

¹Bureau of Land Management, ²USDA ARS Pest Management Research Unit, ³Agriculture and Agri-Food Canada, ⁴Forest Service–Forest Health Protection

generally emerge earlier in the spring than brown-colored adult *Aphthona* spp. (*A. cyparissiae*, *A. flava*, and *A. nigriscutis*).

Larvae feed on root hairs and young roots, inhibiting root function and stunting spurge stem growth. At some locations, larval feeding damage makes attacked roots more susceptible to soil-inhabiting pathogens. Adults feed on leaves and flowers, decreasing photosynthesis and plants' sugar-making ability for root reserves.

Adults may be observed around spurge shoot tips throughout summer. Because larvae feed on root hairs and roots, they can be difficult to detect unless roots are dissected.

All five *Aphthona* spp. established in North America cause very similar feeding damage. Consequently, it is necessary to observe adults before making a proper identification. *Aphthona czwalinai* and *A. lacertosa* adults have black bodies. They differ in that the hind femurs of *A. lacertosa* are red to darker brown rather than solid black like *A. czwalinai*. *Aphthona cyparissiae*, *A. flava*, and *A. nigriscutis* adults all have brown bodies. *Aphthona cyparissiae* and *A. nigriscutis* are especially similar, differing in that *A. nigriscutis* typically has a black spot on the back. *Aphthona flava* is generally more orange in color than *A. cyparissiae* or *A. nigriscutis*; however, coloration differences among brown spurge flea beetles are often unreliable. Twelve native *Glyptina* flea beetles are described in North America, and some have been encountered in leafy spurge stands east of the Rocky Mountains. *Glyptina* beetles are brownish, similar to *A. cyparissiae*, *A. nigriscutis*, and *A. flava*. They differ by being only 1–2 mm long rather than the 3–4 mm of *Aphthona*.

CLASSIFICATION

RANKING	SCIENTIFIC NAME	COMMON NAME
Kingdom	Animalia	Animals
Phylum	Arthropoda	Arthropods
Class	Insecta	Insects
Order	Coleoptera	Beetles
Family	Chrysomelidae	Leaf beetles
Genus	<i>Aphthona</i>	Spurge flea beetles

HOST SPECIES IN NORTH AMERICA

Cypress and leafy spurge

LIFE CYCLE

Overwintering larvae resume feeding on young roots in early spring as cypress and leafy spurge are resuming growth. Pupation occurs in the soil. Adults are active from early summer to late summer, feeding on spurge leaves and flowers as spurges bolt, flower, and mature. Females lay numerous eggs into the soil throughout the growing season. Hatching larvae burrow into spurge roots to feed, developing through three instars. There is one generation per year (**Fig. 1**). Black-colored adult *Aphthona* spp. (*A. czwalinai* and *A. lacertosa*)

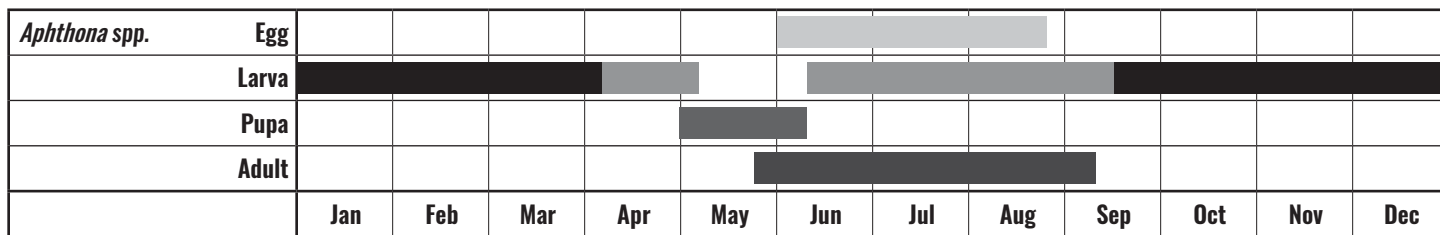


Figure 1. Schematic life cycle of *Aphthona* spp. in North America. Bars indicate the approximate length of activity for each life stage; dates will vary depending on local conditions. Black bars represent the inactive and/or overwintering periods. There is typically one generation per year. Black-colored adult *Aphthona* spp. generally emerge earlier than brown-colored adult *Aphthona* spp.

Seven other biological control agents are currently also established on cypress and/or leafy spurge in North America (see [Table 1](#) on page 18 for a quick guide in differentiation).

Aphthona cyparissiae (Koch) Brown dot leafy spurge flea beetle

DESCRIPTION

Larvae are 1–5 mm long and have a white body (**Fig. 2a**) and yellow head with a thick head capsule. Pupae are white and 2–3 mm long (**Fig. 2b**). Adults are usually just over 3 mm long. They are a light reddish-brown color and oval in shape (**Fig. 2c**). Although they have fully developed wings and are capable of flight, they more often walk or utilize their enlarged hind legs (**Fig. 2d**) to jump when disturbed, as is typical of all flea beetles.

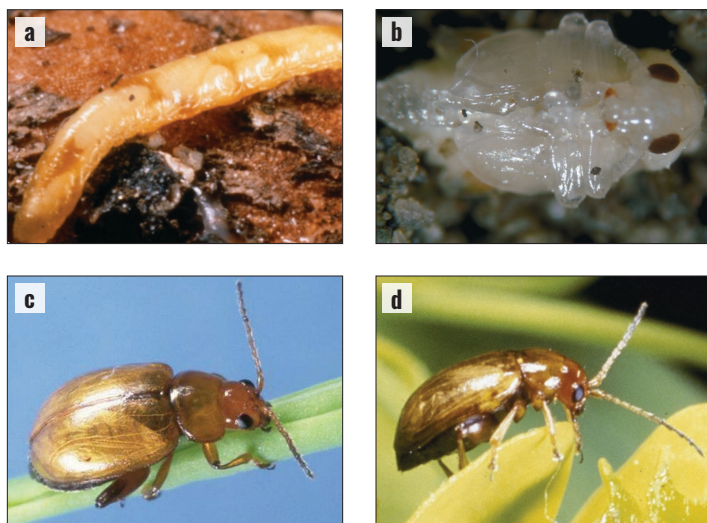


Figure 2. *Aphthona cyparissiae* (a) larva on leafy spurge root; (b) pupa; (c,d) adult (a: USDA FS; b: Neal Spencer, USDA ARS; c: R. Richard, USDA APHIS; d: USDA APHIS PPQ; a–d: Bugwood.org, CC BY-3.0 US)

PREFERRED HABITAT

This species does best in moderately dense infestations of cypress and leafy spurge found on dry to semi-moist sites. It does poorly in soils with too much clay.

HISTORY AND CURRENT STATUS

Aphthona cyparissiae is native to Europe. Populations sourced from Austria, Hungary, Italy, and Switzerland were released on leafy spurge in several states in the USA beginning in 1986 and were redistributed to cypress spurge starting in 1995. Many USA releases contained a mixture of *Aphthona* species. In Canada, beetles from Austria, Hungary, and Switzerland were released on both cypress and leafy spurge in several provinces beginning in 1982.

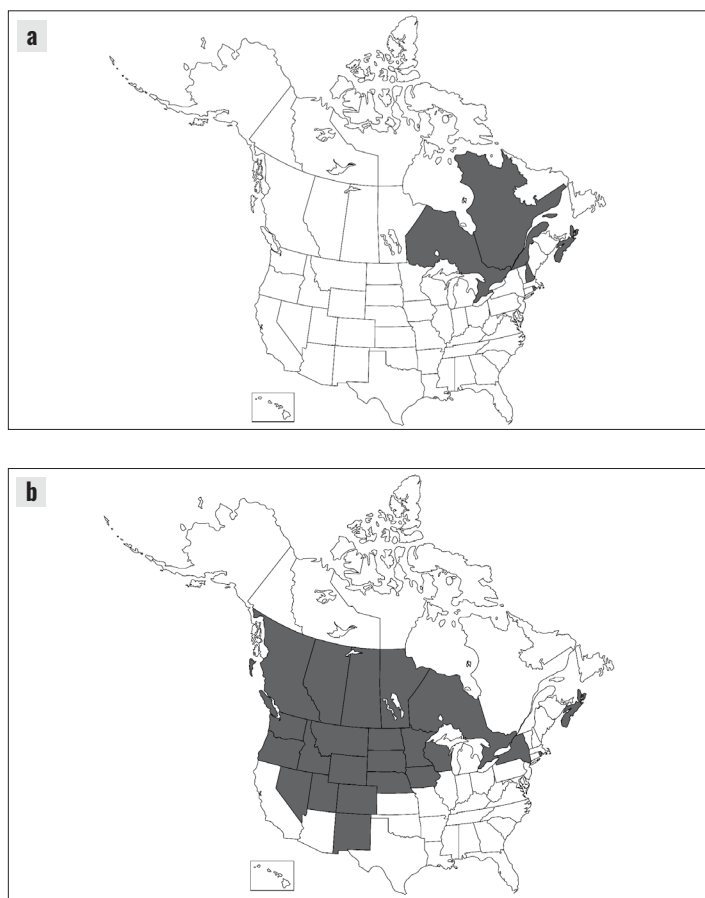


Figure 3. *Aphthona cyparissiae* distribution on (a) cypress spurge and (b) leafy spurge in North America (Winston et al. 2023)

This species is established on both cypress and leafy spurge in North America (**Fig. 3**). In the USA, it is present on cypress spurge in New Hampshire and is present and abundant in Rhode Island. *Aphthona cyparissiae* has been recorded on leafy spurge in far more states (**Fig. 3b**). Though it is well established at a few leafy spurge release sites, it is overall much less abundant on leafy spurge than other *Aphthona* spp. On both spurge species, *A. cyparissiae* populations are highest at dry, mesic sites with sandy loam soils. Under these conditions, stem density may decrease quickly, but unattacked roots help plants recover. Numerous years under the right conditions are required for this biocontrol agent to decrease spurge populations permanently. Damage is typically greatest in combination with other *Aphthona* spp.



Figure 4. *Aphthona cyparissiae* adult feeding damage on leafy spurge (USDA ARS, Bugwood.org, CC BY-3.0 US)

In Canada, *A. cyprissiae* is more distributed on leafy spurge (Fig. 3). On both spurge species, high beetle populations (Fig. 4) effectively control cypress and leafy spurge at dry, open sites, but insect densities are too low and ineffective elsewhere.

NONTARGET EFFECTS

None reported

Aphthona czwalinai (Weise) Black leafy spurge flea beetle

SYNONYMS

This species is sometimes misspelled as *Aphthona czwalinae*, though taxonomists have confirmed the correct name is “czwalinai” and not “czwalinae.”

DESCRIPTION

Larvae are up to 5 mm long, slender, whitish, and have a brown head capsule. Pupae are white and 4–5 mm long (Fig. 5a). Adults are shiny black. Middle and front legs are reddish-brown while the entire surfaces of the hind femurs are black (Fig. 5b). Males are just under 3 mm long, while females are usually just over 3 mm. Although adults have fully developed wings and are capable of flight, they more often walk or utilize their enlarged hind legs (Fig. 5b) to jump when disturbed, as is typical of all flea beetles.

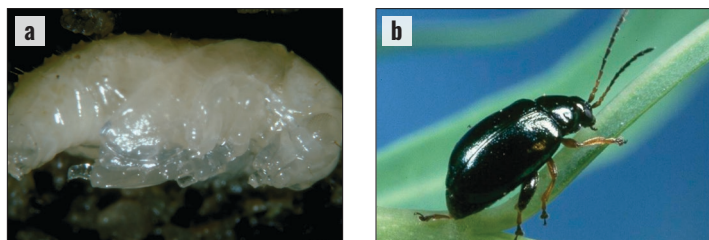


Figure 5. *Aphthona czwalinai* (a) pupa; (b) adult (a: Neal Spencer, USDA ARS; b: R. Richard, USDA APHIS; a,b: Bugwood.org, CC BY-3.0 US)

PREFERRED HABITAT

This beetle does best in moderately dense infestations of cypress and leafy spurge found on more mesic sites in areas with cool summers. It does poorly in soils with too much sand or clay.

HISTORY AND CURRENT STATUS

Aphthona czwalinai is native to Europe. Populations sourced from Austria and Hungary were released on leafy spurge in several states in the USA beginning in 1987. Established populations were then redistributed to cypress spurge

starting in 1995. Many USA releases contained a mixture of *Aphthona* species. A second population originally sourced from Russia was released in Montana in 1993, though it is unknown if this established. In Canada, beetles sourced from Austria were released on leafy spurge beginning in 1985 and on cypress spurge beginning in 1987. Individuals established on leafy spurge in the USA were also redistributed to leafy spurge in Canadian provinces beginning in 1995.

This species is established on both cypress and leafy spurge in North America (Fig. 6). In the USA, it is established on cypress spurge in New Hampshire and Rhode Island (Fig. 6a), though populations are low as this species, and *A. lacertosa* are being replaced by *A. flava* and *A. nigriscutis*. *Aphthona czwalinai* has been recorded on leafy spurge in several more states (Fig. 6b). For many years it was believed *A. czwalinai* was a major component in the control of leafy spurge achieved on the local level (along with *A. nigriscutis* and *A. lacertosa*). It was later discovered most of what was being called *A. czwalinai* was in fact *A. lacertosa*. *Aphthona czwalinai* was subsequently considered insignificant for leafy spurge control in most areas, though small pockets of this species persist in North Dakota and elsewhere.

