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Notes on the morphology of *Elysia subornata* and *Oxynoe antillarum* (Mollusca, Opisthobranchia, Sacoglossa) from the state of Rio de Janeiro, Brazil

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Abstract

This paper presents morphological data for Brazilian specimens of two sacoglossan species (*Elysia subornata* and *Oxynoe antillarum*), including color photos of living animals, scanning electronic microscope pictures of radula and penis morphology. *Elysia subornata* is characterized mainly by its papillose body and a very elongated renopericardial ridge. The variation found in body color and tooth morphology, as well as the wide geographical distribution attributed to this species, may be indicative of a species complex. *Oxynoe antillarum* is a light green species covered by small white dots which resembles *Oxynoe azuropunctata*, but in the latter the patches of the body are larger and more conspicuous. The material studied herein represents the first record of the order Sacoglossa in the state of Rio de Janeiro, Brazil.

Key words: Mollusca, Gastropoda, Elysiidae, Oxynoidae, Western Atlantic.

Resumo

O presente trabalho apresenta dados morfológicos de duas espécies de Sacoglossa (*Elysia subornata* e *Oxynoe antillarum*), incluindo fotografias coloridas de animais vivos, fotografias de rádula em microscopia eletrônica de varredura e a morfologia do pênis de espécimes brasileiros. *Elysia subornata* é caracterizada principalmente pelo corpo coberto por papilas e pela região do pericárdio bastante alongada. A variação existente relativa a coloração do corpo, morfologia do dente radular e a ampla distribuição geográfica atribuída a esta espécie podem ser indícios de que há um complexo de espécies. *Oxynoe antillarum* é uma espécie verde clara com pequenos pontos brancos e se assemelha a *Oxynoe azuropunctata*, porém no último as manchas do corpo são largas e conspícuas. O material aqui estudado constitui o primeiro registro da ordem Sacoglossa para o estado do Rio de Janeiro, Brazil.

Palavras-chave: Mollusca, Gastropoda, Elysiidae, Oxynoidae, Atlântico Oeste

Introduction

Sacoglossans constitute a group of small marine gastropods that feed on algae. They have been the subject of genetic studies; and have been identified as capable of making horizontal transfer of functional nuclear genes from algae, being able to maintain chloroplasts active in their bodies, and absorbing photosynthesis products (Pierce et al., 2003). Most species are cryptic with their food, making them difficult to see and collect directly. There are approximately 300 valid species described worldwide, most of them from tropical and subtropical seas (Jensen, 2007). The lack of knowledge about Brazilian sacoglossans is indicated by the small number of species recorded, most without good morphological descriptions. Currently, 21 valid species are listed as occurring in Brazil, most of them described by Ernst and Eveline Marcus based on material collected in the state of São Paulo (eg. Marcus, 1957; Er. Marcus & Ev. Marcus, 1970). Recently, García et al. (2002) added two species to this list based on material collected at the archipelago of Fernando de Noronha.

This paper presents morphological data for Brazilian specimens of two sacoglossan species (*Elysia subornata*, Verrill 1901 and *Oxynoe antillarum* Mörch, 1863), including color photos of living animals, scanning electronic microscope pictures of radula and penis morphology.

Material and Methods

A list of the material examined follows the description of each species. Specimens were obtained from institutional collections (listed below). Some of these specimens were collected recently by the author. This material was photographed and measured alive, frozen in seawater, fixed in 10% formalin and preserved in 70% ethanol. Specimens were dissected by standard techniques, using a binocular stereomicroscope. Radulae were also examined under Scanning Electron Microscope (SEM) at the Universidade Federal do Rio de Janeiro. The illustrated structures were drawn using the camera lucida of the binocular stereomicroscope.

Abbreviations of the structures: **cns**, central nervous system; **dd**, deferent duct; **dm**, dorsal muscle; **eso**, esophagus; **ey**, eye; **mo**, mouth; **pha**, pharynx; **p**, penis.

Abbreviations of institutions: **MZSP**, Museu de Zoologia da Universidade de São Paulo, São Paulo, Brazil; **MNRJ**, Museu Nacional/Universidade Federal do Rio de Janeiro, Rio de Janeiro, Brazil.

Systematics

Family Elysiidae

Genus *Elysia* Risso, 1818
(Type species: *Elysia timida* Risso, 1818, by monotypy)

Elysia subornata Verrill, 1901
(Figs 1, 2, 5, 7, 8, 11)

Elysia subornata Verrill, 1901: 29 (pl. 4, Fig. 4); Clark, 1984:88 (figs. 10-14); Valdés et al., 2006:67 (fig).

