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DENDRODOA (*STYELOPSIS*) *ABBOTTI*, SP. NOV. (STYELIDAE, ASCIDIACEA) FROM THE PACIFIC COAST OF THE UNITED STATES, AND ITS IMPACT ON SOME GONADAL CRITERIA OF ITS GENUS AND SUBGENUS

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Abstract: ***Dendrodoa*** **(*Styelopsis*) *abbotti*, a newly described styelid ascidian from the central and northern California coast, the San Juan Islands of Washington, and southwestern Vancouver Island, resembles *D. carnea* but differs in branchial and gonadal traits. Inclusion of *D. abbotti* in the genus *Dendrodoa* requires modification of the gonadal criteria of the genus to accommodate styelan gonadal resemblances (non-encapsulation of the testis-lobes with the ovary) and styelan or cnemidocarpan spermiducal resemblances (gonad's single vas deferens and spermipore).**

Introduction

The tunicate named and described in this paper, *Dendrodoa* (*Styelopsis*) *abbotti*, is a styelid ascidian that has long been collected along the central and northern California coast. Donald P. Abbott, who first found this ascidian in 1948 near Point Arena (Mendocino County), included it as "*Alloeocarpa* sp." in the urochordate key of the second edition of *Light's Manual* (Light et al. 1954) but, for want of more certain identification, omitted it from that handbook's third edition (Smith and Carlton 1975).

This ascidian's aggregative habit does create an appearance of budding (Fig. 1A), but adjacent zooids' tests are unfused and easily separated from one another; no evidence of budding has been found in several hundred zooids from several sites and all seasons. Apparently, then, this is a solitary ascidian and cannot be placed in the genus *Alloeocarpa*. It shows *Dendrodoa*'s restriction of the single, elongate ovary to the zooid's right side. The ovary's unbranched shape and the pharynx's simplicity place the species in the subgenus *Styelopsis* of *Dendrodoa*. The specific name, *abbotti*, honors Professor Donald P. Abbott, of the Hopkins Marine Station of Stanford University, who has shared with his students and colleagues a singular keenness of intellect and generosity of spirit, and it expresses the esteem and affection of his fellow ascidiologists.

Materials and Methods

This report is based principally on specimens collected intertidally at Pigeon Point, San Mateo County, California (lat. 37°11′0″N, long. 122°23′10″W), at intervals of roughly six weeks throughout 1977. I have also drawn on material taken over the past two decades from there; from Point Pinos, Monterey County, California (lat.

