

First records of the bean-slug *Sarasinula plebeia* (Gastropoda: Veronicellidae) in Argentina

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Abstract. *Sarasinula plebeia* is a common land slug in tropical and subtropical areas, including South America. This species is known as Bean-slug but considered a pest of great importance in numerous crops, horticultural facilities, plant nurseries, and garden. Also, it is a natural host for nematodes that cause parasitosis in different countries. We report for the first time the occurrence of *Sarasinula plebeia* in Argentina, based on material collected in the provinces of Chaco and Misiones, extending the distribution of the species in South America to 34 terrestrial ecoregions.

Key-Words. Systellomatophora; Potential pest; Disease transmitter; Native species.

INTRODUCTION

Several species of the genus *Sarasinula* have been nominated for South America. However, in the reviews carried out by Thomé (1989, 1993), who studied the group for decades, he considered four possible valid species: *S. linguaeformis* (Semper, 1885), *S. marginata* (Semper, 1885), *S. dubia* (Semper, 1885) and *S. plebeia* (Fisher, 1868). Thomé (1989) also questioned the validity of *S. dubia* and *S. marginata*, which he considered a possible synonym of *S. plebeia* and *S. linguaeformis*, respectively. The main morphological difference between *S. dubia* and *S. plebeia* is found in the penis. In *S. plebeia* the penis is club-shaped, while in *S. dubia* it is tapered in the distal extremity (Thomé, 1989), which, however, can be considered a morphological variation in *S. plebeia* (Gomes & Thomé, 2001, 2002). Further research by other authors already considered these species synonyms (Mansur & Thomé, 1994; Rueda *et al.*, 2002; Naranjo-García *et al.*, 2007; Molet, 2014; Oliveira Rocha, 2019).

Sarasinula linguaeformis (= *S. marginata*) was described for Guayaquil, Ecuador (*S. marginata* for Rio de Janeiro, Brazil) and is currently reported in the following countries in South America: Guyana, Colombia, Ecuador, Peru, Paraguay, Argentina, and

Brazil where is considered a native species (Thomé, 1993; Santin & Miquel, 2015; Oliveira Rocha, 2019).

Darrigran *et al.* (2020) considered *Sarasinula plebeia* (= *S. dubia*) as cryptogenic in South America since this species was described for New Caledonia (Oceania). However, *Vaginula behni* Semper, 1885, that is currently a synonym for *S. plebeia* according to Thomé (1993), was originally described based on material from Rio de Janeiro, Brazil, what indicates that it is present for a long time in South America as well. Besides, the other species of the genus is also found in America and *Sarasinula* has relationships with other American genera (Dayrat *et al.*, 2011), supporting the American origin hypothesis for *S. plebeia*, as postulated by Cowie *et al.* (2008). Currently, *S. plebeia* is registered in South America in the following countries: Brazil (since 1885), Colombia (1978), Venezuela (1992), Chile (1993, without specifying location), Ecuador (2008) and Peru (2015) (Thomé, 1993; Darrigran *et al.*, 2020). Besides, it is registered in several regions, in which is considered non-native or invasive as North and Central America, the West Indies, Asia, Africa, Australia, Fiji, Hawaii, Indonesia, Marianas, New Caledonia, Philippines, Solomon Ids, Tahiti, Tuamotu, Vanuatu, Western Samoa West Islands (Thomé, 1993; Gomes & Thomé, 2004; GBIF, 2020).

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Sarasinula plebeia has been reported as an intermediate host of health-important nematodes such as *Angiostrongylus costaricensis* Morera & Céspedes, 1971 (in Central America) that cause abdominal angiostrongyliasis, and the rat lungworm, *Angiostrongylus cantonensis* (Chen, 1935), which is the etiologic agent of eosinophilic meningitis (in Pacific Islands) (Robinson & Hollingsworth, 2004). This species is known as Bean-slug and considered a pest of great importance in numerous crops, horticultural facilities, plant nurseries, and gardens (Rueda et al., 2002; Naranjo-García et al., 2007; Constantino et al., 2010).

