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New records of marine "sea slugs" (Mollusca: Gastropoda: Heterobranchia) in the outlets of the estuary systems in Paraná, southern Brazil

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Abstract: Four species of shell-less marine gastropods, collectively called "sea slugs", are newly recorded from outlets of estuarine systems, the Paranaguá estuarine complex and Guaratuba Bay, on the coast of Paraná state. These include a marine pulmonate slug, *Onchidella indolens* (Gould, 1852) (Eupulmonata: Systellommatophora: Onchidellidae); two species of sea hares, *Bursatella leachii* de Blainville, 1817 (Euthyneura: Sacoglossa: Aplysiidae) and *Elysia serca* Er. Marcus, 1955 (Euthyneura: Sacoglossa: Plakobranchidae); and one species of nudibranch, *Spurilla braziliana* MacFarland, 1909 (Nudipleura: Aeolidiidae). Egg mass shapes of *E. serca* and *B. leachii* are newly described.

Key words: egg masses, sea slugs, distribution gap, new records

Sea slugs are marine gastropods with no shell or the shell reduced and internal. They are hermaphrodites and may have their first stages of life in egg masses attached to a substratum or in larval forms of free living individuals (Schlesinger *et. al.* 2009; Matthews-Cascon *et. al.* 2011). Besides, the form and ornamentation of the egg masses are used to identify some heterobranch species (Matthews-Cascon *et. al.* 2011).

Currently, approximately 200 sea slugs (Cephalaspidea; Systellommatophora; Sacoglossa; Nudibranchia) species are reported from Brazil (Rios 2009; DaCosta *et al.* 2010). Along the southern coast of Brazil, 45 species were recorded, including 21 from the state of Rio Grande do Sul, 31 from Santa Catarina and 4 from Paraná (Table 1). The perceived paucity of few sea slugs species from Paraná may be associated to the few studies on the group in the area or to a lack of favorable environmental conditions for their development.

The Paraná coast, located in southern Brazil, extends from the Ararapira village in the north (25°12′44″ S, 48°01′15″ W) to Saí-Guaçu river mouth in the south (25°58′38″ S, 48°35′26″ W) and has two main estuaries: Paranaguá estuarine complex and Guaratuba Bay (Figure 1). This shore is characterized by several sandy beaches and few extensions of rocky coast (Noernberg *et al.* 2008).

Four individual of *Onchidella indolens* (Gould, 1852) were collected by hand in a rocky shore associated to macroalgae in the outlet of the Paranaguá estuarine complex, Mel Island, Encantada beach (25°33′47.77″ S, 48°19′05.74″ W; 28 July 2010; collector: Iarema Carvalho). Also at the same outlet and associated with macroalgae were collected 3 individuals of *Elysia serca* Er. Marcus, 1955. Two individuals of *Bursatella leachii* de Blainville, 1817 were collected on the intertidal sand-mud flat at Baixio do Perigo (25°28′24.05″ S, 48°26′05.01″ W; 4 August 2011; collector: Augusto Ferreira-Jr). Cross-fertilization between individuals of *Bursatella leachii* was observed in the field, with two to five individuals in sexual intercourse inside a depression (Figure 2). One specimen of *Spurilla braziliana* MacFarland, 1909 was collected at the outlet of Guaratuba Bay in an oyster culture located at Pinheiros River (25°49′56.02″ S, 48°34′46.78″ W; 20 July 2011; collector: Augusto Ferreira-Jr) (Figure 2).

In the laboratory, the specimens of the four species were acclimatized in water with salinity varying from 20 to 30 psu. During this period, the specimens of *Spurilla braziliana* and *Elysia serca* spawned spiral egg masses (Figure 2). Egg mass shape was previously observed by Matthews-Cascon *et al.* (2011) for *S. neapolitana*, but is not previously known for *E. serca*. Egg masses of *Bursatella leachii* are a long, coiled, gelatinous string with each egg capsule with more than one larva (Figure 2). In the laboratory, *Onchidella indolens* and *E. serca* fed on macroalgae, as also reported by Rios (2009). *Spurilla braziliana*, preferred to feed on bryozoans and hydrozoans that were attached to oyster shells from which it was collected.

The new record of *Elysia serca* extends the known range of this species approximately 80 km south of the previous known distribution (Figure 1). The new records of *Spurilla braziliana* and *Onchidella indolens* in the coast of Paraná fill gaps in the known distributions of these two species, thus enabling a connection between the populations of the States of São Paulo and Santa Catarina, described earlier (Pimpão and Magalhães 2004; Rios 2009; Carmona *et al.* 2014). Recently

Carmona *et al*. (2014) reported that the species of *Spurilla* present along the Brazilian coast is *Spurilla braziliana* and not *Spurilla neapolitana* (Delle Chiaje, 1841).

