

Final Report

Final pre-release investigations of the gorse thrips (*Sericothrips staphylinus*) as a biocontrol agent for gorse (*Ulex europaeus*) in North America

Date: August 31, 2012

Award Number: **10-CA-11420004-184**

Report Period: June 1, 2010– May 31, 2012 Project Period: June 1, 2010– May 31, 2012

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Introduction

Gorse (*Ulex europaeus*) is an environmental weed classified as noxious in the states of Washington, Oregon, California, and Hawaii. A classical biological control program has been applied in Hawaii with the introduction of 4 gorse-feeding arthropods, but only two of these (a mite and a seed weevil) have been introduced to the mainland U.S. The two insects that have not yet been introduced include the gorse thrips, *Sericothrips staphylinus* (Thysanoptera: Thripidae), and the moth *Agonopterix umbellana* (Lepidoptera: Oecophoridae). With prior support from the U.S. Forest Service (joint venture agreement # 07-JV-281), we were able to complete host specificity testing of *S. staphylinus* on 44 North American plant species that were on the original test plant list. However, following review of the proposed Test Plant List, the Technical Advisory Group on Biocontrol of Weeds (TAG) recommended that we include an additional 18 plant species for testing. In this report, we present host specificity testing and related objectives necessary to bring the program to the implementation stage.

Objectives

- (1) Acquire and grow the additional 18 species of plants recommended by the TAG.
- (2) Complete host specificity trials for the gorse thrips on the 18 plant species.
- (3) Complete and submit petition for field release of *S. staphylinus* to the TAG.
- (4) Select field release study sites in Oregon, Washington and California and collect pre-release data.
- (5) Share information about the gorse biocontrol program with the public.
- (6) With anticipated funding from the Oregon State Weed Board in 2011: Rear and release the gorse thrips at sites throughout the Pacific Northwest.



Figure 1. (A) Gorse infestation near Baker Beach, Oregon. (B) Close-up of flowering twig.

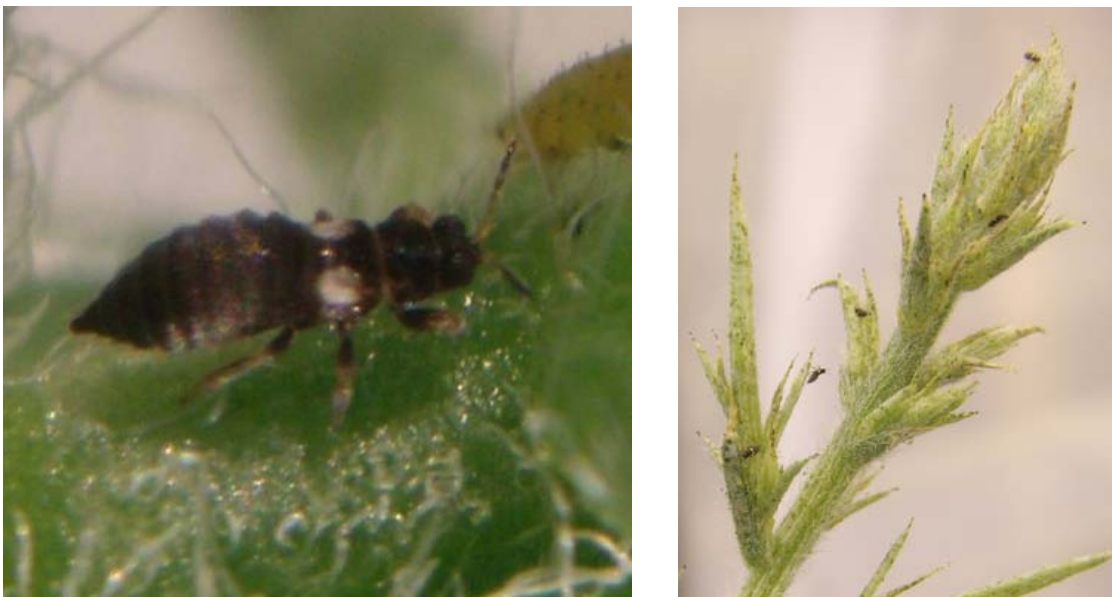


Figure 2. *Sericothrips staphylinus* (gorse thrips) on gorse. The shoot tip on right shows tissue damage from gorse thrips feeding.

