Sarasinula spp.*

*In April 2013, the family Veronicellidae, a target on the 2013 and 2014 AHP Prioritized Pest Lists, was broken down into six genera of concern, including *Sarasinula* spp. Information in the datasheet may be at the family, genus, or species level. Information for specific species within the genus is included when known and relevant; other species may occur in the genus and are still reportable at the genus level.

Portions of this document were taken directly from the New Pest Response Guidelines for Tropical Terrestrial Gastropods (USDA-APHIS, 2010a).

*Information for specific species within the genus is included when known and relevant. Other species may occur in the genus and are still reportable at the genus level.

Figure 1. *Sarasinula plebeia* on *Phaseolus* spp. (bean) in Honduras (Frank Peairs, Colorado State University, Bugwood.org).

Scientific Names

Sarasinula plebeia (Fischer, 1871)
Sarasinula linguaeformis (Semper, 1885)

Synonyms:
Sarasinula plebeia
Vaginulus plebeius Fischer, 1868
Sarasinula dubia (Semper, 1885)

Common Name

No common name, leatherleaf slugs

Sarasinula plebeia: Caribbean leatherleaf slug, bean slug

Type of Pest

Mollusk

Figure 2. *Sarasinula plebeia* on *Phaseolus* spp. (bean) in Honduras (Frank Peairs, Colorado State University, Bugwood.org).

Taxonomic Position
Class: Gastropoda, **Order**: Systellommatophora, **Family**: Veronicellidae

Reason for Inclusion in Manual
CAPS Target: AHP Prioritized Pest List for FY 2011 – 2015*

*Originally listed under the family Veronicellidae.

Pest Description
Veronicellidae are anatomically distinct from many other terrestrial slugs in that they have a posterior anus, eyes on contractile tentacles, and no pulmonate lung. The sensory tentacles are bilobed. This family also lacks a mantel cavity (Runham and Hunter, 1970).

Figure 3. *Sarasinula plebeia* (Fischer) from the West Indian island of Guadeloupe (From Robinson and Hollingsworth, 2004).

Although this family is fairly easy to tell apart from others, species within this family can be difficult to distinguish due to similar morphology between species and multiple color variations within a single species. Taxonomy is based on the morphology of the hermaphroditic reproductive system.

Sarasinula plebeia
"*Sarasinula plebeia* (Fischer, 1868) is a relatively large shell-less slug. The upper surface (notum) is leathery and can sometimes appear pitted. The body form is flattened and becomes more elongate when the animal is alive and crawling. The notum colour is generally light to dark mottled brown with no pale stripe. Like all members of its family a mantle cavity is absent. The pneumostome (breathing pore) is very small (Shea 2006) and located at the posterior, under the notum. The head has two pairs of tentacles; the upper pair have terminal eyes. The tentacles are hidden under the notum when the slug is inactive" (Brodie and Barker, 2012).

Sarasinula plebeia has a grey notum with randomly placed minute dark marks weighing an average of 3 grams (Rueda et al., 2002). The foot is narrower than the hyponotum (Rueda et al., 2002).

Biology and Ecology
The biology of Veronicellidae is not well known; they are known to be nocturnal herbivores (Runham and Hunter, 1970).

Sarasinula plebeia
Rueda et al. (2002) state that *Sarasinula plebeia* is a nocturnal slug that prefers disturbed habitats including backyards, gardens, and cultivated areas. This slug is oviparous with clutches averaging 37 eggs. The slugs lay one to two clutches per year but can have as many as four. In laboratory conditions, the slugs mature by around 6 months. Self-fertilization is common in this slug. In previous laboratory studies, *S. plebeia* was found to copulate several times in the same night that maturity was reached, suggesting a sexual pheromone may be released once slugs have matured sexually (Rueda et al., 2002). In Fiji, breeding occurs in the wet season and can lead to high population densities in disturbed habitats (Brodie and Barker, 2012). During the dry season, *S. plebeia* can bury themselves to a depth of 25 cm or up to 1 m (about 3 feet) (reviewed in Naranjo-Garcia et al., 2007).

