



The family Ascidiidae Herdman (Tunicata: Ascidiacea) in Bocas del Toro, Panama. Description of six new species

NADIA Y. K. BONNET¹ & ROSANA M. ROCHA²

¹Universidade Federal do Paraná, graduate program in Zoology, CP 19020, 81.531-980, Curitiba, Paraná, Brazil.

E-mail: nyk_bonnet@yahoo.com.br

²Universidade Federal do Paraná, Zoology Department, CP 19020, 81.531-980, Curitiba, Paraná, Brazil. E-mail: rmrocha@ufpr.br

Table of contents

Abstract	1
Introduction	1
Material and methods	2
Results	3
<i>Ascidia archaia</i> Sluiter, 1890	3
<i>Ascidia bocatorensis</i> sp. nov.	4
<i>Ascidia collini</i> sp. nov.	7
<i>Ascidia corallicola</i> sp. nov.	10
<i>Ascidia curvata</i> (Traustedt, 1882)	13
<i>Ascidia interrupta</i> Heller, 1978	14
<i>Ascidia monnioti</i> sp. nov.	16
<i>Ascidia</i> cf. <i>munda</i> Sluiter, 1897	19
<i>Ascidia panamensis</i> sp. nov.	21
<i>Ascidia sydneyensis</i> Stimpson, 1855	24
<i>Phallusia fragilis</i> sp. nov.	26
<i>Phallusia nigra</i> Savigny, 1816	29
Tabular key for Caribbean Ascidiidae species	32
Acknowledgments	32
References	32

Abstract

We have been collecting Ascidiaceans in the Bocas del Toro region of Panama since August 2003, mostly in the mangroves but also in shallow coral reefs. Here we will describe six new species from this region (*Phallusia fragilis*, *Ascidia bocatorensis*, *A. collini*, *A. corallicola*, *A. monnioti* and *A. panamensis*), register and complement the description of an additional seven species in the family Ascidiidae (*A. archaia*, *A. curvata*, *A. interrupta*, *A. cf. munda*, *A. sydneyensis*, *A. tenue* and *Phallusia nigra*). We also provide a tabular identification key that also includes *P. caguayensis* and *A. xamaycana*. Most of the species are very abundant on mangrove roots.

Key words: *Ascidia*, biodiversity, *Phallusia*, taxonomy, Tunicata

Introduction

Although a wide variety of species of ascidians are found in the Caribbean Sea, most islands and much of the coastal southern Caribbean have not been extensively surveyed for ascidian species. Van Name (1945) listed sixteen species of Ascidiacea for the Atlantic coasts of Costa Rica, Panama, Colombia and Venezuela, of which only three occurred in Panama.

A recent review of the ascidian species in Bocas del Toro included 58 species and compared this fauna with other locations in the western Atlantic (Rocha *et al.* 2005). Tunicate diversity is greater than that compared with other Caribbean sites and tunicates are surprisingly abundant on prop roots. The genus *Ascidia* is one of the most species rich, including six new species that we will describe here (*Phallusia fragilis*, *Ascidia bocatorensis*, *A. collini*, *A. corallicola*, *A. monnioti* and *A. panamensis*). Five species were previously known from the region (*A. archaia*, *A. curvata*, *A. interrupta*, *A. sydneyensis* and *Phallusia nigra*) and one possibly recently introduced species was identified (*A. cf. munda*).

Material and methods

Ascidians have been surveyed in a variety of areas in the Bocas del Toro province (Table 1) in northwestern Panama since 2003. Most samples were in shallow water (< 3.0 m) among mangrove roots and coral reefs, with fewer samples from artificial substrates and experimental polyethylene plates. The region includes shallow bays bordered by mangroves, both along the island and continental margins and the sea bottom is covered by *Thalassia testudinum* beds or shallow coral reefs (Collin 2005). Human impact is increasing in the region because of large investment in tourism in the last 6-8 years. As a consequence, mangroves have been cut for timber and replaced by many over-water buildings, creating new habitat for sessile fauna.

Descriptions of collecting and fixation methods and of sites can be found in Rocha *et al.* (2005). Holotypes were deposited in the Museu de Zoologia da Universidade de São Paulo (MZUSP) and paratypes were deposited in the Departamento de Zoologia da Universidade Federal do Paraná (DZUP).

TABLE 1. Locations and geographic coordinates where species were collected in Panama.

Collecting Site	Location	Latitude	Longitude
Galleta floating dock	Colon city	9°24'15"N	79°51'49"W
Galleta Station	Colon city	9°24'07"N	79°51'40"W
Punta Caracol	Colon Island	9°22'27"N	82°17'53"W
Big Bight	Colon Island	9°22'N	82°16'W
Casa Blanca	Colon Island	9°21'42"N	82°16'29"W
STRI Bay	Colon Island	9°21'09"N	82°15'32"W
STRI dock	Colon Island	9°21'04"N	82°15'26"W
Mangrove Inn	Colon Island	9°19'55"N	82°15'14"W
Marina	Colon Island	9°20'08"N	82°14'48"W
City	Colon Island	9°20'08"N	82°14'32"W
Sachen	Colon Island	09°21'11"N	82°12'50"W
Hospital Point	Solarte Island	09°20'04"N	82°13'10"W
Garden	Solarte Island	09°19'30"N	82°13'11"W
Baía Honda	Solarte Island	09°18'22"N	82°10'28"W
Solarte	Solarte Island	09°16'38"N	82°12'24"W
South Solarte	Solarte Island	09°16'37"N	82°12'24"W
Bastimentos Island	Bastimentos Island	09°16'49"N	82°10'20"W
Crawl Cay	Bastimentos Island	09°15'16"N	82°08'10"W
Popa Island	Popa Island	09°13'44"N	82°07'28"W
Pastores Island	Pastores Island	09°14'15"N	82°19'47"W
Isla San Cristobal	San Cristobal Island	09°14'N	82°13'W
Almirante Bay	Bocatorito Bay entrance	09°14'N	82°14'W
Bocatorito Bay	Bocatorito Bay	09°13'N	82°12'W

Results

Principal characteristics of the newly described species are summarized in the tabular key for species identification of the Caribbean Ascidiidae, based on observed characters and complemented with bibliography (Table 2). This tabular key may be observed after the descriptions.

Ascidia archaia Sluiter, 1890

(Fig. 1)

Material examined. DZUP ASC58—1 ind.; City; on polyethylene recruitment plate; 12/xi/2009.

Individuals are usually small, around 1.0 cm long, oval in outline. This species is uncommon with only one specimen collected in this study. Living individuals are slightly red because the completely transparent and colorless tunic allows one to see the red vessels that branch within the tunic as well as the red transverse vessels of the pharynx. The reddish color stays for at least one month after fixing in formalin. In live animals the transverse vessels have bright white spots along the ventral region; these spots disappear in animals fixed in formalin.

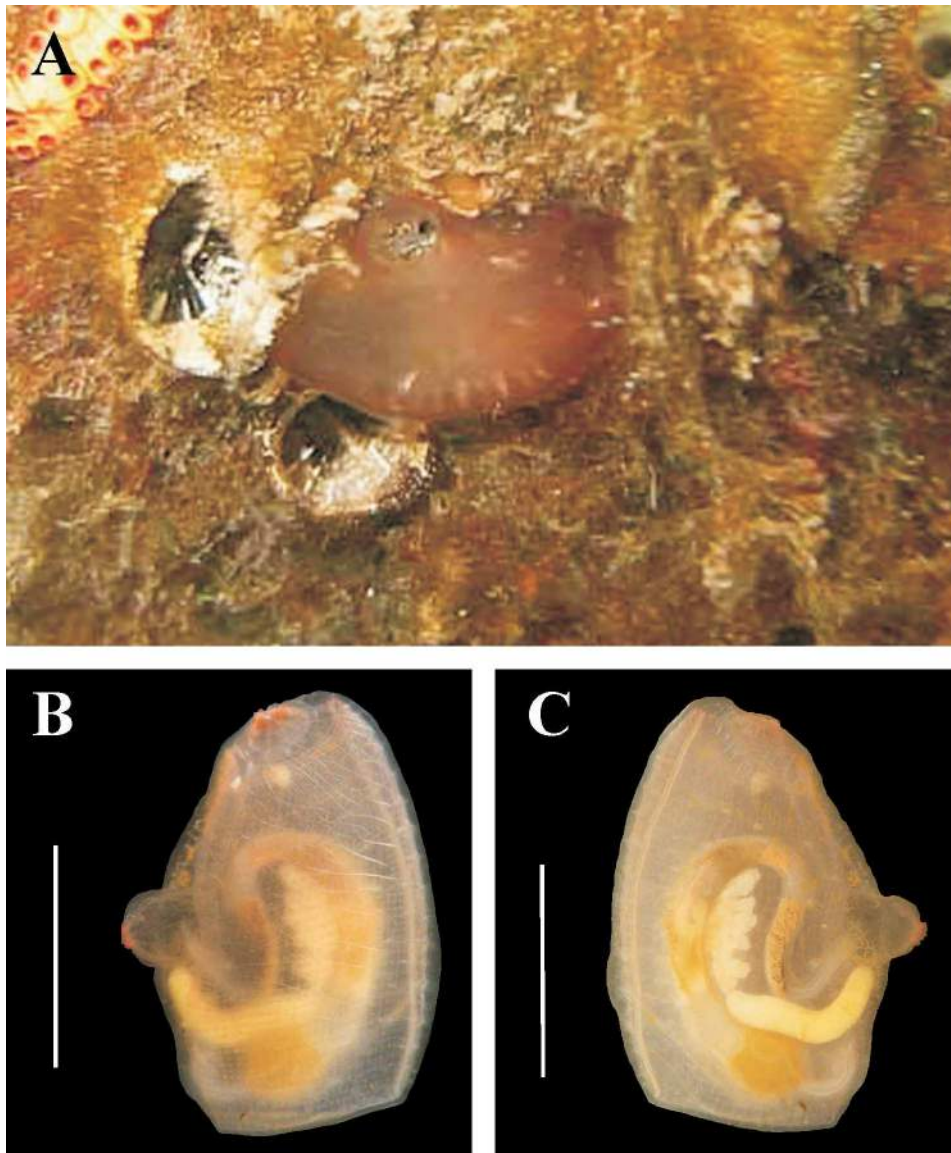


FIGURE 1. *Ascidia archaia* Sluiter, 1890. A. Animal in the field. B. Right side of body (without tunic). C. Left side of body (without tunic). Scale bar: B, C = 0.5 cm. Credit of field picture: Arjan Gittenberger.

Characteristics agree with descriptions of animals from the Pacific (Tokioka 1953; Nishikawa 1986; Kott 1985) and Atlantic Oceans (Van Name 1945; Monniot 1983). We report some differences here. The oral siphon is almost sessile, while the atrial siphon is 2.0 mm long and midway or slightly farther along the dorsal margin. Both siphons have eight wide and short rounded red lobes between each of which is one red spot. Lobes do not have projections.

Body musculature is formed by few thin fibers that are oblique from the oral siphon to the middle of body. Muscles in the siphons form longitudinal bands.

Eighteen oral tentacles are in four sizes. A wide area separates the circle of oral tentacles from the prepharyngeal groove, which lacks papillae. The neural ganglion is close to the dorsal tubercle. The dorsal lamina is toothed. Long languets appear on the right side of the esophageal aperture.

The pharynx does not extend posteriorly to the stomach. The pharynx has 32 longitudinal vessels on the right side, 28 on the left, 63 transverse vessels and 4–6 stigmata per mesh. The primary papillae are short and rounded at the end and the secondary papillae are very small and triangular.

The stomach is yellow in fresh specimens, with 4–5 internal folds. The intestine has a similar cross section throughout and forms two open loops and the anus has two smooth lips, 5.0 mm from the circle of oral tentacles. We confirm that round papillae form a band on the side of the stomach facing the atrial cavity and ascending the loop of the intestine, as described by Monniot (1983). Each papillae is crowned by other diminutive round projections. Renal vesicles are visible only on the stomach wall facing the atrial cavity.

The elongate ovary is lobed and completely enclosed within the primary loop of the intestine in a more or less vertical position. The elongate follicles of the testis are sparsely scattered on the external margin of the intestinal loop. Both gonoducts open side by side just posterior to the aperture of the anus.

Remarks. One individual was found in this study, and the body musculature, reduced number of oral tentacles and the ovary allow confirmation of the identification as compared with other descriptions. Nonetheless, morphological variations can be observed: Kott (1985) commented on the presence of around 40 oral tentacles in animals from Australia, while Monniot (1983) described 30 tentacles in animals from Guadalupe and Tokioka (1953) found 15 tentacles in samples from Japan. The two latter descriptions also spoke of fewer stigmata per mesh (3–5). *Ascidia corelloides* (Van Name, 1924) (Atlantic species) and *A. rhabdophora* Sluiter, 1904 (Pacific species) were synonymized by Tokioka (1953) and both were synonymized to *A. archaia* (Kott 1985). One difference with the original description of *A. rhabdophora* is that Sluiter (1904) described calcareous spicules in the tunic, but these were not found in this or any other study. The sample we dissected had white spots along transverse vessels of the pharynx and tests with hydrochloric acid proved that they were not calcareous. Therefore the synonymy is valid and the calcareous spicules described by Sluiter for *A. rhabdophora* were probably only pigmentation.

***Ascidia bocatorensis* sp. nov.**

(Figs 2–3)

Material examined. Holotype: MZUSP 00015—1 ind.; City; 1.0 m, on polyethylene recruitment plates; 12/vii/2009.

Paratypes: DZUP ASC144—1 ind.; Marina; 1.0 m, on recruitment plates; 05/iii/2009; DZUP ASC147—1 ind.; Marina; 16/vi/2009. DZUP ASC145—2 ind.; City; 0.5 m, on recruitment plates; 29/iii/2009; DZUP ASC146—1 ind.; City; 21/v/2009; MZUSP 00016—2 ind.; City; 1.0 m, on recruitment plates; 12/vii/2009. DZUP ASC143—1 ind.; Solarte; 23/viii/2006.

Etymology. The name is in reference to the type locality.

Diagnosis. Orange vessels in the tunic in life; pharynx with 7–10 stigmata per mesh; 9–17 internal folds in the stomach; ovary lobed and within both intestinal loops.

The animals are fixed to the substrate on the left side of the body; they may have hydroids and colonial ascidians on the free surface. The tunic is thick, cartilaginous, with numerous orange vessels (in live and preserved materials). The body is elongate, 2.5–5.0 cm (including the oral siphon) by 1.0–1.7 cm, without the tunic; it retains an orange coloration two months after fixing in formalin but loses that color over longer time in preservation. Both siphons are 0.3–0.7 cm long; the oral siphon has 8–9 smooth lobes; the atrial siphon is displaced 1.0–2.1 cm from the oral tentacles and has 6–7 smooth lobes, between which are orange spots.

On the right side the musculature comprises a thin net of fibers; on the left side the longitudinal fibers extend from the oral siphon and short fibers are perpendicular to the dorsal margin of the body. In the siphons, wide longitudinal muscles bands may be seen in relaxed animals.

The 59–101 oral tentacles are of four sizes, with the largest 1.6–4.5 mm long. The prepharyngeal groove is double, without projections; the distance between the prepharyngeal groove and the oral tentacles ring is 0.4–1.0 mm and within this region some animals may have papillae. The peritubercular area is small; the dorsal tubercle aperture is U-shaped and may or may not have enrolled ends. The neural ganglion is close to the dorsal tubercle. The dorsal lamina is smooth and double anteriorly, toothed and simple posteriorly; it passes by the esophageal aperture on the left and follows to the end of the pharynx (3.7–8.8 mm beyond the stomach); papillae are absent on the right side of the dorsal lamina. A narrow lamina is on the right side of the esophageal aperture. The pharynx is very pleated and has 34–42 longitudinal vessels on each side and 87–178 transverse vessels; 7–10 stigmata per mesh; primary papillae are simple or trilobed. Secondary papillae and parastigmatic vessels are absent.

The alimentary canal occupies about half of the left side of the body. The stomach is rounded, with 9–17 internal folds; the isodiametric intestine has both loops; the aperture of the anus is bilobed and opens 4.4–20.0 mm away from the ring of oral tentacles. Renal vesicles are 0.06–0.1 mm in diameter, cover the stomach and intestine and are more conspicuous on the side of the atrial cavity.

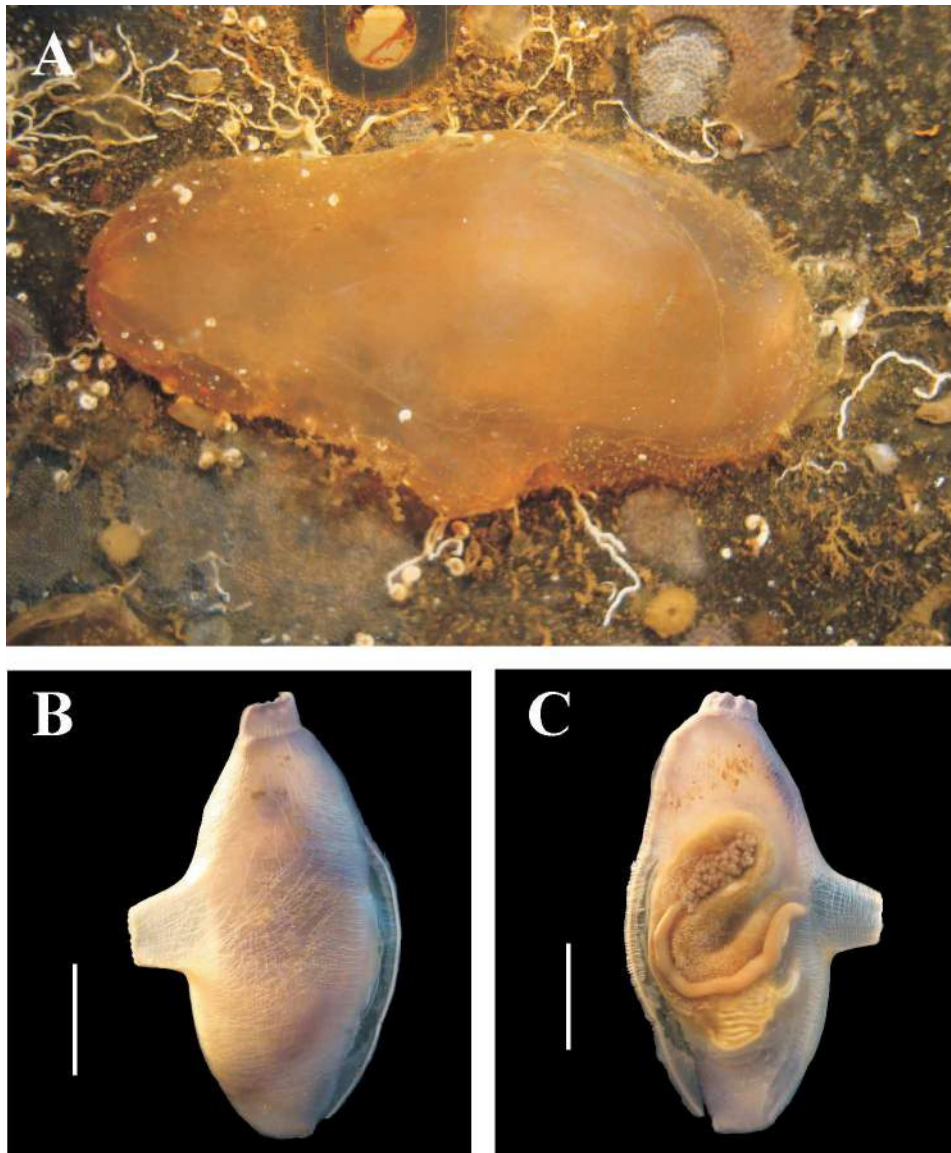


FIGURE 2. *Ascidia bocatorensis* sp. nov. A. Animal in the field. B. Right side of body (without tunic). C. Left side of body (without tunic). Scale bar: B, C = 1.0 cm.