Elysia cauze Marcus, 1957:405 (figs. 25-44); Ev. Marcus & Er. Marcus, 1960:153 (fig. 34); Er. Marcus & Ev. Marcus, 1970:44 (fig. 81); Marcus & Hughes, 1974:505 (figs. 13-14); Thompson, 1977:124 (figs. 25h-j, 26f); Marcus, 1980:69 (figs. 15, 52); Jensen & Clark, 1983:4; Rios, 1994:203 (fig. 962, pl. 67); Ortea et al.1998:89.

Description

External morphology (Figs 1-2). Elongated body; labial region laterally extended; prominent head with long, rolled and papillose rhinophores distally oriented; anterior and lateral parts of the head with small papillae; head with elongated posterior region; small eyes situated behind the base of each rhinophore. Large and long parapodia with irregular margins, ending at the tail tip; external surface with conical papillae. Very elongated renopericardial ridge (2/3 of the body length); eight vessels extending from each side; ramified vessels towards the parapodial margins; small papillae occur between vessels. Light green body; head and external side of each parapodia covered by brownish yellow patches, small black rings and orange dots. Dorsal vessels and their ramifications are also brownish yellow in color.

Internal morphology (Figs 5, 7, 8, 11). Pharyngeal bulb very near to the mouth; unidentified blue structures cover its external antero-dorsal region; large pharynx with a series of dorsal annular muscles; conical eyes, each with an elongated base, situated laterally to the central nervous system; esophagus leaving the pharynx in its posterior region passing through the central nervous system; radula with 26 teeth, ascending limb with five teeth and descending limb with 21 teeth (no tooth found in ascus); each tooth straight and elongated with knife-like distal portion, edges with very small denticles (each 1-2 µm long), and base longer than wide (Figs 7-8). Muscular, curved and not projecting penis; thin and winding tube vas deferens (Fig 11).

Measurements: the species grows up to 70 mm long (Valdés et al., 2006). The live specimen from Rio de Janeiro herein examined had 15 mm long.

Distribution: Castle Harbor, Bermuda (type locality); USA: Florida; Mexico, Belize, Bahamas, Aruba, Cayman Islands, Jamaica, Puerto Rico, Virgin Islands, Martinique, Trinidad & Tobago (Valdés et al. 2006); Madeira, Canary and Cape Verde islands (Ortea et al. 1998); Brazil: state of São Paulo (island of São Sebastião and near Ubatuba) and state of Rio de Janeiro (present study).

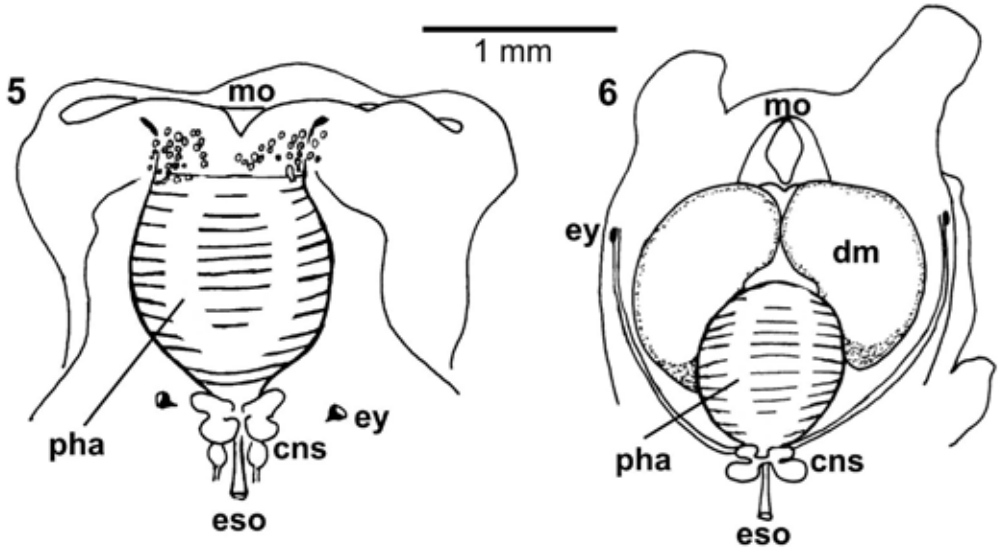
Habitat: generally associated with the algae *Penicillus dumetosus*, *Udotea flabellum* (Valdés et al. 2006) and also *Caulerpa* spp. (Jensen & Clark, 1983).

