

Mecinus janthiniformis Tosevski & Caldara

INVASIVE SPECIES ATTACKED: Dalmatian toadflax (*Linaria dalmatica*)

PREVIOUSLY KNOWN AS: *Mecinus janthiniformis* was previously described as *Mecinus janthinus*.

Notation: Weevils were released in Canada and the U.S.A as *Mecinus janthinus* and were later discovered to be a mix of *M. janthinus* and the closely related weevil species *M. janthiniformis* (see EFFECTIVENESS ON HOST PLANT section) (Sing et al. 2016). As of 2019, *M. janthinus* is not believed to have survived in B.C., therefore, the following text pertains to *M. janthiniformis* unless otherwise described (see BRITISH COLUMBIA RECORD section).

OPERATIONAL FIELD GUIDE: *Mecinus janthiniformis* (*Mecinus janthinus*) – Operational Field Guide, Ministry of Forests and Range.

TYPE OF AGENT: Stem-mining beetle (weevil)

COLLECTABILITY: Mass

ORIGIN: Macedonia

DESCRIPTION AND LIFE CYCLE

Adult:

Mecinus janthiniformis adults are black to somewhat blue coloured weevils appearing slightly metallic when young. They have elongated, cylindrical bodies 3.2 - 6.0 mm in length and distinct linear, parallel grooves running the length of their wing covers (elytra). The weevils have long snouts and the males have strongly toothed front femurs (Sing et al. 2016; Harris et al. 2005). They emerge in May and begin feeding on foliage, concentrating on the tender shoot tips of their hosts. The feeding is easily distinguished by the shot-hole shape left in the tissue that with multiple agents can deform the plant and prevent flowering. Mating and egg-laying begins immediately, continuing until mid-July (Powell et al. 1994). Females chew cavities typically into the upper portion of the main stem or the basal portion of the flowering side-branches and oviposit a single egg into each. Egg-laying continues at a rate of about one egg per day for 2.5 months or more. Several eggs can be oviposited into each stem. Ideal stem width is 0.9 mm for successful development. Prostrate stems are not favoured (Toševski et al. 2011; Harris et al. 2005).

Egg:

The oval, white eggs incubate for 6 - 7 days at 24°C (day) and 18°C (night) (Harris et al. 2005). A visible callus forms at the oviposition site.

Larva:

M. janthiniformis larvae are "C" shaped (i.e. similar to other weevil larvae), and white to yellowish in colour with pale brown head capsules and are about 5 mm in length (Sing et al. 2016). They require summer development temperatures to be 24°C (day) and 18°C (night) for 23 - 34 days. Over 100 *M. janthiniformis* larvae may fully develop within a single stem, where each will mine about a 1 cm length tunnel inside the stem (Harris et al. 2005; Toševski et al. 2011). Poor development occurs on the less nutritious prostrate stems (Harris et al. 2005).

Pupa:

Pupae are 3.0 - 4.5 mm long. It takes 30 - 40 days for them to mature during which they change from cream-coloured to black. (Harris et al. 2005). Pupation takes place inside the stems, is complete in late summer, and the following spring new adults chew the outer stem wall and exit through highly visible, distinct circular holes.



Fig. 1. *M. janthiniformis* adult (credit Powell et al.)



Fig. 2. *M. janthiniformis* adult with two larva instars

Overwintering stage:

Adults overwinter in pupal cells in toadflax stems. Cold winter climates or fluctuating winter temperatures cause high mortality as the weevils cannot endure freezing. Adults inside stems that remain standing in the winter and exposed above the snow do not survive at temperatures below -28°C and the population can experience mortality in the range of 75-100%. This mortality varies at sites where stems are covered and insulated by snow. However, usually enough weevils survive to revive the population and continue attack the following year. (De Clerck-Floate and Miller 2002).

