

Mogulones crucifer (Herbst)

INVASIVE SPECIES ATTACKED: Hound's-tongue (*Cynoglossum officinale* L.)

PREVIOUSLY KNOWN AS: *Ceutorhynchus cruciger* and *Mogulones cruciger*

Operational Field Guide: Mogulones cruciger – Operational Field Guide, B.C. Ministry of Forests

TYPE OF AGENT: Root feeding beetle (weevil)

ORIGIN: Hungary and Serbia

COLLECTABILITY: Mass

DESCRIPTION AND LIFE CYCLE

Adult:

Mogulones crucifer adult weevils are round, 2 - 3 mm long, dull brown with a white cross pattern on their wing covers. Adults are capable of flying, freely dispersing to nearby invasive plant patches. They feed on foliage, leaving their signature circular and oval feeding holes over the entire leaf. Males and females occur on the plants at the same time of the year with a near equal ratio. They are long-lived (1 - 2 years), during which females can oviposit three times. Mature overwintered females that emerge in early or late spring will have mated and oviposited up to 10 eggs the preceding autumn. Their second oviposition period in the spring will be the main one, laying up to an additional 180 eggs. Females search for ideal oviposition locations by walking down leaf stems into basal locations, preferring large rosettes with large basal leaves over flowering shoots, although floral shoots and small leaves will be used when options run low.

The females chew 0.5 mm wide and 1 mm deep pockets into leaf stems near the root crowns, into the shoot bases, or into the crowns. The eggs are deposited individually into each cavity, and then sealed with frass. The oviposition site becomes marked with a small dark green spot which appears blistered as it hardens. By the end of May, this generation will have finished depositing eggs and most females die. However a few will move to the soil to hibernate, reappearing intermittently over the remainder of the summer to briefly feed. The summer generation normally appears in mid-summer, but small quantities of spring emerged weevils may persist throughout the summer. Immature adults are required to feed for about two weeks before mating and entering into their first oviposition period. The summer generation will start their first oviposition in September, laying up to 10 eggs before preparing to overwinter in the soil and plant litter. The spring adults that hibernated will emerge again in September, mix with the summer adults and mate and oviposit their third time.

Egg:

Eggs are 0.9 x 0.6 mm. They require temperatures above 6°C to develop. At 25°C, eggs hatch in seven days. Hatching occurs during the oviposition period.

Larva:

White larvae with brown heads, in a typical weevil "C" shape, develop through three instars. Bristles are the only differentiating feature that distinguishes the instars. Because the eggs are laid and hatch throughout the oviposition period, larvae feeding occurs throughout the year, except in August. The entire larval stage feeds on the roots. The first instar begins feeding from the upper crown downward. The second instar is usually found in the upper parts of tap roots. Mature larvae feed lower on the basal parts of the tap roots and secondary roots. This feeding pattern separates the instars, preventing competition which can occur in high larvae densities. They often chew through root walls, exit and re-enter at another location. Larvae feeding and mining tunnels become filled with light brown frass. *M. crucifer* larvae are not cannibalistic. Mature larvae leave the root to pupate in the soil.

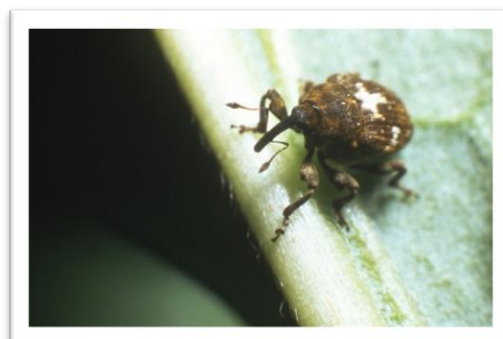


Fig. 1. *M. crucifer* adult

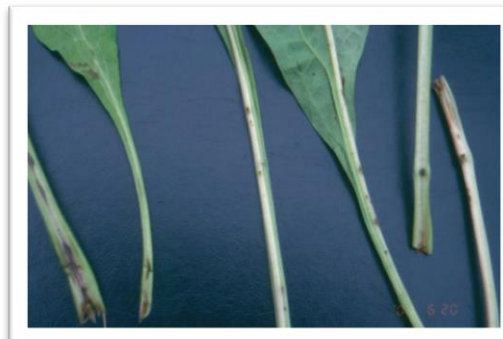


Fig. 2. *M. crucifer* oviposition marks



Fig. 3. *M. crucifer* larva

Pupa:

Pupation occurs in a prepared silk oval cocoon, 7 x 5 mm, which becomes covered with soil particles. During the summer, pupation takes 24 - 26 days. The pupal skin is shed but new adults remain inside the cocoon for 10 days until their outer shell hardens.

