the irregular network of vessels constituting the branchial sac (pl. 2, fig. 30) contains no true stigmata, are two. First, the absence of cilia which are held to be characteristic of all true stigmata in Ascidians; and second, the absence of vessels situated on the inner surface of the web. This last criterion would be valid only on the assumption that the web should really be of the type presented by the genera related to *Corynascidia*, namely, *Hypobythius*, *Abyssascidia*, *Corella*, etc.; that is, that the vascular network present represents the "internal vessels" of the genera mentioned, the true stigmatic membrane being unrepresented in the present species. The possi-

bility, however, that we have to do here with a membrane of the Clavelina type, should not be forgotten, namely, one in which the true membrane is without *internal vessels.* Were this the truth the cilia criterion would be the only one by which the identification could be made. The view that cilia are absent may, I think, be accepted with confidence since were they present there should be no difficulty in observing them, for the specimens were preserved in formalin while still in a fresh condition. It can hardly be supposed that they were lost by post-mortem changes.

Not knowing the orientation of the visceral mass within the animal, I have said nothing in the diagnosis about the direction of the major vessels of the branchial network. From the fragment figured as connected with the visceral mass (pl. 2, fig. 28) it is seen that they run lengthwise of the intestinal loop. As the network is bound to the mantle of the vessels, there is no doubt that the fragment is in its natural position as regards the intestine. It would follow, if my assumption be true that the intrabranchial tentacles are dorsal languets, that these major branchial vessels run lengthwise of the body.

The irregularity in both size and shape of the meshes is most unusual. In this particular the species in hand appears to resemble *Bathypera splendens* Michaelson, more than any other ascidian. This species, however, Michaelson regards, seemingly with full justification, as related to *Molgula.* In other respects there is little in common between our species and *Bathypera.*

The problem of the affinities of this species would be difficult even were our information about its adult structure not so imperfect. That on the whole it has more in common with *Corynascidia* than with any other known genus may be gathered from the descriptions and discussions already presented. The several genera which it resembles to some extent are *Abyssascidia, Agnesia, Bathypera, Bathynoneus, Clavelina, Corynascidia, Eupera,* and *Hypobythius.* The following tabulation of characters of these genera will display most conveniently how *Benthascidia michaelseni* stands with reference to each genus:

	Abyssaseidia	*Agnesia*	*Bathypera*	*Bathyoncus*	*Clavelina*	*Corynascidia*	*Eupera*	*Hypotythius*	*Benthascidia*
General form	not pedunculate	not pedunculate	not pedunculate	not pedunculate	elongate, colony formed by budding	pedunculate	pedunculate	pedunculate	pedunculate
Test	soft and transparent	cartilaginous, transparent	leathery with calcarious spicules	Leathery, slightly or not at all transparent	cartilaginous transparent	cartilaginous semi-transparent	cartilaginous transparent	membranous transparent	cartilaginous transparent
Appertures	lobed	inconspicuously lobed	inconspicuously lobed	lobed but not prominently	not lobed	not lobed	not lobed or inconspicuously lobed	not lobed	not lobed
Branchial tentacles	simple filiform	simple	compound	simple	simple filiform	simple filiform	simple	not known	simple club-shaped
Branchial sac.	not folded, stig. straight, internal longitudinal bars present	not folded, stig. curved, inter. long. vessels absent, papillae present	folded, stigmata irregular, internal long. vessels present	folded, stigmata absent, internal long. vessels present	not folded, stig. straight, no internal vessels	not folded, stig. spirally coiled, inter. long. vessels present	folded (rudimentary), stig. absent	not folded, stig. irregular, no internal vessels	not folded stig. absent, an irregular web of internal vessels
Dorsal lamina	languets	languets	languets	membrane	languets	languets	fold with fleshy lobes	membrane	languets? filiform
Viscera	simple loop right side	?	unknown	left side	behind branchial sac	on dorsal edge of branchial sac	an open loop, left side of sac	open loop on dorsal edge of branchial sac	close loop on dorsal (?) side of sac
Gonads	on loop of intestine	in intest-loop, left side	single mass right side ? close to endostyle	elongate mass one on each side, attached to mantle	in intestinal loop	single mass on intestinal loop	3 masses on each side attached to mantle	massive in loop of intestine ova 1.5 m. m.	massive, in loop of intes., ova 3 m. m.
Depth	1950 to 2600 fath.	7 fath.	2603 fath.	1600 fath. to 2603 fath.	shore	1375 to 2160 fath.	2633 fath.	600 to 2900 fath.	2182 fath.
Distribution	Australia	Terra del Fuego	Enderby Land	Enderby Land	many localities	South Pacific	Mid Atlantic	N. Pacific, Mid Atlantic	Coast of California