Progress in Accomplishing Project Goals and Objectives

Goal/Objective 1

Planned: Acquire and grow the additional 18 species of plants recommended by the TAG

Actual: Although we originally planned to add 18 plants to the list, we exceeded that by obtaining and growing 19 plant species to cover the concerns of the TAG. The 19 plant species were selected to cover the following recommendations of the TAG: (1) Include representative plants of other nearby plant families; (2) include (or add more) *Lupinus*, *Trifolium*, *Astragalus*, *Thermopsis*, *Cledastris*, *Hedysarum*, and *Crotolaria* spp. as well

as the chick pea *Cicer arietinum*; (3) Include more of the introduced ornamental plants in the Genista-Cytisus complex. The plant species were obtained from a variety of sources, including mail order nurseries and seed suppliers, the USDA National Plant Germplasm System, native seed networks, and rare plant curators. A few of the ornamental plants were obtained as potted plants from nurseries and others were transplanted directly from field locations, but the majority was obtained as seeds. Some species had very low germination rates and it was necessary to obtain more seeds and try a variety of germination techniques such as scarification and heat treatment. In the end, we were able to grow at least 6 healthy plants of each species, sufficient for our host specificity testing.

Goal/Objective 2

Planned: Complete host specificity trials for the gorse thrips on the 18 plant species

Actual:

Host specificity trials were carried out on for 19 plant species and the results incorporated with the full list test results.

We received a fresh shipment of *Sericothrips staphylinus* from Hawaii in September 2010 to revive our colony. Host specificity tests were carried out by caging thrips onto test plants in a ‘no-choice’ situation. Test plants were individually caged in either a 6 x 30 cm or 13 cm x 30 cm (D x H) clear plastic tube, depending on the size of the plant species. The side of each tube had a 15 cm square ventilation hole that was covered with 150 x 150 micron no-thrips. The cap had an 8 cm diameter ventilation hole that was also covered with thrips screen fabric. The tube was securely inserted 2 cm into the potting media. The treatments were conducted at 21° C under artificial light with a 16:8 h (L:D) regime and approximately 80% humidity within the tubes. Five pairs of adult thrips were placed on the plant for a ten-day oviposition period. At the end of the 10-day period, the surviving adults were counted (to provide an estimate of adult survival) and removed. Oviposition was not assessed due to the difficulty in finding the eggs non-destructively. Instead positive host use was measured by the development of an F1 generation of nymphs and adults. The test plants were maintained in the tube cage for 32 days after removing the initial adults, at which time they were thoroughly searched under magnification for the presence of nymphs and adults.



Figure 3. Experimental set up for thrips testing.

Table 1. Results of host specificity no-choice tests of *Sericothrips staphylinus* (gorse thrips). Ten adult gorse thrips were caged onto plants for a 10-day period and the plant was thoroughly searched for nymphs and adults after 35 days. Plants marked with an asterisk were obtained and tested as part of the current project.