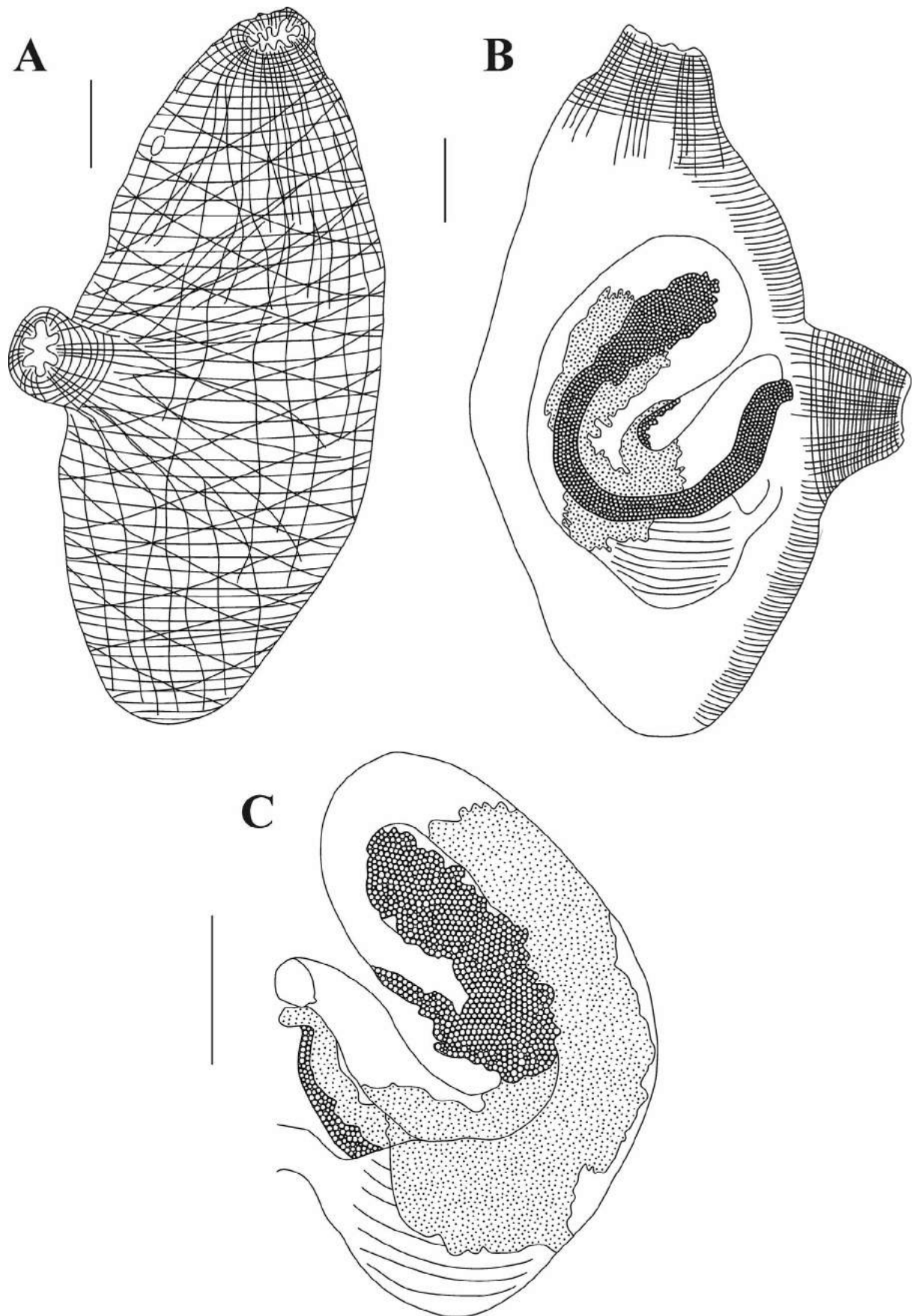


FIGURE 3. *Ascidia bocatorensis* sp. nov. A. Right side of body (external), showing muscles. B. Left side of body (external), showing the gut and gonads. C. Gut and gonads (internal). Scale bar: A, B, C = 0.5 cm.

The ovary is cauliflower-shaped, located within the primary and secondary intestinal loops, visible both from the outside and from the atrial cavity side; oocytes are 0.1–0.15 mm in diameter. The testis follicles are elongated and overlay the stomach and most of the intestine. Gonoducts open just posterior to the anal aperture.

Remarks. In Panama, on the Atlantic side, another orange species, *Ascidia corallicola* **sp. nov.**, also has lobes in the siphons with smooth margins and orange spots between the lobes, body musculature formed by a net, primary pharynx papillae trilobed, 8–11 internal folds in the stomach and ovary lobed. However, *A. corallicola* **sp. nov.** has ten lobes in the atrial siphon, well-developed body musculature, projections on the prepharyngeal groove, 5–7 stigmata per mesh, dilated rectum and ovary restricted to the primary intestinal loop. In the same region, *Ascidia curvata* is similar in the number of lobes in the siphons, body musculature pattern, and the shape of both the digestive tube and ovary. But *A. curvata* does not have bands of longitudinal muscle fibers on the siphons, the body musculature is organized in parallel fibers on the ventral margin, and there are only 5–7 stigmata per mesh, differing from *A. bocatorensis* **sp. nov.** In the Atlantic Ocean, *A. tenue* is very similar to *A. curvata* and can be distinguished from *A. bocatorensis* **sp. nov.** by the absence of muscular bands in the siphons, reduced number of stigmata per mesh (2–5), presence of papillae on the right side of the dorsal lamina and fewer folds in the stomach (6–8).

Ascidia decepta Kott, 1985 and *A. occidentalis* Kott, 1985, both described from the Pacific Ocean (Australia and Tasmania), also have a net of fibers of muscles on the right side of the body and large number of stigmata per mesh (Kott 1985). *Ascidia decepta* differs from *A. bocatorensis* **sp. nov.** because of the sand embedded in the tunic, absence of muscular longitudinal bands in the siphons and body musculature arranged as parallel fibers along the ventral margin (Kott 1985). Presence of projections in the lobes of the siphons and reduced number of oral tentacles (about 30) (Kott 1985) are the characteristics that distinguish *A. occidentalis* from *A. bocatorensis* **sp. nov.**

***Ascidia collini* sp. nov.**

(Figs. 4–5)

Material examined. Holotype: MZUSP 00014—1 ind.; Casa Blanca; on polyethylene recruitment plate; 05.vii.2009.

Paratypes: DZUP ASC162—1 ind.; STRI Bay; on recruitment plate; 18.x.2008; DZUP ASC139—2 ind.; STRI Bay; 0.5 m, on recruitment plate; 09.iii.2009; DZUP ASC140—1 ind.; STRI Bay; 0.5 m, on recruitment plate; 25.iii.2009; DZUP ASC141—2 ind.; STRI Bay; 0.5 m, on recruitment plate; 09.iv.2009.

Etymology. The name is in homage to Dr. Rachel Collin, director of Bocas del Toro Research Station of the Smithsonian Tropical Research Institute, who enthusiastically supported this study at the research station.

Diagnosis. Small individuals; brown lobes in the siphons; body musculature comprising complete transverse fibers; reduced number of longitudinal vessels in the pharynx; small alimentary canal, with isodiametric intestine; ovary ramified.

Individuals attach to the substrate on the left side of the body, with fine sediment and sometimes with epibionts (algae and hydrozoans) covering the free surface. Tunic uncolored, translucent, smooth and thin (0.1–0.16 mm) of cartilaginous consistency with transparent vessels.

The largest specimen is 2.1 cm and oblong. Without the test is 0.9–2.0 cm (including oral siphon) by 0.3–0.7 cm. Siphons are 0.2–0.4 cm long; the oral siphon has eight smooth lobes, the atrial has 7–10 smooth lobes and is 0.4–0.7 cm posterior from the ring of tentacles. Lobes in both siphons are brown with a yellow spot between each.

The body wall is colorless; on the right side the musculature comprises mostly transverse muscle fibers, which completely cross the body from the ventral to the dorsal margin and a few oblique fibers. On the left side, the musculature comprises short transverse fibers in the dorsal margin. The few longitudinal muscle fibers of the siphons are somewhat concentrated towards each lobe and extend for only a short distance posterior to the base of the siphons.

The 62–82 oral tentacles are of four lengths with the largest of 0.7–2.0 mm. The prepharyngeal groove is double, with smooth margin, 0.3–0.8 mm from the ring of tentacles; the area between the prepharyngeal groove and the tentacles has a few large papillae. The peritubercular area is rounded; the dorsal tubercle aperture U-shaped, without enrolled ends. The neural ganglion is very close to the dorsal tubercle. The dorsal lamina is double anteriorly, with small finger-like projections formed by the ends of the left transverse vessels, between which are additional

small projections. The dorsal lamina continues past the esophageal aperture on the left to the end of the pharynx; usually papillae are absent on the right side. A toothed lamina is on the right side of the esophageal aperture. The pharynx has 27–31 longitudinal vessels on the right, 24–28 on the left and 37–67 transverse vessels; it is slightly pleated and the meshes have 4–6 stigmata; the primary papillae are bilobed. Parastigmatic vessels and secondary papillae are absent.

The alimentary canal occupies less than half of the body wall in the middle of the body. The stomach is rounded, with 5–7 internal longitudinal folds; the intestine is isodiametric, with accentuated primary and secondary loops; anus with bilobed margin, about 3.0–7.1 mm from the oral tentacles. Renal vesicles are not conspicuous, 0.04–0.09 mm diameter, covering the stomach and primary intestinal loop. There are small and irregular papillae on the digestive tube.

The ramified ovary is within the primary intestinal loop and extends over the intestine; it is completely visible from the side of the atrial cavity; from the outside it is visible only in and around the primary intestinal loop; oocytes are 0.08–0.10 mm in diameter. Testis follicles are elongated and spread out over the intestine, but not on the stomach and rectum. Gonoducts open posteriorly to the anus.

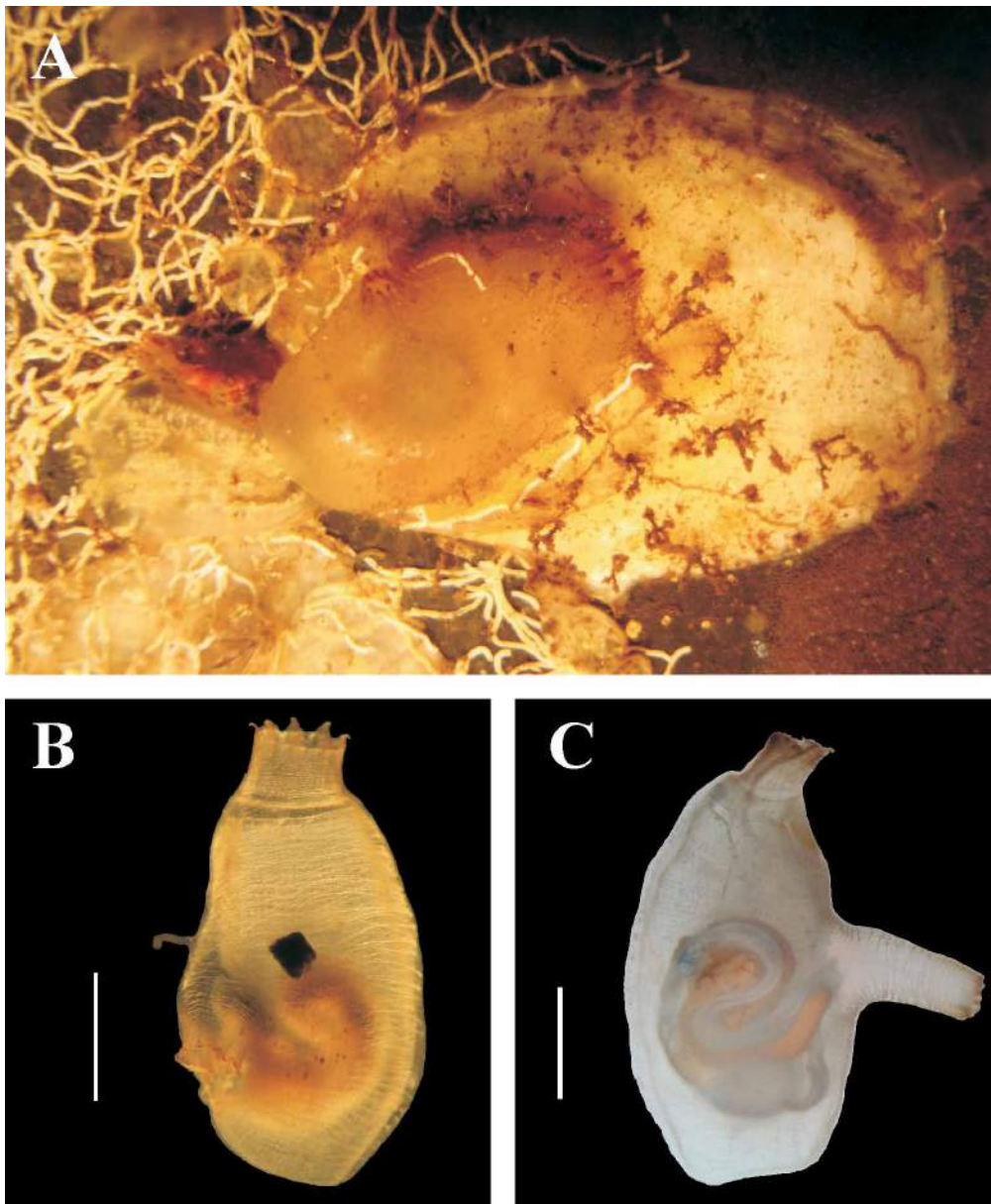


FIGURE 4. *Ascidia collini* sp. nov. A. Animal in the field. B. Right side of body (without tunic). C. Left side of body (without tunic). Scale bar: B, C = 0.5 cm.

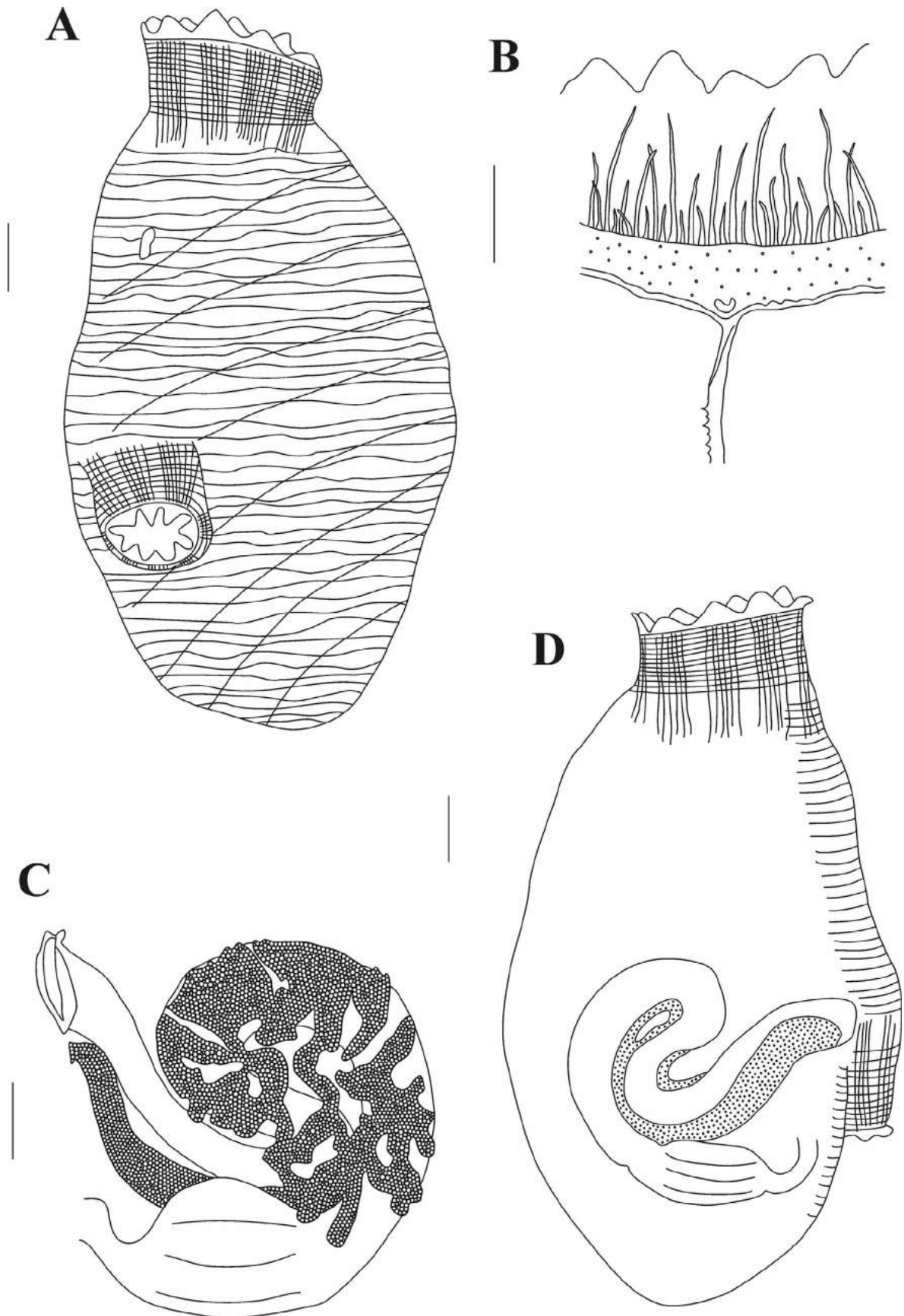


FIGURE 5. *Ascidia collini* sp. nov. A. Right side of body (external), showing muscles. B. Dorsal tubercle and anterior part of the dorsal lamina. C. Gut and gonads (internal). D. Left side of body (external), showing the gut and gonads. Scale bar: A, B, C, D = 1.0 mm.

