

Biological Control of Invasive Hawkweeds – Determining Risks to Non-target Plants Final Report

**Center For Invasive Plant Management
Grant GC174-02-Z1138**



Contact person: Jeffrey Littlefield
Montana State University
Department of Entomology
Bozeman, MT 59717-3020
Phone: (406) 994-4722
E-mail: JeffreyL@Montana.edu

Cooperators: Linda Wilson
University of Idaho
Department of Plant, Soils, & Entomological Sciences
Moscow, ID 83844-2339

Gitta Grosskopf
CABI Bioscience – Switzerland Centre
Delémont, Switzerland

Additional Sponsors: Montana Noxious Weed Trust Fund
Bureau of Land Management

Introduction

Meadow hawkweed, *Hieracium pratense*, and orange hawkweed, *H. aurantiacum*, are weeds of European origin that have become serious pests in the Inland Northwest. Infested regions include higher elevation pastures and meadow in the throughout the Intermountain West and the front range of the Rocky Mountains. First reported near Spokane, Washington in 1945 and 1965 respectively, these weeds have established large infestation in meadows, pastures, forest clearings, and on wildlife range throughout northern Idaho, northwestern Montana, northeastern Washington, and into British Columbia and Alberta. In Montana hawkweed infestations are estimated at over 56,000 ac. (51,000 ac of orange hawkweed alone) (Montana Weed Control Summit Document). Recently, northeastern Oregon and Colorado have reported increasing and expanding infestations of hawkweeds as well. Rapidly spreading by stolons, rhizomes and adventitious root buds, these highly prolific weeds can quickly dominate large areas forming monocultures, often invading habitats where native hawkweeds grow and threaten some endemic flora of northern Idaho and western Montana.

Biological control of invasive meadow and orange hawkweed is a relatively new biocontrol program in the United States. Hawkweeds, both meadow hawkweed and orange hawkweed are undergoing rapid range expansion by the establishment of new infestations and by vegetative spread of established infestations. This rapid expansion into new areas and quick vegetative dominance of a site has outpaced the ability of manager to track, locate and treat these weed infestations by conventional means. The need for biocontrol led to the establishment of the Hawkweed Action Committee (HACI), established in 1992, in St. Maries, Idaho. Members of HACI, a grassroots organization aimed at establishing biological control, were instrumental in forming the Biocontrol of Hawkweed Consortium in July 1999. This larger partnership includes a broader, more diverse membership spanning numerous local, state and federal agencies, and private industry.

An important impetus to the hawkweed biocontrol effort comes from New Zealand. The highly invasive mouse-ear hawkweed (*H. pilosella*) is a very close relative (same subgenus) of meadow and orange hawkweed. As the most serious range pest in New Zealand, a biocontrol program was initiated in 1993. Working in cooperation with CABI, New Zealand has funded the foreign exploration and host specificity testing, resulting in the identification and testing of five insect species, four of which are now imported into New Zealand. These species have also shown potential as suitable biocontrol agents for hawkweed in North America. Thus, as a consequence of the research already conducted by CABI and funded by New Zealand for the past 7 years, much of the host specificity testing has already been conducted. Biocontrol of hawkweed in North America can benefit from the New Zealand program. The time and financial savings to do minimal testing requirement will make it an inexpensive program to initiate in the United States. However, it is imperative that the biocontrol program move forward without delay, as funding by New Zealand has ended. To meet this challenge, the Hawkweed Biocontrol Consortium has supported continued testing of four insects for meadow hawkweed control. Montana has taken the initiative in screening the gall wasp *Aulacidea subterminalis*, which will not attack meadow hawkweed but will infest orange hawkweed, the more important species in western Montana.

Previous Work Conducted

Extensive host specificity tests of several hawkweed insects for use in New Zealand has been conducted by Swiss researchers (Grosskopf and Hassler 1998; Grosskopf et al. 2000; Grosskopf et al. 2001) at CABI Bioscience - Switzerland. Five insect species were identified and have been subsequently introduced into New Zealand. Additional host specificity testing is required to determine the potential host utilization of North American hawkweed species, both invasive and native, and other closely related plant species prior to the introduction of these organisms into North America.

Working in cooperation with CABI Bioscience and the University of Idaho, we are conducting additional tests on the gall wasp *Aulacidea subterminalis*. This wasp attacks the developing stolons of both mouse-ear and orange hawkweeds.

Specific Objectives and Methodology

Objectives

The primary objective is to conduct a risk assessment of the possible effects of introducing potential biological control agents into North America. Sub-objectives are to: A) Develop a list of plant species that may be at risk to attack by hawkweed biocontrol agents & to collect and propagate those plants; B) Determine the host specificity of *Aulacidea subterminalis*; and C) Conduct a risk analysis of the potential impact of the introduction of biological control agents on target and non-target plant species to complete the regulatory requirements for introduction.

Results

Objective A. Develop a list of plant species that may be at risk to attack by hawkweed biocontrol agents & to collect and propagate those plants.

