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ENTOMOLOGY

Annual Bluegrass Weevil
A Metropolitan Nightmare

By Dr. Patricia J. Vittum, University of Massachusetts

The annual bluegrass weevil, *Listronotus maculicollis*, is also often called the Hyperodes weevil because it was formerly assigned to the genus Hyperodes. The insect is a major pest of golf courses in the northeastern United States, particularly in the metropolitan New York area, including Long Island; the counties just north of New York City; southwestern Connecticut; and northern New Jersey. However, it has also been reported causing damage on golf courses throughout New England, upstate New York, central and eastern Pennsylvania and around Toronto, Ontario, Canada.

As its name suggests, the annual bluegrass weevil feeds primarily on annual bluegrass (*Poa annua*) and is particularly damaging on turf with low mowing heights. Damage is usually most severe on collars and approaches, tees, greens and fairways. The weevil can cause damage to fine turf wherever annual bluegrass grows in its perennial form. Since the multiple generations overlap, damage can occur any time from late May through early September. In the metropolitan New York area, the damage is usually most noticeable in early June and again in late July and early August.

Where Weevils Exist

The annual bluegrass weevil has been reported in more than 30 states, but so far is only a problem on fine turfgrass in the Northeast and Middle Atlantic states. It was first report-

Typical pattern of annual bluegrass weevil damage along the edge of a collar.

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ed as a turfgrass pest in Connecticut in 1931 and on Long Island in the late 1950s. Initially, turf managers blamed "spring die out" of annual bluegrass on the agronomics of the plant, specifically its inherent intolerance of summer temperatures. However, in many cases the obvious and rapid decline of annual bluegrass can be traced to weevil activity.

Weevil Description

The annual bluegrass weevil, like most weevils, is a beetle with a distinct snout (Figure 1). The adult is about 1/8 inch long, slightly smaller than most turf billbugs, and the thorax only occupies about 25% of the total body length. The snout is shorter and stouter than that of a billbug and the antennae are attached near the apex (far end) of the snout. Mature adults are dark brown or black with gray or yellow-brown hairs and scales on much of the thorax and hind wings. Teneral adults (recently emerged from pupae) are reddish brown.

Females usually lay two or three eggs at a time, lined up end to end inside the leaf sheath. Each annual bluegrass weevil egg is deposited between leaf sheaths. The egg is pale yellow when laid, but turns smoky gray as it matures. It is elliptical, about three times as long as it is wide.

The larva (Figure 2) is cream colored with a brown head capsule, sometimes with a slight gray coloration along the back. Larvae are legless but have several distinct "ridges" along the body and can move quite well through the thatch and upper part of the soil. They are somewhat elliptical, although the midsection is often slightly wider than the fore or hind end. Larvae are small (1/16-inch long when first emerging to 1/5-inch long just before pupating) and spend most of their development inside grass stems in their earlier developmental stages or near the crowns of plants as they mature.

The pupa has many adult characteristics, including the developing eyes, mandibles, antennae, legs and wings. Creamy white when it first develops, it later becomes reddish brown, just before the adult weevil emerges.

Life Cycle

As with any insect, it is important to understand the life cycle and to know when the insect is vulnerable to control treatments. In the metropolitan New York area, the annual bluegrass weevil normally completes two or three generations per year.

The insect overwinters in the adult stage, usually in nearby woods (especially in the litter underneath white pines) or in tufts of high grass between the rough and woods. As temperatures warm, adults begin to migrate toward the short cuts of annual bluegrass. The earliest movement typically begins in late March, but many weevils do not begin migrating until early or mid-April.

Once the females reach the low-mown annual bluegrass (fairways or shorter), they begin to lay eggs inside the leaf sheath. This usually occurs in late April or early May. Eggs are reasonably well protected and take about a week to hatch into tiny larvae. The larvae are small enough that they can burrow inside the grass stem and feed as borers for about a week. Larvae molt once during this stage.

When the larvae grow large enough that they must leave the stem, they move down the outside of the stem to the crown of the plant and continue feeding. Larvae pass through a total of five larval instars (three or four of which are outside the stem), spending about five to seven days in each stage.

