

*Galerucella pusilla* (Duftschmid)  
(Coleoptera: Chrysomelidae)

DESCRIPTION AND LIFE CYCLE Adults, 2–4 mm long, and larvae very closely resemble *G. californiensis*. Refer to *G. californiensis* photos for identification. Adults emerge from hibernation and feed on shoot tips and young leaves in April. Mating begins immediately, with egg laying starting approximately 1 week later and continuing until the end of July. Larvae hatch 12 days after egg laying; larvae develop over the next 2 weeks feeding first on leaf and flower buds and then on all parts of the plant in the later stages of development. Mature larvae leave the plant and pupate in leaf litter and the upper portion of the soil. Adults emerge 9–11 days later. Adults that emerge before August mate and lay eggs for a 1 month period. Adults feed on foliage and hibernate in the soil before winter.

WEED ATTACKED Purple loosestrife.

HABITAT Egg laying is strongly curtailed by low temperatures. Tolerates the variety of habitat conditions in which purple loosestrife is found.

COLLECTION, SHIPPING, AND HANDLING Collect with the sweep net technique and use standard shipping and handling procedures.

RELEASE

Follow standard release procedures for insects. Take precautions not to dump the beetles in the water.

MONITORING Determine presence by looking for adults on foliage in April or August.

REFERENCE

Blossey, B. and D. Schroeder. 1991. Study of potential biological control agents of purple loosestrife (*Lythrum salicaria* L.). Final Report. European Station Report. C.A.B. International Institute of Biological Control, Delemont, Switzerland. 27 p.



*Gymnaetron antirrhini* Paykull (Coleoptera: Curculionidae)

DESCRIPTION AND LIFE CYCLE Grey adults emerge in May and feed on the young stems. Mating begins in June; eggs are laid into the ovary of flowers between the end of June and mid-August. Larvae hatch 12–17 days after egg laying and feed on the gall tissue the plant forms around the seeds. Pupation occurs 20–30 days later inside the seed head; pupation lasts 10–15 days. Adults emerge and feed on the plants before hibernation. Adults may overwinter in the seed capsule or in debris on the ground.

WEED ATTACKED Yellow toadflax and Dalmatian toadflax. Two strains of the beetle have been released in British Columbia; one is specific to yellow toadflax, and the other is specific to Dalmatian toadflax.

HABITAT Does not do well in areas with extreme cold winter temperatures.

COLLECTION, SHIPPING, AND HANDLING Collect adults using sweep nets from July to August. Follow standard shipping and handling procedures for insects.

RELEASE Follow standard release procedures for insects. *Brachyterolus pulicarius* larvae will feed on *Gymnaetron* larvae through early summer to August. Avoid releasing *Gymnaetron* in areas where *Brachyterolus* is abundant.

MONITORING Determine presence by using sweep nets from July to August.

## REFERENCES

- Groppe, K. 1992. *Gymnaetron antirrhini* Paykull (Col.: Curculionidae). A candidate for biological control of Dalmatian toadflax in North America. European Station Report. C.A.B. International Institute of Biological Control, Delemont, Switzerland. 39 p.
- Smith, J.M. 1959. Notes on insects, especially *Gymnaetron* spp. (Coleoptera: Curculionidae), associated with toadflax, *Linaria vulgaris* Mill. (Scrophulariaceae), in North America. Canadian Entomologist 91:116–121.



Figure 70 *Gymnaetron antirrhini*



Figure 71 *Gymnaetron antirrhini* larval case.  
Note the spurs.

*Hylemya seneciella* Meade (Diptera: Muscidae)

DESCRIPTION AND LIFE CYCLE Adults, dull grey, 4–5 mm long, and covered in short hairs, emerge coinciding with bud formation on tansy ragwort. Mating and egg laying into the flower buds begins immediately. Larvae are white, and occur one per seedhead. Larvae eat receptacles and later in the summer feed on immature fruits; the larval feeding has marginal effects on tansy ragwort, resulting in approximately 2–5% seed reduction per year. Pupation begins in the fall and development continues overwinter.

WEED ATTACKED Tansy ragwort.

HABITAT *Hylemya* has distributed itself throughout the tansy ragwort infestations in the Fraser Valley, Vancouver Island, and coastal areas of British Columbia and does not appear to be selective of individual habitat types.

COLLECTION, SHIPPING, AND HANDLING Collect mature larvae in seedheads in the fall or winter and store in moist sand under refrigeration (4°C) until the following spring to allow pupation. Redistribution is not necessary in the Fraser Valley, Vancouver Island, or coastal areas of British Columbia.

RELEASE Timing the emergence of the flies to coincide with optimum tansy ragwort bud development in the field is key to successful establishment. Place stored plant material in the field just before peak bud formation. A release of 1000–1500 seedheads, with an average of 10–15% attack rate, is sufficient to establish a new population.

MONITORING During the first set of tansy ragwort flowers to set seed, look for dead flowers tied together with a brown pappus. Attacked flower heads have a hole in the receptacle. *Hylemya* is the only seedhead agent released on tansy ragwort.

REFERENCE

Frick, K.E. 1969. Behaviour of adult *Hylemya seneciella*, an anthomyiid (Diptera) used for the biological control of tansy ragwort. *Annals of the Entomological Society of America* 63:184–187.



Figure 72 *Hylemya seneciella* puparia in tansy ragwort seedhead

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*Hyles euphorbiae* (L.) (Lepidoptera: Sphingidae)

**DESCRIPTION AND LIFE CYCLE** Brown adult moths have checkered pink, white, and black markings on the wings and can have up to an 8 cm wingspan. Adults emerge in the spring and mating and egg laying coincide with the floral bloom in leafy spurge. Larvae have plump, 10 cm long bodies, brightly coloured with a mixture of red, black, yellow, and white markings. Larvae feed on leaves and develop over a period of 42–72 days. Pupation occurs in the fall and hawkmoth overwinters in pupal form.

**WEED ATTACKED** Leafy spurge.

**HABITAT** Exact habitat requirements are not known for British Columbia. Preliminary information indicates that they require mild overwinter temperatures, although the moth has established well in Montana where it is exposed to fairly severe winter conditions.

**COLLECTION, SHIPPING, AND HANDLING** Hand pick larvae from plants from summer to fall. Follow standard shipping and handling procedures for insects.

**RELEASE** Follow standard release procedure for insects. Hawkmoth is highly susceptible to predation losses from ants; release sites should be carefully chosen to avoid large ant colonies.

**MONITORING** Determine presence by capturing adults with sweep nets, or by observing larvae feeding on spurge plants.

**REFERENCE**

Forwood, J.R. and M.K. McCarty. 1980. Observations on the life cycle of spurge hawkmoth. Transactions of the Nebraska Academy of Sciences 8:31–34.



Figure 73 *Hyles euphorbiae* moth



Figure 74 *Hyles euphorbiae* caterpillar

*Hylobius transversovittatus* Goeze  
(Coleoptera: Curculionidae)

**DESCRIPTION AND LIFE CYCLE** Adult weevils emerge in April and feed on the developing loosestrife shoots. Egg laying begins in early May and continues to mid-September. Eggs are deposited on the shoot bases and in the soil near the roots. Larvae hatch 2 weeks after egg laying; those laid in the soil feed on root hairs and then burrow into the roots. Those laid on the stem mine the shoots for some time before tunnelling into the roots. Larval development can take from 1–2 years; larval development is arrested each time the attacked roots are flooded. Pupation occurs in the upper portion of the root stock. Most adults emerge between July and the end of August. The weevils feed on leaves and some mate and lay eggs. In late autumn they leave the plant and hibernate in the soil. Adults are long lived and may hibernate two or three seasons before they die.

**WEED ATTACKED** Purple loosestrife.

**HABITAT** Tolerates a wide range of environmental conditions and has excellent host-searching capacity, as indicated by its presence in small scattered stands of loosestrife in its native Europe.

**COLLECTION, SHIPPING, AND HANDLING** Adults are night active. Collection techniques have not been finalized. Follow standard shipping and handling procedures for insects.

**RELEASE** Follow standard release procedures for insects. Release near the end of the day or early evening to allow the weevils to begin feeding in their new location soon after release.

**MONITORING** Determine presence by pulling plants and opening roots to observe larvae. Open roots only until the first larva is found.

**REFERENCE**

Blossey, B. and D. Schroeder. 1991. Study of potential biological control agents of purple loosestrife (*Lythrum salicaria* L.). Final Report. European Station Report. C.A.B. International Institute of Biological Control, Delemont, Switzerland. 27 p.



