



Biological Control Agents for Utah Weeds: the Knapweed Seedhead Gall Flies

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Several introduced species of knapweeds are highly problematic weeds on western rangelands. Those most troublesome in Utah include squarrose knapweed (*Centaurea virgata* Lam. subspecies *squarrosa* Gugl.), spotted knapweed (*C. maculosa* Lam.), diffuse knapweed (*C. diffusa* [Lam.]), and Russian knapweed (*C. repens* L.).



Squarrose, spotted, and diffuse (but not Russian) knapweed are subject to attack by two species of small flies of the fruit fly family (*Urophora affinis* Frauenfeld and *U. quadrimaculatus* [Meigen], Tephritidae). As their common name indicates, these flies develop in galls fashioned from plant tissue within knapweed seedheads. The feeding activities of immature flies (larvae) can greatly reduce the number of seeds produced by a plant, thus aiding in stemming the spread of these weeds. These flies are now readily available for release in Utah. This fact sheet briefly highlights the biology of these insects and their use as biological control agents against knapweeds.

Biography of the Flies

Both flies are native to Europe where they attack knapweeds. After extensive testing to ensure that these species restrict their feeding to knapweeds, the flies were introduced to Canada and Montana in the early 1970s. They quickly became established in North America, and are now widespread throughout much of the western United States and Canada.

Adult flies of both species are small (approximately 3/16" in length). Their clear wings with black markings are distinctive, extending at a 45° angle from the body when the adult is at rest. The wing markings of *U. quadrifasciata* are particularly dark and bold, forming a pattern roughly resembling the letters UV across the wing; the markings of *U. affinis* appear as four, less distinct lines or bands across the wing.



Wing patterns on *Urophora quadrifasciata* (left wing) and *Urophora affinis* (right wing)

Adult females of *U. affinis* lay their eggs in early to mid-summer on immature knapweed flower heads (approximately 1/4" in diameter); females of *U. quadrifasciata* tend to appear a bit later each year and attack more mature flower heads. Three or four days after an egg is laid, a small grub or larva hatches from the egg and burrows into the flower head to feed in the tissue where seeds are formed.

As the larva feeds, a gall is formed around it. The straw- or cream-colored galls of *U. affinis* are 1/8" long, thick and hard (woody), and tear-shaped (they form in the plant receptacle tissue, and are relatively well-hidden when a seedhead is opened); the smaller galls of *U. quadrifasciata* are thin, transparent, and soft and papery (they form in the ovary). Several to many galls may be formed in each flowerhead of diffuse and spotted knapweed while generally one or two galls occur in the smaller flowerheads of squarrose knapweed; larvae of the two species often coexist in shared flowerheads.

Feeding and gall formation by fly larvae destroys developing seeds in attacked flowerheads. In addition, gall formation by *U. affinis* diverts plant nutrients otherwise destined for other, unattacked flowerheads; this can result in reduced seed set in these flowerheads as well.

Both fly species spend the winter as larvae in the galls inside the knapweed flowerheads. In the spring, the larvae enter the pupal stage in which they transform themselves into adults. These adults emerge from the galls in late June and early July. Most of their offspring will enter the winter as larvae, but some will develop in 5-6 weeks, pupate, and emerge as adults to lay a second generation of eggs that same summer on late maturing flowerheads of the knapweed. *Urophora quadrimaculatus* has a greater tendency to produce a second generation than does *U. affinis*; adults of both species are more likely to emerge in late summer to produce a second generation if they develop in early versus late maturing flowerheads.

Adults of *U. affinis* are weak fliers and do not disperse far from where they matured. They spend much of their time on the host plant, and hence populations of this fly spread slowly from sites of initial release. Adults of *U. quadrifasciata* are stronger fliers and disperse more rapidly (and hence may be particularly valuable in their potential to seek out and attack isolated host plants). They appear competitively inferior to *U. affinis*, however, and the latter species is typically most numerous at sites (both in Europe and in North America) where the

two species coexist. Continued coexistence across the landscape is probably facilitated because the competitive disadvantage of *U. quadrifasciata* is offset by its greater tendency to disperse and to produce a second generation each year (which bolsters its capacity to increase rapidly in numbers in wet summers when large numbers of late maturing knapweed flowerheads are available).

Use of the Flies as Biocontrol Agents

The knapweed gall flies have great potential to reduce seed set by their weedy hosts. Seed production has been reduced by as much as 95% in knapweed populations in British Columbia following the successful establishment of these flies. While such rates of attack are very impressive, they alone may be insufficient to reduce densities of knapweeds, and the release of additional biocontrol agents appears necessary to augment the activities of the seedhead flies.

Nevertheless, high levels of seed destruction by the flies may be very important in slowing the spread of knapweeds in Utah. For example, both species of fly have been found to complete their life cycles on squarrose knapweed in central Utah. This weed appears to spread in large part as seedheads are caught and carried in the wool of sheep trailed through infested areas. The effort now underway by USU Extension to introduce the flies throughout the range presently infested with squarrose knapweed should result in sheep dispersing substantially fewer viable seeds.

Those wishing to introduce seedhead gall flies to diffuse, spotted, or squarrose knapweed may purchase these insects at low cost from private collectors in other states [contact USU Extension Entomology for additional details]. At present, the flies are not established in sufficient numbers at previous release sites in Utah to enable individuals to collect these insects in large numbers for redistribution.

In situations where diffuse or spotted knapweed grows over at least a five-acre area and it can be guaranteed that the land will not be sprayed with herbicide or otherwise disturbed for at least five years, it may be possible to receive flies for release without cost from USDA-APHIS [interested parties should inquire with the Officer-in-charge for Utah at the USDA-APHIS office in Salt Lake City].

Remember that if you decide to obtain flies for release in Utah from a collector in another state, you are required to receive permission prior to such releases from the State Entomologist at the State of Utah Department of Agriculture (Salt Lake City).

Sources of Additional Information

Evans, T. 1993. Biological control of weeds through use of introduced insects. USU Extension Entomology Fact Sheet No. 87

Story, J. M. 1984. Collection and redistribution of *Urophora affinis* and *Urophora quadrifasciata* for biological control of spotted knapweed. Cooperative Extension Service, Montana State University, Bozeman. Circular 308. 9 pp (with excellent color photographs of flies and weeds).

USDA-APHIS. Biological control of knapweeds. [Printed annually to provide an update on knapweed biocontrol agents distributed by the Bozemen Biological Control Facility. For a current copy and additional information, contact: USDA-APHIS-PPQ, Forestry Sciences Lab, Montana State University, Bozeman, MT 59717-0278.]

Whitson, T. D., L. C. Burrill, S. A. Dewey, D. W. Cudney, B. E. Nelson, R. D. Lee, and R. Parker. 1991. Weeds of the west. Published by The Western Society of Weed Science [and printed by Pioneer of Jackson Hole, 132 West Gill Street, Jackson, Wyoming, 83001].

[A review of the scientific literature concerning the biology of the seedhead gall flies may be found in Story, J. M., K. W. Boggs, and W. R. Good. 1992. Voltinism and phenological synchrony of *Urophora affinis* and *U. quadrifasciata* (Diptera: Tephritidae), two seed head flies introduced against spotted knapweed in Montana. *Environmental Entomology*, Vol. 21: 1052-1059.]

[A review of the biology of squarrose knapweed in Utah may be found in Roche, C. T. and B. F. Roche, Jr. 1989. Introductory notes on squarrose knapweed (*Centaurea virgata* Lam. ssp. *squarrosa* Gugl.). *Northwest Science*, Vol. 63: 246-252.]

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