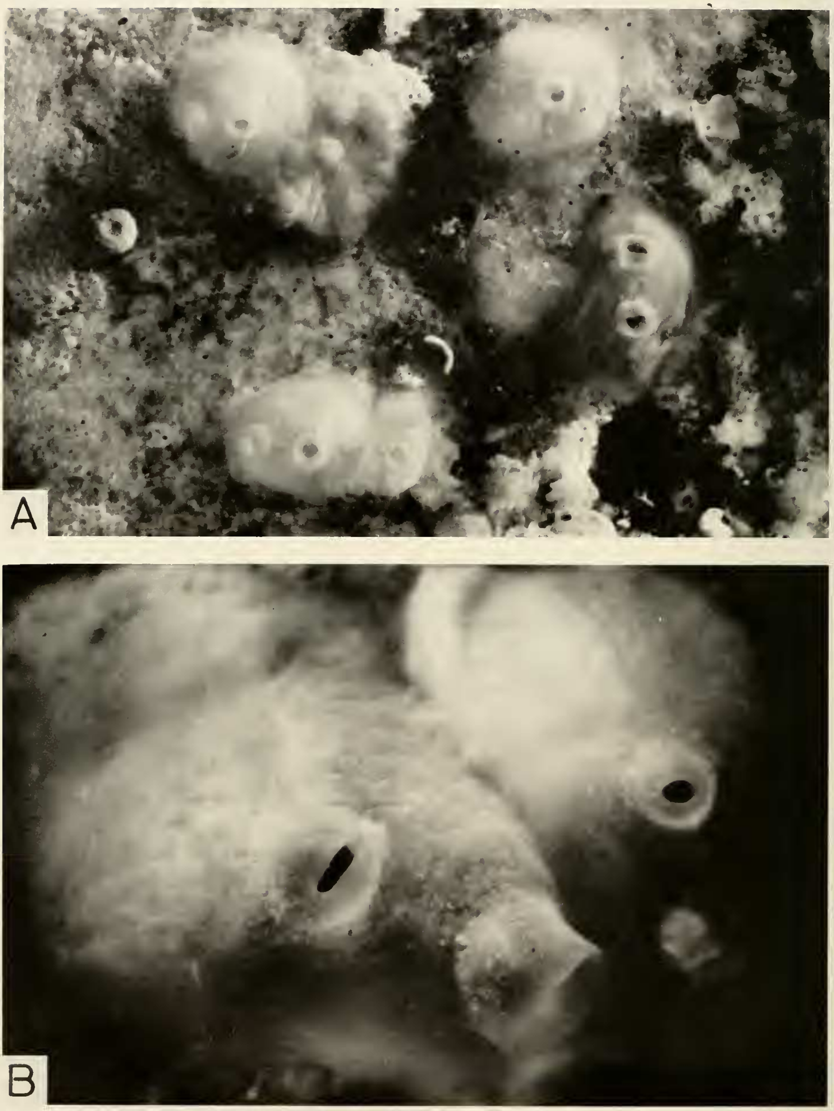


FIGURE 1. A) Living zooids of *Dendrodoa abbotti*, including one (upper left-center) that has been wounded or severely disturbed and is extremely contracted while the others remain relaxed. Zooids are about 1 cm long. B) Closer view of two slightly disturbed zooids, showing siphons in the process of bilabial closure. Brood pouch is detectable in the left zooid by inflated aspect of the posterior region of the zooid (to left in photo). Zooids are about 1 cm long.

36°38′0″N, long. 121°56′0″W); and subtidally from Peavine Pass (lat. 48°35′4″N, long. 122°45′48″W) in the San Juan Islands, Washington. I have used, as well, D. P. Abbott's unpublished notes and drawings of specimens from northern and central California.

In all, I have examined approximately 30 specimens thoroughly. I have examined several dozen more in a cursory way to verify the criteria that characterize the species. All specimens were relaxed with $MgCl_2$ or $MgSO_4$, and menthol, then fixed in seawater Bouin's fluid or 10% formalin, and all were preserved in 70% ethanol. The Bouin's-fixed material provided excellent serial sections but brittle dissections. Formalin always fixed adequately for dissections but rarely well enough for close scrutiny by serial section (which was required, for example, to trace the very fine spermiducts). Specimens were dissected in 70% ethanol. Dissected specimens usually were stained, once opened, with Grenacher's borax carmine; serially sectioned specimens were either prestained, often for prior dissection, in Grenacher's alcoholic borax carmine or stained in section with "standard alum hematoxylin" (Galigher and Kozloff 1964) and eosin. Prestaining proved satisfactory for general examination, but staining in section was necessary to reveal finer structural details or to take advantage of the better fixation achieved with Bouin's fluid than with formalin.

Coordinates.—The endostyle designates the anterior-posterior axis and the ventral midline. Thus, the dorsal midline extends from the oral siphon through and beyond the atrial siphon. By these coordinates, the ovary lies against the right ventral margin of the zooid, and the loop of the gut dominates the left posterior region of the zooid (Fig. 2).

Description of Species

Dendrodoa (Styelopsis) abbotti, sp. nov.

Type-specimens.—Holotype at California Academy of Sciences, San Francisco, Calif. (CAS #034790). Paratypes at California Academy of Sciences, San Francisco, Calif. (CAS #034791).