Heterobranchia from Paraná state are not well known, and this may be due to a lack of appropriate sampling in suitable habitats, both during larval and adult stages. The absence of studies focused in heterobranchs may explain the difference in occurrence of species in the state of Paraná, compared with the larger diversity of sea slugs reported from São Paulo and Santa Catarina. Further fieldwork on the coast of Paraná may add information about species still yet unknown from the state, as well as possibly increasing knowledge of the reproductive characteristics of heterobranch species in the region. The integration of morphological and molecular tools may also contribute to better identification of species and their distribution, as well as the interaction between populations of heterobranchs in southern Brazil.

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Table 1. Records of marine heterobranchs from the southern Brazil coast. PR: Paraná state; SC: Santa Catarina state; RS: Rio Grande do Sul state.

Species	Location	References
Acteocina bidentata (d´Orbigny, 1841)	PR, SC, RS	Morretes 1949; Garcia *et al.* 2008; Agudo-Padrón *et al.* 2009
Acteocina bullata (Kiener, 1834)	SC, RS	Wiggers and Magalhães 2003; Agudo-Padrón *et al.* 2009
Acteocina candei (d'Orbigny, 1841)	SC, RS	Morretes 1949; Garcia *et al.* 2008; Agudo-Padrón *et al.* 2009
Acteocina inconspicua (H. Adams, 1872)	SC, RS	Garcia *et al.* 2008; Agudo-Padrón *et al.* 2009
Acteon pelecais Ev. Marcus, 1972	SC, RS	Garcia *et al.* 2008; Agudo-Padrón *et al.* 2009; Rios 2009
Aeolidiella indica Bergh, 1888	SC	Padula *et al.* 2011
Aplysia brasiliana Rang, 1828	SC	Agudo-Padrón *et al.* 2009; Rios 2009
Aplysia dactylomela Rang, 1828	SC	Agudo-Padrón *et al.* 2009
Aplysia juliana Quoy & Gaimard, 1823	SC	Wiggers and Magalhães 2003; Agudo-Padrón *et al.* 2009
Aplysia fasciata Poiret, 1789	SC	Morretes 1949; Garcia *et al.* 2008; Agudo-Padrón *et al.* 2009; Rios 2009
Armina muelleri (Ihering, 1886)	SC	Morretes 1949; Garcia *et al.* 2008; Agudo-Padrón *et al.* 2009; Rios 2009
Berghia rissodominguezi Muniain & Ortea, 1999	SC	Padula *et al.* 2011
Bulla striata Bruguìere, 1792	PR, SC	Morretes 1949; Boehs *et al.* 2004; Garcia *et al.* 2008; Agudo-Padrón *et al.* 2009; Rios 2009
Bursatella leachii de Blainville, 1817	**PR**, RS	**This study**; Garcia *et al.* 2008; Rios 2009
Crenilabium birmani Simone, 2006	RS	Rios 2009
Chromodoris paulomarcioi Domínguez, García & Troncoso, 2006	SC	Padula *et al.* 2011
Cylichna crispula Watson, 1883	SC	Agudo-Padrón *et al.* 2009
Cylichna discus Watson, 1883	RS	Garcia *et al.* 2008; Rios 2009
Cylichna verrillii Dall, 1889	SC, RS	Wiggers and Magalhães 2003; Garcia *et al.* 2008; Agudo-Padrón *et al.* 2009
Doris verrucosa Linnaeus, 1758	SC	Morretes 1949; Garcia *et al.* 2008; Agudo-Padrón *et al.* 2009; Rios 2009
Elysia serca Er. Marcus, 1955	PR	**This study**
Dendrodoris krebsii (Mörch, 1863)	SC	Ev. Marcus 1977; Agudo-Padrón *et al.* 2009; Rios 2009
Dondice occidentalis (Engel, 1925)	SC	Wiggers and Magalhães 2003; Agudo-Padrón *et al.* 2009
Etidoris ladislavii Ihering, 1886	SC	Rios 2009
Flabellina engeli lucianae Dacosta, Cunha, Simone & Schrödl, 2007	SC	DaCosta *et al.* 2007
Glaucus atlanticus Forster, 1777	RS	Garcia *et al.* 2008; Rios 2009
Haminocea elegans (Gray, 1825)	PR, SC, RS	Boehs *et al.* 2004; Garcia *et al.* 2008; Agudo-Padrón *et al.* 2009; Rios 2009
Hypselodoris lajensis Troncoso, Garcia & Urgorri, 1998	SC	Domínguez *et al*. 2006; Rios 2009
Marionia cucullata (Couthouy, 1852)	SC	Garcia *et al.* 2008; Agudo-Padrón *et al.* 2009; Rios 2009
Mysouffa cumingii (A. Adams, 1855)	RS	Garcia *et al.* 2008; Agudo-Padrón *et al.* 2009; Rios 2009
Onchidella indolens (Gould, 1852)	**PR**, SC	**This study**; Agudo-Padrón *et al.* 2009; Rios 2009
Philine alba Mattox, 1958	RS	Garcia *et al.* 2008; Rios 2009
Philine falklandica Powell, 1951	RS	Garcia *et al.* 2008; Rios 2009
Philine mera Er. Marcus & Ev. Marcus, 1969	RS	Garcia *et al.* 2008; Rios 2009
Polycera aurisula Er. Marcus, 1957	SC	Agudo-Padrón *et al.* 2009
Pleurobranchus areolatus Morch, 1863	SC	Wiggers and Magalhães 2003; Agudo-Padrón *et al.* 2009; Rios 2009
Pleurobranchus inconspícua Bergh, 1897	RS	Garcia *et al.* 2008; Rios 2009
Scaphander nobilis Verrill, 1884	RS	Garcia *et al.* 2008
Scaphander watsoni Dall, 1881	RS	Garcia *et al.* 2008
Spurilla gabriellae Vannucci, 1952	PR	Vanucci, 1952; Morretes 1954
Spurilla braziliana Macfarland, 1909	**PR**, SC	**This study**; Pimpão and Magalhães 2004; Agudo-Padrón *et al.* 2009; Rios 2009
Volvulella paupercula (Watson, 1883)	RS	Garcia *et al.* 2008; Rios 2009
Volvulella persimilis (Mörch, 1875)	RS	Garcia *et al.* 2008; Rios 2009
Tambja stegosauriformis Pola, Cervera & Gosliner, 2005	SC	Padula *et al.* 2011
Thordisa ladislavii (Ihering, 1886)	SC	Morretes 1949; Rios 2009
Tritonia eriosi Ev. Marcus, 1983	RS	Garcia *et al.* 2008; Rios 2009

