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Section II: Weeds and approved biological control agents – The spurge

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(*Article begins on following page.)



THE SPURGES

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In Europe, 105 native *Euphorbia* species belong to the subgenus *Esula*, the same group to which the weed commonly referred to in the United States as leafy spurge belongs. An additional four species are members of the subgenus *Chamaesyce*. In North America there are 21 native species in the subgenus *Esula*, 26 species in the subgenus *Agaloma*, three species in the subgenus *Poinsettia*, and 57 species in *Chamaesyce*. Two species (*E. garberi* and *E. deltoidea* ssp. *deltoidea*) of the subgenus *Chamaesyce* currently have federal protection under the Threatened or Endangered Species Act.

Many species of spurge have economic or ornamental value such as the poinsettia, the paraffin plant, the petroleum plant, and the crown of thorns.

The taxonomic status of the introduced North American leafy spurge complex is in a state of confusion. Whereas one taxonomist lists 79 different species, crosses and hybrids in Europe as leafy spurge, some believe that leafy spurge complex in the United States is but one species. Logically, it is difficult to believe that only one leafy spurge species was introduced into the United States from Eurasia. More perplexity is added when one considers that this weed may have had multiple introductions from multiple sources. We are aware that either different species or different biotypes of leafy spurge are established in North America, because some biocontrol agents are more effective on some leafy spurge biotypes than others. These conditions must all be considered when natural enemies are being selected for introduction into North America as biocontrol agents.

Contacts: Robert Carlson, Robert Nowierski, Robert Pemberton, Norman Rees, Robert Richard, Neal Spencer



Leafy spurge

Euphorbia esula (complex)

Spurge family - Euphorbiaceae

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R. W. Pemberton, and R. M. Nowierski

Other common name: Faitour's grass.

Native range: Eurasia.

Entry into the United States: The plant was first reported in the United States in 1827.

BIOLOGY

Life duration/habit: Leafy spurge is an aggressive, persistent, deep-rooted perennial, growing to a height of 1 m (3 ft) or taller. Vegetative stems manufacture sugars for root reserves while other stems produce flowers.

Reproduction: Leafy spurge reproduces by vegetative regrowth from spreading roots and by the production of large quantities of seeds that are often distributed by birds, wildlife, humans, and in rivers and streams.

Roots: Leafy spurge roots are brown with pinkish buds. Plants are able to maintain high root reserves through an extensive root system, ranging from a massive network of small lateral roots near the soil surface [within 30.5 cm (12 in)] to deep, penetrating taproots that may extend to depths of 3 to 7 m (9 to 21 ft). This ability to maintain high root reserves permits the plant to recover quickly from physical and most chemical damage.

Stems and leaves: The stems are thickly clustered and bear narrow, 2.5 to 10 cm (1 to 4 in) long leaves that are alternately arranged along the stems. When damaged, leaves and stems exude a milky latex.

Flowers: The small flowers are yellowish-green, arranged in clusters, and enclosed in yellow-green bracts.

Fruits and seeds: Seeds are oblong and gray to purple, and occur in clusters of three. When dry, the seed capsules shatter, scattering seeds away from the plant.

INFESTATIONS

Worst infested states: Leafy spurge now extends from southern Canada through the northern United States, and is approaching areas as far south as Texas.



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Leafy spurge plants.



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Leafy spurge in bloom.

Habitat: It has become dominant on rangelands and pastures in a wide range of environments throughout much of the United States.

Impacts: Leafy spurge produces a milky latex that is poisonous to some animals and can cause blistering and irritation on skin. The digestive tract is similarly affected when this plant is eaten by humans and some animals. In cattle it causes scours and weakness; when ingested in larger amounts it can cause death. Cattle usually refuse to eat leafy spurge unless it is given to them in dry, weedy hay or when better forage is not available.

A conservative 1979 estimated loss in the United States of \$10.5 million annually was based on expenditures for controlling leafy spurge and loss of productivity. Although leafy spurge infestations are most severe on undisturbed lands, on cultivated cropland the weed can reduce crop yields by 10 to 100%. A 1990 study conducted by North Dakota State University estimated the direct annual financial impact in Montana, North Dakota, South Dakota, and Wyoming to be \$40.5 million with secondary impacts at \$89 million and the potential loss of 1,433 jobs annually.



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Horses cross a field of leafy spurge.

COMMENTS

Leafy spurge is extremely difficult to control by chemical means and almost impossible to control by cultural or physical methods. It apparently has the ability to purge undesirable chemicals from the root system in approximately the top 45 cm (18 in) of the soil, allowing the remaining portion of the root system to regenerate as soon as the effect of the chemical in the soil has dissipated.

Although leafy spurge causes problems with cattle that consume it, sheep generally can be taught to feed on it and goats will seek it out. Both sheep and goats are used in weed control programs to “keep the yellow out” and to retard the spread of leafy spurge.

People should handle the plant with caution because the latex can cause irritation, blotching, blisters, and swelling in sensitive individuals. The eyes should never be rubbed until after the hands are thoroughly washed. The dried latex is often very difficult to wash off, consider wearing lightweight latex gloves when handling the plant.

Contacts: Richard Hansen, Peter Harris, Robert Nowierski, Robert Pemberton, Norman Rees, Robert Richard, Neal Spencer



Aphthona abdominalis

Common name: Minute spurge flea beetle.

Type of agent: Insect: Beetle, flea beetle
(Coleoptera: Chrysomelidae).

Native distribution: Found in northern and central Italy, Spain, France, southern Poland, Austria, the eastern part of the former Yugoslavia, the Balkans, Naxos, Hungary, Romania, Bulgaria, southern part of the former USSR, Asia Minor, and northwestern Iran.

Original source: Europe.

BIOLOGY

Generations per year: Up to four.

Overwintering stages: Larval and adult.

Egg stage: The eggs are laid singly or in clusters of two to six on the plant near the soil surface or in the soil near the plants from April until October. Females lay as many as 100 eggs which require three to six days of incubation during ideal conditions or up to 16 days under harsh conditions. The eggs require high relative humidity to survive.

Larval stage: There are three larval instars. The larvae feed on young roots, root buds, and subterranean shoots. These larvae are elongate and have prominent head capsules.

Pupal stage: The pupal stage lasts 10 to 11 days within the soil.

Adult stage: Adults appear to live for 40 to 55 days, and those that are alive in December in Italy (generally fourth generation) begin diapause. The adults usually hide among plant duff and under stones and branches on the soil. This species is more gray to straw-colored than the other *Aphthona* species. The head, prothorax and mesothorax are reddish-yellow and the abdomen and metathorax are black. This species is also relatively small, measuring an average of 2.0 mm (0.08 in) long by 1.0 mm (0.04 in) wide. The outer pair of wings is transparent and straw-colored.



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Aphthona abdominalis adult.

Actual adult size



EFFECT

Destructive stages: Larval and adult.

Plant species attacked: Leafy spurge (*Euphorbia esula*) complex.