From this it appears that *Benthascidia michaelseni* is nearer akin to *Corynascidia* than to any other genus. But even so the differences in the branchial sac of the two are too great to permit them to be placed in the same genus. Even were we to imagine the retrogressive modification of the interstigmatic vessels of *Corynascidia* already so far advanced, continued to their complete obliteration, the internal vessels with their long triangular processes (see Herdman '82, pl. XXV, fig. 6) would still have no counterpart in the sac of *Benthascidia michaelseni.* I am not disposed to attach as much importance to the internal vessels and papillae of the sac as some writers have done, yet considering all the groups of Ascidians in which they occur, they certainly present a high degree of constancy, and to place together in the same genus two species one of which possesses true stigmata, internal vessels, and papillae, while the other has the vessels alone, would be to grossly violate the most reasonable view we have been able thus far to attain relative to Ascidian morphology and classification. But it is probable that more knowledge will find other good generic differences between *Corynascidia* and *Benthascidia.* The minute processes on the inner surface of the pharyngeal area of the latter are likely to be such. And in this connection attention may be again called to the irregular club form of the branchial tentacles. I have thought that the enlargements and irregularities might possibly be either the beginnings or the remnants of branches of compound tentacles. The conjecture rests however on meagre evidence. *Benthascidia michaelseni* I place then, pending more light on its structure, near *Corynascidia,* and without taking a definite stand on the merits of the somewhat divergent views recently expressed by Michaelsen and Sluiter relative to just how this and the several related genera should be grouped into families, should hold it to belong to the order Ascidiidae as recognized by Herdman. However, before dropping the question of the relationship of our species, I deem it worth while to call attention to the particulars in which it inclines toward *Clavelina,* or perhaps better the Clavelinidae. The large open, lobeless branchial orifice may first be noted; but should my interpretation of the branchial web as being without true stigmata (which I do not believe will happen) prove to be at fault, then we should

have to look to *Clavelina* for the sac most resembling that of our species.

Station 4390, Lat. 33° 02′ N., Long. 120° 42′ W., at the foot of the continental shelf, off San Diego; depth 2,182 fathoms, bottom gray mud.

It gives me pleasure to dedicate this new and in several respects specially interesting addition to the ascidian deep-sea fauna to Dr. W. Michaelsen, in recognition of his efficient studies on both littoral and abyssal tunicate life.

Ascidia clementea, n. sp.

Pl. 3, figs. 31 to 34.

General Characters.—Somewhat pear-shaped, the small end bearing the branchial orifice, turned to the dorsal side. Outline rather regular, and surface even. Area of attachment at posterior end, and to some extent on left side. Siphons distinct even in contracted state; probably prominent in life. Branchial turned to the dorsal side; atrial on the dorsal side about midway the length of the body. The lobes of both orifices large, the ventral ones (uppermost from the bent-over position of the siphon) of the branchial orifice, larger. Eight lobes to the branchial orifice, and six to the atrial (pl. 3, fig. 31). *Test* semi-transparent, thickness moderate and nearly uniform in all parts of the body, rather soft. Length of largest specimen 11 cm., greatest thickness 6 cm., distance between orifices 5.5 cm. *Musculature of mantle* nowhere highly developed, wholly wanting on most of the left side; the constituent fibers without regular arrangement.

Branchial Apparatus.—Branchial *tentacles* 75 or more, simple, filiform, and situated on the edge of a *broad, rather thick membrane or velum* (pl. 3, fig. 33) *t.e.* *Hypophysis* mouth horse-shoe shaped, the open end directed forward. The right horn turned in slightly in the specimen examined. *Gland* rather large, situated behind the hypophysis mouth a little more than its own length. *Ganglion* long and narrow, the anterior end immediately over the gland. The *peribranchial groove* narrow, outside the tentacular corona a distance about equal to the width of the membrane that carries the tentacles. *Dorsal lamina* a broad

membrane with numerous ribs on its sides, and short processes on its edge. Anteriorly the edge of the lamina is grooved for a distance about equal to the length of the combined ganglion and hypophysis gland (pl. 3, fig. 33). At its posterior end the lamina passes to the right of the mouth of the esophagus, and extends a full centimeter behind this point, and from its extremity a shallow groove turns back on the lamina and extends forward to the esophagus mouth.

Internal longitudinal vessels of branchial sac all of one size, and uniformly distant from one another, armed with strong *papillae* at the crossings of the transverse vessels, and also with smaller intermediate papillae. Spaces between the internal longitudinal vessels about equal to the distance between the transverse vessels, so that the meshes are nearly square. A rather pronounced horizontal membrane on the transverse vessels. Besides the ordinary transverse vessels, a system of very *large vessels*, or pipes (pl. 3, fig. 34), *t.b.p.*, on the external surfaces of the branchial membrane. These mostly running around the sac, but with occasional anastomosing longitudinal pieces. Typically about a dozen series of stigmata between two of these transverse pipes, but sometimes fewer. The diameter of a pipe equal to the space between two transverse vessels.

The branchial membrane with deep, narrow *plications*, these however not regular, and not involving the entire area of the membrane. Where the plicae are not present, about seven stigmata between two internal longitudinal vessels.

Digestive Apparatus.—Situated on the left side. The intestinal loop wide and simple, there being a slight curve only in the rectal part of the intestine. Stomach but little larger in diameter than the intestine, which is of very uniform calibre throughout its length. Wall of stomach with numerous, regular well defined folds. Esophagus very small. Renal organ voluminous, situated in the mantle, and covering over the entire digestive tract, extending considerably beyond it all around. Composed of a conglomerate of large clear vesicles, in the center of each of which is a yellow green body (pl. 3, fig. 32, *r.*)

Reproductive Organs.—Situated in the intestinal loop chiefly, but the ovary extending behind it somewhat. The ovary a retic-

ulation. Testis branched, situated on and immediately behind the stomach. Both oviduct and vas deferens following the course of the intestine to open into the atrial chamber near the atrial orifice (fig. 32, *ov.* and *t.*)

Several rather important variations from the type here diagnosed have been observed.

In some individuals the ribbing of the dorsal lamina, and the corresponding toothing of its edge, pertain to only the posterior half, or even less, of the membrane.

The great transverse pipes, or vessels of the branchial sac, are far less conspicuous in some specimens than in the one here figured. Again the plications of the branchial membrane are but feebly developed in some specimens. Finally, the renal vesicles are much less in volume in some than in others.

