



## Ascidians of the genus *Aplidium* collected on shallow hard-bottom reefs of coastal Georgia (Atlantic coast of N America, U.S.A.)

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### Abstract

Four shallow-water species of colonial ascidians of the genus *Aplidium* are identified in the collections made by divers off the coast of Georgia, U.S.A. One of the specimens, *Aplidium ruzickai* n. sp., is characterized by a combination of high numbers of rows of stigmata and stomach folds and is described as a new species.

**Key words:** Ascidiacea, *Aplidium*, Atlantic, Georgia

### Introduction

The Carolinian biogeographic province of North America represents an area extending from Cape Hatteras, NC to Cape Canaveral, FL, U.S.A. (cf. Gosner 1971). Approximately 30% of the seafloor in this area is composed of hard-bottom areas of lithified limestone or sandstone embedded with fossilized scallop shells or other organisms (Harding and Henry 1994, Garrison *et al.* 2008). Reefs in this region that occur off the coast of Georgia, including those located within Gray's Reef National Marine Sanctuary (GRNMS) 32 km offshore, are characterized by hard-bottom ridges and ledges of moderate relief [1 to 2 m above the seafloor] that vary in depth from 13–30 m and are separated by sandy plateaus or valleys (Hunt 1974). Surveys conducted within the 58 km<sup>2</sup> area of GRNMS indicate that the hard-bottom ridges and ledges comprise <1% of the total area but have the highest biodiversity and house the majority of the biomass of both sessile invertebrates and ichthyofauna (Kendall *et al.* 2005).

Benthic invertebrates inhabiting ledge systems in the Carolinian biogeographic province, especially those off Georgia, have received little attention. Except for a recently published survey of sponges (Freeman *et al.* 2007), most of our knowledge regarding diversity of benthic invertebrates in this general area is contained within two large scale investigations carried out more than 25 years ago (SCWMRD 1982a, b). These studies used dredge and trawl collections to provide a description of benthic and nektonic organisms at a limited number of reef sites throughout this biogeographic province, including one site within GRNMS.

The current communication provides a description of ascidians in the genus *Aplidium* collected at several hard-bottom sites off the coast of Georgia, U.S.A.. Specifically, ascidians described in this study were from collections carried out at the GRNMS Monitoring Site (31°23.815' N, 80°53.461' W) as well as three other nearby sites: J Reef (31°36.056' N, 80°47.431' W), R-2 Tower Live-bottom (31°24.305' N, 80°34.010' W), and Anchor Ledge (31°37.688' N, 80°34.662' W). These sites range in depth from 14 to 30 m and are separated geographically by no more than 40 km. Water temperatures on these reefs can approach 30° C during summer (peak in August/September) and decline to nearly 10° C in winter (minimum in January/February) (Gleason

unpublished). Ascidians described in this communication were collected by divers by hand and preserved in 4% formalin upon surfacing.

## Descriptions

### *Aplidium antillense* (Gravier, 1955)

(Figures 1, 2)

*Amaroucium antillense* Gravier, 1955: 618.

*Aplidium antillense*: Monniot, 1972: 953; 1983: 414.

**Material examined:** collected in 2004, at 31°23.815' N, 80°53.461' W, specimen #172 (KBPIG 1/1236) and at 31°36.056' N, 80°47.431' W, specimen #190 (KBPIG 2/1237); 2006, specimen #36 (KBPIG 3/1378) and specimen #38 (KBPIG 4/1379) both collected at 31°36.056' N, 80°47.431' W.