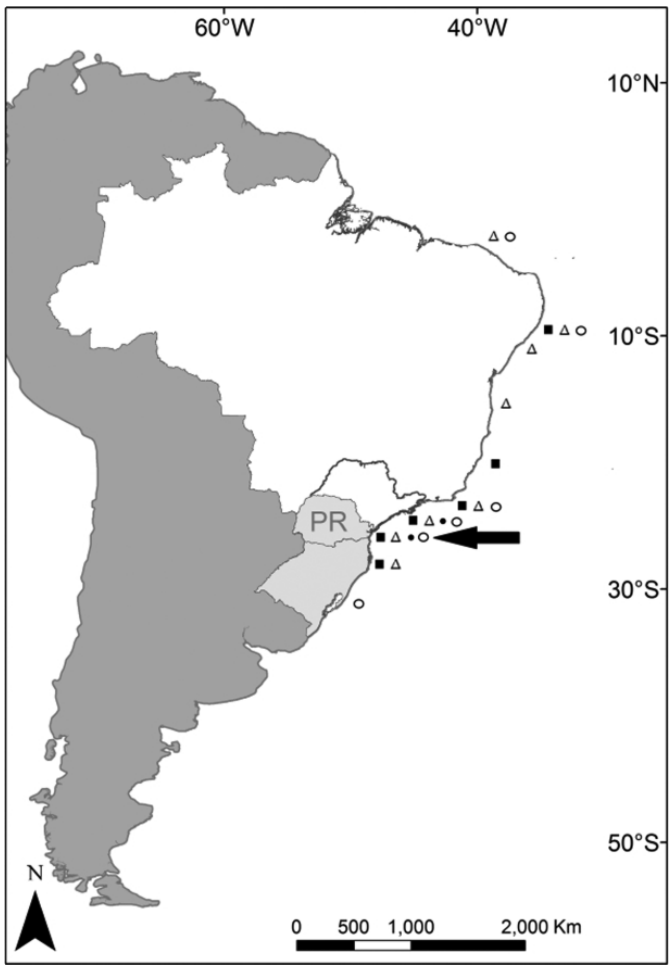

Figure 1. Geographic distribution of Onchidella indolens (■), *Spurilla braziliana* (Δ), *Bursatella leachii* (○) and *Elysia serca* (●), with indication of the news records from Paraná (PR) state (⬅). Light grey indicates southern Brazil.

