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Redescription of the deep-sea colonial ascidian *Synoicum molle* (Herdman, 1886): first record since its original finding during the Challenger Expedition

Tamara Maggioni[1], Anabela Taverna[1], Marcos Tatián[1]

1 *Instituto de Diversidad y Ecología Animal (CONICET-UNC) and Facultad de Ciencias Exactas, Físicas y Naturales, Universidad Nacional de Córdoba, Avenida Vélez Sarsfield 299, (5000), Córdoba, Argentina*

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Corresponding author: *Tamara Maggioni* (tamaramaggioni@gmail.com)

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Abstract

The colonial ascidian *Synoicum molle* (Herdman, 1886) was recorded for the first time after its original description. The slope area where *S. molle* was discovered during the Challenger Expedition (1872-1876), located at the mouth off Río de La Plata (Argentine Sea), still remains highly underexplored. During a series of deep-sea prospections along the SW Atlantic (A.R.A. Puerto Deseado, August 2012), 7 colonies of *S. molle* were collected few km from the type locality. The finding permitted to perform, for the first time, a complete morphological description of this species. The proper identification of marine species, especially deep-sea organisms, has implications for the general knowledge of biodiversity, a necessary tool for the conservation and study of ecosystem benefits that marine environments provide.

Introduction

Ascidians (Tunicata) are important components of marine benthic communities, even in the deep-sea. In relation to other invertebrates, ascidians reach their maximum richness at greater depths (Monniot and Monniot 1978).The deep waters of the SW Atlantic have been scarcely explored. Few research campaigns have circumnavigated the area, thus, the ascidiofauna remains highly undersampled. The Challenger Expedition (1872–1876) (Station 320: 37°17'S, 53°52'W, 1097 m), collected a total of 10 ascidian species, all of them new to science (Herdman, 1886). In a neighboring area, the U.S. Atlantis II 60th Campaign recovered 22 ascidian species, of which 7 were reported new (Monniot and Monniot 1976). The taxonomical status of 4 ascidian species collected during the Challenger Expedition lacks a proper description and thus requires a revision: these are *Aplidium incrustans* Herdman, 1886; *Psammaplidium* (*Aplidium*) *flavum* Herdman, 1886; *Hypobythius moseleyi* Herdman, 1882; *Styela flava* Herdman, 1881 and *Polyclimun* (*Synoicum*) *molle* Herdman, 1886.

The colonial ascidian *Synoicum molle* (Herdman, 1886), originally named *Polyclinum molle* Herdman 1886, constituted the second deepest register in the genus. The original description performed by W. Herdman lacks several characters, which are essential for a proper species identification: the disposition of the zooids around the cloacal aperture, the number of stigmata rows (and number of stigmata per row), the shape and position of the atrial aperture, the number and disposition of the muscle bands, the level of row of stigmata at which the border of the anus culminates, and the description and number of larvae incubated in the atrial cavities. Hartmeyer (1912) doubted the inclusion of this species under *Polyclinum* due to the location and depth where it was found. Van Name (1945) noticed the absence of branchial papillae, a reliable character to diagnose *Polyclinum*. He proposed, instead, the genus *Synoicum* in consideration of the latter and also based on the presence of a rounded and almost globular stomach and the shape of the post-abdomen.

We analyzed a total of 7 colonies that match the characters listed by Herdman for *S. molle* in a close area from

the type locality of that species. These include: the form and texture of the colony; the color of the tunic; the average size of the zooids; the form of the atrial languet; the shape and characteristics of the stomach; the general form of the post-abdomen; and the elongated body of the larvae. We provide a more comprehensive and detailed description of the species including illustrations of the entire colony and of the individual zooids.

Materials and methods

The examined specimens were collected by the research vessel A.R.A Puerto Deseado during the first Continental Slope Campaign, within the Argentinean Exclusive Economic Zone, on August 2012. The prospections comprised a bathymetric gradient between 200 and 3,000 m close to 38°S, including the Mar del Plata submarine canyon (Fig. 1). The sampling devices used consisted of a fishing net and two epibenthic trawls (mesh sizes of 3×3 cm and 1×1 mm).

Onboard, the colonies were photographed, relaxed under seawater with menthol crystals for 2 hours, and then fixed in formalin-seawater 4%. In the laboratory, a minimum of 10 zooids per colony were removed and studied under a stereo microscope. Each zooid was drawn, measured and photographed. The 7 colonies were deposited in the collection of the Museo de Zoología, Universidad Nacional de Córdoba (MZUCVIO192).

The actual status of the different species was verified through the World Register of Marine Species (WoRMS) webpage (www.marinespecies.org).

Results

Synoicum molle (Herdman, 1886)

Polyclinum molle Herdman, 1886: 194, pl. XXV, figs 7-9; non Rocha and Costa 2005: 59, fig 2-4.
Synoicum molle; Van Name 1945: 84, fig. 20.

