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Progress in Whitetop Biological Control at CASI-Switzerland

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Whitetop or hoary cress *(Lepidimn draba)* is a deep-rooted, perennial mustard, introduced to the U.S.A. from Europe in the late 19th century. Since then, whitetop has spread throughout the western and northeastern states, and is now a declared noxious weed in 15 U.S. states. It spreads by seed and by vegetative root growth, which enables whitetop to develop dense stands quickly. Whitetop is an aggressive invader of crops, rangelands and riparian land and is particularly prevalent in disturbed and/or irrigated areas. Whitetop reduces rangeland forage and is toxic or unpalatable to livestock.

There are currently no satisfactory long-term control methods for whitetop. Therefore, a consortium was established on the initiative of Prof. Mark Schwarzlander (University of Idaho) in 2001 to initiate a classical biological control for whitetop. Since 2001, CABI in Switzerland has been pursuing several biological control agents for release in North America. As a result of literature- and field-surveys conducted between 2001 and 2003, seven plant-feeding insect species were prioritized as potential biological

Adult C. *cardariae*

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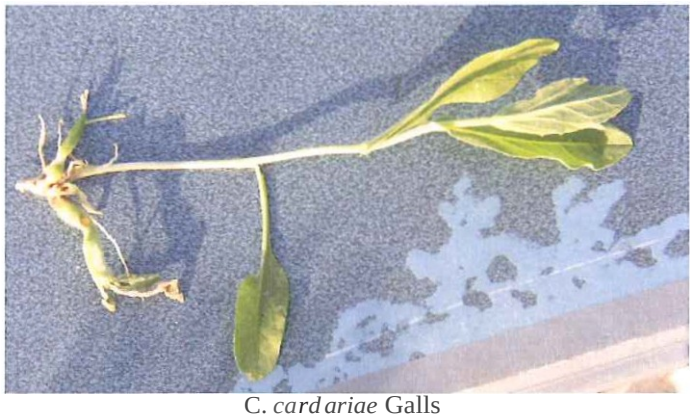

C. *cardariae* Galls

control agents based on records of their specificity to whitetop: four weevils, one flea beetle and two gall midges. Recently, we have concentrated our work on the four weevils: a stem- and leaf-galler *(Ce11torf?ynch11s cardariae)*, a seed feeder *(Ce11torf?y 11ch11s t11rbat11s)*, a stem miner *(Ce1ttorf?ynch11s merkli)* and a root galler *(Ce11torf?y11ch11s assimilis)*. The work on the root galling weevil is being con-

C. *cardariae* Multiple-choice Field Cage Test

continued on page 2...Whitetop

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ducted in collaboration with the U.S. Department of Agriculture – Agricultural Research Service. The following is a brief summary of our recent progress.

Leaf- and stem-galling weevil, *C. cardariae*

In December 2011, we submitted a petition to the USDA-APHIS Technical Advisory Group *(TAG),* for field release of the stem galling weevil, C. *cardatiae.* Five reviewers recommended release without reservation s, eight wanted us to conduct additional tests, and two reviewers from Canada did not recommend release of the weevil. Based on reviewer comments we started conducting additional host-range tests in 2013. We have been able to conduct trials with 11 new test plant species, nine of which are native to North America (NA), including two new *Lepidi11111* species and two federally listed threatened or endangered (T&E) species. Five plant species, four native to NA, supported adult development of C. *carda1iae.* Additional native *Lepidittm* species were obtained in 2013, which are currently being tested. However, not all of them germinated, so we are planning to complete tests in 2015 with the aim of submitting a revised petition to TAG in late 2015.

Seed feeding weevil, *C. turbatus.*

Ce11torl?J11ch11s tt1rbat11s is proving to be the most specific of the agents that we are currently working with. Tests in 2013 again worked very well. In egg-laying tests, eggs were found in only two test plant species, the European *Lepidittm campestre* and the native NA L. *11itidt1m.* Of 528 *Nast11rti1111 gambelii* fruits that were checked, only one had signs of feeding but none of its seeds were destroyed nor contained eggs. We will next evaluate whether or not L *11itid11111* supports C. *t11rbat11s* larval development in 2014. In lai:val development tests conducted in 2013, only the target weed *L. draba* and *L. chalepe11se* supported development of C. *t11rbat11s* to mature larvae. The proportion of viable seeds destroyed in L *draba* during oviposition and development tests was again high (57-83%). Only L *campestre* had comparable numbers of seeds destroyed.

Adult C. *turbatus*

C. *turbatus* Feeding Damage

Stem mining weevil, *C. merkli.*

In 2013, we repeated an open-field test with the stem mining weevil *Cet1torf?J11c/ms merkli* in southern Russia. Although none of the seven test plant species showed any signs of attack, the test is currently being repeated because of veiy low levels of attack were recorded on L *draba.*

Root galling weevil, *C. assimilis.*

Work on the root-gall forming weevil *Cet1torl?Jncht1s assimilis* advanced very well in 2013. In larval development tests, C. *assimilis* emerged from two native NA Brassicaceae. However, in a subsequent multiple-choice test, C. *assimilis* did not lay any eggs on these two species. This result justifies further work with C. *assimilis.* We were able to set up additional no-choice development tests with 34 test plant spe- cies in autumn 2013, which will soon be checked for emerging adults.

