

Nematodes for White Grubs

Amara R. Dunn, New York State Integrated Pest Management Program, Cornell University

Kyle Wickings, Entomology, Cornell University

What's biological control?

Biological control (biocontrol for short) uses living organisms—natural enemies—to keep pests in check. How? Natural enemies might eat pests, make them sick, or lay their eggs in or on them. When those eggs hatch, *voila*—their meal is ready and waiting. But not all natural enemies are members of the bug-eats-bug club. Microbes such as bacteria, fungi, and viruses make compounds toxic to pests. They could also use up space or other resources a pest needs. Or they could make your grass, garden vegetables, flowers, and even houseplants more resilient to attack.

The basics of beneficial nematodes

Nematodes are tiny roundworms—so tiny you need a microscope to see them. While some are pests because they eat your plants, others are beneficial because they kill insects—including many pests. These nematodes that kill insects are called entomopathogenic nematodes, or EPNs, for short. They are completely harmless to you and your plants and are most often found in soil. Different EPN species and strains prefer different temperatures, use different strategies for finding the insects they eat, and live at different depths in the soil. Some are better at killing certain insect species than others.

Name of “active ingredient”

Although EPNs will kill pests, they are not regulated as pesticides. So they will not have the typical list of active ingredients you would find on a pesticide container. However, any product that contains beneficial nematodes should tell you which nematode species it contains. When you want to manage

white grubs in your lawn, look for one or both of the following species:

- *Heterorhabditis bacteriophora*
- *Steinernema feltiae*

What pests can EPNs control?

At first glance, white grubs (Fig. 1) may all look alike, but there are actually many species that could be munching on the roots of your grass. Common species found in New York are listed in Table 1. Immature (larval) crane flies (Fig. 2) and weevils may look similar, but they are not white grubs (Fig. 3). For this fact sheet, we're focused just on white grubs. Regardless of the species, EPNs will be most effective when the grubs are young.

Most lawns in New York don't need to be treated for grubs. The number of grubs your lawn can tolerate before it's damaged—and therefore the number



Figure 1. White grubs are the immature (larval) stage of many different beetle species. The grubs feed on the roots of the grass in your lawn and can cause damage if present at high enough numbers. Photo: A. Dunn.

Table 1. Identify the species of white grub in your lawn, and count how many you have per square foot. For each species, do you have more than the listed number per square foot? If not, then don't waste time or money treating your lawn!

Asiatic garden beetle	18-20
Black turfgrass ataenius	30-50
European chafer	5-8
Green June beetle	5
Japanese beetle	8-10
Oriental beetle	8
Northern masked chafer	8-12
May and June beetle	3-4



Figure 2. Crane fly larvae look very different from white grubs—in color, lack of legs, and lack of a distinct head capsule. Photo: K. Wickings.

