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Collection and Redistribution of Biological Control Agents of St. Johnswort

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St. Johnswort (*Hypericum perforatum*) (Fig. 1), also known as goatweed or Klamath weed, is a rangeland weed that causes photosensitization in livestock that feed upon it. St. Johnswort's aggressive nature also greatly reduces the grazing capacity of infested areas by crowding out desirable range plants.

This perennial plant, a native of southern Europe, was found in California about 1900. The weed spread into several western states and within 30 years was sufficiently abundant in the Clearwater and Salmon River drainages to cause concern. By 1950, Idaho contained over 600,000 infested acres.

Chemical control of the weed was impractical due to the inaccessibility and environmental complexity of most of the infested rangeland, the cost of treatment and the low value of the infested rangeland. Biological control, using host-specific natural enemies, was started in California in 1944 with two leaf beetle species imported from Australia. These beetles, *Chrysolina quadrigemina* and *C. hyperici*, were brought to Idaho in 1948 and first released in Nez Perce County, then in Idaho and Kootenai counties. The beetles became established and gradually suppressed large scale infestations of the weed. Both insects are now found throughout northern Idaho. *Chrysolina quadrigemina* is typically the dominant species.

Additional biological control agents have been introduced into Idaho with varying degrees of success. A third species of leaf beetle, *Chrysolina varians*, and a gall-forming fly, *Zeuxidiplosis giardi*, were released in the early 1950's but neither is believed to be established. A root-boring beetle, *Agrilus hyperici*, was released in 1953 and again in 1981. Its presence in Bonner, Kootenai, Nez Perce, Lewis and Idaho counties has recently been confirmed and it will likely be found in neighboring counties.

Fig. 1. Yellow flowers of St. Johnswort in full bloom in northern Idaho.

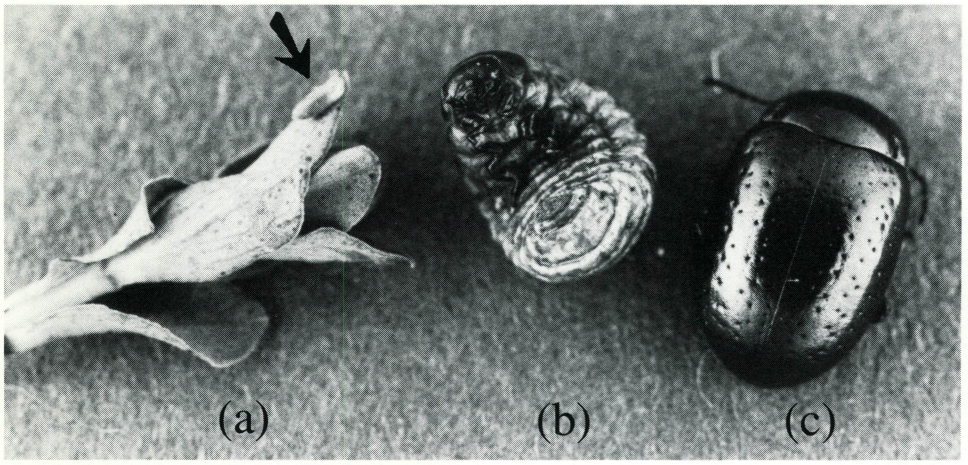

Fig. 2. Representative life stages of *Chrysolina quadrigemina*: (a) orange-colored egg (arrow) on St. Johnswort foliage, (b) light orange, full grown larva and (c) bronze, blue, green colored adult beetle.

The combination of *Chrysolina* and *Agrilus* beetles provides an effective method of combatting St. Johnswort on northern Idaho rangelands. This method can be even more effective when beetles are manually transferred to areas where they are lacking. Redistribution of *Chrysolina* beetles is important because they rarely fly and are slow in moving to new areas. Due to their conspicuous color and habits, collection and redistribution are easy. In contrast, *Agrilus* beetles readily fly and are likely better dispersers than *Chrysolina*. However, *Agrilus* adults are inconspicuous and not so easily collected. Roots infested with *Agrilus* larvae have been used as a transfer medium, but their use has limited practicality. Collection and redistribution of adults is preferable.

Life Cycle of St. Johnswort

Basal foliage that has overwintered begins growing in early spring. Vertical stems start developing in April, and the plant grows rapidly in late April, May and early June. In second-year and older plants, flowering begins in June and continues into July. Leaf drop begins near the end of bloom, and by mid-August, most plants growing in dry areas are essentially reddish skeletons. Seeds ripen in September and are released for the next 2 months. Germination occurs the following May. If autumn moisture is sufficient, new basal growth starts. Otherwise, new growth occurs the following spring.

