Weevils from Serbia show promise in yellow toadflax biological control in Canada

Yellow toadflax (*Linaria vulgaris*) flowers

The Trouble with Yellow Toadflax

Don't be fooled by its pretty yellow snapdragon-like flowers. Yellow toadflax (*Linaria vulgaris*) is an invasive perennial weed of agriculture and natural habitats across Canada.

Originally from Eurasia, its first reported foothold in Canada was in southern Quebec in the early 1800s. By the early to mid-1900s, the weed had spread across the Prairie provinces where it remains a significant weed of perennial and annual crops. In particular, it is a growing problem in pastures and rangelands in Western Canada where it outcompetes forage plants, impacting cattle production and native biodiversity.

Yellow toadflax spreads aggressively by both seed and vegetative growth to form patches of individuals and clonal colonies. The individual plant making up a clonal colony can produce up to 30,000 wind-borne seeds and generate hundreds of shoots from buds located along horizontally-growing roots. Root fragments with buds can be transported to other locations to start new toadflax colonies.

Horizontal roots and shoots of yellow toadflax

Although yellow toadflax can be managed using herbicides and tillage (e.g. in annual crops), these options are less feasible or simply not possible in perennial crops, pastures, or native rangelands. This is where biological control may help.

Introducing *Rhinusa pilosa*, a New Biocontrol Agent for Yellow Toadflax

Since the late 1950s, three European insects have been purposely imported and released under the Canadian biological control program for yellow toadflax: a defoliating moth – *Calophasia lunula*; a root-mining moth – *Eteobalea serratella*; and a stem-mining weevil – *Mecinus janthinus*. These agents have not been as successful as hoped, so the search overseas for more agents has continued.

A promising new biocontrol agent – a small, hairy weevil named *Rhinusa pilosa* – was found in Eastern Europe in the early 2000s. It is highly specific to yellow toadflax and capable of inflicting significant damage to its host weed. The weevil causes damage by producing large tumor-like growths (galls) on toadflax stems. The gall houses and feeds the developing larvae of *R. pilosa*, and the growth of both the gall and larvae together hijack nutrients normally used by the weed for its own growth and reproduction.

Life Cycle: Overwintered *R. pilosa* adults emerge in early spring to feed and mate on yellow toadflax. Females then deposit their eggs within the rapidly growing yellow toadflax shoots. A female typically lays several eggs close together in succession near the shoot tip. This produces a large, oblong gall (about 2-5 cm long and 1-3 cm wide) containing multiple cohabitating larvae. Small, round galls (about 1-2 cm in diameter) usually harbouring a single larva can also occur. A mystery fluid, deposited with each egg, is believed to initiate gall development. By the time the eggs hatch, their gall is near full grown. Mature galls are light green to reddish in colour. The larvae undergo three developmental stages before pupating within their gall in mid- to late summer. New adults remain inside their galls for several weeks to feed before chewing their way out to overwinter in soil or litter. One generation of weevils is produced per year.

Overseas studies and the first Canadian releases

Beginning in 2003, *R. pilosa* collected from yellow toadflax in Serbia underwent extensive testing and study. Based on strong evidence of its safety and effectiveness, the weevil was approved for use in Canada in 2014.

Between 2014-2018, 57 releases of the biocontrol weevil have been made across Canada under a wide variety of environmental conditions (BC – 10 releases; AB – 25; SK – 7; MB – 3; ON – 4; NS – 7; PEI – 1). Successful establishment on yellow toadflax has been confirmed at most sites, with a few of the oldest releases showing strong increases in weevil number as of 2018.