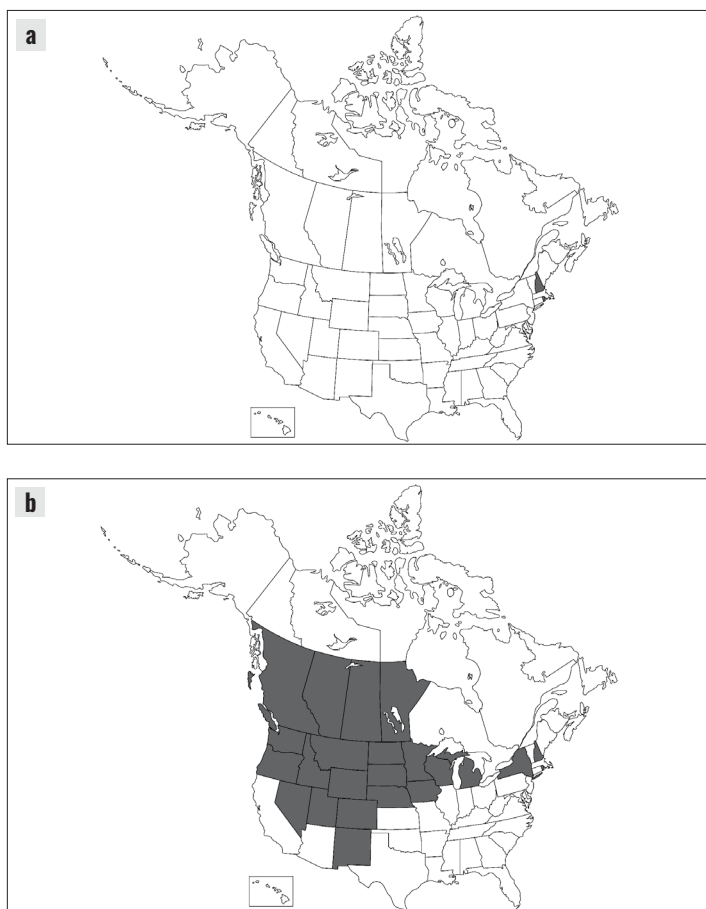


Figure 6. *Aphthona czwalinai* distribution on (a) cypress spurge and (b) leafy spurge in North America (Winston et al. 2023)

In Canada, *A. czwalinai* is established only on leafy spurge (Fig. 6), and its distribution is limited. Release sites now appear to be dominated by *A. lacertosa*, so the overall impact of *A. czwalinai* is considered minor at best.

NONTARGET EFFECTS

None reported

Aphthona flava Guillebeau Copper leafy spurge flea beetle

DESCRIPTION AND LIFE CYCLE

Larvae are 1–6 mm long, slender, whitish (more translucent when young), and with a brown head capsule (Fig. 7a). Adults are orangish-copper in color and 3½ mm long. Females are slightly larger than males. Although adults have fully developed wings and are capable of flight, they more often walk or utilize their enlarged hind legs (Fig. 7b) to jump when disturbed, as is typical of all flea beetles.

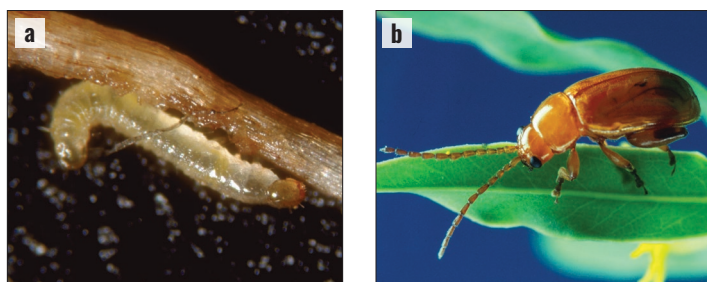


Figure 7. *Aphthona flava* (a) larva on leafy spurge root; (b) adult (a: Neal Spencer, USDA ARS; b: USDA ARS; a,b: Bugwood.org, CC BY-3.0 US)

PREFERRED HABITAT

In the USA, this species does best in moderately dense infestations of leafy spurge found on more mesic, dry sites in alluvial soils above flood lines and in light shade to full sun. In Canada, this beetle does best at mesic, dry sites with warm temperatures. It does poorly in soils with too much sand or clay and in dense shade. It is probably less likely to survive low temperatures than other *Aphthona* spp.

HISTORY AND CURRENT STATUS

Aphthona flava is native to Europe. Populations sourced from Hungary and Italy were released on leafy spurge in several states in the USA beginning in 1987. Established populations were then redistributed to cypress spurge starting in 1995. Many USA releases contained a mixture of *Aphthona* species. In Canada, beetles from Hungary and Italy were released on both cypress and leafy spurge in several provinces beginning in 1982, but these original introductions established only on leafy spurge.

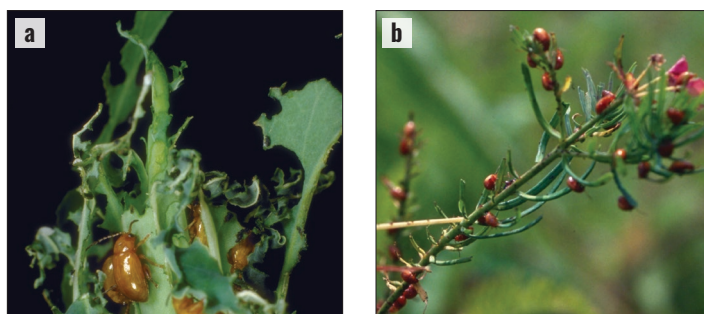


Figure 8. *Aphthona flava* adult feeding damage on (a) leafy spurge; (b) cypress spurge (a: Norman E. Rees, USDA ARS; b: Heather Faubert; a,b: Bugwood.org, CC BY-3.0 US)

This species is established on both cypress and leafy spurge in North America (Fig. 8, 9). In the USA, it is present on cypress spurge in New Hampshire and is present and abundant on cypress spurge in Rhode Island (Fig. 9a) where, along with *A. nigriscutis*, it is replacing *A. lacertosa* and *A. czwalinai*. Under ideal conditions, stem density may decrease quickly, but unattacked roots help plants recover; numerous years are typically required for this biocontrol agent to decrease cypress spurge populations permanently. *Aphthona flava* is

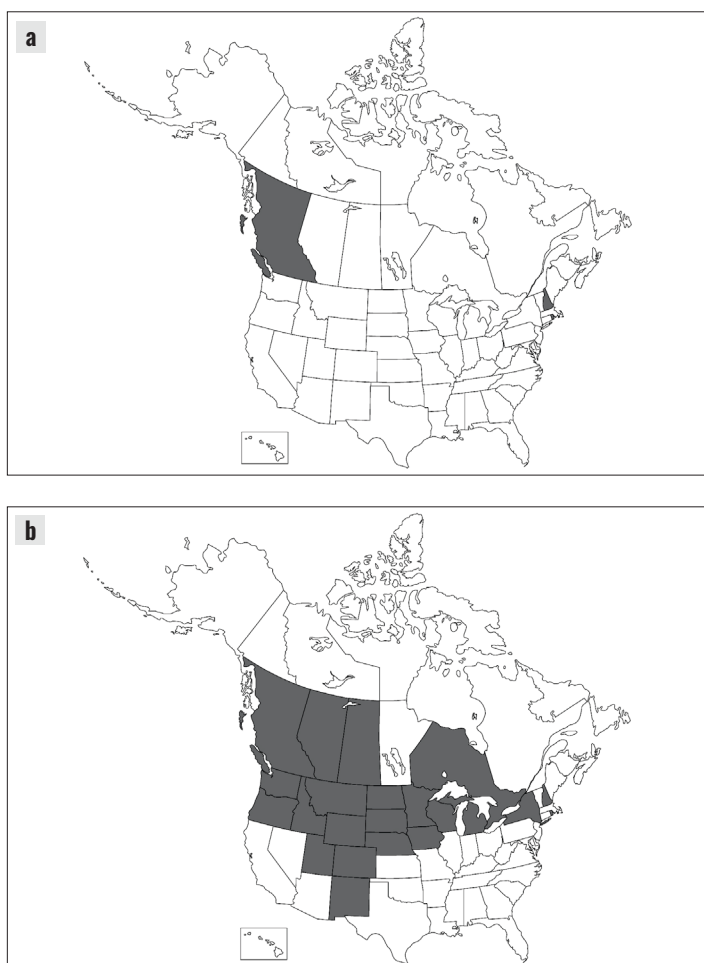


Figure 9. *Aphthona flava* distribution on (a) cypress spurge and (b) leafy spurge in North America (Winston et al. 2023)

more widely established on leafy spurge in the USA (**Fig. 9b**). Although its impact has reportedly been spectacular in one area in Montana, overall it is much less abundant than other *Aphthona* spp. It persists at fairly low levels with little noticeable impact on infestations.

In Canada, this species is moderately abundant on leafy spurge in Ontario and western Canada (**Fig. 9b**). Leafy spurge density has declined where populations of *A. flava* are high; however, this is typically at sites where *A. nigriscutis* is also present. In 2011, beetles were redistributed from leafy spurge to cypress spurge within British Columbia and successfully established (**Fig. 9a**); however, this species is rarely encountered on cypress spurge, and its impact is likely low.

NONTARGET EFFECTS

None reported

Aphthona lacertosa Brown-legged leafy spurge flea beetle

DESCRIPTION

Larvae are up to 5 mm long, slender, whitish, and with a brown head capsule. Adults are shiny black and 3 mm long (**Fig. 10a**). Their legs are largely reddish-brown in color, though the tops of the hind femurs sometimes have dark patches. Although adults have fully developed wings and are capable of flight, they more often walk or utilize their enlarged hind legs (**Fig. 10b**) to jump when disturbed, as is typical of all flea beetles.

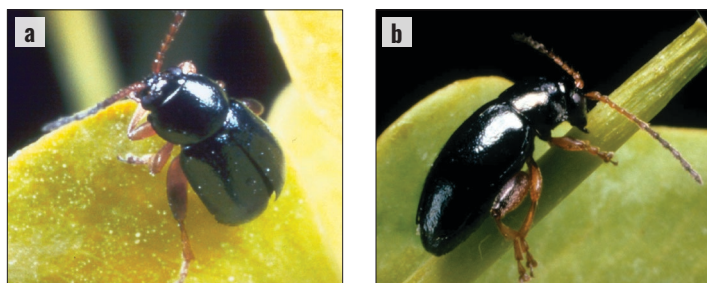


Figure 10. *Aphthona lacertosa* adults (a: USDA APHIS PPQ; b: Mark Schwarzländer, University of Idaho; a,b: Bugwood.org, CC BY-3.0 US)

PREFERRED HABITAT

This species does best in moderately dense infestations of cypress and leafy spurge found growing in loamy soils. It can adapt locally to both dry and wet habitats in the USA but does better at mesic to moist sites in Canada. It does poorly in soils with too much sand or clay.

HISTORY AND CURRENT STATUS

Aphthona lacertosa is native to Europe. Populations sourced from Austria, Hungary, and the former Yugoslavia were released on leafy spurge in several states in the USA beginning in 1993. Established populations were then redistributed to cypress spurge starting in 1995. Many USA releases contained a mixture of *Aphthona* species. In Canada, *A. lacertosa* has only been released on leafy spurge. Beetles sourced from Hungary and the former Yugoslavia were released in four Canadian provinces beginning in 1987. Individuals established on leafy spurge in the USA were redistributed to leafy spurge in four Canadian provinces beginning in 1995. Both sources resulted in establishment on leafy spurge in Canada.