Plant species were collected during the summer by L. Wilson. Nearly all the proposed test plant species have been collected during the summer 2001 & 2002. The following plant species were collected and were provided to MSU and CABI Bioscience for testing:

Species	Origin	Tribe	Seed/Plants
CATEGORY 1: Genetic types of invasive <i>Hieracium</i> species			
<i>H. aurantiacum</i>	I	Hieraciinae	P
<i>H. pilosella</i> (WA)	I	Hieraciinae	P
<i>H. caespitosum</i>	I	Hieraciinae	P
<i>H. floribundum</i>	I	Hieraciinae	P
<i>H. glomeratum</i>	I	Hieraciinae	P
<i>H. pilosella</i>	I	Hieraciinae	P
<i>H. piloselloides</i>	I	Hieraciinae	P

CATEGORY 2: Species in the same genus as *Hieracium*.

Species in the subgenus *Hieracium*

<i>H. canadense</i>	N	Hieraciinae	P
---------------------	---	-------------	---

Species in subgenus *Stenotheca*

<i>H. albertinum</i>	N	Hieraciinae	P
<i>H. albiflorum</i>	N	Hieraciinae	P
<i>H. bolanderi</i>	N	Hieraciinae	P
<i>H. carneum</i>	N	Hieraciinae	P
<i>H. fendleri</i>	N	Hieraciinae	P
<i>H. gracile</i>	N	Hieraciinae	P
<i>H. greenei</i>	N	Hieraciinae	P
<i>H. gronovii</i>	N	Hieraciinae	P
<i>H. horridum</i>	N	Hieraciinae	P
<i>H. longiberbe</i>	N	Hieraciinae	P
<i>H. parryi</i>	N	Hieraciinae	P
<i>H. scabrum</i>	N	Hieraciinae	P
<i>H. scouleri</i> var. <i>cynoglossoides</i>	N	Hieraciinae	P

CATEGORY 3: Genera in the Asteraceae family.

3. Species in different subtribes of the same tribe (Lactuceae) as *Hieracium*

<i>Crepis atribarba</i>	N	Crepidinae	P
<i>Crepis intermedia</i>	N	Crepidinae	P
<i>Agoseris grandiflora</i>	N	Microseridinae	P
<i>Krigia biflora</i>	N	Microseridinae	P
<i>Microseris nutans</i>	N	Microseridinae	P
<i>Lygodesmia juncea</i>	N	Stephanomeriinae	P
<i>Stephanomeria tenuifolia</i>	N	Stephanomeriinae	P

Most of the plants arrived in Bozeman in good shape and were immediately used for host specificity testing, while others were maintained in the greenhouse to collect seed. The exceptions were plants in other subtribes of the Lactuceae. These plants were very difficult to transplant, thus the majority of plants quickly died. Other plant species were collected by J. Littlefield MSU to supplement existing plants or to replace plant species that died.

Objective B. Determine the host specificity of *Aulacidea subterminalis*.

Methods - Galls of the wasp, *Aulacidea subterminalis*, were received in the spring of 2001 through 2003. These were from a rearing colony maintained by G. Grosskopf, CABI Bioscience, Delémont, Switzerland. Gall were kept in moist vermiculite in cold storage (approximately 8° C) until plants were in the correct phenological stage for infestations, i.e. producing stolons or vegetative shoots. Orange hawkweed (*Hieracium*

auranticaum) plants from Idaho and Montana were used as a control. In addition its native host, mouse-ear hawkweed (*H. pilosella*) was also used as a control in the test. Galls were removed throughout the summer, and were kept at room temperature until adult emergence. Three adult females were then transferred to a test plant. Wasps were originally (2001) contained on the plant using a 9-cm diameter plastic cage. The cage was vented at the top using a 100 mesh screen and cages were cut to the size of the plant. In subsequent years cages were replaced with netting since it was determined that the plastic used for caging was slightly phytotoxic to hawkweeds. After three days of exposure, adults were removed. Plants were inspected after approximately four months to determine the presence of galls.

Results - Galls or larvae have been only observed only on orange hawkweed, *H. floribundum* and mouse-ear hawkweed. Galls were not observed on any other test plant. In 2001 and 2002 the mouse-ear hawkweed plants tested were from New Hampshire. An identification of this hawkweed by a botanist from Germany indicates that the plant was *H. flagellare* rather than mouse-ear's hawkweed, *H. pilosella*. This may explain why these plants have been less than optimal hosts for the wasp. For testing in 2003, mouse-ear hawkweed from Washington State was used. This appeared to be a more suitable host compared to *H. flagellare*. *H. floribundum* appears to be possible host for the wasp as well. This species was not attacked in testing conducted by CABI (Grosskopf et al. 2000).

All plants infested belong to the subgenus *Hieracium* and all are introduced species producing stolons. Galls were only induced within the stolon tips. Galls were considered to be a single unit, although they are comprised of multiple chambers. No flower stems were utilized by the wasps. Therefore all native hawkweed plants should be excluded from selection by adult *A. subterminalis*. Only one native hawkweed, *H. canadense*, belongs to the subgenus *Hieracium*. This species does not produce stolons and was not utilized by the wasp. The remaining North American hawkweeds belong to the subgenus *Stenotheca*, and are thought to be more distantly related. None of the species within this grouping produce stolons.