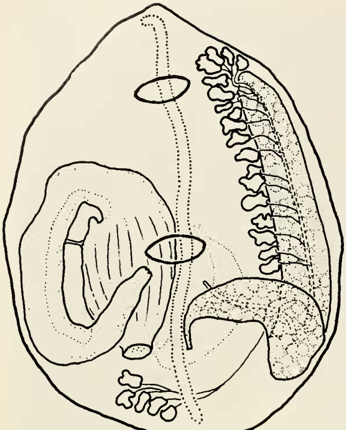
Type-locality.—North side of Pigeon Point, San Mateo County, California (lat. 37°11′0″N, long. 122°23′10″W).

Other Records.—Intertidal records from Point Pinos and Hopkins Marine Reserve (Monterey County), Pigeon Point and Moss Beach (San Mateo County), Point Arena (Mendocino County), California, and near Sooke, Vancouver Island, British Columbia; subtidal records from Peavine Pass (San Juan County), Washington.

External Appearance (Fig. 1).—Zooids round or oval (lengthened antero-posteriorly) low hemispheres; entire sub-endostylar surface applied to substrate; attached surface extends beyond ovary on right and gut-loop on left. Specimens including test reach 8 to 12 mm length, 6 to 10 mm width, 2 or 3 mm height when relaxed; zooids removed from test reach 8 to 10 mm length, 6 to 8 mm width, 2 to 3 mm height. Test clean, thin, and parchment-like, spreading as a thin apron 1 to 2 mm wide on the substrate around the zooid. Ventral test extremely thin. Color in life translucent gray tinted with ochre or very pale brownish pink, with borders of siphonal apertures sometimes slightly darker. Zooids fixed in formalin become plain translucent white-gray. Alive or fixed, zooid's branchial sac, gut, ovary, and mass of brooded young are faintly visible through dorsal and lateral regions of test. Oral siphon far anterior; atrial siphon placed centrally atop hemispheric zooid; both siphons fairly evident in relaxed living animals but reduced to obscure slits in contracted ones. Relaxed zooids have circular siphonal apertures; disturbed zooids close their siphons bilabially into transverse slits (Fig. 1B) and flatten themselves against the substrate within a delicately crumpled test. Zooids are simple and non-budding but often aggregate in pairs or trios (rarely groups of more) with young ones often settling adjacent to or even on the test "apron" around older zooids (but not on zooidal surfaces themselves). Mature zooids, even when tightly adjacent to one another, attach entirely to the substrate itself; they do not form clumps of zooids growing thickly one upon another. Adjacent zooids often are oriented similarly on the substrate.

Vascular Elements of the Test.—Test-vessels not prominent; as revealed by staining, branching systems of test-vessels ramify toward the margin of the test. Test-vessel ramifications connect to zooid by one or more sub-zooidal circulatory junctions; tips of all branches of test-vessel ramifications end peripherally in slender, bulbous vascular ampullae.

Mantle.—Thin, lightly muscled mantle except for extensive arrays of fibers radiating from each siphon and controlling its bilabial closure; fairly conspicuous concentric musculature surrounding oral siphon, less developed concentric musculature around atrial siphon. About a dozen endocarps project from the mantle into the atrium



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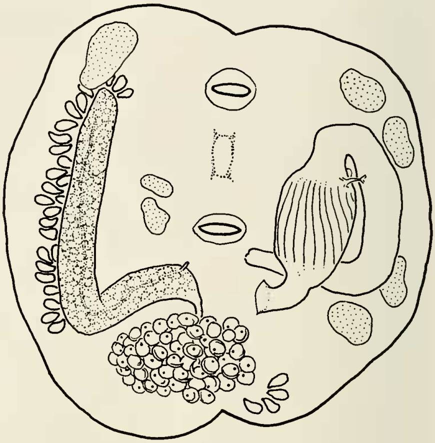

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FIGURE 2. Dorsal view of zooid, with pharynx removed to show disposition of ovary and testis-lobes (including far posterior group), vasa efferentia and vas deferens (including tiny spermiporal papilla near atrial siphon), mid-ventral endostyle and heart beneath it, and gut-tract (stomach, pyloric duct, caecum, intestine). Position of oral and atrial siphons indicated by ovals.