This species is established on both cypress and leafy spurge in the USA but only on leafy spurge in Canada (**Fig. 11**). Its abundance is limited on cypress spurge in Rhode Island where it and *A. czwalinai* are being replaced by *A. flava* and *A. nigriscutis*. Its density and impact on cypress spurge in New Hampshire are unknown. This beetle is widespread

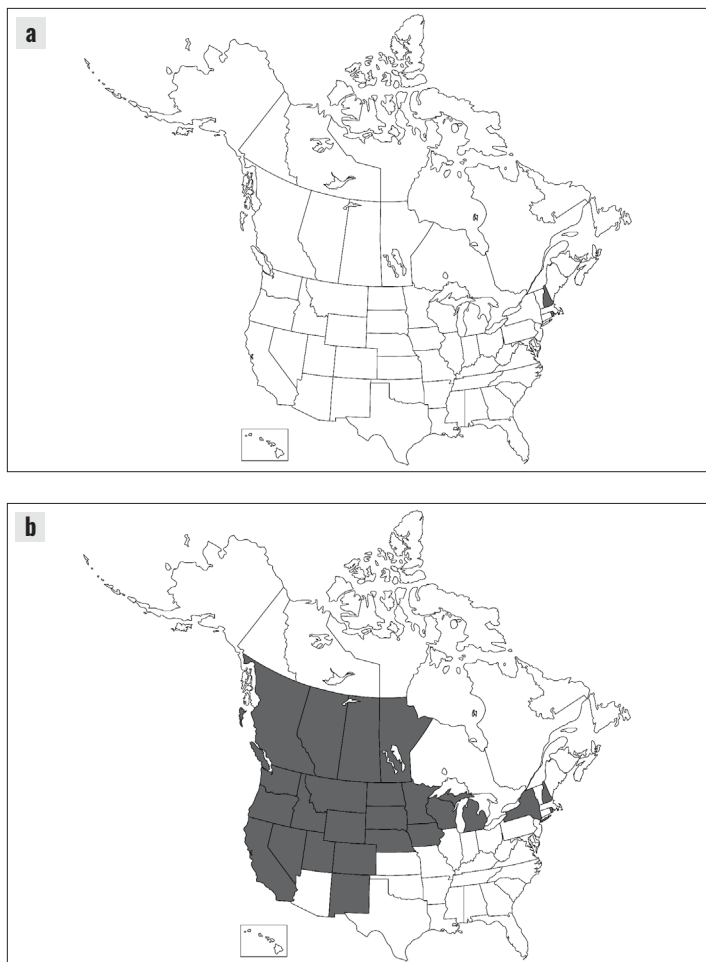


Figure 11. *Aphthona lacertosa* distribution on (a) cypress spurge and (b) leafy spurge in North America (Winston et al. 2023)

and abundant on leafy spurge in the USA. Along with *A. nigriscutis*, it is significantly reducing leafy spurge density at the local level in most regions (Fig. 12), though it is not effective at all sites. In Canada, this beetle is reducing plant density at most sites and appears to be displacing *A. czwalinai* at many locations.

NONTARGET EFFECTS

None reported

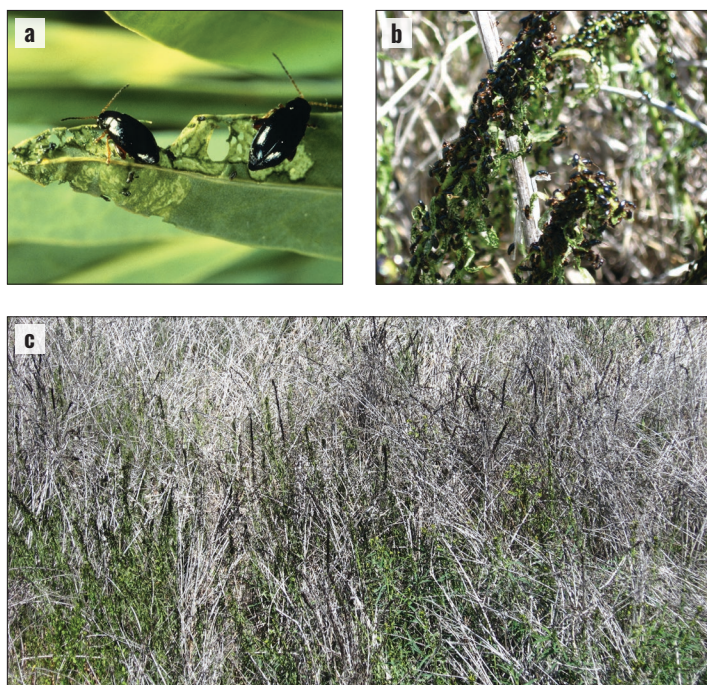


Figure 12. *Aphthona lacertosa* adult feeding damage on leafy spurge (a: Todd Pfeiffer, Klamath County Weed Control; b: Heather Faubert; a,b: Bugwood.org, CC BY-3.0 US)

Aphthona nigriscutis Foudras Black dot leafy spurge flea beetle

DESCRIPTION

Larvae are 1–6 mm long, slender, whitish (more translucent when young, Fig. 13a), and have a brown head capsule (Fig. 13b). Adults are usually just over 3 mm long. They are orangish-brown and typically have a black dot on the back near the leading edge of the wings (Fig. 13c,d). Although adults have fully developed wings and are capable of flight, they more often walk or utilize their enlarged hind legs (Fig. 13e) to jump when disturbed, as is typical of all flea beetles.

PREFERRED HABITAT

This species prefers relatively sparse cypress and leafy spurge patches at dry sites with sandier soil. It does poorly in soils with too much clay.

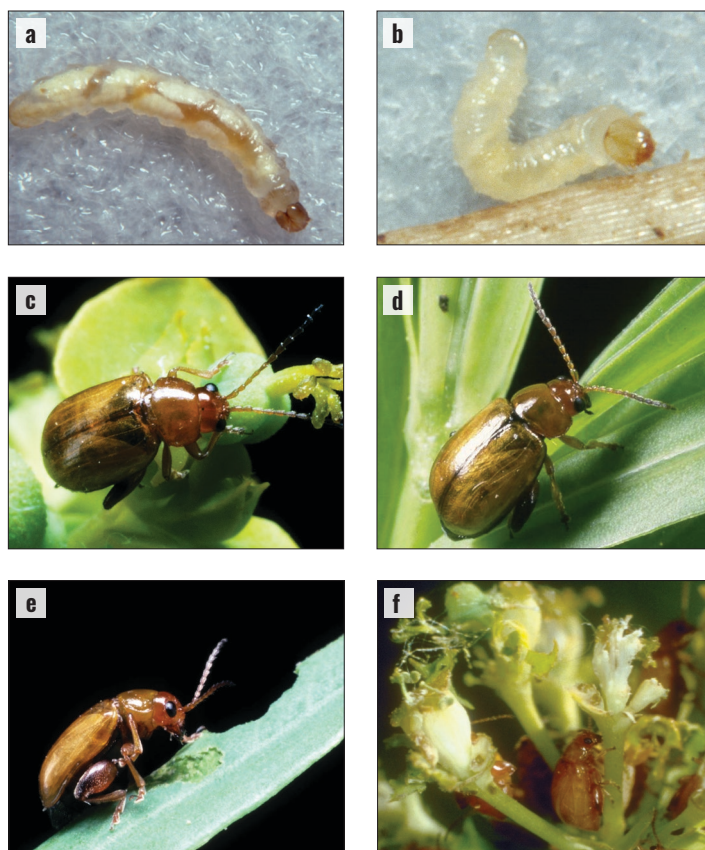


Figure 13. *Aphthona nigriscutis* (a,b) larva; (c,d) adult; (e) adult feeding damage to leafy spurge leaf and (f) inflorescences (a,b: Neal Spencer, USDA ARS; c,e: Mark Schwarzländer, University of Idaho; d: R. Richard, USDA APHIS; f: Norman E. Rees, USDA ARS; a–f: Bugwood.org, CC BY-3.0 US)

HISTORY AND CURRENT STATUS

Aphthona nigriscutis is native to Europe. Individuals from Hungary were first released on leafy spurge in Canada beginning in 1983 and on cypress spurge starting in 1986. After establishment in Canada, beetles were redistributed to leafy spurge in several states in the USA beginning in 1989 and were subsequently redistributed to cypress spurge in 1995. Many USA releases contained a mixture of *Aphthona* species.

This species is established on both cypress and leafy spurge in North America (Fig. 14). In the USA, it is present on cypress spurge in New Hampshire and is present and abundant on cypress spurge in Rhode Island where, along with *A. flava*, it is replacing *A. lacertosa* and *A. czwalinai*. Under ideal conditions, stem density may decrease quickly, but unattacked roots help plants recover; numerous years are typically required for this biocontrol agent to decrease cypress spurge populations permanently. *Aphthona nigriscutis* is widespread and abundant on leafy spurge in the USA. Along with *A. lacertosa*, it is significantly reducing plant density at the local level in most regions, though it is not effective at all sites. Beetle abundance and impact may be hindered by a bacterium that causes female-bias in populations.



Figure 14. *Aphthona nigriscutis* distribution on (a) cypress spurge and (b) leafy spurge in North America (Winston et al. 2023)

In Canada, *A. nigriscutis* abundance and impact are variable. It helps control cypress spurge in the immediate vicinity of release sites at dry, open locations. It has been successful at reducing or removing leafy spurge in open, warm, very dry habitats with lighter soils. Populations are low or absent at moist, sheltered sites on heavy soil.

NONTARGET EFFECTS

Spillover feeding by adult beetles was observed in Wyoming, USA on the native *Euphorbia robusta*; however, there was no impact of feeding on *E. robusta* populations. As leafy spurge densities declined, the feeding on *E. robusta* also declined, and *E. robusta* populations increased.

Chamaesphecia empiformis

Cypress spurge clearwing moth

Chamaesphecia empiformis is a biological control agent approved in North America for release against [cypress spurge](#).

CLASSIFICATION

RANKING	SCIENTIFIC NAME	COMMON NAME
Kingdom	Animalia	Animals
Phylum	Arthropoda	Arthropods
Class	Insecta	Insects
Order	Lepidoptera	Butterflies and moths
Family	Sesiidae	Clearwing moths
Genus	<i>Chamaesphecia</i>	
Species	<i>Chamaesphecia empiformis</i> (Esper)	Leafy spurge clearwing moth

DESCRIPTION

Eggs are flattened, oval, and brown. Larvae are white and up to 15 mm long (**Fig. 15a**). Adults are dark brown with yellow-white bands (**Fig. 15b**). Bodies are typically 10–14 mm long, and wingspans are 16–22 mm. Each wing is brown with yellow markings and a few transparent windows with dark margins. Body and wing tips are fringed.

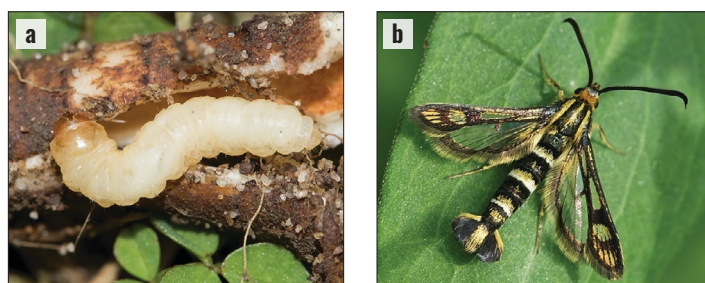


Figure 15. *Chamaesphecia empiformis* (a) larva; (b) adult (a: Jurriën van Deijk, Waarneming.nl CC-BY-NC-ND 4.0; b: Vojtek Pavel, iNaturalist.org CC-BY-NC 4.0)

LIFE CYCLE

Overwintering larvae resume feeding in cypress spurge root tunnels in early spring. They mine upwards in the plant stem, pupating within. Adults emerge from late spring and lay eggs on cypress spurge plants. Hatching larvae burrow into the stem, mine down, and feed on roots. There is one generation per year (**Fig. 16**).

HOST SPECIES IN NORTH AMERICA

Cypress spurge

DAMAGE

Larval feeding (**Fig. 15a**) destroys affected stems and roots which reduces overall plant reserves and vigor and may result in plant death. Larval feeding damage may make attacked sites more susceptible to pathogens.

FIELD IDENTIFICATION

Adult *Chamaesphecia empiformis* may be observed on cypress spurge foliage throughout summer. Larval mining is not readily visible during very early stages unless stems and roots are dissected.

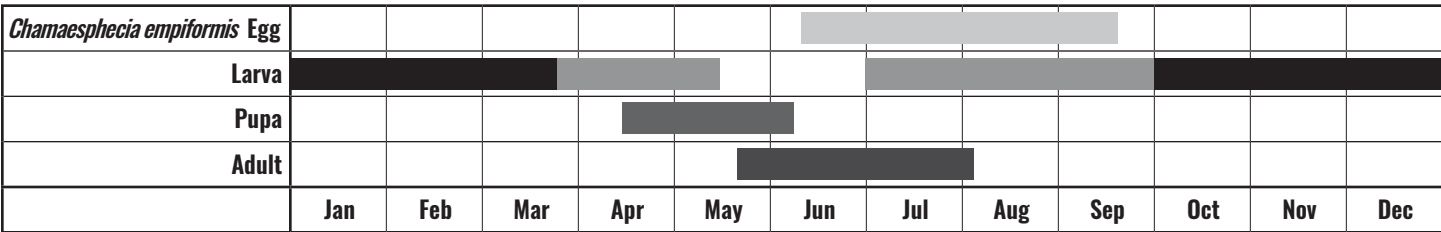


Figure 16. Possible schematic life cycle of *Chamaesphecia empiformis* in North America, largely reflecting its life cycle in Europe. Bars indicate the approximate length of activity for each life stage; dates will vary depending on local conditions. Black bars represent the inactive and/or overwintering periods. There is typically one generation per year.

Most of the 11 other biocontrol agents currently established on cypress and/or leafy spurge in North America can be readily differentiated (see [Table 1](#)). Similar to *C. empiformis*, the larvae of the beetle *Oberea erythrocephala* also mine the stems and roots of spurge; they differ by preferring leafy spurge, and their larvae have obvious inflated segments (**Fig. 26a**). The moth *Hyles euphorbiae* differs in that its larvae are defoliating and conspicuously colored (**Fig. 18a–d**), and its adults are much larger and pink and brown (**Fig. 18f**). The moth *Lobesia euphorbiana* (released and established only in Canada) differs in that its larvae are leaf-tying, and its adults are smaller and a mottled rust color (**Fig. 22d,e**).

