
Progress and Prospects for Biological Control of *Solanum viarum* Dunal in the USA

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Introduction

Solanum viarum Dunal (Solanaceae), commonly known as tropical soda apple in the USA, is a perennial weed native to southeastern Brazil, northeastern Argentina, Paraguay, and Uruguay that has invaded Florida grasslands and natural ecosystems. How this South American plant entered Florida is unknown. Earliest records indicate that it was initially detected in Hendry county (southwest Florida) in the 1980s. Currently, the infested area is estimated at more than a half million acres. Due to the favorable environmental conditions, lack of natural enemies (herbivores and pathogens), and seed dispersal by wildlife and cattle feeding on the fruits, this exotic plant has been spreading rapidly and it has been observed in the majority of the counties in Florida and eight other states (Alabama, Georgia, Louisiana, Mississippi, North Carolina, Pennsylvania, South Carolina Tennessee).

Surveys for natural enemies of *Solanum viarum* were initiated by University of Florida and Brazilian researchers in June 1994 (Medal *et al.* 1996), and by the USDA-ARS-Biocontrol Laboratory in Argentina in 1996 (Gandolfo 1998). The current surveys involve researchers of the University of Florida, the USDA-ARS-Biocontrol lab in Argentina, the USDA-ARS quarantine in Stoneville, Mississippi, the INTA-Cerro Azul agricultural experiment station in Misiones, Argentina, the Universidade Federal do Paraná in Curitiba, Brazil, the Universidade de Santa Catarina in Blumenau, Brazil, and Dr. Terry Olckers from the Plant Protection Research Institute of Pietermaritzburg, South Africa.

Host-specificity tests of the potential biocontrol candidates were initiated at the Florida quarantine facility in December 1996. The international/inter-agency cooperative research work has greatly accelerated the screening tests and field surveys to determine insect-plant host associations of the biocontrol candidates. At the present time, additional screening tests with the leaf-feeding chrysomelid beetle, *Metriona elatior* (Klug) are being conducted in Florida-quarantine as recommended by the Technical Advisory Group for Biological Control Agents of Weeds (TAG), and a request for field release will be resubmitted probably in late summer 1999. A second chrysomelid, *Gratiana boliviana* (Spaeth), is currently being tested, and a request for field release will be submitted probably during the fall of 1999. Specificity-tests with a third leaf-feeding chrysomelid, *Platyphora* sp, will continue when we obtain enough insects for the tests, and specificity tests with 6 additional agents (a flower bud-feeder, a leaf-roller, a leaf-tier, a leaf-feeder, a stem-borer, and a fruit feeder) will soon be initiated.

Prospects for Biocontrol of *Solanum viarum*

Final approval of the request for release of the leaf-feeding beetle *Metritona elatior*, is pending. The request for field release of this insect that was submitted to the USDA-APHIS in October 1998 was approved by nine of the twelve TAG members, and three of the members recommended further testing including seven native Solanaceous species that occur in California, and some other species of families closely related to the target weed. The preliminary feeding tests and study of the biology of *M. elatior* were conducted in Argentina (Gandolfo 1997) and Brazil (Pitelli and Santana 1998). This insect is commonly found associated with *S. viarum* (primary host) causing significant defoliation in southeastern Brazil (São Paulo, Paraná, Santa Catarina, Rio Grande do Sul), northeastern Argentina (Misiones, Corrientes), and southeastern Paraguay. *M. elatior* is reported by Morelli *et al.* (1993), and Ponce de Leon *et al.* (1993) to cause significant defoliation on silverleaf nightshade, *Solanum elaeagnifolium* Cavanilles in eastern Uruguay (Departamento de Rocha). However, Gandolfo and Medal during a field survey conducted in April 1999 in Uruguay with one of the authors (Ponce de Leon) of the two papers previously indicated, found that the plant referred in those published papers as *S. elaeagnifolium* was in fact *S. viarum*. During the field explorations that we have conducted from 1994 to 1999, we have also found *M. elatior* feeding occasionally, but not abundantly, on the following secondary hosts: *Solanum palinacanthum* Dun, *Solanum aculeatissimum*, Jacq, and *Solanum sisymbryfolium* Lam. in Argentina, Brazil, and Paraguay. Although feeding-tests (Medal *et al.* 1999) in Florida quarantine showed that *M. elatior* fed and laid eggs on eggplant, this insect has never been reported attacking this plant in South America. Surveys of organically grown eggplant fields in Argentina, Brazil, and Uruguay, and field experiments in Brazil and Argentina corroborate that eggplant is not a host of *M. elatior*.