Figure 75 *Hylobius transversovittatus*



Figure 76 *Hylobius transversovittatus* pupa

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*Larinus minutus* Gyll. (Coleoptera: Curculionidae)

**DESCRIPTION AND LIFE CYCLE** Mottled-brown adults, 5–10 mm long, emerge from leaf litter at the base of plants 2–4 weeks before knapweed budding (early May to June). Mating coincides with the bud stage of knapweed and continues over the 5 to 14 week life span of the adults. Females first feed, then lay eggs into flower buds as they open. Larvae hatch within 3 days of egg laying; larvae consume the entire flower head contents. Larvae are fully developed within 1 month and pupation occurs in the flower head. Adults emerge from late September to October and feed for a short time before moving into the soil and plant litter for winter.

**WEED ATTACKED** Spotted knapweed.

**HABITAT** Does best in areas with hot, dry summers.

**COLLECTION, SHIPPING, AND HANDLING** Pick adult weevils from the flower buds in early summer, following the technique for hand picking insects. Alternatively shake top of the knapweed plants over a collection tray or funnel, or use a sweep net. Follow standard shipping and handling requirements for insects.

**RELEASE** Follow standard release procedure for insects.

**MONITORING** Check the release site in June and July for adult weevil presence. They will be conspicuously located on the upper part of the knapweed plant, congregating mostly on the flower buds. Count the number of weevils per plant to estimate population densities.

**REFERENCE**

Groppe, K. 1990. *Larinus minutus* Gyll. (Coleoptera: Curculionidae), a suitable candidate for the biological control of diffuse and spotted knapweed in North America. European Station Report. C.A.B. International Institute of Biological Control, Delemont, Switzerland. 31 p.



Figure 77 *Larinus minutus*



Figure 78 Seedhead damage by *Larinus minutus* larvae

*Larinus obtusus* Gyll. (Coleoptera: Curculionidae)

**DESCRIPTION AND LIFE CYCLE** Dark-brown adults begin to emerge from hibernation in mid-May. Mating begins at the end of May on open flower heads and is followed directly by females laying their yellow eggs into the flower heads; mating and egg laying can occur throughout the beetles' 5 to 6 month life span (occasionally adults may hibernate a second time and live a second season). Eggs hatch in 3–6 days after laying. After hatching, larvae feed on the flowers and seeds. Larval development is completed within 4–6 weeks and pupation occurs in the seedhead. Adults emerge in mid-July and feed briefly on foliage before moving to hibernation places in the soil around the root area.

**WEEDS ATTACKED** Diffuse knapweed and spotted knapweed; shows a preference for spotted knapweed.

**HABITAT** Warm, dry conditions are preferred during the mating season.

**COLLECTION, SHIPPING, AND HANDLING** Pick adult weevils from the flower buds in early summer, following the technique for hand picking insects. Alternatively shake top of the knapweed plants into a collection tray or funnel, or use sweep nets or vacuum aspiration techniques. Follow standard shipping and handling requirements for insects.

**RELEASE** Follow standard release procedure for insects.

**MONITORING** Check the release site in June and July for adult weevils. They will be conspicuously located on the upper part of the knapweed, congregating mostly on the flower buds. Count the number of weevils per plant to estimate population densities.

**REFERENCE**

Groppe, K. 1992. *Larinus obtusus* Gyll. (Col.: Curculionidae), a candidate for biological control of diffuse and spotted knapweed. Final report. European Station Report. C.A.B. International Institute of Biological Control, Delemont, Switzerland. 46 p.



Figure 79 *Larinus obtusus*



Figure 80 *Larinus obtusus* larva

*Larinus planus* (F.) (Coleoptera: Curculionidae)

**DESCRIPTION AND LIFE CYCLE** Dark-brown adults, 5–10 mm long, emerge from leaf litter at base of plants before Canada thistle budding (mid-June). Mating coincides with the bud stage of the thistle, 7–14 days after emergence. Females first feed on, then lay eggs into unopened flower buds that are less than 7 mm in diameter. Larvae hatch within a few days of egg laying and consume flower head contents over the course of summer. Attacked flower heads have a small brown mark near the base and appear bent and twisted. Pupation occurs in the flower head in mid-summer. Adults emerge from late August to September and feed for a short time before moving into the soil and plant litter for winter.

**WEED ATTACKED** Canada thistle.

**HABITAT** Adapted to the variety of habitats in which Canada thistle is found.

**COLLECTION, SHIPPING, AND HANDLING** Pick adult weevils from the flower buds and the leaf axils at the top of the thistle plant in early summer, following the technique for hand picking insects. Alternatively, shake top of thistle plants into a collection tray or funnel. Vacuum aspirators can also be used to collect this insect. Sweep nets will become tangled and torn in the thistle, and therefore should not be used. Do not collect thistles or redistribute thistle heads because they may contain parasites. Follow standard shipping and handling requirements for insects.

**RELEASE** A release of 100 adults is sufficient to establish a new colony. Follow standard release procedure for insects.

**MONITORING** Check the release site in June and July for adult weevils. They will be conspicuously located on the upper part of the thistle plants, congregating mostly on the flower buds. Count the number of weevils per plant to estimate population densities. Determine presence by opening brown, bent, or twisted flower heads to check for larvae in late summer.

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REFERENCE

McClay, A.S. 1990. The potential of *Larinus planus* (Coleoptera: Curculionidae), an accidentally introduced insect in North America, for biological control of *Cirsium arvense* (Compositae). *In* Proceedings of VII International Symposium on Biological Control of Weeds, 6–11 March 1988, Rome, Italy. E.S. Delfosse (editor), pp.173–179.



Figure 81 *Larinus planus*



Figure 82 *Larinus planus* larva

*Lobesia euphorbiana* (Freyer) (Lepidoptera: Tortricidae)

DESCRIPTION AND LIFE CYCLE Mottled yellow, brown, and reddish-brown adult moths live for 3–7 days. Mating and egg laying occur at dawn and dusk. Females lay the flat, translucent yellow eggs singly on the lower leaf surface. Newly hatched larvae migrate to the leaf tip, and roll the leaf together to begin development. As the larvae develop, they tie together additional young leaves or florets at the plant growing tips in a silky webbing. The leaf ties impair leafy spurge growth and prevent flowering. Before pupation, the larvae spin a thick web in the tip of the leaf tie; pupation occurs in the leaf ties and second-generation adults emerge in late summer to early fall. Mating and egg laying begin immediately. Larvae, which are solitary and cannibalistic, develop in the fall and overwinter in this form.

WEED ATTACKED Leafy spurge.

HABITAT Prefers fringe forested areas, with mesic soil moisture regimes and shade. It also favours actively growing plants through the entire growing season, which provide the growing tips for larvae to tie together. The moth is generally found near water, such as a river or lake.

COLLECTION, SHIPPING, AND HANDLING Collect leaf ties containing larvae in the early to mid-summer. Follow standard shipping and handling for biological control agents in plant material. Adult moths are too short lived for collection and redistribution.

RELEASE Place one leaf tie per plant on spurge plants at the release site to allow the larvae to move into the new plant material. Connect the leaf material together with a fine thread such that the leaf ties are in contact with fresh plant material onto which the larvae can transfer. A release of 50 leaf ties is sufficient to establish a new colony.

MONITORING Determine presence by looking for larvae in leaf ties from the early summer through to fall.

## REFERENCE

Harris, P. and J. Sirocco. n.d. *Lobesia (Lobesiodes) euphorbiana* (Fr.) (Lepidoptera: Olethreutinae): a candidate for the biological

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control of leafy spurge in North America. Agriculture Canada, Regina Research Station, 36 p.



Figure 83 *Lobesia euphorbiana* moth



Figure 84 *Lobesia euphorbiana* larvae in leaf tie webbing

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*Longitarsus flavicornis* Steph. (Coleoptera: Chrysomelidae)

DESCRIPTION AND LIFE CYCLE Copper-coloured adults, 2.5–3 mm long, become active in the spring and may remain active for more than a year feeding on foliage. Mating and egg laying begin immediately and continue over the summer. Eggs are laid into the surface layer of the soil and take approximately 42 days to develop. White, comma-shaped larvae mine into the root crown and down into the root core. Occasionally, larvae will also migrate up the stem. Larvae overwinter in the plant, pupate, and form adults in the following spring.

WEED ATTACKED Tansy ragwort.

HABITAT Prefer well-drained areas with a high density of plants because they redistribute themselves by walking. Larval development is best in areas with climates similar to that on southern Vancouver Island, with long fall periods and a mild winter.

COLLECTION, SHIPPING, AND HANDLING Collect adults in October when there are abundant new rosettes on which they actively feed. Collect using a vacuum aspirator or light sweep nets; as soon as the leaves are disturbed, the adults will begin jumping off the plants. Collection, therefore, must be done quickly and thoroughly. It can be done on the same area within a half hour, as the flea-beetles reposition themselves on the rosettes shortly after disturbance. Follow standard shipping and handling procedures for insects.

RELEASE Choose a dense stand of tansy ragwort for release. Approximately 1000 adults are preferred for a release. Follow standard release procedures for insects.