Remarks. In the Atlantic Ocean, only *A. achimotae* Millar, 1953 (from the west coast of Africa) is similar to *A. collini* **sp. nov.**: it has undeveloped body musculature, a dorsal tubercle that is U-shaped close to the nervous ganglion, isodiametric intestine and few internal folds in the stomach (Millar 1953). However, *A. achimotae* differs from *A. collini* **sp. nov.** because it has well developed longitudinal muscles in the siphons, 2–3 stigmata per mesh in the pharynx, and smooth dorsal lamina (individuals described were young and so they had no gonads) (Millar 1953).

In the Pacific Ocean, *A. citrina* Nishikawa & Tokioka, 1975 is described as having eight or more lobes in the short siphons, toothed dorsal lamina, 5–6 stigmata per mesh, a small digestive tract and isodiametric intestine (Nishikawa & Tokioka 1975), and our samples also fit that description. But *A. citrina* has yellow coloration when alive, body musculature formed by a net of fibers (mainly transverse), around 30 oral tentacles, no papillae between the ring of tentacles and the prepharyngeal groove, and 48–54 longitudinal vessels in each side (Nishikawa & Tokioka 1975), differing from *A. collini* **sp. nov.** *Ascidia melanostoma* Sluiter, 1885, is another Pacific species that is similar to ours, with a brown tunic, numerous lobes and longitudinal muscles forming bands in the siphons, small digestive tract, few folds in the stomach, isodiametric intestine and open second intestinal loop (Monniot 1987; Nishikawa 1986). However, *A. melanostoma* and *A. collini* **sp. nov.** may be separated by color, body musculature formed by a net of fibers, the long longitudinal muscles fibers in the left side of the body and the lobed ovary.

Ascidia lambertae Monniot, 2007 was recently described and is a new species from the Pacific Ocean of Mexico. This species is small (the largest is 3.0 cm long), with light brown tunic (darkest at the siphons), with about 60 oral tentacles, papillae between the ring of tentacles and the prepharyngeal band, 38 longitudinal vessels on the right side of the pharynx and 29 on the left side, isodiametric intestine and ramified ovary (Monniot 2007). Thus, it is similar to *A. collini* **sp. nov.** However, the black spots between the lobes in the siphons, body musculature formed by an irregular network of fibers on the right side, dorsal lamina with long papillae on the right side and a larger digestive tube (Monniot 2007) all separate *A. lambertae* from *A. collini* **sp. nov.**

Ascidia corallicola **sp. nov.**

(Figs. 6–7)

Material examined. Holotype: MZUSP 00017 —1 ind.; Solarte; 07/vi/2009; 0.5 m; coral reef.

Paratypes: DZUP ASC130—1 ind.; Casa Blanca; 05/vii/2009; 0.5 m, on polyethylene recruitment plate. DZUP ASC128—1 ind.; STRI Bay; 06/vi/2009. DZUP ASC125—1 ind.; Garden; 7.0 m, in death coral; 10/viii/2008; DZUP ASC131—1 ind.; Garden; 7.0 m, coral reef; 23/xii/2008. DZUP ASC127—1 ind.; Bastimentos island; 18/v/2009; 0.5 m, on polyethylene recruitment plate. MZUSP 00018—1 ind.; Solarte; 07/vi/2009; 0.5 m; coral reef. DZUP ASC129—4 ind.; Pastores island; 13/vi/2009; 1.0–2.0 m, coral reef. DZUP ASC126—1 ind.; Almirante Bay; 0.5 m, mangrove roots; 25/iii/2009.

Etymology. The name derives from the coral reefs in which it is most commonly found.

Diagnosis. Tunic thick and cartilaginous with red and slightly branching vessels, especially around the siphons; the transparent body wall is slightly orange on the siphons and on the dorsal margin of the body; musculature on the right side comprises a dense net of fibers in different directions, especially oblique and horizontal with few longitudinal fibers; oral tentacles slender and separated from each other; 49–56 longitudinal vessels on the right side and 40–53 on the left side of the pharynx; 7–12 stigmata per mesh; primary pharyngeal papillae may have lateral expansions; alimentary canal with a sac-like dilation; anus margin smooth; ovary cauliflower-shaped, inside the primary intestinal loop; testis follicles elongated and not very ramified.

The animals attach by the left and ventral side to coral, in a vertical position. The body is orange or slightly reddish especially the tips of the siphons. The tunic is smooth without incrustations, but it may have some triangular projections on the left side. Except for the reddish tint of the blood vessels, it is colorless and translucent. The tunic is also 1.0–2.5 mm thick and firm, of cartilaginous consistency. The body is elongate, cylindrical, slightly flat on both sides, 6.3 cm long (including the oral siphon) and 1.6 cm wide, without the tunic. Siphons are short (around 0.3–1.2 cm), with conspicuous circular and longitudinal musculature with evenly spaced fibers. There are 8–9 triangular lobes on the oral siphon and 6–10 on the atrial, both with a red spot between the lobes and without projections on the margin. The atrial siphon projects slightly anterior to the midpoint of the dorsal margin.

The body wall is colorless, except for the orange siphons and dorsal margin. On the right side, the body wall musculature comprises a dense net of fibers mostly in oblique and horizontal directions. A few longitudinal fibers extend along the body till the posterior margin. On the left side, the ends of the longitudinal fibers from both siphons are found as are short perpendicular fibers along the dorsal margin of the body.

The 49–71 oral tentacles are of four sizes, the largest 1.8–3.1 mm long, slender and well spaced. The tentacles project from a conspicuous muscular ring. The prepharyngeal groove is double; the anterior membrane with projections. The space between the line of tentacles and the prepharyngeal groove is 0.4–1.3 mm wide in which are large papillae. The prepharyngeal groove forms a slight curve past the dorsal tubercle which is U-shaped, with or without enrolled ends. The neural ganglion is midway between the oral and atrial siphons, slightly away from the dorsal tubercle. The dorsal lamina is double anteriorly (along the first 20 rows of stigmata), with finger like projections formed by the ends of the left transverse vessels among which are smaller projections; may have projections on the wall close to the esophageal aperture. The dorsal lamina is uniformly wide throughout and passes the left side of the esophageal aperture to the end of the pharynx, which extends 2.5–6.9 mm past the stomach. The pharynx has 49–56 longitudinal vessels on the right, 40–53 on the left and 151–248 transverse vessels, is very pleated with meshes of 7–12 stigmata. The primary papillae are trilobed or simple; the secondary papillae and parastigmatic vessels are absent.

The alimentary canal is large, filling more than half of the left side of the body. The stomach is oval and wide, with 8–11 internal folds. The intestine forms two loops, the descending part of which is dilated and forms a sac-like pouch. The anus is 9.0–28.0 mm from the oral tentacles, is large and has a plain rim. The renal vesicles are 0.07–0.15 mm in diameter, and cover the entire alimentary canal on its atrial side.

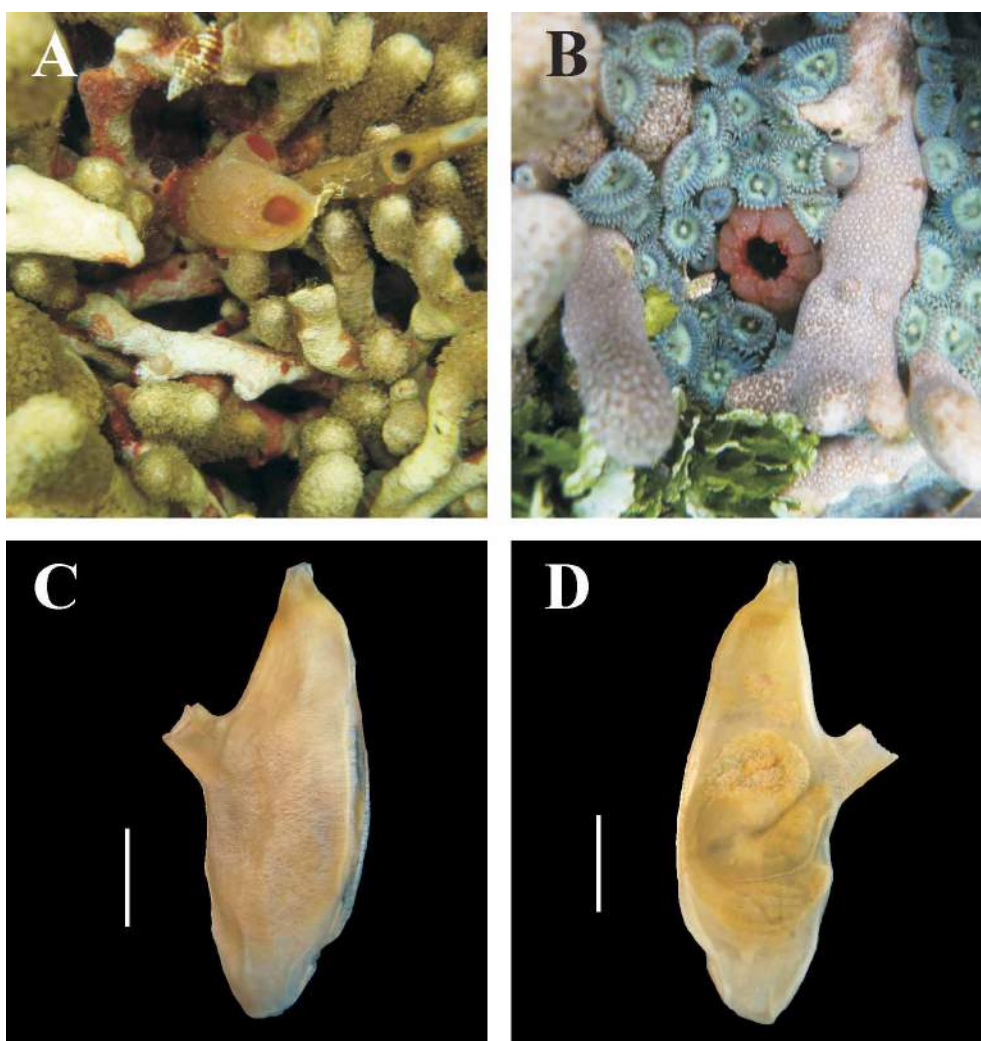


FIGURE 6. *Ascidia corallicola* sp. nov. A, B. Animal in the field. C. Right side of body (without tunic). D. Left side of body (without tunic). Scale bar: C, D = 1.0 cm.

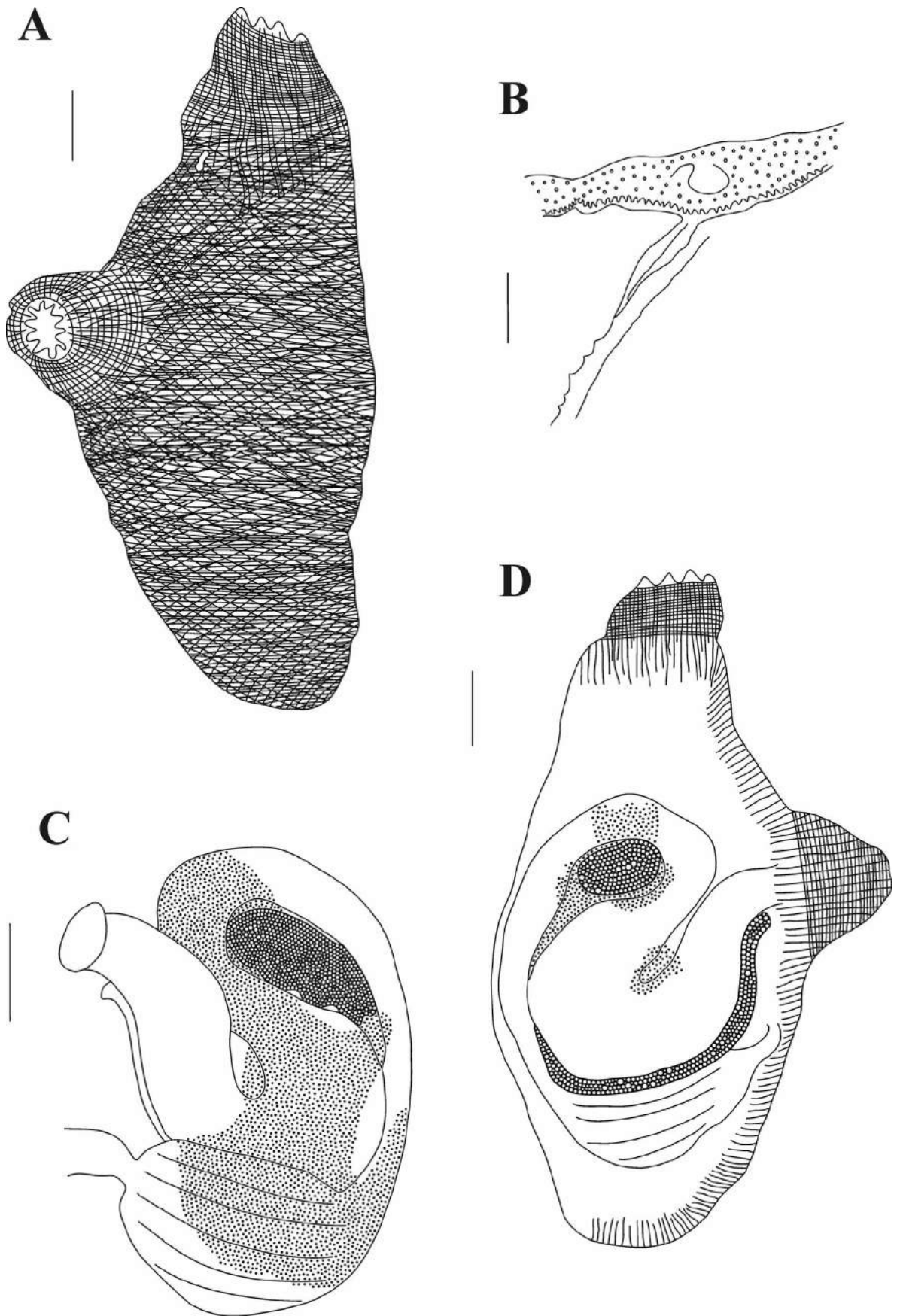


FIGURE 7. *Ascidia corallicola* sp. nov. A. Right side of body (external), showing muscles. B. Dorsal tubercle and anterior part of dorsal lamina. C. Gut and gonads (internal). D. Left side of body (external), showing the gut and gonads. Scale bar: A, C, D = 0.5 cm; B = 1.0 mm.

The ovary is cauliflower-shaped and fills the primary intestinal loop; it is visible both from the outside and the atrial cavity side. In recently fixed animals, oocytes are brown. The testis comprises long follicles, not very branched, spread out over the entire alimentary canal wall on the atrial side (except the rectum). From the outside the testis is visible only inside the primary intestinal loop. Both gonoducts are linked to the rectum wall and open just behind the anus. The oviducal aperture is a large slit, is more external while the sperm duct aperture is smaller and between the oviduct and the rectum.

Remarks. Similar to *Ascidia interrupta*, *A. corallicola* **sp. nov.** has body musculature formed by a net of fibers, trilobed papillae in the pharynx, area between the prepharyngeal groove and tentacles with many papillae, prepharyngeal groove with projections and ovary inside the primary intestinal loop. The orange to reddish color in life, the absence of round projections on the tunic surface and fewer lobes on the oral siphon allow identification of *A. corallicola* **sp. nov.** from *A. interrupta*. In the same region, *A. monnioti* **sp. nov.** is also found, and has a similar dilated rectum and shape and position of the ovary, but has a very rigid tunic, yellow color in life, muscles fibers that are mainly transverse on the right side of the body and many lobes on the siphons (10–16) all of which differ from *A. corallicola* **sp. nov.**

Ascidia gemmata Sluiter, 1895, from the Pacific Ocean, is orange in life, body musculature formed by a net of fibers, large papillae overlying the area between the prepharyngeal groove and the ring of tentacles, 5–6 stigmata per mesh and the ovary is inside the primary intestinal loop (Kott 1985). The round projections on the tunic, six lobes on the atrial siphon, smooth prepharyngeal groove, languets on the right side of the esophageal aperture, trilobed papillae in the pharynx and stomach with four internal folds are all characteristics that distinguish *A. gemmata* from *A. corallicola* **sp. nov.**

Ascidia curvata (Traustedt, 1882)

(Fig. 8)

Material examined. DZUP ASC159—2 ind.; STRI Bay; on polyethylene plate; 08/vii/2008; DZUP ASC161—2 ind.; STRI Bay; on polyethylene plate; 18/x/2008. DZUP ASC24—3 ind.; Solarte; 0.5 m; 04/viii/2003. DZUP ASC22—1 ind.; San Cristobal island; 0–1.0 m; 12/viii/2003. DZUP ASC61—4 ind.; City; 19/viii/2006.

The species is very common and individuals are usually directly attached to mangrove roots or on the shells of bivalves that are on the roots, with siphons oriented downwards. Aggregations of 15–20 individuals are common. Individuals are usually 4.0–5.0 cm long but can be 8.0 cm in length. The tunic is transparent, thick and smooth, occasionally encrusted. This is a well known species, so a complete description can be found in Van Name (1945) and Monniot (1983).

The body wall is transparent, yellowish at the anterior region especially between siphons in freshly preserved animals. The oral siphon has eight round, large and short lobes, very thin and transparent and, in live animals, with a yellow spot between each; the atrial siphon has six similar lobes. Lobe margins are plain. The spots between siphons may be orange or red in animals fixed in formalin. The musculature is conspicuous and both siphons have a band of dense circular fibers at the margin forming a sphincter. Longitudinal fibers do not form bands.

Musculature on the right side is slender, with fibers in many directions covering the entire dorsal-ventral extension of the body, but not so dense that internal structures are not visible. Along the ventral margin and the posterior region to the atrial siphon the fibers are mainly transverse. On the left side, longitudinal fibers extend from the siphons and transverse fibers are very short and slender in the dorsal region.