Site of attack: Adult beetles feed on the leaves and flowers while the larvae feed on root hairs and young roots.

Impact on the host: The larvae seriously damage shoots, shoot buds, and roots, and in heavy attacks plants are stressed and cannot produce new stems. This root feeding reduces the plant's ability to take up moisture and nutrients, while the adults' feeding on the foliage, especially when it is concentrated on the youngest leaves at the tip of the plant, decreases the plant's sugar-making ability for root reserves. Since this species feeds on the foliage, flowers, root hairs and young roots, this beetle has a great potential, under ideal conditions, to be extremely effective in reducing plant density. It is also possible that its four generations per year could give it an advantage over other flea beetle species in some locations.



USDA-ARS

Aphthona abdominalis larva.

RELEASES

First introduced into the United States: 1993, Montana and North Dakota.

Now established in: Not yet recovered.

Habitat: One year's data indicate that favorable areas are more moist than for *Aphthona nigriscutis* but drier than for *A. czwalinae*. This includes climates that receive between 30.5 to 45.7 cm (12 to 18 in) of moisture per year and have ample relative humidity during the egg stage. This species may not do well in heavy clay soils.

Availability: The availability is limited from Europe.

Stage to transfer: Adult.

Redistribution: Collect the adult beetles with a sweep net. Adults can be stored or shipped for four to five days with fresh food in cardboard containers if kept cool. They can also be reared at room temperature or retained for several weeks if kept in large cages and provided with fresh food daily, or they can be stored for several weeks if kept cool and periodically warmed, exercised, and fed. To release, either sprinkle adult beetles on moderately dense leafy spurge plants, or swing the open container in an arc to distribute the beetles over a wider area. Do not release in very dense stands of leafy spurge. Sites with high ant populations should be avoided.

COMMENTS

After this species is released, the aboveground density of the leafy spurge plants is greatly reduced at first. However, roots that were not attacked, including the taproot, are able to send up small new shoots to supply the sugars for root reserves. It is only through the persistence of the beetles over a long period of time that the lateral roots will be destroyed, the taproots weakened, and the plants eliminated from the area.

Aphthona abdominalis is a grayish color and about one-third to one-fourth the size of most other introduced *Aphthona* spp. This species also has four generations per year and overwinters as larvae and/or adults, whereas the other approved species have only one generation per year and overwinter as larvae.

Contacts: Luca Fornasari, Richard Hansen, Norman Rees, Robert Richard, Neal Spencer



Aphthona cyparissiae

Common name: Brown dot leafy spurge flea beetle.

Type of agent: Insect: Beetle, flea beetle
(Coleoptera: Chrysomelidae).

Native distribution: Europe.

Original sources: Europe, Austria, Hungary, and Italy.

BIOLOGY

Generations per year: One.

Overwintering stages: Mature larval.

Egg stage: Eggs are generally laid on the lower stem next to the soil or on the soil next to the stem during July, August, and September. They hatch in about 13 days.

Larva stage: The larvae are active from August until early spring. There are three larval instars: the first lasts about eight days (under ideal conditions), the second lasts 25 to 30 days, and the final instar requires about 45 days. A cold period is needed to cause the mature larvae to pupate. The head is well sclerotized and subcompressed and the body is whitish in color.

Pupal stage: Pupation lasts about 20 days within a soil cell, from late spring to early summer.

Adult stage: Adult beetles are found on the leafy spurge plants from July until about September with many individuals surviving and laying eggs for three to four months. Adults are oval and brown and measure about 3.2 mm (0.13 in) long.

EFFECT

Destructive stages: Adult and larval.

Plant species attacked: Leafy spurge (*Euphorbia esula*) complex, and especially cypress spurge (*E. cyparissias*).

Site of attack: Adult beetles feed on the leafy spurge leaves and flowers while larvae feed on/in the root hairs and young roots.

Impact on the host: Adult feeding on the foliage reduces the plant's photosynthetic production of sugars for the roots, while larval feeding on or in the root hairs and young roots reduces the plant's



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Aphthona cyparissiae adult.

Actual adult size



USDA-ARS

Aphthona cyparissiae pupa.

ability to take up moisture and nutrients. This decreases the height attained by the plant, delays the flowering period, and causes the plant to take its nourishment from the taproot. Over prolonged periods, continuous pressure by the beetles weakens the taproot resulting in the death of the plant. This species is effective in a specific ecological range.

RELEASES

First introduced into the United States: 1987, Montana.

Now established in: Colorado, Idaho, Iowa, Minnesota, Montana, Nebraska, Nevada, New Mexico, North Dakota, Oregon, South Dakota, Washington, Wisconsin, and Wyoming.

Habitat: Peter Harris of Agriculture Canada suggests that green needle grass (*Stipa viridula*) be present as an indicator, that flowering spurge stems be taller than 51 cm (20 in), that the density be between 50 and 125 stems/m² (11.5 stems/ft²), and that the soils be 40 to 60% sand. These requisites are often found on dry alluvial fans. This flea beetle prefers warm, open, sunny areas and slightly more moist conditions than *A. nigriscutis* but less moist than *A. flava*.

Availability: Limited.

Stage to transfer: Adult.

Redistribution: Collect the beetles with a sweep net. After they are sorted, they can be shipped or stored on leaf material for several days if kept cool, or for several weeks under cool temperatures with intermittent warm feeding and exercise periods. To release, sprinkle beetles among moderately dense leafy spurge plants. Areas of high ant activity should be avoided.

Frozen roots and soil removed from the field in the winter may be kept frozen until four to six weeks before the adults are desired. The beetles can then be reared at ambient or room temperature.

COMMENTS

After this species is released, leafy spurge plant density is greatly reduced at first. However, roots that are not attacked (including the taproot) are able to send up small new shoots to supply the sugars for root reserves. It is only through the persistence of the beetle over a long period of time in ecosystems that favor beetle development that the lateral roots of leafy spurge will be destroyed, the taproots weakened, and the plants eliminated from the area.

Eric Maw of Canada covers several species of *Aphthona* in his master's thesis at the University of Alberta and provides excellent descriptions of the larval and pupal stages of *A. cyparissiae*, *A. czwalinae*, and *A. flava*. He considers *A. cyparissiae* to have the greatest potential as an agent for control of perennial spurges. Its long developmental period may preclude its use in regions with short growing seasons. The type of damage inflicted may limit its efficacy at sites where other stresses on the plant are minor. Host preference in Europe seems to be for *Euphorbia cyparissias*, *E. esula*, *E. seguieriana*, and *E. virgata*, in that order. Most collections have been made in mesic to dry areas with sandy to sand-gravel soils and sparse vegetation. Like many of the other flea beetle species that attack leafy spurge, *A. cyparissiae* tends to congregate for feeding, mating, and egg-laying.

Contacts: Richard Hansen, Peter Harris, Eric Maw, Robert Nowierski, Robert Pemberton, Norman Rees, Robert Richard, Neal Spencer



USDA-ARS

Aphthona cyparissiae adults feeding on leafy spurge.