This species is found in various suburban areas, including gardens, in several areas of the Northern Territory, Australia (Smith and Dartnall, 1976). Brodie and Barker (2011) state that this species is found under stones, grass, decaying wood, leaf litter and ground crevices. It is arboreal on low vegetation. In Fiji, it can be found in lowland to mid-elevation forests, plantations, grasslands, and gardens (Brodie and Barker, 2011).

Damage
Due to their apparent lack of host specificity, few reports as to specific damage caused by Veronicellidae species to agriculture have been published in the malacological or agricultural literature.

Visual signs of *Veronicellidae* can include chewing or rasping damage to plants, presence of eggs, juveniles and adults, mucus and slime trails, and/or large-ribbon like feces.

Sarasinula plebeia
In Central America, *S. plebeia* damages beans by severing seedlings at soil level and consuming leaves, growing shoots, and young pods (reviewed in South, 1992; Naranjo-Garcia et al., 2007).

Pest Importance
Veronicellidae can be pests in tropical regions of America, Africa, and Asia where distribution is limited (Runham and Hunter, 1970). This family can also transmit pathogens to humans indirectly when they consume vegetables and fruits that have been contaminated with mucus and feces. The slugs can also transmit pathogens to plants and livestock. Displacement of native mollusk species may also occur (USDA-APHIS, 2010a).

Sarasinula plebeia
This species soon became a pest in Central America after its introduction in the mid-1960s (reviewed in South, 1992). In many Central American regions, *Sarasinula plebeia* is considered the most important bean crop pest (Rueda et al. 2002). Damage can be so high, that some farmers will abandon growing bean crops (reviewed in

Contreras, 2000). It has caused regional losses estimated at US$27-45 million per year (reviewed in South, 1992). Losses in Nicaragua in 1980-81 were estimated to be 35%; yield losses in Honduras have been reported as high as 50 to 100% (reviewed in Contreras, 2000). In Brazil, studies on bean damage have been conducted to determine susceptibility of different bean varieties and potential control options (Sannazzaro et al., 2000).

Sarasinula plebeia has also become a pest on sweet pepper and tomatoes in Panama and cucurbits in Nicaragua (Rueda et al. 2002). It is considered a pest in Saipan where it causes feeding damage to white radish, red taro, Chinese cabbage, and pechay (Robinson and Hollingsworth, 2004). This species can become very abundant and serve as a public nuisance in both urban and suburban areas (Cowie et al., 2009).

This species was introduced into Hawaii in the 1970s. Anecdotal observations suggest that the decline of another pest slug, *Laevicaulis alte*, in Hawaii has coincided with the introduction of *Sarasinula plebeia*. This could be due to competition between the two species (Cowie, 1998). According to Hata et al. (1995), the population of this species continues to increase in Hawaii and can cause severe damage to flowers and foliage. This species is a concern to Hawaii's potted-foliage growers as this species can infest the commodity (Hata et al., 1995).

This species is also present in Florida. To date, there have been no reports of this slug causing any significant damage in Florida and large colonies reported in the literature have not been detected (Stange, 2004).

Known Food Sources*

These species are polyphagous, eating many different plants, organic material, and detritus (USDA-APHIS, 2010a).

Hosts specifically mentioned for each pest are listed below (lists are not meant to be all inclusive):

Sarasinula plebeia

Borreria spp. (borreria), *Brassica oleracea* (Broccoli, cabbage), *Capsicum annuum* (sweet pepper), *Cucurbita* spp. (squash), *Ipomoea batatas* (sweet potato), *Lactuca sativa* (lettuce), *Phaseolus* spp. (bean), *Phaseolus vulgaris* (bean), *Solanum lycopersicum* (tomato), *Solanum tuberosum* (potato) (Sannazzaro et al., 2000; Rueda et al, 2002; CABI, 2007; Naranjo-Garćia et al., 2007).