As the specimens in which I have observed these less pronounced expression of characters, as set forth in the diagnosis, were both considerably smaller than that from which the figures and diagnosis were made, it is possible that the differences are age or growth differences. This however, judging from our knowledge of life stages in some other ascidians, is hardly probable. It is more likely that we have to do with true individual variations.

It is probable that a genus will ultimately have to be formed to receive the species represented by the animal here described, but until more material can be examined it has seemed the wiser course to place it provisionally in the central genus of the ascidia group. The presence of a voluminous renal organ in the mantle is, of course, a violent shock to the best established characterization of the genus *Ascidia*. This, however, is the only character that favors an alliance with *Ascidiella*, the other recognized genus that calls for consideration in connection with it. In the distance of the ganglion and gland from the hypophysis mouth; the presence of a post esophageal extension of the dorsal lamina; and of intermediate papillae on the internal longitudinal vessels, the *Ascidia* as opposed to the *Ascidiella* affinities are clear enough, particularly if the count is to be on a numerical basis alone. As a matter of fact I am of the opinion that considerably more weight should be given to the position of the renal organ than to

any single one of the other characters above mentioned. It can hardly be regarded as weighty enough, though, to offset all the others.

The two particulars which, in connection with those that tend to break down the distinction between *Ascidia* and *Ascidiella*, will probably entitle the form to independent generic rank, are the broad muscular velum, or valve, that carries the tentacles; and the great external transverse vessels, or pipes, of the branchial sac.

Even in the genera like *Cynthia* and *Microcosmus*, where the "Tentakelträger" reaches its greatest development, I know of no other instance of its having a width and strength at all comparable with what we have here. Not only is it distinctly broader than the tentacles are long, but it is well provided with muscle fibers.

Although the large transverse vessels are not so unique as the tentacle carrier, corresponding as they undoubtedly do to the "vessels of the first order" in numerous other Ascidians, there appears to be no instance in which they are so large relatively to the other transverse vessels, and particularly where their position is so largely on the external surface of the branchial membrane.

In the wide, simple intestinal loop this species resembles *A. archaia*, Sluiter, but this is about the only character common to the two. Relative to the *Ascidiella* character of the renal organ, it may be recalled that Kiaer ('93 and '96) has pointed out that the disposition of these organs cannot be relied upon altogether for separating the two genera, since in *Ascidiella obliqua* of the Norwegian seas, they are restricted to the intestinal wall. Kaier consequently excludes this point from his definition of *Ascidiella*. One specimen was taken at station 4405, near San Clemente Island, 654-704 fathoms, April 9, 1905; and seven from station 4425 (see data under *Ciona mollis*).

Ciona mollis, n. sp.

Pl. 3, figs. 35 to 38.

External Characters.—Very soft and flabby, preserved specimens all in a collapsed and more or less shriveled condition. Form variable, usually somewhat longer than broad, but never

greatly so. Semi-transparent, the strong muscle bands of the mantle, and the digestive tract distinctly visible through the test. Siphons distinct though not long. Some of the specimens clinging to fragments of hexactinelid sponge by the posterior end and left side; others adhering to a compound ascidian, and still others to an anemone. Largest specimens about 2.5 to 3 cm. in length. *Test*, soft, transparent, rather thin, containing great numbers of cells, many of which are of peculiar granular character. *Mantle muscle bands* strong, usually six on each side, scarcely stronger on one side than the other, those running lengthwise of the body converging to a point at the posterior end of the animal (pl. 3, fig. 35); circular fibers in the siphons only.

Branchial Apparatus.—Siphons both at anterior end and not far apart, rather prominent, the atrial a little longer. Branchial with eight lobes (normally) and the atrial with six (normally).

Branchial tentacles numerous, more than 200, filiform, of several lengths, the longer and shorter not regularly alternating (fig. 36). *Hypophyseal mouth* simple, narrow-elliptical, the long axis extending radially with reference to the tentacular circle; *gland* on ventral side of ganglion, smaller than the ganglion. *Dorsal languets* finger-like with broad transversely expanded bases, rather close together. *Branchial sac* with both longitudinal and transverse internal vessels; also with stout papillae. Transverse vessels of two sizes, the larger crossing the stigmata at their middle, the smaller in pairs one each side of each larger vessel, both crossing the stigmata. Longitudinal vessels slightly larger than the smaller transverse ones. *Branchial membrane* proper, without folds, stigmata straight, long and narrow, in regular series, the vessels separating the series of two sizes, the larger and smaller alternating regularly. From four to six stigmata between each two internal longitudinal vessels (pl. 3, fig. 38).

Digestive Apparatus.—Situated on left side far toward the dorsum, general form that of an elongated open S. *Esophagus* short, *stomach* regular, elliptical in longitudinal section, the long axis usually about twice the length that of the transverse; wall regularly and closely plicated, the plicae about twenty in number; situated at the extreme posterior end of the body, the long

axis directed transversely to the antero-posterior axis of the animal. *Intestine* quite as long as the animal and of nearly uniform diameter throughout its length; anal opening near the atrial siphon, surrounded by about eight rounded lobes (pl. 3, fig. 35). No "*liver*" present.

Reproductive Organs.—Ovary a compact mass situated in the posterior loop of the intestinal S, near the stomach. *Testis* not seen. *Genital duct* (oviduct?) running parallel with the intestine to open near the anus.

