Chapter 65

*Vincetoxicum nigrum* (L.) Moench, *V. rossicum* (Kleopow) Barbar., swallow-worts, dog strangling vine (*Apocynaceae*)

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# 65.1 Pest Status

European populations of swallow-worts, *Vincetoxicum nigrum* (L.) Moench and *V. rossicum* (Kleopow) Barbar. (*Apocynaceae*) have become established in northeastern North America, where there are no effective arthropod herbivores to suppress populations and deter further spread (Sheeley, 1992; Christensen, 1998; Lawlor, 2000; Milbrath, 2010). *Vincetoxicum* spp. display superior competition for resources among native plants and often form dense monocultures in a variety of habitats (Cappuccino, 2004). They are a threat to native species and habitats, and negatively affect farming practices, livestock, and ornamental landscapes. *Vincetoxicum* spp.contain the haemolytic glycoside vincetoxin, which is toxic to humans and most other mammals (DiTommaso *et al*., 2005). In addition to disrupting agricultural crops such as no-till corn, *Zea mays* L. (*Poaceae*), *Vincetoxicum* spp. have been reported as a major pest in tree nurseries: the twining vines of swallow-worts have been documented pulling down small trees and smothering vegetation planted at restoration sites (Christensen, 1998**)** and pine plantations in Ontario (DiTommaso *et al*., 2005).

*Vincetoxicum* spp. are long lived, herbaceous perennial plants that produce multiple shoots from overwintering root buds each spring. They flower beginning in late spring and continue until late August. Flowers are insect- or self-pollinated and produce one to two elongate seedpods containing about 20 seeds. The polyembryonic seeds have fibrous tufts that aid in wind dispersal and can germinate during late summer to fall or in the following spring (DiTommaso *et al*., 2005).

The two species of concern, *V. nigrum* and *V. rossicum*,are now widely distributed along the Atlantic coast of the USA and in Ontario and Quebec in Canada. *Vincetoxicum nigrum* is native to Mediterranean regions of France, Italy and Spain; *V. rossicum* is naturally distributed in southeast Ukraine and Russia. The earliest record for *V. rossicum* in Canada was from British Columbia in 1885; however this species has not persisted in that province. The earliest record for Ontario was 1889 (DiTommaso *et al*., 2005). *Vincetoxicum nigrum* is less common in Canada, primarily occurring in localised patches in Ontario; early records were often confused with *V. rossicum.* It has however been confirmed to be in Ontario since the early 1950s (DiTommaso *et al*., 2005). Despite the long history of *Vincetoxicum* spp. presence in North America, they have only become a significant problem in recent decades due to range expansion and unhindered population growth (Lawlor, 2000).

# 65.2 Background

Substantial efforts in the use of conventional control methods such as mowing, hand pulling, and herbicides have largely been unsuccessful in eliminating established infestations of *Vincetoxicum* (Lawlor and Raynal, 2002; DiTommaso *et al*., 2005; McKague and Cappuccino, 2005; Averill *et al*., 2008; Douglas *et al*., 2009). The only method to ensure long-term control of *Vincetoxicum* spp.requires excavation of entire plants because root crown fragments left behind can root in the soil and produce additional shoots (DiTommaso *et al*., 2005). Hand picking seedpods from plants to limit spread is another control measure where digging and herbicides are not an option, such as in rocky habitats or protected natural areas. However removal of seedpods is only effective in reducing seed pressure if it is repeated throughout the growing season (Lawlor, 2000).

Repeated mowing was shown to reduce the average stem height of *V. rossicum* but did not decrease overall cover (Christensen, 1998). Subsequent studies found little or no effect of mowing or clipping on plant biomass, stem cover, density, or seedpod production, with some variation associated with the timing of the treatment in the season (McKague and

Cappuccino, 2005; Averill *et al*., 2008). When the primary aerial stem is damaged, swallow-worts usually compensate by sending up multiple axillary shoots (DiTommaso *et al*., 2005; McKague and Cappuccino, 2005).

In Ontario, at least two applications of glyphosate in mid-June and early August were required in order to reduce *V. rossicum* cover by 90% the following year (Christensen, 1998). However after treatment, the sites were open for successful colonization by another invasive plant, sweet white clover, *Melilotus alba* Medik.(*Fabaceae*) which replaced *V. rossicum* as the dominant vegetation (Christensen, 1998). In New York, one treatment of triclopyr (1.9 kg ai/ha) reduced *V. rossicum* cover and stem density by 56% and 84% after 2 years (Averill *et al*., 2008). However, despite these results, the authors cautioned that long-term control could only be sustained by repeated applications and active restoration.