*Terrestrial mollusks do not show host specificity and can feed on multiple crops as well as other materials, like decaying organic matter.

Pathogen or Associated Organisms Vectored

Human and Animal Pathogens

Species of this family have been found to carry several nematode parasites, including *Angiostrongylus cantonensis* (rat lungworm), *A. costaricensis*, and *A. malaysiensis*. *A.*

cantonensis can cause symptoms similar to meningitis in humans including headache, stiff neck, tingling or painful feelings in the skin, lowgrade fever, nausea, and vomiting (USDA-APHIS, 2010a).

Sarasinula plebeia is considered a principle intermediate host of *Angiostrongylus costaricensis* in Central America. This pathogen can cause human abdominal angiostrongyliasis. Individuals can become infected when they consume food contaminated by slugs or infected mucus (reviewed in South, 1992). This species has also been associated with *A. cantonensis* in the Pacific Basin (reviewed in Robinson and Hollingsworth, 2004).

Sarasinula linguaeformis has also been identified as an intermediate host for *A. costaricensis* in Southern Brazil (Laitano et al., 2001).

Note: While most cases of human infections result from consumption of raw or partially cooked snail meat, government inspectors, officers and field surveyors are at-risk due to the handling of live snail, samples, and potential exposure to mucus secretions. ***Wear gloves when handling mollusks and wash hands thoroughly after any mollusk survey or inspection activities.***

Plant Pathogens
Unknown.

Known Distribution

Distribution lists may not be all inclusive.

Sarasinula linguaeformis
Caribbean: Grand Cayman (Cayman Islands), Guadeloupe, Dominica and Martinique; **South America:** Argentina, Brazil, Colombia, Paraguay, Peru, and Guyana (Thomé et al., 1997).

Sarasinula plebeia
Robinson and Hollingsworth (2004) state that this species is found in Central and South America, the West Indies, and has been introduced throughout the Pacific Basin. It is believed that this species is native to South America (Robinson and Hollingsworth, 2004).

Africa: Madagascar, Comoros; **Asia:** China, Indonesia, Philippines, Vietnam; **Caribbean:** Canouan (Saint Vincent and the Grenadines), Cuba, Dominica, Dominican Republic, Jamaica, Puerto Rico, St. Lucia, and Virgin Islands; **Central America:** Belize, Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua, and Panama; **North America:** Mexico; **Oceania:** Australia, Fiji, Guam, Hawaii, Northern Marianas Islands, New Caledonia, New Zealand, Solomon Islands, Tahiti, Tonga, Tuamotu, Vanuatu, and Samoa; **South America:** Brazil, Chile, Colombia, Galapagos Islands, and Venezuela (Evans et al., 1997; Thomé et al., 1997; Coppois, 2000; Rueda et al., 2002; USDA, 2003; Gomes and Thomé, 2004; Thomé, 2008; Robinson et al., 2009).

Pathway

This genus can move through international trade. From 1985 to 2009, *S. plebeia* has been intercepted a total of 110 times on 37 different plant genera. Top ranked plant material interceptions have occurred on include: *Dracaena*, *Chamaedorea*, and *Ananas* (USDA-APHIS, 2010a).

This species is now widely distributed throughout the Americas and the Pacific (Brodie and Barker, 2012). Spread was likely unintentional through movement of infested plant and plant associated material. Cowie (1998) states that this species was likely accidentally introduced into Hawaii.

Potential Distribution within the United States

No risk documents exist for any of the tropical terrestrial mollusks that give potential distribution in the United States. Host material is unlikely to limit their distribution since they are all polyphagous, but these species are limited by climate. If introduced, the tropical terrestrial mollusks would most likely be limited to the southern part of the United States and possibly the West Coast where the climate is similar to native ranges. This is supported by detections of these species which have all been in either the southern United States or West Coast (USDA-APHIS, 2010a).