The pleated pharynx extends beyond the posterior margin of the stomach and has 30–42 complete longitudinal vessels on the left, and 41–54 on the right, with 5–9 longitudinal stigmata per mesh. Primary papillae are slightly curved and large, some with lateral protrusions. Very small papillae in a transverse line indicated the formation of a new vessel; also some minute button-like intermediary papillae may be seen. The prepharyngeal groove has a double membrane, the anterior with or without projections along the margin. The area between the prepharyngeal groove and tentacles have papillae. The neural ganglion is close to the dorsal tubercle.

The renal accumulation vesicles are small, white or transparent spheres, both on the atrial wall of the esophagus, stomach and rectum as well as on the externally facing wall. The atrial epithelium that covers the alimentary canal facing the atrial cavity is mostly covered by minute papillae and the anterior margin of the stomach, the ascending portion of the intestine and the primary intestinal loop have large irregularly shaped papillae.

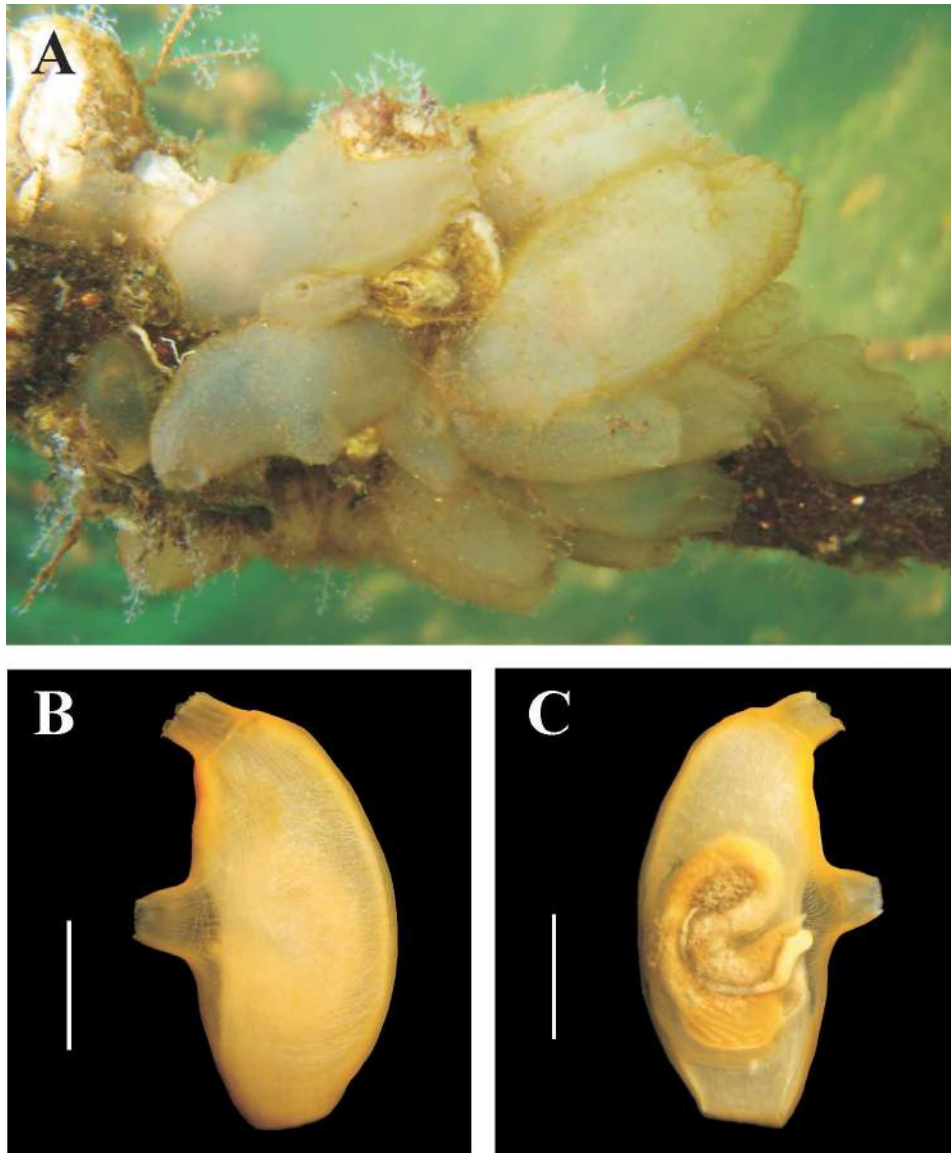


FIGURE 8. *Ascidia curvata* (Traustedt, 1882). A. Animals in the field. B. Right side of body (without tunic). C. Left side of body (without tunic). Scale bar: B, C = 1.0 cm.

Both gonads are spread over both intestinal loops and are visible from outside and inside the atrial cavity. The gonoducts are attached to the rectum and open at the level of the anus.

Remarks. *Ascidia curvata* is known from 11 locations in the Caribbean (Van Name 1945; Millar 1962; Monniot 1983; Goodbody 1984a, 2000, 2003; Rocha *et al.* 2005) as well as in Bermudas (Berrill 1932; Van Name 1945), northeastern (Lotufo 2002), southeastern (Marins *et al.* 2010) and southern Brazil (Rocha & Nasser 1998).

Ascidia interrupta Heller, 1978

(Fig. 9)

Material examined. DZUP ASC80—1 ind.; Galleta floating dock; 1.0 m; 06/i/2009. DZUP ASC81—1 ind.; Galleta Station; 1.0 m, coral reef; 06/i/2009. DZUP ASC82—1 ind.; Casa Blanca; 0.5 m, on PVC recruitment plate; 26/iii/2009. DZUP ASC84—1 ind.; Sachen; 11/vi/2009. DZUP ASC73—5 ind.; STRI dock; 22/viii/2006; DZUP ASC78—1 ind.; STRI dock; 0.5 m, on aluminum plate; 20/x/2008; DZUP ASC83—2 ind.; STRI dock; 1.5 m; 10/iv/2009. DZUP ASC79—1 ind.; Marina; 0.5 m, concrete floats; 12/xii/2008. DZUP ASC68—1 ind.; Punta Caracol; 1.0–2.0 m, coral reef; 05/viii/2003. DZUP ASC75—1 ind.; Baía Honda; 0.5 m, mangrove roots; 23/viii/2006.

DZUP ASC26—1 ind.; Solarte; 0.5 m, mangrove roots; 04/viii/2003; DZUP ASC70—1 ind.; Solarte; 0.5 m, mangrove roots; 15/viii/2006; DZUP ASC74—1 ind.; Solarte; 0.5 m, mangrove roots; 23/viii/2006. DZUP ASC86—1 ind.; Bastimentos island; 0.5 m, on PVC recruitment plates; 09/vii/2009. DZUP ASC76—2 ind.; Crawl Cay; 25/viii/2006; DZUP ASC77—1 ind.; 2.0 m, coral reef; 20/x/2008. DZUP ASC69—1 ind.; Pastores island; 0.5 m, coral reef; 10/viii/2003; DZUP ASC72—5 ind.; Pastores island; 1.0–2.0 m, coral reef; 17/viii/2006; DZUP ASC85—6 ind.; Pastores island; 13/vi/2009. DZUP ASC25—2 ind.; San Cristobal island; 0.5 m, mangrove roots; 12/viii/2003. DZUP ASC28—1 ind.; Bocatorito Bay; 0.5 m, mangrove roots; 12/viii/2003. DZUP ASC71—1 ind.; City; 15/viii/2006.

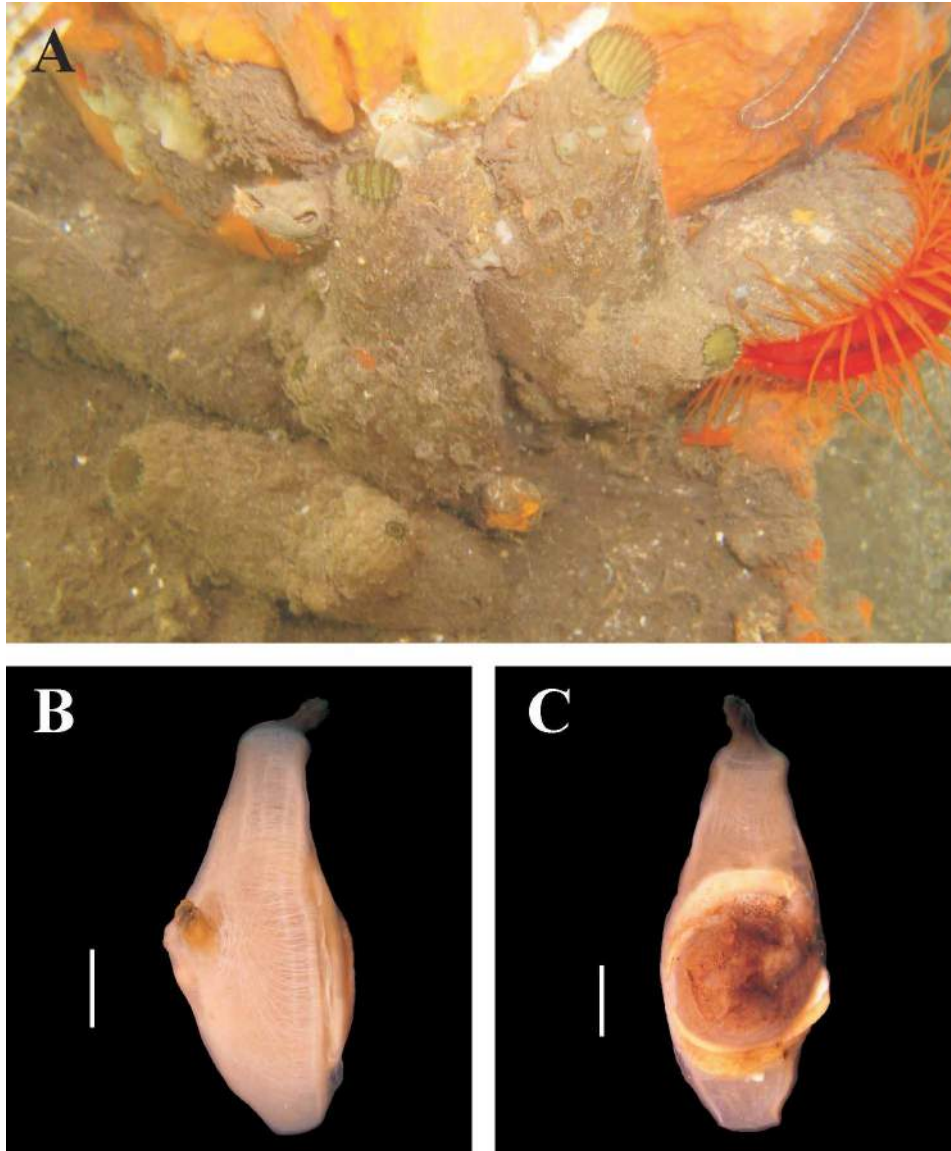


FIGURE 9. *Ascidia interrupta* Heller, 1878. A. Animals in the field. B. Right side of body (without tunic). C. Left side of body (without tunic). Scale bar: B, C = 1.0 cm.

Individuals (to 15.0 cm, usually 5.0–10.0 cm) attach to mangrove prop roots by the posterior or the entire left side. The wide-open oral siphon with white radial lines is diagnostic in the field and the general color of the animals ranges from dark green to gray or black, but may also be yellow. The tunic is 2.0–5.0 mm thick, beige, transparent, wrinkled in some specimens. Hemispheric projections are characteristic and mostly around the siphons and on the right side, although a very few animals lack these projections. Tunic vessels are conspicuous and branched in some individuals, especially around the siphons; vessels are black in live and recently-fixed animals but fade with long term fixation.

The oral siphon is apical, variable in length (1.0–3.5 cm); the atrial siphon (~ 1.0 cm) is in the mid-dorsal line or displaced somewhat posteriorly. Both siphons have 8–10 smooth lobes in young animals (2.0–4.0 cm long) and 14–16 in large adults; there is a dark spot between each lobe.

The body wall is opaque, brown or dark green, sometimes colorless; the siphons are usually darker than the rest of the body. Musculature on the right side comprises a net of 0.15 mm thick fibers. On the left side, the longitudinal muscles from the oral siphon are short (when they are long, never reach the intestinal loop) and a band of short parallel transverse fibers are found on the dorsal margin. The number of oral tentacles ranges between 50–140, very slender and densely packed on a thin muscular ring. Tentacles may be missing from part of the ring in some individuals. The large space between the tentacles and the prepharyngeal groove has many minute papillae. The anterior lamina of the prepharyngeal groove is usually wider, occasionally with long filiform projections. The prepharyngeal groove surrounds the dorsal tubercle forming a shallow U-shaped area. The dorsal tubercle is slightly protruding, with a U-shaped aperture, sometimes with spiraled horns; in very large animals it may become more complex with numerous irregular apertures. The neural ganglion is mid-way between the circle of tentacles and the atrial siphon, usually close to the dorsal tubercle. The primary papillae are long, laterally flattened, bi- or trilobed, with one lateral protrusion on each side. Intermediate papillae are very rare. In some animals the dorsal lamina has small projections on the right side, just before and near the esophageal aperture. The complete longitudinal vessels are 40–80 on each side, fewer on the left.

The alimentary canal occupies half or more of the left side, with an oval folded stomach (11–16 internal folds), dilation of the rectum forms a large pouch and the anus has a smooth rim. Renal accumulation vesicles are a few transparent spheres on the stomach.

Externally viewed, the cauliflower-shaped ovary is brown or dark brown within the primary loop of the intestine. The testicle comprises small, ramified follicles, on both primary and secondary intestinal loops in mature animals, inside the primary loop only in immature animals; in large animals the testis may form many patches viewed both externally and from within the atrial cavity.

Remarks. In Bocas del Toro, *A. curvata* and *A. interrupta* are sympatric in calm waters on mangrove roots, in contrast to Guadeloupe, where they are not found in this habitat (Monniot 1983). *Ascidia interrupta* can be confused with *A. sydneyensis* because of the large dilation of the intestine and long siphon, but musculature on the right side and tunic thickness and consistency are very different. *Ascidia interrupta* is known from 12 locations in the Caribbean (Van Name 1945; Millar 1962; Monniot 1983; Goodbody 1984a, 1984b, 2000, 2003; Rocha *et al.* 2005) as well as in northeastern Brazil (Monniot 1969–70) and Congo (Millar 1960).

Ascidia monnioti sp. nov.

(Figs. 10–11)

Material examined. Holotype: MZUSP 00019—1 ind.; Isla Pastores; 0.5 m, coral reef; 13/vi/2009.

Paratypes: DZUP ASC138—Casa Blanca; coral reef; 05/vii/2009. DZUP ASC134—1 ind.; Hospital Point; 8.0 m, coral reef; 23/xii/2008. DZUP ASC137—2 ind.; Crawl Cay; 0.5 m, coral reef; 14/vi/2009. DZUP ASC132—2 ind.; Pastores island; coral reef; 17/viii/2006; DZUP ASC133—1 ind.; Pastores island; coral reef; 20/viii/2006; DZUP ASC135—2 ind.; Pastores island; 1.5 m, coral reef; 25/ii/2009; MZUSP 00020—3 ind.; Pastores island; 0.5 m, coral reef; 13/vi/2009. DZUP ASC136—1 ind.; Big Bight; 1.0 m, coral reef; 05/vi/2009.

Etymology. The name is in homage to Claude and Françoise Monniot for their great contributions to the study of ascidian diversity in the world.

Diagnosis. Live animals yellow with both siphons close together; tunic 1.0–2.0 mm, smooth without projections or incrustations, gelatinous and completely transparent; musculature on the right side comprising thick transverse fibers that may cross each other, sometimes as long as the dorsal-ventral width, sometimes divided forming two or more longitudinal patches; 10–16 round lobes in each siphon; 50–90 oral tentacles, slender and side by side; pharynx with 40–70 longitudinal vessels on each side; 4–8 stigmata per mesh; stomach with many internal folds; large alimentary canal, with sac-like dilation; smooth anus rim; elongated ovary inside the primary intestinal loop.

Animals attach on the left side to living or dead coral in a vertical position, siphons pointing up. The tunic is very delicate and usually it tears when taking the animal from the substrate. It can be wrinkled in contracted animals.

The body is elongate, cylindrical, slightly flat on both sides, 3.0–7.5 cm (including the oral siphon) by 1.0–2.1 cm, without tunic. The oral siphon is 0.5–1.0 cm long and the atrial is 1.0–1.3 cm and displaced towards the oral siphon. Thus, in living animals, the apertures are close together. Both have conspicuous circular and longitudinal musculature, not forming bands. There are 10–16 triangular lobes on both siphons, with smooth or slightly indented margins, and a yellow or orange spot between the lobes.

The body wall is colorless. On the right side, the body wall musculature comprises short and thick transverse fibers, parallel or even crossing each other and thin longitudinal fibers; fibers sometimes are not complete forming two or more longitudinal patches. On the left side, there are short transverse fibers along the dorsal margin.