Material examined. Station 2: 37°58'S, 55°12'W; 7 colonies; 308 m; Ago/17/2012.

Description. The colonies are almost identical in shape: globular, nearly spherical (Fig. 2). The biggest colony measures 9.1 cm in diameter by 3.2 cm in height, while the smallest one reaches 2.5 cm in diameter. The tunic is grayish with variation in intensity, the smallest colonies being the darkest. The zooids, when alive, are white. When fixed in formalin, they turn pale yellow. The test is soft and free of foreign material. Only in two small specimens, some grains of sand and a few epibiotic foraminifera were detected. The tunic is consistent and rigid. The zooids, in variable numbers, are arranged in irregular rosette-like systems around common, although not visible to the naked eye, cloacal apertures. One colony shows zooids with no arrangement at all in the uppermost area,

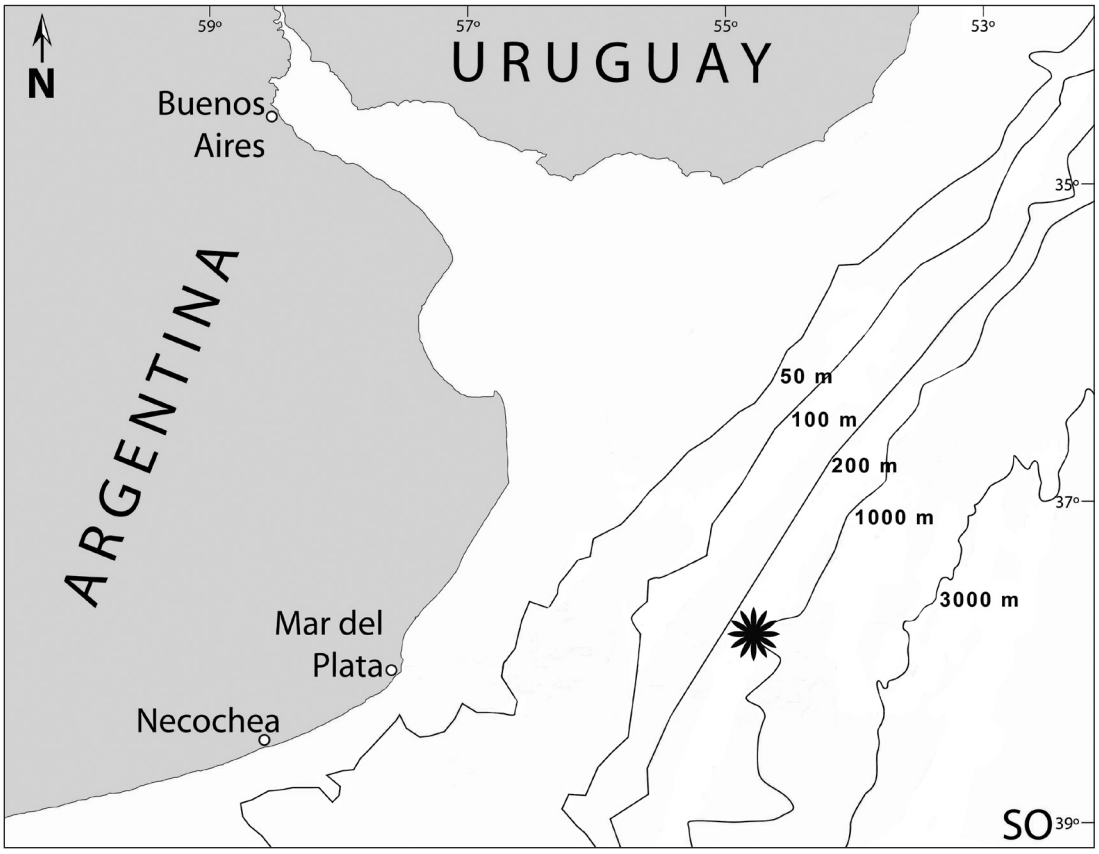

Figure 1. Study area in the SW Atlantic. The asterisk shows the sampling location.

Figure 2. Colony of *Synoicum molle* photographed in vivo.