EFFECTIVENESS ON HOST PLANT

Larvae mine stems which significantly contributes to the plants' inability to maintain vigour and reproduce by affecting water and nutrient flow. On Dalmatian toadflax, high populations of adult *M. janthiniformis* feeding prevents flowering and kills the shoot tips. In a study of the impact *M. janthiniformis* has on populations of Dalmatian toadflax in Southern B.C. between 2000 and 2007, it was clear that the weevil has affected its host weed on a landscape scale. The weevil's numbers rapidly increased after release, typically peaking by the eighth year, during which time Dalmatian toadflax stem length and plant density noticeably decreased. Dalmatian toadflax patches also became more fragmented, with 15% of the resultant smaller patches disappearing altogether (Van Hezewijk et al. 2010).

Mecinus janthinus was screened in the 1980s and approved for import and release in Canada in 1991 to attack both Dalmatian and yellow toadflax. Subsequently, it has been determined as a result of recent taxonomic changes of the target plants and through genetic analysis of the weevils and investigation of historic records, that the original shipments contained a combination of two *Mecinus* species: *M. janthiniformis* imported from Macedonia that is specific to Dalmatian toadflax; and *M. janthinus* imported from Southern Germany and Northern Switzerland that is specific to yellow toadflax. These two *Mecinus* species are very similar in appearance, behaviour and life cycle (Toševski et al. 2018). To date, *M. janthiniformis* is well-established in North America where it has significantly decreased populations of its target plant whereas *M. janthinus* is not as widespread but has been able to decrease yellow toadflax populations in local areas (Sing et al. 2016). However, to 2019, despite *M. janthinus* having established in the USA and other Canadian provinces like ALTA, it is believed it has not survived in B.C. Details of these early shipments, releases and collections are found in the BRITISH COLUMBIA RECORD section below.

HABITAT AND DISTRIBUTION

Native:

Its geographic range is eastern-central and eastern-south of Europe consisting of Hungary, Serbia, Romania, Bulgaria, Macedonia and Greece yet potentially further to cover the range of its host plants *L. genistifolia* and *L. dalmatica*. *M. janthiniformis* is found from low elevation areas up to elevations of 1500 m. (Toševski et al. 2011).

North America:

M. janthiniformis prefers grassland or open forested areas with hot dry conditions.



Fig. 3. Mature *M. janthiniformis* adults extracted from Dalmatian toadflax stem to show larval feeding damage and pupation location



Fig. 4. Dalmatian toadflax plant with heavy *M. janthiniformis* adult foliar feeding.



Fig. 5. Adult *M. janthiniformis* on Dalmatian toadflax plant with typical foliar feeding.

British Columbia:

M. janthiniformis weevils have been released and found established and/or dispersed in the Bunchgrass, Boreal white and black spruce, Coastal Douglas-fir, Coastal western hemlock, Interior cedar-hemlock, Interior Douglas-fir, Montane spruce and Ponderosa pine biogeoclimatic zones. The weevils have also been released into the Englemann spruce-subalpine fir zone (one site) and the Sub-boreal spruce zone (eighteen sites), however, only three of the Sub-boreal spruce zone sites have been monitored a single time and one site has been found established (BCMFLNRO 2015). To date, *M. janthiniformis*' known established range in B.C. includes from the Canada/U.S.A. border north to Terrace.

BRITISH COLUMBIA RECORD

Origin:

M. janthiniformis populations established in B.C. originate from Macedonia.

History:

The screening research performed and subsequently approved in 1991 for import of the *Mecinus* weevils was done with both *M. janthinus* and *M. janthiniformis*. Between 1991 and 1999, 1748 weevils were shipped by CABI to N.A.: 1555 weevils collected off yellow toadflax in the Rhine Valley, Southern Germany and Northern Switzerland; 30 weevils collected from a mixed stand of yellow and Dalmatian toadflax in Hungary; and 193 weevils collected off a subspecies of Dalmatian toadflax in Macedonia, *L. dalmatica* ssp. *macedonica*. At that time all shipped weevils were identified as *Mecinus janthinus* purported to attack both toadflax species (Toševski et al., 2018).