Material examined: BRAZIL. **Rio de Janeiro:** Armação dos Búzios, Tartaruga beach, 22°45'S; 41°54'W, MNRJ 12631, 1 specimen, 15 mm long alive, under a rock in the intertidal zone (25/ii/2005, V. Padula col.). **São Paulo:** São Sebastião, MZSP 25313, 1 specimen (1958, E. Marcus col.).

Discussion

The material examined has the major characteristics described by Marcus (1957) for the type material of *Elysia cauze* (from São Paulo), such as a papillose body, the presence of small parapodial black rings, an elongated renopericardial ridge, and the esophagus leaving the pharynx in its posterior region. These characteristics have been considered by many authors to identify *E. cauze*. The species has been reported from many localities in the Caribbean Sea (Ev. Marcus & Er. Marcus, 1960; Er. Marcus & Ev. Marcus 1970; Marcus & Hughes, 1974; Thompson, 1977). The original description of the papillose *Elysia subornata* (from Bermuda) lacks any internal features (Verrill, 1901). This species was not cited in most taxonomic papers of the last century that included western Atlantic elysiid species. Marcus (1957), for example, did not discuss *E. subornata* in the original description of *E. cauze*. It was only after the collection of several new specimens from Bermuda that Clark (1984) observed a relatively broad intraspecific variation for *E. subornata* in body color. This observed variation, as well as the similarity of radular teeth in both species, led Clark (1984) to conclude that *E. cauze* is a junior synonym of *E. subornata*. Unfortunately, Clark (1984) did not provide much anatomical data for these new specimens from Bermuda, so a good description of specimens from the type locality is unavailable. The presence of wide variation in body color, including specimens with or without black parapodial margins; teeth morphology, with some specimens not presenting the series of denticles in the edges of the radular teeth (see Thompson, 1977), and the wide geographical distribution attributed to this species in the Atlantic ocean indicate that *E. subornata* may represent a complex of species. The subspecies *Elysia cauze scops* Marcus & Marcus, 1967 was considered a distinct species (*Elysia scops*) from *E. cauze* by Valdés et al. (2006). This is a decision that I support in the present work.

Figures 1-4. Living specimens of *Elysia subornata* (MNRJ 12631, 15mm long alive) and *Oxynoe antillarum* (MNRJ 12632, 10mm long alive). 1. *E. subornata*, dorsal view. 2. *E. subornata*, lateral view. 3. *O. antillarum*, dorsal view. 4. *O. antillarum*, lateral view.



Figures 5-6. Schematic drawings of the anterior structures. 5. *E. subornata* (MNRJ 12631). 6. *O. antillarum* (MNRJ 12632).

Family Oxynoidae

Genus *Oxynoe* Rafinesque, 1819
(Type species: *Oxynoe olivacea* Rafinesque, 1819, by monotypy)

Oxynoe antillarum Mörch, 1863
(Figs 3, 4, 6, 9, 10, 12, 13)

Oxynoe antillarum Mörch, 1863:27; Engel, 1927:111, Ev. Marcus & Er. Marcus, 1963:16; Jong & Kristensen, 1965:49; Ev. Marcus & Er. Marcus, 1967:25 (fig. 20); Er. Marcus & Ev. Marcus, 1970:28 (figs. 34-38); Marcus & Hughes, 1974:502 (figs. 5-6); Thompson, 1977:120 (fig. 23); Clark, 1984:87 (fig. 9); Rios, 1994:202 (fig. 952, pl. 66); Valdés et al., 2006:55.
Oxynoe aguayoi Jaume, 1945:22.