This work aims to report for the first time the occurrence of *Sarasinula plebeia* in Argentina, based on material collected in the provinces of Chaco and Misiones.

MATERIAL AND METHODS

The slugs were obtained by manual collection by Gutiérrez Gregoric in 2000 and 2011. The collected specimens were relaxed in menthol solution for one day, to be later preserved in ethanol (material of the year 2000) and Railliet-Henry solution (material of the year 2011) and deposited in the Malacological Collection at the La Plata Museum (MLP-Ma) of the La Plata National University, Buenos Aires Province, Argentina. The identification of the material was carried out following Thomé (1971) and Gomes & Thomé (2001, 2002). For the synonymous list, the work carried out by Thomé (1989, 1993) for America and Gomes & Thomé (2004) for the Australian region was taken as a basis.

Due to the collection time of the material from the province of Chaco (2000), and the type of conservation of the material from Misiones (Railliet-Henry solution), it was not possible to extract DNA from the samples.

RESULTS

Sarasinula plebeia (Fischer, 1868)

Vaginulus plebeius Fischer, 1868: 145-146; Thomé, 1971: 34-36.

Vaginula andreana Semper, 1885: 321.

Vaginula behnii Semper, 1885: 310-311.

Vaginula dubia Semper, 1885: 296; Thomé, 1972: 252-253.

Veronicella hedleyi Simroth, 1889: 552; Simroth, 1891: 863-906; Simroth, 1918: 281-292.

Vaginula levucana Simroth, 1918: 262-290.

Vaginula samoana Simroth, 1918: 290-291.

Vaginula tahitiana Simroth, 1918: 290-292.

Sarasinula plebeja Grimpe & Hoffmann, 1924: 177; Grimpe & Hoffmann, 1925a: 19-26; Grimpe & Hoffmann, 1925b: 357-362; Hoffmann, 1925: 190, 251-252; Thomé, 1975: 25-27.

Imerinia plebeja Baker, 1925; Hoffmann, 1934: 259-260.

Veronicella discrepans Thiele, 1927: 328.

Sarasinula lemei Thomé, 1967: 528-531.

Vaginulus (Sarasinula) plebeius Forcart, 1969: 149-150; Aguayo, 1964; Forcart, 1973; Cowie, 1998.

Sarasinula dubia Thomé, 1993: 71; Thomé et al., 1997: 530; Simone, 2006: 96; Agudo-Padrón, 2008: 153.

Vaginula plebeia Cowie, 1997: 38.

Sarasinula plebeia Thomé, 1975: 25-27; Thomé, 1989: 19-23; Thomé, 1993: 71; Thomé et al., 1997: 530; Gomes & Thomé, 2001: 141-143; Gomes & Thomé, 2002; Gomes & Thomé, 2004: 591; Simone, 2006: 97; Agudo-Padrón, 2008: 153.

Material examined: Puerto Iguazú, Misiones province (25°36'39"S, 54°34'49"W), March 2011, N = 1, MLP-Ma 15015; Selvas del Río de Oro, Chaco province (26°45'09"S, 58°58'30"W), July 2000, N = 1, MLP-Ma 15016.

Description (Fig. 1): Thickened notum that sometimes appears dotted (Fig. 1A); light brown to dark coloration without pale stripes. The tentacles are contracted and hidden underneath the notum when the slug is dormant. Penis (Fig. 1C) short, smooth, without annular protrusion, bilaterally symmetrical, with an enlarged glans. There is no spatha. Digitiform gland (= penial gland, Fig. 1B) with an elongated papilla with 6 short tubules with varying lengths (not bifurcate). Proximal region of the tubules meandering and covered by a thick membrane. The width to length ratio of the papilla is 2.33, and the width to length ratio of the glans is 1.52. Copulation bursa (or spermatheca) formed by a globular and thin sac seated over a thick cylindrical uniform duct, which narrows slightly until it penetrates the integument, where it joins the oviduct, opening in the female genital pore. Canalis junctor (or junctor duct) thin and short, penetrating the narrowest part of the copulation bursa itself. The rectum penetrates the integument near the female genital pore, located near the middle of the right hyponotum. The two nerve pairs, pedal and pallial, originate in their respective ganglia in the periesophageal ring and stretch through the body cavity in two sets, right and left, which runs together from the nerve ganglion to the posterior end of the body, centrally along the foot. The pairs leave a small anterior space for the passage of the main artery (fide Grimpe & Hoffmann, 1925b).

