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NON-TARGET FEEDING BY GALERUCELLA CALMARIENSIS ON SANDBAR WILLOW (SALIX INTERIOR) IN ILLINOIS

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Purple loosestrife, *Lythrum salicaria* L., is an introduced Eurasian perennial herb that has been in North America since the early 1800s (Thompson et al. 1987). Purple loosestrife has been considered a serious threat to the integrity of North American wetlands (Thompson et al. 1987, Blossey et al. 2001a). *L. salicaria* has been the target of a significant North American project using biological control to combat it (Malecki et al. 1993, Blossey et al. 2001a). Importation biological control reunites natural enemies from the ancestral home of the weed in the new setting. Critical to the safety of a biological control project is the specificity of the agents to be used which determines what, if any, impact there may be against non-target plants. Five species of host-specific herbivores of European origin were screened for their specificity against an array of native plants prior to their release in North America. Two of the introduced species, *Galerucella calmariensis* L. and *Galerucella pusilla* Duft. (Coleoptera: Chrysomelidae), have been distributed extensively and are established in many US states and Canadian provinces (Blossey et al. 2001a).

The purpose of host-specificity tests is to prevent the introduction of herbivores that could negatively affect non-target species. Although of crucial importance, these tests will not assure the complete absence of non-target feeding (Pemberton 2000). Prior to release, testing of the *Galerucella* species indicated a strong degree of host specificity, although limited feeding was noted on several other Lythraceae, including: *Lythrum alatum* Pursh, *Decodon verticillatus* (L.) Ell., and *Lagerstroemia indica* L.; as well as: *Rumex verticellata* L., *Gaura biennis* L., and *Salix interior* Rowlee (Blossey et al. 1994, Blossey and Schroeder 1995). Of these plants on which feeding or oviposition was noted, only *L. alatum* supported complete development of *Galerucella* species.

A monitoring program was established (Blossey and Skinner 2000) to assess changes in densities of *L. salicaria* after release of the agents, as well as to document the abundance of insects and changes to wetland plant communities. At many release sites in a number of states and provinces, *L. salicaria* has been shown to decline after releases of *Galerucella* spp. At a few of these thousands of release sites, there have been observations of feeding by *Galerucella* spp. on some non-target plants: *Rosa multiflora* Murray, *Decodon verticellatus, Salix* discolor Muhl., and *Myrica pensylvanica* Loisel in Rhode Island; *Potentilla anserine* L., and *Cornus stolonifera* Michaux in Michigan; *D. verticellatus* in Connecticut; and *R. multiflora* in New Jersey (Blossey et al. 2001b). In all of those cases, non-target feeding by *Galerucella* spp. was spatially isolated and ephemeral, and each was considered "spill-over".

Since 1994, a program to use biological control against *L. salicaria* in Illinois has resulted in release of over 2.7 million adult *G. calmariensis* L. and *G. pusilla* Duft. at approximately 230 sites in northern Illinois. Beetles have established at most of those sites and large emergences of *Galerucella* spp., in conjunction with almost complete defoliation of *L. salicaria*, have been seen at approximately 30 of those Illinois sites. One of those sites, Powderhorn Forest Preserve, Cook County, IL, showed significant feeding and oviposition on loosestrife in a wetland by overwintered *Galerucella* in late May and June 2003, followed by even more-complete defoliation by larvae and newly emerged F_1 adults in early July.

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While monitoring the site on 10 July 2003, large numbers of *G. calmariensis* adults were observed feeding on sandbar willow, *Salix interior*. Feeding was limited to plants growing along the fringe of Powderhorn Lake, approximately 50 m from the wetland at which the July emergence of *Galerucella* had occurred. Identifications of the adults confirmed them to be *G. calmariensis*. Feeding on *S. interior* was noted to be extremely patchy; a few plants were heavily fed upon and other plants were untouched. Likewise, some plants held large numbers of adults, other plants had zero. Numbers of beetles on the plants were not quantified at that time.