Taxon	Species	Category	Nativity	Reps.	F1 Nymphs	F1 Adults
Family Fabaceae						
Subfamily Papilionoideae						
Tribe Genisteae						
Subtribe Genistinae	<i>Ulex europeaus</i>	1	I	120	11.19 ± 1.30	61.96 ± 3.68
	<i>Genista canariensis</i> *	3a	I	6	12.33 ± 4.43	5.83 ± 2.91
	<i>Genista lydia</i>	3a	I	6	0	0
	<i>Genista monspessulana</i>	3a	I	6	1.83 ± 1.28	1.00 ± 0.26
	<i>Petteria ramentacea</i>	3a	I	6	1.67 ± 0.92	5.50 ± 2.87
	<i>Cytisus praecox</i> *	3a	I	6	0.5 ± 0.34	0.17 ± 0.17
	<i>Cytisus battandieri</i> *	3a	I	5	0	0
	<i>Cytisus nigicans</i> *	3a	I	6	0	0
	<i>Cytisus scoparius</i> cv. 'moonlight'	3a	I	6	0	0
	<i>Cytisus striatus</i>	3a	I	6	0	0
	<i>Cytisus spachianus</i> *	3a	I	6	0	0
Subtribe Lupininae	<i>Lupinus albicaulis</i>	3b	N	6	0	0
	<i>Lupinus albifrons</i> *	3b	N	6	0	0
	<i>Lupinus arboreus</i>	3b	N	6	0	0
	<i>Lupinus argenteus</i>	3b	N	6	0	0
	<i>Lupinus bicolor</i>	3b	N	6	0	0
	<i>Lupinus caudatus</i>	3b	N	6	0	0
	<i>Lupinus littoralis</i>	3b	N	6	0	0
	<i>Lupinus perennis</i>	3b	N	6	0	0
	<i>Lupinus polyphyllus</i>	3b	N	6	0	0
	<i>Lupinus rivularis</i> *	3b	N	6	0	0
	<i>Lupinus sulphureus</i> var. <i>kincaidii</i>	3b, 4	N	6	0	0
	<i>Lupinus texensis</i> *	3b	N	6	0	0
Tribe Sophoreae	<i>Sophora leachiana</i>	3c	N	6	0	0
	<i>Cladastris kentukia</i> *	3c	N	9	0	0
Tribe Thermopsidae	<i>Baptisia australis</i>	3c	N	6	0	0
	<i>Pickeringia montana</i>	3c	N	6	0	0
	<i>Thermopsis montana</i> var. <i>montana</i> *	3c	N	6	0	0
Tribe Aeschynomeneae	<i>Aeschynomene americana</i>	3c, 4	N	6	0	0
Tribe Amorpheae	<i>Amorpha fruticosa</i>	3c, 4	N	6	0	0
Tribe Cicereae	<i>Cicer arietinum</i> *	3c	I	6	0	0
Tribe Crotolariae	<i>Crotolaria purshii</i> *	3c	N	3	0	0
	<i>Crotolaria sagittalis</i> *	3c	N	6	0	0
Tribe Desmodieae	<i>Lespedeza capitata</i>	3c, 4	N	6	0	0
Tribe Galegeae	<i>Astragalus tener</i> var. <i>titi</i>	3c, 4	N	6	0	0
	<i>Astragalus canadensis</i> *	3c	N	6	0	0
	<i>Astragalus cicer</i>	3c	I	6	0	0
	<i>Astragalus purshii</i>	3c	N	6	0	0
	<i>Oxytropis campestris</i>	3c, 4	N	6	0	0
Tribe Hedysareae	<i>Hedysarum boreale</i> *	3c	N	6	0	0
Tribe Loteae	<i>Securigera varia</i>	3c	I	6	0	0
Tribe Phaseoleae	<i>Vigna unguiculata</i>	3c	I	6	0	0
Tribe Psoraleeae	<i>Rupertia physodes</i> *	3c	N	6	0	0
Tribe Robineae	<i>Robinia pseudoacacia</i>	3c	N	6	0	0
	<i>Sesbania punicea</i>	3c, 4	I	6	0	0
Tribe Fabeae	<i>Lathyrus japonicus</i>	3c	N	6	0	0
Tribe Loteae	<i>Lotus unifoliolatus</i> var. <i>unifoliolatus</i>	3c	N	6	0	0
	<i>Lotus denticulatus</i>	3c	N	6	0	0

Taxon	Species	Category	Nativity	Reps.	F1 Nymphs	F1 Adults
	<i>Lotus micranthus</i>	3c	N	6	0	0
Tribe Trifolieae	<i>Medicago sativa</i>	3c	I	6	0	0
	<i>Trifolium willdenovii</i>	3c	N	6	0	0
	<i>Trifolium longipes*</i>	3c	N	6	0	0
	<i>Trifolium wormskioldii*</i>	3c	N	6	0	0
Tribe Vicieae	<i>Vicia americana</i>	3c, 7	N	6	0	0
	<i>Vicia nigricans spp. gigantea</i>	3c, 7	N	6	0	0
	<i>Vicia tetrasperma</i>	3c, 7	I	6	5.33 ± 1.14	8.50 ± 3.93
Subfamily Caesalpinioideae						
Tribe Cercideae	<i>Cercis orbiculata</i>	3d	N	6	0	0
Tribe Cassieae	<i>Chamaetocrista fasciculata</i>	3d, 4	N	6	0	0
Tribe Caesalpinieae	<i>Hoffmannseggia glauca</i>	3c, 4	N	3	0	0
Family Polygalaceae	<i>Polygala chamaebuxus</i>	6	I	6	0	0
Family Ericaceae	<i>Vaccinium macrocarpon</i>	6	N	6	0	0
Family Pinaceae	<i>Pseudotsuga menziesii</i>	6	N	6	0	0
Family Zygophyllaceae	<i>Larrea tridentata*</i>	6	N	6	0	0
Family Rubiaceae	<i>Galium aparine</i>	6, 7	N	6	0	0

In the event that thrips development occurred on a non-target plant, those thrips were placed back on to the caged plant (or a new plant of the same species) and monitored for an additional 42 days to determine if the F1 generation was able to reproduce on the non-target host.