Aphthona czwalinae

Common name: Black leafy spurge flea beetle.

Type of agent: Insect: Beetle, flea beetle
(Coleoptera: Chrysomelidae).

Native distribution: This species is found from central and eastern Europe to central Asia and eastern Siberia. Eastern Austria and north-western Hungary are probably the southwestern limits of its range.

Original source: Europe (Hungary).

BIOLOGY

Generations per year: One.

Overwintering stage: Mature larval (in leafy spurge roots).

Egg stage: Eggs are generally deposited in the ground next to leafy spurge stems during July, August, and September. The yellowish eggs are oval and measure 0.66 by 0.36 mm (0.03 by 0.01 in). They hatch in 16 to 17 days.

Larval stage: There are three larval instars. The larvae are slender, elongate, and whitish except for the head which is light brown. Larvae burrow into the soil and begin feeding on small roots. Feeding continues through the summer and into the fall until the onset of cold temperatures and dormancy.

Pupal stage: Pupation occurs within a soil cell from late spring to early summer.

Adult stage: Adults can be located on leafy spurge plants from mid-June to July. Adults are black, while the front and middle femora (upper part of the legs) are yellow-brown. The hind femora are dark-colored. The males are about 2.9 mm (0.11 in) long while the females measure about 3.1 mm (0.12 in). This species is slightly smaller than *A. cyparissiae* and *A. flava*.

EFFECT

Destructive stages: Adult and larval.

Plant species attacked: Leafy spurge (*Euphorbia esula* and *E. virgata*; *E. esula* complex).

Site of attack: Adults feed on the leaves and flowers; larvae feed in/on the root hairs and young roots.

Impact on the host: Like the other flea beetle species, the adults feed on the leaves creating



USDA-ARS

Aphthona czwalinae adult.

Actual adult size



“shot-holes” which reduce the plant’s photosynthetic production of sugars for the root. The larvae feed on the root hairs and young roots and reduce the plant’s ability to take up moisture and nutrients. Moderate feeding reduces the plant’s potential height and delays the flowering period. More intense feeding diminishes the number and vigor of aboveground plant stems.

RELEASES

First introduced into the United States: 1987, Montana.

Now established in: Colorado, Iowa, Minnesota, Montana, Nebraska, North Dakota, Oregon, South Dakota, Washington, Wisconsin, and Wyoming.

Habitat: Desired sites are moist areas of somewhat high relative humidity and mesic, loamy sites where the host plant is growing with other vegetation. However, this species also does well in areas of warm and dry summers in subcontinental and Mediterranean-type climates, and in well-drained, sandy or rocky, sun-exposed sites. Undesirable habitats include compact clay soils and areas with high ant populations.

Availability: Limited.

Stage to transfer: Adult.

Redistribution: Collect the beetles with a sweep net from mid-June through July. They can be shipped for several days with fresh leaves, and they can be stored under cool conditions for longer periods if they are provided with intermittent warm feeding and exercising periods. Maintaining them in cages at room temperature is possible if they are provided with fresh leafy spurge leaves, but the longer they remain in the cage, the fewer eggs will be deposited in the field. To release the adults, either sprinkle them on leafy spurge plants of moderate density, or quickly swing your arm with the open container to distribute them over a wider distance. Areas with high ant activity should be avoided.

COMMENTS

This is one of two black flea beetles approved for release in the United States.

After this species is released, leafy spurge plant density is greatly reduced at first. However, roots that are not attacked (including the taproot) are able to send up small new shoots to supply the sugars for root reserves. It is only through the persistence of the beetles over a long period of time in ecosystems that favor beetle survival that the lateral roots of leafy spurge will be destroyed, the taproots weakened, and the plants eliminated from the area.

Eric Maw of Canada covers several species of *Aphthona* in his master’s thesis from the University of Alberta, providing excellent descriptions of the larval and pupal stages of *A. cyparissias*, *A. czwalinae*, and *A. flava*. Like many of the other flea beetle species that attack leafy spurge, this species tends to congregate for feeding, mating, and egg-laying.

Contacts: Richard Hansen, Peter Harris, Eric Maw, Robert Nowierski, Robert Pemberton, Norman Rees, Robert Richard, Neal Spencer



USDA-ARS

Aphthona czwalinae pupa.



Aphthona flava

Common names: Copper leafy spurge flea beetle, amber spurge flea beetle.

Type of agent: Insect: Beetle, flea beetle (Coleoptera: Chrysomelidae).

Native distribution: Europe.

Original sources: Italy and Hungary.

BIOLOGY

Generations per year: One.

Overwintering stage: Larval (within young leafy spurge roots).

Egg stage: The eggs are deposited in June through early fall, generally on the plant stem at or below the soil surface, and sometimes on or in the soil but near the plant stem.

Larval stage: The larvae are active from July through early spring of the following year. The young larvae begin feeding in/on the root hairs; as they become older and larger, they migrate to the larger roots. They are difficult to observe except under a microscope. The more mature larvae are whitish and worm-like and can be observed with the naked eye in freshly extracted roots.

Pupal stage: Pupation occurs in a soil cell from late spring to early summer.

Adult stage: Adults will emerge in June through early fall, depending on degree-days. This species is larger and yellower than *Aphthona cyparissiae* and *A. nigricutis*. It has the characteristic flea beetle appearance and jumps when disturbed. Adult males are about 3.4 mm (0.13 in) long; females are about 3.6 mm (0.14 in) long.

EFFECT

Destructive stages: Adult (on the leaves) and larval (root hairs and young roots).

Plant species attacked: Leafy spurge (*Euphorbia esula*) complex.

Site of attack: Adult beetles feed on the leaves and flowers; larvae feed in/on the root hairs and young roots.

Impact on the host: Feeding on the foliage reduces photosynthesis, and flower consumption slightly reduces flowering ability. Feeding within



USDA-ARS

Aphthona flava adult.

Actual adult size



USDA-ARS

Aphthona flava larvae.

the roots reduces the plant's ability to absorb moisture and nutrients. Light populations reduce plant height and retard flowering, while high populations reduce plant density and cause what is often referred to as "a hole in the spurge." At one research site this species reduced the aerial portion of leafy spurge in a 212 by 167 m (700 by 550 ft) area in six years from 57% to less than 2%.

RELEASES

First introduced into the United States: 1985, Montana.

Now established in: Colorado, Idaho, Iowa, Minnesota, Montana, Nebraska, North Dakota, Oregon, South Dakota, Utah, Washington, Wisconsin, and Wyoming.

Habitat: The best areas for this beetle are on south-facing slopes in cooler climates that receive 46 to 51 cm (18 to 20 in) of moisture per year. Sunny locations are also desirable. The beetles are hard to establish in clay or acidic soils and in heavily shaded areas.

Availability: Moderate.

Stage to transfer: Adult.