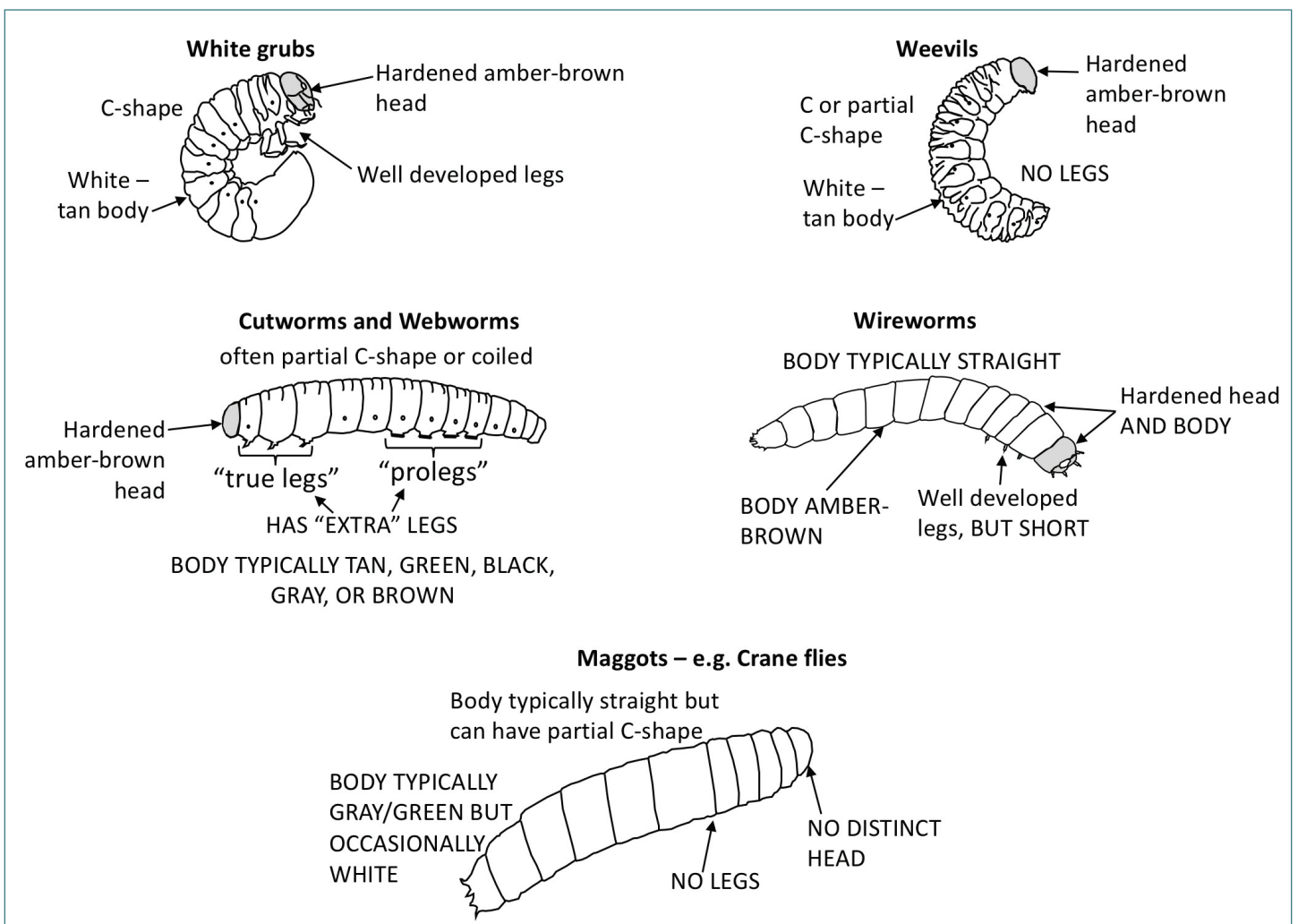


Figure 3. Is it a grub? Other immature (larval) insects are present in the soil besides white grubs. Make sure you properly identify your pest before considering any management strategy. Illustration: K. Wickings.

of grubs you should tolerate before treating for grubs—depends not only on the overall health of your lawn, but also on the grub species you have. Knowing which white grub species you have in your lawn is important. Of course, if you're happy with the way your lawn is (perhaps including some grub damage), no need to do anything! Even when you are using biological control, you never want to waste time and money on unnecessary pest management! Fortunately, identifying the white grubs in your lawn is easy. Find a penny, a hand lens (with a minimum of 15X magnification), and go to the Grub ID Key website: grubid.cals.cornell.edu (Fig. 4).

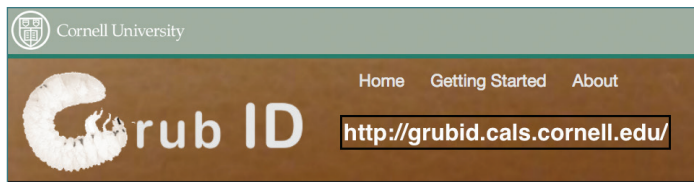


Figure 4. Use this Grub ID website to identify the white grub species in your lawn before you take any management steps.

A note about white grubs and the beetles they grow into: As you may have figured out from the list of species, some lawn grubs grow up to be adult beetles that are pests of other garden plants (e.g., Japanese beetles). These beetles are often good fliers, and controlling their grubs in your lawn may not affect the population of adult beetles that feed on your vegetables, flowers, and trees. Even if adults don't emerge from your lawn, they may emerge from other nearby lawns or natural areas. Managing the adult stage of these pests is a topic for another fact sheet.

Do EPNs actually work?

Under optimal conditions EPNs can reduce insect pest numbers and damage. Scientists are trying to understand how to use them so that they work more consistently. Applying them correctly is critical (see "How should EPNs be used?"). The soil to which you are applying them also makes a difference. Sufficient soil moisture is essential, and EPNs are more likely to be effective in sandy soil or soil with sufficient organic matter.

How do EPNs work in your lawn?

The guts of EPNs are filled with unique bacteria. These bacteria and the EPNs work together to kill and eat insects. EPNs enter the bodies of white grubs that are near the soil surface in your lawn. Once inside, the EPNs regurgitate the bacteria, which infect and kill the grubs. Then the EPNs feed on the dead grubs (and the

bacteria) and reproduce (Fig. 5). Young nematodes (carrying their bacterial partners) then go looking for another grub to eat. For a great visual summary of how these EPNs live and kill insects, check out this video: *Life Cycle of Entomopathogenic Nematodes*; youtu.be/sVKjK5mKtdQ.