 All current control measures are generally only effective in the short-term, require substantial resources or labor and could have collateral impacts on native species in the surrounding habitats (Lawlor, 2000). The use of biological control agents is likely the only viable option for long-term reductions in *Vincetoxicum* spp. populations. Surveys of native herbivores on *Vincetoxicum* spp. have found a limited fauna of primarily generalist species with limited potential to control the plant (Ernst and Cappuccino. 2005; Milbrath. 2010).

# 65.3 Biological Control Agents

Field surveys in Europe identified five potential biological control agents for *Vincetoxicum* spp.: two leaf feeding caterpillars, two leaf feeding chrysomelid beetles, one of which also feeds on the roots of the plant as a larva, and a seed feeding tephritid fly (Weed *et al*., 2011c). An initial test-plant list for swallow-wort biological control agents, drafted with a North American perspective that included Canada and Mexico, was developed by Milbrath and Biazzo (2007) and approved by the USDA Technical Advisory Group (TAG) on Biological Control of Weeds. During the testing process, additional plant species were added to increase representation in groups of concern and the final list of tested plants included 83 species (Casagrande *et al*., 2012).

*Chrysolina asclepiadis asclepiadis* (Villa) (Coleoptera: Chrysomelidae) is a univoltine leaf beetle that is found on white swallow-wort *Vincetoxicum hirundinaria* Medik. (*Apocynaceae*) in the Western Alps (Weed and Casagrande, 2011a). Eggs overwinter in the leaf litter and both the larvae and the adults feed on the leaves. In initial no-choice testing using 37 plant species, beetle larvae completed development on nine species within the genera *Artemisia* and *Tanacetum* (*Asteraceae*) and *Asclepias* and *Vincetoxicum* (*Apocynaceae*). The host range for adult feeding was even broader with 13 plant species within five genera receiving sustained feeding. Based on these results this species was dropped from further consideration as a potential biological control agent in North America (Weed and Casagrande, 2011a).

*Chrysochus (Eumolpus) asclepiadeus* Pallas (Coleoptera: Chrysomelidae) has a broader distributionin Europe than *Chrysolina asclepiadis asclepiadis* with populationsfound on *V. nigrum* in France, *V. hirundinaria* in Switzerland and *V. rossicum* in Ukraine. There has been particular interest in this species because adults feed on the leaves of the plant and larvae feed on the roots, causing significant damage to the plant (Weed *et al*., 2011b). The life cycle of *C. asclepiadeus* varies between 1 and 3 years and this may be associated with regional population differences. The mean genetic divergence between specimens from France and Ukraine was 3%. Thus, the two populations should be treated at least at the level of a well-differentiated subspecies (Gassmann *et al*., 2011). Work on this insect has been suspended because larvae can complete development on four North American *Asclepias* spp. (Gassmann *et al*., 2011)*.*  Additional studies in Canada have demonstrated, using similar conditions to the European tests, that a very closely related North American beetle species, *Chrysochus auratus* (Fabricius) (Coleoptera: Chrysomelidae),can also complete development on *Asclepias* spp. (R. DeJonge, 2012, unpublished results). However, this species is a specialist on dogbane, *Apocynum cannabinum* L. (*Apocynaceae*), and does not attack *Asclepias* in the field (Dobler and Farrell, 1999). Work is ongoing to better characterise the host range of *C. auratus* and *C. cobaltinus* LeConte (Coleoptera: Chrysomelidae), two North American species that occupy the same niche as the European *C. asclepiadeus,* and test if there is potential to use them for *Vincetoxicum* spp. biological control. This work may also lead to a reassessment of host-range testing results of the European species *C. asclepiadeus*.