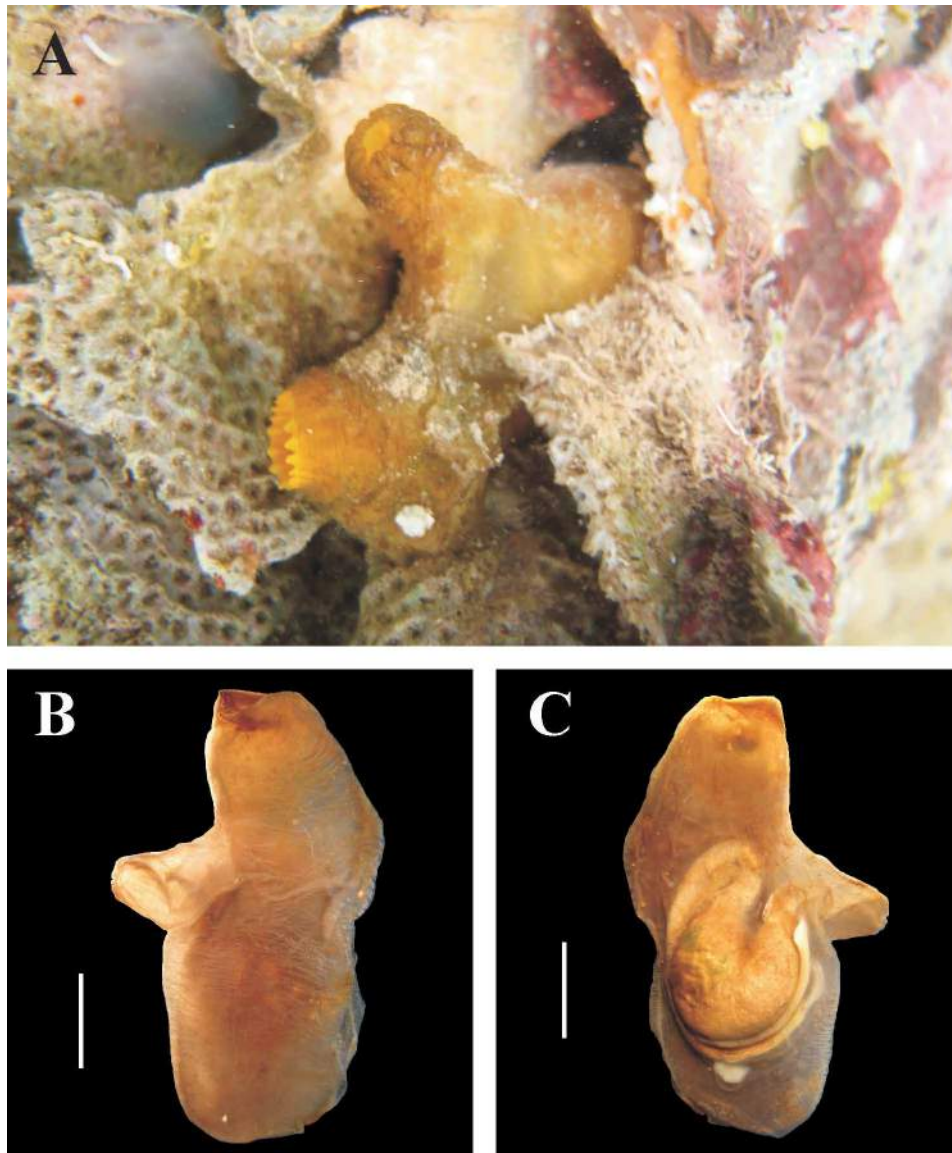


FIGURE 10. *Ascidia monnioti* sp. nov. A. Animal in the field. B. Right side of body (without tunic). C. Left side of body (without tunic). Scale bar: B, C = 1.0 cm.

The 50–90 oral tentacles are of four sizes, the largest 2.0–6.0 mm long, wide at the base, slender and close to one another. Tentacles project from a conspicuous but thin muscular ring. The double prepharyngeal groove has an anterior lamina with long filiform projections. The area between tentacles and prepharyngeal groove is 0.3–1.5 mm wide and has small papillae (in variable density). The peritubercular area is U-shaped; the aperture of the dorsal tubercle is heart or U-shaped with or without enrolled ends. The neural ganglion varies in position but is usually closer to the atrial siphon and away from the dorsal tubercle. The dorsal lamina is double anteriorly (5.0 mm) and with small finger-like projections formed by the ends of the left transverse vessels, between which are additional small projections; the dorsal lamina wall close to the esophageal aperture lacks projections. The dorsal lamina is uniformly wide throughout and passes on the left of the esophageal aperture to the end of the pharynx. The ends of

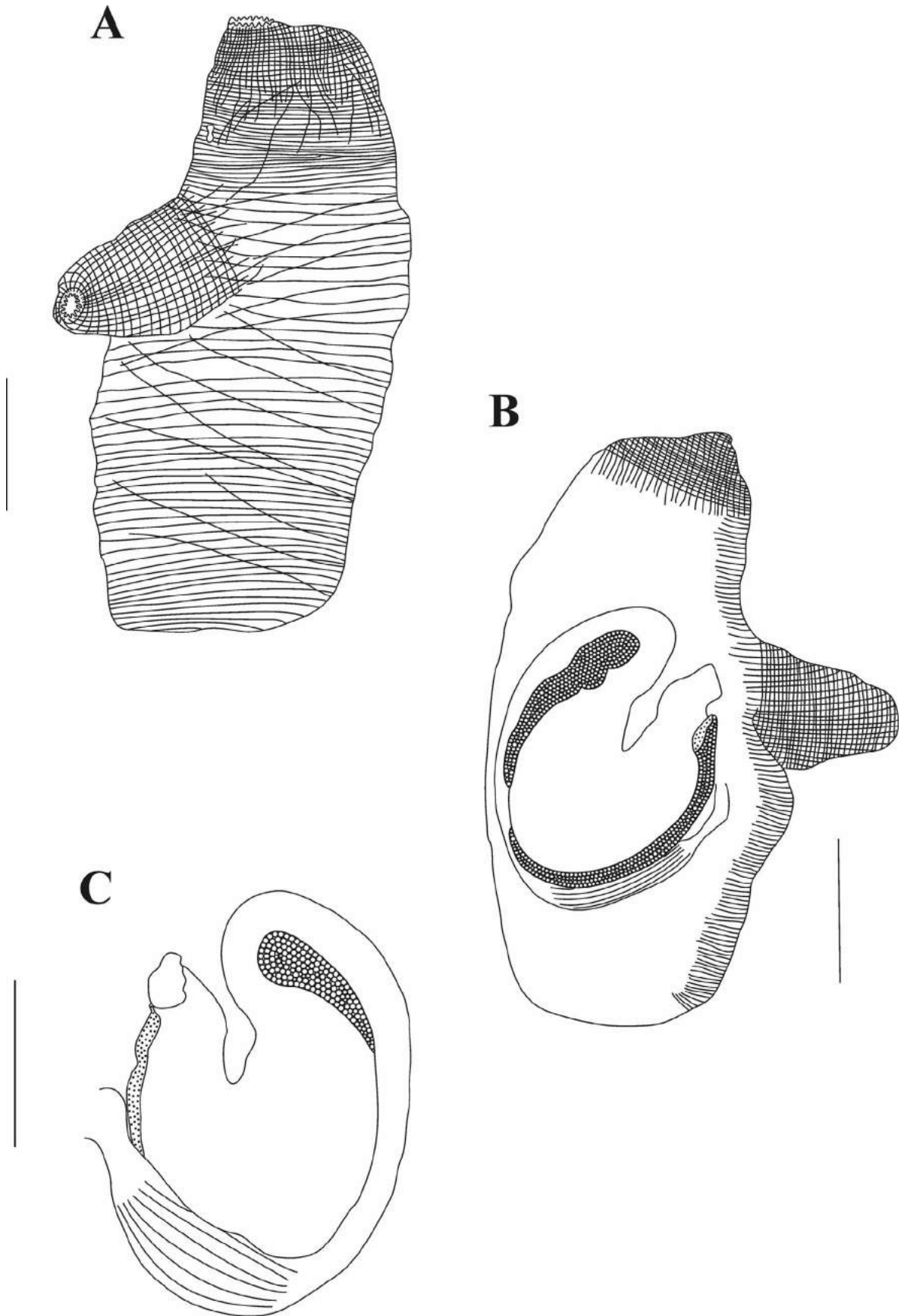


FIGURE 11. *Ascidia monnioti* sp. nov. A. Right side of body (external), showing muscles. B. Left side of body (external), showing the gut and gonads. C. Gut and gonads (internal). Scale bar: A, B, C = 1.0 cm.

the right transverse vessels form a narrow membrane on the right side of the esophageal aperture. The pharynx has 40–60 longitudinal vessels on each side and as many as 232 transverse vessels; it is not pleated and meshes have 4–8 stigmata. The primary papillae comprise one small lobe (some papillae have another lobe at the base), may have a lateral expansion on each side; pharynx lacks intermediate papillae, but there are few (if any) parastigmatic vessels.

The alimentary canal is large, occupying half of the left side of the body. It has a thin, transparent wall through which internal contents may be seen. The stomach is oval and wide with 10–18 internal folds. The intestine forms two loops and the descending portion is dilated as a sac-like pouch. The large, plain-rimmed anus is 1.0–2.7 cm from the oral tentacles at the level of the anterior extremity of the primary loop of the intestine. Irregularly-shaped papillae cover the stomach wall and the ascending portion of the intestine on the side of the atrial cavity.

The lobed ovary occupies the space inside the primary intestinal loop and may be seen from both, outside and the atrial cavity, although it is usually more external. The oviduct opens by a large slit close and posterior to the anal aperture. The testis is extensively branched and comprises small pyriform follicles, covering the alimentary canal wall (including the rectum) on the atrial side; difficult to see externally. When well developed it also covers the primary intestinal loop making it impossible to see the ovary from inside. The sperm duct aperture is between the oviduct aperture and the anus, but smaller.

All samples had many copepods and some amphipods inside the pharynx and one had a large isopod between the body wall and the tunic.

Remarks. The yellow color in life is very conspicuous in the field, though only the siphons are exposed. In the Caribbean region, two known *Ascidia* species have many lobes in the siphons: *A. xamaycana* Millar & Goodbody, 1974 and *A. interrupta* Heller, 1878, in addition to *Ascidia panamensis* **sp. nov.** All also have a dilated rectum and ovary within the primary intestinal loop. However, *A. xamaycana* is green in life, body musculature on the right side as a net, few oral tentacles (12–30), 2–3 stigmata per mesh, small alimentary canal without the secondary intestinal loop (Millar & Goodbody 1974); *A. interrupta* and *Ascidia panamensis* **sp. nov.** have dark vessels in the tunic, a net of muscles fibers on the right side of the body and a big saculiform dilation in the rectum. *Ascidia gemmata* Sluiter, 1895 is also similar to *Ascidia monnioti* **sp. nov.**: it has a yellow tunic, numerous lobes in the oral siphon, area between prepharyngeal groove and tentacles with many papillae, toothed dorsal lamina and dilated rectum (Kott 1985). However, in the former the body musculature forms a net, the prepharyngeal groove is smooth, there are few internal folds in the stomach and the anus is bilobed.

Within the Ascidiidae, *Phallusia julinea* Sluiter, 1915 also has many siphon lobes, a toothed lamina on the right side of the esophageal aperture, 6–8 stigmata per mesh and dilated rectum that forms a sac-like pouch. Additionally, *P. julinea* may not have accessory openings (Monniot 1987), as do the *Ascidia*. In contrast to *Ascidia monnioti* **sp. nov.**, *P. julinea* has indented lobes in the siphons, 70–90 longitudinal vessels on each side of the pharynx, and anus with multilobed rim.

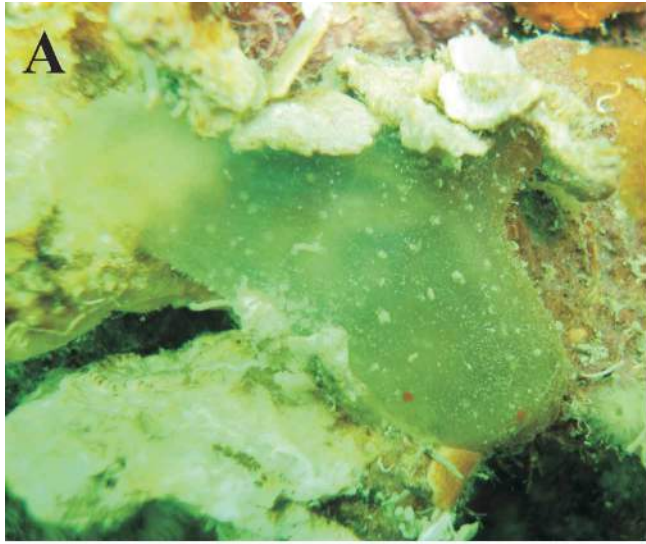
Ascidia cf. *munda* Sluiter, 1897

(Fig. 12)

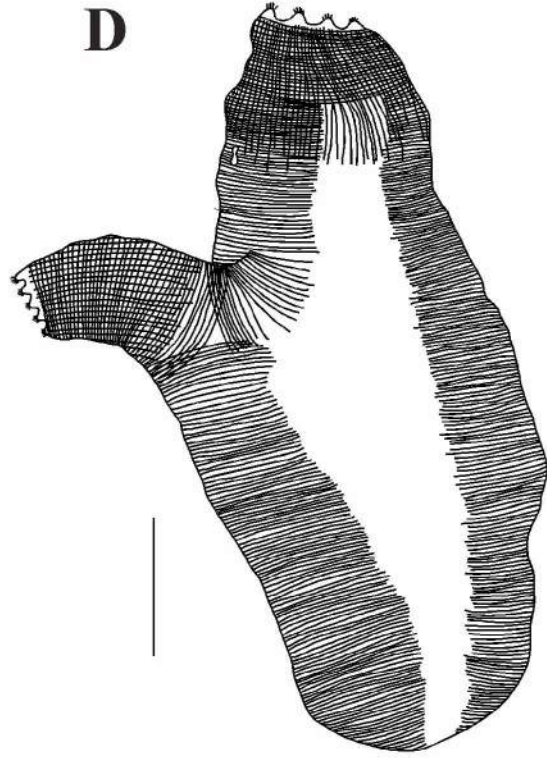
Material examined. DZUP ASC158—1 ind.; Garden; 7.0 m; coral reef; 10.viii.2008.

The only animal found was attached by its left side to a dead coral fragment on the sea bottom. The tunic is smooth with a few round projections connected by a thin stalk; it is thin and completely transparent. The body is elongate, oval, slightly flat on both sides, 3.6 cm long (including the oral siphon) by 1.4 cm, without tunic. The oral siphon is 0.5 cm long, the atrial siphon is 0.8 cm and displaced towards the oral siphon. Eight triangular lobes are on the oral siphon and 10 on the atrial, both with projections at the margins, and a yellow spot between the lobes. Siphons are lined by a delicate membrane which has small papillae on the posterior half of the oral siphon.

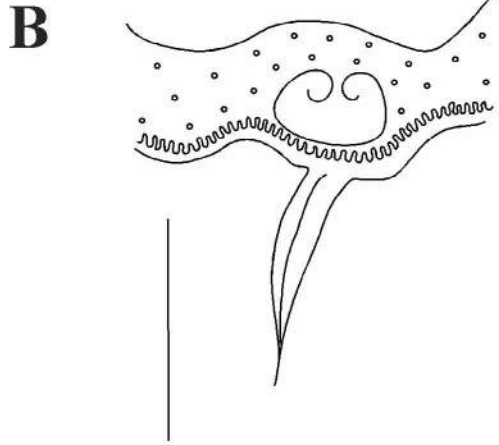
The body wall is colorless. On the right side, the body wall musculature is complex, comprising bands of parallel fibers along the dorsal and ventral margins; the dorsal band is larger posteriorly. There are also very few and thin longitudinal fibers in the anterior margin. On the left side, short transverse fibers are along the dorsal line. Musculature in the siphons is weak, but both siphons have circular and longitudinal musculature (not concentrated in bands).



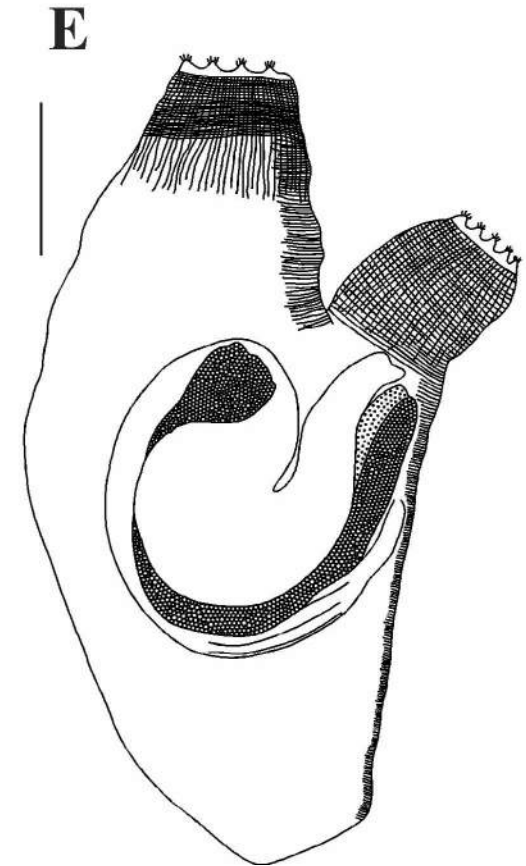
A



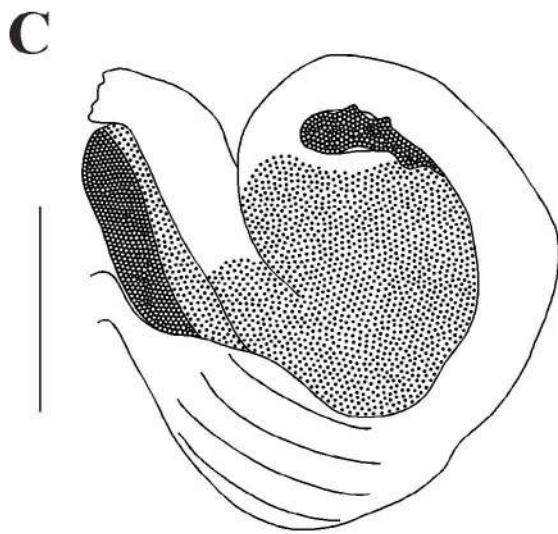
D



B



E



C

FIGURE 12. *Ascidia* cf. *munda* Sluiter, 1897. A. Animal in the field. B. Dorsal tubercle and anterior part of the dorsal lamina. C. Gut and gonads (internal). D. Right side of body (external), showing muscles. E. Left side of body (external), showing the gut and gonads. Scale bar: B = 1.0 mm; C, D, E = 0.5 cm.

The 80 oral tentacles are of three sizes, the largest is 2.5 mm long, thick along most of its length and slender at the tip. The tentacles project from a conspicuous but thin muscular ring. The peripharyngeal groove is double, the anterior lamina has long filiform projections; the line of tentacles is separated from the prepharyngeal groove by 0.7 mm, in which area are several large papillae. The peritubercular area is U-shaped; the dorsal tubercle aperture is U-shaped with enrolled ends. The neural ganglion is displaced toward the oral siphon, close to the dorsal tubercle. The dorsal lamina is double anteriorly and with small finger like projections formed by the ends of the left transverse vessels and additional small projections between them; there are also small papillae on the right side of the dorsal lamina before the esophageal aperture. The dorsal lamina is equally wide in all the extension and passes by the esophageal aperture on its left to the end of the pharynx, which extends beyond the stomach. The pharynx has 47 longitudinal vessels on the right, 40 on the left and 124 transverse vessels; it is not pleated and meshes have 5–7 stigmata. The primary papillae comprise one or two large lobes with a lateral expansion on each side; the lobes are long and have a large base connecting to the transverse vessels; pharynx lacks intermediate papillae. The parastigmatic vessels are very rare and when found are usually associated with incomplete transverse vessels.