Overwintering stage:

M. crucifer can overwinter in three forms:

- As mature adults in the soil (in warm climates it periodically feeds on foliage);
- As pupae and new adults in cocoons in the soil; and
- As larvae in roots.

EFFECTIVENESS ON HOST PLANT

Larvae feeding will feed on all underground plant parts. Rosettes are weakened and unable to bolt or are killed. Reproductive plants produce shortened bolting stalks or multiple weak bolting stalks, all with fewer flowers. When high adult populations occur during the spring and summer, seedlings attacked often fail to develop into productive rosettes. With larvae developing almost continuously all year (except in August), plants have little opportunity to recover.

HABITAT AND DISTRIBUTION

Native:

M. crucifer is not common in its native range throughout Europe and western North Africa. It feeds on two varieties of *Cynoglossum*, but is restricted to hound's-tongue (*C. officinale*) in Europe. In Morocco and Algeria it feeds on *C. cheirifolium*.

North America:

M. crucifer easily establishes in a wide variety of hound's-tongue habitats. Adults emerge in late winter and early spring. Emergence dates may be somewhat affected at high elevation sites which encounter late snowfall or below-zero temperatures.

British Columbia:

M. crucifer releases have been made and found established or dispersed in the Bunchgrass, Interior cedar-hemlock, Interior Douglas-fir, Montane spruce and Ponderosa pine biogeoclimatic zones. It continues to increase and disperse throughout hound's-tongue's geographic range in B.C.

BRITISH COLUMBIA RECORD

Origin:

M. crucifer populations in B.C. originate from Hungary and Serbia.

History:

In 1997, six open field releases were made throughout the southern interior, of which one was a research trial. Another population was placed into rearing tents in Kamloops. British Columbia habitat is favourable for *M. crucifer* and agents were found the following year. In 2005, *M. crucifer* was designated to secondary status. Assisted redistribution is ongoing.

Propagation results:

In six years, from 1997 to 2002, 49,509 *M. crucifer* were released into B.C. habitat, of which 40,487 were reared at the Ministry of Forests and Range Propagation Facility in Kamloops.



Fig. 4. *M. crucifer* larvae root feeding evidence



Fig. 5. Established *M. crucifer* release near Oyama (Interior Douglas-fir zone)



Fig. 6. Established *M. crucifer* release site near Princeton (Interior Douglas-fir zone)

Field Results:

M. crucifer has proven to be a highly effective tool for controlling hound's-tongue. In a trial near Princeton, the plants at a 2001 release site steadily decreased over four years. On two permanent transects in 2003 there were 97 plants, in 2004 there were 84 plants, in 2005 there were only 3 plants, and in 2006 there were no plants. Because the plants are biennial, seedling production may appear to increase every other year, however, the early emerging *M. crucifer* adults feed heavily on all plants and, therefore, destroy young rosettes and seedlings. In heavy populations, plant roots are reduced to skeleton shells. In the field, *M. crucifer* and *Longitarsus quadriguttatus* occur on the same site.

Collection for redistribution:

Adult field collections can be difficult. Adults drop easily from leaves, and camouflage on the soil. Adults can successfully be aspirated from plants with a small hand aspirator. Collecting adults with a large aspirator and using a self-sorting apparatus is more efficient and the preferred method.

NOTES

- *M. crucifer* can co-exist with *L. quadriguttatus* as they feed on different root parts, preferring different plant sizes and stages.
- Early spring emergence of adults rapidly decreases the plants' ability to set bolts.
- The native weevil, *Rhinoncus castor* was found in 2007 on hound's-tongue plants near Princeton. *R. castor* is quite similar to *M. crucifer*, but the white cross found on the back of *M. crucifer* is replaced with a yellow-brownish mark on *R. castor*.

REFERENCES

1. De Clerck-Floate, R. and P. Harris. 2006. Classical biological control of weeds established biocontrol agent *Mogulones cruciger* (Herbst). Root - feeding weevil. Agriculture and Agri-Food Canada. Updated July 27, 2006. http://res2.agr.ca/lethbridge/weedbio/agents/amoqcruc_e.htm. (Accessed February 13, 2007).
2. De Clerck-Floate, R.A. and M. Schwarzlander. 2002. Chap. 67, *Cynoglossum officinale* (L.), Houndstongue (Boraginaceae). In Biological Control Programmes in Canada, 1981-2000. P.G. Mason and J. T. Huber, (editors). CAB International.
3. Jordon, T., M. Schwarzlander, I. Tosevski, and A. Freese. 1993. *Ceutorhynchus cruciger* Herbst (Coleoptera, Curculionidae): a candidate for the biological control of hound's-tongue (*Cynoglossum officinale* L., Boraginaceae) in Canada.
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