Gratiana boliviana preliminary feeding tests and studies of the biology were conducted at the USDA-ARS-Biocontrol Laboratory in Hurlingham, Buenos Aires Province, Argentina. Adults and larvae feed intensively on *S. viarum* plants through the growing season. Florida quarantine feeding tests indicated that this insect fed and developed on *S. viarum*, on turkeyberry, *Solanum torvum* Sw. (weed of Asiatic origin, a Federal Noxious Weed), and on eggplant. As with *M. elatior*, *G. boliviana* has never been reported or found attacking eggplant in South America. *M. elatior* and *G. boliviana* possess the ideal characteristics of a biocontrol agent including: high reproductive rate, short generation time, good dispersal capability, synchronization with their host plant, and specific feeding only on a few closely related *Solanum* weeds. The release of these 2 insect species in *S. viarum* heavily infested areas in the southeastern USA may significantly reduce the *S. viarum* infestations.

Specificity tests with a third leaf-feeding beetle (*Platyphora sp.*) are currently being conducted at the Florida quarantine facility. Initial tests (multiple-choice) with adults exposed in small cages (60x60x60 cm) to 24 plant species in 6 families indicated an intense feeding on *S. viarum* (>60% of the leaf area offered), a moderate feeding on red soda apple (*Solanum capsicoides*, South American origin) and on turkeyberry (21-40% of the leaf area offered), and a light feeding on earleaf nightshade (*Solanum mauritianum* Scop., South American origin) (5-20% of the leaf area offered). *Platyphora* adults (15 adults/replication, 3 replications) that were exposed in a multiple-choice test during 4-weeks did not feed on eggplant. This leaf-feeding beetle occurs seasonally and sporadically (not widespread in southern Brazil). *Platyphora* species are larviparous. Females

give birth to larvae on leaves of *S. viarum*. The biology of the majority of *Platyphora* species in South America is poorly known. Medeiros *et al.* (1996) conducted a weekly field survey during a two-year study in the Ijuí region, Rio Grande do Sul state, Brazil to determine the plant association of 12 chrysomelid species including the following three species of *Platyphora*: *P. quadrisignata* (Germar), *P. fasciatomaculata* (Stal), and *P. vinula* (Stal). They found that each species of Chrysomelidae was associated with a single species of non-cultivated Solanaceae, except *P. vinula* which was found associated with two *Solanum* species, indicating that monophagy was the most common chrysomelid-plant host association.

Specificity tests with six other biocontrol candidates: a flower-bud feeder, *Anthonomus tenebrosus* Boheman (Coleoptera: Curculionidae), a leaf-roller (Lepidoptera: Pyralidae), a leaf-tier (Lepidoptera: Oecophoridae), a leaf-feeder, *Epitrix?* sp. (Coleoptera: Chrysomelidae), a fruit feeder, *Thecla?* sp. (Lepidoptera: Lycaenidae), and a stem-borer (Diptera: Agromyzidae) (Table 1.) will be initiated once we know which species we are dealing with and the number of insects required for testing.

Table 1.
Phytophagous Insects Associated with *Solanum viarum* Dunal in Argentina, Brazil, Paraguay, and Uruguay, and their Status.