MONITORING To sample for larval presence and density, check the corky layers on the outside of the root crown on large roots; establishment and survival is best determined by adult presence on rosettes in October. Adult density is difficult to determine because the flea-beetles are easily missed and jump from plants when disturbed.

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REFERENCES

- Ireson, J.E., D.A. Friend, R.J. Holloway, and S.C. Paterson. 1991. Biology of *Longitarsus flavicornis* (Stephens) (Coleoptera: Chrysomelidae) and its effectiveness in controlling ragwort (*Senecio jacobaeae* L.) in Tasmania. *Journal of the Australian Entomological Society* 30:129–141.
- McEvoy, P.B., C. Cox, and E. Coombs. 1991. Successful biological control of ragwort, *Senecio jacobaeae*, by introduced insects in Oregon. *Ecological Applications* 1:430–442.



Figure 85 *Longitarsus flavicornis*

*Longitarsus jacobaeae* (Waterhouse)  
(Coleoptera: Chrysomelidae)

**DESCRIPTION AND LIFE CYCLE** Sandy-brown to yellowish adults, 2.5–3 mm long, emerge in the early summer. Adults feed briefly and then aestivate over the remainder of summer. Adults become active again in the fall and may remain active for more than a year, feeding on foliage if freezing does not occur. Mating and egg laying begin in the fall and continue until freeze-up; eggs are laid into the surface layer of the soil and take approximately 42 days to develop. White, comma-shaped larvae feed on the outer surface of lateral and central roots, leaving long grooves in the root. Larvae overwinter in the plant and pupate, with adults emerging the following spring.

**WEEDS ATTACKED** Tansy ragwort.

**HABITAT** These flea-beetles prefer well-drained areas with a high density of plants because they redistribute themselves by walking. Larval development is best in areas similar to that in the lower Fraser Valley with long fall periods and a mild winter. They also prefer lower elevations, but are not exclusive to them. In mild climates, larvae can withstand flooding by feeding on the petioles of the leaves rather than on the roots.

**COLLECTION, SHIPPING, AND HANDLING** Collect adults in October when there are abundant new rosettes on which they actively feed. Collect using a vacuum aspirator or sweep net; as soon as the leaves are disturbed, the adults will begin jumping off the plants. Collection, therefore, must be done quickly and thoroughly. It can be done on the same area within a half hour as the flea-beetles reposition themselves on the rosettes shortly after disturbance. Follow standard shipping and handling techniques for insects.

**RELEASE** Choose a dense stand of tansy ragwort for release. Approximately 1000 adults are preferred for a release. Follow standard release procedures for insects.

**MONITORING** To sample for larval presence and density, check the corky layers on the outside of the root crown on large roots;

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establishment and survival is best determined by adult presence on rosettes in October. Adult density is difficult to determine because the flea-beetles are easily missed and jump from plants when disturbed.

REFERENCE

McEvoy, P.B., C. Cox, and E. Coombs. 1991. Successful biological control of ragwort, *Senecio jacobaea*, by introduced insects in Oregon. *Ecological Applications* 1:430–442.



Figure 86 *Longitarsus jacobaeae*



Figure 87 *Longitarsus jacobaeae* larva

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*Mecinus janthinus* Germar (Coleoptera: Curculionidae)

**DESCRIPTION AND LIFE CYCLE** Black adults, elongate in shape, and 5 mm long, emerge in May and begin mating after a short feeding period. Egg laying starts in May or early June and lasts until mid-July; eggs are laid into cavities chewed into the shoots. Larvae hatch in 6–7 days and mine the centre of the shoot. Larvae feed on the shoot, develop over the next 3–5 weeks, and then pupate in the stem. Stems generally swell and crack with the developing larvae inside, and the stem portion above the larvae often dies. Pupal development occurs over the next 30–40 days and adults emerge approximately 2 weeks later. Adults overwinter in their pupal cells in the stem.

**WEEDS ATTACKED** Yellow toadflax and Dalmatian toadflax.

**HABITAT** Hot, dry conditions are preferred; grasslands or open forest with grassland are suitable. Large-stemmed plants generally support larval development for the entire growing season.

**COLLECTION, SHIPPING, AND HANDLING** Use light sweep nets to collect adults from May until July. Follow standard shipping and handling procedures for insects.

**RELEASE** Follow standard release procedures for insects.

**MONITORING** Adult weevils can be observed on plant material from May until July. To determine larvae, pupae, and unemerged adults' presence, cut open toadflax stems longitudinally, from June to the spring of the following year. Affected stems are swollen and cracked and often dead above the larvae.

**REFERENCE**

Jeanneret, P. and D. Schroeder. 1991. *Mecinus janthinus* Germar (Col.: Curculionidae): a candidate for the biological control of Dalmatian and yellow toadflax in North America. European Station Report. C.A.B. International Institute of Biological Control, Delemont, Switzerland. 36 p.



Figure 88 *Mecinus janthinus*



Figure 89 *Mecinus janthinus* larva

*Metzneria paucipunctella* Zeller  
(Lepidoptera: Gelechiidae)

DESCRIPTION AND LIFE CYCLE Pale brown adults, 1 cm long, emerge in late May to early August, and live approximately 3 weeks. Mating begins immediately and eggs are laid into closed flower buds within 2–3 days. Larvae hatch in 10–12 days, coinciding with the opening of knapweed. Larvae are 4–5 mm long, cream coloured, with distinct body segments, a brown head capsule, and several pairs of legs. Larvae feed on the flower base (receptacle) and immature and mature seeds, overwintering in the seedhead. Pupation begins in April or early May and lasts for 3–4 weeks.

WEED ATTACKED Spotted knapweed.

HABITAT Does not tolerate severe winter conditions.

COLLECTION, SHIPPING, AND HANDLING Collect larvae by picking spotted knapweed stems with intact, infested seedheads in late summer and early fall, or in early spring (March to April) before emergence. Avoid storing in bulk; the native predatory mite *Pynotes* sp. will rapidly spread through the plant material.

RELEASE Select a release site at approximately the same elevation as the collection site, and avoid areas that are subject to frost pockets. *Metzneria* will not co-exist in the same seedhead as *Urophora affinis*; the moth larvae will consume up to two-thirds of the *Urophora* larvae.

MONITORING Check for adults with sweep nets in June and July. Check for establishment from October to May by examining the base of the seedhead for larvae. There will normally be signs of larval feeding in the attacked heads and several seeds may be webbed together. In the release year, you will likely encounter infested heads only within a few metres of the release point.

REFERENCE

Englert, W. 1971. *Metzneria paucipunctella* Zel. (Gelechiidae, Lepidoptera): a potential insect for the biological control of

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*Centaurea stoebe* L. in Canada. Weed Projects for Canada Progress Report No. 28. European Station Report. Commonwealth Institute of Biological Control, Delemont, Switzerland. 12 p.



Figure 90 *Metzneria paucipunctella* moth



Figure 91 *Metzneria paucipunctella* larva in spotted knapweed seedhead

*Pelochrista medullana* (Strig.) (Lepidoptera: Tortricidae)

DESCRIPTION AND LIFE CYCLE Grey and mottled-brown adults, 14–21 mm long, emerge from mid-June to the end of July, with peak emergence in mid-July. Mating begins immediately and continues over their 12 to 13 day life span. Females begin laying eggs 2–3 days after mating begins. Eggs hatch in 7–9 days, and larvae migrate to the rosette and burrow into the root collar; larvae will only develop on plants in the rosette stage. Larvae become dormant over the winter, and briefly resume development in the spring before pupation.

WEEDS ATTACKED Diffuse knapweed and spotted knapweed; shows a preference for diffuse knapweed.

HABITAT The moth requires moderately moist sites with a dense stand of diffuse knapweed. It prefers habitats similar to the Ponderosa Pine biogeoclimatic zone in its native Europe. It has not established well in British Columbia.

COLLECTION, SHIPPING, AND HANDLING Vacuum aspirate adult moths. Because of the similarity of *Pelochrista* to many native moths, rearing and collection in tented plots is suggested to ensure correct identity. Follow standard shipping and handling techniques for insects.

RELEASE Follow standard release procedures for insects.

MONITORING Check roots in late August or September after larvae have established, or check in spring before emergence. Check the outside of the root for feeding damage, frass, larvae, pupae, or unemerged adults by lightly scraping dirt from the outer surface with a knife.

REFERENCE

Gassmann, A., D. Schroeder, and H. Muller. 1982. Investigations on *Pelochrista medullana* (Stgr.) (Lep.: Tortricidae), a possible biocontrol agent of diffuse and spotted knapweed, *Centaurea diffusa* Lam. and *C. maculosa* Lam. (Compositae) in North America. European Station Report. Commonwealth Institute of Biological Control, Delemont, Switzerland. 18 p.