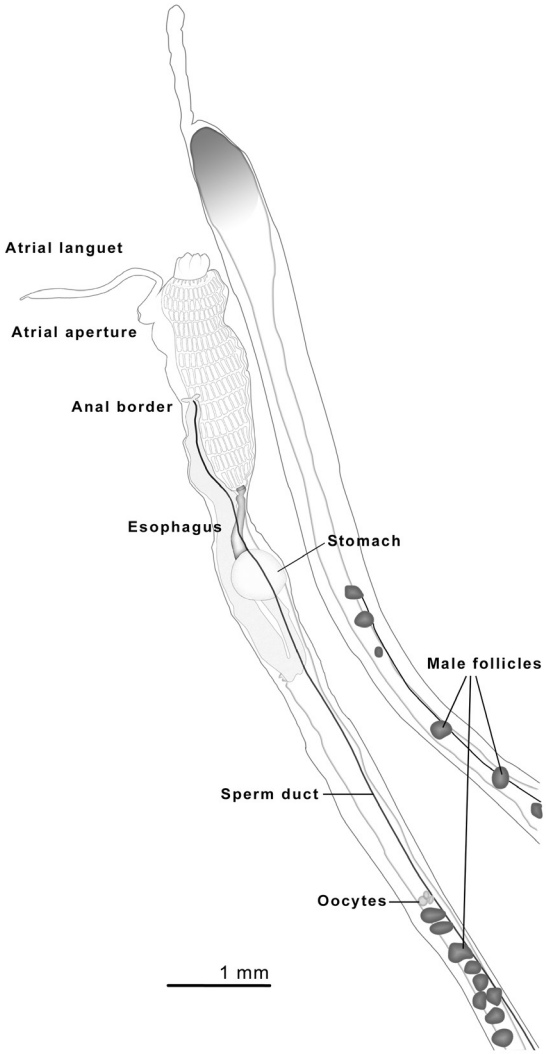

Figure 3. Zooid of *Synoicum molle*. Only the initial and last sections of the post-abdomen are shown.

while the area nearest to the base maintains the irregular rosette-like configuration.

All colonies present zooids with a marked variation in size and also of sexual maturation. When fully developed, zooids are large, with an average length of 13 mm (Fig. 3). Zooids with empty thoraces and no digestive systems but fully developed gonads were also found in the biggest colony. These reach a maximum length of 29 mm. The oral siphon bears 6 distinct lobes. The atrial aperture is small, most of the times completely surrounded by an extension of the tunic that forms a small ring. It extends between the 4th and 8th rows of stigmata. The atrial languet is generally thin, long and simple, though it can also be bifid. It extends as long as the entire length of the thorax, or long enough to cover the atrial aperture. The margins are smooth or slightly serrated.

The thorax bears 8 to 10 thin longitudinal muscle bands on each side, running along the entire body and joining at the end of the post-abdomen. There are between 14 and 16 simple and stout oral tentacles, alternating in size and placed in a circle. The dorsal tubercle is small and rounded.

There are from 12 to 14 rows of stigmata. Rarely, zooids may bear only 9 or 10. Nonetheless, they never exceed 14 rows. Each row contains 10 longitudinal rectangular-shaped stigmata. These vary slightly in size, being thinner and longer towards the center of the thorax. Branchial papillae are not present.

The straight and thin-walled esophagus connects with the stomach vertically. The stomach wall is smooth, although some striations -never folds- might occur randomly (Fig. 4). The stomach shows two alternate shapes: almost spherical or dome-shaped with a straight base. The intestine turns to the dorsal and anterior end vertically. The anus shows two lobes and is located at the level of the 8th row of stigmata.

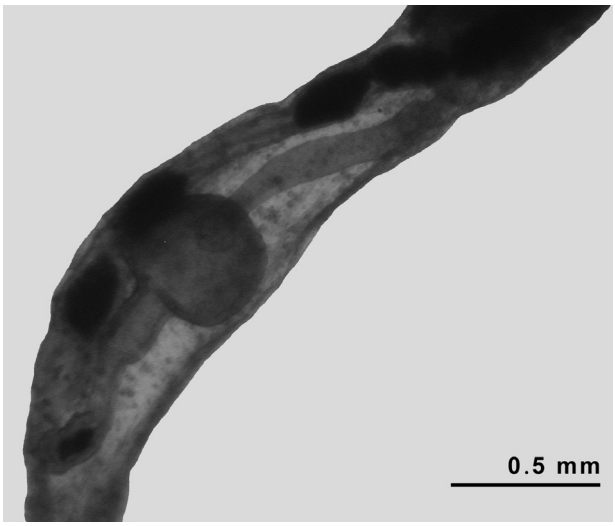

Figure 4. Abdomen of *Synoicum molle* showing the rounded smooth-walled stomach.

The gonads are situated in a long post-abdomen, either directly adjacent to the abdominal region or at some distance (0.3 to 4.7 mm) away from it. The ovary contains from one to 2–3 or 6–8 small oocytes. The male follicles are found just below or surrounding the oocytes, disposed in clusters or arranged in a straight line.

On average, a dozen of immature larvae are present in the atrial cavities of a few zooids of one colony. They are arranged in double rows along the entire length and half the width of the thorax. In that immature stage, larvae had only developed a small and stout tail but lacked sensory organs, papillae and vesicles.