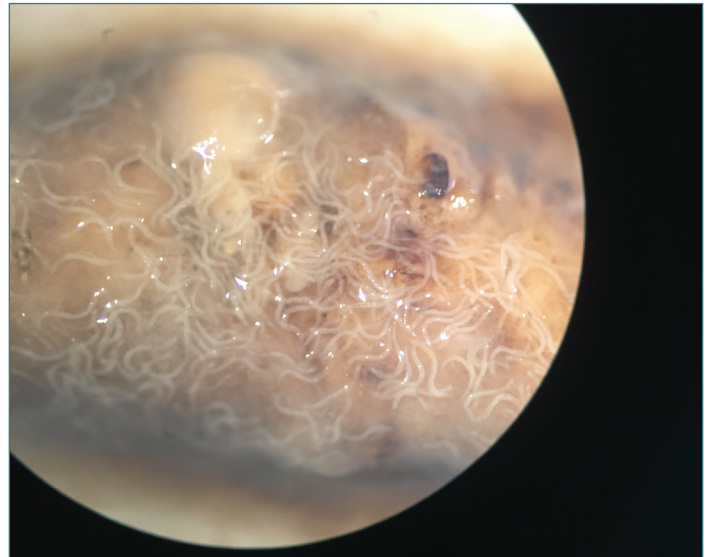


Figure 5. Looking through a microscope, you can see entomopathogenic nematodes (EPNs) that have reproduced inside (and killed) a grub and are ready to infect a new one! Photo: K. Wickings.

What types of products contain EPNs and can be used in New York?

EPNs are technically pesticides (because they destroy pests), but they are exempt from pesticide regulations under the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA). This means that they won't have a label in the New York State Pesticide Administration Database (NYSPAD), dec.ny.gov/nyspad/products, even though you are allowed to use them in New York. If you are purchasing EPNs for your lawn, check that you are using the right species (see section on "active ingredients") and apply them according to the instructions on the package.

How should EPNs be used?

To be effective, EPNs need to be applied correctly and at the right time. The following guidelines will maximize the likelihood of pest management success:

- First, always know whether you need to take any grub management action. Many people don't need to do anything about grubs in their lawn. Depending on the grub species, your lawn can tolerate a few to many grubs per square foot without being damaged (or needing treatment). Start by scouting your lawn using instructions

found in this brochure: *Grubs in Your Lawn? a guide for lawn care professionals and homeowners*; hdl.handle.net/1813/43856. Then identify the grubs you find and use Table 1 to determine whether you need to act. Remember that there might only be a small area of your lawn that really needs to be treated. Only apply EPNs to spots where grub numbers exceeded the thresholds in Table 1.

- Before you use EPNs, make sure they are still alive. Take a pinch of the preserved nematodes (Fig. 6) and mix them in non-chlorinated water. Check them after about 1 hour with a 15X hand lens or magnifying glass. Straight or just slightly curved and rigid nematodes are dead. Wriggling nematodes are alive (Fig. 7). If all the nematodes look straight and rigid after 1 hour, check again after 2 hours. Sometimes it takes them a while to wake up.



Figure 6. When you buy entomopathogenic nematodes (EPNs), they may come in the form of a dry powder. As long as they are stored at the right temperature and used by the expiration date, the EPNs will wake up once you add water. Photo: A. Dunn.

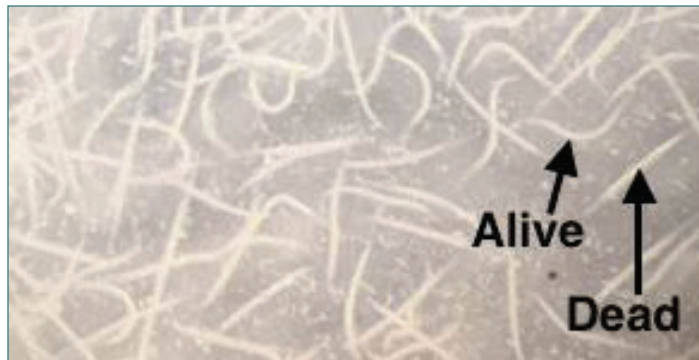


Figure 7. Living nematodes wiggle. Dead nematodes are straight and rigid. Check your EPNs before you apply them to make sure they are alive. Photo: K. Wickings.