FIGURE 3. Zooid opened by mid-ventral cut to show ovary, testis-lobes (including posterior lobes), larvae in brood pouch, several endocarps (stippled), gut-tract, siphons with neural complex between them. Pharynx removed.

of most zooids; particularly large endocarps usually protrude from the atrial mantle anterior to the ovary and in the region of the gut-loop.

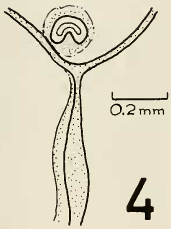
ORAL TENTACLES.—36 to 40 filiform oral tentacles of three sizes; largest ones most abundant (24–30), others about half their size intercalated irregularly, a few to many tiny papillae evident upon close examination of the band of oral tentacles. Just distal to this circle of tentacles is a siphonal flange that marks the inward limit of the test that lines the oral siphon.

ATRIAL TENTACLES.—40 to 50 tiny filiform atrial tentacles in band analogous to that of the circle of oral tentacles. Just distal to this inconspicuous circle is the atrial siphonal flange that marks the inward limit of the test lining the atrial siphon.

DORSAL TUBERCLE (Fig. 4).—Simple C-shaped slit atop a short, stout projection; concavity of the C faces posteriorly (toward the dorsal lamina). The dorsal tubercle is set slightly to the right of the dorsal midline.

NEURAL COMPLEX.—In dorsal or ventral silhouette, whole complex forms a rectangle elongated antero-posteriorly and extended somewhat at each corner. Like the dorsal tubercle, the neural complex is set slightly to the right of the dorsal midline.

BRANCHIAL SAC (PHARYNX) (Fig. 5).—Folds absent, perhaps represented by internal longitudinal branchial vessels. In dissection, 4 internal longitudinal vessels are evident on each side of the pharynx; in transverse serial sections, a fifth internal longitudinal vessel is sometimes discernible on each side close to the endostyle, and in a few specimens even a sixth vessel on each side may run only some length of the sac. Usually 9 or 10 stigmata lie between these internal longitudinal vessels. Ten to 12 transverse vessels separate the rows of longitudinally oriented stigmata, and there are about 10 parastigmatic vessels partly or entirely traversing each side of the pharynx. Along the ventral midline the branchial sac connects with the body wall by widely spaced sub-endostylar vascular trabeculae, not by a continuous sub-endostylar membrane. Other vascular trabeculae connect the branchial sac abundantly in all directions to the



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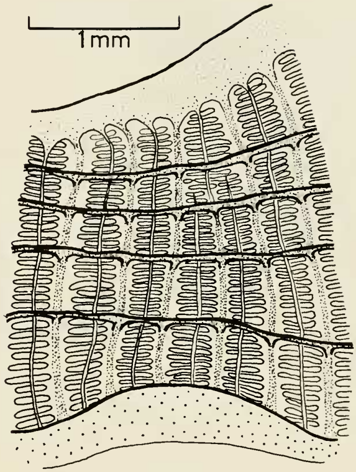

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FIGURE 4. Dorsal tubercle in relation to peripharyngeal groove and dorsal lamina.

FIGURE 5. Right side of pharynx, showing several rows of stigmata and the four internal longitudinal branchial vessels of the pharynx's right side. Dorsal lamina at top, endostylar groove at bottom. Drawing based in part on unpublished notes of D. P. Abbott, in part on freshly dissected specimens.

atrial surface of the mantle and to the atrial epithelium around the gut.

DORSAL LAMINA.—Prominent, continuous, smooth-bordered dorsal lamina, without languets.