After the larvae have completed feeding, they pass through a "prepupal" stage, which resembles the larvae but is slightly longer. The prepupae carve out a little cell in the soil, just at the soil/thatch interface. (Often the tip of the larvae will "spin" in the soil when disturbed.) Each prepupa then transforms to a pupa, a quiescent stage during where the insect does not move or feed. Many changes occur internally during this stage, including the development of a reproductive system and muscles to power the wings and legs of the adult. The pupa stage lasts about five to seven days, after which

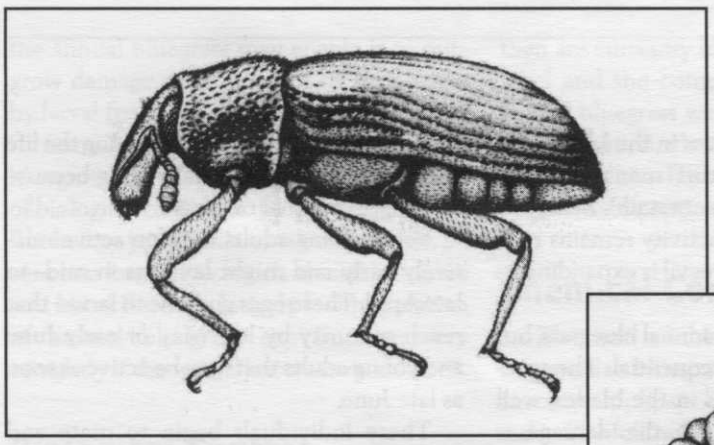

Figure 1. The annual bluegrass weevil adult is a dark brown or black beetle about 1/8 inch long with a short, distinct snout.

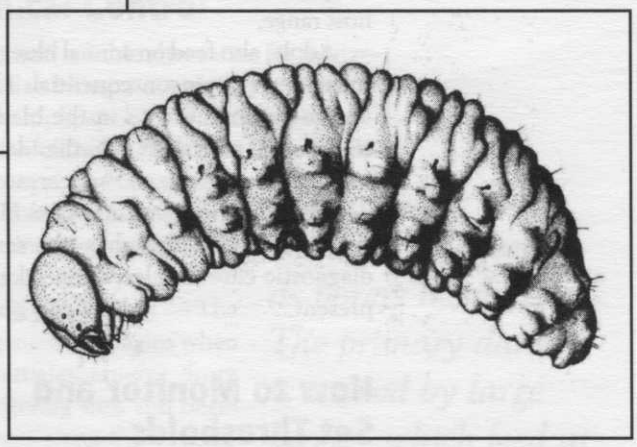

Figure 2. Larva are cream colored, legless and small (1/16 to 1/5 inch long). They have a brown head capsule with chewing mouthparts. Adapted from Cameron and Johnson, 1971.

young ("callow") adults emerge. These adults are reddish brown for a few days and the exoskeleton is not as hard as it will be once the insect matures fully. The callow adults tend to be more vulnerable to environmental extremes than the more mature "hardened" adults.

The completion of the first generation is marked by the emergence of adults the end of June or early in July. A second generation then develops, with egg laying possible only a week after the adults emerge. Each subsequent developmental stage occurs more quickly than in the spring generation because summer temperatures are higher and physiological activity is accelerated. So the large larvae of the second generation often are active by the end of July or early August. They then pupate and 2nd generation adults appear by mid August.

In unusually warm years, the development of each generation can be accelerated enough that second generation adults appear in *early* August, which allows a third generation to develop, resulting in larvae activity throughout August and into September.

Regardless of the number of generations that occur during the summer, only adults will survive the ensuing winter. We often find large larvae or pupae in the soil in late September or early October, but we never find these stages when we sample the same areas the following spring.

Look for Damage

Annual bluegrass weevil larvae, which have chewing mouthparts, can cause severe damage to turf. Young larvae feed as borers inside stems, sometimes depositing tan sawdust-like material inside the stems. However, the primary damage is caused by the large larvae which feed at the crown of the plant. Studies conducted in the 1970s demonstrated that an individual larva can sever 10 to 12 plants outright during its feeding (Cameron and Johnson 1971).

Damaged areas first appear as small yellow-brown spots. Small spots eventually coalesce into larger areas and take on a "water-soaked" appearance. Damage often coincides with, and can be confused with, anthracnose.