PREFERRED HABITAT

This species was only recently discovered established at limited locations in Ontario, Canada. Consequently, its habitat preferences in North America are not known.

HISTORY AND CURRENT STATUS

Chamaesphecia empiformis is native to Europe. Individuals sources from Austria, Germany, and Switzerland were released on cypress spurge in Ontario, Canada in 1970 and 1989 and in Idaho and Montana, USA in 1975. All releases were initially believed to have failed establishment. Beginning in 2015, images posted on citizen science platforms indicated that *C. empiformis* was in fact established. This



Figure 17. *Chamaesphecia empiformis* distribution on cypress spurge in North America (McClay et al. 2023)

was subsequently confirmed in eastern Ontario (**Fig. 17**) by morphological and molecular identification of field-collected adults and eggs. The moth’s overall abundance and impact are currently unknown.

NONTARGET EFFECTS

None reported

Hyles euphorbiae
Leafy spurge hawk moth

Hyles euphorbiae is a biological control agent approved in North America for release against [cypress and leafy spurge](#).

SYNONYMS

Celerio euphorbiae (L.)

CLASSIFICATION

RANKING	SCIENTIFIC NAME	COMMON NAME
Kingdom	Animalia	Animals
Phylum	Arthropoda	Arthropods
Class	Insecta	Insects
Order	Lepidoptera	Butterflies and moths
Family	Sphingidae	Sphinx moths
Genus	<i>Hyles</i>	
Species	<i>Hyles euphorbiae</i> (Linnaeus)	Leafy spurge hawk moth

DESCRIPTION

Larvae are up to 10 cm long. They change color upon maturation going from dark green, to brown and yellow longitudinally striped, to green with white spots, to red, black, yellow, and white with a horn at the back end (**Fig. 18a–d**). Larvae contain toxin, protecting them from predators. Pupae are 4–5 cm long and light brown maturing to maroonish-brown with intricate dark markings (**Fig. 18e**). Adults have wingspans up to 5 cm and are white, pink, and grayish-brown on the back (**Fig.18f**) but pink on the undersides.

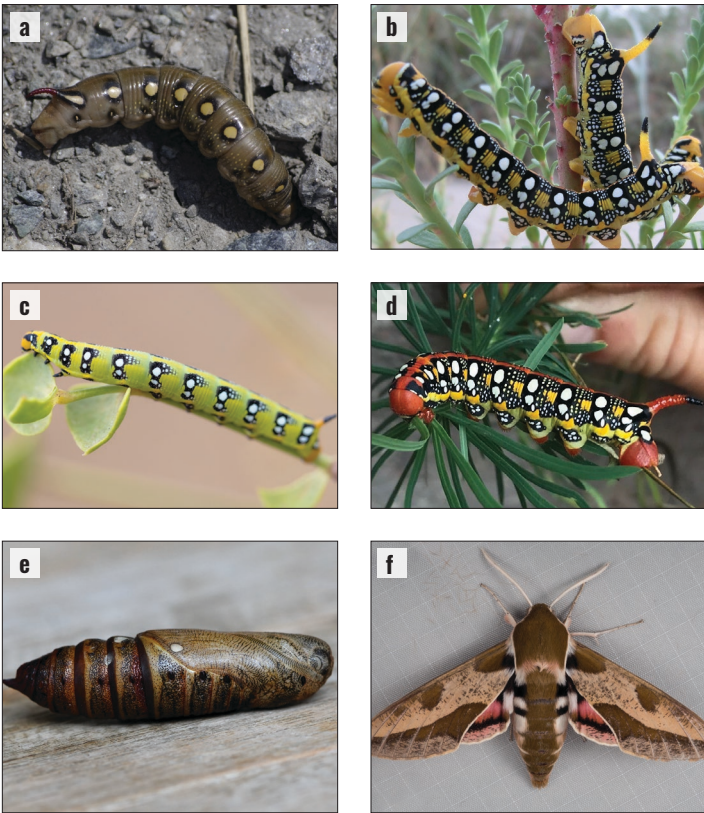


Figure 18. *Hyles euphorbiae* (a–d) larvae; (e) pupa; (f) adult (a: Baudier; b: Mario Vega Pérez; c: Shamil Murtazin; d: Miaklocke; e: Achine; f: Kristi DuBois; a–f: iNaturalist.org CC BY-NC 4.0)

LIFE CYCLE

There are up to two generations per year (**Fig. 19**). Adults emerge in early to mid-summer when cypress and leafy spurge are bolting/flowering. Females lay 70–150 eggs in clumps on leaves and bracts. Hatching larvae feed on these plant parts as cypress and leafy spurge are flowering. Larvae feed through five instars, and then pupation occurs in the soil. In locations and years where late summer temperatures are sufficiently high to speed up egg and larval development, second generation adults emerge in late summer and repeat the cycle. Newly hatched larvae move to the soil to pupate. Regardless of whether there are one or two generations, pupae overwinter.

HOST SPECIES IN NORTH AMERICA

Cypress and leafy spurge

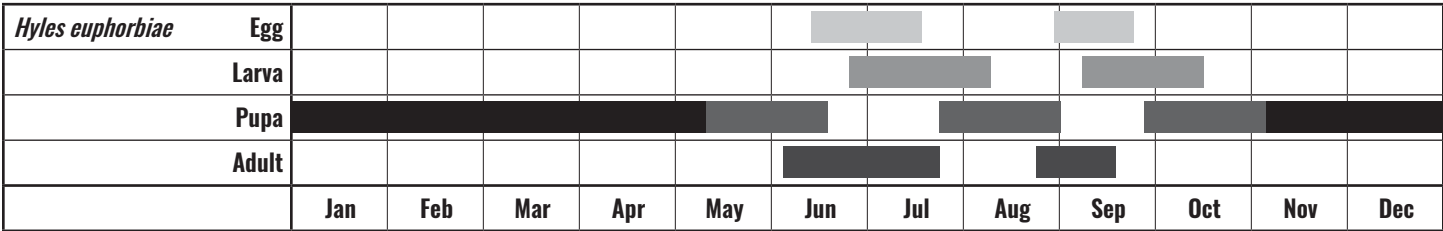


Figure 19. Schematic life cycle of *Hyles euphorbiae* in North America. Bars indicate the approximate length of activity for each life stage; dates will vary depending on local conditions. Black bars represent the inactive and/or overwintering periods. There are typically two generations per year.

DAMAGE

Larval feeding defoliates spurges (**Fig. 20**), though this often does not kill the attacked plants.



Figure 20. *Hyles euphorbiae* larva defoliating cypress spurge (Stefanodirektor, Naturalist.org CC BY-NC 4.0)

FIELD IDENTIFICATION

Hyles euphorbiae adults and larvae may be observed on cypress and leafy spurge foliage throughout summer. The conspicuous coloration of larvae (**Fig. 18a–d**) easily differentiate them from other species. Native *Hyles* species also occur in North America, and many adults of these species resemble *H. euphorbiae*. Adults of *H. euphorbiae* tend to have more pink on their undersides and are diurnal, whereas native species tend to be more nocturnal.

Most of the 11 other biocontrol agents currently established on cypress and/or leafy spurge in North America can be readily differentiated (see **Table 1**). The moth *Lobesia euphorbiana* (released and established only in Canada) differs because its larvae (**Fig. 22a**) are leaf-tying and lack the conspicuously colored spots and stripes of *H. euphorbiae*, and its adults are smaller and a mottled rust color (**Fig. 22d,e**).

PREFERRED HABITAT

This species does best in thick spurge infestations growing in open areas near trees. Pupae are heavily preyed upon so sites with low populations of rodents, ants, etc. are preferred.

HISTORY AND CURRENT STATUS

Hyles euphorbiae is native to Europe. Moths from France, Germany, and Switzerland were released in Canada on

cypress spurge beginning in 1965 and on leafy spurge in 1966. Established populations were redistributed to leafy spurge in several states in the USA starting in 1966. The same Canadian source material was released on oblong and cypress spurge in the USA in 1974 and 1976, respectively. A second population of *H. euphorbiae* was sourced from Hungary and released in the USA in 1980.

This species is established on both cypress and leafy spurge in North America (**Fig. 21**); it failed to establish on oblong spurge. In the USA, it is established on the fertile tetraploid form of cypress spurge in New York where initially high densities of this moth have since decreased due to high levels of predation. Even where high densities have resulted in total cypress spurge defoliation, impact is insignificant as plant populations can tolerate yearly defoliation. Both source populations established on leafy spurge in the USA where they have since intermixed and can no longer be differentiated. Though moth densities may be locally high in some years, disease and predation typically prevent densities from developing to levels substantial enough to impact leafy spurge populations in most areas. Even where high densities

have resulted in total plant defoliation, impact has been insignificant as this does not kill plants.

In Canada, *H. euphorbiae* abundance is typically limited to moderate on both cypress and leafy spurge due to predation. It is scattered but widespread in Ontario and increasingly common in western provinces. Even when moth populations are high, plants recover from defoliation. This moth has limited biocontrol value alone, but may stress the weeds when in combination with other biocontrol agents.

NONTARGET EFFECTS

None reported

Lobesia euphorbiana
Spurge leaf-tying moth

Lobesia euphorbiana is a biological control agent approved in Canada for release against [leafy spurge](#).

CLASSIFICATION

RANKING	SCIENTIFIC NAME	COMMON NAME
Kingdom	Animalia	Animals
Phylum	Arthropoda	Arthropods
Class	Insecta	Insects
Order	Lepidoptera	Butterflies and moths
Family	Tortricidae	Leafroller moths
Genus	<i>Lobesia</i>	
Species	<i>Lobesia euphorbiana</i> (Freyer)	Spurge leaf-tying moth

DESCRIPTION

Eggs are translucent yellow and round. Larvae have brown head capsules and segmented bodies up to 12 mm long. Young larvae are pale yellowish-green (**Fig. 22a**), turning nearly black with maturity. Mature larvae spin grayish-white webs under which they pupate (**Fig. 22b**). Pupae are pale green initially, turning brown with time (**Fig. 22c**). Adults are mottled with yellow, brown, and rust tones and light-colored legs and antennae (**Fig. 22d,e**). Adults can be 9–11 mm long with wingspans up to 14 mm.

LIFE CYCLE

Adults emerge in spring as leafy spurge is bolting and flowering (**Fig. 23**). Females lay eggs immediately (an average of 55 eggs each) and singly on the undersides of leaves. Hatching larvae move towards terminal leaf tips and tightly tie leaves with silky webbing (**Fig. 24**). They feed on

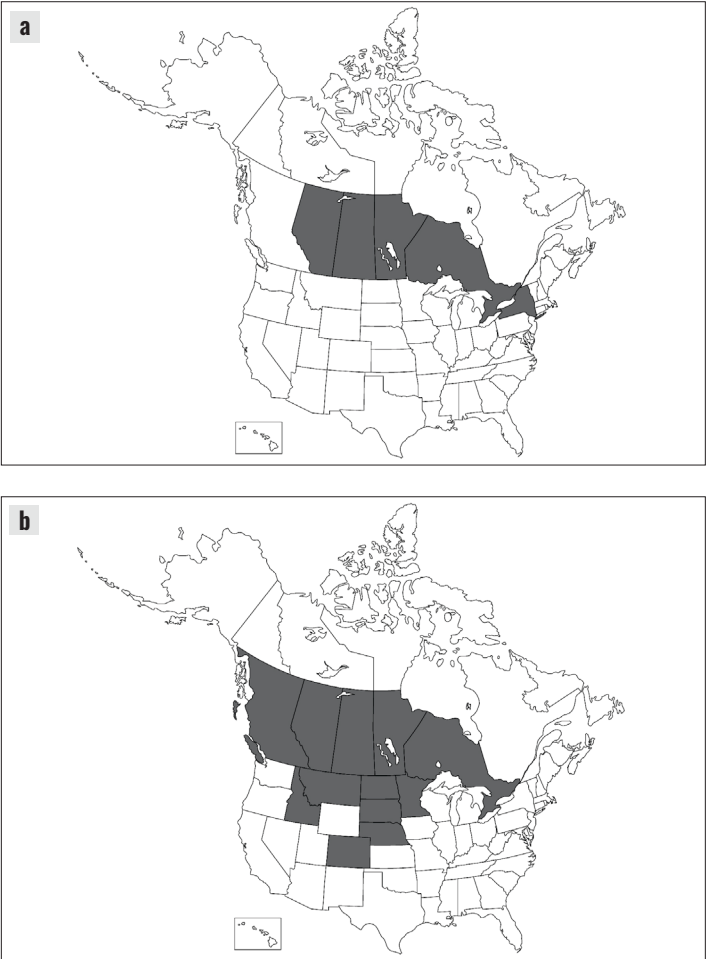


Figure 21. *Hyles euphorbiae* distribution on (a) cypress spurge and (b) leafy spurge in North America (Winston et al. 2023)