Redistribution: Collect the beetles with a sweep net from late June through mid-August. Beetles can be kept several days at room temperature if given fresh leafy spurge leaves and confined in containers. The beetles can also be maintained for several weeks at room temperature if kept in large cages and given fresh food, or for several weeks if kept cool and fed and exercised periodically at room temperature. However, the longer they are kept in captivity, the fewer eggs will remain for the field. To release, sprinkle beetles on moderately dense leafy spurge plants. Areas of high ant activity should be avoided for initial releases.

Frozen roots and soil that contain overwintering larvae can be dug from the field during winter and kept frozen until several weeks before adults are desired. The beetles can then be reared at ambient or room temperature.

COMMENTS

This was the first leafy spurge flea beetle released in the United States. In the area near Bozeman, MT, its effect has been spectacular.

After this species is released, leafy spurge plant density is greatly diminished at first. However, roots that were not attacked (including the taproot) are able to send up new shoots to supply the sugars for root reserves. It is only through the persistence of the beetles over a long period of time in ecosystems that favor beetle survival that the lateral roots of leafy spurge are destroyed, the taproots weakened, and the plants eliminated from the area.

Eric Maw covers several species of *Aphthona* in his master's thesis from the University of Alberta, and provides excellent descriptions of the larval and pupal stages of *A. cyparissiae*, *A. czwalinea*, and *A. flava*. Like many of the other flea beetle species that attack leafy spurge, this species tends to congregate for feeding, mating, and egg-laying.

Contacts: Richard Hansen, Peter Harris, Eric Maw, Robert Nowierski, Robert Pemberton, Norman Rees, Robert Richard, Neal Spencer



USDA-ARS

Aphthona flava adults feeding on leafy spurge.



Aphthona lacertosa

Common name: Brown-legged leafy spurge flea beetle.

Type of agent: Insect: Beetle, flea beetle (Coleoptera: Chrysomelidae).

Native distribution: Austria, Italy, the former Yugoslavia, and eastern Hungary.

Original sources: Hungary and the former Yugoslavia.

BIOLOGY

Generations per year: One.

Overwintering stage: Larval (within the spurge roots).

Egg stage: The eggs are deposited in small batches underground near the root of their host over a period of several months during the summer.

Larval stage: Upon hatching, the larvae migrate to the root hairs and feed until the onset of cool fall temperatures and dormancy.

Pupal stage: Pupation occurs within a soil cell from late spring to early summer.

Adult stage: The adults emerge throughout the summer and feed on the leaves of leafy spurge. Each female produces 200 to 300 eggs. Adults are about 3 mm (0.12 in) long, black, and resemble *A. czwalinae*, except that the hind femora are brown.



USDA-ARS

Aphthona lacertosa adult.

Actual adult size



EFFECT

Destructive stages: Larval and adult.

Plant species attacked: Cypress spurge (*Euphorbia cyparissias*), *E. virgata*, with a lesser preference for *E. lucida*, *E. stepposa*, and leafy spurge (*E. esula*). In laboratory studies, survival of this species was high on *E. myrsinites* and *E. seguieriana*. This species does not survive outside the subgenus *Esula*.

Site of attack: Adult (leaves and flowers) and larval (within the root hairs and young roots).

Impact on the host: As with the other flea beetle species, the beetles reduce the plant's root reserves and diminish its ability to replace them. Since the beetles are concentrated in the feeding areas, the effects are obvious. In low populations the affected plants are shorter and have delayed flowering periods. High concentrations of the beetles reduce plant density, or cause what often is referred to as "a hole in the spurge."

RELEASES

First introduced into the United States: North Dakota; cleared for release in 1993.

Now established in: Montana, North Dakota, Oregon, and Washington.

Habitat: Found in the steppe biome of western Europe, mesic-dry to wet sites, with loamy soils and well developed herbaceous vegetation. Dry sites or flooded areas are considered unfavorable.

Availability: Moderate.

Stage to transfer: Adult.

Redistribution: Collect the beetles from leafy spurge plants with a sweep net during the summer.

The storage and shipping times are similar to those of other *Aphthona* spp. Frozen roots and soil containing overwintering larvae can be dug from the field and kept frozen. The beetles can then be reared at room temperature. Sprinkle beetles in moderately dense leafy spurge infestations. Areas of high ant activity should be avoided.

COMMENTS

This species and *A. czwalinae* are the only two *black* flea beetles released for leafy spurge control.

In host testing, this flea beetle readily accepted Canadian leafy spurge as strongly as it did its native hosts. It has a strong preference for *E. virgata* and its host range is limited to a few species in the subgenus *Esula*. Judging from its distribution in Europe, this species is anticipated to work in southern Canada and the northern part of the United States, but will not extend to the southern part of the United States. Like many of the other flea beetle species that attack leafy spurge, this species tends to congregate for feeding, mating, and egg-laying.

After this species is released, leafy spurge plant density is greatly diminished at first. However, roots that are not attacked (including the taproot) are able to send up new shoots to supply the sugars for root reserves. It is only through the persistence of the beetles over a long period of time in ecosystems that favor beetle survival that the lateral roots of leafy spurge will be destroyed, the taproots weakened, and the plants eliminated from the area.

Contacts: Richard Hansen, Peter Harris, Eric Maw, Robert Nowierski, Robert Pemberton, Norman Rees, Robert Richard, Neal Spencer



Aphthona nigriscutis

Common name: Black dot leafy spurge flea beetle.

Type of agent: Insect: Beetle, flea beetle (Coleoptera: Chrysomelidae).

Native distribution: Europe.

Original source: Europe.

BIOLOGY

Generations per year: One.

Overwintering stage: Larval (within the spurge roots).

Egg stage: The eggs are laid on the stem of the plant near or below the soil surface.

Larval stage: Larvae can be found from July to early spring of the following year. After hatching, they burrow into the soil and begin feeding on small roots. Feeding continues throughout the summer until the onset of cold temperatures and dormancy.

Pupal stage: Pupation occurs within a soil cell from late spring to early summer.

Adult stage: Adults are in the field in late June, July, and August. They are 3 to 3.5 mm (0.12 to 0.14 in) long, and brown or brownish with a black dot on the back behind the thorax at the leading edge of the wings.

EFFECT

Destructive stages: Adult and larval.

Plant species attacked: Leafy spurge (*Euphorbia esula*) complex.

Site of attack: Adult beetles feed on the leaves and flowers while larvae feed on the root hairs and young roots.

Impact on the host: Adult feeding on the foliage causes some injury, but larval feeding in and on the root hairs and young roots causes the greatest damage. The former reduces the plant's ability to make sugars for the root reserves, and the latter impairs the roots from taking up moisture and nutrients, thus reducing the potential plant height and retarding the flowering period. Higher concentrations of the beetles often reduce plant density, causing what often is referred to as "a hole in the spurge."

RELEASES

First introduced into the United States: 1989, Montana.

Now established in: Colorado, Idaho, Montana, Nebraska, North Dakota, Oregon, and Washington.



USDA-APHIS

Aphthona nigriscutis adult.

