

Classical Biological Control of Tropical Soda Apple in the USA¹

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Introduction

Tropical soda apple, *Solanum viarum* Dunal (Solanaceae), is an invasive nonnative weed of pastures and woody areas in the southeastern United States. This perennial prickly shrub, native to South America, has been spreading at an alarming rate during the last decade. Tropical soda apple was first discovered in Glades County, Florida, in 1988, and has since been reported in Alabama, Georgia, Louisiana, Texas, Mississippi, North Carolina, South Carolina, Tennessee, Pennsylvania, and Puerto Rico. In Florida, over 1 million acres are currently estimated to be infested with tropical soda apple. Cattle and wildlife feed on the mature fruits of tropical soda apple and are primarily responsible for spreading the weed by passing the undigested seeds in their droppings (Figure 1).

Field surveys in South America for potential biological control agents were initiated in 1994 by researchers from the University of Florida in collaboration with the Universidade Estadual Paulista Jaboticabal campus, Sao Paulo state, Brazil, and the

USDA-ARS South American Biological Control Laboratory, Buenos Aires province, Argentina.

South American insects identified as potential biological control agents of tropical soda apple include the defoliating leaf beetles, *Gratiana boliviana* Spaeth, *Gratiana graminea* Klug, *Metriona elatior* Klug (Chrysomelidae), and the flower bud weevil, *Anthonomus tenebrosus* Boheman (Curculionidae).

The Tropical Soda Apple Leaf Beetle *Gratiana boliviana*

Host-specificity studies (choice & no-choice feeding & oviposition tests) conducted in Argentina and in the USA, and field surveys in South America, confirmed the high degree of specificity and damaging effect of *G. boliviana* on the foliage of tropical soda apple. A petition to release this insect from quarantine was approved by the USDA-APHIS-PPQ in May 2003. Initial field releases of this beetle began in August 2003 at Mr. Joe Costine's ranch in Polk County, Florida. Since

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Figure 1. Cattle feeding on tropical soda apple fruits. Credits: Julio Medal, University of Florida

then more than 220,000 beetles have been released in 39 counties in Florida, 3 counties in Georgia, 2 counties in Alabama, and 1 county in Texas. The beetles have established at all sites in Central Florida where they have been released since 2003. They are causing extensive defoliation on tropical soda apple (20-100%), and are spreading from 1 to 10 miles/year from the initial release sites. Six years post-release, no nontarget effects have been observed on closely related plants growing in close proximity to tropical soda apple.

Larvae (Figure 2) and adults (Figure 3) of *G. boliviana* feeding on tropical soda leaves reduce the vigor, growth rate, and fruit production of the plants. The feeding damage is reducing the competitive advantage this invasive weed has over native vegetation and forage grasses in improved pastures.

The life cycle of *G. boliviana* begins when females deposit eggs individually on tropical soda apple leaves and petioles. Females produce an average of 300 eggs. The egg stage lasts 5-6 days at 25°C. The larval stage is completed in 15-18 days, and there are five instars. The pupa stage usually lasts 6-7 days. In total, 26 to 31 days are required for the insect to develop from the egg to the adult stage.



Figure 2. Larva of *Gratiana boliviana*. Credits: Julio Medal, University of Florida

The Tropical Soda Apple Leaf Beetle *Gratiana graminea*

Plant host-specificity tests with *G. graminea* adults and first instar larvae were conducted from September 2000 to September 2008 at the



Figure 3. Adult of *Gratiana boliviana*. Credits: Jeff Lotz, FDACS-DPI

FLDACS-DPI quarantine facility in Gainesville, FL, and an open field risk assessment with solanaceous crops was concluded at the Universidade Regional de Blumenau, Santa Catarina state, Brazil, in June 2006. A request for field release was submitted in August 2006 to UF/IFAS for internal review and it was submitted to the Technical Advisory Group (TAG) for Biological Control Agents of Weeds in October 2006. Field release of this insect in Florida is anticipated in the summer-fall of 2010.

Leaf feeding by the adults (Figure 4) and larvae (Figure 5) of *G. graminea* reduce the plant growth and fruit production of tropical soda apple similar to *G. boliviana* already established in Florida. However, this *Gratiana* species is more cold tolerant than *G. boliviana* and remains active during the winter season in southern Brazil when other insects are not present.