Sarasinula plebeia

This species is present in Florida and Texas (Thomé et al., 1997). It is also present in Hawaii (Cowie, 1998). Although this species has been spread widely in tropical and subtropical regions, it can endure sub-freezing temperatures suggesting that this species is cold tolerant (reviewed in Naranjo-Garcia et al., 2007).

Survey

CAPS-Approved Method*:

Visual. See the Introduction to the mollusk manual for specific information on visual surveys.

Survey Site Selection

New introductions of terrestrial mollusks will likely be related to commerce and human-assisted movement. The habitat and land-use type of each survey site may be variable, ranging from agricultural land, to residential or industrial features. When planning the survey route for a particular site, examine the following microhabitats:

- Near heavily vegetated areas, especially gardens and fields where plants have been damaged by feeding;
- Under rocks, asphalt or cement pieces that are in loose contact with the ground surface;
- Discarded wooden boards and planks, fallen trees, logs, and branches;
- Damp leaf litter (not wet or soggy), compost piles, and rubbish heaps; and

- Under flower pots, planters, rubber mats, tires and other items in contact with the soil.

Trap Placement
Trapping ***cannot*** be used alone, but can be used to supplement visual surveying. Trapping for terrestrial mollusks is not species specific and will attract non-target species, including non-mollusks. Platform or baiting traps can be used to supplement visual inspection. Trap placement can occur in the same areas that visual surveys occur.

Time of year to survey
Most species of terrestrial mollusks are active during nocturnal hours, when environmental conditions are cool and wet. Some species may also be active during daylight, especially during overcast and rainy days in the spring and fall. If possible, plan surveys during spring and fall, and during early morning and overcast days. Many slugs and snails have diurnal patterns of activity, so early morning and evening hours may be the best time to carry out a survey (Pearce and Örstan, 2006).

*For the most up-to-date methods for survey and identification, see Approved Methods on the CAPS Resource and Collaboration Site, at http://caps.ceris.purdue.edu/.

Key Diagnostics/Identification

CAPS-Approved Method*:
Morphological and Molecular: Differentiation from the native species is only by dissection and only if the specimen is mature enough. All veronicellid samples should be sent to Dr. Robinson for morphological identification. All specimens will then be confirmed through molecular diagnostics performed at the CPHST Mission lab.

A key to terrestrial mollusks (including Veronicellidae) is found here: http://idtools.org/id/mollusc/index.php.

In April 2013, the family Veronicellidae, a target on the 2013 and 2014 AHP Prioritized Pest Lists, was broken down into six genera of concern. When conducting a general mollusk survey, if samples are negative for Veronicellidae, then negative data may be reported for each of these six genera: *Belocaulus, Colosius, Laevicaulis, Sarasinula, Semperula,* and *Veronicella*. All positives must be reported at the species level.

Refer to “Appendix N - Data Entry Guide for Selected Taxonomic Groups” of the most recent year’s CAPS Guidelines for additional information on data entry for mollusks. https://caps.ceris.purdue.edu/caps_agreement_guidelines.

*For the most up-to-date methods for survey and identification, see Approved Methods on the CAPS Resource and Collaboration Site, at http://caps.ceris.purdue.edu/.

Easily Confused Species

Sarasinula plebeia can be confused with one native species, *Leidyula floridana.* It may also be confused with exotic species that are either not known to be established or of limited distribution in the United States, including: *Laevicaulis natalensis*, *Semperula wallacei* (not present in the United States), and *L. alte* (limited distribution) (Herbert, 2010; Brodie and Barker, 2012). *Sarasinula plebeia* is externally similar to *Diplosolenodes occidentalis* (Guilding) (Walls, 2009).

Sarasinula plebeia cannot be separated from *Leidyula moreleti* through external examination (Naranjo-Garcia et al., 2007). *Sarasinula plebeia* was initially misidentified in Florida as *L. moreleti* (Capinera et al., 2011).