The muscle bands of the mantle are of an unusual and striking character in this species. Their course and arrangement are indicated in the diagnosis and in pl. 3, fig. 35. The figure would give the impression that they are confined to the right side of the body, as they are, practically, in many of the Ascidiidae. This is not the case. They are as strongly developed on one side as on the other, and the number is in general the same on the two sides. Although they converge toward the posterior end of the animal in so pronounced a way, they do not fuse together at the point of confluence, a small area being left there about which the bands terminate abruptly. A feature about the bands not well brought out by the figure is the fact that the constituent fibers are disposed chiefly in two bundles or columns, so that each muscle has the appearance of being double. The breaking up of each muscle into several branches as it enters the siphon may be noted, but this is not unusual.

The branchial tentacles (pl. 3, fig. 37) contain within the lumen a series of narrowly pyramidal structures the bases of which are directed toward the thickened, grooved, narrower side of the triangular tentacle. These appear to be of a connective tissue, or secretive nature, but what their office may be it is difficult to understand. I do not know definitely of anything quite like these bodies in any other ascidian. Herdman '99 has shown (pl. Cyn. XV, fig. 5) a condition of the tentacles of *Styela persona* that may be similar, but in the absence of a statement in his text relative to the point, it is not possible to know how close the similarity is. It will be seen from fig. 36 that the tentacles are situated on a slight ridge. So far as I am able to determine there are from 225 to 250 of these tentacles.

There is considerable variation from the typical structure of the branchial sac as this is given in the diagnosis, and in the figure (pl. 3, fig. 38). The secondary or smaller transverse vessels are frequently absent. The primary transverse vessels while undoubtedly to be regarded as "internal" since they usually cross the stigmata, are as a rule less raised above the surface of the membrane than the figure gives the impression that they are. Furthermore there are considerable stretches on some of the stigmatic series where the primary vessels are absent.

The distally lobulated, enlarged, curved papillae deserve special notice. It will be seen that in general a single smaller projection occurs on the side of the papilla underneath the larger terminal lobe, or bent-over end of the papilla. In many cases there are two or even three of these lateral processes. The internal longitudinal vessels are distinctly more "internal" than are any of the transverse ones. It is interesting to notice that the longitudinal vessels are connected with the papillae some distance from their bases, and quite independently of any of the secondary lobes of the papillae. The interest in this fact lies in its possible bearing on the question of the secondary lobes attached to the papillae of some other ascidians, notably *Perophora*. It has been suggested that the secondary lobes in that genus are the remnants of internal longitudinal vessels. In the species now under examination we have the longitudinal vessels in full development, and secondary lobes on the papillae besides. I do not mean to imply by this that I should regard the secondary papillae in *Perophora* and in the present species as homologous. The condition now described does, however, show the possibility of secondary lobes on the papillae quite independently of the internal vessels.

The *dorsal languets*, about fifteen in number, are as shown in fig. 36 much broadened transversely and flattened antero-posteriorly at their bases. They are considerably farther apart toward the posterior end of the row than at the anterior. They are not situated on a membrane or other prominence.

From the posterior extremity of the long meandering endostyle, a shallow but distinct gutter continues on, nearly or quite to the esophageal opening.

In view of the fact that generally the viscera in *Ciona* extends unequivocally behind the branchial sac, it is important to determine precisely the relation of these parts in the present species, where apparently the viscera are alongside the sac. So far as concerns the specimen represented in fig. 35, it would appear that it actually falls short somewhat of reaching back to the posterior limit of the body. In a majority of the specimens of the collection the digestive tract was in quite a different relation to the sac from that here shown. It was thrust out dorsally and somewhat posteriorly as compared with its position in the specimen figured. This condition I have supposed to be unnatural, probably due to pressure of some sort. As a consequence the specimen figured was selected because it was believed to be more nearly normal as regards artificial distortion than any of the others. I am inclined to believe that some of these others, could they have been examined before contraction and distortion, would have been found to conform somewhat more closely to the usual Ciona type of viscera than did the one figured.

Although the present species is very distinct from any *Ciona* hitherto described, there can hardly be a question as to its generic affinities. It is true that the viscera extend but slightly if at all behind the branchial sac and that this character has usually been regarded as a rather important one for the genus. In view, however, of the fact that in all other respects, unless possibly in the number and structure of the branchial tentacles, its Ciona traits are so positive; and in view of the further fact that probably in life the viscera do here extend somewhat behind the sac, and that in at least one other species of the genus, viz., *C. savignyi* Herdman, the backward extension of the viscera is not great, I have felt no hesitation in assigning *mollis* to this genus.

About a dozen specimens were taken all at one haul at Station 4425, 21.8 miles S. 7°E. of the east point of San Nicolas Island, 1100 fathoms, on bottom of green mud, sand and globigerina.

Cystodites cretaceous? v. Dr.

A large quantity of a fine representative of this genus, closely related to *C. cretaceous* v. Dr., comes from the vicinity of Monterey Bay. Although there are a dozen colonies, or perhaps pieces

of the same colony, the largest of which is not less than 15 cm. across, I am still unable to decide positively what to do with the species systematically. From what evidence I can get I can not differentiate it from Drasche's Mediterranean species. In color, size and general characters of the colony it appears to agree almost perfectly with that species. I think, too, the spicules are practically alike in the two. However, there is some doubt on this point, since very few of what I suppose to be the natural spicules are present in the specimens. The cellular portions of the spicule cases, and also calcareous matter, are abundant enough, but the calcium carbonate is in the form of minute, long, slender crystals, instead of being the usual Cystodites discs, though a very few of the latter have been found. My conclusion is that the original spicules have been destroyed, probably by the formaldehyde in which the specimens are preserved, and some of the calcium carbonate recrystallized in the form in which it now appears—though why this recrystallization should have taken place is not obvious.