**Previous records:** Martinique (Gravier, 1955), Guadeloupe (Monniot, 1983) and Bermudas (Monniot, 1972).

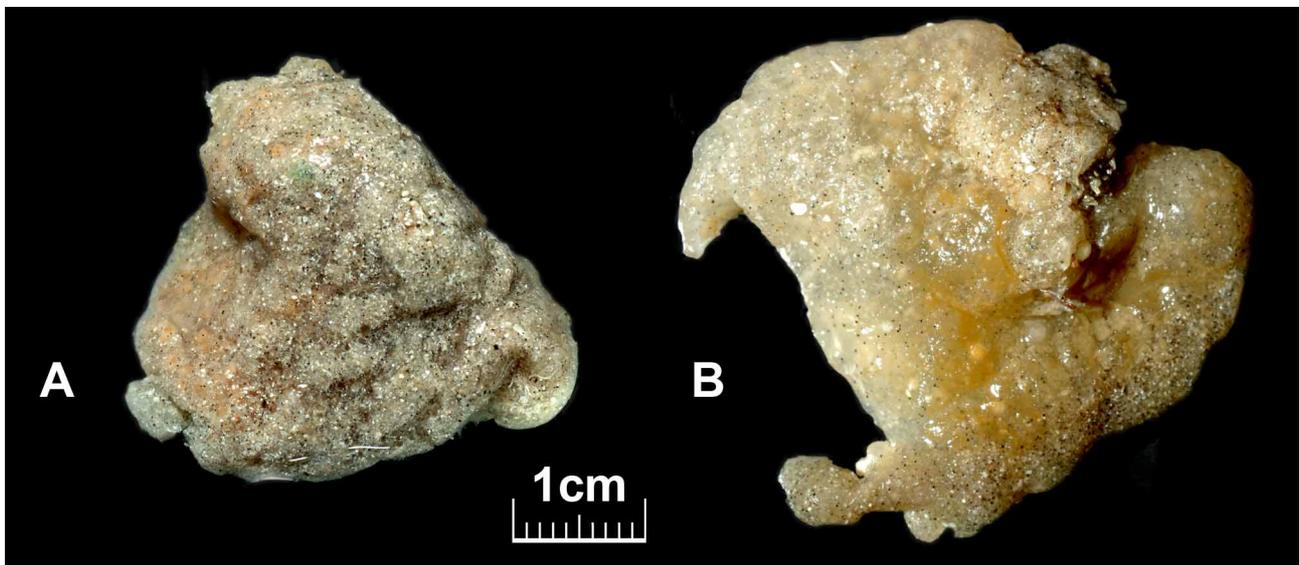
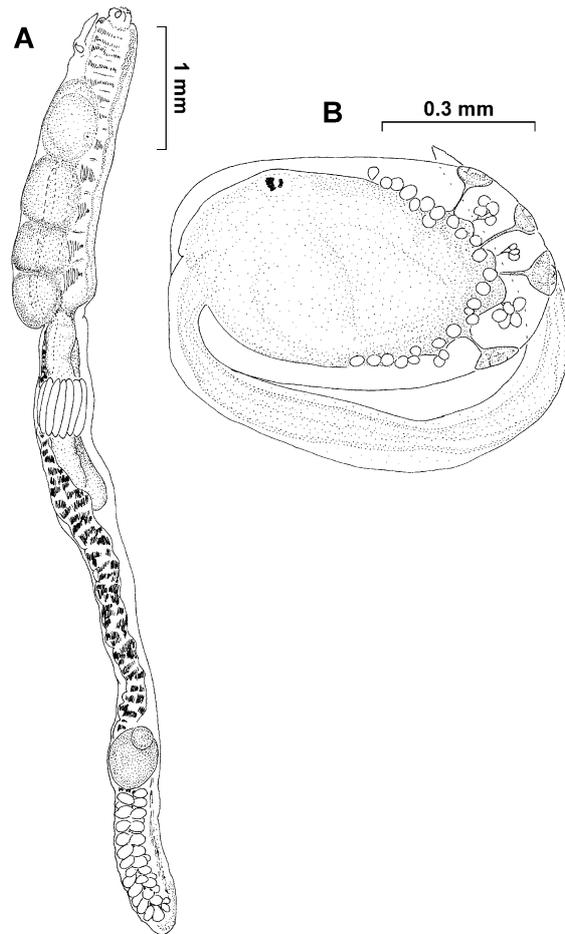


FIGURE 1. *Aplidium antillense*, colonies.

**Description.** Colony is a small low cushion with irregular margins (KBPIG 1/1236, Fig. 1A) or a flat sheet up to 40x35 mm in extent and 8–9 mm thick (KBPIG 2/1237, Fig. 1B). Zooids are arranged in double rows separated by oval or irregular zooid-free spaces that are slightly elevated. The limits of each system and a common cloacal opening are not discernible. Fine sand grains are spread over the surface and present throughout the colony, but only occasionally abundant. Otherwise the test is colourless and transparent. Living specimens are described by collectors as having an "almost transparent tunic with visible orange zooids inside".