Females produce from 112 to 325 eggs during a period of 3 to 4 months. Eggs are laid individually on tropical soda apple leaves and petioles. Larvae undergo five instars and it may take from 14 to 20 days to reach the pupa stage, which lasts from 6 to 9 days attached by the last abdominal segment to the underside of the leaf. At least 4 to 6 generations/year can occur under optimum environmental conditions.



Figure 4. Adults of *Gratiana graminea*. Credits: Jeff Lotz, FDACS-DPI



Figure 5. Larvae of *Gratiana graminea*. Credits: Jeff Lotz, FDACS-DPI

The Tropical Soda Apple Leaf Beetle *Metriona elatior*

Feeding-oviposition tests with *M. elatior* adults and first instar larvae were conducted from January 1997 to May 2001 at the FLDACS-DPI quarantine facility in Gainesville, FL. Open field risk assessments with Solanaceous crops were conducted during 2002 in Argentina, and from August 1998 to March 2006 in Brazil. A request for field release was submitted for internal review in May 2006 to UF/IFAS and was submitted to the Technical Advisory Group (TAG) for Biological Control Agents of Weeds in 2006. Field release of this insect in Florida is anticipated in the summer-fall of 2007.

Most of the life-cycle of this beetle was studied at the Universidade Estadual Paulista, Jaboticabal campus, Brazil. Leaf feeding by the adults (Figure 6) and larvae of *M. elatior* reduce plant growth and vigor of tropical soda apple similar to *G. boliviana* already established in Florida. However, *M. elatior* prefers to feed on tropical soda apple plants growing in woody

areas or under shady conditions contrary to *G. boliviana* that prefers semi-shady to sunny conditions.



Figure 6. Adult of *Metriona elatior*. Credits: Jeff Lotz, FDACS-DPI

Females laid from 32 to 98 egg-cases, and each case contains between 1 to 21 eggs (mostly from 4 to 8 eggs). Larvae undergo five instars and a non-feeding pre-pupae stage. As in many other tortoise beetles in the Cassidini tribe, the larvae have spiny-form processes or anal forks that carry fecal material and exuviae. Pupation lasts from 7 to 10 days. Females live from 94 to 139 days while males are short lived, surviving only from 56 to 90 days.

The Tropical Soda Apple Flower Bud Weevil *Anthonomus tenebrosus*

Feeding and oviposition tests with the flower bud weevil *A. tenebrosus* were conducted in South America and at the Florida quarantine facility. The results obtained indicated a narrow host range for this insect. The life cycle of the weevil is currently being investigated.

Larvae of *A. tenebrosus* develop inside the flower buds and inhibit fruit production by causing the flowers to abort prematurely. Efforts were initiated in the summer of 2002 to develop an artificial diet for mass rearing this insect; these studies are currently ongoing. Screening tests (laboratory and open-field) were concluded in 2006. A request for field release was submitted to UF/IFAS in 2006 and TAG committee in 2007. Field release of

this insect in Florida is anticipated in the summer-fall of 2010.

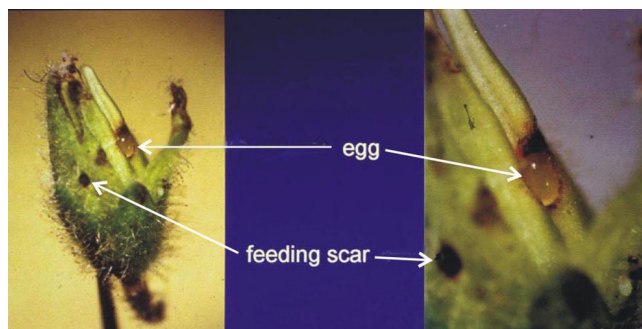


Figure 7. Egg and feeding scars of the flower-bud weevil, *Anthonomus tenebrosus*. Credits: Daniel Gandolfo, USDA-ARS



Figure 8. Adult flower-bud weevil *Anthonomus tenebrosus*. Credits: Stephan McJonathan

Expected Impacts of Host Specific Insects on Tropical Soda Apple

The impact that the released and established leaf beetle *G. boliviana* is having on tropical soda apple in Florida will be complimented by the introduction of other insects (e.g., the leaf-beetles *G. graminea*, *M. elatior*, and the flower bud weevil *A. tenebrosus*) that damage the leaves, flowers, and seeds of the target weed. These insects will reduce the competitive ability of tropical soda apple. The establishment of a complex of host specific insects attacking different plant parts will contribute to the permanent restoration of grasslands and conservation areas currently infested with tropical soda apple.

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