Figure 92 *Pelochrista medullana* moth

*Pterolonche inspersa* Strg. (Lepidoptera: Pterolonchidae)

**DESCRIPTION AND LIFE CYCLE** Grey-white adults, 14–28 mm long, emerge from June to early September with peak emergence in mid-August. Mating begins immediately and egg laying starts within 5–9 days and continues over the 15 to 16 day life span. Eggs hatch 8–16 days after they are laid and larvae migrate down the root core and feed in the centre of the root. Up to four larvae will feed on the same root through the fall. Larvae overwinter in a silky cocoon on the root and resume development in the spring. Pupation occurs in late spring.

**WEEDS ATTACKED** Diffuse knapweed and spotted knapweed; shows a strong preference for diffuse knapweed.

**HABITAT** Requires hot, dry habitats with low to moderate densities of diffuse knapweed.

**COLLECTION, SHIPPING, AND HANDLING** Collect adult moths using vacuum aspirators. Because of the similarity of *Pterolonche* to many native moths, rearing and collection in tented plots is suggested to ensure correct identity. Follow standard shipping and handling techniques for insects.

**RELEASE** Follow standard release procedures for insects. *Pterolonche* larvae will consume *Sphenoptera* larvae and pupae and should not be released in new *Sphenoptera* area until the latter are established.

**MONITORING** Check roots in late August or September after larvae have established, or check in spring before emergence. Check the outside of the root for feeding damage, frass, larvae, pupae, or unemerged adults by lightly scraping dirt from the outer surface with a knife.

**REFERENCE**

Dunn, P.H., S.S. Rosenthal, G. Campobasso, and S.M. Tait. 1984. A petition for the release of *Pterolonche inspersa* Strg. (Lepidoptera: Pterolonchidae) in the United States as a biological control agent for *Centaurea diffusa* Lam. U.S. Department of Agriculture, Agriculture Research Service, Biological Control of Weeds Research Unit, Washington, D.C. 29 p.



Figure 93 *Pterolonche inspersa* moth



Figure 94 *Pterolonche inspersa* larva

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*Puccinia acroptili* P. & H. Syd. (Uredinales: Pucciniaceae)

DESCRIPTION AND LIFE CYCLE Rust-coloured pustules form on the plants 12–16 days after inoculation. Stem and leaf infections occur; pustules cover the surface, impairing or preventing photosynthesis. Pustules produce spores that spread by wind and water and inoculate other plants.

WEED ATTACKED Russian knapweed.

HABITAT Capable of inhabiting all areas where Russian knapweed occurs.

COLLECTION, SHIPPING, AND HANDLING Collect plant material infected with rust. Follow standard shipping and handling procedures for biological control agents on plant material.

RELEASE Follow standard release procedures for biological control agents on plant material. *Puccinia* distributes itself well and can be found in most areas where Russian knapweed occurs. Check for presence before making a redistribution at a new location.

MONITORING Determine the presence and extent of attack by conducting visual checks of rust pustules on the plant material in August and September.

REFERENCE

Mortensen, K., P. Harris, and W.K. Kim. 1991. Host ranges of *Puccinia jaceae*, *P. centaureae*, *P. acroptili*, and *P. carthami*, and the potential value of *P. jaceae* as a biological control agent for diffuse knapweed (*Centaurea diffusa*) in North America. Canadian Journal of Plant Pathology 13:71–80.



Figure 95 *Puccinia acroptili* rust pustules on Russian knapweed

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*Puccinia chondrillina* (Uredinales: Pucciniaceae)

**DESCRIPTION AND LIFE CYCLE** Rust-brown coloured pustules, surrounded by a yellow halo, infest upper and lower leaf surfaces of seedlings and rosettes produced from spring to the fall. Spores develop in the pustules and are dispersed by wind and rain to infest new plant material; new pustules form on the plants 12–16 days after inoculation. Seedling plants can be killed by heavy infections, and all infected plants show reduced growth, vigour, and reproductive potential. As rosette leaves die from the infection, the fungus can spread onto flowering stems and buds; these pustules are dark brown and remain dormant over the winter. In spring, the sexual stage of the fungus is produced; clusters of yellow fruiting bodies form on rosette leaves, which in turn produce airborne spores that initiate the rust-brown pustules.

**WEED ATTACKED** Rush skeletonweed.

**HABITAT** Capable of inhabiting all areas where rush skeletonweed occurs. Some varieties of rush skeletonweed are resistant to the fungal infection.

**COLLECTION, SHIPPING, AND HANDLING** Collect plant material infected with rust. Follow standard shipping and handling procedures for biological control agents on plant material.

**RELEASE** Follow standard release procedures for biological control agents on plant material. *Puccinia* distributes itself well and can be found in most areas where rush skeletonweed occurs. Check for presence before making a redistribution at a new location.

**MONITORING** Determine the presence, density, and extent of attack by conducting visual checks of rust pustules on the plant material in August and September.

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REFERENCE

Cheney, T.M., G.L. Piper, G.A. Lee, W.F. Barr, D.C. Thill, R.B. Hawkes, R.F. Line, R.R. Old, L.L. Craft, Jr., and E.B. Adams. 1981. Rush skeletonweed: biology and control in the Pacific Northwest. Current Information Series No. 585. University of Idaho, College of Agriculture, Cooperative Extension Service, Agriculture Experiment Station, Moscow, Idaho. 4 p.



Figure 96 *Puccinia chondrillina* rust pustules on rush skeletonweed

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*Puccinia jaceae* Oth. (Uredinales: Pucciniaceae)

**DESCRIPTION AND LIFE CYCLE** Rust-coloured pustules form on the plants 12–16 days after inoculation. A yellow halo forms around the pustules when they are small. The fungi forms moderate (15–20% of the surface area) infestations of stem and leaves. Rust pustules vary in size from 0.4 to 1.3 mm in diameter. The rust spreads by wind-spread spores throughout the growing period of knapweed.

**WEEDS ATTACKED** Diffuse knapweed and spotted knapweed.

**HABITAT** Capable of inhabiting all areas where diffuse knapweed and spotted knapweed occur.

**COLLECTION, SHIPPING, AND HANDLING** Collect plant material infected with rust. Follow standard shipping and handling procedures for plant material.

**RELEASE** Follow standard release procedures for biological control agents on plant material. *Puccinia* distributes itself well and can be found in most areas where knapweed occurs. Check for presence before making a redistribution at a new location.

**MONITORING** Determine presence and extent of attack by conducting visual checks of rust pustules on the plant material in August and September.

**REFERENCE**

Mortensen, K., P. Harris, and W.K. Kim. 1991. Host ranges of *Puccinia jaceae*, *P. centaureae*, *P. acoptili*, and *P. carthami*, and the potential value of *P. jaceae* as a biological control agent for diffuse knapweed (*Centaurea diffusa*) in North America. Canadian Journal of Plant Pathology 13:71–80.



Figure 97 *Puccinia jaceae* rust pustules on knapweed

*Rhinocyllus conicus* Froelich (Coleoptera: Curculionidae)

**DESCRIPTION AND LIFE CYCLE** Dark brown, oval-shaped adults, 3–7 mm long, become active in the spring and disperse to find thistles on which to feed. Adults feed on leaves until early summer when mating and egg laying begin. The weevils lay eggs on the underside of the thistle flower bud. Larvae hatch 6–9 days after egg laying and bore directly into the flower bud. Mature larvae form hard cells in the flower head in which they pupate; pupation lasts 8–14 days and adults begin emerging in mid-summer. Those emerging while day is more than 16 hours long complete a second generation. The majority, however, hibernate in soil litter over the winter. Adults can survive for up to 15 months; they are adept at finding isolated pockets of nodding thistle.

**WEEDS ATTACKED** Plumeless thistle, nodding thistle, and to a lesser extent Canada thistle. One strain also attacks bull thistle, but has not established well in British Columbia.

**HABITAT** Occupies a habitat that is contiguous with the current distribution of plumeless and nodding thistle.

**COLLECTION, SHIPPING, AND HANDLING** Collect flower heads after flowering: wearing gloves, pull off the first heads to turn brown, but before the wind-carried seed is released. Standard shipping and handling requirements should be followed. Because insects will complete their development quickly and emerge to hibernate, place the heads at the new site as quickly as possible.

**RELEASE** Follow standard release procedures for biological control agents in plant material.

**MONITORING** Check thistle flower buds for weevil eggs on the flower bracts in early summer, or open the first flowers to turn brown after flowering to check for larvae. Pupal chambers can also be found in old flower heads in the fall after adult emergence.

**REFERENCE**

Zwolfer, H. and P. Harris. 1984. Biology and host specificity of *Rhinocyllus conicus* (Froel.) (Col., Curculionidae), a successful

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agent for biocontrol of the thistle, *Carduus nutans* L. Technical Communication No. 4. Commonwealth Institute of Biological Control, Delemont, Switzerland, pp. 36–62.