Most zooids are strongly contracted and have short posterior abdomens. Less contracted zooids are rarer and up to 7.5 mm in length, half of which consists of the posterior abdomen. A simple atrial languet arises from the upper rim of the small atrial opening. The branchial sac has either 12 (KBPIG 1/1236) or 11 or 12 (KBPIG 2/1237) rows of stigmata. A cylindrical stomach, located in the middle of the abdomen, has 12–14 high, strait unbroken folds. The ovary, containing one or two large ova, is in the middle of the posterior abdomen. The testis follicles are serially arranged in two rows just posterior to the ovary. The sperm duct is very thick in all zooids and sometimes fills almost the entire width of the anterior part of the posterior abdomen.



**FIGURE 2.** *Aplidium antillense*. A—zooid; B—larva.

Up to five serially arranged embryos are in the atrial cavity of almost all zooids examined. The trunk of the tailed larva is 0.75 mm in length. Three or occasionally four adhesive organs alternate with wide, short median ampullae (which are sometimes absent) and bunches of epidermal vesicles branching off of them. A single arc of vesicles is on each side of the adhesive organs.

**Remarks.** The present specimens conform to those described by Monniot (1972, 1983). The larva illustrated by Monniot (1972, Fig.2 D) appears to be immature and groups of epidermal vesicles between the adhesive organs are not shown.

***Aplidium stellatum* (Verrill, 1871)**

(Figures 3, 4A,B)

*Amouroucium stellatum* Verrill, 1871: 291.

*Amaroucium stellatum*: Van Name, 1945: 34 (and synonymy)

**Material examined:** collected in 2004, 31°36.056' N, 80°47.431' W, specimen #240 (KBPIG 1/1233); 24.05.2005, 31°23.815' N, 80°53.462' W, specimen #1 (KBPIG 2/1243).

**Previous records:** The species has already been recorded from Georgia and is widely distributed from Massachusetts to the Gulf of Florida (Van Name 1945).

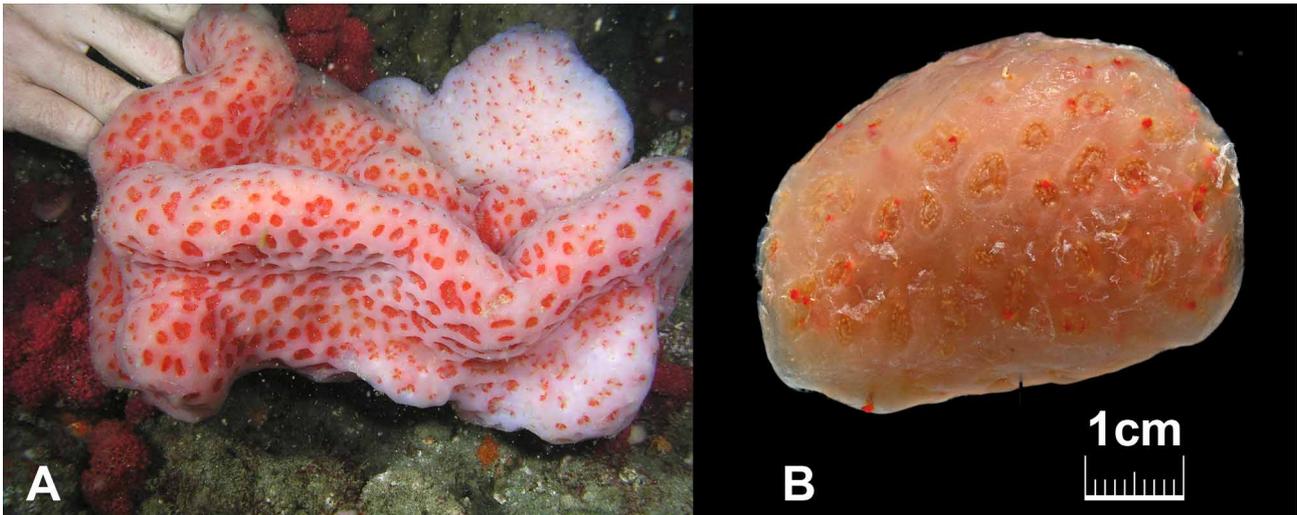


FIGURE 3. *Aplidium stellatum*. A—underwater; B—formalin preserved colony.