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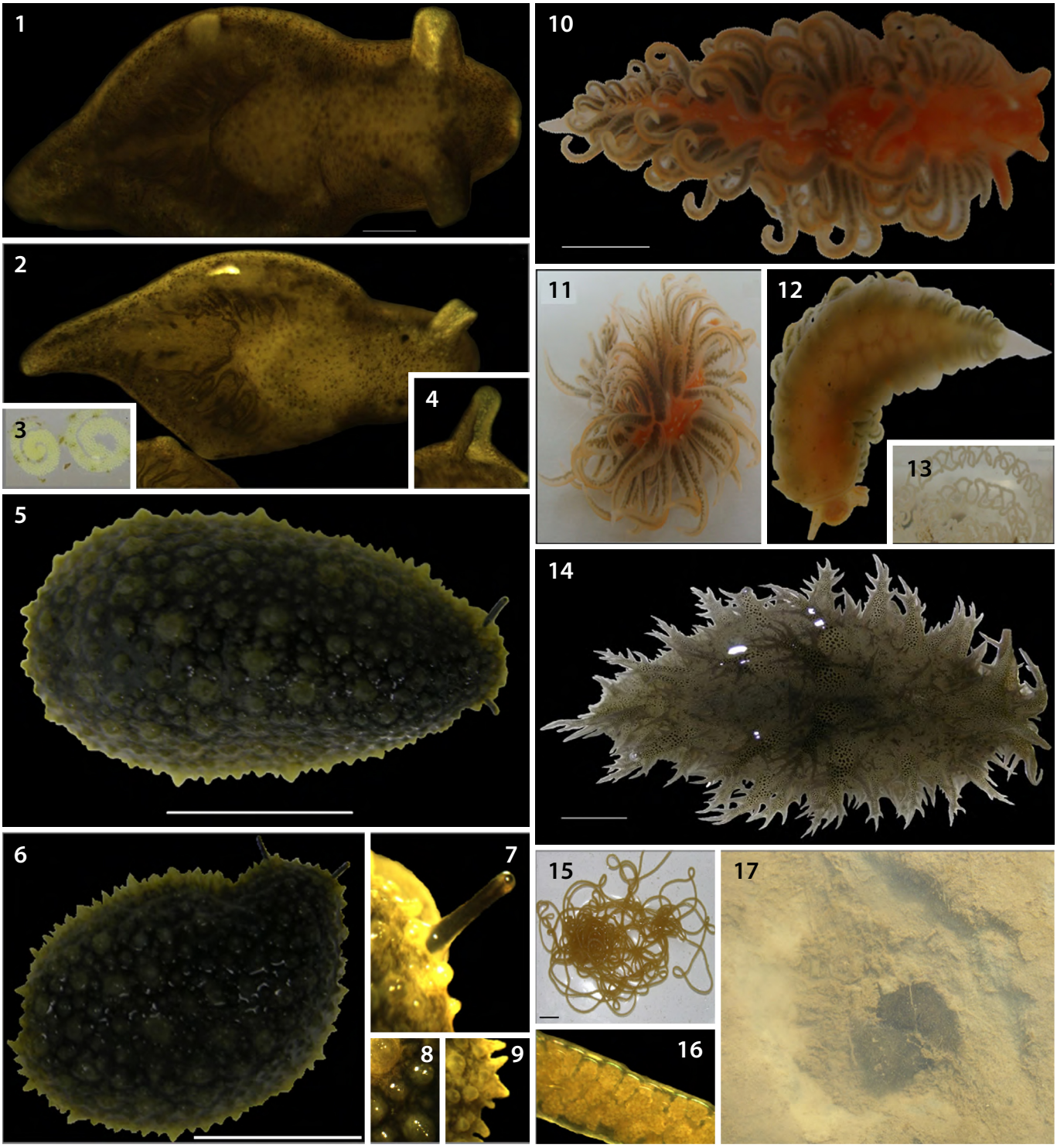

Figure 2. Heterobranchia from Paraná state, southern Brazil. 1–4: *Elysia serca*, Baixio do Perigo; 2, cross-fertilization; 3, egg mass; 4, rhinophore. 5–9: *Onchidella indolens*, Praia de Encantadas; 7, retractile tentacle bearing eyes; 8 and 9, skin projections. 10–13: *Spurilla braziliana*, Pinheiros River; 11, defense position; 12, ventral view and movement of spawning; 13, spawning; 14–17: *Bursatella leachii*, Baixio do Perigo; 15, spawning; 16, capsule and embryos; 17, sexual intercourse in the field. Scale bars: 1, 100 µm; 5, 6, 10; 14 and 15, 1 cm.