Ecological notes: Both new records were found in residential gardens, under branches and trunks, so it is inferred that the trade-in plants are the pathway of dispersal of this species. The Selvas del Río de Oro locality corresponds to the Humid Chaco terrestrial ecoregion (humid temperate climate), while Puerto Iguazú locality corresponds to the Alto Paraná Atlantic Forest ecoregion (subtropical climate), ecoregions defined by Olson & Dinerstein (2002). Both records are the first to be cited for these terrestrial ecoregions (Fig. 2).

Distribution in South America (Fig. 2): Argentina: Misiones and Chaco provinces (This study). Brazil: States of Rio Grande do Sul, Santa Catarina, São Paulo, Rio de Janeiro, Espírito Santo, Bahia, Pará (Santarém), Paraíba, and Ceará (Thomé, 1993; Mansur & Thomé, 1994; Thomé et al., 1997; Simone, 2006; Agudo-Padrón, 2008; GBIF, 2020). Colombia: Departments of Risaralda (Pereira),

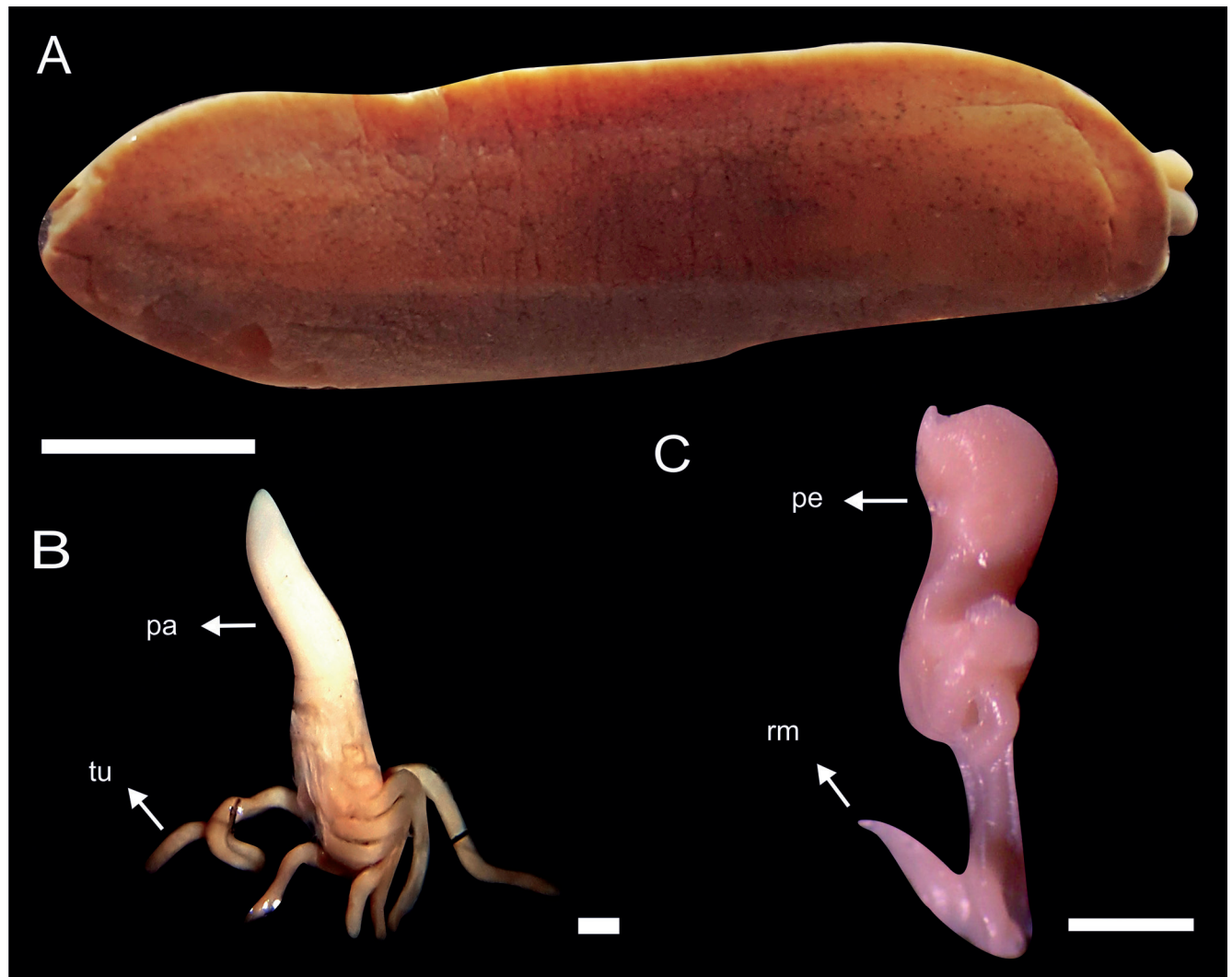


Figure 1. *Sarasinula plebeia* for Misiones province (MLP-Ma 15015). (A) Dorsal view; (B-C) part of male genitalia; (B) digitiform gland; (C) penis. pe = penis; pa = papilla of the digitiform gland; rm = penis retractor muscle; tu = tubules. Scale bar: A = 1 cm; B and C: 1 mm.

Atlántico (Barranquilla), Valle del Cauca (Palmira) Antioquía (San Nicolás Valley), and Caldas. (Götting, 1978; GBIF, 2020). Andina región (Constantino *et al.*, 2010). Ecuador: Provinces of Zamora and Pichincha (GBIF, 2020). Peru: Departments of Lambayeque and Loreto (Iquitos) (GBIF, 2020). Venezuela: States of Anzoátegui (San Tome), Aragua, Caracas (Campo Alegre), Mérida, Miranda (El Hatillo), Monagas, Sucre, and Táchira, (Fernández de Varela, 1982; Thomé *et al.*, 1997; GBIF, 2020).