Life History and Habits Of *Chrysolina* Beetles

Chrysolina beetles are effective biological control agents because they feed exclusively on St. Johnswort and are seasonally synchronized with their plant host. Beetles mate in autumn, and females lay orange eggs (Fig. 2a) on the developing basal foliage. Some larvae hatch from these eggs and feed on shoot tips; they may survive the winter if conditions are moderate. Most of the eggs overwinter in northern Idaho. Some adults also survive the winter and lay additional eggs in the spring. The overwintering eggs and newly laid eggs hatch in the spring. The larvae (Fig. 2b) feed chiefly at night on the basal and developing vertical foliage. The continued destruction of this foliage leads to the eventual decline and death of the plants. During this period of feeding, larvae experience three molts.

Beginning about mid-May, full grown larvae leave the plant to pupate in the soil. The adults are about ¼ inch long and are bronze, blue, green or purplish (Fig. 2c). They emerge in early June and feed on the terminal foliage through the end of July. By this time the St. Johnswort is responding to drier conditions by dropping its leaves, and the beetles likewise respond by concealing themselves in debris on the soil surface. Autumn precipitation activates the adult beetles, and they return to the plants to lay eggs.

Life History and Habits Of *Agrilus* Beetles

Agrilus beetles effectively complement the foliage-eating *Chrysolina* beetles by feeding within the roots. They lay their eggs (Fig. 3a) near the base of living stems beginning in late June or early July. Larvae (Fig. 3b) tunnel down the stem beneath the surface of the stem and enter the rootstalk where they continue to feed and grow until late fall. One to several larvae may be present in the roots of a single plant. Larvae overwinter in the roots without feeding. Pupation occurs in mid- to late spring, and by early summer the purplish, metallic-appearing adults (Fig. 3c) chew round holes through the crown and emerge. Adults are about $\frac{3}{16}$ inch long. They emerge about a month after the *Chrysolina* adults and can be found through July and possibly August. Adults feed on terminal foliage causing negligible damage. They are active during the day, but they are difficult to see among the leaves and flowers.

Selection of Beetle Release Sites

Both species of *Chrysolina* can exist in the variety of areas that support St. Johnswort stands despite the fact that *C. quadrigemina* is often considered the better species for dry regions and *C. hyperici* the better spe-

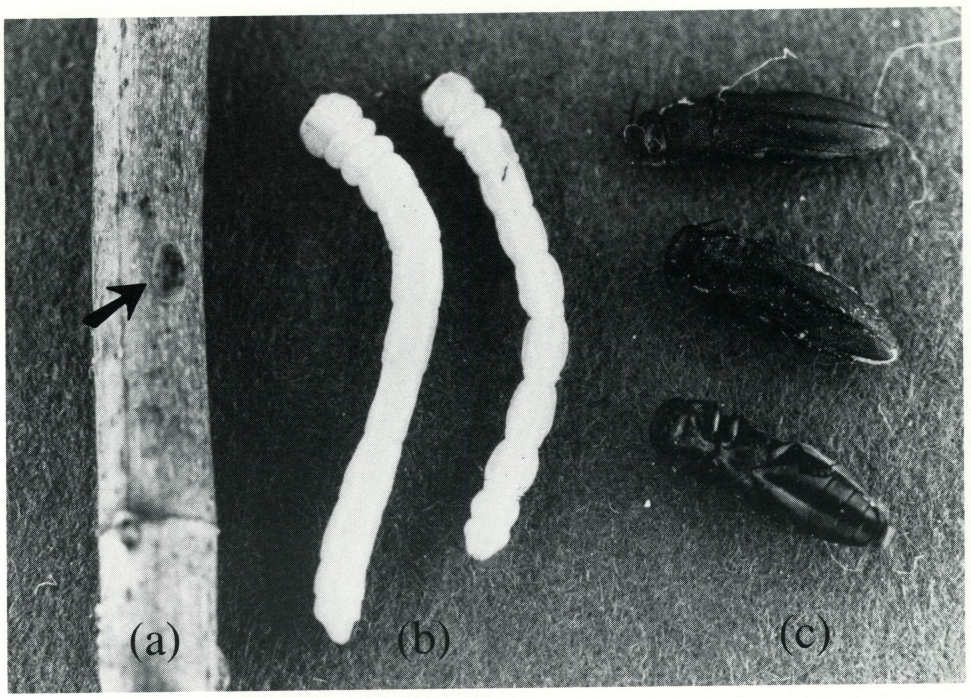

Fig. 3. Representative life stages of *Agrilus hyperici*: (a) gray-colored egg (arrow) on stem, (b) full grown larvae and (c) adult beetles.

cies for moist regions. Large, open stands of St. Johnswort that are free of disturbances such as livestock and insecticide use are best suited for *Chrysolina* and *Agrilus* releases. In general, *Chrysolina* populations have not done well in shaded, forested areas.