GUT (Figs. 2, 3).—Esophageal aperture far dorso-posterior in pharynx; stout esophagus bends sharply ventrally into stomach; stomach empties anteriorly into fore-intestine, which bends to left and passes posteriad on the lateral side of the stomach. Hind-intestine then curves sharply dorsad and follows the left mantle to the anus, which lies slightly to the left-posterior of the atrial siphon. Stomach has 16 to 18 moderately evident external folds corresponding to well-developed internal gastric septa. The gastric septa are reduced to low ridges in the left pyloric region of the stomach, near the pyloric caecum. Pyloric caecum is small, sometimes absent. A highly vascularized pyloric duct joins the sinusoidal sheath surrounding the stomach with that surrounding the fore-intestine. Intestine comprises a fore-intestine with a large typhlosole-like longitudinal plication of its wall and a thick sinusoidal jacket between the gut wall and its sheath of atrial epithelium, and a hind-intestine of more simply tubular section whose atrial sheath is much closer to the gut wall. Anus lies dorso-medial or slightly to the left, above the stomach; anus is cut square to the axis of the rectum; anal margin is scalloped into usually 5 lobes that fit together when the anus is tightly closed.

HEART.—Fairly straight within a somewhat curved and inflated pericardium; set at about 45° obliquely to the endostyle, oriented right-anterior to left-posterior, centered roughly beneath the endostyle in the posterior half of the zooid (site and orientation in Fig. 2).

OVARY (Figs. 2, 3).—Single, unbranched, sausage-shaped ovary along the right ventral margin of the zooid, extending almost the entire length of the zooid, curving sharply dorsad posteriorly and following the right mantle to arch halfway over the atrium, recurving dorsally to terminate in an oviduct directed posteriorly toward the brood pouch and away from the atrial siphon. Oviduct lies lateral (away from atrium) to main mass of ovary, with its lumen penetrating among the ripening gametes; lateral surface (away from germinal tissue) of oviduct heavily ciliated, other oviducal surfaces apparently not ciliated. Ovaries of all specimens examined by dissection or serial section show all stages of ovogenesis present, regardless of season.

TESTIS (Figs. 2, 3).—A dozen to more than 20 separate lobate sacs, not encapsulated with the ovary but instead lying in the mantle wall adjacent to but clearly outside the ovary's delimiting membrane. Most sacs lie medial to the ovary; some lie anterior to the ovary; few are lateral; many lobes lie partly "beneath" the ovary, in the mantle between the ovary and the ventral surface of the zooid. In many specimens, but not all, a few testis-lobes lie far posteriorly and on the left side of the ventral midline, but their spermiducts join the vas deferens of the testis-lobes that lie beside the ovary. All sacs join by vasa efferentia to a single, long vas deferens that lies between the ovary and the atrial epithelium. This duct follows the ovary to the region of the atrial siphon, and there leaves the ovarian surface to project toward the atrial siphon from the dorsal roof of the atrium while the ovary bends posteriad toward its ovipore. The ciliated vasa efferentia are extremely thin, visible only in serial section; the vas deferens, also scarcely visible except in serial section, is a compressed, ciliated channel terminating in a tiny, spermipore-bearing papilla pointing toward the atrial aperture. In all specimens examined from all seasons for gametic condition, many testis-lobes have tailed sperm, but the spermiducts contain only scattered sperm.

BROOD CHAMBER AND BROODED YOUNG (Figs. 1, 3).—The posterior region of the atrium serves as a brood chamber, occluded anteriorly by the branchial sac, on the left by the gut-loop, on the right by the ascending limb of the ovary. All specimens examined were brooding young in all stages of development from (relatively rarely) fertilized eggs and cleavage stages to (usually) tadpoles that were still curled (although many of these straightened upon removal from the brood chamber during dissections). Quantities of brooded young vary greatly—fewest (20 to 30) in midwinter specimens, most (100 to 200) in late spring to midfall specimens. The brood chamber often is so swollen with young that it is readily apparent in living animals. Young are crammed tightly into the chamber; external study of zooids divested of test may suggest only a few larvae, but dissection then reveals many dozens. The brood chamber is criss-crossed by many vascular trabeculae that connect the branchial sac and the atrial and gut wall and may keep loose young from being swept from the brood chamber by atrial water-currents.