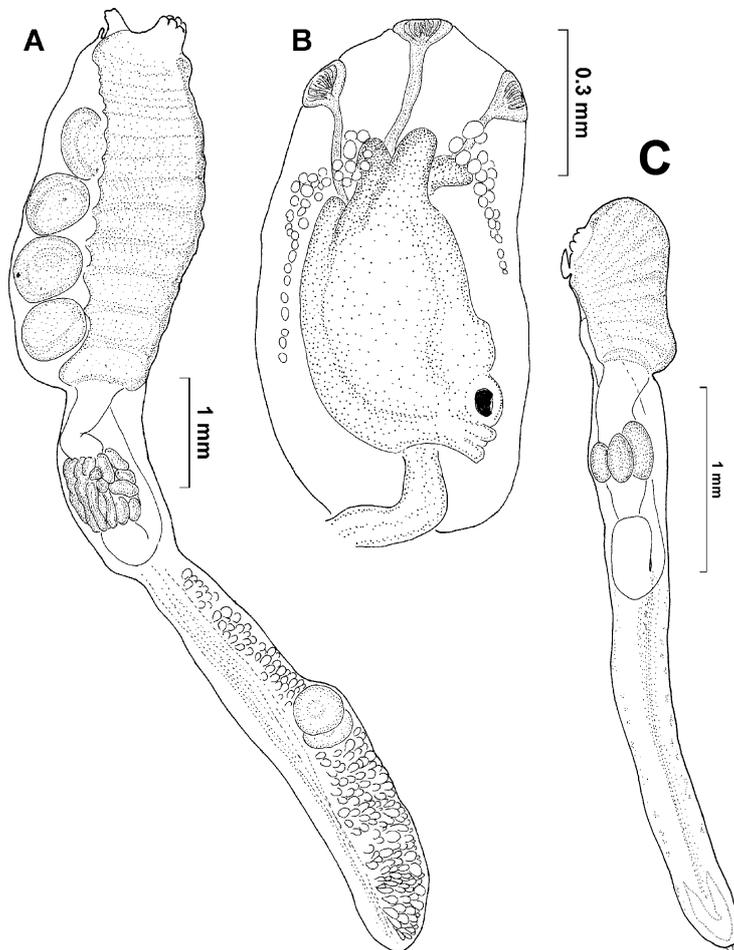


FIGURE 4. *Aplidium stellatum*, A—zoid; B—larva. *Aplidium* sp., C—zoid.

**Description.** Several fragments up to about 5 cm in their largest dimension were examined. Underwater photographs show robust colonies that are large and thick (up to about 20 cm in width and length) that are attached to hard substratum by a wide basal surface (Figure 2A). Colonies are irregularly lobed and folded; the test is firm and hard to the touch. Zooids are in regularly spaced circular, oval, or sometimes slightly elongated systems and open into the base of the test depressions. The depressions on living specimens are

bright red and contrast with the white or pinkish test that separates them. In preservative the test is pinkish and zooids (especially their thoraxes) still retain their bright red colour even after three years of storage in formalin.

Most zooids are contracted, the thorax and abdomen together are 3–5 mm long, and the posterior abdomen may reach 10 mm. The branchial siphon has six short rounded lobes. A short atrial languet extends from the upper rim of the atrial aperture and has a simple blunt tip. About 15 thin longitudinal muscles are on each side of the thorax. The branchial sac has 14 (one colony) or 12 (another colony) rows of stigmata of about 15 stigmata per half row. The abdomen is relatively short; in the rare zooid that is more or less expanded, it is shorter than the thorax. The barrel shaped stomach has nine or ten well marked folds which may be regular and undivided, or occasionally broken (Figure 4A). In many zooids the posterior abdomen is filled with numerous closely packed testis follicles distributed along the whole of its length. A few large ova are in the middle part of the posterior abdomen.

Up to five larvae are in the atrial cavity of many zooids. The trunk of tailed larvae is 1–1.1 mm. Larvae have three adhesive organs and four thick median ampullae, the latter are not always well developed. Epidermal vesicles are in four bunches, one on each side of the dorsal and ventral mid-lines behind the adhesive organs (Figure 4B).

**Remarks.** The colony shape and colour, and the hardness of the test allow easy identification of this species and confusion with other *Aplidium* species in the region is hardly possible.

*Aplidium peruvianum* Sanamyan & Schories, 2004 described from Peru has almost identical colonies and similar zooids. It has slightly smaller larvae with anterior bunches of epidermal vesicles which are not present in the examined specimens of *A. stellatum*. Synonymy between Pacific and Atlantic species is unlikely.