R. pilosa gall

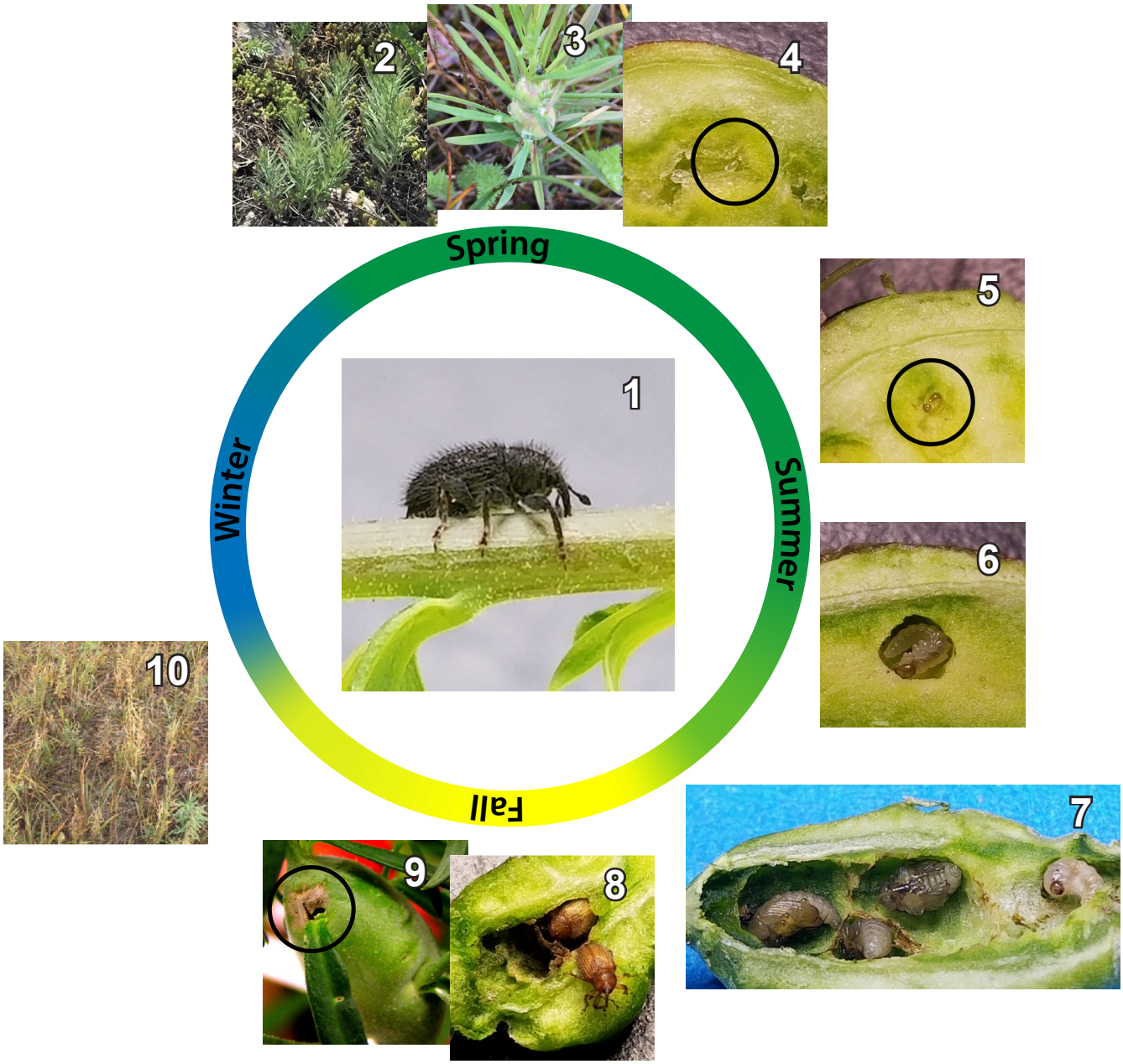
What's next for *Rhinusa pilosa*?

Release methods are being developed to optimize the weevil's establishment and increase, and to facilitate its operational use.

Originally, releases were made only in early spring, to coincide with the first emergence of yellow toadflax. We now know that releases can be made within a broader window of time, from late April to early June. We also know that both spring and fall releases can lead to successful establishment.

Next, we will be studying the effects of soil moisture availability on *R. pilosa* survival and impact, so that we can advise on the best habitats for release of the weevil for effective yellow toadflax control.

General *Rhinusa pilosa* annual life cycle



Photos: 1 - *Rhinusa pilosa* adult; **2 -** When they emerge in the spring, *R. pilosa* adults lay eggs in young yellow toadflax stems; **3 -** Galls begin to develop after eggs are laid; **4 -** *R. pilosa* egg in gall (circled); **5 -** 1st instar *R. pilosa* larva in gall (circled); **6 -** 2nd instar *R. pilosa* larva in gall; **7 -** 3rd instar *R. pilosa* larva and pupae; **8 -** *R. pilosa* adults ready to emerge from gall; **9 -** Gall exit hole (circled); **10 -** Adult *R. pilosa* overwinter in nearby soil or litter.

How does Biological Control work?

Used as a weed management tool, biological control is the purposeful introduction of an invasive plant species' natural enemies (typically insects) from the plant's native range. In the case of yellow toadflax, the weed and its insect natural enemies (known as 'biocontrol agents') have come from Europe.

Biological control is not intended to eradicate a weed. Rather, introduced biocontrol agents weaken or kill its host weed through feeding to reduce its overall dominance in an invaded area. The goal is to reduce the weed's population below damaging levels for agriculture production or the environment (i.e. to give other plants a fighting chance). This also ensures the biocontrol agent persists in the environment since without a host, it will die out.

A commonly asked question is, 'Will an introduced biocontrol agent feed on other plant species?' Before an agent is given regulatory approval for release in Canada, it is thoroughly tested to ensure it will not become a threat to non-target plants such as crop, forage, horticultural or native species. These tests can take many years to perform but provide confidence in an agent's safety for use.

For more information about this project:
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