This species is also similar to unstriped or otherwise unmarked forms of *Veronicella cubensis* and can only conclusively be determined through anatomical study (Robinson and Hollingsworth, 2004).

References

Brodie, G. and G. M. Barker. 2011. Introduced land snails in the Fiji Islands: are there risks involved? In: Veitch, C. R.; Clout, M. N. and Towns, D. R. (eds.). 2011. Island invasives: eradication and management. IUCN, Gland, Switzerland. pp. 32-36.

Brodie, G. and G. M. Barker. 2012. *Sarasinula plebeia* (Fischer, 1868). Family Veronicellidae. 'USP Introduced Land Snails of the Fiji Islands Fact Sheet Series'. No. 4.

CABI. 2007. Crop Protection Compendium. Wallingford, UK: CAB International.

Capinera, J. L., J. White, and G. Bernon. 2011. Terrestrial slugs of Flordia (Mollusca: Stylommatophora: Veronicellidae, Phylomycidae, Agrolimacidae and Limacidae). EENY 494. University of Florida, IFAS Extension.

Contreras, L. J. A. 2000. Evaluación agroeconómica de tres prácticas para el control de babosa (Sarasinula plebeia) en el cultivo de frijol en el Departamento de Olancho, Honduras (in Spanish). Bachelor Degree Thesis for Agricultural Engineer. Zamorano, Honduras.

Coppois, G. 2000-2001. Invertebrate research overview: 2. The endemic land snails. Charles Darwin Foundation for the Galapagos Islands. Retrieved October 27, 2010 from GPDD archives: https://www.gpdd.info/references/944_Coppois_2000_Invertebrate_Research_18981.pdf

Cowie, R. H. 1998. Patterns of introduction of non-indigenous non-marine snails and slugs in the Hawaiian Islands. Biodiversity and Conservation 7: 349-368.

Cowie, R. H., R. T. Dillon, Jr., D. G. Robinson and J. W. Smith. 2009. Alien non-marine snails and slugs of priority quarantine importance in the United States: a preliminary risk assessment. *American Malacological Bulletin*, 27: 113-132.

Evans, A., S. Wratten, C. Frampton, S. Causer and M. Hamilton. 1997. Row covers: Effects of Wool and Other Materials on Pest Numbers, Microclimate, and Crop Quality. *Journal of Economic Entomology*, 90, 1661-1664.

Gomes, S.R. and J.W. Thomé. 2004. Diversity and distribution of the Veronicellidae (Gastropoda: Soleolifera) in the Oriental and Australian biogeographical regions. *Memoirs of the Queensland Museum*, 49(2): 589-601.

Hata, T. Y., B. K. S. Hu, and A. H. Hara. 1995. Mealybugs and slugs on potted-foliage plants. Horticulture Digest #106. Hawaii Cooperative Extension Service.

Herbert, D. G. 2010. The Introduced Terrestrial Mollusca of South Africa. SANBI, Biodiversity Series, 15. 117 pp.

Laitano, A. C., J. P. Genro, R. Rontoura, S. Siqueira, L. Branco, R. L. Maurer, C. Graeff-Teixeira, J. M. Milanez, L. A. Chiaradia, and J. W. Thomé. 2001. Report on the ocurrence [sic] of *Angiostrongylus costaricensis* in southern Brazil, in a new intermediate host from the genus *Sarasinula* (Veronicellidae, Gastropoda). Revista da Sociedade Brasileira de Medicina Tropical 34(1): 95-97.

Naranjo-Garćia, E., J. W. Thomé and J. Castillejo. 2007. A review of Veronicellidae from Mexico (Gastropoda: Soleolifera). Revista Mexicana de Biodiversidad 78:41-50.

Pearce, T. A. and A. Örstan, 2006. Chapter 22. Terrestrial Gastropoda. In Sturm, C. F., T. A. Pierce, and A. Valdés (eds.). The Mollusks: A Guide to Their Study, Collection, and Preservation. American Malacological Society.