As to the zooids, they are everywhere so excessively contracted that, in spite of much effort, I am unable to get at anything more than their general features. So far as these go, I can not distinguish the specimens from *C. Delle Chiajae* v. Dr., Neapolitan specimens of which I have compared them with; and from Lahille ('90) I learn that, so far as the zooids are concerned, *C. Delle Chiajae* does not differ in any essential way from *C. cretaceus*. On the whole, the zooids of my colonies are somewhat larger than are those of *C. Delle Chiajae*, but the difference may easily be due to the fact that the specimens from Naples are preserved in alcohol, while the Californians are in formaldehyde. The milk-white of the zooid capsules and the transparency of the remaining parts of the test are the facts that make me associate these specimens with *C. cretaceous* rather than with *C. Delle Chiajae*.

I think it is rather probable that when specimens of the California species are obtained in such condition that all their characters can be made out, a new species will have to be formed for them. Under present conditions, however, I must leave the point in doubt.

Station 4463, Point Pinos Light S. 17°W. 8 miles, May 13, 1904, 111 to 41 fathoms, rocky bottom.

Psammaplidium spauldingi, n. sp.

Pl. 3, fig. 39.

General Characters of the Colony.—Expanded, loosely adherent by whole under surface, top smooth but undulating, hard from great quantity of sand, which is uniformly disseminated through the whole test. Edge of the colony rolled up a little. The small zooids numerous, evenly distributed, no systems (?), each branchial orifice marked on surface of colony by a small papilla. Color uniform grey, due to the imbedded sand.

The single colony taken, 6 cm. by 5 cm. in its greatest dimensions and 1.8 cm. thick in thickest part, though considerably thinner in most places.

Zooids.—Abundant, long, slender and nearly straight, the thorax but little thicker than the abdomen and long post-abdomen. Thorax about 3 mm. long; abdomen, before contraction, probably about 2 mm.; post-abdomen variable, but several times as long as thorax and abdomen combined. Mantle containing a few slender longitudinal muscle bands which extend far down into the post-abdomen.

Thorax.—Branchial orifice on prominent siphon, six-lobed, atrial situated well back—a distance from the end of the branchial siphon about equal to the thickness of the thorax. Atrial orifice beset with a moderately long languet, this usually undivided, but occasionally bifid at tip. The long cylindrical sac with about eighteen series of short stigmata, muscle bands in interstigmatic series well developed. Endostyle large and tortuous. Branchial tentacles about ten, unequal in length, some of them quite long.

Digestive Apparatus.—Loop narrow, esophagus about equaling the stomach in length, and also about equal both in thickness and length to the pyloric portion of the intestine. Stomach with three or four large longitudinal folds or lobes. A distinctly set-off enlarged section of the intestine following the pyloric portion. Ascending rectal limb of the intestine straight, uniform in diameter and parallel with the descending limb.

Gonads.—Far behind the intestinal loop in the post-abdomen,

the testes further back and disposed in a number of spherical lobes.

This species falls into the section of the genus in which the zooids are long, slender and uniform in outline, and with *P. obesum* (Sluiter 1898), from the South African coast, represents about the extreme in this direction. In the character of the atrial languet and stomach folds, however, these two species are distinctly differentiated from each other.

A single colony, Station 4420. (See data under *Didemnum opacum.*

Didemnum opacum, n. sp.

Pl. 3, figs. 40 and 41.

General Characters of the Colony.—Narrow elongate (in the single specimen seen), thickness varying in different parts from 1 mm. to 3 or 4 or 5 mm. in places where well defined, rather pointed pyramidal elevations are present. Prevailing color dull brown with traces of green, but where the brown is absent the test is made white by the closely crowded calcareous spicules. Position of the zooids for the most part distinct by reason of the absence of the spicules which are very abundant in all the surrounding test. *Zooids* rather crowded, evenly distributed, no common cloacal orifices on the colony at hand. Length 3.5 cm., width in broadest part 1.3 cm. Attached by whole under surface to a fragment of silicious sponge. *Spicules* very abundant, especially concentrated in a thin layer slightly beneath the surface of the test, but scattered through the whole test, of the stellate form characteristic of the genus, but irregular in both size and conformation, the rays varying from pointed to truncate, and presenting always a more or less positive striate appearance. A massing of spicules into three distinct groups about the branchial orifice of the zooids, clearly visible to surface inspection of the colony as three white bodies equally spaced around the orifice.

Zooids.—Small, much contracted, probably not more than 2 mm. long when fully extended, thorax and abdomen seemingly of about equal length and not very sharply set off from each other; *Mantle muscle-bands* few, running obliquely backward from the anterior end.

Branchial Apparatus.—Siphons both distinct, the branchial longer, its six lobes varying from long and pointed to low and broad. Atrial very far back, obscurely six-lobed. Three rows of stigmata, each row on each side containing about twelve long, narrow openings. No considerable area of unperforated branchial membrane at either end of the sac. *Endostyle* heavy, tortuous, even in the least contracted specimens.

Digestive Apparatus.—Intestinal loop rather narrow, hardly broader than the thorax; stomach elongate globular, smooth-walled; a distinct pyloric section of the intestine, whole intestinal wall containing much brown pigment. Abdomen frequently but by no means always severed from the thorax in the preserved colony.