ECOLOGICAL DISTRIBUTION IN CALIFORNIA.—Intertidal. At Point Pinos and Pigeon Point, peak abundance is at about +0.3 m, and I have found no specimens at either site above +0.6 m or below 0.0 m. This is an open-coast ascidian in California, inhabiting surf-swept rocky habitats where the full force of the waves is broken by surrounding rocks and reefs. Zooids congregate on horizontal undersides of large boulders, usually well back from the boulders' edges. Such boulders restrict waterflow underneath, so much so that at Point Pinos the rocks that harbor *Dendrodoa abbotti* may lie partially in sand that by its odor and color appears to be virtually anoxic. At Pigeon Point most rocks with this ascidian are slightly propped up by their neighbors, so that oxygen remains plentiful in waters percolating or flowing underneath. Large boulders that do not have *D. abbotti* on them may shelter smaller rocks that do. Many rocks that seem appropriate for this species do not harbor specimens. This spotty distribution of aggregated individuals may indicate a short swimming period and quick settlement by brooded larvae, or as yet unclear ecological restrictions on the adults. At Pigeon Point, other invertebrates found on surfaces with *Dendrodoa abbotti* include the anemone *Epiactis prolifera,* the polyclad *Notoplana acticola,* the polychaetes *Spirorbis* and *Salmacina,* the barnacle *Balanus glandula* (and sometimes *Chthamalus dalli*), porcelain crabs such as *Petrolisthes,* several encrusting bryozoans such as *Eurystomella bilabiata,* the asteroid *Leptasterias pusilla,* and the aplousobranch ascidian *Aplidium californicum.* But none of these associated invertebrates seems so severely kept back from the margins of boulders, so cryptic in its under-rock habitat, as *Dendrodoa abbotti.*

ECOLOGICAL DISTRIBUTION IN WASHINGTON.—Subtidal. At Peavine Pass, San Juan Islands, specimens were dredged from 10 to 12 m. The species has been sought elsewhere in rocky areas, but only Peavine Pass, which is swept to the bottom by strong tidal currents, has proved a reliable site for collecting by this method, and even there the species is rarely taken. Debris harboring *Dendrodoa abbotti* contains, as well, *Bal-*

TABLE 1. *DENDRODOA CARNEA* AND *D. ABBOTTI*: CONSISTENT DIFFERENCES.

Feature	*Dendrodoa carnea*	*Dendrodoa abbotti*
Color in life	Bright pink to blood red.	Gray to ochre, occasionally reddish around siphonal apertures.
Siphonal apertures	Bilabial.	Bilabial, somewhat more pronouncedly so than in *D. carnea.*
Dorsal tubercle	Narrow ovoid slit whose axis is oriented almost anterior-posterior.	Fairly sharply bent "C" whose long axis is oriented laterally.
Transverse branchial vessels and rows of stigmata	17 or more.	Ca. 12.
Internal longitudinal branchial vessels and folds (DL = dorsal lamina, (#) = number of vessels in fold, E = endostyle)	Left: DL0(1)0(1)0(1)0(1)0E as in *D. abbotti.* Right: DL0(4–5)0(1)0(1)0(1)0E; prominent low fold carrying at least 4 vessels on right pharyngeal wall.	Left: DL0(1)0(1)0(1)0(1)0E as in *D. carnea.* Right: DL0(1)0(1)0(1)0(1)0E; no multi-vessel fold on right pharyngeal wall.
Endocarps	Many, small, widely scattered over entire atrial wall.	Fewer, larger, more (but not entirely) confined to ventral atrial surface.
Margin of anus	"Reflected but not lobed, often somewhat two-lipped" (van Name 1912, p. 587).	Scalloped into usually 5 lobes.
Ovary	Straight along right ventral margin of body; oviduct continues so.	Along right-anterior ventral margin of body, then bends sharply into ascending limb, recurves behind atrial siphon into dorsal oviduct that projects posteriorly.
Testis	Not clearly encapsulated with ovary, testis-lobes extend somewhat into body wall, predominantly ventro-lateral to ovary; all testis-lobes close to ovary.	Clearly not encapsulated with ovary, testis-lobes lie wholly in body wall, predominantly ventro-medial to ovary; often one posterior group of testis-lobes far from ovary.
Spermiduct	(?) as in *D. grossularia,* many short spermiducts converge in multiple spermipores on atrial surface of ovary (?)	Single, long vas deferens on atrial surface of ovary receives vasa efferentia of all testis-lobes, ends mid-dorsally in spermipore-bearing papilla pointing at atrial siphon.
Brood chamber	Extensive, including right-posterior region beyond oviduct there.	More restricted to far posterior part of body.
Brooded young	(From a small sample) only a few dozen embryos brooded at a time.	Many dozens to more than 100 embryos brooded at a time.