Family Insect species	Plant Part Damaged	Host-range	Status
Chrysomelidae			
<i>Metriona elatior</i> ¹ Klug	Leaf	Narrow	Submitted
<i>Gratiana boliviana</i> ¹ Spaeth	Leaf	Narrow	Under testing
<i>Platyphora?</i> sp.	Leaf	Narrow	Under testing
<i>Diabrotica speciosa</i> Germar	Leaf	Wide	Rejected
<i>Epitrix?</i> sp.	Leaf	Unknown	Untested
Curculionidae			
<i>Anthonomus tenebrosus</i> Boheman	Flowerbud/seeds	Unknown	Untested
Pyralidae			
<i>Neoleucinodes elegantalis</i> ³ Guenee	Fruit	Tomato	Rejected
Unidentified.	Leafroller/leaf-tier	Unknown	Untested
Lycaenidae			
<i>Thecla?</i> sp.	Fruit borer	Unknown	Untested
Nymphalidae			
<i>Mechanitis lysimnia</i> ³ Fabricius	Leaf	Tomato	Rejected
Tingidae			
<i>Corythaica cyathicolis</i> Costa	Leaf	Wide	Rejected
Membracidae			
<i>Amblyophallus maculatus</i> ⁴ Funkhouser	Leaf-stem	Eggplant	Rejected
Agromyzidae			
Unidentified	Stem borer	Unknown	Untested
Oecophoridae			
Unidentified.	Leaf-tier	Unknown	Untested

¹Accepted eggplant in quarantine but not in the field.

¹Currently being tested and showing promise

¹Not tested but rejected on the basis of host records

¹Accepted eggplant in quarantine feeding tests and in the field

Insects tested but not considered for field release

Host-specificity tests with the membracid *Amblyophallus maculatus* Funkhoner, and the tingid *Corythaica cyathicolis* Costa were conducted at the Florida quarantine facility. *A. maculatus* are commonly found feeding on *S. viarum* stems and leaves in South America sometimes forming small aggregations. Quarantine feeding tests indicated that this insect fed and laid eggs on *S. viarum* and eggplant. Although, this species has not been reported in the scientific literature to feed on eggplant, we found nymphs and adults feeding on eggplant in Misiones, Argentina in February 1998. Feeding tests conducted with *C. cyathicolis* corroborate that this insect has a wide host range that includes potato, tomato, tobacco, and eggplant. Based on the potential threat to solanaceous crops, these two insects were dropped from the list of potential biocontrol agents.

Based on literature surveys and preliminary feeding tests two other insect species, the fruit-feeder *Neoleucinodes elegantalis* Guenée (Lepidoptera: Pyralidae), and the leaf-feeder *Mechanitis lysimnia* Fabricius (Lepidoptera: Nymphalidae) whose host plants include tomato, were eliminated from further consideration.

Conclusions

When we initiated the search for potential biocontrol agents for *Solanum viarum* infestations in the USA, we knew that it would be a challenge and a difficult task due to the many economically important cultivated plants in the same family as the target weed. When it was found that two of the most promising agents, *Metriona elatior* and *Gratiana boliviana* that significantly defoliate *S. viarum* in South America, are able to feed and develop on eggplant in small cages in quarantine but do not occur on it in open field situations or natural conditions, it became evident that we needed to use alternative testing procedures that could reflect what really happens in nature. We were facing contradictory results similar to those that were encountered by the South-African researchers who have been working in biological control of *Solanum* weeds since the early 1970s (Olckers 1996, Olckers et al. 1995, Nesar et al. 1989, Hill and Hulley 1995, 1996). To verify the results of the quarantine host specificity tests, we have been conducting open field experiments and surveys of eggplant fields in South America.

When we have the approval for field release of the two leaf-feeding beetles (*Metriona* and *Gratiana*), we will initially focus mainly on the most infested grasslands and woody areas in various Florida and Mississippi counties, conducting pre- and post-release monitoring to determine the combined effects of the released and established agents on the target and non-target plants. Based on their rapid population growth and defoliation effects, we expect that these two agents will stress and reduce the *Solanum viarum* population in the southeastern USA, especially if combined with the damage that would be exerted by additional new biocontrol agents (possibly a flower bud-feeder, and a stem-borer) that are currently or will be soon tested.

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