Reproductive Organs.—Only the ovary seen, this consisting of apparently a few large ova situated alongside the posterior end of the intestinal loop. *Tadpoles* very large, considerably exceeding in bulk the adult zooids. The adhesive tubes, and so-called "gemmiparous tubes" especially well developed; of the former three, the seemingly usual number, being present; of the latter there are typically six, all large, trumpet-shaped and closely crowded.

The zooids are so much contracted and so opaque in the single colony of this species that, in spite of much effort, I have been unable to make the examination as complete as desirable. Enough has been determined, however, to forbid its being identified with any species hitherto described. Its distinctness depends rather on the combination of several characters than on the positiveness of any. For example, the extremely far back position of the atrial siphon would not in itself be a character of sufficient importance to debar the species from several other members of the genus. When, however, this trait is taken together with the length of the siphon, its rather obvious lobing, it seems to become a good character. The absence of unperforated areas of branchial membrane at either end of the sac is also distinctive when joined with other trivial characters. The number of "gemmiparous tubes" of the tadpole is greater than in the young of any other species of which I have found figures of the larvae.

On the whole I should regard this species as more closely related to *D. sargassicola* Giard than any other, but Lahille ('90), from later studies of this species, considers it as not specifically distinct from *D. cereum* Giard, and from this latter our animal differs in several important respects.

Station 4420, east point of San Nicolas Island S. 77°W., 3.8 miles, April 12, 1904, 33 fathoms, bottom fine gray sand.

LITERATURE CITED.

Bonnevie, Kristine.

1896. Ascidiae Simplices and Ascidiae Compositae from the North Atlantic Expedition. The Norwegian North Atlantic Expedition, Zoology XXIII.

Giard, Alfred.

1872. Recherches sur les Ascidies Composées ou Synascidies. Thése, Paris.

Hartmeyer, Robert.

1903. Die Ascidien der Arktis. Fauna Arctica, B., III.

1906. Ein Beitrag zur Kentniss der japanischen Ascidienfauna. Zoologischer Anzeiger. Bd. XXXI, No. 1.

Herdman, W. A.

1882. Report on the Tunicata of the Challenger Expedition. Part I, Ascidiae Simplices. Challenger Reports Zoology, Vol. VI.

1892. Description of Some Simple Ascidians Collected in Puget Sound, Pacific Coast. Trans. Liverpool Biol. Soc., Vol. XII.

1899. Tunicata in the Australian Museum, Sydney, N. S. W.; Australian Museum, Sydney, Catalogue No. XVII.

Kiaer, Johan.

1893. Oversight over Norges Ascidiae Simplices. Christiana Videnskabs-Selskobs Forhandlings No. 9.

1896. A List of Norwegian Ascidiae Simplices. The Norwegian North-Atlanta Expedition. Zoology, XXIII, 3.

Lahille, Fernand.

1890. Contributions à l'étude anatomique et taxonomique des Tuniciers. Thèses, Toulouse.

Michaelsen, W.

1900. Die Holosomen Ascidien des Magalhaeneisch-südgeorgischen Gebietes. Zoologica, Band XII (12).

1904 Die Stolidobranchiaten Ascidien der deutschen Tiefsee Expedition. Wiss. Ergeb. der deutschen Tiefsee Expedition.

Oka, Osajiro.

1906. Notizen über japanischen Ascidien. Annotationes Zoologica Japanenses, Vol. VI.

Pizon, Antoine

1898. Étude Anatomique et Systematique des Molgulieés Appartenant aux Collections du Muséum de Paris. Annales des Sci. Naturelles, Zoologie, 8 serie, T. VII.

Ritter, Wm. E.

1901. The Ascidians. Papers from the Harriman Alaska Expedition. Proc. Washington Acad. of Sciences, Vol. III.

Sluiter, C. Ph.

1898. Tunicaten von Süd-Afrika. Zoolog. Jahrb. Abth. für Systematik, etc.

1898. Tuniciers Recueillis en 1896 par la Chazalie dans la mer des Antilles. Mem. de la Société Zoologique de France.

1904. Die Tunicaten der Siboga Expedition. Siboga Expedition, Monographie, LVIa.

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ABBREVIATIONS.

a. l.—Atrial languet.
b. c.—Body portion of column.
b. f.—Branchial folds.
br. o.—Branchial orifice.
b. m. v.—Vessels from branchial sac to mantle.
br. s.—Branchial sac.
b. t.—Branchial tentacles.
d. l.—Dorsal lamina.
d. ln.—Dorsal languets.
end.—Endostyle.
g.—Gland.
g. i. f.—Groove of intratentacular field.
gl.—Ganglion.
h. f.—Holdfasts.
hv. m.—Hypophysis mouth.
i. l. v.—Internal logitudinal vessels.
inf.—Infundibulum of branchial sac.
i. p.—Papilla of branchial membrane.
m.—Mantle.
ov.—Ovary.
p. b.—Papillary band of test.
p. g.—Peripharyngeal groove.
p. i. f.—Papillae of intratentacular field.
p. v.—Primary vessels of branchial sac.
r.—Renal organ.
s. d.—Sperm duct.
s.—Stomach.
t.—Testis.
t. b. p.—Transverse branchial pipes.
t. c.—Tentacle carrier.
t. ?—Tentacles of doubtful significance.
tst.—Test.
t. v.—Internal transverse vessels of the first order.
t. v.[1]—Internal transverse vessels of the second order.

EXPLANATION OF PLATES.

PLATE I.

Figs. 1 to 6.—*Halomolgula ovoidia.*

Fig. 1. Whole animal, natural size—a rather large specimen.

Fig. 2. Surface view of the test surrounding the branchial orifice, showing the arrangement of the papillae.

Fig. 3. A few of the papillae, considerably enlarged.