Actual adult size



Habitat: It is believed that this insect prefers dry habitats such as sandy knolls. Peter Harris of Agriculture Canada recommends sites with needle-and-thread or porcupine grasses (*Stipa* spp.), flowering spurge stems of less than 70 cm (27 in) tall with fewer than 60 stems/m² (10.7 stems/ft²), and well-drained soils with less than 3% organic matter. This species prefers dry soils that are generally found on hilltops.

Availability: Readily available in states where the insect populations have established.

Stage to transfer: Adult.

Redistribution: Collect the beetles with a sweep net from July through early August. The adult beetles can be shipped or stored for several days at cool temperatures if fed fresh leafy spurge leaves and confined in cardboard containers. They can also be kept at room temperature for several weeks in large cages with fresh food, or for several weeks in smaller cardboard containers if kept cool and exercised and fed periodically under warmer conditions. To release, sprinkle beetles on moderately dense leafy spurge plants. Frozen roots and soil material containing overwintering larvae can be dug from the field and kept frozen until several weeks before adults are desired. The material can be removed from cool storage and warmed to ambient or room temperature. This will allow the beetles to mature and become adults. Sites for initial releases that contain high ant or grasshopper populations should be avoided.



USDA-ARS

Aphthona nigriscutis egg.



USDA-ARS

Aphthona nigriscutis larva.

COMMENTS

Aphthona nigriscutis was first released in Canada in 1983 with spectacular results, and was the fourth flea beetle species cleared for release in the United States. Like many of the other flea beetle species that attack leafy spurge, this species tends to congregate for feeding, mating, and egg-laying.

Leafy spurge plant density is greatly diminished at first. However, roots that are not attacked (including the taproot) are able to send up new shoots to supply the sugars for root reserves. It is only through the persistence of the beetles over a long period of time in ecosystems that favor beetle survival that the lateral roots of leafy spurge will be destroyed, the taproots weakened, and the plants eliminated from the area.

Contacts: Richard Hansen, Peter Harris, Eric Maw, Robert Nowierski, Robert Pemberton, Norman Rees, Robert Richard, Neal Spencer



Chamaesphecia empiformis

Common name: (None widely accepted)

Type of agent: Insect: Moth, clearwing (Lepidoptera: Sesiidae).

Native distribution: Europe.

Original sources: Europe, including Austria, Germany, and Switzerland.

BIOLOGY

Generations per year: One.

Overwintering stage: Larval (in the roots).


Egg stage: It is believed that eggs are usually laid singly on the undersides of leaves, often within 5 cm (2 in.) of the plant's tip. Eggs are light brown and hatch in eight to 10 days.

Larval stage: The larvae live and feed in the root system.

Pupal stage: It is believed that pupation occurs from spring through early summer in loose, silky webs, generally near the root collar.

Adult stage: The black-bodied adults look very similar to adults of *C. tenthrediniformis*. They have a wingspan of 13 to 20 mm (0.52 to 0.8 in) with yellow scales on the wings. The transparent areas of the forewing are indicative of the clearwing moths.

Actual adult size



(wingspan)

EFFECT

Destructive stage: Larval.

Plant species attacked: Cypress spurge (*Euphorbia cyparissias*).

Site of attack: Roots.

Impact on the host: By feeding within the roots of the host, larvae deplete root reserves and the plant's ability to replace those root reserves, causing loss of plant vigor and sometimes death. Soil-borne pathogens may be able to invade damaged root tissues.

RELEASES

First introduced into the United States: 1975, Idaho and Montana.

Now established in: Not recovered in the United States.

Habitat: Undetermined.

Availability: Unavailable.

Stage to transfer: Adult.

Redistribution: Infested cypress spurge roots can be stored at 4 to 12° C (39 to 54° F) for three to four months if the plants are dug in October. Roots containing larvae can be confined or planted until the adults emerge. The adults can then be identified and released.

COMMENTS

This species of clearwing moth is very specific in its host range, attacking mainly cypress spurge. It was apparently released in a mix with *Chamaesphecia tenthrediniformis* which also did not establish.

Contacts: Norman Rees, Neal Spencer



Chamaesphecia hungarica

Common name: Hungarian clearwing moth.

Type of agent: Insect: Moth, clearwing (Lepidoptera: Sesiidae).

Native distribution: Southeastern Austria, the former Czechoslovakia, Hungary, the former Yugoslavia, possibly Romania, and the southern part of the former USSR.

Original sources: Hungary and the former Yugoslavia.

BIOLOGY

Generations per year: One.

Overwintering stage: Larval (in the root).

Egg stage: Eggs are laid shortly after mating. Each female produces an average of 205 eggs which are usually laid singly. During the spurge flowering period, most eggs are laid on the bracts (modified leaves around the flower). After the plants have flowered, eggs are laid on the leaves and stems. The eggs are light brown, measure 0.75 mm by 0.50 mm (0.03 by 0.02 in), are oval and flattened with the shell divided into distinct polygonal structures and covered with minute papillae.

Larval stage: The larvae hatch about 17 days after the eggs are deposited and penetrate into the shoot a few centimeters (nearly an inch) above the ground. Larvae from eggs deposited earlier around the flower apparently have a better survival rate than larvae from eggs laid later on the leaves and stems. The young larvae mine the stem just below the epidermis for a few centimeters (about an inch) before they move into the pith and down into the root where most feeding occurs. There are seven larval instars; the sixth and seventh occur before winter. In the spring the larvae mine up to the stem base and prepare an emergence hole a few centimeters (about an inch) above the ground.

Pupal stage: Pupation occurs in the spring within the stem of the host plant a few centimeters (nearly an inch) above the ground. The empty pupal case is left protruding from the exit hole after emergence.

Adult stage: The adults emerge between mid-May and the end of June in the former Yugoslavia and Hungary; at higher elevations they may emerge until the end of July. Adult females use a scent to attract the males. The abdomen is black and contains whitish bands on segments two, four, and six, with numerous greenish scales on the back. The male also has whitish bands on segment seven. Their bodies are 10 to 14 mm (0.4 to 0.56 in) long. The top of the antennae is black while the ventral side is brown. The outermost area of the 7 to 10 mm



USDA-APHIS

Chamaesphecia hungarica adult.

Actual adult size



(0.28 to 0.4 in) long forewing is black with yellow scales between some of the veins. A black spot is located at the tip of the wing. Three transparent areas of the forewing are clearly visible.

EFFECT

Destructive stage: Larval.

Plant species attacked: *Euphorbia lucida*, *E. palustris*, leafy spurge (*E. esula-virgata* complex), and possibly *E. lathyris* as a marginal host.

Site of attack: Roots.

Impact on the host: By feeding within the roots of the host, larvae deplete root reserves and hamper the plant's ability to replace those root reserves, causing loss of plant vigor and often death.

RELEASES

First introduced into the United States: 1993, Montana.

Now established in: Montana.

Habitat: In its native lands, it is generally found in plants growing in moist, loamy soils and in partly shaded habitats such as river banks, swampy areas, and ditches. It apparently does not like dry, sunny areas.

Availability: Unavailable.

Stage to transfer: Larval.