Here we present results of the current project (the 19 added plant species) along with the host specificity testing that was carried out previously (Table 1). On 58 of the 63 tested non-target plants, no new generation thrips were found at the end of the 37 day development period. On five non-target test plant species, reproduction and development to adulthood did occur, but at much reduced levels (1 to 11%) compared to gorse controls. At the end of the development period, we found a mean of 0.84 ± 0.34 adults and 0.41 ± 0.17 nymphs on *C. praecox*, 1.0 ± 0.26 adults and 1.83 ± 1.28 nymphs on *G. monspessulana*, 5.5 ± 2.87 adults and 1.67 ± 0.92 nymphs on *P. ramentacea*, and 8.50 ± 3.93 adults and 5.33 ± 1.14 nymphs on *V. tetrasperma*. On gorse, the mean number of adults was 76.52 ± 3.53 and the mean number of nymphs was 7.84 ± 0.90 .

In all cases, F1 adults that developed on non-target plants did not successfully reproduce a second time; no nymphs or adults were found on any of these plants after an additional 42 days.

Goal/Objective 3

Planned: Complete and submit petition for field release of *S. staphylinus* to the TAG.

Actual:

The petition, entitled “Petition for Field Release of *Sericothrips staphylinus* (Thysanoptera: Thripidae) for the Biological Control of Gorse, *Ulex europaeus* L. (Fabaceae)”, prepared by F. Grevstad, E. Coombs, and P. Sanguaneko is complete and was submitted to the TAG at the end of August, 2012. The petition proposes 4 initial releases in the Bandon, Oregon area for the first year, followed by up to 20 releases throughout the Pacific States in subsequent years. Review of the petition will likely take 6 months to a year with Environmental Assessment and permit application to follow.

Goal/Objective 4

Planned: Select field release study sites in Oregon, Washington and California and collect pre-release data.

Actual:

In 2011 the P.I. travelled to Coos and Curry Counties on the Oregon Coast to scout potential field sites with collaborator Amy Peters of O.S.U. Extension. We located several sites that would be good for initial releases including Baker Beach (National Forest), Whiskey Run State Park, China Beach, Elk River (private pasture lands), Beach Loop (residential), and Rosa Road (Power line cut or private lands). In April 2012, we met with Sherri Lair, State Parks botanist who provided a tour of several possible sites on State Park land including one Floras Lake State Park near Cape Blanco that will likely be used. We also surveyed two sites on private land near the Bandon Airport and the Elk River. At 4 of the sites, established permanent plots along transects. To quantify the

gorse density and surrounding plant community composition, we used aerial photos taken from the top of a 15 ft. pole, sufficient to capture an image of 5 x 5 m area. Examples of plot images are below (Fig. 5). We will continue to take annual photos of these plots in order to track the long term impacts of gorse thrips on the plant community.