Damage from the larvae that are active in the spring is usually concentrated along the edges of fairways or on edges of greens, tees or collars. Damage later in the year can occur almost anywhere in the low-mown areas.

Larvae feed primarily on annual bluegrass, but we have been able to raise the lar-

vae on perennial ryegrass in the laboratory. In addition, several turf managers have reported damage to certain bentgrass stands. Although this activity remains rare, it is possible that the weevil is expanding its host range.

Adults also feed on annual bluegrass, but their feeding is inconsequential. The weevils chew tiny notches in the blades, well above the meristem, so the damage is mowed off regularly and appears to have no detrimental effect on turf vigor. However, the characteristic notches can serve as a diagnostic clue that larvae are likely to be present.

How to Monitor and Set Thresholds

The easiest way to monitor for annual bluegrass weevil larvae is to cut a wedge of turf with a large knife. Any medium or large larvae that might be present will be clearly visible, with the cream color contrasting against the dark soil or thatch. Another method is to remove a cup cutter plug of turf, bring the core to the maintenance area, pull the turf apart gently, and look for larvae. Put all the loose turf and soil in a bucket or dish pan and fill the pan with luke warm water. Any larvae that were not found by visual inspection will float to the surface of the water.

Adult weevils can be flushed to the surface of the turf with a soapy flush — one or two tablespoons of lemon-scented dish detergent in one or two gallons of water poured over an area one or two feet on each side. The soapy solution irritates many insects and weevils will scramble to the surface within a couple minutes.

The tolerance level for annual bluegrass weevil larvae appears to be between 30 and 80 large larvae per square foot in the spring and around 20 to 40 larvae per square foot in the summer. The lower threshold is a direct function of the additional stresses the turf experiences during the summer months.

Turf managers who have dealt with the annual bluegrass weevil understand that sampling the insect and determining the life cycle is confusing and challenging because of the generational overlap.

Some spring adults become active relatively early and might lay eggs in mid- to late April. These eggs give rise to larvae that reach maturity by late May or early June and young adults that may be active as soon as late June.

These individuals begin to mate and reproduce almost immediately. In the same location, there may be spring adults that delay their movement so they do not reach short cuts of annual bluegrass until May and do not lay eggs until early to mid May. These give rise to larvae that mature in late June or even later.

The end result is that samples taken during the summer often reveal small larvae, medium sized larvae, large larvae and pupae, all in the same area at the same time. However, if a turf manager takes samples regularly (ideally weekly) and notes what proportion of the population is in each developmental stage on each date, the overall pattern can be discerned.

Cultural Control

Several aspects of the biology of the annual bluegrass weevil can be incorporated into turf management programs. First, the weevil overwinters in the adult stage, often in litter under white pine trees.

Anecdotal reports from turf managers in the metropolitan area indicate that removing pine needles in the autumn may remove some of the insulation the weevils need to survive the winter. While no scientific studies have been conducted, superintendents who have removed pine litter for three or more years feel the overall weevil population has declined in surrounding areas.

Adults lay most of their eggs in annual bluegrass and the larvae feed primarily on annual bluegrass. Therefore, any program that manages or reduces the amount of annual bluegrass on greens, tees, collars or fairways will ultimately result in a reduction in the weevil population. Alternatively, any program that enhances the vigor of

the annual bluegrass may enable it to outgrow damage or at least not be devastated by larval feeding.

Some superintendents let the annual bluegrass weevil feed unimpeded as a form of biological control of the annual bluegrass. But before you decide to take that route, be sure you know how much annual bluegrass you have! Even a relatively low population of annual bluegrass can become very unsightly if the weevil becomes established.

Biological Control

There are a few biological control alternatives that bear further investigation. *Steinernema carpocapsae*, an entomopathogenic nematode, is effective against several species of weevils. Laboratory studies have indicated that the nematode has the potential to kill annual bluegrass weevil adults as well. However, attempts to use the nematode in field conditions have been disappointing or inconclusive.

One possible explanation for the poor performance may be the air and water temperatures at the time of application. Spring applications are typically made during late April, when water temperatures used to fill sprayers often are below 55°F. Such temperatures undoubtedly slow nematode activity. Summer applications are typically made in July, when air temperatures may exceed 80°F and nematodes are prone to desiccation.