DISCUSSION

For Argentina, eight species of Veronicellidae are registered according to Santin & Miquel (2015). In their review, *Sarasinula linguaeformis* is cited for Argentina, in the provinces of Tucumán, Corrientes, and Misiones (Puerto Iguazú city), while *Sarasinula plebeia* has no records in Argentina. Mansur & Thomé (1994) examined *Sarasinula* specimens of Corrientes (Argentina), but they do not specify if they were *S. plebeia* or *S. linguaeformis*.

There are no studies in South America that relate the internal anatomy of the different populations of this

species. However, the measurements taken in the male genital system of the specimens studied here (width to length ratio of the penial papilla and width of glans) are according to the those mentioned for the non-Australian specimens (Gomes & Thomé, 2002).

With this new record in the Misiones, there are now seven species of Veronicellidae in this province: *Angustipes difficilis* (Colosi, 1921), *Phyllocaulis soleiformis* (d'Orbigny, 1835), *P. variegatus* (Semper, 1885), *P. tuberculosus* (Martens, 1868), *Latipes erinaceus* (Colosi, 1921), that Oliveira Rocha & D'ávila (2019) recently included in *Angustipes* genus, *Sarasinula linguaeformis*, and *S. plebeia*. In turn, in the Puerto Iguazú city, six of these species are registered (*P. tuberculosus* is absent), and the two *Sarasinula* species coexist. Santin & Miquel (2015) cited *Angustipes difficilis* and *Phyllocaulis soleiformis* in Chaco province. There are no previous records for Selvas de Rio de Oro.