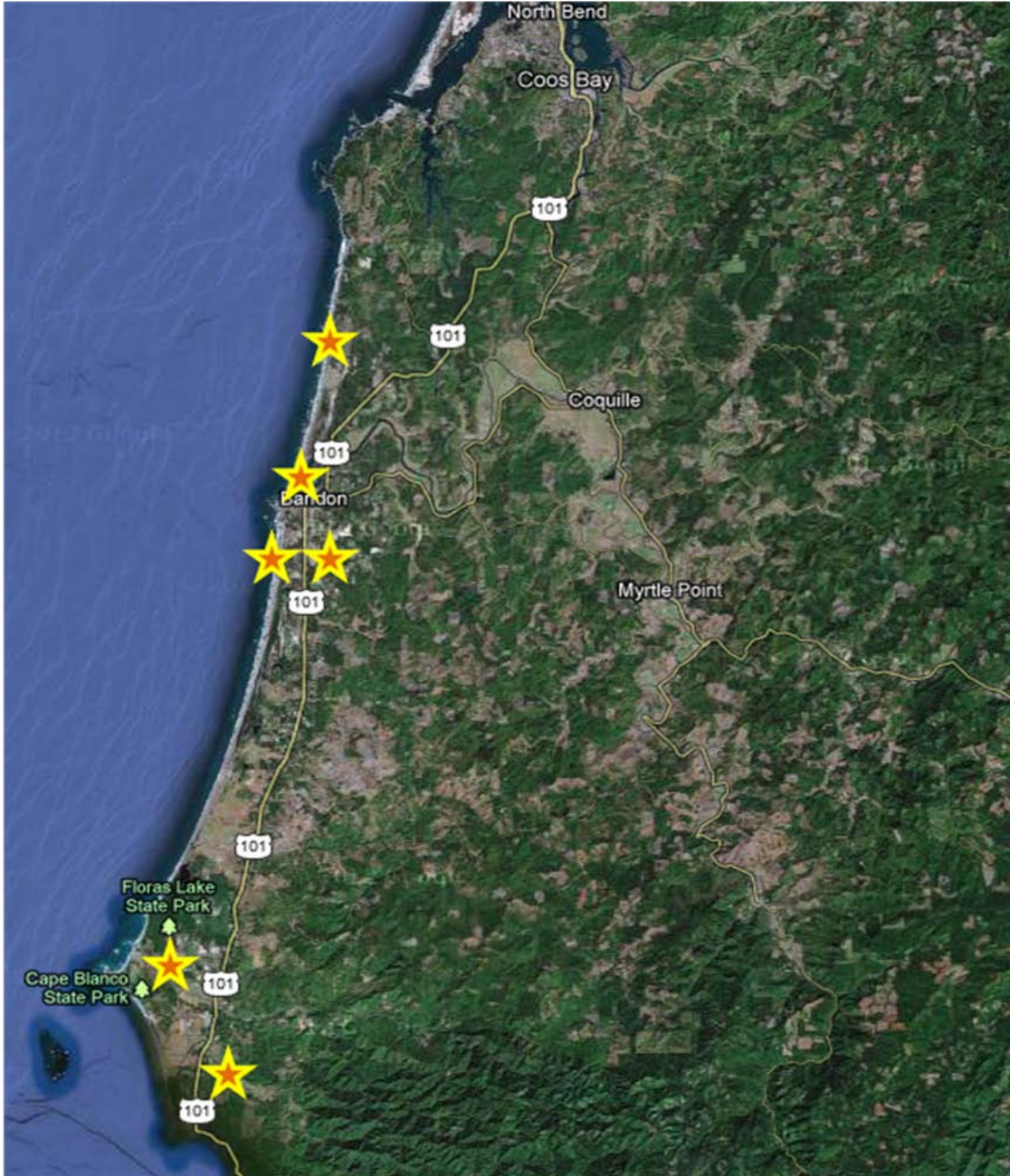


Figure 4. Release sites surveyed along the Oregon Coast.



Figure 5. Examples of aerial plot photos taken at release sites.

Goal/Objective 5

Planned: Share information about the gorse biocontrol program with the public

Actual:

The P.I. collaborated with Amy Peters on a poster that was presented at the National Association of County Agricultural Agents Meeting in Kennewick, Washington. The poster title was “Investigations of the Gorse Thrips (*Sericothrips staphylinus*) as a Possible Biological Control Agent for Gorse (*Ulex europaeus*).”

A poster on the gorse project was also presented at the Biocontrol for Nature Conference in Northampton, MA, October 3-7, 2010. The title was

The P.I. attended and provided an informational session entitled “Gorse Biological Control Efforts in Oregon” at the South Coast Weed Control Conference at the Oregon State Extension Office in Myrtle Point, Oregon (April 18, 2012).

A journal article entitled “Host specificity and efficacy of *Sericothrips staphylinus* (Thysanoptera: Thripidae), a candidate biocontrol agent for gorse (*Ulex europaeus*) in Pacific Coast of the United States” is in preparation for publication.

Goal/Objective 6

Planned: With anticipated funding from the Oregon State Weed Board in 2011: Rear and release the gorse thrips at sites throughout the Pacific Northwest.

Actual:

Releases will take place only after permits are obtained from USDA-APHIS and from individual State Departments of Agriculture. Preparation of the TAG petition several months longer than anticipated, due to the amount of detail required and therefore release permitting has also been delayed. Given the level of host specificity of *S. staphylinus* and its demonstrated potential for impacting gorse, we feel that the insect has a strong chance for being approved for release. We therefore will soon apply for funding from the Oregon Department of Agriculture Noxious Weed Program to support costs of rearing and implementing releases. We are currently maintaining a colony of gorse thrips in the quarantine facility in anticipation of a future release.

Signature of Authorized Official Fritzi Kuska