The alimentary canal is large, occupying half of the left side of the body. The stomach is tubular and narrow, with few (~ 6) internal folds. The intestine forms two loops and the descending portion is dilated forming a sac-like pouch. The anus is located about 7.2 mm from the oral tentacles, is large and has an undulated rim. Large papillae cover the stomach wall and ascending portion of the intestine on the atrial side.

The cauliflower-shaped ovary is restricted to the extremity of the primary intestinal loop and best seen from the outside. The oviduct opens by a large slit on the same level of the anal aperture. The testis comprises large, oval or pyriform follicles, spread mainly on the descending intestine and base of the rectum, and almost not visible from the outside. The sperm duct aperture is beside the female aperture but smaller.

Remarks. Because of the external vesicles on the tunic, this species can be confused with *A. interrupta*. But, in *A. munda* the vesicles attached by a thin stalk, the body wall is colorless, the muscular pattern is different on the right side and fewer lobes are on the oral siphon.

Ascidia munda is known from the Pacific Ocean (Kott 1985; Monniot 1987; Monniot 1990). The sample described here is very similar to specimens from New Caledonia (Monniot 1987), differing by the projections at the border of the siphon lobes and the non-ramified ovary. According to Kott (1985), Australian specimens have projections in the siphons lobes, individuals can reach up to 8.0 cm total length, they have an irregular dorsal tubercle and up to 10 stigmata per mesh in the pharynx (no description of the ovary). Due to this variation, we decided to identify the present material as *A. munda*, probably with an incompletely developed ovary.

***Ascidia panamensis* sp. nov.**

(Figs. 13–14)

Material examined. Holotype: MZUSP 00021—1 ind.; Casa Blanca; 0.5 m, on PVC recruitment plates; 05/vii/2009.

Paratypes: DZUP ASC97—1 ind.; Casa Blanca; 0.5 m, mangrove roots; 26/iii/2009. DZUP ASC91—1 ind.; STRI dock; 1.0 m; 12/viii/2003; DZUP ASC95—1 ind.; STRI dock; 1.0 m, on PVC recruitment plates; 03/viii/2008; DZUP ASC98—1 ind.; STRI dock; 1.5 m; 10/iv/2009. DZUP ASC96—1 ind.; Bastimentos island; 0.5 m, mangrove roots; 04/viii/2008; DZUP ASC99—1 ind.; Bastimentos island; 0.5 m, on recruitment plates; 09/vii/2009. DZUP ASC33—1 ind.; Solarte; 0.5 m, mangrove roots; 11/viii/2003; DZUP ASC34—1 ind.; Solarte; 0.5 m, mangrove roots; 11/viii/2003; DZUP ASC92—1 ind.; Solarte; mangrove roots; 15/viii/2006. DZUP ASC94—4 ind.; Crawl Cay; coral reef; 25/viii/2006; MZUSP 00022—1 ind.; Crawl Cay; 14/vi/2009. DZUP ASC32—1 ind.; Pastores island; 0.5 m, coral reef; 10/viii/2003; DZUP ASC93—7 ind.; Pastores island; coral reef; 17/viii/2006; MZUSP 00023 —2 ind.; Pastores island; 13/vi/2009. DZUP ASC90—1 ind.; Almirante Bay; 04/viii/2003.

Etymology. The name is in homage to the Republic of Panama, where the species was discovered.

Diagnosis. Thick and cartilaginous tunic with black or very dark and ramified vessels, especially around the siphons; in the field, the oral siphon usually has radial, short, white lines; musculature of the right side comprises a net of fibers in different directions; on the left side complete transverse fibers appear at the anterior region; oral tentacles united by a thick membrane; pharynx with 43–77 longitudinal vessels on the right side and 37–68 on the left; 5–7 stigmata per mesh; rectum forms a round sac; lobed ovary inside the primary intestinal loop.

Animals attach to the substrate on the left side of their body, usually without incrustations or epibionts. In coral reefs, only the large oral siphon is visible, with white stripes between the lobes; in mangrove roots, the small atrial siphon can be seen on the posterior region. The tunic is semi-transparent, gray or dark gray when alive, with numerous black vessels conspicuous mainly around the siphons. The tunic is cartilaginous, 0.2–3.0 mm thick, without projections. The body is elongated (2.6–7.0 cm long without the oral siphon; 0.9–2.9 cm wide); the body wall is opaque and brown with darker siphons. Siphons are 0.2–1.4 cm long, both have 10–16 lobes with smooth margins and a black spot between lobes; young individuals (up to 2.0 cm long) have eight lobes on the oral siphon and ten on the atrial.

On the right side, the body wall musculature comprises a net of strong fibers. On the left side of the body are complete transverse vessels close to the base of the oral siphon, longitudinal fibers from the oral siphon to the tip of the primary intestinal loop, and short fibers on the dorsal margin. Longitudinal muscles fibers in the siphons do not form bands.

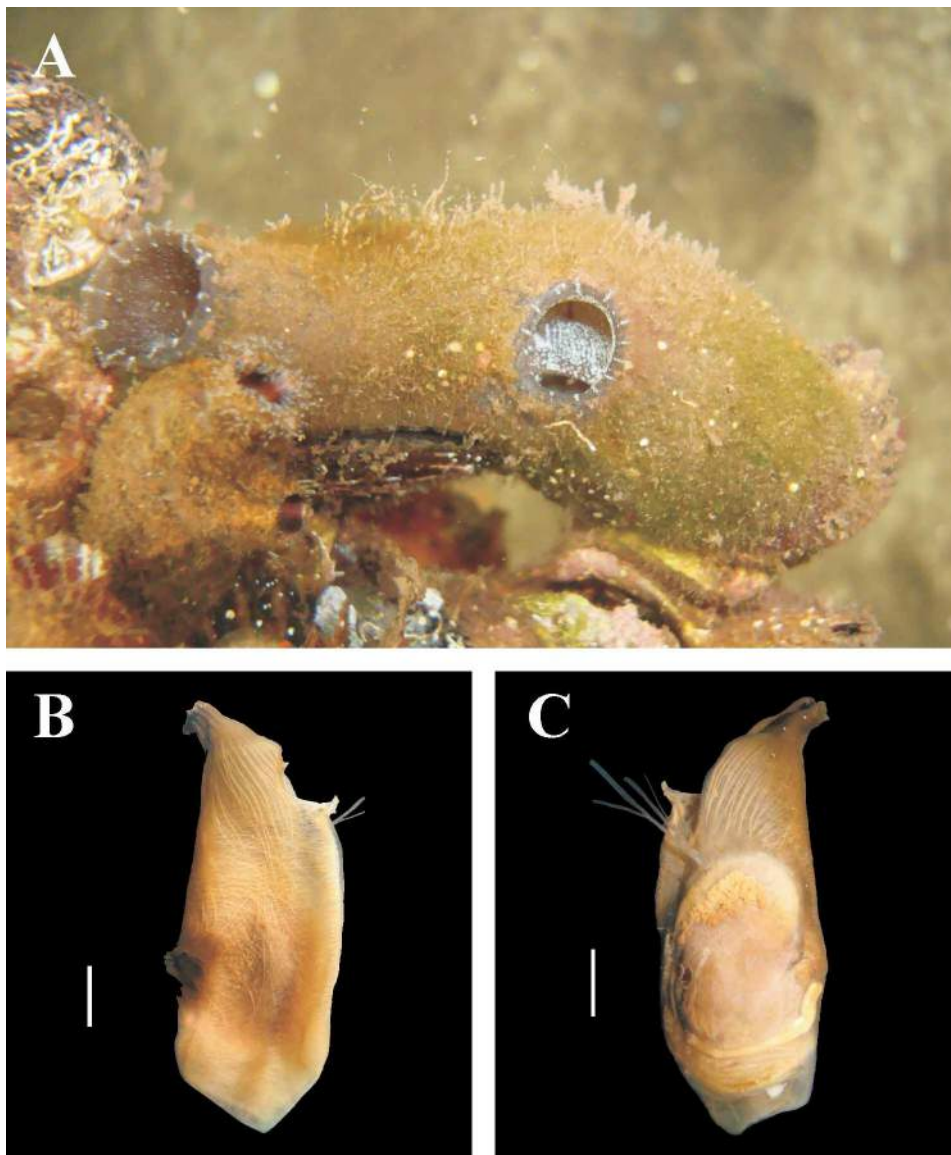


FIGURE 13. *Ascidia panamensis* sp. nov. A. Animal in the field. B. Right side of body (without tunic). C. Left side of body (without tunic). Scale bar: B, C = 1.0 cm.

The 41–115 oral tentacles are of three sizes, the longest 1.5–3.6 mm long. A thick membrane connects the tentacles. The double prepharyngeal groove has projections in the anterior lamina of some individuals; the area between it and the ring of tentacles is smooth, but it may have some small papillae. The peritubercular area is small and the dorsal tubercle aperture is U-shaped with or without curved ends. The neural ganglion is away from the

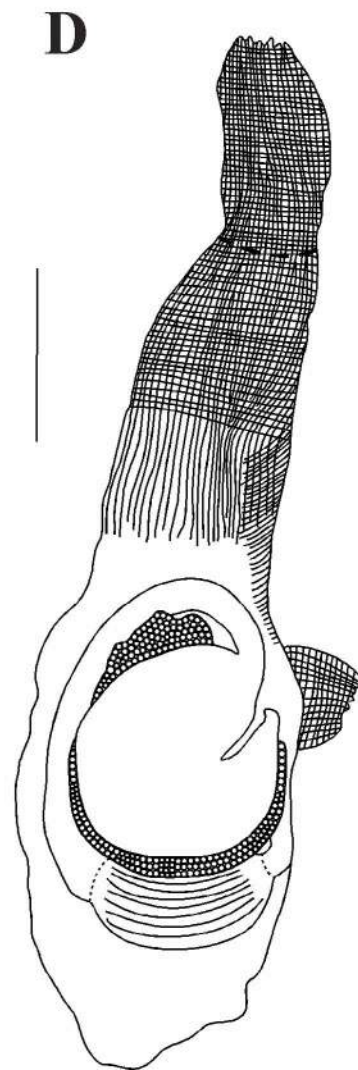
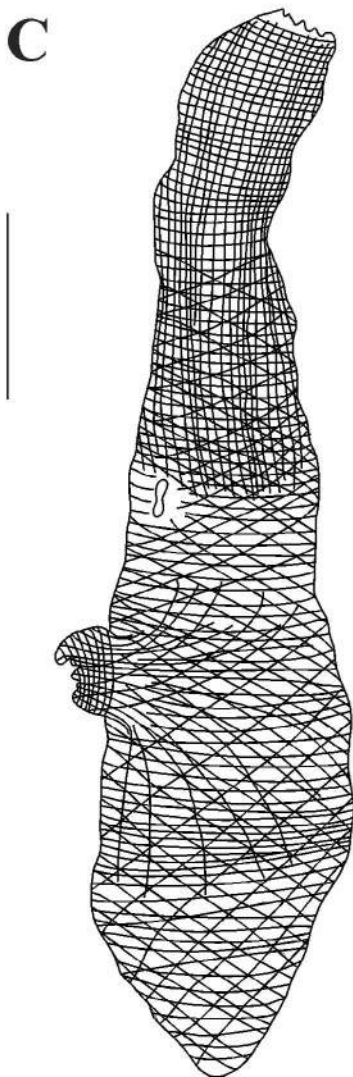
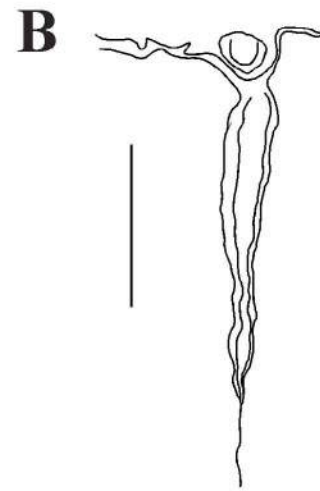


FIGURE 14. *Ascidia panamensis* sp. nov. A. Black vessels in the tunic. B. Dorsal tubercle and anterior part of dorsal lamina. C. Right side of body (external), showing muscles. D. Left side of body (external), showing the gut and gonads. Scale bar: B = 1.0 mm; C, D = 1.0 cm.

dorsal tubercle, close to the atrial siphon. The dorsal lamina is double anteriorly, single and with toothed margin posteriorly (projections formed by the ends of the transverse vessels). The dorsal lamina passes by the left of the esophageal aperture to the end of the pharynx (2.5–14.0 mm beyond the stomach). There is a narrow lamina on the right of the esophageal aperture. The pharynx has 53–77 longitudinal vessels on the right side, 49–68 on the left, and 143–316 transverse vessels; it is very pleated, with 5–7 stigmata per mesh. The primary papillae in the pharynx are bilobed; secondary papillae and parastigmatic vessels are absent.

The alimentary canal occupies half or more of the left side of the body. The stomach is elongated, with 8–16 internal longitudinal folds. The intestine has primary and secondary loops; rectum has dilation forming a large pouch. The anus is located 9–38 mm from the oral tentacles and has a bilobed rim. Renal vesicles of 0.1–0.2 mm diameter cover the intestine and stomach.

The cauliflower-shaped ovary is restricted to the primary intestinal loop, more conspicuous externally; oocytes are 0.15 mm in diameter. The testis is ramified, with numerous follicles overlying the digestive tube. Both gonoducts open near, and just posterior, to the anal aperture.

Remarks. The gray tunic with dark vessels mostly around the siphons is very characteristic, in only one known Atlantic species: *Ascidia interrupta*. This species also has many lobes in the siphons, a net of muscle fibers on the right side of the body, a dilated rectum and a lobed ovary inside the primary intestinal loop. However, *A. interrupta* has a rigid tunic, with fewer vessels and with rounded projections on the surface. Moreover, *A. interrupta* does not have transverse musculature on the left side, has papillae overlying the area between the prepaharyngeal groove and the ring of tentacles, papillae on the right face of the dorsal lamina (close to esophageal aperture), and trilobed papillae in the pharynx—characters never found in *A. panamensis* **sp. nov.**

From the Pacific Ocean, Kott (1985) redescribed *Ascidia empheres* Sluiter, 1895 with conspicuous dark vessels in the tunic after fixation, body musculature formed by a net on the right side of the body, a U-shaped dorsal tubercle and toothed dorsal lamina. *Ascidia empheres* differs from *A. panamensis* **sp. nov.** due to the reduced number of lobes in the siphons (7–8 in the oral and 6–7 in the atrial), papillae on the area between the prepaharyngeal groove and the tentacles, eight stigmata per mesh, isodiametric intestine and ovary inside and outside of the primary intestinal loop (Kott 1985). Another three Pacific species have vessels that are visible in the tunic, a net of muscle fibers on the right side of the body and toothed dorsal lamina: *A. gemmata* Sluiter, 1895, *A. ornata* Monniot & Monniot, 2001 and *A. glabra* Hartmeyer, 1922. However, *A. gemmata* has short muscle fibers on the left side of the body, few lobes on the siphons and isodiametric intestine (Kott 1985), differing from *A. panamensis* **sp. nov.** Described recently, *A. ornata* differs from *A. panamensis* **sp. nov.** by the weak body musculature, fewer oral tentacles (about 30), the number of stigmata per mesh (6–10) and the stomach position (almost vertical) (Monniot & Monniot 2001). *Ascidia glabra* is the most similar species to *A. panamensis* **sp. nov.**, because they share the number of tentacles (60–100) and stigmata per mesh (4–8) (Kott 1985; Monniot 1990). However, they differ in that *A. glabra* is yellow in life, has 9–12 lobes in the oral siphon and 6–8 lobes in the atrial, short longitudinal muscles on the left side of the body, papillae between the prepaharyngeal groove and the ring of tentacles, trilobed papillae in the pharynx, and the ovary in both intestinal loops (Kott 1985; Monniot 1990).

Ascidia sydneyensis Stimpson, 1855

(Fig. 15)

Material examined. DZUP ASC116—1 ind.; Casa Blanca; 0.5 m, mangrove roots; 25/vii/2008; DZUP ASC160—1 ind.; 05/vi/2009. DZUP ASC123—1 ind.; Marina; 1.0 m, inside brick; 05/iii/2009. DZUP ASC38—5 ind.; STRI dock; 1.0 m; 12/viii/2003. DZUP ASC111—1 ind.; Hospital Point; 20/viii/2006. DZUP ASC113—7 ind.; Baía Honda; mangrove roots; 23/viii/2006; DZUP ASC117—6 ind.; mangrove roots; 0.5–1.0 m; 28/vii/2008. DZUP ASC109—3 ind.; Solarte; mangrove roots; 15/viii/2006; DZUP ASC112—1 ind.; mangrove roots; 23/viii/2006. DZUP ASC124—1 ind.; Crawl Cay; 14/vi/2009. DZUP ASC39—2 ind.; San Cristobal island; 0–1.0 m, mangrove roots; 12/viii/2003; DZUP ASC36—2 ind.; San Cristobal island; 0.4 m, mangrove roots; 12/viii/2003; DZUP ASC37—1 ind.; San Cristobal island; 0–1.0 m, mangrove roots; 12/viii/2003. DZUP ASC118—5 ind.; Popa island; 0.5 m, mangrove roots; 30/vii/2008. DZUP ASC110—1 ind.; City; 19/viii/2006; DZUP ASC163—1 ind.; City; 12/vii/2009.

Although few were found during the survey of August 2003, the species is very common both on mangrove prop roots and artificial substrates. Individuals are usually 4.5–5.0 cm long (occasionally to 7.5 cm). Color of living animals is variable and may be white, yellow, red, wine or cream. The color comes from the right side of the body wall, because the tunic is transparent. Conical or more elongated tunic projections occur mainly on the posterior region and are used for attachment. The tunic is usually heavily encrusted with algae and other invertebrates. Siphon position and length are also variable. The oral siphon typically has 7–8 lobes with indented margins, or long projections and a red spot between each two lobes. Each lobe is in the end of an aggregation of longitudinal muscle fibers, and between these muscle bands the tunic forms a marked longitudinal crest when the animals is contracted. The atrial siphon has six triangular lobes, with projections and a dark spot between each (red in living animals). Some individuals lack lobes on the margin of the siphons but still have aggregations of projections where the lobes should be. The neural ganglion is close to the dorsal tubercle. The primary papillae are flat, long and curved, with a basal expansion; intermediate papillae are absent. The alimentary canal is always large and most of the space is occupied by the dilation of the rectum that forms a round sac. The border of the anus is multilobed. Renal accumulation vesicles are absent in the examined material. The ovary is ramified into elongated lobes on the primary and secondary intestinal loops. The testicle has small and irregular follicles, usually inside the primary loop and on the secondary loop. From the outside, the testicular follicles are visible on the dilation of the intestine.