C. *Assimilis* Galls

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Whitetop mite -*Aceria drabae*

Jeff Littlefield, Montana State University

When one thinks of biological control agents for weeds, the first thought is of insects. However, other types of organisms have been considered and released for weed biological control, including eriophyid mites. Only two species of these mites have intentionally been introduced into North America: *Aceria chondrillae* in 1975 for rnsh skeletonweed, and *Aceria malherbae* in 1987 for field bindweed . A third species, *Acetia drabae,* will hopefully be the third mite permitted for release, and the first biological control agent approved for whitetop (aka hoary cress, heart-podded hoarycress or-*Lepidium draba*).

Eriophyids have a number of characteristics that makes them attractive as biological control agents. They are often gall formers, which tend to be highly host specific. In many cases, gall induction can stunt the plant or reduce its reproductive potential. They have multiple generations per year and are often widely dispersed by the wind.

Eriophyid mites are unique within the mite world. Unlike spider mites, they have elongated bodies, often ringed with small protuberances or spines, and reduced numbers of legs (2 instead of 4 pairs), which often end with

Electron Micrograph of Whitetop Mite

ornate featherclaws. They are also very small. How many eriophyids can dance on the head of the pin? I would guess up to 40, depending upon how crowded the dance floor is. In the laboratory, we use a btush made from an eyelash to transfer them to new plants. If both the light and your eye sight are good, you might see an individual at the tip of the brnsh. This small size provides unique challenges in working with these mites.

The life cycle of *Aceria drabae* is typical of other eriophyids. It has four life stages: egg, two nymphal stages, and adult. Generation time from egg to adult is approximately 10 to 14 days depending upon temperature. Populations of the mite within a single gall may reach into the thousands. Eriophyids are primarily dispersed by wind although they occasionally hitch a ride on other insects visiting the plant. They have the potential to spread quite rapidly after establishment.

Acetia drabae overwinters on root buds or possibly in protected places at the base of the plant. As the plants develop in the spring, mites feed on the developing tissue, occasionally inducing vegetative galls, which may stunt the plant. Prior to flowering, *A. drahae* typically moves into the flower buds, inducing gall formation . In Europe, the mite may reduce seed production as much as 90% or more. *Aceria drabae* develop over several generations within the gall tissue and, as the plant senesces during the summer, individuals move back down to the roots.


Whitetop Mite Vegetative Galls

Ace1ia drabae was chosen as a potential biological control agent for whitetop due to its narrow host range and impact on its host. Since the mite is relatively widespread in Europe, it should adapt to varying environmental conditions in North America . The mite has been observed from Spain to Russia but is probably more common in Eastern Europe. The mite population that we used for our host specificity testing came from northern Greece near Thessaloniki, in similar locations to where the collections of the bindweed mite *Aceria mafherbae* originated.

Amia drahae has been reported in the literature on numerous mustard species. Dr. Jerzy Lipa surveyed insects associated with cruciferous plants in Poland and surrounding countries from


Whitetop Mite Flower Galls

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Close-up of Flower Gall

1969 to 1974. All together, 141 species and 14 cultivars were included in his smvey. *Aceria drabae* was only reported on whitetop, *Lepidium* (*Cardana) draba.* Based on his findings, Lia concluded that the mite was probably host specific and that reports in the literature on other host species were a result of misidentification . In 1996, we began screening *Aceria drabae* at the quarantine laboratory at Montana State University in Bozeman. Support was provided through the Montana Noxious Weed Tiust Fund, BLM-Montana, and om cooperators with the USDA-ARS-European Biological Control Laboratory, Thessaloniki Greece. We eventually tested 104 different plant species or varieties, including numerous native North American *Lepiditmt* species and other key native or economic mustards. Host utilization by the mite was confined to *Lepidium draba* nd the closely related *Lepidium appeliam1t11*, both of which are weedy species. *Lepidittm draba* appeared to be a better host, showing greater gall induction and population development of the mite. Based upon test results from MSU, as well as field observations in Poland, this mite appears to be sufficiently host specific for introduction into North America. We therefore submitted a petition for its release to the Technical Advisoty Group on the Biological Control of Weeds *(TAG)* in March of 2012. With a favorable review from TAG, we applied for a release permit with the USDA-APHIS . Cmrently, the Environmental Assessment for the mite's release is going through various regulatory channels, and has been under review by the Endangered Species Office of the U.S. Fish & Wildlife Service since December of 2013.

How effective of an agent is *AceJia drabae* likely to be? It has been identified in Europe as one of three or four of the most promising biocontrol agents for whitetop. I think the mite is more of a stressing agent rather than an outright killer, stunting the plant and reducing its potential to spread by seeds..It would probably be more effective as part of a suite of agents, such as those being screened by CAI Switzerland, or in habitats with good plant competition. We have several potential release sites in Montana that we have been monitoring. Once established (assuming it is approved for release), we hope to make redistributions that will strategically take advantage of wind patterns to aid in its long range dispersal.