#### ***Aplidium* sp.**

(Figure 4C)

? *Aplidium lobatum*: Van Name, 1945: 28 (synonymy). Monniot and Monniot, 1984: 571.

**Material examined:** collected in 2004, 31°36.056' N, 80°47.431' W, specimen #246

**Description.** The one colony examined is in rather poor condition. The colony is a small, irregular thin sheet encrusting a colony of bryozoa. The peripheral layer of the test is filled with minute granules and by large amounts of sand which are present in the internal test. The zooids are strongly contracted and up to 4 mm long, but usually shorter. A simple, small atrial languet arises from the upper margin of the slit-like atrial opening. The branchial sac has 9 rows of stigmata, but the number of stigmata per row is obscured. The abdomen is the same size as the thorax. The stomach is asymmetrical and has five, deep longitudinal folds. The posterior abdomen is about half as long as the zooid and zooids examined contain no gonads.

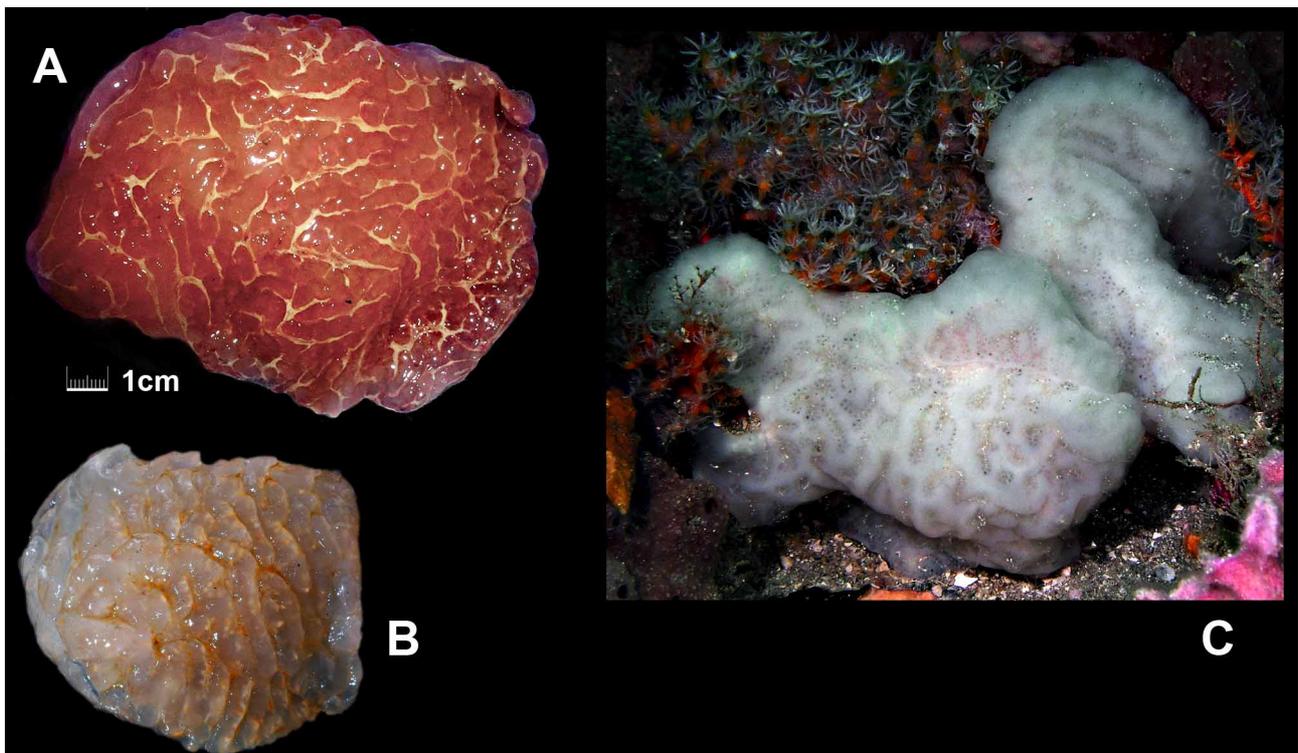
**Remarks.** This specimen might be identical to *A. lobatum*: Van Name, 1945 although the latter specimens may have fewer rows of stigmata ("about seven" according to Van Name 1945: 29). The specimens from Guadeloupe have nine rows of stigmata (Monniot and Monniot, 1984). It is difficult to determine if all of the mentioned specimens belong to the same species, although they are probably not related to *A. lobatum* Savigny, 1816 originally described from the Red Sea (for discussion see Kott, 1992: 512–513).