Only two specimens of *S. plebeia* have been registered in Argentina since no new sampling has been carried out at both sites since then. However, the occurrence in two different ecoregions indicates that their presence in Argentina is possibly due to different events.

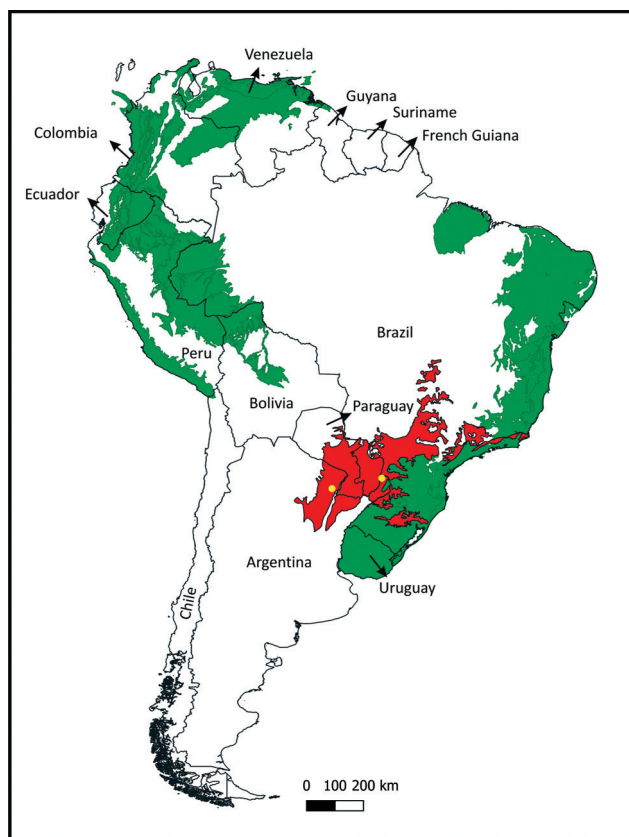


Figure 2. Distribution of *S. plebeia* in South America. Green: ecoregions where *S. plebeia* is recorded according to Darrigran *et al.* (2020) and bibliography (see Distribution in the text). Red: new ecoregions with *S. plebeia*. Yellow circles: new records for Argentina.

Since *S. plebeia* is considered to have a neotropical origin as mentioned by Cowie *et al.* (2008), the presence in Argentina, surely due to human activity, is within its potential distribution. For this reason, the presence in Argentina can be considered as a “Transplant of species” as defined by Pérez *et al.* (2007). The nearest records of *S. plebeia* to Argentina were reported for the Brazilian states of Rio Grande do Sul and Santa Catarina (Mansur & Thomé, 1994; Simone, 2006; Agudo-Padrón *et al.*, 2013; Gomes *et al.*, 2013), both bordering on the province of Misiones and corresponding to the terrestrial ecoregions of Araucaria Moist Forests and Uruguayan Savanna. According to Darrigran *et al.* (2020), and the distribution here presented, this species is present in 32 terrestrial ecoregions of South America. The new records correspond to two new ecoregions so that this entity is now registered in at least 34 ecoregions out of a total of 109 in South America.

The new records in Argentina belong to two new ecoregions for this species, which not only covers Argentina but also regions of Paraguay and Brazil. Given that the environmental conditions in each ecoregion are similar (e.g., climate, geomorphology, soil, hydrology) this species could potentially be registered in Paraguay.

Puerto Iguazú city has been affected since 2010 by the presence of the African giant snail *Achatina fulica* Bowdich, 1822 and other invasive gastropods such as *Bradybaena similaris* (Férussac, 1822) and *Meghimatium*

pictum (Stoliczka, 1873) (Gutiérrez Gregoric *et al.*, 2011, 2013a, b). There are currently 30 non-native species of land gastropods in Argentina, mostly in the North and Northeast regions (Darrigran *et al.*, 2020). The presence of non-native, invasive, or transplanted species increases the transmission of parasitosis in this area, in addition to incorporating a new potential crop pest.

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