

Rhinusa linariae Panzer

INVASIVE SPECIES ATTACKED: Yellow toadflax (*Linaria vulgaris* L.)
Dalmatian toadflax (*L. dalmatica* (L.) Miller)
Narrow-leaved Dalmatian toadflax
(*L. genistifolia* spp. *dalmatica* (L.) Maire & Petim.)

PREVIOUSLY KNOWN AS: *Gymnaetron linariae* Schoenherr, *Gymnetron linariae* Panzer.

TYPE OF AGENT: Root feeding beetle (weevil)

COLLECTABILITY: Limited

ORIGIN: Southern Europe and southern Russia

DESCRIPTION AND LIFE CYCLE

Adult:

Rhinusa linariae weevils are black, 2.5-3.0 mm long and convex-shaped. Their bodies are covered with short dense gray hairs. Their rostrums (nose) are arched and gradually tapered. Adults emerge from overwintering when plants are 5 cm tall, usually late April and May and feed for three weeks before they begin to mate. Mating occurs during the day, from morning to late afternoon and after one week the eggs are laid. Females prepare oviposition locations by chewing holes in root tissue, usually near the crown. The females oviposit the eggs singly into each pocket and cover them with excrement. When suitable plant material is available, females will continue to lay for about two months (mid-May to mid-July). Adults die after the oviposition period, usually by the end of July, and by the end of August and in early September, the new generation will be present. At this time, all adults will have left the roots. In the field more males are found because females tend to hide out of sight, commonly in the soil. Development from egg hatching to adult takes about three months.

Egg:

The eggs are pale yellow, smooth surfaced, pear-shaped and measure 0.39 x 0.22 mm.

Larva:

There are three larval instars which develop in galls formed on roots and rhizomes. The first instar is present until mid-July, the second instar until the first week of August, and the final in mid-August. Fungal infections can attack the galls and cause mortalities during the larval and pupal stages.

Pupa:

Pupation takes place within the galls.

Overwintering stage:

Adults that emerge in August and September overwinter in soil near the plants.

EFFECTIVENESS ON HOST PLANT

When the females chew oviposition pockets, the plant reacts by producing a gall formation. The larvae feeding in the galls may add to the development of further galls. Several galls can fuse together creating masses. Adult feeding on foliage and larvae feeding within galls contribute to using up nutrient reserves, causing stress and reduced plant vigour.



Fig. 1. *R. linariae* adult



Fig. 2. Variations of *R. linariae* gall quantities on yellow toadflax field collection site



Fig. 3. *R. linariae* release site at Louis Creek (Interior Douglas-fir zone)

HABITAT AND DISTRIBUTION

Native:

R. linariae's native distribution occurs throughout south-central and south-northern Europe. It is found in Finland, Sweden, Germany, France, Austria, Czechoslovakia, Central Russia, and Poland. In its native habitat it is common in grasslands and colline habitats, infrequent in the sub-alpine, and cannot be found in the alpine.

North America:

R. linariae tolerates cooler summer temperatures than *R. antirrhini* (Dalmatian toadflax agent) and establishes on yellow toadflax in a variety of locations.

British Columbia:

R. linariae has been released and found established in the Bunchgrass, Interior Douglas-fir and Montane spruce biogeoclimatic zones and in locations that receive some, to significant, snow cover. The weevils have established at elevations between 353 and 1646 m. Habitat preferences are currently being studied.

BRITISH COLUMBIA RECORD

Origin:

The *R. linariae* tested and approved for release in B.C. originated from central and southern Europe and southern Russia. The agents released in B.C. arrived via lab-reared populations from Agriculture and Agri-Food Canada (AAFC) in Lethbridge, Alta.

History:

R. linariae was approved for release in Canada in 1995. In 1996, the first *R. linariae* was released in B.C. into an enclosed Dalmatian toadflax rearing tent in Kamloops and supplemented with additional agents in 1997. This population did not survive. In 1998, weevils were transferred into yellow toadflax rearing tents. The yellow toadflax reared population established and became the initial source of several field releases. In 2009, the first field collections began. From 2001-2014, 18 releases were made at 14 yellow toadflax field sites in the Kamloops, Monte Lake, Fort Steele, Westwold, Barriere Lakes, Eileen Lake, Dairy Lake, Lac La Hache, Louis Creek, Birch Island and Hedley areas. The Barriere Lakes and Eileen Lake sites were the main collection areas for a variety of purposes such as redistribution, research, and propagation. By 2012, the Eileen Lake site became the only collection area, as the plants continued to rapidly decline at the Barriere Lakes site until no more plants remained. In 2013 and 2014, hundreds of galls were collected from the Eileen Lake site for redistribution to other BC field sites and provided to biocontrol partners in Idaho. In 2014, an operational trial was established at a high elevation site near Hedley. In 2008, galls were collected from the rearing plots and shipped to the U.S.A.