Fig.8. Established *M. janthiniformis* release site near Comox (Coastal western hemlock)



Fig. 9. Established *M. janthiniformis* release site near Merritt (Ponderosa pine zone)



Fig. 6. Established *M. janthiniformis* release site north of Lillooet on the Yalokum River (Interior Douglas-fir)



Fig. 7. Established *M. janthiniformis* release site in Lac du Bois area near Kamloops (Bunchgrass zone)

B.C. received shipments of weevils from CABI of what is now understood as *M.*

janthinus from Southern Germany and Northern Switzerland in 1991 and 1992, (79 and 157, respectively), and *M. janthiniformis* from Macedonia in 1992 (30). *M. janthinus* weevils were released at four field sites near Kamloops and Lillooet while the 30 *M. janthiniformis* weevils were placed into a tent at the former Kamloops Propagation Facility (KPF). The target plant at all locations was Dalmatian toadflax, except for a site near Monte Lake that had yellow toadflax nearby.

M. janthiniformis weevils flourished at the KPF, but *M. janthinus* did not. Of note, the larger garden setting contained additional plots of Dalmatian toadflax and yellow toadflax which were tented on and off from 1992 to 2000 for additional biocontrol species. Although *M. janthinus* were confined inside tents containing Dalmatian toadflax, yellow toadflax plants would have been available to any weevils that could either escape their tents from 1991 to 1994 or move about freely from 1995 onward when the *Mecinus* tents were removed. It is possible that *M. janthinus* weevils could have survived in the garden until 1999 when *Mecinus*-designated plots were dismantled or on remnant plants until 2012 when the entire facility was shut down. No collections of weevils off yellow toadflax garden plants were made. Early monitoring of the first releases of *M. janthinus* on Dalmatian toadflax did not yield weevils. The yellow toadflax plants at Monte Lake have been monitored on and off over many years and have had no confirmation of *Mecinus* attack. As of 2019, *M. janthinus* is not believed to have survived in the province.

Multiple collections of *M. janthiniformis* weevils off KPF Dalmatian toadflax garden plants were made between 1994 to 1999. Field collections from Dalmatian toadflax began in 1996, from the Kootenays in south-east B.C. Between 1994 to 2018, 840 field sites had received releases for a total of 250,822 weevils distributed around the province and many sites have exhibited a decline in Dalmatian toadflax. Additionally, between 1999 to 2009, 55,611 *M. janthiniformis* were shared with ALTA and the U.S.A. Records indicate that all established releases and collections made in B.C. originated from the shipment of 30 weevils supplied from Macedonia.

Field results:

The majority of *M. janthiniformis* releases have been made on Dalmatian toadflax. In 2000, *M. janthiniformis* was designated for use as operational treatment tools. By 2005, *M. janthiniformis* populations were found widely dispersed, frequently seen on toadflax sites in the southern interior. Recent observations indicate that it is also dispersing well in the north western part of B.C. where less Dalmatian toadflax is established and fewer releases occur. In large populations, aggressive attack from May through June leaves the plants stunted, weak and unable to flower. Spring feeding causes lateral shoot growth and subsequent flowers are smaller and less productive (smaller flowers and smaller seedpods). It has been found co-existing with *Rhinusa antirrhini*, *R. neta*, *R. linariae*, *Calophasia lunula* and *Brachyterolus pulicarius*.

While *M. janthiniformis* is only found on Dalmatian toadflax, it has been previously, purposefully released onto yellow toadflax in the province. B.C. records retain these details. Subsequent collections/releases from/onto, and dispersal sightings, on Dalmatian toadflax of *Mecinus* weevils should be recorded as *M. janthiniformis*. However, any finding of *Mecinus* weevil attack on (oviposition holes) or within (tunnelling or existence of larvae, pupae or adults) should be reported to FLNRD staff to confirm whether *M. janthinus* exists in the province.

Collection for redistribution:

Aspirate adults from plants during May and June. Alternately, clip pupae/fully-developed adult infested stems in late summer or fall and redistribute them among plants at new sites.

NOTES

- *M. janthiniformis* are capable of existing on the same site with other seed, foliar and root feeding bioagents.
- By 2001, *M. janthiniformis* had dispersed from Canada into Washington State.

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Fig. 10. Established *M. janthiniformis* dispersal site on Nickel Plate Mountain (Montane spruce zone).



Fig. 11. *M. janthiniformis* larva in previous year toadflax stem

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