Sampling of *S. interior* plants was conducted on 17 July along the edge of Powderhorn Lake, based on the distribution of *S. interior*. Five sample points were randomly selected. *Salix interior* plants in each of the sample points were less than 1.25 m tall. At each point, a 1-meter stick was fixed to a center point and rotated, describing an area of 3.14 sq. m. In each of the five sample areas, each *S. interior* plant was assessed and categorized as to the percentage of the leaves that showed characteristic shot-hole feeding by adult *Galerucella*. Categories were: zero leaves fed on (0%); less than 25% of leaves fed on; 25 – 50% of leaves fed on; 50 – 75% of leaves fed on; and greater than 75% of leaves fed on. Note that these categories are not levels of defoliation – a leaf with a single shot hole was counted as fed on, the same as if that leaf had been nearly defoliated. Thus, the percentage of leaves fed on was greater than the percent of the plant defoliated. Numbers of adult *Galerucella* beetles per 3.14 sq. m. plot were noted.

Results are shown in Table 1. Sites contained an average of 90.4 (SD = 20.5) plants per 3.14 sq m. sample plots (= 28.8 plants per sq. m.). An average of 66% of plants had zero feeding on them. Only 8% of plants had greater than 25% of leaves fed on, and no plants had greater than 75% of leaves that had been fed on. Unlike the previous week, *Galerucella* adults were scarce, with an average of 5.8 beetles per 3.14 sq. m. plot (= 0.20 beetles per plant on average). No *Galerucella* eggs or larvae were found. Larger (up to 5 m tall) *S. interior* plants, adjacent to the sample plots, showed no signs of either *Galerucella* adults or feeding damage, nor did *S. interior* plants located further (> 200 m) from the emergence site; thus, feeding was spatially localized.

Table 1. Numbers of *Salix interior* plants with different categories of percentage of leaves fed on by *Galerucella calmariensis*, and number of *G. calmariensis* found per 3.14 sq. m. plots, at Powderhorn Lake, July 2003.

		Number of plants with categories of feeding (percent leaves fed on)					
Sample Number	**Number of plants**	**0**	**< 25%**	**25-50%**	**50-75%**	**> 75%**	**Beetles per plot***
1	116	86	29	1	0	0	5
2	89	45	29	10	5	0	17
3	59	36	15	7	1	0	1
4	92	58	26	8	0	0	4
5	96	80	15	1	0	0	2
Means	90.4	61.0	22.8	5.4	1.2	0	5.8

* plot size was 3.14 sq. m.

The feeding damage seen on 10 July was still evident on 17 July, even though the numbers of beetles feeding on the willow plants had dropped by several orders of magnitude. At subsequent visits to Powderhorn Lake (2003 – 2005), we failed to find any further feeding on *S. interior*, nor any apparent impact on *S. interior* plants; thus the feeding was temporally limited.

Although this was the first report of non-target feeding by *Galerucella* spp. on *S. interior* in the field, the host-specificity testing of non-target plants conducted prior to release of *Galerucella* predicted feeding on *S. interior* (Blossey et al. 1994). The pattern of feeding seen in Illinois mirrors those "spillover" occurrences seen previously for *Galerucella* (Blossey et al. 2001b), which were all associated with emergence of massive numbers of new adults. At the Illinois site, feeding on *S. interior* was limited to the vicinity of emergence, similar to a report of feeding by adult *G. pusilla* and *G. calmariensis* on the non-target plant crepe myrtle, *Lagerstroemia indica*, which decreased dramatically with distance from the colonization source (Schooler et al. 2003).

Non-target impacts of herbivores used for weed biological control have garnered a great deal of attention recently. One criticism of weed biological control is lack of sufficient monitoring to detect (and report) such feeding on non-target plants, when it may occur. Feeding on non-target plants needs to be placed into an overall context of harm – comparing the degree of harm to that from other control methods, or lack of control actions taken. When such feeding is highly localized and very ephemeral – and was predicted 10+ years before, in this case – this seems less an indictment of weed biological control than verification of science done well.

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