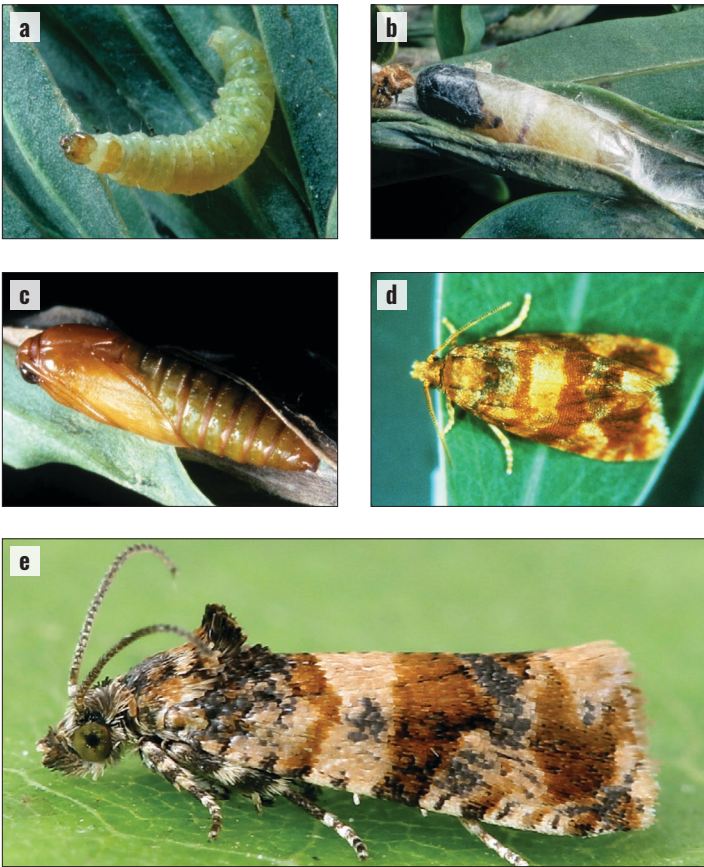


Figure 22. *Lobesia euphorbiana* (a) larva; (b) cocoon; (c) pupa; (d,e) adult (a–c: Laura Parsons, University of Idaho, Bugwood.org, CC BY-3.0 US; d: CABI; e: Andrey Ponomarev, iNaturalist.org CC BY-NC 4.0)

buds within ties, developing through four instars typically, but occasionally five when food is scarce. Prior to pupation, larvae move to leaf tips where they spin thick webs (Fig. 22b). Second-generation adults emerge from mid- to late summer and repeat the process. Second-generation pupae overwinter in plant litter within folded leaves. There are two generations per year, with three possible in suitable climates.

HOST SPECIES IN NORTH AMERICA

Leafy spurge

DAMAGE

Larval feeding on buds (Fig. 24) prevents flowering, and repeated heavy attack may eventually kill plants. When larvae

vacate leaf ties, the sites often receive secondary attack from thrips and aphids.

FIELD IDENTIFICATION

Adult *Lobesia euphorbiana* may be observed on leafy spurge foliage throughout late spring and summer. Where this species is established, larval leaf-tying (Fig. 24) should be readily visible throughout summer and into early fall.



Figure 24. *Lobesia euphorbiana* damage (Laura Parsons, University of Idaho, Bugwood.org, CC BY-3.0 US)

Most of the 11 other biocontrol agents currently established on cypress and/or leafy spurge in North America can be readily differentiated (see Table 1). The moth *Hyles euphorbiae* differs in that its larvae have conspicuously colored spots and stripes (Fig. 18a–d), and its adults are much larger with distinctive white, pink, and gray-brown coloration (Fig. 18f).

PREFERRED HABITAT

This species does best at mesic sites where plants have high nutrient quality. Complete development requires high temperatures, so sites that are warm to hot over summer are preferred. This moth tolerates shade and often inhabits riparian areas as well as fringe forested areas.

HISTORY AND CURRENT STATUS

Lobesia euphorbiana is native to Europe. Individuals sourced from Italy were released on leafy spurge in several Canadian provinces beginning in 1983. Established individuals were subsequently redistributed to cypress spurge in Ontario in 1991, though this redistribution failed.

Lobesia euphorbiana is established only on leafy spurge and only in Canada (Fig. 25) where populations have dispersed well from most release sites. Its overall impact is variable because populations fluctuate with leafy spurge density and vigor; they are low in some provinces but high in others. Repeated heavy attack kills target plants at some locations.

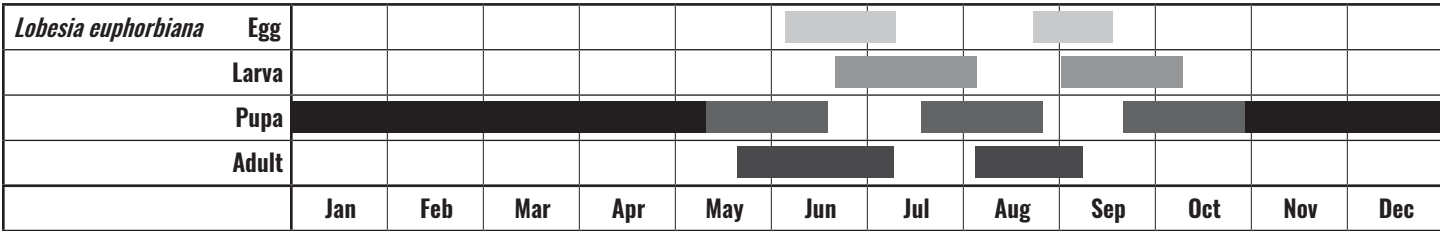


Figure 23. Schematic life cycle of *Lobesia euphorbiana* in North America. Bars indicate the approximate length of activity for each life stage; dates will vary depending on local conditions. Black bars represent the inactive and/or overwintering periods. There are typically two generations per year.

This species is not approved for release in the USA.

NONTARGET EFFECTS

None reported



Figure 25. *Lobesia euphorbiana* distribution on leafy spurge in North America (Winston et al. 2023)

Oberea erythrocephala
Red-headed leafy spurge stem borer

Oberea erythrocephala is a biological control agent approved in North America for release against leafy spurge.

CLASSIFICATION

RANKING	SCIENTIFIC NAME	COMMON NAME
Kingdom	Animalia	Animals
Phylum	Arthropoda	Arthropods
Class	Insecta	Insects
Order	Coleoptera	Beetles
Family	Cerambycidae	Longhorn beetles
Genus	<i>Oberea</i>	
Species	<i>Oberea erythrocephala</i> (Schrank)	Red-headed leafy spurge stem borer

DESCRIPTION

Mature larvae are up to 20 mm long, slender, and white with a yellowish head and a head capsule. Bodies are obviously segmented with inflated segments (Fig. 26a). Adults are slender and 10–12 mm long with long, dark antennae, red heads, and black eyes (Fig. 26b). Adult bodies are dark gray above and lighter gray with reddish markings below. Their legs are yellowish-brown.

LIFE CYCLE

Adults emerge in early to mid-summer (Fig. 27) and feed on leafy spurge leaves and flowers. Females girdle a leafy spurge

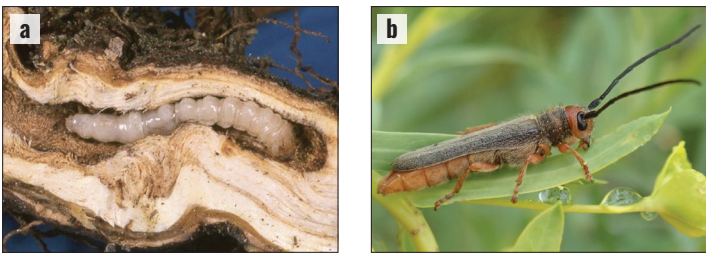


Figure 26. *Oberea erythrocephala* (a) larva in leafy spurge root; (b) adult (a: R. Richard, USDA ARS; b: Julien Preud'homme, iNaturalist.org CC BY-NC 4.0)

stem (Fig. 28a), chew a hole, and deposit a single egg (up to 40 in a lifetime). Hatching larvae mine down the stem until reaching the root crown and nearby lateral roots. Larvae overwinter and pupate within the root crown in spring. Adults chew through remaining plant tissue and emerge from the soil. There is one generation per year in Europe, though two years may be required for full development in colder parts of North America.

HOST SPECIES IN NORTH AMERICA

Leafy spurge

DAMAGE

Larval mining (Fig. 26a) kills shoots and reduces root reserves. Adult feeding is generally insignificant; however, the girdling of stems (Fig. 28a) often leads to shoot death, reducing seed production.

FIELD IDENTIFICATION

Adult *O. erythrocephala* may be observed on leafy spurge foliage throughout summer. Girdled leafy spurge stems (Fig. 28a) can be indicative of this beetle's presence. Larval mining is not readily visible unless stems and root crowns are dissected.

Most of the 11 other biocontrol agents currently established on cypress and/or leafy spurge in North America can be readily differentiated (see Table 1). The larvae of the moth *Chamaesphecia empiformis* (Fig. 15a) also mine the stems and roots of spurge; however, they differ by preferring cypress spurge, and their larvae lack the obvious inflated segments of *O. erythrocephala* (Fig. 26a).

PREFERRED HABITAT

This species prefers mesic sites. It is believed to do well in riparian areas and has been shown to survive harsh winter temperatures.

HISTORY AND CURRENT STATUS

Oberea erythrocephala is native to Europe. Individuals sourced from Italy were released on leafy spurge in the USA in 1980. After these failed to establish, new populations were sourced from Austria, Hungary, and Italy and released on

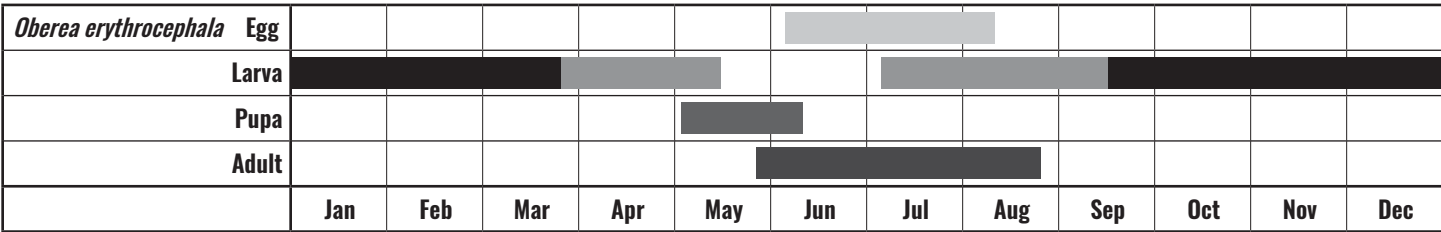


Figure 27. Schematic life cycle of *Oberea erythrocephala* in North America. Bars indicate the approximate length of activity for each life stage; dates will vary depending on local conditions. Black bars represent the inactive and/or overwintering periods. There is typically one generation per year.

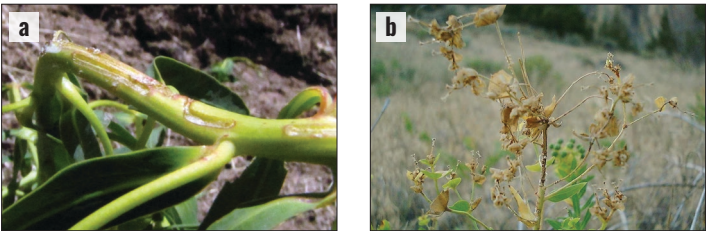


Figure 28. *Oberea erythrocephala* (a) stem girdling; (b) shoot damage (a: Joseph Milan, Bureau of Land Management; b: Eric Coombs, Oregon Department of Agriculture, Bugwood.org CC BY-3.0 US)

USA leafy spurge beginning in 1982. In Canada, individuals from Switzerland were released on leafy spurge starting in 1979 and on cypress spurge beginning in 1986.

This species is established only on leafy spurge in North America (Fig. 29). In the USA, it was initially believed to have the potential to greatly depress leafy spurge populations, but for several years beetle densities appeared to remain too low to impart significant impacts. At some sites, this was attributed to the beetle only attacking specific leafy spurge biotypes. However, since 2020, many populations in the northwestern USA appear to have increased significantly. Additional studies are needed to quantify the effects of the increasing populations, so the overall impact of this species at this time remains unclear.

In Canada, *O. erythrocephala* is established only in Alberta where it is considered rare. At high densities, small plants

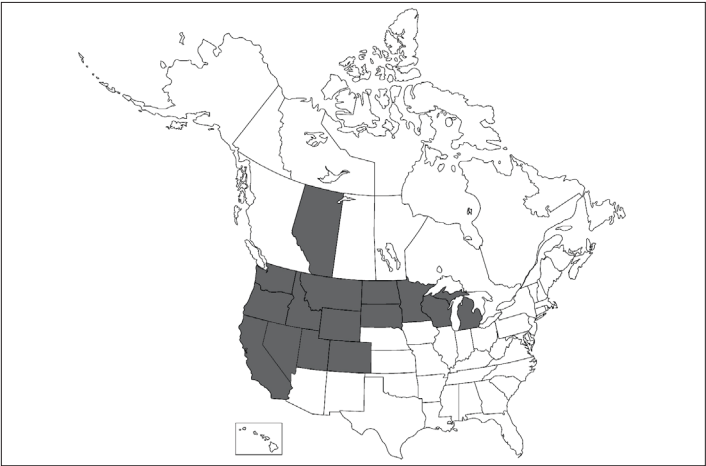


Figure 29. *Oberea erythrocephala* distribution on leafy spurge in North America (Winston et al. 2023)

can be killed, however field populations are too low to have a significant impact in Canada.