Collection and Redistribution Of *Chrysolina* Beetles

While scattered roadside plants may appear to provide a great number of adult beetles for the purpose of redistribution, larger St. Johnswort stands offer a better chance of having enough beetles to make collection worthwhile. Initial releases of 200 to 1,000 adult beetles often result in beetle establishment; however, smaller releases of 50 to 200 beetles are occasionally successful.

The optimum time for collecting is June, before and during early bloom, when beetles are high in the plant canopy and easy to capture (Table 1). This is also the period when plants in target stands still have enough succulent foliage to support introduced adults. The best way to collect *Chrysolina* beetles is with an insect net. Sweep the net through the vegetation and empty the catch periodically. As an alternative method, you may tap beetles from plants into a bucket or similar container placed below them. They usually free-fall when disturbed.

Transport the insects to the new area in a well-ventilated container that is kept from direct sunlight and extreme temperatures. Don't pack too many beetles into a container, particularly if you are going to transport them long distances.

If you delay more than 2 or 3 days between collection and redistribution, you can maintain the beetles by supplying fresh St. Johnswort cuttings. For shorter delays, keep the beetles in a cooler or refrigerator without plant cuttings. Be careful to prevent condensation inside the containers; it can lead to excessive beetle mortality. Inoculate the target weed stand by gently shaking the beetles from the container over several square yards of St. Johnswort.

Collection and Redistribution Of *Agrilus* Beetles

Unlike *Chrysolina* adults, *Agrilus* adults do not cluster on the upper portions of the plant. This and their smaller size make capture more challenging. Sweeping with an insect net is by far the best way to collect this insect. Empty the net contents on a light-colored surface so you can spot the mobile adults. You can collect them with an aspirator or moistened fingertip. The beetles are prone to take flight, so quick search and capture is advised.

The optimum time for collecting *Agrilus* is late June through July (Table 1.) You probably won't collect large numbers of adults at any one site. However, redistribution of smaller numbers of individuals (25 to 50) will

Table 1. Collection and redistribution schedule for *Chrysolina* and *Agrilus* beetles.

Agent	Transfer stage	Where found	When found	When to transfer
Chrysolina	Adult	Pre-bloom and bloom	Early June into July	Early to mid-June (pre-, early bloom)
Agrilus	Adult	Bloom	Late June into August	Late June to mid-July (full bloom)

Fig. 4. Tunnel-induced scarring on lower portion of older St. Johnswort stem (outer surface has weathered away).

usually be effective. Remember that not all the beetles collected are egg-laying females. In general, figure that only half are female (this is true for *Chrysolina* too). Transport and release methods are identical to those for *Chrysolina*.

Monitoring

The first favorable sign of *Chrysolina* beetle establishment at the new release site is the appearance of adults in the plant canopy in autumn. Eggs on basal foliage are additional indication of successful establishment. If the population is small, any sign of beetle presence will be difficult to find. Therefore, check again the following year for establishment.

The presence of *Agrilus* can be checked in several ways:

1. Look for eggs on the basal portion of the stems (Fig. 3a) during summer months.
2. Look for tunnel-induced scarring caused by larval movement down the stem (Fig. 4) on this-season's or older stems in autumn.
3. Cut open crowns or rootstocks late in the year and look for tunneling and larvae.

Control Expectations

Survival of a large or small number of transferred beetles does not mean that immediate weed control will occur. The beetles will require time for their populations to reach levels that can stress the weed sufficiently. The initially transferred beetles will serve as colonizers; their descendants will actually begin weed suppression. Biological control programs may require several years before results can be observed. Once established, they are safe, economical and generally self-sustaining although periodic artificial reinfestation may be necessary.

Biological control of St. Johnswort has worked well in Idaho, and with management such as redistribution of beetles, it should continue to perform as desired. Biological control should be considered as only one part of an effective range management program. Proper grazing management and range rehabilitation programs, such as establishing desirable range plant species where St. Johnswort has been controlled, are still important in the overall management of productive rangeland. In some cases, desirable grasses and forbs may have been eliminated from St. Johnswort-infested lands. While St. Johnswort may be controlled, another weed will probably replace it unless the rangeland is seeded with desirable species.

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