#### ***Aplidium ruzickai* n. sp.**

(Figures 5, 6)

**Material examined:** Holotype: collected in 2004, 31°37.688' N, 80°34.662' W, specimen #192 (KBPIG 1/1380). Paratypes: specimens #181 (KBPIG 3/1382) and #182 (KBPIG 4/1383) both collected at 31°24.305' N, 80°34.010' W; #197 (KBPIG 2/1381) collected at 31°37.688' N, 80°34.662' W.

**Description.** The colonies are thick, massive, sometimes rather irregular and are divided into large lobed cushions that are attached by a wide base. The largest examined specimen (a part cut from a larger colony) is about 6 cm in maximum dimension and 3.5 cm thick. The test is soft, gelatinous, transparent and free from sand on the surface and inside. The surface is characterized by round, raised, branched ridges separated by shallow depressions of double rows of zooids. The systems are large and not numerous and are formed by short and long, sometimes branched, double rows of zooids converging to a common cloacal opening. The limits of each system are discernible on the living specimens (Figure 5C), but are obscured in formalin-preserved material. In preserved colonies, the zooid free ridges of the test become more prominent and the systems appear as deep narrow grooves between these ridges. Zooids open inside these grooves so that the openings are not visible from the surface. The living specimens are either uniformly opaque milky-white (Figure 5C), or with whitish branched systems separated by translucent red ridges (Figure 5A); preserved specimens are colourless.



**FIGURE 5.** *Aplidium ruzickai* n. sp. A—specimen KBPIG 4/1383 (freshly collected); B—formalin preserved specimen; C—holotype KBPIG 1/1380 (underwater).

The zooids are long and narrow, not contracted. The thorax and abdomen together are about 6 mm long, and the posterior abdomen is 5–10 mm or sometimes longer. The branchial siphon is short and wide and has six rounded lobes. A small round sessile atrial opening is noticeably displaced downward along the dorsal side and is on the same level as the fifth or sixth row of stigmata. A simple short and blunt atrial languet arises from the upper rim of the atrial opening. The stigmata are in 19 (KBPIG 1/1380, 2/1381) or 17 or 18 (KBPIG 3/1382, 4/1383) rows of 11–15 per row. The oesophagus is long and the stomach, located half-way down the abdomen, has about 30 narrow and rather regular straight folds. The post-pyloric portion of the intestine is typical for the genus with the duodenum, posterior stomach and rectal valves discernible in some zooids. The anal opening is opposite the 14th or 15th row of stigmata. There is a slight constriction between the abdomen and posterior abdomen. Relatively large male follicles occupy either the entire or only the posterior part of the posterior abdomen and are in single or double series. A compact ovary consisting of one or two large ova and a number of smaller ones is either anterior to the testis and some distance from the gut loop (Figure 6A), or between the testis follicles in the middle part of the posterior abdomen.

Up to six or seven embryos and larvae are in a single series in the posterior half of the thorax. A trunk of the tailed larva is 0.75–0.9 mm long with the tail winding slightly more than halfway around it. It has three adhesive organs on long stalks alternating with short median ampullae with clusters of large epidermal vesicles branching off of them. A bunch of epidermal vesicles is also present on each side of the dorsal and ventral mid-lines. No ampullae are posterior to the dorsal and ventral adhesive organs.