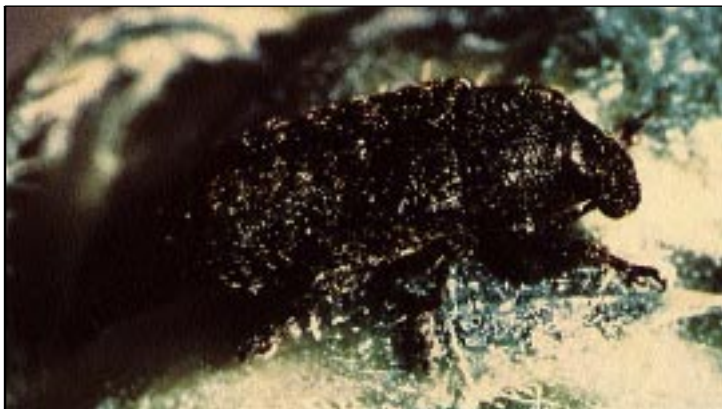


Figure 98 *Rhinocyllus conicus*



Figure 99 *Rhinocyllus conicus* larva

*Sphenoptera jugoslavica* Obenb. (Coleoptera: Buprestidae)

DESCRIPTION AND LIFE CYCLE Dark copper to black adults, elongate-oval shaped and 7–10 mm long, emerge in July, just before diffuse knapweed flowers form. Males emerge 1 week before females. Mating begins within a few days of female emergence and continues over their 4 week life span. Egg laying begins 5–12 days after mating. Larvae hatch 2–4 weeks after egg laying and burrow through the stem, down into the root crown and through the root core. Larvae overwinter in the root and begin pupation in mid-May of the following year. Pupae are initially white, and then darken to black.

WEEDS ATTACKED Diffuse knapweed and spotted knapweed; only rarely attacks spotted knapweed.

HABITAT Requires an arid environment with a summer drought period. Best adapted to dry subzones of the Bunchgrass and Ponderosa Pine biogeoclimatic zones. Sites with aspen, Douglas-fir, or lodgepole pine are likely too moist.

COLLECTION, SHIPPING, AND HANDLING Collect adults on hot, dry summer evenings from mid-July to mid-August with sweep nets. Because of the hardness of dried knapweed stems, canvas bag sweep nets should be used in place of the standard cotton. Adults are usually resting on knapweed foliage, which must be brushed firmly with the sweep net to be effective. Collection on rainy or cool days is ineffective because beetles position themselves near the ground. Follow standard shipping and handling procedures for insects.

RELEASE Follow standard release procedures for insects.

MONITORING Check roots in the spring following release by digging out an entire root and slicing it in half to check for larvae. Larvae are found in the centre of the root; infested roots will generally be swollen, but on large plants this may be inconspicuous.

REFERENCE

Zwolfer, H. n.d. Investigations on *Sphenoptera (Chilostetha) jugoslavica* Obenb. (Col: Buprestidae), a possible biocontrol agent of the

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weed *Centaurea diffusa* Lam. (Compositae) in Canada. European Station Report, Commonwealth Institute of Biological Control, Delemont, Switzerland. 37 p.



Figure 100 *Sphenoptera jugoslavica*



Figure 101 *Sphenoptera jugoslavica* larva

*Subanguina picridis* Kirj. & Ivan (Nematoda: Tylenchidae)

**DESCRIPTION AND LIFE CYCLE** This nematode (not visible to the unaided eye) forms 5–12 mm diameter galls on the leaves, stem, and root collar. Adults are active in the plants during the active growing period of the knapweed. Nematode reproduction and early development occur in the plant galls. Juvenile nematodes are active in the plants until dying plant material desiccates, at which time they enter a stage of quiescence. This dormant period is broken by the return of moisture (typically the following spring), and the juveniles enter the soil out of the decaying plant material. Juveniles require at least 1 month of free-living conditions in the soil before they become infective. Those Russian knapweed plants that are attacked are typically slow growing and retain their active growing tissue (roots and shoots) at or near the soil surface for 2–5 weeks.

**WEED ATTACKED** Russian knapweed.

**HABITAT** Gall formation generally only occurs at sites with cool, moist spring weather.

**COLLECTION, SHIPPING, AND HANDLING** Collect plant material infected with nematode galls. Follow standard shipping and handling procedures for biological control agents in plant material.

**RELEASE** Follow standard release procedures for biological control agents in plant material.

**MONITORING** Look for stem and root galls from early to late summer. Positive identification of the nematode can be made in the laboratory under a microscope.

**REFERENCE**

Watson, A.K. 1986. The biology of *Subanguina picridis*, a potential biological control agent of Russian knapweed. *Journal of Nematology* 18:149–154.



Figure 102 *Subanguina picridis* stem gall on Russian knapweed stem

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*Terellia virens* (Loew.) (Diptera: Tephritidae)

DESCRIPTION AND LIFE CYCLE Adults, clear-winged, with yellow or greenish yellow bodies, emerge about 4 weeks before spotted knapweed flowering. Mating and egg laying begin with the onset of hot, sunny weather and continue for the length of the adults' 48 day life. Yellow-brown larvae emerge within 3–5 days and move into the flower head to feed on seeds. Larvae develop and feed within a single, developing seed early in their development, later outgrowing the confines of the seed and feeding on others within the seedhead.

*T. virens* has one and sometimes two generations per year. Most larvae overwinter in the seedhead and pupate in the spring, but some continue to develop, completing pupation in about 14 days, with second adult emergence in late summer. Pupae are yellow-brown and are enclosed within a yellow-brown case.

WEED ATTACKED Spotted knapweed.

HABITAT Prefers south-facing slopes and dry locations.

COLLECTION, SHIPPING, AND HANDLING Collect larvae by picking spotted knapweed stems with intact, infested seedheads in late summer and early fall, or in early spring before emergence. Avoid storing in bulk; the native predatory mite *Pynotes* sp. will rapidly spread through the plant material. Sweep nets can be used to collect adults. Follow standard shipping and handling procedures.

RELEASE Follow standard release procedures for biological control agents in plant material.

MONITORING Check for flies in late June to August by sweeping the release area; flower heads can be checked for larvae throughout the fall and spring. The yellow-brown *Terellia* larvae and pupae can be distinguished from *Urophora*, which have white larvae and pupae in a brown pupal case, and from *Chaetorellia*, which have white or yellow larvae, pupae, and pupal cases.

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REFERENCE

Groppe, K. and K. Marquardt. 1989. *Terellia virens* (Loew.) (Diptera: Tephritidae), a suitable candidate for the biological control of diffuse and spotted knapweed in North America. European Station Report. C.A.B. International Institute of Biological Control, Delemont, Switzerland. 28 p.



Figure 103 *Terellia virens*



Figure 104 *Terellia virens* larvae in knapweed seedhead

*Trichosirocalus horridus* (Panzer)  
(Coleoptera: Curculionidae)

DESCRIPTION AND LIFE CYCLE Brown, spherical-shaped adults, 3–4 mm long, emerge to feed on the upper and heads at the start of thistle bloom. Adults gather at the base of the flower buds to feed and mate. Mating and egg laying occur in early spring and are largely finished by the time balsam root (*Balsamorhiza sagittata*) is in flower. Larvae mine and feed on vegetative buds as they develop.

WEEDS ATTACKED Plumeless thistle and nodding thistle.

HABITAT Dense stands are required because weevils distribute themselves for egg laying by walking. They are generally capable of inhabiting all areas in which plumeless and nodding thistle occur. They are most effective in areas with long, cool springs.

COLLECTION, SHIPPING, AND HANDLING Collect adults by tapping the upper thistle stems over a tray; the beetles feign death and drop onto the tray. Follow standard shipping and handling procedures.

RELEASE Follow standard release procedures for insects.

MONITORING Check thistle flower buds early in the summer for weevils on flower bracts, or bend flowering thistle over a tray and tap the stem. The weevils will feign death and drop onto the tray. The rosette crown can also be checked for necrosis caused by the larvae in the spring. By pulling on the central leaves in the crown you can easily see the blackened necrotic crown area and sometimes the larvae.

REFERENCE

Harris, P. 1984. *Carduus nutans* L., nodding thistle and *C. acanthoides* L., plumeless thistle (Compositae). In Biological Programmes Against Insects and Weeds in Canada 1969–1980. Kelleher, J.S. and M.A. Hulme (editors). Commonwealth Agricultural Bureaux, London, England, pp. 115–126.