Propagation results:

The initial 2019 adults released in 1996 and 48 adults released in 1997 on Dalmatian toadflax failed to survive at the Kamloops Propagation Facility. In 1998, 271 adults were released into yellow toadflax plots and establishment was successful. In 2001, the first collections were made from the tents for redistribution into open field sites. Additional collections were made from the tents in 2002, 2006, 2009, 2010 and in 2012 for field releases. In 2008, a collection of 300 larvae and pupae infested galls was taken from the tents and shipped to the United States. While *R. linariae* was propagated at the Kamloops Propagation Facility, 1603 adults and 1409 pupae/adult infested galls were collected for redistribution to field sites in B.C. In addition, several small quantities of adults were provided to scientists and partners for research trials or scientific studies. When collections were removed from the tented populations, few weevils were found the following year, subsequently, the collections were generally not made every year. The adults that emerged in August



Fig. 4. *R. linariae* release site near Westwold (Interior Douglas fir zone)



Fig. 5. *R. linariae* release site on Eileen Lk. FSR (Interior Douglas-fir zone)

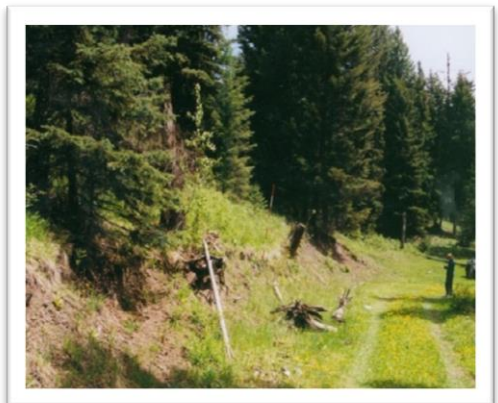


Fig. 6. *R. linariae* release site near Monte Lake (Interior Douglas-fir zone)



Fig. 7. *R. linariae* galls on yellow toadflax plant in Kamloops propagation plots

were not plentiful enough to be collected, therefore, all the current field releases made with adult weevils result from those that have emerged in May and June. In 2009 through to 2011, supplemental adults were collected from field sites and added to the tents to refresh the existing population. In 2012, it was determined the field releases had established well enough to provide for the province, and all infested plants were transplanted to the field and the *R. linariae* plots were dismantled.

Field results:

The first two field releases were made in 2001 near Monte Lake and Louis Creek. Weevils were found at both these sites the following year and subsequent years after their release. Both these sites continued to show declining plant infestation area, density and distribution. In 2003, the Louis Creek site experienced fire, excavation, and repeated compaction and still the weevils have persisted. The Louis Creek site has persisted with irregular intervals of yellow toadflax spread over a wide linear right-of-way and the weevils have continued to produce annual generations. By 2012, only five plants remained at the Monte Lake site. The plants were excavated, but no galls were found. The closest patch of yellow toadflax 365 m away from the original release was monitored and galls were located. The Barriere Lakes site produced many adults for a few years on what became a rapidly declining yellow toadflax infestation. The only release made in the East Kootenays south of Fort Steele became well established by 2004 and it was hoped it would become a collection site, but, by 2013 the plants had disappeared and the infestations of yellow toadflax in the general area also had almost completely vanished. The above observations indicate large sites with high plant densities may be required to sustain a population over time. It also has been observed the agent may require strong multi-stem plants for good establishment. At the Lac La Hache releases, no agents have been found on the single stemmed, weak plants growing at the droughty Douglas-fir site. Redistribution by root gall transfers was done at three sites in 2013. These sites were monitored in 2014, but only one of three established to date. In 2014, 2467 galls were collected over two days at Eileen Lake, mainly for supply to U.S.A. partners. The U.S. scientist described the B.C. gall clusters as being substantially larger with more galls present than those generally found in Europe. The majority of large gall clusters are often found at the base of decaying stumps or at the edge of rocks and cobbles which are partially recessed into the soil. In 2017, an estimated 2500 galls and a few adults were again collected from this site and divided between one new field release site near Kamloops (658 galls and 15 adults) and the U.S. partners (1800 galls). This current collection site is at risk of being lost from the rapid decline of the yellow toadflax and future forest harvest plans. *R. linariae* has been found to exist on the same site as *Brachyterolus pulicarius*, *Mecinus janthinus*, *R. neta*, *Calophasia lunula* and the adventive strain of *R. antirrhini*. Future efforts will focus on monitoring non-established sites, carrying out dispersal monitoring, collecting more galls for redistribution in B.C., and sampling the operational trial.

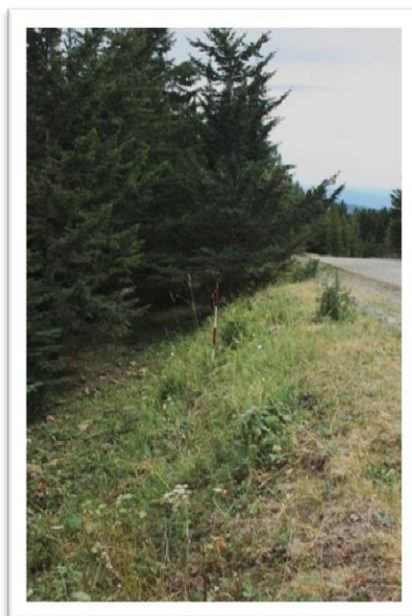


Fig. 8. Established *R. linariae* release site at high elevation near Kamloops (>1600 m) (Montane spruce zone)

NOTES

- *R. linariae* do not compete with the root feeding agents *Eteobalea serratella* and *E. intermediella*.

REFERENCES

1. De Clerck-Floate, R., R. Nowierski, D. Schroeder and K. Jordon. 1994. Proposal to introduce *Gymnetron linariae* Panzer (Col.: Curculionidae) for the biological control of Dalmatian and yellow toadflax (*Linaria dalmatica* (L.) Mill. and *L. vulgaris* Mill.) in North America. Agriculture and Agri-Food Canada, Lethbridge Research Station, Alberta.
2. Norton, A., unpublished data, 2014, Colorado State Univ., Fort Collins, Colorado.