Redistribution: Dig plants of *E. esula-virgata* after this agent has become established. Infested roots can be stored at cool temperatures of 4 to 12° C (39 to 51° F) for three or four months if the plants are dug in the fall. Rear the larvae and release adults. Adults can be collected with a sweep net, but only a few sweeps should be made per series so the netted moths are not damaged.

COMMENTS

No *Chamaesphecia* species have been recorded on an annual spurge. In nature, this moth has only been reported on *E. lucida* and *E. palustris*, although the latter has not been confirmed. In feeding tests, it restricted itself to spurges in the *E. esula-virgata* complex, with *E. lathyris* being a marginal host. Since *E. lucida* is absent in North America and because this agent does attack leafy spurge (*E. esula-virgata*), it is very likely that this moth may be valuable as a strong biocontrol agent of certain leafy spurge biotypes in moist areas without endangering any other spurges in the United States.

In the host testing, it was also determined that the *Euphorbia* subgenera *Chamaesyche*, *Agaloma*, and *Poinsettia* did not support any larval feeding. No rare and endangered native North American spurges are at risk, nor is the economically important *E. pulcherrima*. Other plants of concern, such as *E. robusta* which belongs to the subgenus *Esula*, live in dry climates and are out of the range of this species.

Contacts: Richard Hansen, Peter Harris, Robert Nowierski, Norman Rees, Robert Richard, Neal Spencer



Chamaesphecia tenthrediniformis

Common name: (None widely accepted)

Type of agent: Insect: Moth, clearwing
(Lepidoptera: Sesiidae).

Native distribution: Europe.

Original sources: Europe, Austria, and the former Yugoslavia.

BIOLOGY

Generations per year: One.

Overwintering stage: Larval (in the roots).

Egg stage: It is believed that the majority of eggs are laid singly on the lower part of the leafy spurge stem. The dark brown eggs hatch in eight to 10 days.

Larval stage: The larval stage lasts from early summer to the following spring.

Pupal stage: It is believed that pupation occurs from spring through early summer in silky webs, generally near the root collar.

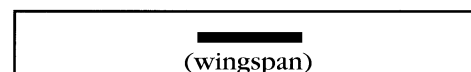
Adult stage: Adults of this species have black bodies with yellow scales on the wings. The wingspan is 13 to 30 mm (0.52 to 0.8 in). Adults appear very similar to *C. empiformis*.



USDA-ARS

Chamaesphecia tenthrediniformis adult.

Actual adult size



EFFECT

Destructive stage: Larval (in the root).

Plant species attacked: Leafy spurge (*Euphorbia esula*).

Site of attack: Roots.

Impact on the host: Feeding by the larvae in the larger root systems reduces the root reserves and provides access for the entry of opportunistic pathogens.

RELEASES

First introduced into the United States: 1975, Idaho and Montana.

Now established in: This species has not been recovered in the United States.

Habitat: Undetermined.

Availability: Unavailable.

Stage to transfer: Larval (in the roots).

Redistribution: Dig infested roots in the late fall. Keep them cool until the next spring when they can be planted and grown at ambient temperatures. When adults emerge, identify and release them in the field. If one can obtain only small numbers, release the moths into a large outdoor cage for one to two weeks, and then remove the cage and allow the moths to disperse.

COMMENTS

This species is extremely restricted to *E. esula* or what some refer to as a biotype of *E. esula*. It was accidentally introduced under the name of *C. empiformis* but was not able to accept the host plants offered it and therefore did not survive.

Contacts: Paul Dunn, Peter Harris, Norman Rees, Neal Spencer



USDA-ARS-EBCL

Chamaesphecia tenthrediniformis larva in a damaged root.



Dasineura sp. nr. *capsulae*

Common name: None. At this time, this species has not received a scientific name other than that which indicates that it is closely related to the species *Dasineura capsulae*.

Type of agent: Insect: Fly, gall midge (Diptera Cecidomyiidae).

Native distribution: Italy, near San Rossore. (Because taxonomy within the species group is difficult, the San Rossore population is considered distinct from others elsewhere.)

Original source: San Rossore, Italy.

BIOLOGY

Generations per year: One.

Overwintering stages: Larval and pupal (in the soil).

Egg stage: Eggs are generally deposited within 24 hours of mating, usually in the inflorescence between the bracts and the cyathium in groups of about 35. Total number of eggs deposited per female is about 89. The incubation period is three to five days. Freshly laid eggs are white, slightly elongated with rounded ends. They have a soft, smooth, translucent shell. Eggs are about 0.27 mm (0.01 in) long.

Larval stage: The larvae are tiny maggots that are first located in the inner part of the bracts that cover the cyathium or inside the cyathium where the galls start to form. Larvae develop for about five weeks before they exit the gall and enter the soil to hibernate until the next spring. One-week-old larvae are about 0.29 mm (0.01 in) long; two-week-old larvae about 0.33 mm (0.01 in) long; three-week-old larvae about 0.72 mm (0.03 in) long; four-week-old larvae about 1.36 mm (0.05 in) long; and five-week-old larvae are about 3.10 mm (0.12 in) long, yellowish, and have distinct and well-formed sternal plates.

Pupal stage: Pupation occurs in early April after mature larvae move to the surface. The pupal stage lasts two to four days. Pupae are about 2 mm (0.08 in) long and are light red with reddish-brown wings and legs.

Adult stage: in San Rossore, adults emerge between mid-April and mid-May and mate shortly thereafter. Adult females live about three days while adult males live for only 2.4 days. The adult body is reddish-yellow with brown, hardened parts. The female is 2.3 mm (0.09 in) long and about 0.4 mm (0.02 in) wide. The male is 1.7 mm (0.07 in) long and 0.02 mm (0.001 in) wide.



USDA-ARS-EBCL

Dasineura sp. nr. *capsulae* adult.

Actual adult size



EFFECT

Destructive stage: Larval.

Plant species attacked: Leafy spurge
(*Euphorbia esula* complex).

Site of attack: Fly larvae attack the inner part of the bracts that cover the cyathium or develop inside the cyathium. Galls are produced mainly by the enlargement and distortion of the cyathium and also by the deformation of the bracts that cover the cyathium or a deformation of the leaves of the growing tips.

Impact on the host: This agent attacks the seed-producing portion of the plant, thus reducing the seed potential.



USDA-ARS-EBCL

RELEASES

First introduced into the United States:

This species has yet to be released. It was cleared for release late in 1991, but because of a very high rate of parasitism, no live adults from foreign collections have been reared in quarantine for release in the United States.

Now established in: Not established.

Habitat: Undetermined.

Availability: This species will not be available for general redistribution until several years after establishment.

Stages to transfer: Egg, larval, pupal (while on or in the host plant), and adult (but are very short-lived and therefore can only be transferred short distances).

