**Bruchidius villosus**  
Broom seed beetle

*Bruchidius villosus* is a biological control agent approved in North America for release against *Scotch broom*.

### CLASSIFICATION

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### DESCRIPTION

Eggs are tiny, white, and oval-shaped ([Fig. 1a](#)). Larvae are an off-white color with brown head capsules and can reach up to 2 mm in length. Pupae are gray or brown and up to 2 mm long. Larvae and pupae are difficult to see as they are both found completely within attacked seeds. Adults are completely gray-black and can be up to 2 mm long ([Fig. 1b](#)). They have segmented antennae, and both their elytra (wing covers) and snouts are short.

### LIFE CYCLE

Overwintering adults emerge in spring when broom begins to flower ([Fig. 2](#)). They congregate on flowers to feed on pollen, which helps stimulate ovary maturation. Eggs are laid singly on the outside of the seed pod ([Fig. 1a](#)). Hatching first-instar larvae burrow into the seed pod wall, sometimes forming visible tunnels ([Fig. 3a](#)), before entering and feeding on developing seeds. The final three instar stages develop completely within seeds ([Fig. 3b, left seed](#)); there is generally one larva per seed. Pupation occurs within the seed coat. New adults emerge in late summer, leaving behind round emergence holes in seeds ([Fig. 3c](#)). Adults do not chew their way out of the seed pod, instead relying on the plant’s dehiscing mechanism to escape. Seed pods dehisce, or dry out, and burst open at maturity in order to spread their seeds, thus releasing adult beetles. Adults overwinter away from the host plant. There is one generation per year.
DAMAGE
Larval feeding on developing seeds (Fig. 3b,c) reduces viable seed production. One larva typically kills one seed. While this does not kill existing broom plants, it can help reduce the rate of spread of broom populations and may have long-term impacts by reducing seed recruitment as established plants senesce and the seed bank is exhausted.

FIELD IDENTIFICATION
Eggs are laid on the outside of broom seed pods (Fig. 1a), and larval tunneling away from the eggs is sometimes visible (Fig. 3a). Because larvae feed completely within seeds (Fig. 3b), they can be difficult to detect unless seeds are dissected. Overwintered adults are readily visible in spring as they congregate on broom flowers and developing seed pods.

The weevil *Exapion fuscirostre* also attacks seeds of Scotch broom. It is easiest to assess insect presence when pods are brown but not yet splitting open. Late-instar larvae of *B. villosus* can be differentiated from *E. fuscirostre* in that *B. villosus* larvae feed completely within broom seeds (Fig. 4a, left), to the extent their presence can be difficult to detect unless seeds are dissected. *Exapion fuscirostre* larvae cause external feeding damage to seeds which is obvious when the pod is first opened (Fig. 4a, right). Adult *B. villosus* are gray-black and have much shorter snouts and elytra (Fig. 4b, left) than adult *E. fuscirostre* (Fig. 4b, right).

PREFERRED HABITAT
The broom seed beetle does best in meadows or on hillsides with southern exposure. It may perform poorly at heavily shaded, cold, high-elevation, and/or coastal sites.

HISTORY AND CURRENT STATUS
*Bruchidius villosus* is native to Europe and was unintentionally introduced to North America. It was first reported on Scotch broom in Massachusetts in 1918 and later spread naturally along the east coast of the USA. Individuals from these unintentionally introduced populations were tested for host specificity following USDA-APHIS TAG protocols and approved for redistribution in the USA. Beginning in 1998, *B. villosus* was deliberately transferred from North Carolina to Scotch broom growing in Oregon and Washington. By 2001, the beetle had spread to French broom (*Genista monspessulana*) growing in Oregon. *Bruchidius villosus* was first recorded on Scotch broom growing in British Columbia, Canada in 2000, although high populations at the time of first record indicate it likely arrived there earlier. From 2006 to 2008 it was redistributed within British Columbia on Scotch broom. In 2003, the beetle was recorded as present on Scotch broom in Nova Scotia. In 2014, the beetle was found to have dispersed naturally onto Scotch broom and French broom in California. *Bruchidius villosus* is now widespread on Scotch Broom in the southeastern USA. It is also widespread in western

Figure 3. *Bruchidius villosus* (a) larval tunnel extending from an egg; (b) larva feeding completely within the left seed; (c) feeding damage to a Scotch broom seed and emergence hole formed by a newly developed adult (a–c: Jennifer Andreas, Washington State University Extension)

Figure 4. Comparison of *Bruchidius villosus* (left) and *Exapion fuscirostre* (right): (a) larvae attacking Scotch broom seeds; (b) adults (a: Thomas Shahan, Oregon Department of Agriculture; b: Jennifer Andreas, Washington State University Extension)
Figure 5. Bruchidius villosus reported distribution in North America (Winston et al. 2021)