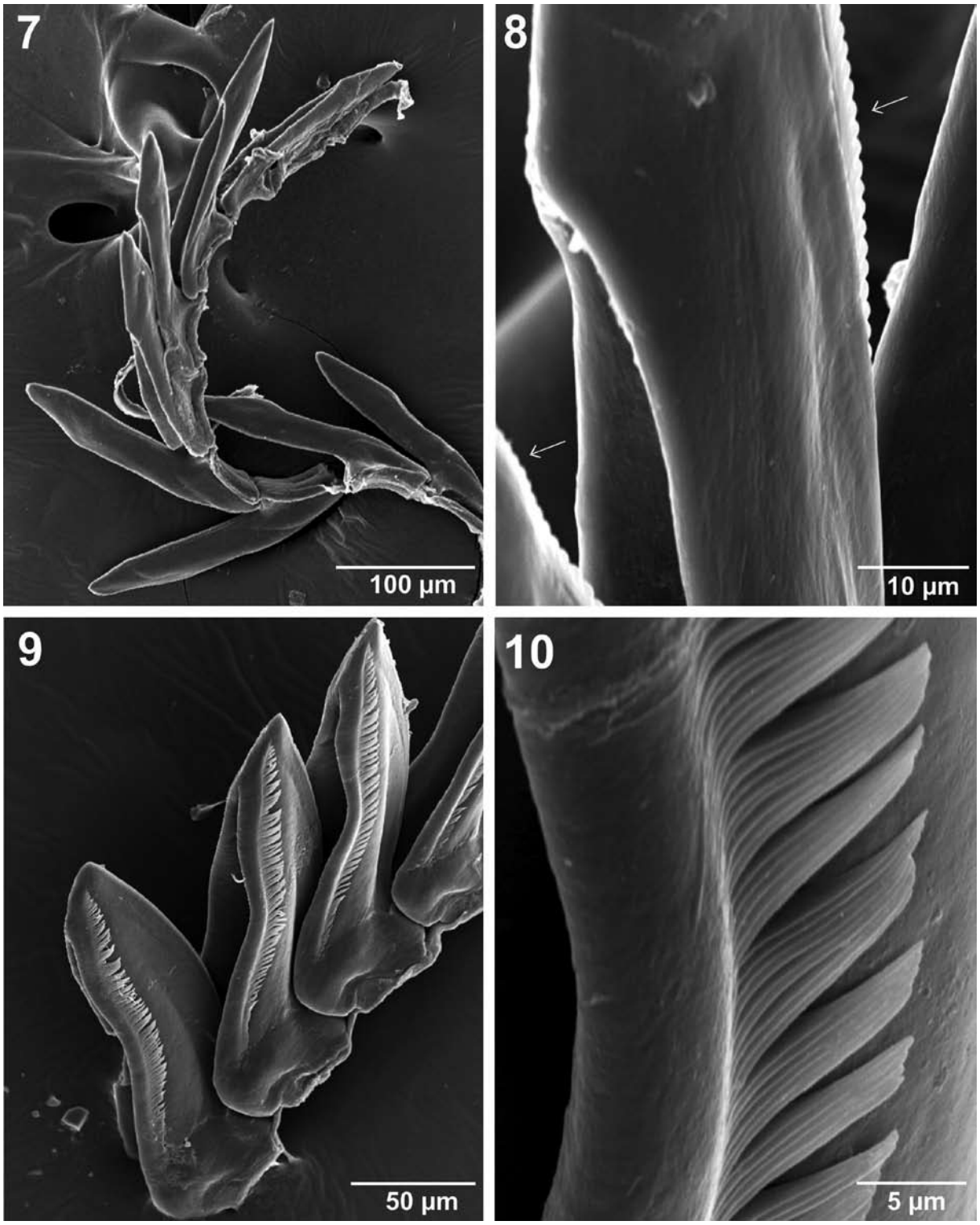
Description

External morphology (Figs 3-4). Elongated body; oval in the central region; prominent head with rolled rhinophores distally oriented; penial opening situated behind the right rinophore; head lateral parts with a thin sulcus in its upper region; small eyes situated above this sulcus near the shell and visceral mass. Large parapodia with conical papillae and irregular margins; large and fragile shell with very wide aperture. Muscular female genital aperture, on the right side just inside the shell. The tail was lost, probably due to autotomy prior to collection, and cannot be characterized. Light green body covered by small white dots; rhinophores with white tips and alternating small greyish blue and white patches in its upper region, this pattern extends laterally to the head and is also present in the parapodial margins. Conical papillae white in color; shell transparent.

Internal morphology (Figs 6, 9, 10, 12, 13). Short oral tube; two groups of muscles attached lateroposterior to each side of the oral tube; each group composed of three main muscles – one dorsal, one ventral and one posterior behind the pharynx; oval pharynx with a series of dorsal annular muscles; oval eyes situated lateral to the dorsal muscles; esophagus leaves the pharynx in its posterior region above the group of posterior muscles, passing behind the central nervous system (Fig. 6); radula with 31 teeth, being 10 in the ascending limb and 21 in the descending limb (no tooth found in ascus); each tooth large, elongated and pointed; series of hair-like extensions occurs on the lateral surface of each tooth, being at least eight extensions per 5 µm; tooth base wider than long (Figs 9-10). Muscular, curved and a non-projecting penis; penis with two small dorsal and one extended lateral lobe; vas deferens winding tube (Figs 12-13).

Measurements: the species grows up to 50 mm long (Valdés et al., 2006). The live specimen from Rio de Janeiro herein examined had 10 mm long.