Redistribution: Collect galls that contain mature larvae and pupae. Let mature larvae leave the spurge galls by placing field-collected galls into plastic bags and put these bags into a refrigerator set at 8° C (38° F) to force the larvae to leave the galls. Then place the larvae in a mixture of sphagnum moss and sand so that they can pupate. This material can be kept up to six months in cool storage to mimic winter conditions. Adults can be reared, identified, and released. The adults are fragile and should be released in the early morning or late evening on calm days when possible. It is during these periods in their short adult lives that they mate and lay eggs.

COMMENTS

As previously noted, this insect has not yet been fully described and named. It is very similar in appearance to *Spurgia esulae* and attacks the plant at nearly the same location. However, the galls of the two species are different: *S. esulae* causes the plant to enclose the larvae in a protective encasement of leaves while the larvae of *D. capsulae* burrow into the ovary and cause the plant to create a gall of swollen plant tissue. A second difference is that *D. capsulae* has only one generation per year. The ultimate effects of these two species are similar, however, in that the growing tip of the plant is attacked and seed production is reduced.

Contacts: Gaetano Campobasso, Richard Hansen, Peter Harris, Robert Nowierski, Pasquale Pecora, Norman Rees, Robert Richard, Neal Spencer

Dasineura sp. nr. *capsulae* galls.



Hyles euphorbiae

Common name: Leafy spurge hawkmoth.

Type of agent: Insect: Moth

(Lepidoptera: Sphingidae).

Native distribution: Southern and central Europe, northern India, and central Asia.

Original sources: France, Germany, Hungary, and Switzerland.

BIOLOGY

Generations per year: Generally two, although considered univoltine in some parts of Canada.

Overwintering stage: Pupal (in the soil).

Egg stage: Each female deposits between 70 to 150 eggs, generally in batches, on leafy spurge leaves and bracts in June and August. The eggs are round and a green fluid can be seen at first through the transparent egg covering in younger eggs; the developing larvae can be seen in the older eggs.

Larval stage: The larvae generally hatch during June and early August.

There are five larval instars which require two to three weeks. Larvae at each growth stage have their own distinctive color pattern. The first-instar larvae are a dark black or blackish green, have six legs and 10 prolegs, and spin very thin threads that adhere to the plant and keep the larvae from falling off. Later the coloration changes to longitudinal yellow and dark brown stripes that change to green with white spots, and by two weeks of age, the larvae will have increased their weight to about 2 to 3 gm (0.07 to 0.11 oz). The last instar is green, black, and red with yellow spots. At pupation time, well-fed larvae are about 11 cm (4-3 in) long; the color changes from the bright green, red, black, and yellow to a darker combination of these colors; and the body length contracts.

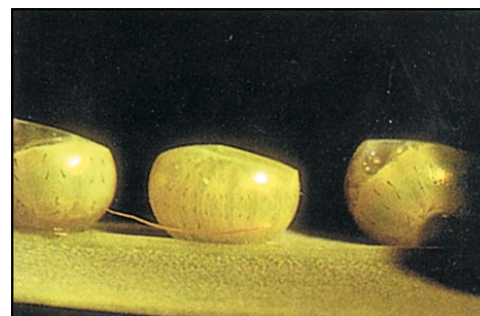
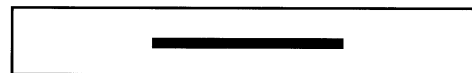
Pupal stage: Mature larvae excavate a hole in the soil or litter 2.5 to 8 cm (1 to 3 in) deep and cement soil particles and other loose material together to form the watertight pupal chambers. If the insect does not enter diapause, the pupal stage lasts 15 to 20 days. Otherwise, it will remain a pupa all winter. Young pupae are



USDA-ARS

Hyles euphorbiae adults.

Actual adult size



USDA-ARS

Hyles euphorbiae eggs.

greenish-white and soft, while mature pupae are dark brown. Pupae are about 4 to 5 cm (1.6 to 2 in) long.

Adult stage: Adults average 25 to 30 mm (1 to 1.2 in) long. They begin to appear in the field from late June to July and again in late August and September. They have a wingspan of about 5 cm (2 in), the wings having distinctive markings, although they can sometimes be confused with other native sphingids.

EFFECT

Destructive stage: Larval.

Plant species attacked: Leafy spurge (*Euphorbia esula* complex).

Site of attack: Leaves and bracts.

Impact on the host: The larvae feed upon the leaves and bracts of plants, producing damage which is apparent in dense patches. However, this feeding does not threaten the plants. By itself, this species is ineffective as a biological control agent.



USDA-ARS

Hyles euphorbiae larva.

RELEASES

First introduced into the United States: 1966, Montana.

Now established in: Idaho, Montana, Nebraska, and North Dakota.

Habitat: This species seems to like areas near trees with much leafy spurge. It has high mortality in areas with many ground squirrels, birds, and other small animals that eat the pupae.

Availability: The moth is generally quite abundant in areas where it has been established for a number of years.

Stages to transfer: Larval and pupal. Movement at these stages has been traditional, although if one can transfer mated females, eggs will be deposited less conspicuously and might be less subject to predation.

Redistribution: Collect the larvae from the plants in July and September and keep them fed with fresh leafy spurge leaves. Larvae can be shipped if the moths have fresh food, the container is kept cool, and the duration of the travel is only two or three days. Adults can be collected with sweep nets or black lights in late June to July and again in late August and September, although care should be taken not to injure the wings. Adults should be moved in large cardboard containers that are kept cool, well ventilated, and provided with leafy spurge branches on which the moths can cling. It is preferable and less destructive to the insects to hand-carry the containers with the adults to new locations rather than ship them commercially. The best method of redistribution is to rear them to the adult stage, allow them to mate, and then release the moths. The adults will deposit the eggs where they have the best chance of survival.

COMMENTS

A generation is completed in 45 to 60 days. The larval skin contains toxins of the leafy spurge plant, which tend to deter predators. This protection, however, is lacking in the pupal skin.

There may be two strains of *Hyles euphorbiae*, each with slightly different host preferences. This biocontrol agent is very visible and its feeding damage quite noticeable. However, it is not considered to be a good agent by itself because a virus has established that infects the moth and rapidly decreases the population. Defoliation alone of leafy spurge does not reduce the infestation.

Contacts: Paul Dunn, Richard Hansen, Peter Harris, Alec McClay, Robert Nowierski, Norman Rees, Robert Richard, Neal Spencer



Oberea erythrocephala

Common name: Red-headed leafy spurge stem borer.

Type of agent: Insect: Beetle
(Coleoptera: Cerambycidae).

Native distribution: Europe.

Original sources: Europe, Italy, and Switzerland.

BIOLOGY

Generations per year: One, with some generations lasting two years in harsher climates.

Overwintering stage: Larval (within the stem or crown).

Egg stage: Eggs are deposited from the end of June to mid-July. The female adult often girdles the upper part of the stem one to four times (usually twice) by cutting grooves completely or partly around it. She then gnaws a hole into the stem above the girdle marks and deposits an egg into it. The hole is generally covered with latex which eventually dries. Usually only one egg is deposited in each shoot, although each female can produce about 60 eggs. The eggs are 1.8 to 2.0 mm (0.07 to 0.08 in) long, pale yellow at first but changing to pinkish-white or pink shortly before the larvae hatch.