*Euphranta connexa* (Fabricius) (Diptera: Tephritidae) is a pre-dispersal seed predator of *V. hirundinaria* and is one of the most broadly distributed and common herbivores of *Vincetoxicum* in Eurasia. Populations of this species have been collected from Germany, Switzerland, France and the Ukraine. Adults oviposit in developing seedpods of *V. hirundinaria.*  The larvae feed on the developing seeds, bore out of the seedpod at maturity and pupate in the surrounding soil (Solbreck, 2000). *Euphranta connexa* successfully attacks and completes development on seedpods of the target weeds (Weed *et al*., 2011c). The initial focus of the dog strangling vine project was on bio;iogical control agents that could directly affect plant biomass, thus efforts to characterise the host range of *E. connexa* were initially delayed. However, as limiting seed spread is a desirable outcome in North America additional studies on biology and host-range testing for *E. connexa* were initiated in 2011. The insect is challenging to test because multiple non-target species must be reared to produce seed. To date five species, *A. cannabinum*, *Asclepias tuberosa* L., *A. curassavica* L., *Amsonia tabernaemontana* Walter and *A. illustris* Woodson (*Apocynaceae*) have been tested for oviposition response by *E. connexa.* (Gassmann *et al*., 2013). Oviposition only occurred on three out of 10 replicates of the ornamental *A. curassavica*. No oviposition occurred on 22 replicates of the native North American *A. tuberosa*.

*Hypena opulenta* (Christoph) (Lepidoptera: Erebidae) was collected from *V. hirundinaria* in Ukraine in a shaded forest habitat (Weed *et al*. 2011c). It is a multivoltine species with overlapping generations (Weed and Casagrande 2010), which indicates it will inflict sustained attack on *Vincetoxicum* spp. throughout the growing season. Impact studies conducted in containment determined that all tested larval densities (2 to 8 larvae) significantly reduced aboveground biomass, seedpod production and seed production of *V. rossicum* (Weed and Casagrande 2010). Host-range testing, completed with a test-plant list of 82 species, indicated that the insect is a specialist on *Vincetoxicum* spp. (Hazelhurst *et al*., 2012).A joint petition for the release of this insect in Canada and the USA was submitted in November 2011. Supplementary data requested by the USDA-APHIS TAG was submitted in November 2012.

*Abrostola asclepiadis* (Denis and Schiffermüller) (Lepidoptera:Noctuidae) is broadly distributed across Europe and primarily associated with *V. hirundinaria.* Like the tephritid *E. connexa*, *A. asclepiadis* attacks plants in both open and forested habitats (Weed *et al*., 2011c). *Abrostola asclepiadis* usually completes one generation per year in northern latitudes, but bivoltine populations are known from Italy. The larvae of *A. asclepiadis* feed on the leaves of *Vincetoxicum* spp. and impact studies in Europe demonstrated complete defoliation of plants at low larval densities (Weed *et al*., 2011b). Host-range records for *A. asclepiadis* indicate that the species is monophagous on *V. hirundinaria* in the western part of its native range (Förare, 1995); other *Vincetoxicum* spp. likely serve as hosts in eastern Europe. Monophagy on *Vincetoxicum* spp. was confirmed with a population collected from *V. hirundinaria* in Ukraine, using the same test-plant list as for *H. opulenta* (Weed, 2010;Hazelhurst, 2012). A draft petition has been prepared for *A. asclepiadis*;however,the petition for the release of *H. opulneta* has been submitted first because multiple overlapping generations are expected to have higher impact on *Vincetoxicum* spp. than unvoltine or bivoltine populations of *A. asclepiadis*. Both species maybe required in North America for suppression of *Vincetoxicum* in all habitats because *H. opulneta* was initially found exclusively at forested sites in Ukraine (Weed *et al*., 2011b).

# 65.4 Evaluation of Biological Control

No agents have been released for biological control of *Vincetoxicum* spp. in North America to date. A joint petition for the release of *Hypena* *opulenta* in Canada and the USA was submitted in November 2011. Supplementary data requested by the USDA-APHIS TAG was submitted in November 2012.

# 65.5 Future Needs

# Future work should include:

1. Continue host-specificity tests with seed feeder *E. connexa*;
2. Continue assessment of host selection biology of potential native biocontrol agents (*Chrysochus* spp*.),* that may attack and damage *Vincetoxicum,* and compare results with European *Chrysochus* species;
3. Maintain rearing colonies of *H. opulenta* and *Abrostola asclepiadis* in quarantine, pending release decision;
4. Prepare North America release petition for *A. asclepiadis* for CFIA, Canadian Biological Control Review Committee and USDA-APHIS TAG.

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