North America (Fig. 5) where its abundance is variable but increasing. In 2014, a study evaluating the attack rate of B. villosus and Exapion fuscirostre on Scotch broom seeds was initiated across the range of Scotch broom in the West. Attack rates can be quite variable depending on site and habitat. Across 75 study sites, the seed attack rate for B. villosus alone ranged between 0 and 98% with an average attack rate of 59% in British Columbia, 44% in Washington, 41% in Oregon, and 0.6% in California. Attack rates increased 10–37% when E. fuscirostre was present. In 2019, the average seed attack rates across 10 western Washington inland populations was 79%, ranging from 61 to 89%. In addition, since 2012, seed reduction was greater than 70% at 26 Washington sites, many of which were over 80%. Seed attack rates at coastal sites tend to be lower than inland sites but may be increasing as beetles acclimatize and establish. Long-term studies in Washington State indicate that B. villosus is consistently the dominant species (compared to E. fuscirostre) at most Scotch broom sites. High attack rates are likely to result in long-term Scotch broom reductions; however, it remains unknown whether this will provide sufficient widespread management.

Bruchidius villosus is also widespread on French broom in southwestern Oregon and increasing its abundance on French broom in California, though its impact on this weed has not been formally evaluated. Parasitism is typically low but may limit biocontrol agent populations in some regions, and B. villosus seems to be less affected than E. fuscirostre.

NONTARGET EFFECTS

There are currently no reported nontarget effects in North America, but studies are ongoing to assess potential attack on Lupinus arboreus, a species native to the USA.

Exapion fuscirostre is a biological control agent approved in North America for release against Scotch broom.

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DESCRIPTION

Eggs are small, white to yellowish, and round. Larvae are an off-white color with brown head capsules (Fig. 6a). They can be up to 2½ mm in length. Pupae are cream colored and up to 3 mm long. Adults have brown bodies with two long, broken, silver or tan bands that run down either side of their bodies (one on each side). Their snouts are long and curved, and they have light brown legs (Fig. 6b).

LIFE CYCLE

In early spring when Scotch broom begins to flower, overwintering adults emerge and feed on stems and flowers. Females must feed on Scotch broom flowers in order to produce eggs. Eggs are laid inside the seed pod, and hatching larvae feed on developing seeds. Feeding by late-instar larvae breaks the seed coat so that the damaged seed and larva or pupa is readily visible when the pod is opened (Fig. 4a right, 6a). Late-instar larval feeding can extend to the seed next to the infested seed so that a single larva can sometimes destroy two
seeds. New adults emerge in late summer. Adults do not chew their way out of the seed pod, instead relying on the plant’s dehiscing mechanism to escape. Seed pods dehisce, or dry out, and burst open at maturity in order to spread their seeds, thus releasing beetles. Adults overwinter in soil litter. There is one generation per year, though generations sometimes overlap as adults are frequently active year-round (Fig. 7).

**DAMAGE**

Adult feeding on stems (Fig. 8a) causes terminal shoot dieback but does not kill the plant. Larval feeding on developing seeds (Fig. 6a, 8b) reduces viable seed production. While this does not kill existing broom plants, it may help reduce the rate of spread of Scotch broom populations and may, in combination with *B. villosus*, have long-term impacts by reducing seed recruitment as established plants senesce and the seed bank is exhausted.

**FIELD IDENTIFICATION**

Eggs are typically not visible under field conditions because they are laid within seed pods. When mature seed pods are opened, late-instar larvae can be observed feeding partly within and partly outside the seed (Fig. 4a right, 6a). Overwintered adults are readily visible in early spring as they feed on Scotch broom stems and flowers and adult females deposit eggs in green pods.

The beetle *Bruchidius villosus* also attacks seed pods of Scotch broom. Late-instar larvae of *E. fuscicrostre* can be differentiated from *B. villosus* once mature seed pods are opened in that *E. fuscicrostre* larvae feed half in and half out of attacked seeds (Fig. 4a right). *Bruchidius villosus* larvae feed completely enclosed within seeds (Fig. 3b left, 4a left), so individual seeds must be dissected to confirm the species is present. Adult *E. fuscicrostre* (Fig. 4b right) are more brown and have much longer snouts and elytra than adult *B. villosus* (Fig. 4b left).

**PREFERRED HABITAT**

The Scotch broom seed weevil does best in meadows or on hillsides with southern exposure. It performs poorly at heavily shaded, cold, high-elevation, and/or damp sites (e.g., in direct contact with ocean spray).