Fig. 4. A tentacle of the first order.

Fig. 5. The ganglion, hypophysis, and meandering course of the pericharyngeal band, dorsal view.

Fig. 6. One side of a branchial fold. Some of the stigmata are more elongate and curved than any shown in this figure.

Figs. 7 and 8.—*Molgula regularis.*

Fig. 7. Lateral view of the animal removed from the test. ×2.

Fig. 8. Ganglion and surrounding parts seen from inside the branchial sac.

Figs. 9 to 16.—*Halocynthia okai.*

Fig. 9. Whole animal, natural size.

Fig. 10. Branchial orifice, × 2.

Fig. 11. One of the large spines, × 3.

Fig. 12. A smaller spine without terminal whorl of spinelets, × 3.

Fig. 13. Two of the short whorled spines, × 42.

Fig. 14. A single tentacle.

Fig. 15. Small portion of the branchial membrane, inner surface.

Fig. 16. Scheme of a section of a branchial fold.

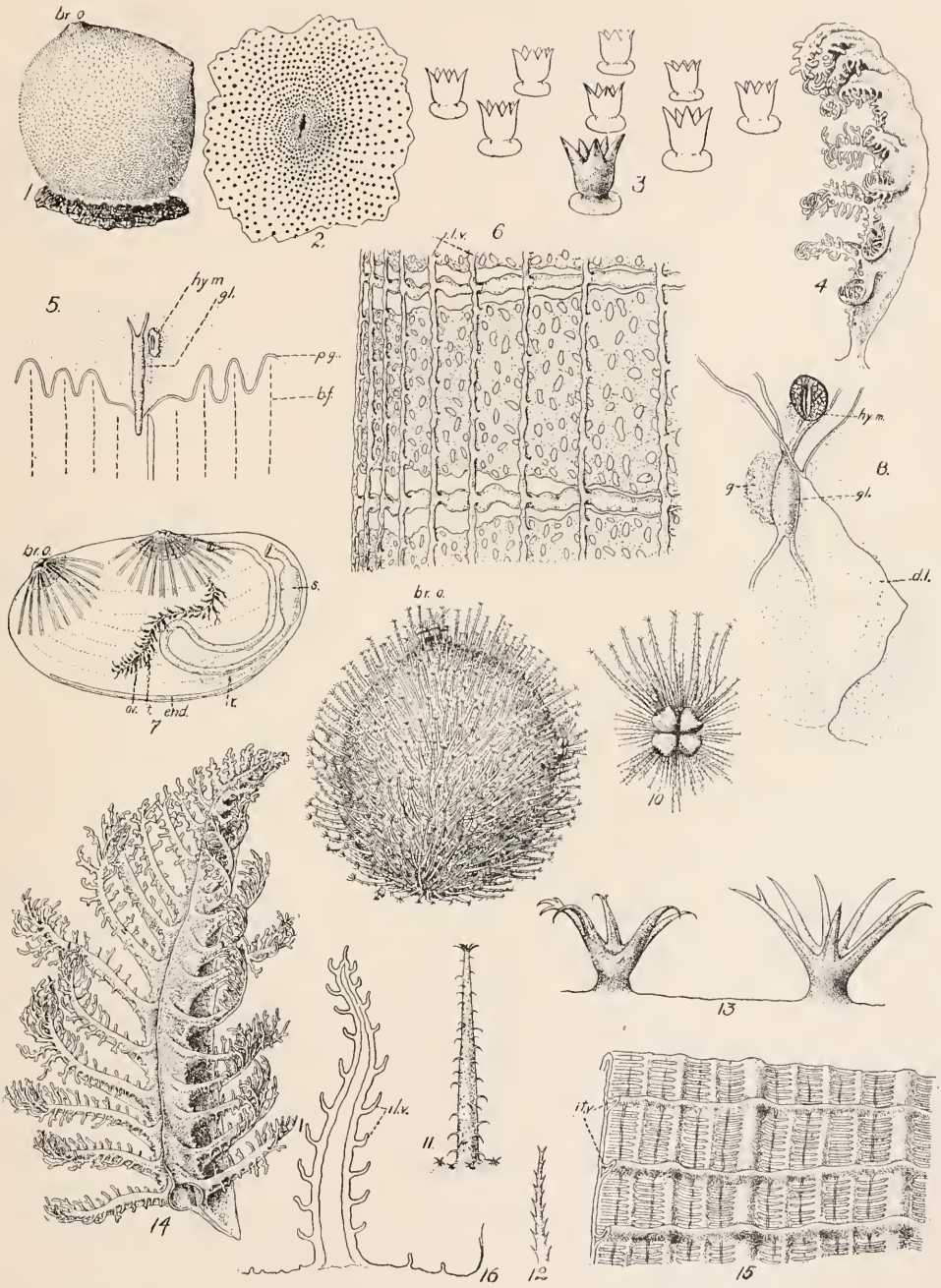
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PLATE 2.

Figs. 17 to 19.—*Boltenia echinata.*

Fig. 17. The whole animal from which the description is mostly drawn, × 1.

Fig. 18. One side of a branchial fold of the specimen shown in figure 17.

Fig. 19. The whole animal, a specimen from near Point Loma, that shown in 17 being from near Point Pinos. × 4.

Figs. 20 and 21.—*Culcolus pyramidalis.*

Fig. 20. Side view of the whole animal, × 1.

Fig. 21. Dorsal view same specimen, × 2.

Figs. 22 and 23.—*Microcosmus transversus.*

Fig. 22. Side view of the whole animal, × 1.