anus nubilis (one of the best indicators that the ascidian may be present) and the hydrocoral *Allopora.* The ascidian occurs especially around the husks of dead barnacles and in crannies in large rocks. But dredging of course destroys the set of surfaces and actual relationships among members of the fauna at the site, and so no comparison can yet be made between the subtidal habitat of *Dendrodoa abbotti* at Peavine Pass and its intertidal circumstances at Pigeon Point.

The bathymetric contrast between California and Washington (San Juan Islands) records of *Dendrodoa abbotti* is striking. The species may occur subtidally in California; its inaccessibility, beneath large boulders, could account for the current lack of such records by dredging or even by diving. But *D. abbotti* does not occur in the very low intertidal zone in California, below about mean low-low tidal levels. Thus, if it does occur subtidally, there is not a continuous distribution of the species from those depths to the low- to mid-tidal habitats where it characteristically is found. In contrast, in the San Juan Islands, I have not found the species at all intertidally in habitats that resemble California's coastal sites—except, of course, for the lack of surf in the San Juans. *Dendrodoa abbotti* appears to be only a subtidal species in that archipelago. But to the west of the San Juan Islands, on the southwest coast of Vancouver Island, B.C., Dr. Ivan Goodbody has found this species "on the underside of boulders at extreme low tide . . . on the open coast north of Sooke." Dr. Goodbody reports (pers. comm.) that the site there is "a rough boulder strewn shore with many large rounded boulders indicating heavy wave action." His record thus extends the intertidal range of *D. abbotti* into those Canadian habitats where surf does resemble California's. Dr. Goodbody's Canadian specimens of *D. abbotti* are now in the collection of the California Academy of Sciences.

Discussion

A. Comparison of *Dendrodoa abbotti* with *D. carnea*

A comparison of *Dendrodoa abbotti* with the western North Atlantic species *D. carnea*—the styelopsid dendrodoan that most closely resembles *D. abbotti*—indicates an array of differences, some trivial, some marked, but all consistent. This comparison sets a great many specimens of *D. abbotti* against necessarily only a few dissected specimens of *D. carnea* (from the USNM collection) and others' reports on *D. carnea* (see van Name 1912, 1945). But differences that emerge even in this perhaps unbalanced sampling of these species gain force as they become elements in a consistent pattern of distinctions between the two taxa, and this pattern has become more persuasive with each examination of new specimens. Table 1 summarizes the comparison.

Even arguably minor distinctions (for example, the character of the brood chamber or of the endocarps) take on significance in Table 1's array. The two species are most effectively distinguished, however, by the following criteria:

1. shape and disposition of the ovary;
2. testis-ovary relationship, including *D. abbotti's* posterior group of testis-lobes;
3. structure of the spermiducts, especially of the vas deferens;
4. arrangement and number of internal longitudinal vessels of the right side of the pharynx;
5. number of transverse branchial vessels and rows of stigmata on both pharyngeal walls;
6. shape and orientation of the dorsal tubercle;
7. color in life.