**HISTORY AND CURRENT STATUS**

*Exapion fuscicrostre* is native to Europe. A population sourced from Italy was released in California, USA in 1964. Following establishment, field populations were redistributed from California to Oregon beginning in 1983, Washington in 1989, and Idaho in 2007. It spread naturally into neighboring British Columbia, Canada by 2006 and was intentionally redistributed within that province beginning in 2007.
The weevil is now moderately abundant on Scotch Broom in the western USA (Fig. 9) and is less abundant in Canada. In 2014, a study evaluating the attack rate of *E. fuscirostre* and *Bruchidius villosus* on Scotch broom seeds was initiated across Scotch Broom’s western range. The seed attack rate of *E. fuscirostre* alone ranged from 10 to 37%. In California surveys between 2015 and 2019, attack rates were often higher than 50%, with some sites reaching over 90%. When *B. villosus* is present, *E. fuscirostre* populations tend to be out-competed. Attack rates can be quite variable depending on site and habitat, and it is unlikely *E. fuscirostre* attack rates alone are sufficient to reduce Scotch broom densities. Whether the combined attack reduces Scotch broom densities remains to be seen. Parasitism is typically low but may limit populations in some regions.

**NONTARGET EFFECTS**
None reported

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**Leucoptera spartifoliella**
Scotch broom twig miner

*Leucoptera spartifoliella* is a biological control agent approved in North America for release against Scotch broom.

**DESCRIPTION**
Eggs are tiny, oval, and white. Larvae are green-brown, translucent, and appear somewhat flattened. They can reach 3–4 mm in length. Pupae are contained within white, silky cocoons 4–5 mm long (Fig. 10a). Adults are small (3–5 mm long) and are seldom seen. They are white with white antennae, feathered wing tips, and have pale gold markings (Fig. 10b).

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**LIFE CYCLE**
Adults lay eggs on young Scotch broom stems when broom has finished flowering (Fig. 11). Larvae hatch in late summer and early autumn and tunnel into young shoots to feed (Fig. 12). Larvae develop through six instars over several months and overwinter in the stems of Scotch broom. Larvae emerge in early spring and spin cocoons on broom stems (Fig. 10a, 12) or the undersides of broom leaves, where they pupate. New adults emerge in late spring and early summer when broom flowers. There is one generation per year.
Larval mining (Fig. 12) causes dieback of Scotch broom stems; however, plants often re-sprout new stems below the sites of damage.

**FIELD IDENTIFICATION**

*Leucoptera spartifoliella* eggs are very small and not easily recognized on Scotch broom stems in the field. Larvae can often be confirmed present when their mines are visible on attacked stems (Fig. 12). Pupae are readily visible on Scotch broom stems or beneath broom leaves (Fig. 10a, 12), but adults are cryptic and rarely seen.

**PREFERRED HABITAT**

The Scotch broom twig miner moth does best at low-elevation infestations with moderate temperatures and ample moisture.

**HISTORY AND CURRENT STATUS**

*Leucoptera spartifoliella* is native to Europe. A population from France was intentionally introduced to California, USA in 1960. However, it was found to have already been present in California, Oregon, and Washington; it was likely imported on ornamental plants prior to 1940. Both the intentional and adventive populations have since intermixed and are no longer differentiated. This twig miner is now widespread on Scotch broom in California and Oregon, but is present at only limited sites in Washington (Fig. 13). High moth numbers can deform Scotch broom plants and cause stem dieback, but plant density is not affected. Because attacked plants often re-grow below the sites of damage, the overall impact of this biocontrol agent is negligible. Populations are also heavily parasitized and may not fare well at hot, dry sites. This species is currently not known to be present in Canada.

**NONTARGET EFFECTS**

None reported

Scotch broom in California and Oregon, but is present at only limited sites in Washington (Fig. 13). High moth numbers can deform Scotch broom plants and cause stem dieback, but plant density is not affected. Because attacked plants often re-grow below the sites of damage, the overall impact of this biocontrol agent is negligible. Populations are also heavily parasitized and may not fare well at hot, dry sites. This species is currently not known to be present in Canada.

**NONTARGET EFFECTS**

None reported

Three accidentally introduced species are established on Scotch Broom in North America. All three species are not approved for use. **It is illegal to intentionally move these species to new areas in the USA.** Care should be taken when transferring approved agents to ensure that these unapproved species are not also included in transferred material.
**Aceria genistae**  
(Acari: Eriophyidae)

**DESCRIPTION AND LIFE CYCLE**
All stages are tiny and best viewed with a microscope. Larvae and nymphs are white to orange and 0.10–0.12 mm long (Fig. 14a). Adults are white to (typically) orange and have a worm-like appearance (Fig. 14b). They have two pairs of developed legs near their heads and can be 0.16–0.23 mm long. All stages feed on stem bud tissue by extracting sap from plant cells. This induces the development of galls 5–30 mm in diameter, which serve as protective housing to hundreds of mites. Galls are the best indication of mite presence (Fig. 14c,d). As galls grow, they become increasingly hairy until they senesce, at which time mites migrate to new buds to form new galls. Galls may develop faster and have greater impact at hot, dry sites; mite numbers appear to be greatly reduced during overwintering. There can be several generations per year, and all stages are capable of overwintering within new buds.