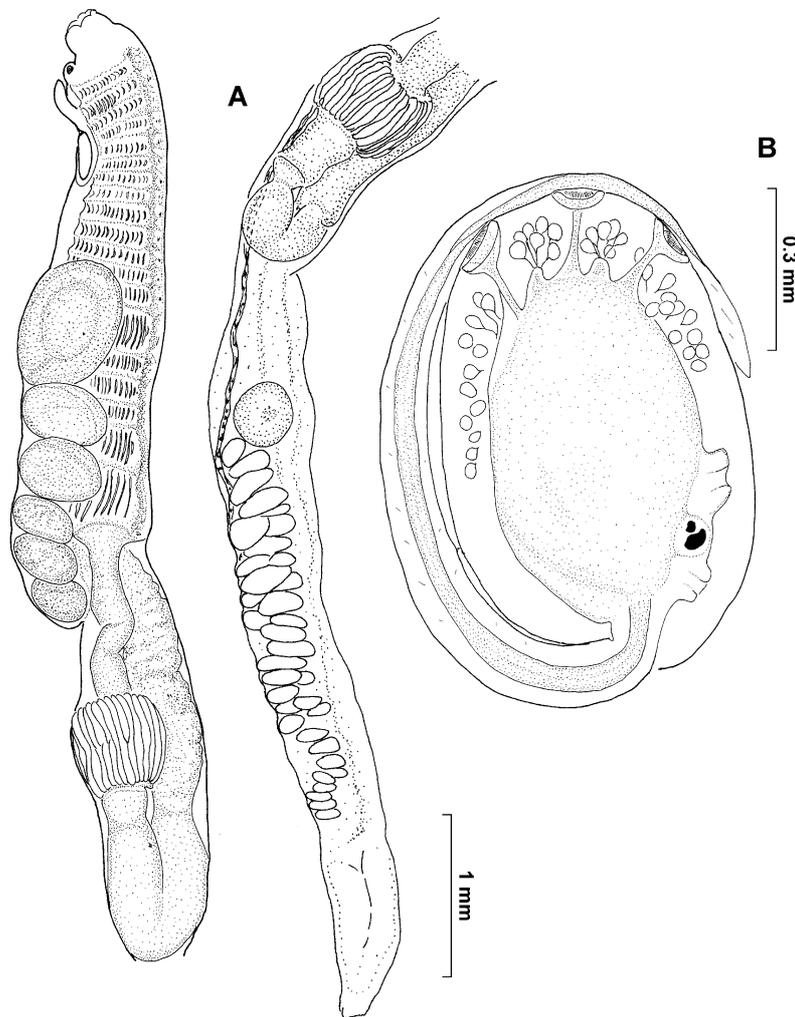


FIGURE 6. *Aplidium ruzickai* n. sp. A—zoid; B—larva.

**Remarks.** The most distinctive feature of the species is the combination of large numbers of stomach folds and large numbers of rows of stigmata. The genus currently contains about 235 valid species, of which only five have a combination of numerous (more than 20) stomach folds and numerous (more than 17) rows of stigmata. These include the Atlantic *A. pellucidum* (Leidy, 1855), Pacific *A. japonicum* (Tokioka, 1949) and *A. propinquum* (Van Name, 1945), Antarctic *A. loricatum* (Harant & Vernieres, 1938), and, probably, Mediterranean *A. gelatinosum* (Médioni, 1970). All these species are separated from the present record geographically and differ from *Aplidium ruzickai* n. sp. in many features: *A. pellucidum* and *A. propinquum* have completely different sandy colonies, *A. japonicum* has a trifold atrial languet and the larva seems to be different (Tokioka, 1949, Plate 1.), *A. loricatum* has ovoid dome-shaped colonies with a smooth surface and double rows of zooids converging to a few cloacal apertures on the upper surface. *Aplidium gelatinosum* is insufficiently described, but the number of stomach plications, while not specified, appears to be less than in the present species and the larva is different (Médioni, 1970, Plate 6).

The present species is not related to any West Atlantic species of which only *A. pellucidum* (discussed above), *A. constellatum* (Verrill, 1871) and *A. exile* (Van Name, 1902) may have more than 20 stomach folds (but still less than 30 in the present species). The colonies of *A. constellatum* are "ovate or more or less turbinate in form, attached by a narrow base" (Van Name, 1945: 38), and it has only 10–13 rows of stigmata and different larva (Monniot F, 1983). *Aplidium exile* has 12–14 rows of stigmata and much smaller, button shaped colonies. *Aplidium bermudae* (Van Name, 1902) may have up to 17 rows of stigmata but only 10–15 stomach folds and its colony is different.

The shape of the colony surface of *Aplidium* n. sp. is stable and characteristic but not unique and resembles *A. cerebrum* Monniot, 2001, *A. lenticulum* Kott, 1992, *A. multiplicatum* Sluiter, 1909 and some other species (see Kott, 1992, Plate 13f, 14e, Monniot and Monniot, 2001, Fig.112B). All these species have different zooids.

The species is named after Rob Ruzicka to acknowledge his contribution in establishing the collection of benthic invertebrates of Gray's Reef National Marine Sanctuary housed in the Department of Biology at Georgia Southern University.

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