Figure 105 *Trichosirocalus horridus*

*Tyria jacobaeae* (L.) (Lepidoptera: Arctiidae)

**DESCRIPTION AND LIFE CYCLE** Adults, 0.5–2.5 cm long, with deep red (cinnabar) and black forewings, emerge in late spring. Mating begins soon after emergence and pale yellow eggs are laid on the underside of ragwort leaves. Cinnabar caterpillars, black and ringed with orange-gold bands, feed on foliage and buds over the entire tansy ragwort plant, from the onset of bolting to the bud stage. Larval movement increases with development and, in the latter stages, larvae move between plants; larvae take approximately 30 days to develop. Larvae can achieve up to 40% defoliation of tansy ragwort plants. Pupation takes place in ground litter, crevices, or small holes in the ground or decaying wood. The moth overwinters in the pupal stage.

**WEED ATTACKED** Tansy ragwort.

**HABITAT** Adapted to a wide variety of habitats in which tansy ragwort is found. Dense stands are preferred to allow larvae to move between plants. The cinnabar moth does not survive in water-logged sites or sites flooded in the winter.

**COLLECTION, SHIPPING, AND HANDLING** Collect by hand picking larvae or shaking larvae from plants into a collection tray or funnel. When plants are shaken some larvae may fall to the ground; however, they will quickly recover and climb onto the plants. Care should be taken not to walk on larvae that fall to the ground. Follow standard shipping and handling procedure for insects.

**RELEASE** Follow standard release procedure for insects. Take care not to walk on larvae that fall onto the ground at the release site.

**MONITORING** Check for caterpillars at release site in late June through July the year following release. Alternatively, look for the bright red moths in early to mid-spring.

**REFERENCES**

- Issacson, D.L. 1973. A life table for the cinnabar moth, *Tyria jacobaeae*, in Oregon. *Entomophaga* 18:291–303.
- McEvoy, P.B., C. Cox, and E. Coombs. 1991. Successful biological control of ragwort, *Senecio jacobaea*, by introduced insects in Oregon. *Ecological Applications* 1:430–442.

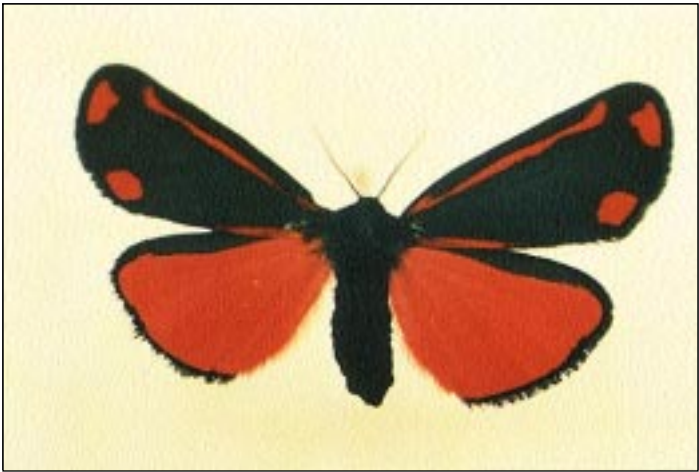


Figure 106 *Tyria jacobaeae* moth



Figure 107  
*Tyria jacobaeae*  
caterpillars on  
tansy ragwort

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*Urophora affinis* Frauenfeld (Diptera: Tephritidae)

**DESCRIPTION AND LIFE CYCLE** Adults, 1–3 mm long, are dark bodied, with clear wings faintly marked with a bar. The wings are often held together in line with the body while the fly is at rest. Females have a prominent black ovipositor. Adults emerge in early to mid-June as flower buds are developing. Mating begins immediately and egg laying starts 3 days later. Eggs hatch within 3–4 days and the larvae burrow into the flower head. The presence of the larvae stimulates the plants to form woody galls around the larvae. The energy needed to form galls reduces the seed and flower production in the plants. *Urophora affinis* presence can reduce seed production by 90%. Larvae feed on the inner tissue of the galls and usually overwinter in the larval form in the seedhead. Some of the early developing flies will pupate in mid-August and a second generation of adults will emerge approximately 14 days later. Most larvae, however, require a cold phase to induce pupation, which normally occurs in late spring to early summer the next year.

**WEEDS ATTACKED** Diffuse knapweed and spotted knapweed.

**HABITAT** Contiguous with diffuse and spotted knapweed distribution. It generally does better in mesic habitats and wetter years.

**COLLECTION, SHIPPING, AND HANDLING** Collect larvae by picking knapweed stems with intact, infested seedheads in the fall (September or October) or in early spring (March to May) before pupation. Avoid storing in bulk; the native predatory mite *Pynotes* sp. will rapidly spread through the plant material. Sweep nets can be used to collect adults in June and July.

**RELEASE** Follow standard release procedures for biological control agents in plant material. The fly establishes best on the species from which it was collected; use flies from diffuse knapweed for release on diffuse knapweed and likewise for spotted knapweed. *Urophora* is already present in most stands in British Columbia; check old seedheads for the presence of galls before making additional releases.

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MONITORING Check for adult flies in June to July with sweep nets, or examine the mature flower heads for galls throughout the year. A woody gall from the current year will contain a larva; heads from the previous year will contain empty gall shells.

REFERENCE

Roze, L.D. and B.D. Fraser. 1978. Biological control of diffuse and spotted knapweed by *Urophora affinis* and *U. quadrifasciata* in British Columbia. *In* Proceedings of 1st Rangeland Congress, Denver, Colorado, pp. 664–666.



Figure 108  
*Urophora affinis*  
female with prominent  
ovipositor

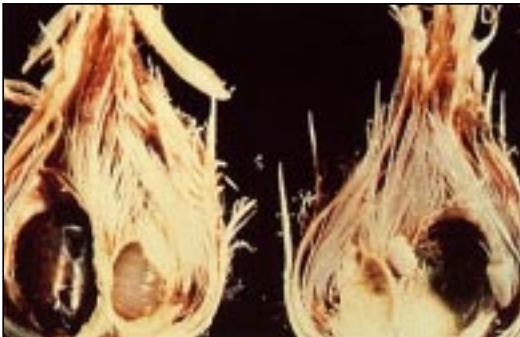


Figure 109 *Urophora affinis* larvae in woody  
seedhead gall

*Urophora cardui* (L.) Diptera: Tephritidae)

DESCRIPTION AND LIFE CYCLE Adults are black bodied, with clear wings marked with a ``W'' pattern. Females have a prominent ovipositor. Adults emerge from May to July and begin mating immediately. Females lay eggs into the growing tips of the thistle shoots 1–2 days after emergence. Eggs hatch in 4–8 days and larvae burrow into the stem tissue. Large galls form in the thistle's stem tissue about 15 days after egg laying and enlarge over a 50 to 60 day period. Galls contain 1–30 larvae, each enclosed in its own chamber. The larvae overwinter in the galls, pupating and emerging as adults in the following spring.

WEED ATTACKED Canada thistle.

HABITAT These flies are restricted to moist to wet low-elevation sites with at least partial shade. River edges and lake shores with a partial overstory of trees are sufficient.

COLLECTION, SHIPPING, AND HANDLING Collect larvae and pupae in gall tissue in late summer until snow cover. Follow standard shipping and handling procedures for biological control agents in plant material.

RELEASE Follow standard release procedures for biological control agents in plant material. Because females prefer to lay eggs into host plants 50–100 cm tall, a stand of this height would be beneficial.

MONITORING Adult flies are not readily visible on the plants and do not congregate in large numbers for sweep netting. To determine presence, look for new galls in July and August.

REFERENCES

- Forsyth, S.F., D.P. Peschken, and A.K. Watson. 1986. Biological control of Canada thistle with *Urophora cardui* (L.). Canadex 641.613. Agriculture Canada, Ottawa, Ontario, 4 p.
- Peschken, D.P. and J.L. Derby. 1992. Effect of *Urophora cardui* (L.) (Diptera: Tephritidae) and *Ceutorhynchus litura* (F.) (Coleoptera: Curculionidae) on the weed Canada thistle, *Cirsium arvense* (L.) Scop. Canadian Entomologist 124:145–150.



Figure 110 *Urophora cardui* larvae in  
Canada thistle stem gall

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*Urophora quadrifasciata* (Meigan) (Diptera: Tephritidae)

**DESCRIPTION AND LIFE CYCLE** Adults are 1–3 mm long, black bodied, with black wings striped in a distinctive “UV” pattern. This fly usually holds its wings in a “V” shape from its body while at rest. Females have a prominent black ovipositor. Adult flies emerge in late June to early July as knapweed flower buds are developing. Mating begins immediately and continues over a 3 week period; egg laying begins 3 days later. Eggs hatch within 3–4 days and the larvae burrow into the flowers. The presence of the larvae stimulates the flower's ovary walls to form galls around the larvae. The energy needed to form galls reduces the seed and flower production in the plants. The larvae feed on the galls and almost entirely consume them, leaving only a thin, papery tissue. Larvae pupate inside the galls 20–25 days after hatching and a second generation of adults emerges in early to mid-August. The second generation overwinters as larvae inside the seedhead and emerges the following spring.