Distribution: Saint Thomas, Virgin Islands (type locality). Widely distributed throughout the Caribbean Sea (see Valdés et al. 2006); Brazil: states of Per-



Figures 7-10. SEM photographs of the radula of *Elysia subornata* (MNRJ 12631) and *Oxynoe antillarum* (MNRJ 12632). 7. Teeth of *E. subornata*. 8. Arrows indicate the denticulate pattern at the edge of the teeth from the ascending limb of *E. subornata*. 9. Teeth of *O. antillarum*. 10. Detail of the hair-like processes at the border of the teeth of *O. antillarum*.

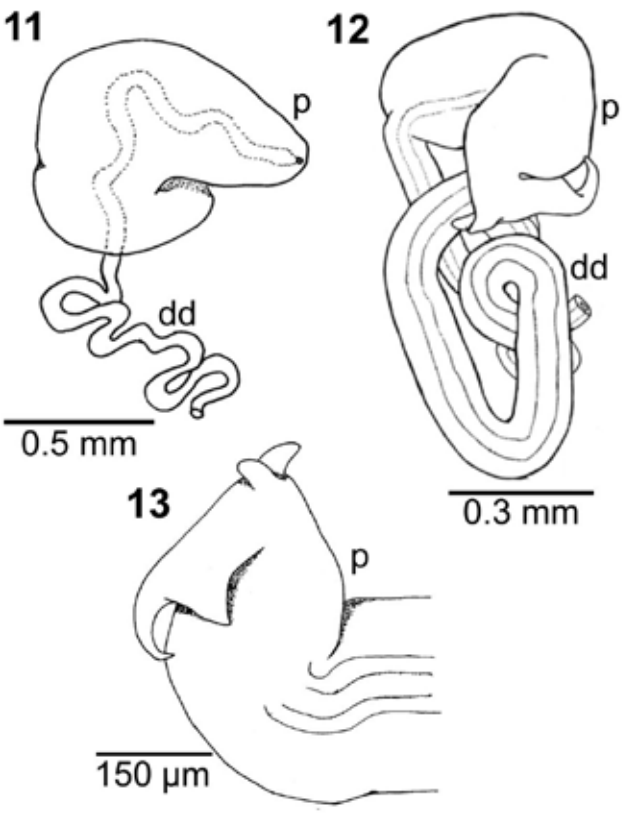


Figure 11-13, male reproductive system. 11, Distal portion of the male reproductive system of *Elysia subornata* (MNRJ 12631). Figure 12. Distal portion of the male reproductive system of *Oxynoe antillarum* (MNRJ 12632). Figure 13. Detail of the penis of *O. antillarum* (MNRJ 12632).

nambuco, Bahia, São Paulo (Rios, 1994) and Rio de Janeiro (present study).

Habitat: generally associated with the algae *Caulerpa racemosa*, on which it can be very cryptic (Clark & Jensen, 1983).

Material examined: BRAZIL. **Rio de Janeiro:** Cabo Frio, Conchas beach, 22°52'S; 41°58'W, MNRJ 12632, 1 specimen, 10 mm alive, 2 m depth (24/ii/2005, V. Padula col.). Búzios, MZSP 37948, 5 specimens (20/ix/1975, Marcus det.).

Discussion

The specimens studied herein have characteristics typical of *Oxynoe antillarum* such as the light green body and radular teeth with densely arranged (more than ten extensions for each 10 µm) hair-like processes (Jensen, 1980). *Oxynoe antillarum* resembles *Oxynoe azuropunctata* Jensen, 1980, which also occurs in the Caribbean Sea. Jensen (1980) argued that differences between the two species can be found, for example, in the number and size of the parapodial papillae (more numerous and bigger in *O. azuropunctata*), the size of the tail (larger in *O. antillarum*), and the body color (*O. antillarum* being usually uniformly green and *O. azuropunctata* being green with conspicuous iridescent blue and white patches). In reality, differences between the two species concerning parapodial papillae size and body color are not evident in some cases. The living specimen of *O. antillarum* studied herein, and also specimens illustrated by Valdés et al. (2006), possess visible white and greyish blue patches at rhinophores and parapodial margins, being therefore not uniformly green. What appears to characterize *O. azuropunctata* is the fact that these patches are always large and conspicuous, covering the major part of rhinophores, marginal band of parapodia, dorsal region of the tail, and the border of the foot. The images of the radular teeth presented here are very similar to SEM images of radular teeth from one specimen of *O. antillarum* from the type locality (Jensen, 1993: 140). In both cases, the dense arrangement of the hair-like processes on the radular teeth (more than 10 per 10 µm) can be observed. It differs from *O. azuropunctata*, which has up to 10 processes per 10 µm (Jensen, 1980).

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