Larval stage: The larvae hatch seven to 10 days after oviposition and begin to feed immediately on the pith. In thicker stems they begin to tunnel downward at once, while in thinner stems they tunnel upward first and then down. In Montana, stem diameters of at least 3.0 mm (0.12 in) are usually selected by the females for egg laying. The first three to four larval instars consume all the pith of the stem leaving only the cortical tissue, and fill their galleries with fibrous frass. The mined stems wilt and dry up by the end of July and so do not produce flowers and seeds.

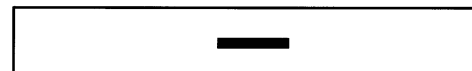
Regardless of the length of time required to complete development, the larvae remain in the crown of the plant during the winter. Only a single larva develops per stem; if several larvae occupy the same stem, the more mature larva will survive at the expense of the younger. In well-developed roots of large plants with several



USDA-ARS-EBCL

Oberea erythrocephala adult.

Actual adult size



USDA-ARS

Oberea erythrocephala larva in a leafy spurge root.

attacked stems, several larvae can complete their development. The whitish larvae are long and slender, and have sclerotized heads.

Pupal stage: Prior to pupation, the mature larvae mine the root crown and prepare pupal cells just above ground level. Pupation occurs during May.

Adult stage: Males emerge several days before the females. Both sexes are sexually immature for two weeks. The grayish-black, red-headed adults are 6 to 14 mm (0.24 to 0.56 in) long and very slender. The female's antennae are a little shorter than the male's.



USDA-APHIS

EFFECT

Destructive stages: Adult feeding on the leaves and stems does not greatly affect plant survival. However, girdling by the adult with subsequent egg-laying generally results in shoot death. The larvae in the stem also cause the stem to die, and destructive feeding in the crown and root greatly reduces the plant's root reserves.

Plant species attacked: Leafy spurge (*Euphorbia esula* complex).

Site of attack: Larvae live and feed in the stem and crown of plants with stem diameters in excess of 3.0 mm (0.12 in).

Impact on the host: Although this agent has the potential to greatly depress leafy spurge populations, it attacks only specific biotypes of leafy spurge and, therefore, has not yet increased its population sufficiently in many areas to be effective.

Hole made by *Oberea* adult for depositing eggs.

RELEASES

First introduced into the United States: 1982, Montana.

Now established in: Montana, North Dakota, and Oregon.

Habitat: This species seems to prefer areas with trees, and has established and increased best in riparian areas.

Availability: Somewhat limited at present except for one Montana county.

Stage to transfer: Adult.

Redistribution: Use a sweep net or hand-collect the adults. These can be stored up to several weeks if kept cool and allowed to warm up, exercise, and feed for two-hour periods, three times per week. They can be shipped in a cool environment with plant stems and leaves for food. However, shipments should take no longer than six days.

COMMENTS

This species can be confused with a flower beetle that has the same general coloration and appearance, except the flower beetle's head is slightly larger and black, and the abdomen is larger and much more flattened.

This was the second insect species introduced to control leafy spurge. There is some indication that in some Montana locations the life cycle tends to require two years rather than just one, probably because of the cooler temperatures. It appears that this species is very host-specific and apparently prefers certain leafy spurge biotypes over others.

Contacts: Paul Dunn, Richard Hansen, Peter Harris, Robert Nowierski, Robert Pemberton, Chuck Quimby, Norman Rees, Robert Richard, Neal Spencer



Spurgia esulae

Common name: Leafy spurge tip gall midge.

Type of agent: Insect: Fly, gall midge (Diptera: Cecidomyiidae).

Native distribution: Only known in Italy.

Original source: Italy.

BIOLOGY

Generations per year: Two in Montana, with a partial third; emergence coincides with availability of new shoots.

Overwintering stage: Mature larval.

Egg stage: The females lay eggs on the external and internal leaves of the growing tip. Newly laid eggs are smooth and soft, measure about 0.35 mm (0.01 in) long, and are light red at first, darkening with age. The egg is cigar-shaped and slightly curved.

Larval stage: There are three larval instars. The newly hatched larvae move to the internal part of the growing tips to feed on young leaves, which causes the formation of galls. Galls consist of a tight cluster of abnormal, warty and flattened leafy spurge leaves, among which are found the developing larvae. Larvae are legless and orange. Mature larvae possess sternal plates on the lower side of the first thoracic segment.

Pupal stage: Pupation of all generations, except for the overwintering generation, occurs in silken cocoons inside the gall. The overwintering generation passes the winter as pupac in the soil. Pupae measure about 1.84 mm (0.07 in) long and are light red, except for the legs and wings which tend to be reddish-brown.

Adult stage: Adults emerge in early April. This very delicate fly is short-lived, its life being measured in hours rather than days. Mating and egg-laying generally occur in the cool, calm periods around twilight and dusk. During the heat of the day they seek shady areas and move very little. The males are about 1.86 mm (0.07 in) long and possess forceps on the end of the abdomen, whereas females are about 1.90 mm (0.07 in) long and have a tapering abdomen with an exposed ovipositor.

EFFECT

Destructive stage: Larval.

Plant species attacked: Leafy spurge (*Euphorbia esula* complex).

Site of attack: Growing points of the plant.



USDA-ARS

Spurgia esulae adult.

Actual adult size



Impact on the host: Each generation attacks the growing tips of leafy spurge plants, destroying the shoots' ability to flower and produce seeds. The tips eventually die, and the plants then produce new shoots from below the attacked areas. These shoots are then attacked by the next generation of flies.

RELEASES

First introduced into the United States:

1985, Montana and North Dakota.

Now established in: Montana, North Dakota, and Oregon.

Habitat: It prefers dense leafy spurge populations growing on south-facing slopes in cooler climates. It survives best between windbreaks, and galls can often be found downwind from large shrubs in otherwise open fields. It does not survive well near rivers, probably because of predatory insects and birds which attack the galls.

Availability: Somewhat restricted; Montana and North Dakota.

Stages to transfer: Larval and pupal (in galls).

Redistribution: To collect, clip galls containing mature larvae. (Sweeping with a net will damage the very fragile adults.) Clipped stems should be bunched and the bottoms wrapped in damp towels or damp cotton. They should be taken to the field as quickly as possible and placed upright in a wire frame or other device so that the larvae will not be found by ants and other predatory insects.

COMMENTS

This species was tested and introduced into the United States under the name of *Bayeria capitigena*, but later changed by Dr. Ray Gagné. The North Dakota colony has been infested by native parasitoids of other native cecidomyiid fly species.

Contacts: Robert Carlson, Richard Hansen, Peter Harris, Robert Nowierski, Pasquale Pecora, Robert Pemberton, Chuck Quimby, Norman Rees, Robert Richard, Neal Spencer



USDA-ARS

Spurgia esulae larvae and pupae in a leafy spurge gall.



USDA-ARS

Leafy spurge gall containing *Spurgia esulae* larvae and pupae.