NONTARGET EFFECTS

None reported

Pegomya curticornis & P. euphorbiae

Leafy spurge gall flies

Pegomya curticornis and *P. euphorbiae* are closely related biological control agents approved in North America for release against [cypress](#) and [leafy spurge](#).

CLASSIFICATION

RANKING	SCIENTIFIC NAME	COMMON NAME
Kingdom	Animalia	Animals
Phylum	Arthropoda	Arthropods
Class	Insecta	Insects
Order	Diptera	Flies
Family	Anthomyiidae	Root maggot flies
Genus	<i>Pegomya</i>	
Species	<i>Pegomya curticornis</i> (Stein) <i>Pegomya euphorbiae</i> (Kieffer)	Leafy spurge gall flies

SYNONYMS

These two species were previously lumped together under the name *Pegomya argyrocephala* (Meigen).

DESCRIPTION

Pegomya curticornis and *P. euphorbiae* are virtually indistinguishable. Larvae are light gray maggots. Adults are dark-colored with maroon eyes and scattered black hairs on the head and thorax (Fig. 30). Wings are dark and translucent and span up to 6 mm.



Figure 30. *Pegomya euphorbiae* adult (André Gassmann, CABI Switzerland)

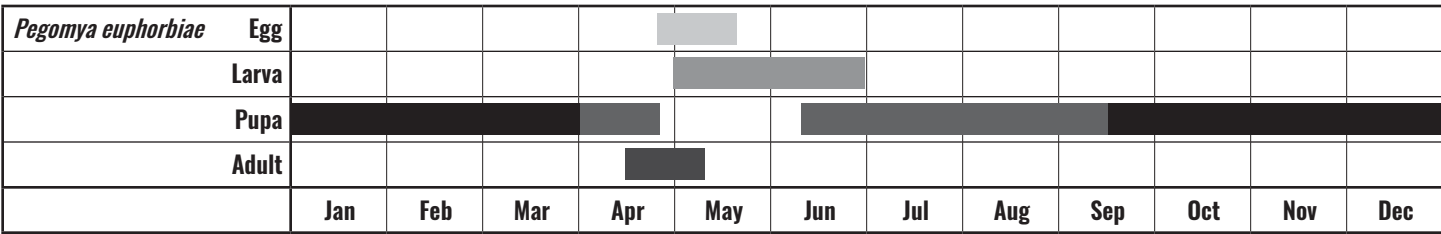


Figure 31. Possible schematic life cycle of *Pegomya euphorbiae* in North America, largely reflecting its life cycle in Europe. Only *P. euphorbiae* is included because *P. curticornis* is believed to have failed to establish. Bars indicate the approximate length of activity for each life stage; dates will vary depending on local conditions. Black bars represent the inactive and/or overwintering periods. There is typically one generation per year.

LIFE CYCLE

In Europe, adults emerge in early spring and lay eggs in leaf buds of new shoots after spurses have resumed growing. Hatching larvae tunnel down young shoots, which have less toxic milky latex than older shoots. Larvae develop through three instars. Larval vascular feeding induces the formation of galls in subterranean stems and in spurge roots. Puparia are formed inside galls in midsummer, within which pupae overwinter. There is one generation per year (**Fig. 31**). Additional work is required to confirm the phenology in North America.

HOST SPECIES IN NORTH AMERICA

Leafy spurge

DAMAGE

Mined and galled spurge stems wilt and eventually die.

FIELD IDENTIFICATION

Only *P. euphorbiae* is believed to be established in North America. Adults are uncommon, and additional work is required to determine how long they survive after spring flight periods. Larval mining is not readily visible unless stems and root crowns are dissected, but the presence of galls in subterranean stems and roots of leafy spurge may be indicative of this species’ presence.

Most of the 11 other biocontrol agents currently established on cypress and/or leafy spurge in North America can be readily differentiated (see **Table 1**). The larvae of the moth *Chamaesphecia empiformis* and the beetle *Oberea erythrocephala* also mine the stems and roots of spurge, similar to *P. euphorbiae*; however, *C. empiformis* prefers cypress spurge, and its larvae are much larger (up to 15 mm long, **Fig. 15a**). *Oberea erythrocephala* larvae are also much larger (up to 20 mm long) and have obvious inflated segments (**Fig. 26a**). Adults of the *Spurgia* spp. midges are much smaller (≤ 2 mm) and delicate (**Fig. 33c,d**) compared to *Pegomya* adults, and their larvae are tiny and induce the formation of obvious galls on the tips of spurge stems (**Fig. 35**).

PREFERRED HABITAT

Specific habitat requirements for both species are unknown.

HISTORY AND CURRENT STATUS

Pegomya curticornis and *P. euphorbiae* are both native to Europe. In Canada, *Pegomya curticornis* was collected from Hungary and released on leafy spurge beginning in 1988. *Pegomya euphorbiae* also sourced from Hungary was released on leafy spurge beginning in 1988 and on cypress spurge in 1989. Though these species were also approved for release in the USA, they have only ever been released in Canada.

It was initially believed that all introductions of *Pegomya* spp. failed to establish. However, in 2014, establishment was confirmed at the original leafy spurge release sites in Manitoba and Saskatchewan (**Fig. 32**). While there is still some uncertainty, it appears the established species is *P. euphorbiae*. Its overall abundance and impact on leafy spurge in Canada are unknown.



Figure 32. *Pegomya euphorbiae* distribution on leafy spurge in North America (Winston et al. 2023)

NONTARGET EFFECTS

None reported

Spurgia esulae & *S. euphorbiae*

Leafy spurge tip gall midges

Spurgia esulae and *S. euphorbiae* are closely related biological control agents approved in North America for release against cypress and leafy spurge.

SYNONYMS

These two species were previously lumped under the name *Bayeria capitigena* Bremi, which was transferred to the genus *Spurgia* and separated into two distinct species (*Spurgia capitigena* and *S. esulae*) in 1990. *Spurgia capitigena* was later synonymized with *S. euphorbiae*. One subsequent study with these midges revealed no evidence to support them being considered as two separate species, but a revision of this group has not been published. Thus for this publication, both names are used; however, as life cycles and host plant use are similar, they can effectively be treated as one species.

CLASSIFICATION

RANKING	SCIENTIFIC NAME	COMMON NAME
Kingdom	Animalia	Animals
Phylum	Arthropoda	Arthropods
Class	Insecta	Insects
Order	Diptera	Flies
Family	Cecidomyiidae	Gall midges
Genus	<i>Spurgia</i>	
Species	<i>Spurgia esulae</i> Gagné <i>Spurgia euphorbiae</i> (Vallot)	Leafy spurge tip gall midges

DESCRIPTION

Both “species” are virtually indistinguishable. Eggs are orange and cylindrical (Fig. 33a). Larvae are orange and

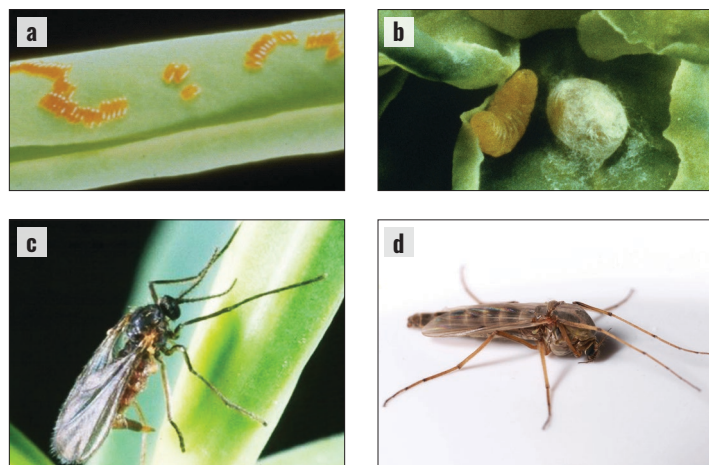


Figure 33. *Spurgia* spp. (a) eggs; (b) larva and pupa; (c,d) adult (a: L.L. Berry; b: Norman Rees, USDA ARS; c: USDA APHIS PPQ; d: Joseph Berger; a-d: Bugwood.org, CC BY-3.0 US)

1–2 mm long (Fig. 33b). Adults are dark gray with reddish abdomens and tiny, dark heads (Fig. 33c,d). Adults are just under 2 mm long; males are slightly smaller than females. Males have forceps on the end of the abdomen while females have an exposed ovipositor.

LIFE CYCLE

Adults emerge in spring when cypress and leafy spurge are resuming growth (Fig. 34). They live only a number of hours. Eggs are laid in groups of 20+ among leaves on spurge growing tips (Fig. 33a). Hatching larvae feed on tips (through three instars), causing galls to form (Fig. 35). Pupation occurs in silken cocoons within galls; adults emerge and repeat the cycle. There are two generations/year in cold climates and 3–5 in warmer areas if new shoots are available. Last-generation larvae overwinter and pupate in the soil.

HOST SPECIES IN NORTH AMERICA

Cypress and leafy spurge

DAMAGE

Larvae attack spurge growing tips which destroys the shoot’s ability to flower and produce seeds. Shoots eventually die and are replaced by new stems that are attacked by the next generation of midges.

FIELD IDENTIFICATION

Short-lived adults may be observed around the tips of cypress and leafy spurge throughout spring and summer. Because they are tiny and delicate, they are easily missed. Their presence is more often confirmed by observing larval-induced galls on the tips of cypress and leafy spurge (Fig. 35). Dissection of galls will reveal tiny orange larvae (Fig. 33b).

Most of the other biocontrol agents currently established on cypress and/or leafy spurge in North America can be readily differentiated from *Spurgia* spp. (see Table 1). Adults of the fly *Pegomya euphorbiae* are larger (≤ 6 mm) and less delicate (Fig. 30), and *P. euphorbiae* larvae mine the stems of spurge plants, causing the formation of galls in subterranean stems and in roots.

PREFERRED HABITAT

These species prefer dense spurge infestations growing on south-facing slopes in cool climates, and can reportedly tolerate some shading.

HISTORY AND CURRENT STATUS

These two species were previously lumped together under the name *Bayeria capitigena*. After their introduction, *B. capitigena* was transferred to the genus *Spurgia* and split into two species. Consequently, the release history is convoluted.

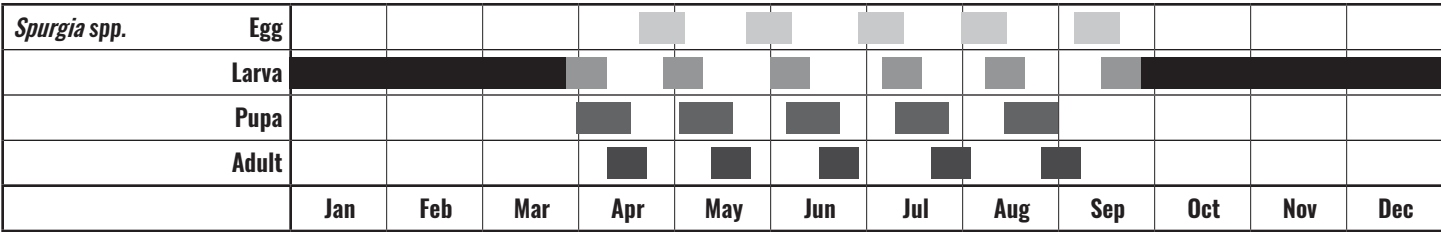


Figure 34. Schematic life cycle of *Spurgia* spp. in North America. Bars indicate the approximate length of activity for each life stage; dates will vary depending on local conditions. Black bars represent the inactive and/or overwintering periods. There are two generations/year in cold climates and 3–5 in warmer areas if new shoots are available.

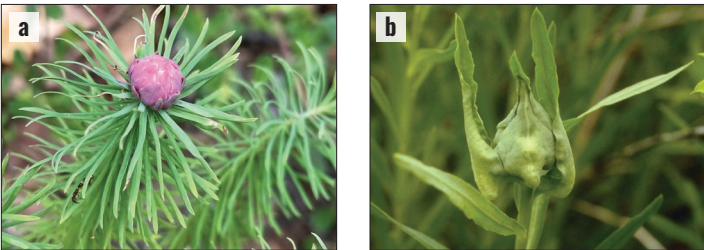


Figure 35. *Spurgia* spp. galls on (a) cypress and (b) leafy spurge (a: Wolff Christiane, iNaturalist.org CC BY-NC 4.0; b: Norman E. Rees, USDA ARS, Bugwood.org CC BY-3.0 US)

Spurgia esulae was introduced from Italy and released on leafy spurge in the USA beginning in 1985 and redistributed to cypress spurge beginning in 1995. *Spurgia euphorbiae* is believed to have been a contaminant of one shipment of *S. esulae* released on leafy spurge in North Dakota in 1986. Both

Spurgia spp. were redistributed to leafy spurge in Canada starting in 1987 and to cypress spurge beginning in 1990. *Spurgia euphorbiae* from France was intentionally released on leafy spurge in North Dakota in 2001 and 2002.