Remarks. This species is widely distributed in all oceans.

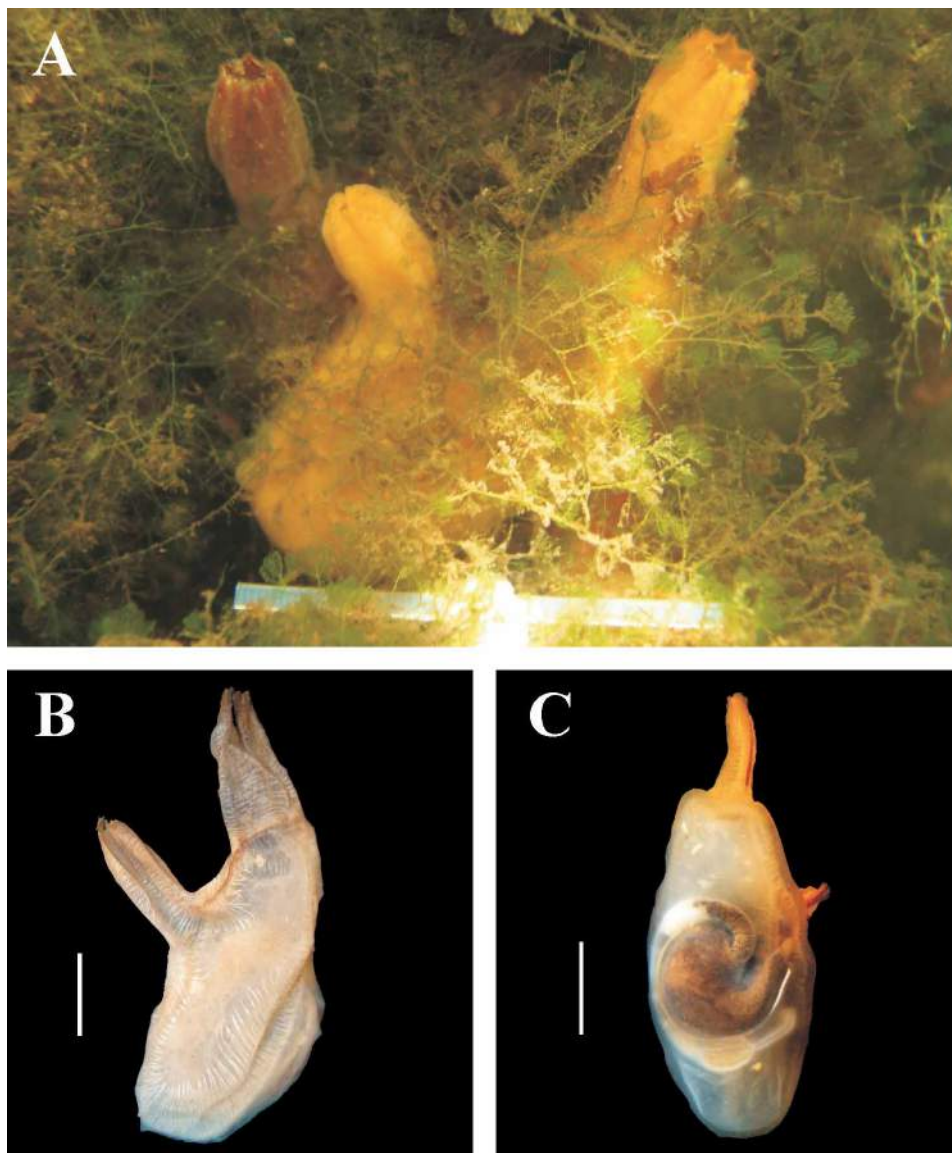


FIGURE 15. *Ascidia sydneyensis* Stimpson, 1855. A. Animal in the field. B. Right side of body (without tunic). C. Left side of body (without tunic). Scale bar: B, C = 1.0 cm.

***Phallusia fragilis* sp. nov.**

(Figs. 16–17)

Material examined. Holotype: MZUSP 00012 —1 ind.; Pastores island; 1.0 m, coral reef; 10/viii/2003.

Paratypes: DZUP PHA23—1 ind.; Casa Blanca; coral reef; 05/vi/2009. DZUP PHA19—3 ind.; Garden; 7.0–9.0 m, in dead coral reef; 10/viii/2008; DZUP PHA20—1 ind.; 6.0 m, coral reef; 23/xii/2008. MZUSP 00013 —1 ind.; South Solarte; 06/viii/2003. DZUP PHA17—1 ind.; 1.0 m, Garden, coral reef; 10/viii/2003; DZUP PHA18—2 ind.; Garden, coral reef; 17/viii/2006; DZUP PHA21—1 ind.; Garden, coral reef; 25/ii/2009. DZUP PHA22—1 ind.; Big Bight; coral reef; 05/vi/2009.

Etymology. The specific epithet is due to the delicate tunic and body wall.

Diagnosis. Long cylindrical body; no musculature on the oral siphon and on the left side; musculature on the right side formed by short parallel fibers on the dorsal and ventral margins; oral tentacles project from a delicate membrane joining them by their bases; dorsal tubercle absent; accessory apertures concentrated near to the neural gland; 58–78 longitudinal vessels on the right side and 47–64 on the left side of the pharynx; 3–5 stigmata per mesh; filiform primary papillae on the first anterior transverse vessel; elongated or sac-like dilation at the rectum; ovary inside the primary intestinal loop, ramified on the intestine wall; gonads of both sexes are not found at the same time.

This species is usually found buried in coral rubble, between 2.0–10.0 m deep, with only the oral siphon visible above the surface. In the field the oral siphon projects 1.0–2.0 cm from the bottom and is easily recognized by the pale yellow color and by its shape, with the aperture diameter smaller than the siphon itself (about 1.0 cm). Numerous yellow papillae project from tunic around the siphons. The animal is attached to coral fragments and shells by the left side which is very delicate and easily broken when attempting to remove the animal from the substrate. The tunic is yellow and transparent; on the right side it is thicker (2.0 mm) and gelatinous, with some protuberances. Blood vessels are very ramified and have swollen blind ends which appear as small yellow papillae on the surface of the tunic.

The body is elongate, up to 7.5 cm total length (include siphons). Without the tunic the distance between the oral tentacles and the posterior margin is 3.5–6.4 cm, and 1.2–1.7 cm wide. The body wall is usually colorless, but some animals fixed in formalin are brownish on the right side. The oral siphon is apical with the atrial siphon somewhat posteriorly displaced 1.8–3.9 cm from the circle of oral tentacles. The oral siphon is from 5.0–35.0 mm long and the atrial siphon is shorter at 2.0–5.0 mm. Both siphons have a plain rim or eight small rounded transparent lobes. The neural ganglion is at the level of the tip of the intestinal loop, midway between the oral tentacles and the atrial siphon.

On the right side, the body wall musculature comprises short and thick fibers perpendicular to the dorsal and ventral margins. The posterior margin has no fiber and the anterior margin has a band of well organized circular fibers forming a sphincter at the level of the oral tentacles. Posterior to this sphincter the musculature forms a net of fibers on both ventral and dorsal margins. Some very slender fibers run longitudinally to the posterior end over the transverse fibers. No muscle fibers are on the left side nor on the oral siphon. The atrial siphon has a conspicuous sphincter of circular fibers.

The 46–70 simple oral tentacles are of three sizes, the largest are 1.4–2.5 mm long and the tentacles extend from a wide muscular membrane. Oral tentacles are wide and flat along most of their length narrowing at the extremity. The double prepharyngeal groove has no projections and the anterior membrane may be wider; the width of the area between the line of tentacles and the prepharyngeal groove may be 2.5 mm in which are many papillae. The peritubercular area is V-shaped, sometimes very deep and lacking a dorsal tubercle. The fusiform neural gland is displaced posteriorly alongside the neural ganglion and has 24–92 small sessile apertures to the atrial cavity (Fig. 16E). The dorsal lamina is double anteriorly and wide posteriorly with finger like projections formed by the ends of the transverse vessels without any intermediate projections; there are no projections close to the esophageal aperture. The dorsal lamina narrows alongside the esophageal aperture on its left and then widens towards the end of the pharynx (7–18 mm beyond the stomach). The area between the dorsal lamina and the first right longitudinal vessel is wide and often is perforated by large openings, just prior to the esophageal aperture. On the right side of the esophageal aperture, the transverse vessels form long languets. The pharynx has 58–78 longitudinal vessels on the right side, 47–64 on the left side and 192–317 transverse vessels, is not pleated and with few stigmata in the meshes (3–5). Primary papillae are bilobed, and only those on the first anterior transverse vessel have a filiform lobe and longer; intermediate papillae are very small, button-like or completely lacking. Parastigmatic vessels were not seen.

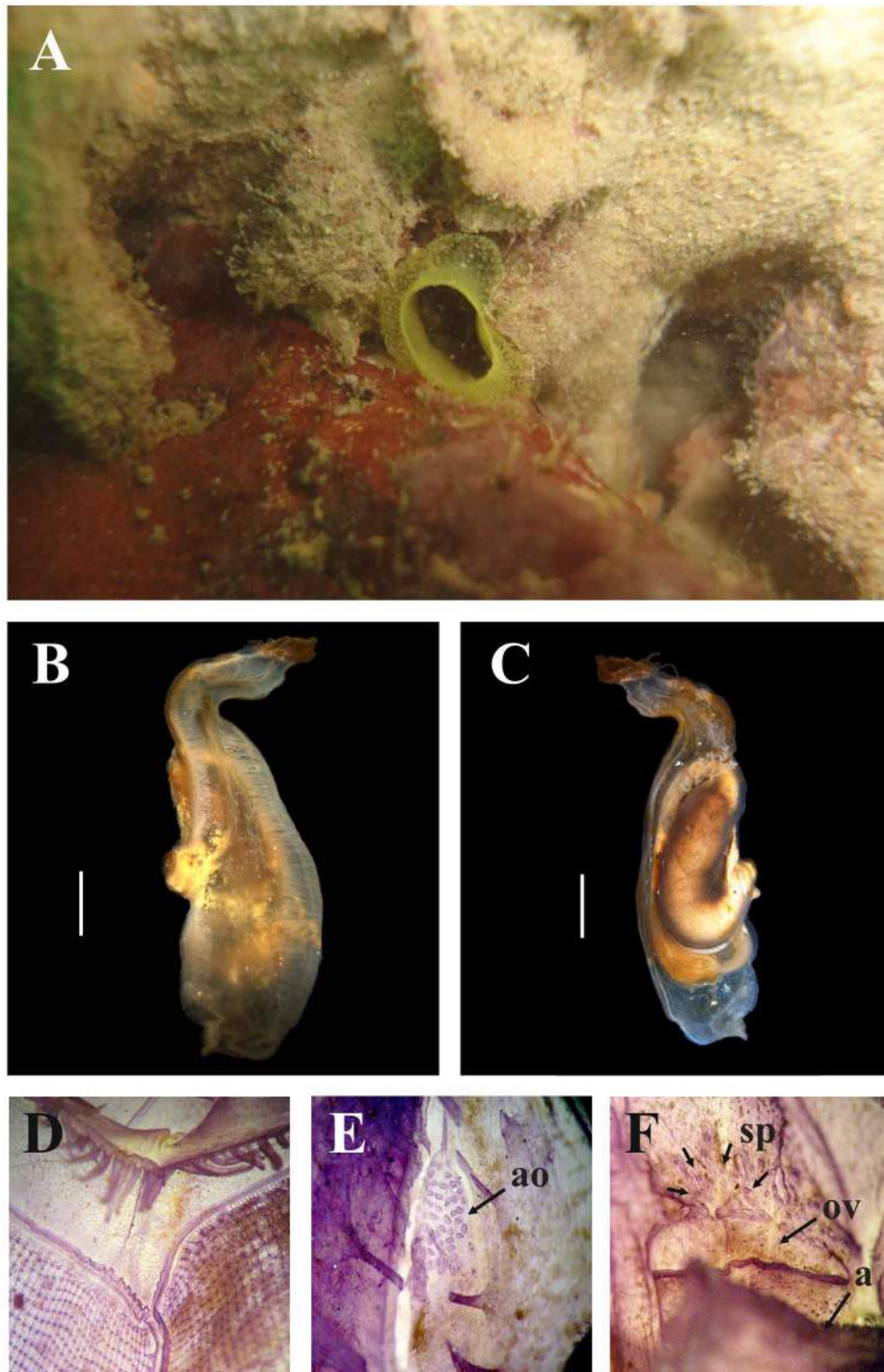


FIGURE 16. *Phallusia fragilis* sp. nov. A. Animal in the field. B. Right side of body (without tunic). C. Left side of body (without tunic). D. Anterior region of a dissected animal. E. Accessory openings (ao) on the neural gland. F. Gonoduct openings (ov = oviduct, sp = sperm duct) anterior to the anus opening (a). Scale bar: B, C = 1.0 cm.

The alimentary canal is large, occupying half or more of the left side of the body. The stomach is oval, short, with four internal folds. The intestine forms two loops and the descending part is dilated forming an elongate or sac-like pouch. The anus with a plain rim is located 23.2–37.8 mm from the oral tentacles. The atrial epithelium covering the alimentary canal has diminutive papillae, except on the stomach and ascending intestine walls where they are larger. Long filiform papillae were seen in some animals. Renal vesicles are 0.1–0.25 mm in diameter and they cover the entire atrial side of the alimentary canal.

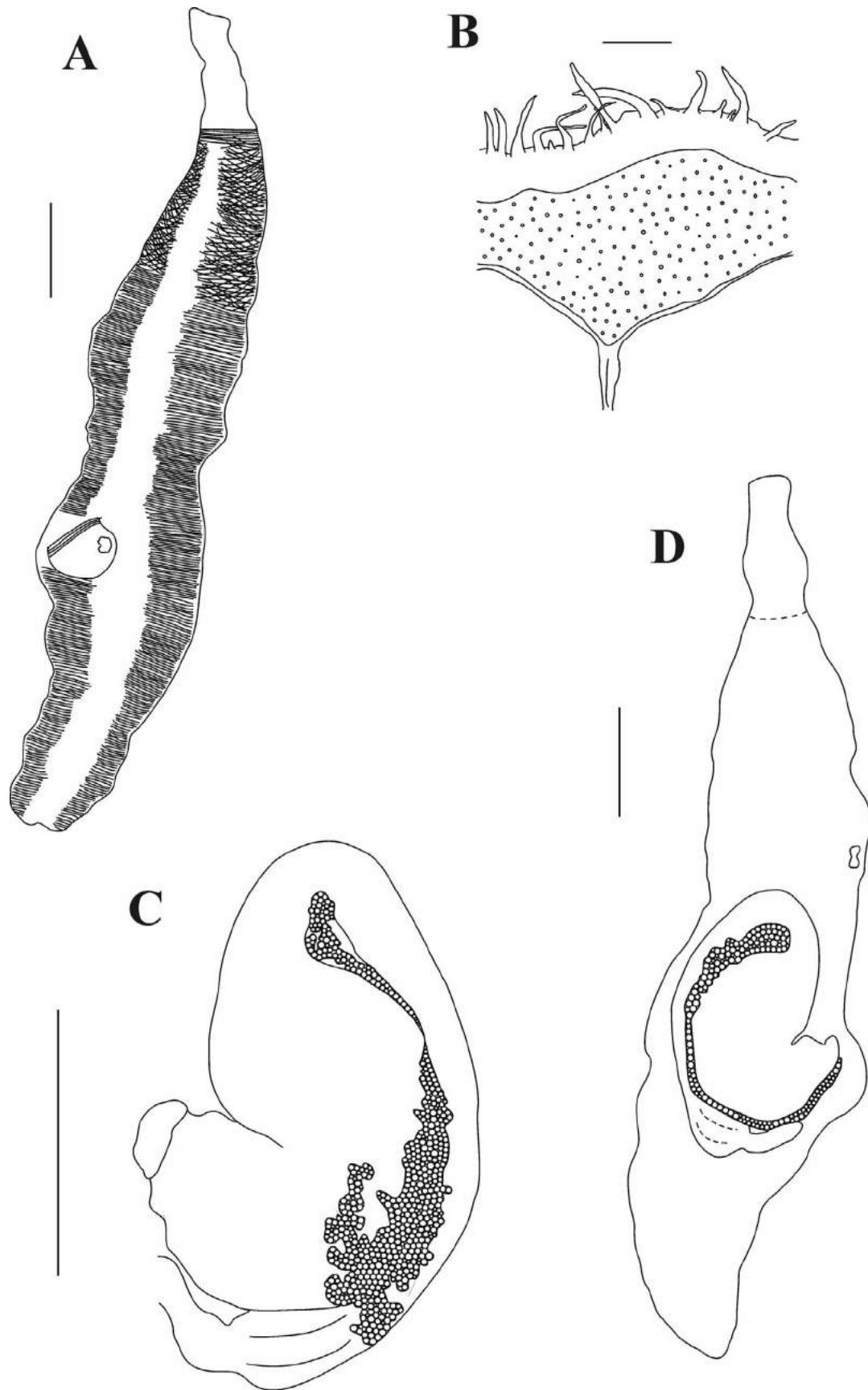


FIGURE 17. *Phallusia fragilis* sp. nov. A. Right side of body (external), showing muscles. B. Dorsal tubercle and anterior part of dorsal lamina. C. Gut and gonads (internal). D. Left side of body (external), showing the gut and gonads. Scale bar: A, C, D = 1.0 cm; B = 1.0 mm.

The species is apparently sequentially hermaphrodite: only the ovary was developed in individuals collected in June and August, while only the testis was visible in those collected in December and February. The ovary is mostly located inside the primary intestinal loop. Outside the loop it may branch on the intestinal wall at the top of the primary loop. From the inside, there is a portion inside the primary loop and also a portion on the rectum at the extremity of the secondary loop, which do not show ramifications, instead it is more cauliflower like. Oocytes are 0.1 mm in diameter. The oviduct adheres to the body wall instead to the wall of the rectum and its aperture is very large and anterior to the anus. The testis has long and little ramified follicles covering the wall of the ascending intestine and of the intestinal dilation, both externally and on the atrial cavity side. The sperm duct has many small apertures spread on the body wall anterior to the oviducal aperture (Fig. 16F).