**WEEDS ATTACKED** Diffuse knapweed and spotted knapweed.

**HABITAT** Contiguous with diffuse and spotted knapweed distribution. Larvae are intolerant of severe winter conditions with partial or no snow cover.

**COLLECTION, SHIPPING, AND HANDLING** Collect larvae by picking knapweed stems with intact seedheads in infested areas in fall (September or October) or early spring (March to May) before pupation. Avoid storing in bulk; the native predatory mite *Pynotes* sp. will rapidly spread through the material. Sweep nets can be used to collect adults in June and July.

**RELEASE** Follow standard release procedures for biological control agents in plant material. The fly establishes best on the species from which it was collected; use those collected from diffuse knapweed for release on diffuse knapweed and likewise for spotted knapweed.

*Urophora* is already present in most stands in British Columbia; check old seedheads for the presence of galls before making additional releases.

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MONITORING Check for adult flies in late June to August with sweep nets, or examine mature flower heads for papery galls throughout the year. A gall from the current year will contain a larva, and heads from the previous year will contain empty gall shells.

REFERENCE

Roze, L.D. and B.D. Fraser. 1978. Biological control of diffuse and spotted knapweed by *Urophora affinis* and *U. quadrifasciata* in British Columbia. In Proceedings of 1st Rangeland Congress, Denver, Colorado, pp. 664–666.



Figure 111  
*Urophora  
quadrifasciata*  
female with  
prominent  
ovipositor



Figure 112  
*Urophora  
quadrifasciata*  
larvae in  
papery  
seedhead gall

*Urophora solstitialis* L. (Diptera: Tephritidae)

**DESCRIPTION AND LIFE CYCLE** Emergence of the black-bodied adults, with a distinctive pattern on the wings, coincides with the flower budding on plumeless thistle in the late spring to early summer. Eggs are laid singly into developing floret tubes inside the immature flower buds in June or July. Larvae mine down the flower tube, through the ovule, and into the receptacle. The plant responds to larval feeding by developing gall tissue around the larvae in the receptacle. If multiple attacks occur in a single flower head, the galls will fuse together into a single large gall; in all circumstances the gall tissue hardens with age and often encloses ovules and other floral tissue. Early developing larvae pupate and adults emerge in late summer; mating and egg laying continue into the fall as long as suitable flower buds are available. Larvae overwinter in the galled seedheads and continue development in the spring.

**WEEDS ATTACKED** Plumeless thistle; occasionally attacks nodding thistle.

**HABITAT** No information on habitat preference is currently available.

**COLLECTION, SHIPPING, AND HANDLING** Collect larvae by picking knapweed stems with intact, galled flower heads in the fall, or in early spring before fly emergence.

**RELEASE** Follow standard release procedures for biological control agents in plant material.

**MONITORING** Check for adult fly presence in the summer with sweep nets, or examine mature flower heads for galls throughout the year. A gall from the current year will contain a larva; heads from the previous year will contain empty gall shells.

**REFERENCE**

Moller-Joop, H. and D. Schroeder. 1986. *Urophora solstitialis* (L.) (Diptera:Tephritidae): a candidate for the biological control of plumeless thistle (*Carduus acanthoides* L.) in Canada. Final Screening Report. European Station Report. Commonwealth Institute of Biological Control, Delemont, Switzerland. 23 p.



Figure 113 *Urophora solstitialis* female with prominent ovipositor

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*Urophora stylata* (L.) (Diptera: Tephritidae)

**DESCRIPTION AND LIFE CYCLE** Adults, 4–8 mm long, are dark bodied with clear wings. The wings are marked with bands forming a ``D'' at the tip with a small break at the bottom; the band near the middle is often incomplete or broken. Females have a prominent ovipositor, 3–4 mm long. Adult males emerge in early June and establish territories over bolting thistle plants. Mating occurs before bloom on the thistle (July) and eggs are laid into the flower head. Larvae hatch after a week and burrow into the flowers where the surrounding tissue forms into a hard, woody gall. Several galls can form in a single flower head and will tend to coalesce to form a large gall with many compartments. Larvae overwinter in the gall and pupate in the following spring.

**WEED ATTACKED** Bull thistle.

**HABITAT** Capable of inhabiting all the areas where bull thistle is currently established. Fly colonies only survive, however, where there is a stable bull thistle population.

**COLLECTION, SHIPPING, AND HANDLING** Collect seedheads containing galls from late August to November; squeeze mature flower heads (wear gloves) to detect the hard galls, then collect them by pulling off the head. Follow standard shipping and handling procedures for biological control agents in plant material.

**RELEASE** Place the galls on the ground at the new location in the fall, or store over the winter in refrigeration (4° C) for release in early spring. Scatter the galls over a small area to reduce predation by mice. Keep refrigerated galls moist but do not let them mould. About 50 galls or 200 flies are adequate to establish a new colony.

**MONITORING** Check establishment by examining heads for galls; larvae can be seen if the galls are cut open.

**REFERENCE**

Harris, P. and A.T.S. Wilkinson. 1986. Biological control of bull thistle with *Urophora stylata* Fabr. Canadex 641.613. Agriculture Canada, Ottawa, Ontario.



Figure 114 *Urophora stylata* female with prominent ovipositor



Figure 115 *Urophora stylata* larvae in bull thistle gall

APPENDIX 1.  
CURRENT STATUS OF BIOLOGICAL CONTROL AGENTS

Biological control agents approved for release in British Columbia are classified into one of three categories of availability:

- available for general distribution (G)
- pending release and distribution (P)
- under propagation or limited field distribution and not available for general distribution (N).

The following is the status of the biological control agents as of January 1, 1994:

<i>Aceria chondrillae</i> .....	N
<i>Agapeta zoegana</i> .....	G
<i>Agrilus hyperici</i> .....	N
<i>Aphis chloris</i> .....	N
<i>Aphthona cyparissiae</i> .....	G
<i>Aphthona czwalinae</i> .....	P
<i>Aphthona flava</i> .....	N
<i>Aphthona lacertosa</i> .....	P
<i>Aphthona nigriscutis</i> .....	G
<i>Aplocera plagiata</i> .....	G
<i>Brachypterolus pulicarius</i> .....	G
<i>Calophasia lunula</i> .....	N
<i>Ceutorhynchus litura</i> .....	N
<i>Chaetorellia acrolophi</i> .....	N
<i>Chrysolina hyperici</i> .....	G
<i>Chrysolina quadrigemina</i> .....	G
<i>Cochylis atricapitana</i> .....	N
<i>Cyphocleonus achates</i> .....	G
<i>Eteobalea intermediella</i> .....	N
<i>Eteobalea serratella</i> .....	N
<i>Galerucella californiensis</i> .....	N
<i>Galerucella pusilla</i> .....	P
<i>Gymnaetron antirrhini</i> .....	G
<i>Hylemya seneciella</i> .....	N
<i>Hyles euphorbiae</i> .....	N

<i>Hylobius transversovittatus</i> . . . . .	P
<i>Larinus minutus</i> . . . . .	N
<i>Larinus obtusus</i> . . . . .	N
<i>Larinus planus</i> . . . . .	G
<i>Lobesia euphorbiana</i> . . . . .	G
<i>Longitarsus flavicornis</i> . . . . .	G
<i>Longitarsus jacobaeae</i> . . . . .	G
<i>Mecinus janthinus</i> . . . . .	G
<i>Metzneria paucipunctella</i> . . . . .	G
<i>Pelochrista medullana</i> . . . . .	N
<i>Pterolonche inspersa</i> . . . . .	N
<i>Puccinia acroptili</i> . . . . .	G
<i>Puccinia chondrillina</i> . . . . .	G
<i>Puccinia jaceae</i> . . . . .	G
<i>Rhinocyllus conicus</i> . . . . .	G
<i>Sphenoptera jugoslavica</i> . . . . .	G
<i>Subanguina picridis</i> . . . . .	N
<i>Terellia virens</i> . . . . .	N
<i>Trichosirocalus horridus</i> . . . . .	G
<i>Tyria jacobaeae</i> . . . . .	G
<i>Urophora affinis</i> . . . . .	G
<i>Urophora cardui</i> . . . . .	N
<i>Urophora quadrifasciata</i> . . . . .	G
<i>Urophora solstitialis</i> . . . . .	N
<i>Urophora stylata</i> . . . . .	G

## APPENDIX 2. BIOLOGICAL CONTROL RELEASE FORM

### BIOLOGICAL CONTROL RELEASE RECORD

**AGENT**

Site Number:

1. Insect Species:

Immediate Source: \_\_\_\_\_

Insect Origin: \_\_\_\_\_

2. Stage  Egg  Larva  Pupa  Adult  Other \_\_\_\_\_

3. Collection  Y/M/D 4. Release  Y/M/D 5. Time.  6. Number.

**RELEASE**

1. Target Weeds:  2. Purpose: Biocontrol  Collection Site

3. Land Owner \_\_\_\_\_ Phone ( ) \_\_\_\_\_

4. Local Contact \_\_\_\_\_ Phone ( ) \_\_\_\_\_

5. Released By \_\_\_\_\_  
Name Organization

**SITE**

1. Forest District:  Range Unit:  No.

2. Location: \_\_\_\_\_  
\_\_\_\_\_

3. BCGS (Forest Cover) Map No:

4. UTM System:  Zone  Easting  Northing

5. Weed Density:   

$< 1 \text{ plant/m}^2$	<input style="width: 50px;" type="text"/>	$2 - 5 \text{ plants/m}^2$	<input style="width: 50px;" type="text"/>
$6 - 10 \text{ plants/m}^2$	<input style="width: 50px;" type="text"/>	$> 10 \text{ plants/m}^2$	<input style="width: 50px;" type="text"/>

6. Size of Infestation:   

$< 001 \text{ ha}$	<input style="width: 50px;" type="text"/>	$0.01 - 0.04 \text{ ha}$	<input style="width: 50px;" type="text"/>
$0.04 - 0.25 \text{ ha}$	<input style="width: 50px;" type="text"/>	$0.25 - 0.5 \text{ ha}$	<input style="width: 50px;" type="text"/>
$0.5 - 1 \text{ ha}$	<input style="width: 50px;" type="text"/>	$> 1 \text{ ha}$	<input style="width: 50px;" type="text"/>

7. Weed Distribution: Continuous Stand  Scattered Patches

8. MAP REQUIRED FOR EACH RELEASE attached to this form  
(1 15,000 or 1 20 000 Forest Cover Map with the release Site clearly marked)

**BIOPHYSICAL DESCRIPTION**

1. Slope(%)  2. Aspect (deg.)  3. Elevation (m)

4. Biogeoclimatic classification:  Zone  Subzone  Variant  Site series

5. Comments: \_\_\_\_\_  
\_\_\_\_\_





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## INDEX

- Aceria chondrillae*, 55  
*Acroptilon repens*, 9  
*Agapeta zoegana*, 57  
*Agrilus hyperici*, 59  
*Anaitis plagiata*. See *Aplocera plagiata*
- Aphids  
    *Aphis chloris*, 61  
*Aphthona cyparissiae*, 63  
*Aphthona czwalinae*, 65, 69  
*Aphthona flava*, 67  
*Aphthona lacertosa*, 69  
*Aphthona nigriscutis*, 71, 63  
*Aplocera plagiata*, 73
- Beetles  
    *Agrilus hyperici*, 59  
    *Aphthona cyparissiae*, 63  
    *Aphthona czwalinae*, 65, 69  
    *Aphthona flava*, 67  
    *Aphthona lacertosa*, 69  
    *Aphthona nigriscutis*, 63, 71  
    *Brachypterolus pulicarius*, 75, 99  
    *Ceutorhynchus litura*, 79  
    *Chrysolina hyperici*, 83, 85  
    *Chrysolina quadrigemina*, 83, 85  
    *Cyphocleonus achates*, 89  
    *Galerucella calmariensis*, 95, 97  
    *Galerucella pusilla*, 97  
    *Gymnaetron antirrhini*, 99  
    *Hylobius transversovittatus*, 105  
    *Larinus minutus*, 107  
    *Larinus obtusus*, 109  
    *Larinus planus*, 111  
    *Longitarsus flavicornis*, 115  
    *Longitarsus jacobaeae*, 117  
    *Mecinus janthinus*, 119  
    *Rhinocyllus conicus*, 133  
    *Sphenoptera jugoslavica*, 125, 135  
    *Trichosirocalus horridus*, 141
- Biological control agents  
    collecting, 43  
    handling, 47  
    monitoring, 51  
    propagating, 43  
    releasing, 48  
    screening, 43  
    shipping, 47
- Biological control releases,  
    monitoring, 51
- Brachypterolus pulicarius*, 75
- Bull thistle, 19
- Butter and eggs. See Yellow toadflax
- Calophasia lunula*, 77
- Canada thistle, 17
- Carduus acanthoides*, 11
- Carduus nutans*, 13
- Centaurea diffusa*, 27
- Centaurea maculosa*, 15
- Ceutorhynchus litura*, 79
- Chaetorellia acrolophi*, 81
- Chondrilla juncea*, 31

- Chrysolina hyperici*, 83  
*Chrysolina quadrigemina*, 85  
 Cinnabar moth. *See* *Tyria jacobaeae*  
*Cirsium arvense*, 17  
*Cirsium vulgare*, 19  
*Cochylis atricapitana*, 87  
 Coleoptera. *See* Beetles  
 Common toadflax. *See* Yellow toadflax  
*Cynoglossum officinale*, 21  
*Cyphocleonus achates*, 89  
 Dalmatian toadflax, 37  
 Diffuse knapweed, 27  
 Diptera. *See* Flies  
*Eriophyse chondrillae*. *See* *Aceria chondrillae*  
*Eteobalea intermediella*, 91, 93  
*Eteobalea serratella*, 91, 93  
*Euphorbia esula*, 33  
 Flea-beetles. *See* Beetles  
 Flies  
*Chaetorellia acrolophi*, 81, 139  
*Hylemya seneciella*, 101  
*Terellia virens*, 139  
*Urophora affinis*, 81, 139, 145  
*Urophora cardui*, 147  
*Urophora quadrifasciata*, 81, 139, 149  
*Urophora solstitialis*, 151  
*Urophora stylata*, 153  
 Galls  
 Seedhead, 55, 145, 149, 151, 153  
 Stem, 55, 137, 147  
*Galerucella californiensis*, 95, 97  
*Galerucella pusilla*, 97  
 Goat weed. *See* St. John's wort  
*Gymnaetron antirrhini*, 99  
 Hawkmoth. *See* *Hyles euphorbiae*  
 Herbicides, 4  
 Hound's-tongue, 21  
*Hylemya seneciella*, 101  
*Hyles euphorbiae*, 103  
*Hypericum perforatum*, 35  
*Hylobius transversovittatus*, 105  
 Insects. *See* Aphids, Beetles, Flies, Moths  
 Integrated vegetation management, 3  
 Klamath weed. *See* St. John's wort  
 Knapweed, 15, 27  
*Larinus minutus*, 107  
*Larinus obtusus*, 109  
*Larinus planus*, 111  
 Leafy euphorbia. *See* Leafy spurge  
 Leafy spurge, 33  
*Linaria dalmatica*, 37  
*Linaria vulgaris*, 39  
*Lobesia euphorbiana*, 113  
*Longitarsus flavicornis*, 115  
*Longitarsus jacobaeae*, 117  
*Lythrum salicaria*, 23  
*Mecinus janthinus*, 119  
*Metzneria paucipunctella*, 121

## Mites

*Aceria chondrillae*, 55

## Moths

*Agapeta zoegana*, 57

*Aplocera plagiata*, 73

*Calophasia lunula*, 77

*Cochylis atricapitana*, 87

*Eteobalea intermediella*, 91, 93

*Eteobalea serratella*, 91, 93

*Hyles euphorbiae*, 103

*Lobesia euphorbiana*, 113

*Metzneria paucipunctella*, 121

*Pelochrista medullana*, 57, 123

*Pterolonche inspersa*, 125

*Tyria jacobaeae*, 143

Musk thistle. *See* Nodding thistle

## Nematodes

*Subanguina picridis*, 137

Nodding thistle, 13

*Pelochrista medullana*, 57, 123

Pink/purple-flowered weeds,  
7–24

Plumeless thistle, 11

*Pterolonche inspersa*, 125

*Puccinia acroptili*, 127

*Puccinia chondrillina*, 129

*Puccinia jaceae*, 131

Purple loosestrife, 23

*Rhinocyllus conicus*, 133

Rush skeletonweed, 31

Russian knapweed, 9

## Rusts

*Puccinia acroptili*, 127

*Puccinia chondrillina*, 129

*Puccinia jaceae*, 131

Spear thistle. *See* Bull thistle

*Sphenoptera jugoslavica*, 125,  
135

Spotted knapweed, 15

St. John's wort, 35

*Subanguina picridis*, 137

Tansy ragwort, 41

*Terellia virens*, 139

*Trichosirocalus horridus*, 141

*Tyria jacobaeae*, 143

*Urophora affinis*, 81, 139, 145

*Urophora cardui*, 147

*Urophora quadrifasciata*, 81,  
139, 149

*Urophora solstitialis*, 151

*Urophora stylata*, 153

## Weed control

cultural methods of, 5

mechanical, 5

Weevils. *See* Beetles

White flowered weeds, 25–28

Wild snapdragon. *See* Yellow  
toadflax

Wolf's milk. *See* Leafy spurge

Yellow-flowered weeds, 29–42

Yellow toadflax, 39