In the USA, *Spurgia* spp. attack both cypress and leafy spurge (Fig. 36), but densities are generally low on both. Even where abundant, galls form after flowering, so their overall impact is insignificant. In Canada, *Spurgia* spp. are confirmed established on both cypress and leafy spurge (Fig. 36). Although galls prevent flower formation and seed production, the overall impact of these midges appears negligible.

NONTARGET EFFECTS

None reported

NON-ESTABLISHED SPECIES

Aphthona abdominalis
(Coleoptera: Chrysomelidae)

DESCRIPTION AND LIFE CYCLE

In Europe, overwintering adults emerge from plant litter in late spring and feed on leafy spurge foliage during bolting or flowering. Adults are 2 mm long and grayish-brown with a reddish-yellow head and transparent outer wings (Fig. 37). Females lay eggs at or just below the soil surface. Hatching larvae burrow into spurge roots to feed, developing through three instars. Larvae are white with a yellow head and prominent head capsule and are 1–3 mm long. Pupation occurs in the soil near roots. There are up to four generations per year.

HISTORY AND CURRENT STATUS

Aphthona abdominalis collected from Italy were released on leafy spurge in the western USA beginning in 1993, but all releases failed to establish. **This species was never released in Canada.**

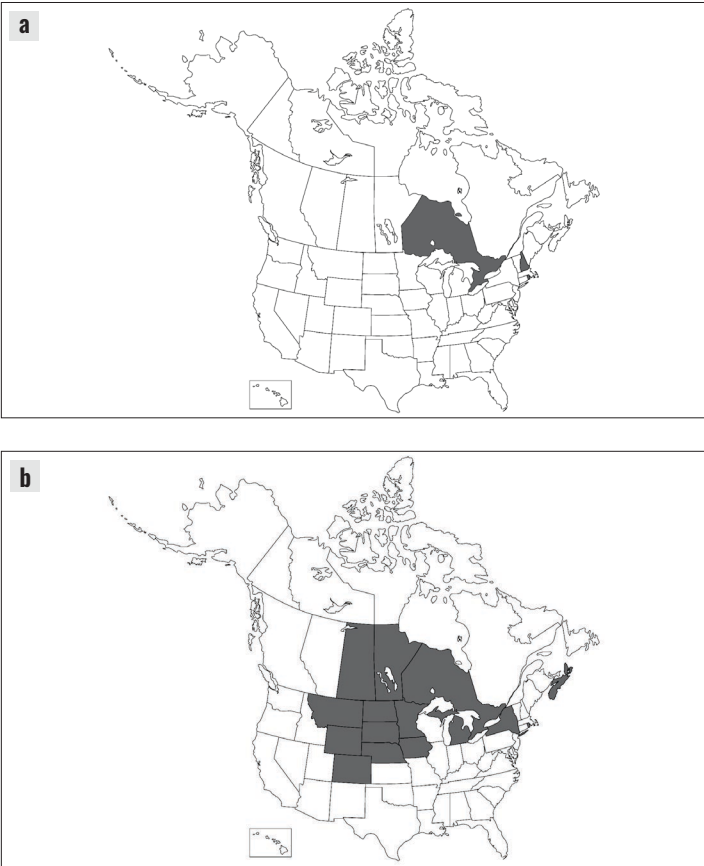


Figure 36. *Spurgia* spp. distribution on (a) cypress spurge and (b) leafy spurge (Winston et al. 2023)

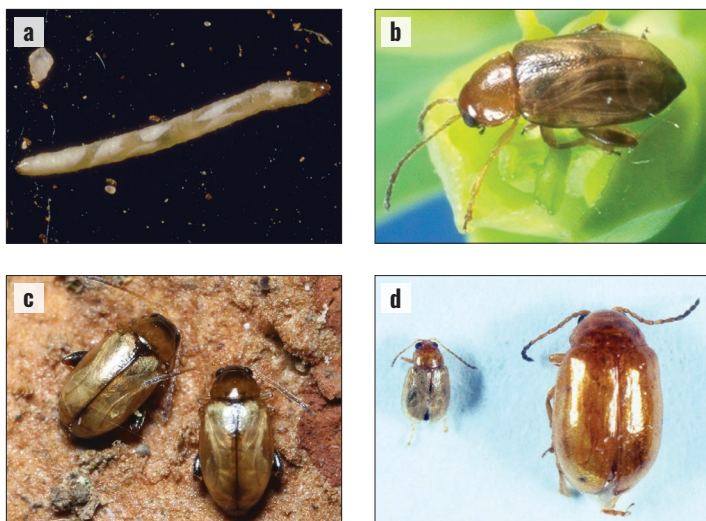


Figure 37. *Aphthona abdominalis* (a) larva; (b) adult; (c) adults; (d) size comparison between *A. abdominalis* (left) and *A. cyparissiae* (right) (a: Neal Spencer, USDA ARS; b: R. Richard, USDA APHIS; c: Tosakah, iNaturalist.org CC BY-NC 4.0; d: Norman E. Rees, USDA ARS; a,b,d: Bugwood.org CC BY-3.0 US)

Chamaesphecia spp. (Lepidoptera: Sesiidae)

DESCRIPTION AND LIFE CYCLE

Five *Chamaesphecia* species have been intentionally released in North America as biocontrol agents of spurge. *Chamaesphecia empiformis* is believed to have successfully established on cypress spurge in Ontario (see earlier section of this publication). Four additional species were released on leafy spurge in Canada and the USA, but all are believed to have failed to establish. All four of these species are morphologically very similar (Fig. 38). They have white larvae up to 15 mm long. Larvae mine the plant stem or roots, usually pupating within stems. In Europe, these species overwinter either as larvae or as pupae. Adults emerge from late spring and lay eggs on spurge plants. Adults are dark brown with yellow-white bands. Wingspans are typically 15–22 mm. Each wing is brown with yellow markings and a few transparent windows with dark margins. Body and wing tips are fringed. There is one generation per year.

HISTORY AND CURRENT STATUS

Chamaesphecia tenthrediniformis from Europe was released on leafy spurge in Ontario, Canada in 1971 and in the western USA beginning in 1975. Starting in 1991, *C. crassicornis* and *C. hungarica* from Europe were released on leafy spurge in western states and provinces. It was initially believed releases of *C. empiformis* made in North America beginning in the 1970s failed to establish. However, what is believed to be an individual *C. empiformis* was photographed on cypress

spurge in Ontario in 2015. Because the species in question could be *C. tenthrediniformis*, additional confirmation is needed before declaring either species established in North America. *Chamaesphecia astatififormis* from Europe was released in western Canada in 1993 **but never in the USA.**

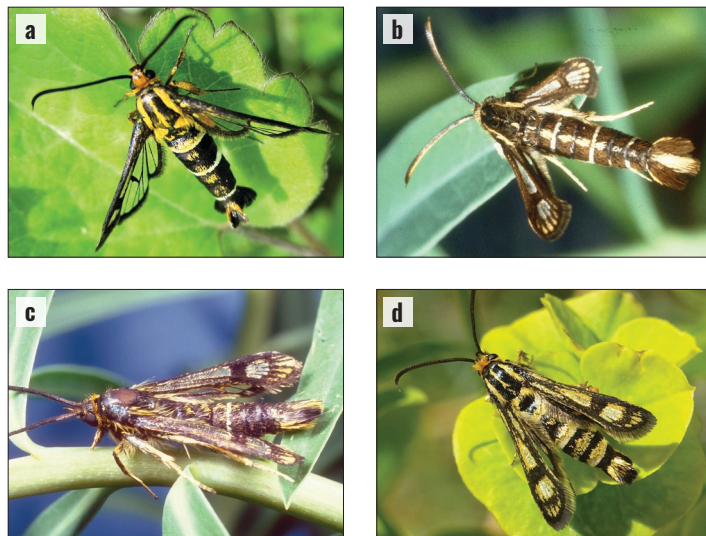


Figure 38. Adult (a) *Chamaesphecia astatififormis*; (b) *C. crassicornis*; (c) *C. hungarica*; (d) *C. tenthrediniformis* (a: Sanca13, iNaturalist.org CC BY-NC 4.0; b: USDA ARS, Bugwood.org CC BY-3.0 US; c: USDA APHIS PPQ, Bugwood.org CC BY-3.0 US; d: Joey Bom, iNaturalist.org CC BY-NC 4.0)

Minoa murinata (Lepidoptera: Geometridae)

DESCRIPTION AND LIFE CYCLE

Pupae overwinter just beneath the soil surface. Adults emerge in late spring and lay eggs on spurge leaves. Adults are gray to tan with a metallic sheen (Fig. 39). Wings are fringed and span 18–23 mm. Hatching larvae feed on the undersides of leaves. Larvae are grayish-pink with variable black markings, brown heads, pink warts, and an orange or yellow stripe along each side. They can be up to 13 mm long and develop through four instars before dropping to the soil in fall to pupate. There can be two generations per year in suitable climates. Adults of the second generation emerge in late summer.



Figure 39. *Minoa murinata* adult (Eugenio Pighi, iNaturalist.org CC BY-NC 4.0)

HISTORY AND CURRENT STATUS

Moths collected in Germany and Austria were released on leafy spurge in Canada in 1988, but all populations eventually died out. **This species has never been released in the USA.**

Table 1. Key traits for differentiating introduced natural enemies established on cypress and leafy spurge in North America.

	SPECIES	APPROVAL STATUS	HOSTS	ATTACK	ADULT DESCRIPTION	ADULT
BEETLES	<i>Aphthona cyparissiae</i>	Approved in the USA and Canada	Cypress and leafy spurge	Adults: feed on foliage and flowers Larvae: feed on root hairs and young roots	Oval, light reddish-brown, enlarged hind legs, just over 3 mm long	
	<i>Aphthona czwalinai</i>	Approved in the USA and Canada	Cypress and leafy spurge	Adults: feed on foliage and flowers Larvae: feed on root hairs and young roots	Oval, shiny black, middle and front legs reddish-brown, hind femurs dark and enlarged, ~3 mm long	
	<i>Aphthona flava</i>	Approved in the USA and Canada	Cypress and leafy spurge	Adults: feed on foliage and flowers Larvae: feed on root hairs and young roots	Oval, orangish-copper, enlarged hind legs, 3½ mm long	
	<i>Aphthona lacertosa</i>	Approved in the USA and Canada	Cypress and leafy spurge	Adults: feed on foliage and flowers Larvae: feed on root hairs and young roots	Oval, shiny black, all legs reddish-brown, hind femurs enlarged and may have dark spot, 3 mm long	
	<i>Aphthona nigriscutis</i>	Approved in the USA and Canada	Cypress and leafy spurge	Adults: feed on foliage and flowers Larvae: feed on root hairs and young roots	Oval, orangish-brown, often with black dot on back near leading edge of wings, ~3 mm long	
	<i>Oberea erythrocephala</i>	Approved in the USA and Canada	Established only on leafy spurge	Adults: superficially feed on stems Larvae: mine stems and root crowns	Slender, dark gray elytra, reddish body beneath, long dark antennae, red head, black eyes, 10–12 mm long	
FLIES	<i>Pegomya euphorbiae</i>	Approved in the USA and Canada but only released in Canada	Established only on leafy spurge	Adults: none Larvae: mine stems, forming galls in subterranean stems and roots	Dark bodies with scattered black hairs, eyes maroon, wings dark and translucent, wingspan ≤6 mm	
	<i>Spurgia esula</i> & <i>S. euphorbiae</i>	Approved in the USA and Canada	Cypress and leafy spurge	Adults: none Larvae: feed on stem tips within galls	Delicate, dark gray, reddish abdomens, tiny dark heads, 2 mm long	
MOTHS	<i>Chamaesphecia empiformis</i>	Approved in the USA and Canada	Cypress spurge	Adults: none Larvae: mine stems and roots	Dark brown with yellow-white bands, wings with transparent patches, wing tips fringed, wingspans 16–22 mm	
	<i>Hyles euphorbiae</i>	Approved in the USA and Canada	Cypress and leafy spurge	Adults: none Larvae: feed externally on foliage	White, pink, and grayish-brown on back, pinkish undersides, wingspans ≤5 cm	
	<i>Lobesia euphorbiana</i>	Approved in Canada; not approved for release in the USA	Established only on leafy spurge	Adults: none Larvae: feed on buds within leaf ties	Mottled yellow, brown, and rust, legs and antennae lighter-colored, wingspans ≤14 mm	

