

Biocontrol of Spotted Knapweed: Monitoring and Collection of *Cyphocleonus achates* & *Larinus* spp.

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Spotted knapweed, *Centaurea stoebe*, is a deeply taprooted perennial plant from Eurasia that has become a serious weed of rangeland and pasture in Montana and other areas of the Pacific Northwest. First reported in Montana in 1927, the plant now infests over 4 million acres of rangeland and pasture in the state.

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BIOLOGICAL CONTROL, THE DELIBERATE USE OF natural enemies, has been used against spotted knapweed in Montana since the mid 1970s. Twelve natural enemy insect species have been introduced against the plant. All of the insects were extensively tested to prove they wouldn't attack non-target plants. Eight of the insects attack the flower heads and four attack the roots.

Four of the insect species are having a significant impact on spotted knapweed. The most effective agent has been *Cyphocleonus achates*, a root-feeding weevil. Following large population increases, the weevil has significantly reduced the density of mature spotted knapweed plants between 77 and 99 percent in some areas. The effects of *C. achates* are being complemented by three-seed head insects – a fly (*Urophora affinis*) and two weevils (*Larinus minutus* and *Larinus obtusus*), which together are reducing spotted knapweed seed production by about 94 percent in many areas of western Montana. This reduction in seed production has resulted in a 98 percent reduction in the knapweed seed bank, which in turn has resulted in a significant decline of spotted knapweed seedlings. The combined effects of these four insects have resulted in a significant decline of spotted knapweed density in parts of western Montana, particularly the Bitterroot Valley.

The fly *U. affinis* is well established and widely distributed throughout the state. However, the other three insects, particularly *C. achates*, are not as widely established and thus require further redistribution efforts. Information on these three insects life history, and methods for monitoring and collecting are described below.

Cyphocleonus achates

C. achates is a medium-sized ($\frac{9}{16}$ in.), brown, gray and black mottled weevil with a pronounced snout (Figure 1). The weevil overwinters as a larva in the root. Larvae pupate within the roots and emerge as adults from mid-

July to October, with peak emergence usually occurring in mid-August. Adults, which apparently do not fly, regularly feed on spotted knapweed foliage throughout their 8- to 15-week life span. Each female lays one to three eggs per day throughout her adult life. Eggs are laid singly in a notch excavated by the female on the root crown, just below the soil surface. Larvae hatch in 10 to 12 days and tunnel into the root center. Feeding by the larvae within the roots causes considerable damage, especially to small plants or plants containing more than one larva. The weevil has one generation per year.

Assessing establishment. Presence of the weevil is determined by either searching the roots for larvae or by searching for adults in the field.

Larval detection. Larvae are best detected in the roots during June and July when the larvae reach their maximum size. The larvae are white with a brown head, have a slightly curved, plump body (about $\frac{1}{2}$ in. long and $\frac{3}{16}$ in. wide), and are legless (Figure 2, page 2). These features distinguish the *L. achates* larvae from the larvae

FIGURE 1. *Cyphocleonus achates* adult.

(photo by Sean McCann, flickr.com)



FIGURE 2. *Cyphocleonus achates* larvae.

(photo by Kandace Rich, Weedbusters Biocontrol)



of other insects found in spotted knapweed roots (which are slender in shape and have legs). The weevil larvae are typically found in the upper four inches of the root in tunnels in the center of the root, or in cavities created in surrounding root tissues. Areas of the root attacked by the larvae will often be swollen. The tissue of heavily-attacked roots will be "spongy" and fragile, compared to uninfested roots which are hard and smooth (some knapweed pathogens may also cause spongy roots). The stalks of heavily-infested plants will often break off at the root crown if pulled.

Detection of the larvae is done by splitting the upper four inches of the root lengthwise, peeling the outer root tissues, and searching for the large tunnels, swollen areas of the root, and "spongy" root tissues. The larvae are often readily apparent in the large tunnels ($\frac{3}{8}$ in. wide) and cavities when the fragile tissues are separated. Larvae are more likely to be found in large, bolted knapweed plants. Thus, a quick and easy method to determine establishment is to sample the roots of 10 large, randomly selected knapweed plants at a site. The observation of several larvae from the 10-plant examination is a good indication that the weevil is well established. An estimate of the weevil population size can be obtained by digging up all the knapweed plants in 10, randomly chosen 2 ft. x 2 ft. plots at a site and counting the number of larvae per root.

Adult detection. Adults can be monitored by visual surveys. The adults can be found on the upper parts of knapweed plants and other vegetation in the afternoon on hot, calm days in August. During the morning and during cool weather, the adults may be found on or near the ground on root crowns and under basal leaves. The weevil is easily overlooked due to its camouflage coloration, especially when present in low numbers, so the inability to detect the insect in a survey does not necessarily mean it is not present at the site. Sampling should be repeated

at later dates if the insect is not seen on the first attempt. An estimate of the adult population can be obtained by counting the number of adults in 10 randomly chosen 5 yd. x 5 yd. plots.

Collection procedures. The best time to collect is in the afternoon on warm, calm days in August. Collection is done by hand picking adults from the ground and the knapweed plants or by sweeping. Sweeps are conducted by swinging a coarse fabric (not mesh) insect net in a horizontal motion through the knapweed plants while walking through a knapweed infestation. Adults should be transported in paper cans containing knapweed foliage. Collected weevils must be kept cool (-40°F) and out of direct sunlight until they are released. Releases should consist of a minimum of 50 to 100 adult weevils scattered in about a 2 yd. x 2 yd. area. The weevil establishes fairly easily but does best in dry areas with large, scattered knapweed plants and some bare ground.

Larinus minutus* and *Larinus obtusus

These two weevil species are almost indistinguishable and their behaviors are identical, so they are treated as one species and called the "Larinus species." The Larinus species are small ($\frac{1}{4}$ in.) brown-black weevils that attack the flower heads of spotted and diffuse knapweed (Figure 3). Adult weevils become active in May and June and do some feeding on knapweed leaves. Eggs are deposited into freshly-opened flower heads in July. Larvae hatch in about four days and immediately feed downwards into the flower-head, where they eat seeds and other parts of the flower head. Larval development is completed in about 17 days followed by a 9-day pupation period. Adults of the new generation emerge from the seed head in late summer, approximately 30 days after egg deposition. Adults feed on knapweed leaves for a short period before entering the soil to overwinter. The adults are good fliers and disperse rapidly. The weevils have one generation per year.

FIGURE 3. *Larinus* species adult

(photo by USDA-APHIS)



Assessing establishment. Presence of the weevil is determined by 1) detection of adult weevils feeding in the knapweed flowers in late July to early August, or 2) detection of exit holes (Figure 4) in the seed heads during October through May. The dark bodies of the feeding adults are easily seen in the purple flowers. The exit holes, created by the emerging adults, are also very noticeable on the upper surface of the seed heads.

Collection procedures. *Larinus* species collection is best done with a sweep net in late July and early August when the adults are active. Collection is best done in the afternoon on warm, calm days. Sweeps are conducted by swinging a coarse fabric (not mesh) insect net in a horizontal motion through the knapweed plants while walking through a knapweed infestation. Adults should be transported in paper cans containing knapweed foliage. Collected weevils must be kept cool (~40°F) and out of direct sunlight until they are released. Releases should consist of a minimum of 50 adult weevils released in about a 2 yd. x 2 yd. area.

FIGURE 4. Exit holes from emerged *Larinus* species adults





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