Discussion

Most characters today considered of taxonomic validity were deemed not important or could not be studied in detail in the XIX century, either because of the difficulties regarding the techniques used or due to the limited number of available specimens. Out of 14 ascidian species collected and originally described from Station 320 (Challenger Expedition), 10 are currently accepted. After taxonomical revision of the types, various specimens were placed under a different species: *Styela oblonga* Herdman, 1881 was synonymized with *Styela squamosa* Herdman, 1881 (Monniot and Monniot 1982, 1983); *Ascidia tenera* Herdman, 1880 was synoymized with *Ascidia meridionalis* Herdman, 1880 (Van Name 1945, Monniot and Monniot 1976); *Psammaplidium effrenatum* Herdman, 1886 was synonymized with *Aplidium effrenatum* (Herdman, 1886) (Van Name 1945) and *Leptoclinum tenue* Herdman, 1886 with *Didemnum tenue* (Herdman, 1886) (Van Name 1945). Still, other ascidians from the same station remain uncertain: the status of *Psammaplidium (Aplidium) flavum* is unknown (*nomen dubium*) (Van Name 1945, Rocha and Lambert pers. com. 2013); *Hypobythius moseleyi* might be closer to *Dicopia* or *Situla* (Monniot and Monniot 1976); *Styela flava* remains a dubious species (Rodrigues 1966) and *Aplidium incrustans* was proposed to be a synonym of *Synoicum molle* (Van Name 1945). The latter is not *Psammaplidium incrustans* Herdman, 1891 with type locality in Port Stephens, New South Wales, Australia, a synonym of *Aplidium solidum* (Ritter & Forsyth, 1917) (Kott 2005).

According to Herdman (1886), *S. molle* and *A. incrustans* are alike in external appearance and structure of the test. However, they differ in two essential aspects: the shape of the stomach and the structure of the branchial sac. Van Name (1945) does not agree with this characterization. First, he doubts the existence of true folds on the stomach of *A. incrustans*, suggesting the condition observed by Herdman could be caused by collapse or muscular squeeze. Second, he was impeded to compare between branchial sacs, since the description of this organ in *S. molle* lacks the number of stigmata rows as well as the number of stigmata per row. But a deeper inspection of the specimens of *S. molle* collected during the Continental Slope Campaign, granted us the possibility of comparing in detail the structures of the branchial sac. While we cannot give any statement about the nature of the folds of *A. incrustans* unless a revision of the type is made, we can certainly assure that neither the number of rows nor the stigmata per row of both species coincide: *A. incrustans* is described as having "at least 15 rows of stigmata, with nearly twenty in each row" (Van Name 1945, p. 59). The colonies of *S. molle* recovered showed from 12 to 14 rows of stigmata (never exceeding 14) and only 10 stigmata per row. Thus, we propose to maintain both entities as separate species, rejecting the synonymy proposed by Van Name (1945).

The maximum species richness for many invertebrate zoological groups is located between 2,000 and 3,000 m. However, for ascidians, this boundary is located between 4,000 and 4,500 m (Monniot and Monniot 1978, Vinogradova 1962). Colonial ascidians are frequently found in shallow waters. But their presence diminishes with depth, being replaced by solitary forms (Monniot and Monniot 1978). The genus *Synoicum* follows this trend. Only 7 species out of the 84 listed under the genus *Synoicum* have been reported at depths below 500 m: *S. adareanum* (Herdman, 1902), *S. daucum* Monniot C. & Monniot F., 1977, *S. georgianum* Sluiter, 1932, *S. molle* (Herdman, 1886), *S. pererratum* (Sluiter, 1912), *S. ramulosum* Kott, 1969 and *S. tentaculatum* Kott, 1969. *S. georgianum* shows the widest distribution range, presenting registers in the SO and the SW Atlantic (Patagonian shelf and off La Plata River). *S. adareanum* has a circumantarctic register (Kott 1969). The other 5 species, on the contrary, have more restricted distribution ranges. All are reported from only one location: *S. daucum* from the NE Atlantic (Monniot and Monniot 1974), *S. pererratum, S. ramulosum* and *S. tentaculatum* from the Southern Ocean (Sluiter 1912, Van Name 1945, Kott 1969), and *S. molle* from the SW Atlantic off Mar del Plata (Herdman 1886, Van Name 1945). Additionally, *S. molle* can be characterized as eurybathic. This is due to the fact that we found the

species for the second time at 308 m depth, 700 m shallower than the original observation (1,097 m).

An increase of bathymetrical gradient studies would help to test the proposed hypothesis of the establishment of a pattern of reduction of colonial forms with increasing depths as well as to elucidate the mechanisms governing this process. Moreover, the increment of the range of the bathymetrical gradient at least up to 5,000 m depth would be especially useful in consideration of the maximum species richness registered for this group of benthic animals (Monniot and Monniot 1978, Vinogradova 1962).

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