Photo credits Table 1: *Aphthona cyparissiae*, *A. czwalinai*, *A. nigriscutis*: R. Richard, USDA APHIS, Bugwood.org, CC BY-3.0 US; *Aphthona flava*: USDA ARS, Bugwood.org, CC BY-3.0 US; *Aphthona lacertosa*: Mark Schwarzländer, University of Idaho, Bugwood.org, CC BY-3.0 US; *Oberea erythrocephala*: Julien Preud'homme, iNaturalist.org CC BY-NC 4.0; *Pegomya euphorbiae*: André Gassmann, CABI Switzerland; *Spurgia esulae*: USDA APHIS PPQ, Bugwood.org, CC BY-3.0 US; *Chamaesphecia empiformis*: Vojtek Pavel, iNaturalist.org CC-BY-NC 4.0; *Hyles euphorbiae*: Kristi DuBois, iNaturalist.org CC BY-NC 4.0; *Lobesia euphorbiana*: Andrey Ponomarev, iNaturalist.org CC BY-NC 4.0

REFERENCES

- Alex, J. 1991. Biological Control of Weeds in Ontario. In: G. Boiteau, Ed. Proceedings of the 38th Annual Meeting of the Canadian Pest Management Society. 27–31 July 1991, Fredericton, New Brunswick, Canada. Agassiz Research Station, Agriculture Canada. pp. 111–117.
- Andreas, J.E., J. Milan, C. Randall, and J. Price. 2020. Biological Control. In: E. Peachey, Ed. Pacific Northwest Weed Management Handbook. Oregon State University, Corvallis, Oregon. pp. A1-A7.
- Baker, J.L. and N.A.P. Webber. 2008. Feeding impacts of a leafy spurge biological control agent on a native plant, *Euphorbia robusta*. In: M.H. Julien, R. Sforza, M.C. Bon, H.C. Evans, P.E. Hatcher, H.L. Hinz, and B.G. Rector, Eds. Proceedings of the XII International Symposium on Biological Control of Weeds. 22–27 April 2007, La Grande Motte, France, CAB International. pp. 503–506.
- Biocontrol Agents and Host Plants in British Columbia. 2018. In: Invasive Plants with Biocontrol. British Columbia Ministry of Forests, Lands,

- and Natural Resource Operations, <https://www2.gov.bc.ca/gov/content/environment/plants-animals-ecosystems/invasive-species/management/plants/biological-control/biological-control-agents-host-plants?keyword=biological&keyword=control>.
- Bourchier, R.S., S. Erb, A.S. McClay, and A. Gassmann. 2002. *Euphorbia esula* (L.), leafy spurge and *Euphorbia cyparissias* (L.), cypress spurge (Euphorbiaceae). In: P.G. Mason and J.T. Huber, Eds. Biological Control Programmes in Canada 1981–2000. CAB International, Wallingford, U.K. pp. 346–358.
- Bourchier, R., R. Hansen, R. Lym, A. Norton, D. Olson, C.B. Randall, M. Schwarzländer, and L. Skinner. 2006. Biology and Biological Control of Leafy Spurge. USDA Forest Service, Forest Health Enterprise Technology Team, Morgantown, West Virginia. FHTET-2005-07.
- Bourchier, R., and B.H. Van Hezewijk. 2013. *Euphorbia esula* (L.), leafy spurge (Euphorbiaceae). In: P.G. Mason and D. Gillespie (Eds.) Biological Control Programmes in Canada 2001–2012. Chapter 47. CABI Publishing Wallingford, U.K. pp. 316–320.
- Coombs, E.M., J.K. Clark, G.L. Piper, and A.F. Cofrancesco, Jr. (Eds.). 2004. Biological Control of Invasive Plants in the United States. Oregon State University Press, Corvallis. 467 pp.
- De Clerck-Floate, R. and H. Cárcamo. 2011. Biocontrol Arthropods: New Denizens of Canada's Grassland Agroecosystems. In: K.D. Floate, Ed. Arthropods of Canadian Grasslands: Inhabitants of a Changing Landscape. Vol. 2. Biological Survey of Canada, Ottawa. pp. 291–321.
- Faubert, H. and R.A. Casagrande. 2002. Cypress Spurge. In: R. Van Driesche, S. Lyon, B. Blossey, M. Hoddle, and R. Reardon, Eds. Biological Control of Invasive Plants in the Eastern United States. USDA Forest Service, Forest Health Technology Enterprise Team, Morgantown, West Virginia. FHTET-2002-04. pp. 195–207.
- Forwood, J.R., and M.K. McCarty. 1980. Control of leafy spurge (*Euphorbia esula*) in Nebraska with the spurge hawkmoth (*Hyles euphorbiae*). Weed Science 28(3) 235–240.
- Gagné, R.J. 1990. Gall midge complex (Diptera: Cecidomyiidae) in bud galls of palearctic *Euphorbia* (Euphorbiaceae). Annals of the Entomological Society of America 83: 335–345.
- Gagné, R.J. and M. Jaschhof. 2021. A Catalog of the Cecidomyiidae (Diptera) of the World. Fifth Edition. Digital. 816 pp.
- Gassmann, A., and D. Schroeder. 1995. The search for effective biological control agents in Europe: history and lessons from leafy spurge (*Euphorbia esula* L.) and cypress spurge (*Euphorbia cyparissias* L.). Biological Control 5: 466–477.
- Gassmann, A., and J.D. Shorthouse. 1990. Structural damage and gall induction by *Pegomya curticornis* and *Pegomya euphorbiae* (Diptera: Anthomyiidae) within the stems of leafy spurge (*Euphorbia x pseudovirgata*) (Euphorbiaceae). The Canadian Entomologist 122(3): 429–439.
- Hansen, R.W., R.D. Richard, P.E. Parker, and L.E. Wendel. 1997. Distribution of biological control agents of leafy spurge (*Euphorbia esula* L.) in the United States: 1988–1996. Biological Control 10(2): 129–142.
- Kalischuk, A.R., R.S. Bourchier, and A.S. McClay. 2004. Post hoc assessment of an operational biocontrol program: efficacy of the flea beetle *Aphthona lacertosa* Rosenhauer (Chrysomelidae: Coleoptera), an introduced biocontrol agent for leafy spurge. Biological Control 29(3): 418–426.
- Kremer, R.J., A.J. Caesar, and T. Souissi. 2006. Soilborne microorganisms of *Euphorbia* are potential biological control agents of the invasive weed leafy spurge. Applied Soil Ecology 32(1): 27–37.
- Löbl, I. and A. Smetana, Eds. 2010. Catalogue of Palearctic Coleoptera. Vol. 6. Apollo Books, Stenstrup, Denmark. 426 pp.
- Lym, R.G. 2019. Leafy spurge (*Euphorbia esula*) control and soil seed bank composition 19 years after release of *Aphthona* spp. biological control agents. In: H.L. Hinz et al., Eds. Proceedings of the XV International Symposium on Biological Control of Weeds. 26–31 August 2018, Engelberg, Switzerland. pp. 269–270.
- Lym, R.G., and R.B. Carlson. 2002. Effect of leafy spurge (*Euphorbia esula*) genotype on feeding damage and reproduction of *Aphthona* spp.: implications for biological weed control. Biological Control 23: 127–133.
- McClay, A., R.S. Bourchier, J.F. Landry, C.E. Morris, and I. Toševski. 2023. Citizen science reveals the establishment of *Chamaesphecia empiformis* (Esper) (Lepidoptera: Sesiidae), a long-lost biological control agent for *Euphorbia cyparissias* (Euphorbiaceae), in Ontario, Canada. The Canadian Entomologist 155: e29.
- McClay, A.S., D.E. Cole, P. Harris, and C.J. Richardson. 1995. Biological control of leafy spurge in Alberta: progress and prospects. AECV95-R2. Alberta Environmental Centre, Vegreville, Alberta, Canada. 63 pp.
- Nowierski, R.M., and R.W. Pemberton. 2002. Leafy Spurge. In R. Van Driesche, S. Lyon, B. Blossey, M. Hoddle, and R. Reardon, Eds. Biological Control of Invasive Plants in the Eastern United States. USDA Forest Service, Forest Health Enterprise Technology Team, Morgantown, West Virginia. FHTET-2002-04, pp. 181–194.
- Pemberton, R.W. 1995. Leafy spurge. In: J.R. Nechols, L.A. Andres, J.W. Beardsley, R.D. Goeden, and C.G. Jackson, Eds. Biological Control in the Western United States: Accomplishments and Benefits of Regional Research Project W-84, 1964–1989. Publication 3361. University of California, Division of Agriculture and Natural Resources, Oakland, California, pp. 289–295.
- Progar, R.A., G. Markin, J. Milan, T. Barbouletos, and M.J. Rinella. 2011. Population dynamics and impacts of the red-headed leafy spurge stem borer on leafy spurge (*Euphorbia esula*). Invasive Plant Science and Management 4: 183–188.
- Progar, R.A., G. Markin, D. Scarbrough, C.L. Jorgensen, and T. Barbouletos. 2013. Observational monitoring of biological control vs. herbicide to suppress leafy spurge (*Euphorbia esula*) for eight years. In: Y. Wu, T. Johnson, S. Sing, S. Raghu, G. Wheeler, P. Pratt, K. Warner, T. Center, J. Goolsby, and R. Reardon, Eds. Proceedings of the XIII International Symposium on Biological Control of Weeds. 11–16 September 2011, Kohala Coast, Hawaii, USA. Forest Health Technology Enterprise Team, Morgantown, WV, USA. pp. 417–422.
- Roehrdanz, R., R. Bourchier, A. Cortilet, D. Olson, and S. Sears. 2011. Phylogeny and genetic diversity of flea beetles (*Aphthona* spp.) introduced to North America as biological control agents for leafy spurge. Annals of the Entomological Society of America 104: 966–975.
- Shorthouse, J.D. and A. Gassmann. 1994. Gall induction by *Pegomya curticornis* (Stein) (Diptera: Anthomyiidae) within the roots of spurge *Euphorbia virgata* Walkdst. and Kit. *E. esula* L. (Euphorbiaceae). The Canadian Entomologist 126(2): 193–197.
- Winston, R.L., C.B. Randall, B. Blossey, P.W. Tipping, E.C. Lake, and J. Hough-Goldstein. 2017. Field Guide for the Biological Control of Weeds in Eastern North America. USDA Forest Service, Forest Health Technology Enterprise Team, Morgantown, West Virginia. FHTET-2016-04.
- Winston R.L., M. Schwarzländer, H.L. Hinz, M.D. Day, M.J.W. Cock, and M.H. Julien, Eds. 2023. Biological Control of Weeds: A World Catalogue of Agents and Their Target Weeds. <https://www.ibiocontrol.org/catalog/> [Accessed 20 November 2023].

ACKNOWLEDGMENTS

The authors thank two anonymous reviewers for providing helpful comments on earlier versions of this publication. This fact sheet was produced by the North American Invasive Species Management Association (NAISMA) with financial support from USDA Forest Service. The layout was designed by Rachel Winston, MIA Consulting.

NAISMA is a network of professionals challenged by invasive species: land managers, water resource managers, state, regional, and federal agency directors and staff, researchers, and nonprofit organizations. NAISMA's members are a diverse group of individuals and organizations who are involved in implementing invasive species management programs at all scales. Our mission is to support, promote, and empower invasive species prevention and management in North America. Our vision is to have North America's lands and waters protected from invasive species. NAISMA's programs aim to provide the support, training, and standards needed by the professional invasive species management community.

SUGGESTED CITATION

Milan, J., N.M. West, R.S. Bouchier, and C.B. Randall. 2024. Spurge Biocontrol Agents: History and Ecology in North America. *In*: R.L. Winston, Ed. Biological Control of Weeds in North America. North American Invasive Species Management Association, Milwaukee, WI. NAISMA-BCW-2024-40-SPURGES-A.

In accordance with Federal civil rights law and U.S. Department of Agriculture (USDA) civil rights regulations and policies, the USDA, its Agencies, offices, and employees, and institutions participating in or administering USDA programs are prohibited from discriminating based on race, color, national origin, religion, sex, gender identity (including gender expression), sexual orientation, disability, age, marital status, family/parental status, income derived from a public assistance program, political beliefs, or reprisal or retaliation for prior civil rights activity, in any program or activity conducted or funded by USDA (not all bases apply to all programs). Remedies and complaint filing deadlines vary by program or incident.

Persons with disabilities who require alternative means of communication for program information (e.g., Braille, large print, audiotape, American Sign Language, etc.) should contact the responsible Agency or USDA's TARGET Center at (202) 720-2600 (voice and TTY) or contact USDA through the Federal Relay Service at (800) 877-8339. Additionally, program information may be made available in languages other than English.

To file a program discrimination complaint, complete the USDA Program Discrimination Complaint Form, AD-3027, found online at http://www.ascr.usda.gov/complaint_filing_cust.html and at any USDA office or write a letter addressed to USDA and provide in the letter all of the information requested in the form. To request a copy of the complaint form, call (866) 632-9992. Submit your completed form or letter to USDA by: (1) mail: U.S. Department of Agriculture, Office of the Assistant Secretary for Civil Rights, 1400 Independence Avenue, SW, Washington, D.C. 20250-9410; (2) fax: (202) 690-7442; or (3) email: program.intake@usda.gov.

USDA is an equal opportunity provider, employer, and lender.