**Figure 14.** Aceria genistae (a) larva/nymph (see arrows) between gall hairs; (b) magnified adult; (c) galls; (d) extensive damage to a Scotch broom plant (a-d: Eric Coombs, Oregon Department of Agriculture; Bugwood.org, CC BY-3.0 US; b: Paul Pratt, USDA ARS WRRC; c: Jennifer Andreas, Washington State University Extension)

**HISTORY AND CURRENT STATUS**
*Aceria genistae* was accidentally introduced to North America. It was first recorded in Oregon and Washington, USA in 2005. The mite is widespread in Washington and Oregon where its overall impact is low to moderate. At high densities, mites can reduce Scotch broom flowering and plant biomass, and in some cases, may cause stem and plant mortality (Fig. 14d). The mite was first recorded in California in 2014. Though its distribution in California is still limited, the mite has significant impact at some well-established sites, reducing plant growth and reproduction and sometimes causing plant death. In British Columbia, Canada, sightings of *Aceria genistae* were first reported in 2007, and identification was later confirmed in 2010. It has had only minor impact to date.

*Aceria genistae* also attacks ornamental hybrids derived from Scotch broom and the exotic and weedy Portuguese broom, *Cytisus striatus*. It has been recorded on the native *Lupinus albicaulis* under field conditions, although no galls were formed, and it is currently not approved for redistribution in the USA.

A mite originally identified as *A. genistae* was recorded on French broom (*Genista monspessulana*) and *gorse* (*Ulex europaeus*) in California in the 1990s. This mite has since been identified as a different species, *Aceria davidmansoni*.

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**Agonopterix nervosa**  
(Lepidoptera: Depressariidae)

**DESCRIPTION AND LIFE CYCLE**
Adults are 10–15 mm long with variable coloring. Typical adults have white or yellowish wings with small gray to brown mottling, sometimes appearing as stripes on wing veins (Fig. 15a). Their wingspan is 16–22 mm. Overwintering adults emerge during early spring to lay eggs on stems and leaf axils of *gorse*, Scotch broom, and Portuguese broom. Eggs are yellowish, cylindrical, and 1 mm long. Larvae hatch in late spring and spin tubes of plant material on shoot tips of their host plant. They vary in color from yellowish-gray to brown and can be up to 15 mm long (Fig. 15b). Larvae develop through five instars, feeding on young leaves, shoot tips (Fig. 15c), and flower buds (Fig. 15d). The brown pupae are 10–15 mm long. Pupation occurs within the feeding tubes. New adults emerge in late summer and overwinter in their host plant foliage. There is one generation per year.

**HISTORY AND CURRENT STATUS**
This species was accidentally introduced to North America. It was recorded on gorse in British Columbia by 1915 and has since been recorded on Scotch broom in British Columbia as well. Though its impact on gorse and Scotch broom have not been formally studied in Canada, its overall abundance is limited so impact is likely limited as well.

*Agonopterix nervosa* likely spread from Canada to the USA in the 1920s. It attacks both Scotch broom and gorse.
in California, Oregon, and Washington, though it is more abundant on gorse. It may stunt shoots and reduce seed production, but overall its impact on both weed species is limited. Populations are heavily parasitized in the USA. This moth also attacks Portuguese broom in Oregon. *Agonopterix nervosa* is not approved for redistribution in the USA.

**DESCRIPTION AND LIFE CYCLE**

Overwintering eggs are embedded in Scotch broom stems beneath a waxy cap. Tiny nymphs (<2 mm long) hatch in early spring and gather near new leaf buds. Nymphs vary from whitish to orange to gray (Fig. 16a). They feed primarily along the stem, rarely on the leaves themselves. Nymphs grow through five instars before developing into brown or grayish, aphid-like adults 2–3 mm long with clear wings (Fig. 16b,c). Adults feed on new growth of Scotch broom, lay eggs, and die by early summer. There is one generation per year.

**HISTORY AND CURRENT STATUS**

This species was accidentally introduced to North America. It was first recorded on Scotch broom in Washington, USA in 1935. It is now widespread in California, Oregon, and Washington where it is the most common and abundant of Scotch broom natural enemies. It has also been reported on Scotch broom in Virginia, Georgia, North Carolina, and South Carolina, though both its abundance and impact in the Southeast are limited. High densities (Fig. 16d) can reduce Scotch broom growth and may weaken plants stressed from competition, making them vulnerable to pathogens; however, the overall impact of this psyllid is likely small. This species is not approved for redistribution in the USA; it is currently not known to be present in Canada. The honeydew produced by this species may interfere with collections of approved Scotch broom biocontrol agents.

**REFERENCES**


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