Remarks. In the Caribbean sea, there are two known *Phallusia* species: *P. nigra* and *P. caguayensis* (Millar & Goodbody, 1974). Both are very different from *Phallusia fragilis* **sp. nov.**: *P. nigra* has a rigid and dark tunic (black or gray), the body musculature formed by a net of fibers on the right side of the body and it has a dorsal tubercle; *P. caguayensis* has thin and light gray tunic, musculature restrict to the dorsal margin of the body, about 120 oral tentacles, up to 200 accessory openings, only primary papillae and 8–10 stigmata per mesh (Millar & Goodbody 1974). No other *Phallusia* registered in the world is similar to *Phallusia fragilis* **sp. nov.**

Ascidia muricata Heller, 1874, described from the Mediterranean and Azores is similar to *P. fragilis* **sp. nov.** in having a yellow tunic (not all individuals) with papillae, elongate body, similar number of oral tentacles (40–60) projecting from a muscular membrane, lack of the dorsal tubercle in some individuals, and presence of small intermediate papillae (Monniot 1974). However, *A. muricata* differs from *Phallusia fragilis* **sp. nov.** by the absence of secondary openings of the neural gland, different musculature pattern on the right side of its body, fewer number of longitudinal vessels, presence of digitiform and long primary pharyngeal papillae, dorsal lamina not surpassing the esophageal aperture, smaller alimentary canal and lack of rectum dilation, simultaneous presence of both gonads, ovary not visible from the outside.

***Phallusia nigra* Savigny, 1816**

(Fig. 18)

Material examined. DZUP PHA14—1 ind.; STRI Bay; 0.5 m, on PVC recruitment plate; 20/x/2008; DZUP PHA15—1 ind.; 0.5 m, mangrove roots; 17/ii/2009; DZUP PHA27—1 ind.; City; on PVC recruitment plate; 12/vii/2009. DZUP PHA09—1 ind.; Solarte; 15/viii/2003. DZUP PHA02—1 ind.; South Solarte; 06/viii/2003. DZUP PHA03—3 ind.; Mangrove Inn; 07/viii/2003.

This species is very common on mangrove prop roots, on coral reefs and artificial substrates. The tunic is black, but young individuals may be gray. The atrial siphon is long and anterior, its aperture is very close to the oral aperture which is usually bent dorsally.

Since this is a well known species, this is a complementary description to Van Name's (1945). There are 8–12 lobes on the oral siphon and 8–10 on the atrial, with one red spot between each in living animals. These spots turn black with formalin fixation. The lobes are large, round, transparent with plain rim. There are conspicuous longitudinal muscles over a net of more transverse and oblique slender fibers covering the right side of the body, while on the left side the longitudinal fibers from both siphons extend till the intestinal loop. Fibers from the atrial siphon sometimes cover the secondary intestinal loop. Some oral tentacles are very wide and flat at their bases (around one third of them) while the others are short and slender. The prepharyngeal groove is double, the posterior membrane inflated, forming a V area surrounding the dorsal tubercle with a U or V-shaped aperture. The neural ganglion and gland are very close to the atrial siphon. The 9–26 accessory openings between the dorsal tubercle and the neural gland are underneath the dorsal lamina. The dorsal lamina is double from the dorsal tubercle to the neural ganglion, beyond which it forms a wide membrane with long languets on the margin formed by the ends of the transverse vessels. The lamina decreases in width along the esophageal aperture and it ends just after the end of the aperture. The extremities of transverse vessels form long languets on the right side of the esophageal aperture and posterior to the pharynx. The pharynx is very pleated, with 6–9 small oval stigmata per mesh. There are 50–90 longitudinal vessels on the right side of the pharynx and 40–80 on the left; instead of parallel, the longitudinal vessels are

oblique to the dorsal lamina in the portion where it is double. The primary papillae are flat, wide and round at the tip with a lobe at the base; there are some intermediate papillae, similar to but smaller than the primary. The alimentary canal comprises a long esophagus, a folded large stomach, an intestine with closed primary and secondary loops without dilation and the anus with a multilobed margin. The renal accumulation vesicles are abundant and transparent spheres on the wall of the intestinal tract, on both the atrial and body faces. The cauliflower-shaped ovary is dark and ramified laying inside both intestinal loops. The testis follicles are very difficult to see underneath the renal vesicles in old large animals. Follicles spread on intestinal wall in both loops. Both gonoducts are attached to the rectum wall and open beside the anus.

Remarks. The species has an extensive geographical distribution in warm seas. In the western Atlantic the most northern locality is Bermuda (Van Name 1945; Monniot 1972) while the southern geographical distribution limit is São Paulo, Brazil (Rodrigues 1962).

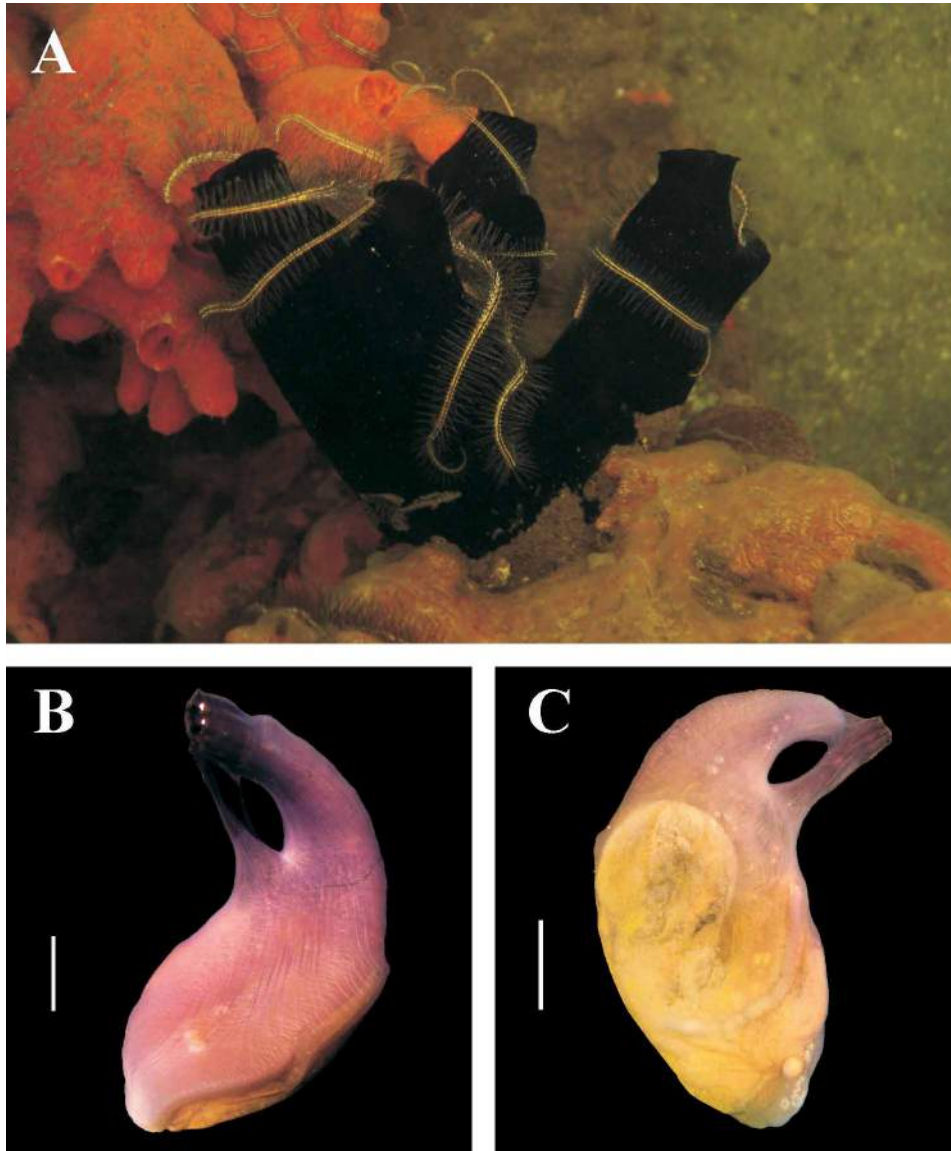


FIGURE 18. *Phallusia nigra* Savigny, 1816. A. Animal in the field. B. Right side of body (without tunic). C. Left side of body (without tunic). Scale bar: B, C = 1.0 cm.

Table 2. Tabular key for the identification of Caribbean Ascidiidae species

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	Species
R	S	8-10	0	O	B	15-40	0	0	0	0	4-6	S	P	>1/2	4-5	0	E	<i>Ascidia archaica</i> Sluiter, 1890
O	S	8-9	0	V	B/0	60-100	0	0	P/0	0	7-10	S/T	0	½	9-17	0	C	<i>Ascidia bocatorensis</i> sp. nov.
O	S	8-9	0	V	0	50-70	0	P	P	P/0	7-12	S/T	0	>1/2	8-11	P	C	<i>Ascidia corallicola</i> sp. nov.
I	S	8	0	V	0	70-150	0	P/0	P/0	0	5-7	S	0	>1/2	10-24	0	C	<i>Ascidia curvata</i> (Traustedt, 1882)
I	S	8	0	V	0	70-165	0	P/0	P	P	2-5	S	0	>1/2	6-8	0	C	<i>Ascidia tenue</i> Monniot, 1983
I	S	8	0	T	B	70-85	0	0	P	P/0	4-6	B	0	<1/2	5-7	0	R	<i>Ascidia collini</i> sp. nov.
I	M	?	?	D	?	~120	~200	?	?	?	8-10	S	0	>1/2	?	P	R	<i>Phallusia caguayensis</i> Millar & Goodbody, 1974
I	R	6-8	P	B	0	~80	0	P	P	P	5-10	T	0	½	~6	P	C	<i>Ascidia cf. munda</i> Sluiter, 1897
V	R	8-16	0	V	0	45-140	0	P/0	P	P/0	4-10	B/T	0	½	11-16	P	C	<i>Ascidia interrupta</i> Heller, 1878
V	E	6-10	P	B	B	35-285	0	0	0	0	6-12	B	0	>1/2	5-9	P	R	<i>Ascidia sydneyensis</i> Stimpson, 1855
B	S	8-12	0	V	B	30-100	9-26	0	P	0	4-9	B	0	>1/2	6-7	0	C/R	<i>Phallusia nigra</i> Savigny, 1816
B	S	10-16	0	V	0	40-115	0	P/0	0	0	5-7	B	0	>1/2	8-16	P	C	<i>Ascidia panamensis</i> sp. nov.
Y	?	16-24	P	V	?	12-30	0	?	?	?	2-3	S/B	0	<1/2	?	P	C	<i>Ascidia xamaycana</i> Millar & Goodbody, 1974
Y	S	10-16	0	T	0	50-90	0	P	0	0	4-8	S	0	½	10-18	P	C	<i>Ascidia monniti</i> sp. nov.
Y	S/R	0/8	0	B	-	46-70	24-92	0	P	0	3-5	B	P	>1/2	4	P	C	<i>Phallusia fragilis</i> sp. nov.

Tabular key for Caribbean Ascidiidae species

- 1. Color in living specimens:** B. Black or gray; G. Greenish; R. Red or reddish; O. Orange; U. Uncolored or white; V. Various colors; Y. Yellow or lime green
- 2. Surface of the tunic:** E. Elongated projections; M. mammillated; R. Round or hemispheric projections; S. Smooth
- 3. Number of lobes on the oral siphon**
- 4. Projections on the lobes of siphons:** P. Presence; 0. Absence
- 5. Musculature on the right side:** B. Parallel short fibers forming a band around all the margin; D. Parallel short fibers forming a band only on the dorsal margin; O. Mainly oblique; T. Mainly transverse; V. In various directions
- 6. Longitudinal musculature in the siphons:** B. Concentrated in bands that correspond to each lobe; 0. Without any pattern; -. Absence
- 7. Number of oral tentacles**
- 8. Number of accessory openings along the neural gland duct**
- 9. Projections in the pharyngeal groove:** P. Presence; 0. Absence
- 10. Papillae in the area between the oral tentacles and the prepharyngeal groove:** P. Presence; 0. Absence
- 11. Papillae on the right side of the dorsal lamina wall, near to the esophageal aperture:** P. Presence; 0. Absence
- 12. Number of stigmata per mesh**
- 13. Shape of the primary papillae on the pharynx:** S. Simple; B. Bilobed; T. Trilobed
- 14. Intermediate papillae on the pharynx:** P. Presence; 0. Absence
- 15. Size of digestive tract:** > ½ size of the left side; ½ size of the left side; < ½ size of the left side
- 16. Number of plications in the stomach wall**
- 17. Dilatation of the rectum:** P. Presence; 0. Absence
- 18. Shape of the ovary:** C. Cauliflower (=lobed); E. Elongated; R. Elongated and ramified

Acknowledgments

We would like to thank Dr. Rachel Collin for having invited RMR to the Marine Invertebrate Taxonomy Workshop held in the Smithsonian Tropical Research Station (STRI) at Bocas del Toro in August, 2003 and for subsequent visits. We also thank Gabriel Jacome, Plinio Gondola and Arcadio Castillo which aided with diving and lab logistics during the collections, MSc. Angelico Asenjo for the help with the plates, and James J. Roper for reviewing the English. CNPq supplied a Master scholarship to NYKB and a sabbatical grant to RMR. This paper is the contribution 1494 of Departamento de Zoologia, Universidade Federal do Paraná.

References

- Berrill, N.J. (1932) Ascidiens of the Bermudas. *The Biological Bulletin*, 62(1), 77–88.
- Collin, R. (2005) Ecological monitoring and biodiversity surveys at the Smithsonian Tropical Research Institute's Bocas del Toro Research Station. *Caribbean Journal of Science*, 41(3), 367–373.
- Goodbody, I. (1984a) The ascidian fauna of two contrasting lagoons in the Netherlands Antilles: Piscadera Baai, Curaçao, and the Lac of Bonaire. *Studies of the fauna of Curacao and other Caribbean Islands*, 67(202), 21–61.
- Goodbody, I. (1984b) Ascidiens from Caribbean shallow water localities. *Studies of the fauna of Curaçao and other Caribbean Islands*, 67(203), 62–76.
- Goodbody, I. (2000) Diversity and distribution of ascidiens (Tunicata) in the Pelican Cays, Belize. *Atoll Research Bulletin*, 480, 302–326.
- Goodbody, I. (2003) The ascidian fauna of Port Royal, Jamaica. I. Harbor and mangrove dwelling species. *Bulletin of Marine Science*, 73, 457–476.
- Kott, P. (1985) The Australian Ascidiacea. Part 1. Phlebobranchia and Stolidobranchia. *Memories of the Queensland Museum*, 23, 1–440.
- Lotufo, T.M.C. (2002) *Ascidiacea (Chordata: Tunicata) do litoral tropical brasileiro*. Doctoral thesis, Zoology Department, Universidade de São Paulo, 183 pp.

- Marins, F.O., Novaes, R.L.M., Rocha, R.M. & Junqueira, A.O.R. (2010) Non indigenous ascidians in port and natural environments in a tropical Brazilian bay. *Zoologia*, 27(2), 213–221.
- Millar, R.H. (1953) On a collection of ascidians from the Gold Coast. *Proceedings of the Zoological Society London*, 123, 277–325.
- Millar, R.H. (1960) Discovery Reports. Ascidiacea. *National Institute of Oceanography*, 30, 1–160.
- Millar, R.H. (1962) Some ascidians from the Caribbean. *Studies on the Fauna of Curaçao and Other Caribbean Islands*, 13(59), 61–77.
- Millar, R.H. & Goodbody, I. (1974) New species of ascidian from the West Indies. *Studies on the Fauna of Curaçao and Other Caribbean Islands*, 148(45), 142–161.
- Monniot, C. (1969-1970) Ascidiées Phlebobranches et Stolidobranches. In: Campagne de la Calypso au large des côtes de l'Amérique du Sud. *Annales de l'Institut Océanographique*, 47, 33–59.
- Monniot, C. (1972) Ascidiées Phlebobranches des Bermudes. *Bulletin du Muséum Nationale d'Histoire Naturelle*, 3 ser. Zool., 61(82), 938–948.
- Monniot, C. (1974) Ascidiées littorales et bathyales récoltées au cours de la campagne Biaçores: Phlébobranches et Stolidobranches. *Bulletin du Muséum Nationale d'Histoire Naturelle*, 3 ser. Zool., 173, 1327–1352.
- Monniot, C. (1983) Ascidiées littorales de Guadeloupe 2. Phlebobranches. *Bulletin du Muséum Nationale d'Histoire Naturelle*, 4 ser. Zool., 5(1), 51–71.
- Monniot, C. (1987) Ascidiées de Nouvelle-Calédonie. I. Phlébobranches du lagon. *Bulletin du Muséum National d'Histoire Naturelle*, 4 ser. Zool., 9(1), 3–31.
- Monniot, C. (1990) Ascidiées de Nouvelle-Calédonie. VIII. Phlébobranches (suite). *Bulletin du Muséum National d'Histoire Naturelle*, 4 ser. Zool., 3-4, 491–515.
- Monniot, F. (2007) Some ascidians (Tunicata) from the Clipperton Island. *Cahier de Biologie Marine*, 48, 303–310.
- Monniot, F. & Monniot, C. (2001) Ascidians from the tropical western Pacific. *Zoosystema*, 23(2), 201–383.
- Nishikawa, T. (1986) Ascidians from the Gilbert and Solomon Islands and Nauru. I. Perophoridae, Ascidiidae and Corellidae. *Proceedings of the Japanese Society of Systematic Zoology*, 32, 30–78.
- Nishikawa, T. & Tokioka, T. (1975) Contributions to the Japanese ascidian fauna XXVI. Notes on simple ascidians commonly found in the waters near the Sabiura Marine Park Research Laboratory. *Publications of the Seto Marine Biological Laboratory*, 22(1/4), 217–222.
- Rocha, R.M. & Nasser, C.M. (1998) Some ascidians (Tunicata, Ascidiacea) from Paraná State, Southern Brasil. *Revista Brasileira de Zoologia*, 15(3), 633–642.
- Rocha, R.M., Moreno, T.R. & Faria, S.B. (2005) Ascidians from Bocas del Toro, Panama. I. Biodiversity. *Caribbean Journal of Science*, 41(3), 600–612.
- Rodrigues, S.A. (1962) Algumas ascídias do litoral sul do Brasil. *Boletim da Faculdade de Filosofia, Ciências e Letras Universidade de São Paulo, Série Zoologia*, 24, 193–216.
- Sluiter, S.P. (1904) Die tunicaten der Siboga-Expedition. Pt. I. Die socialen und holosomen Ascidien. *Siboga Expeditie*, 56A, 1–126.
- Tokioka, T. (1953) *Ascidians of Sagami Bay*. Iwanami Shoten, Tokyo, 315 pp.+79 plates.
- Van Name, W.G. (1945) The North and South American ascidians. *Bulletin of the American Museum of Natural History*, 84, 1–476.