Robinson, D.G., A. Hovestadt, A. Fields and A.S.H. Breure. 2009. The land mollusca of Dominica (Lesser Antilles), with notes on some enigmatic or rare species. *Zoologische Medelingen*, 83(13): 615-650.

Robinson, D. G. and R. G. Hollingsworth. 2004. Survey of slug and snail pests on subsistence and garden crops in the islands of the American Pacific: Guam, and the Northern Mariana Islands: Part I. The Leatherleaf Slugs (Family: Veronicellidae). 1-11. United States Department of Agriculture, Animal and Plant Health Inspection Service.

Rueda, A., R. Caballero, R. Kamnsky, and K. L. Andrews. 2002. Vaginulidae in Central America, with emphasis on the bean slug *Sarasinula plebeia (*Fisher). In: G. M. Barker, ed., Molluscs as Crop pests. CABI Publishing, Wallingford, U.K., pp. 115-144.

Runham, N. W. and P. J. Hunter. 1970. Terrestrial slugs. Hutchinson and Company LTD, London, England.

Sannazzaro, A. M., S. H. F. de Oliveira and E. B. Wutke. 2000. Damage of slugs (*Sarasinula plebeia* Fischer) on beans (*Phaseolus vulgaris* L.). Arquivos do Instituto Biológico, 67(2), 271-274.

Smith, B. J. and A. J. Dartnall. 1976. Veronicellid slugs in the Northern Territory with notes on other land molluscs. J. Malac. Soc. Aust. 3(3-4): 186.

South, A. 1992. Terrestrial Slugs: Biology, Ecology and Control. Chapman & Hall, London. 428 pp.

Stange, L. A. 2004. Personal Correspondence between Lionel A. Stange and Gary Bernon on June 21, 2004. United States Pacific Basin Agricultural Research Center. USDA-ARS

Thomé, J. W. 2008. Archived email from Dr. J.W. Thomé to Gary Bernon. Lab Malacol., Inst. Biocience. PUCRS, Ave. Ipiranga, 6681-predo 12, 90619-9900 Porto Alegre, RS, Brazil. Retrieved October 27, 2010 from GPDD archives: https://www.gpdd.info/correspondence/944_Thome_062104.pdf

Thomé, J. W., P. H. dos Santos and L. Pedott. 1997. Annotated list of Veronicellidae from the collections of the Academy of Natural Sciences of Philadelphia and the National Museum of Natural History, Smithsonian Institution, Washington, D.C., U.S.A. (Mollusca: Gastropoda: Soleolifera). *Proceedings of the Biological Society of Washington*, 520-536.

USDA. 2003. Importation of Chinese Penjing into the United States With Particular Reference to *Serissa foetida*, 2003 Supplementary Assessment. United States Department of Agriculture, Animal and Plant Health Inspection Service, Plant Protection and Quarantine, Center for Plant Health Science and Technology, Plant Epidemiology and Risk Analysis Laboratory. 35 pp.

USDA-APHIS. 2010a. New Pest Response Guidelines. Tropical Terrestrial Gastropods. USDAAPHIS-PPQ-Emergency and Domestic Programs-Emergency Planning, Riverdale, Maryland. http://www.aphis.usda.gov/import_export/plants/manuals/

USDA-APHIS. 2010b. New Pest Response Guidelines. Temperate Terrestrial Gastropods. USDA-APHIS-PPQ-Emergency and Domestic Programs-Emergency Planning, Riverdale, Maryland. http://www.aphis.usda.gov/import_export/plants/manuals/

Walls, J. G. 2009. Just a plain black slug: *Belocaulus angustipes*. *American Conchologist*. 37(1): 28-29.

This datasheet was developed by USDA-APHIS-PPQ-CPHST staff. Cite this document as:

Molet, T. 2014. CPHST Pest Datasheet for *Sarasinula* spp. USDA-APHIS-PPQ-CPHST.

Reviewed by: David Robinson, USDA-APHIS National Malacologist.