B. Generic Traits

By most accounts and diagnoses, in the genus *Dendrodoa* the testis and ovary are "encapsulated" within a common sheath (Monniot and Monniot 1972), and the testis comprises many lobes that do not lie in the body wall but rather hug the parietal (away from the atrium) surface of the ovary (Huntsman 1913). Most of the gonad of *Dendrodoa grossularia* shows this condition of encapsulation and testis-ovary juxtaposition clearly, although some of the anterior testis-lobes do lie more in the body wall than wholly against the ovary. *Dendrodoa carnea* exhibits a somewhat looser gonadal arrangement: the testis-lobes apparently are still encapsulated with the ovary and lie largely against its parietal surface, but they extend into the adjacent body wall much more than do the testis-lobes of *D. grossularia*, especially to the lateral (right) side of the ovary. *Dendrodoa abbotti* carries this loosening of the testis-ovary bond further still: the testis-lobes of *D. abbotti* lie "beneath" the ovary or close by on the medial (left) side of the ovary, but they lie in the body wall itself, not against the ovarian mass, and there is no sheath enclosing these gonadal elements into a single structural unit of intimately juxtaposed parts. And although most of the testis-lobes of *D. abbotti* lie very close to the ovary, there is often a group of testis-lobes lying in the far posterior atrial floor of the zooid, and actually on the left side of the zooid, although even this separated and isolated group is still connected by a vas deferens to the common spermiduct of all the other, "ovary-affiliated" testis-lobes.

Dendrodoa carnea is so much like *D. grossularia* (Traustedt's (1883) type species of his genus *Styelopsis*, now a subgenus of *Dendrodoa*) that Ärnbäck (1922) and Hartmeyer (1903) have both suggested these could be merely geographic variants of a single species—a view not held, however, by van Name (1945). The main distinction between these two species is their different number of internal longitudinal branchial vessels, more numerous in *D. grossularia* than in *D. carnea*. But the slight gonadal contrast reported here also seems to be a consistent one. The difference takes on added taxonomic significance when *D. abbotti* joins the comparison, because the genus thereby shows a series of testis-ovary juxtapositions from a tightly joined one to an appreciably looser one—from the condition "characteristic" of the genus *Dendrodoa* to one rather akin to that of the genus *Styela*.

Perhaps the perplexing *Dendrodoa uniplicata*

Hartmeyer 1903, which Millar (1966) redesignates *Styela uniplicata* Bonnevie 1896 because "the structure of the gonad agrees better with *Styela*," extends the *grossularia-carnea-abbotti* series of gonadal arrangements further while retaining dendrodoan features of the pharnyx. Unfortunately, the meager remnants currently available of *Dendrodoa* (or *Styela*) *uniplicata* will not by themselves resolve this question.

Another dendrodoan trait from which *Dendrodoa abbotti* diverges involves the spermiduct. In the genus *Dendrodoa*, testis-lobes empty in groups into very short vasa deferentia or even more cloaca-like pits on the atrial surface of the ovary, and there are several such spermiporal loci on the ovary (Berrill 1950). The repetition of short vasa deferentia, each emptying a group of testis-lobes, is not usually as striking in *D. grossularia* as in the somewhat stylized depiction of this trait by Lacaze-Duthiers and Delage (1892), from which work many accounts of the species have been partly drawn. But Riedlinger (1902) indicates in his careful study how slight or even absent the vasa deferentia may be in that species, in place of which spermiporal loci serve the converging vasa efferentia of groups of testis-lobes. *Dendrodoa carnea* also appears to have multiple spermipores along the atrial surface of the ovary (again, though, a condition difficult to discern in dissections). In contrast, the gonad of *D. abbotti* has a single, long vas deferens, as in *Cnemidocarpa* and *Styela* (Fig. 2). All the spermiducts of this species are exceedingly fine, and their disposition difficult to trace except in serial sections. Such a close scrutiny of *D. carnea* would seem appropriate, to find out if that species is intermediate between *D. grossularia* and *D. abbotti* in this trait, as it is in testis-ovary juxtapositions.

Dendrodoa (*Styelopsis*) *abbotti* is placed in *Dendrodoa* by its possession of a single gonad, and in *Styelopsis* because of its unbranched ovary and its simple pharynx, which lacks folds and possesses few internal longitudinal vessels. *Dendrodoa abbotti* is so much like *D. carnea*, which in turn is so much like *D. grossularia*, that this placement of the new species seems indisputable. But the consequence is to relax and modify long-held gonadal criteria of *Dendrodoa*, recognizing that species with styelan gonadal patterns or cnemidocarpan spermiducal patterns occur in the genus.

Acknowledgments

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