Microctonus hyperodae is a parasitic wasp which is highly effective against the Argentine stem, a closely related weevil. Studies conducted in New Zealand in 1996 and 1997 indicate that the wasp is unlikely to be an effective parasitic agent against the annual bluegrass weevil. However, a closely related wasp (*Microctonus aethiopoides*) shows more promise and will be investigated in the future.

Spinosad is a naturally derived product from an actinomycete (a kind of bacterium), and is now available commercially as Conserve™. Studies with spinosad in 1996 (conducted as a series of experimental formulations), in the metropolitan New York area, indicated that spinosad reduced larval populations under field conditions. However, the application rates were much higher than are currently included on the product label and the company has not included annual bluegrass weevils on their label. So, at this point, further field work is necessary to determine whether Conserve will prove to be a viable option.

Chemical Control

The most reliable alternative for managing annual bluegrass weevil populations involves application of traditional insecticides. The following discussion will concentrate on spring and summer applications directed toward weevils in areas where two generations occur per year.

Young larvae feed as borers inside stems. The primary damage is caused by large larvae, which feed at the crown of the plant, severing as many as 12 plants in a feeding.

Spring generation — The spring generation begins when adult females emerge from overwintering sites and begin to lay eggs along the edges of fairways and other short-cut grasses. Therefore, insecticide applications should be concentrated along the edges. "Wall to wall" applications are not necessary.

Spring applications are most effective if they are directed toward adults just as they begin to arrive at the oviposition sites. This typically occurs between forsythia full bloom and dogwood (*Cornus florida*) full bloom (actually full color of the bracts) —usually between mid-April and early May in the metropolitan area. Applications should be watered in lightly (one or two passes of a sprinkler head).

Until recently, chlorpyrifos (Dursban™) was the material of choice but, in areas where annual bluegrass weevils have been present in damaging numbers for several years, turf managers feel the material has become less effective. In the last two years, superintendents have begun to use synthetic pyrethroids with generally good success. Our field trials have indicated there is little difference in efficacy between the pyrethroids, including bifenthrin (Talstar™), cyfluthrin (Tempo™), lambda-cyhalothrin (Battle™, Scimitar™) and deltamethrin (Deltagard™), when used at their labelled rates. Note, however, that the

labels vary — some include golf course turf and some do not and annual bluegrass weevil is not specifically mentioned on all the products.

Some superintendents have used tank mixes of a pyrethroid with imidacloprid (Merit™) or a pyre-throid with chlorpyrifos (Dursban). Again our field trials have found that tank mixes with Merit have been very effective, often providing more than 95% control. However, the difference between the tank mix and the pyrethroid alone is seldom statistically significant, so the tank mix might be providing an expensive form of "overkill." Merit alone is usually not particularly effective against annual bluegrass weevils. Several other insecticides are also labelled for annual bluegrass weevils and can be effective.

Concentrate on the areas where the "risk factors" are highest — for example, sites with substantial amounts of annual bluegrass near white pines.

The keys to the spring generation are to concentrate on the perimeters, time the application to coincide with appropriate plant phenology and water in the material lightly.

Summer generation — The second generation of weevils is less predictable in some ways, because there is so much overlap in development. However, in the metropolitan area, adult activity often peaks around July 4th.

We are in the process of developing a degree day model to predict weevil activity and hope to validate that model this year. In the meantime, July 4th provides a good initial target date. If larval damage was observed in early June, insecticide applications for the second generation probably should be made close to July 4th. If larval damage occurred in mid- to late-June, summer applications should be made about a week after July 4th.

Because adult activity will originate from where the larvae were present in the spring, the weevils may spread to virtually any part of the nearby fairways, tees or greens, so applications often should be made over a wider area. Insecticides should be watered in lightly to move the material off the blades and into the thatch.

Some formulations of pyrethroids are sensitive to high temperatures and Dursban can be sensitive to ultraviolet rays, so applications should be made as late in the day as possible — or, alternatively, as early in the morning as possible. The same materials that are effective in the spring should suppress populations in the summer as well.

Risk Factors

While some golf courses have had a history of annual bluegrass weevils and manage populations aggressively, many others only experience activity sporadically. Often spot treatment can be very effective. Concentrate on the areas where the "risk factors" are highest — for example, white pines nearby or substantial amounts of annual bluegrass.

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