Fig. 23. The same specimen removed from the test and the mantle cut open and laid back, × 1.

Figs. 24 to 29.—*Benthascidia michaelseni.*

Fig. 24. The column with holdfasts, × 2.

Fig. 25. A small tuft of the holdfasts, × 12.

Fig. 26. Some of the mantle musculature in the region of the supposed branchial orifice.

Fig. 27. The digestive apparatus and sexual organs, × 1.

Fig. 28. Outline of the digestive tract, showing the tuft of filiform appendages near the esophageal orifice and a fragment of the branchial membrane attached.

Fig. 29. A portion of the tentacular circlet and hypophyseal region seen from within.


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PLATE 3.

Figs. 30 to 34.—*Ascidia clementea.*

Fig. 30. A fragment of the branchial network.

Fig. 31. The whole animal, × 2.

Fig. 32. The animal removed from the test, showing intestinal tract, reproductive organs and "kidney."

Fig. 33. Hypophyseal complex, dorsal lamina, and tentacular circlet seen from within.

Fig. 34. Small piece of branchial membrane with two of the large transverse vessels.

Figs. 35 to 38.—*Ciona mollis.*

Fig. 35.—The animal removed from the test, × 2.

Fig. 36. Hypophyseal region with dorsal languets and a portion of the tentacular circlet.

Fig. 37. A single tentacle.

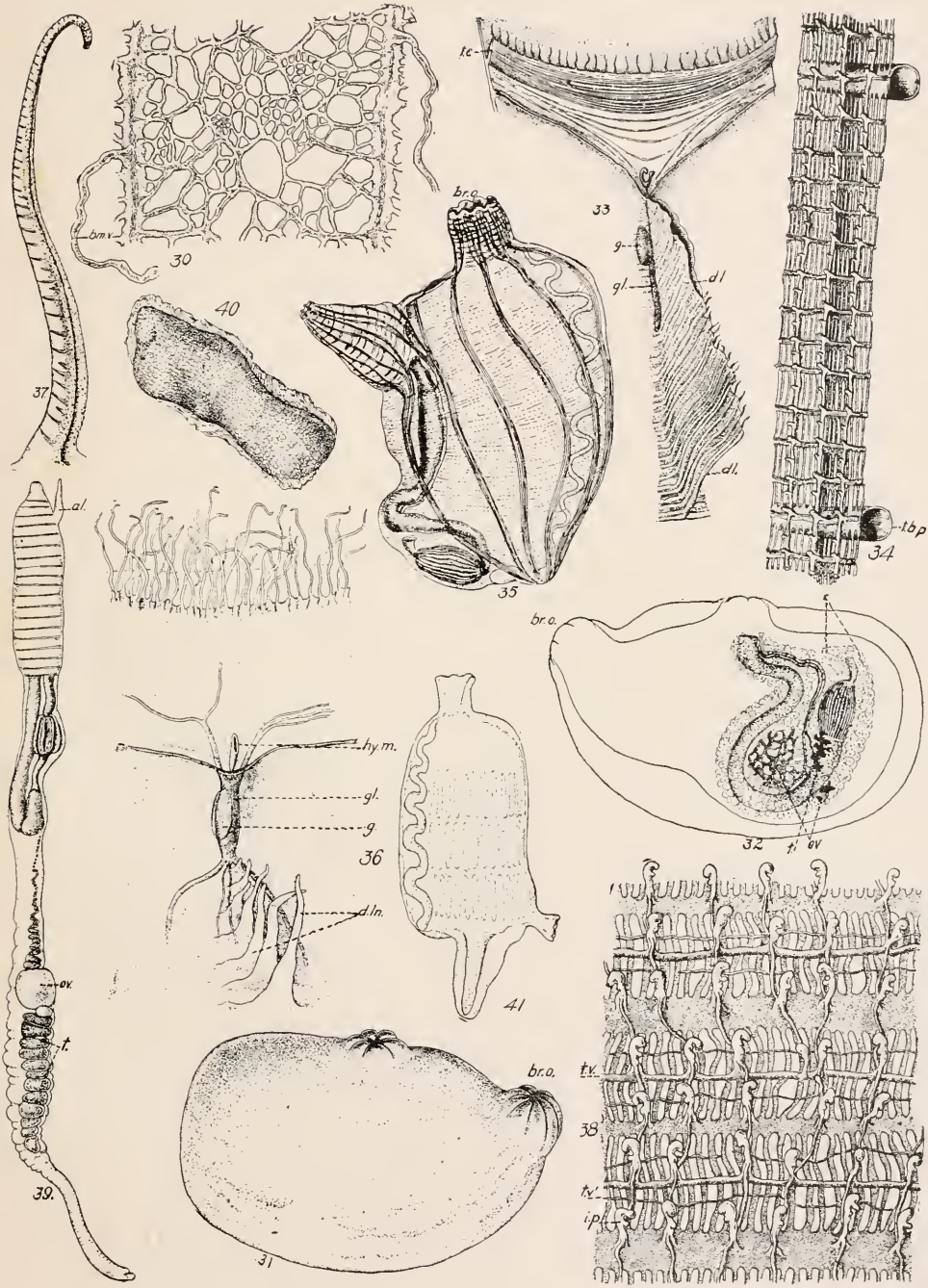
Fig. 38. Portion of the branchial membrane, inner surface.

Fig. 39. A zooid of *Psammaplidium* Spauldingi, × 20.

Figs. 40 and 41.—*Didemnum opacum.*

Fig. 40. The colony × 1.

Fig. 41. A branchial sac much enlarged.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