Future Work

Aulacidea subterminalis appears to be very host specific to a few species of introduced hawkweeds. Additional tests of a few species (eg. *Lygodesmia juncea*, *Stephanomeria minor*, and *Microseris nutans*) in different subtribes of the tribe Lactuceae will be performed in spring of 2004 to complete the host testing. Also gall that were induced in 2003 tests will be placed in cold storage and adults will be reared from the galls in spring 2004 to determine if the host species is suitable of supporting complete development of the wasp, i.e. to adult. Studies will also be initiated to determine possible impacts of gall development on hawkweed plants, especially in orange hawkweed. Studies in New Zealand suggest that mouse-ear hawkweed does not compensate damage caused by gall induction by producing additional stolons. We would like to determine if this applies to orange hawkweed as well.

Host specificity testing of *Aulacidea subterminalis* - Montana State University 2001-2003

Species	Origin (State)	Tribe	2001		2002		2003	
			# Reps	# Galls	# Rep.	# Galls	# Reps.	# Galls

CATEGORY 1: Genetic types of invasive *Hieracium* species

<i>H. aurantiacum</i>	ID/MT	Hieraciinae	4	1	8	3	15	11
<i>H. caespitosum</i>	ID	Hieraciinae	-	-	4	0	1	0
<i>H. floribundum</i>	MI	Hieraciinae	-	-	5	2	10	13
<i>H. glomeratum</i>	BC	Hieraciinae	-	-	6	0	-	-
<i>H. pilosella</i>	WA	Hieraciinae	-	-	-	-	19	13
<i>H. piloselloides</i>	MT	Hieraciinae	1	0	10	0	-	-
<i>H. sp. (prob. flagellare)</i>	NH	Hieraciinae	3	14	9	3	4	9

CATEGORY 2: Species in the same genus as *Hieracium*.

Species in the subgenus *Hieracium*

<i>H. canadense</i>	ID	Hieraciinae	3	0	12	0	-	-
---------------------	----	-------------	---	---	----	---	---	---

Species in subgenus *Stenotheca*

<i>H. albertinum</i>	ID	Hieraciinae	6	0	2	0	1	0
<i>H. albiflorum</i>	ID/MT	Hieraciinae	3	0	2	0	12	0
<i>H. bolanderi</i>	OR	Hieraciinae	3	0	2	0	-	-
<i>H. carneum</i>	AZ	Hieraciinae	-	-	15	0	-	-
<i>H. fendleri</i>	AZ	Hieraciinae	-	-	10	0	-	-
<i>H. gracile</i>	OR	Hieraciinae	-	-	10	0	-	-
<i>H. greenei</i>	OR	Hieraciinae	4	0	10	0	-	-
<i>H. gronovii</i>	MI	Hieraciinae	5	0	-	-	-	-
<i>H. horridum</i>	AZ	Hieraciinae	-	-	3	0	-	-
<i>H. longiberbe</i>	WA	Hieraciinae	3	0	5	0	-	-
<i>H. parryi</i>	OR	Hieraciinae	4	0	7	0	-	-
<i>H. scabrum</i>	MI	Hieraciinae	3	0	-	-	-	-
<i>H. scouleri</i> var. <i>cynoglossoides</i>	OR	Hieraciinae	3	0	3	0	-	-

CATEGORY 3: Genera in the Asteraceae family.

Species in different subtribes of the same tribe (Lactuceae) as *Hieracium*

<i>Prenanthes sagittata</i>	MT	Lactucinae	1	0	3	0	7	0
<i>Agroseris grandifolia</i>	OR	Microseridinae	-	-	2	0	1	0
<i>Crepis atribarba</i>	WA	Crepidinae	-	-	7	0	-	-
<i>Crepis sp.</i>	NH	Crepidinae	-	-	7	0	3	0
<i>Krigia biflora</i>	MI	Microseridinae	-	-	2	0	-	-
<i>Lygodesmia juncea</i>	ID/MT	Stephanomeriinae	1	0	-	-	-	-
<i>Stephanomeria minor</i>	OR/MT	Stephanomeriinae	2	0	-	-	1	0
<i>Microseris nutans</i>	ID	Microseridinae	1	0	-	-	-	-

References

Grosskopf, G., and A. Hassler. 1998. Investigations on potential biocontrol agents of mouse-ear hawkweed, *Hieracium pilosella*. Annual Report 1998. CABI-Bioscience Centre, European Station, Switzerland. 38 pp.

Grosskopf, G., C. Lucas, and M. Brockington. 2000. Investigations on potential biological control agents of hawkweeds, *Hieracium* spp. Annual Report 2000. CABI-Bioscience Centre, European Station, Switzerland. 36 pp.

Grosskopf, G., S. Butler, H. Recher, and H. Schneider. 2001. Biological Control of Hawkweeds, *Hieracium* spp. Annual Report 2001. CABI-Bioscience Centre, European Station, Switzerland. 36 pp.