- EPNs are living organisms. Store them correctly. After you purchase EPNs, store them as quickly as possible at the temperature recommended on the package (usually somewhere cool). Use them before the expiration date.
- Apply enough EPNs – at least 10,000 per square foot (or at least one billion per acre).
- Apply EPNs at the right time of year. White grubs that eat your lawn are most susceptible to attack by EPNs when they are young, small, and near the soil surface. In New York, this is August to early October. You may notice damage to your lawn in the spring, but do not apply nematodes until new grubs appear in the late summer/early fall (Fig. 8).
- Protect EPNs from ultraviolet light by applying them at dawn, dusk, or just before it rains.
- Apply EPNs correctly. First, mix them up in non-chlorinated water, if it's available. If your tap water is chlorinated, fill a bucket and let it sit for 24 hours before you use it. This allows the chlorine to evaporate. Once they are mixed, apply EPNs with

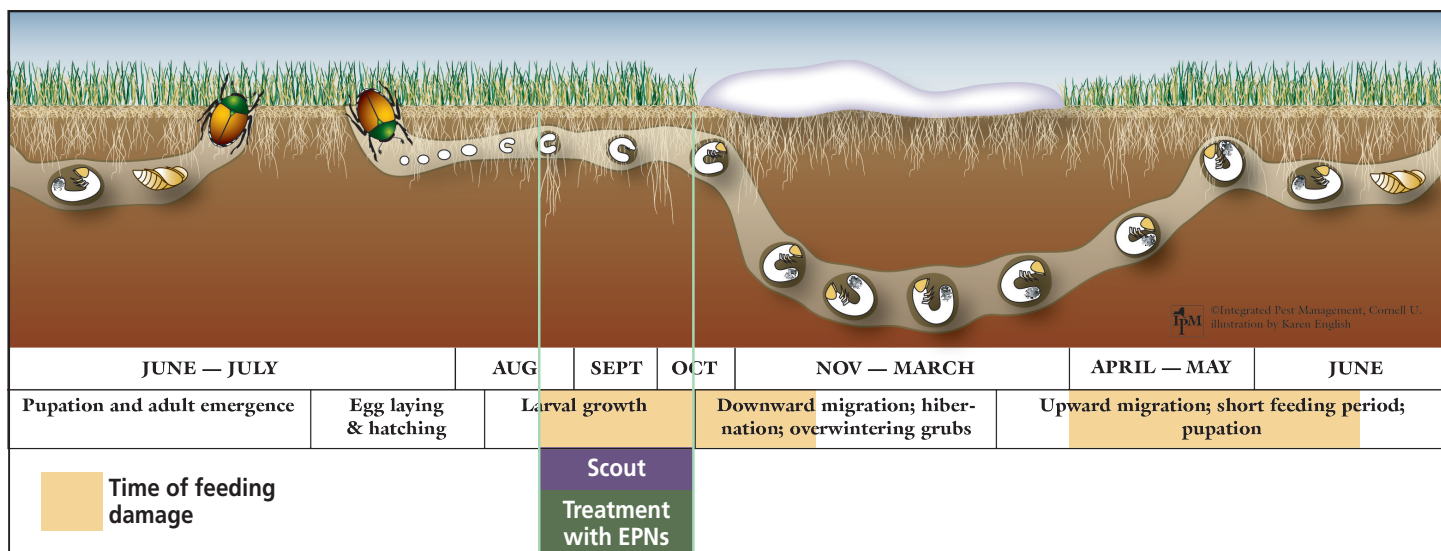


Figure 8. Late August through early October is the perfect time of year to look for white grubs in your lawn, since they are closer to the surface. It's also the perfect time to treat your lawn with entomopathogenic nematodes, if you need to. Illustration: K. English, NYSIPM.

any type of sprayer (as long as it doesn't contain a fine mesh) or even a watering can. If you use a sprayer, keep the pressure below 300 pounds per square inch (psi) and make sure that screens have been removed from any spray nozzles. Make sure that the EPNs stay suspended in the water while you spray by swirling the tank of the sprayer or the watering can.

- Get EPNs into the soil quickly before they dry out. Water will wash the nematodes from the grass blades into the soil where the grubs are. So apply EPNs right before it rains, or water the lawn immediately after you apply them. Chlorinated water is fine for this step.
- Find out if the EPNs worked! In 2-4 weeks, scout your lawn again (see link to instructions above) and decide whether or not you need to re-apply them.

Do EPNs pose risks to you, your pets, or other organisms?

EPNs only infect insects, so they are safe for you, your family, your pets, and wildlife around your home. Scientific studies suggest that they are also safer for beneficial insects in the soil than other products you might use to manage lawn grubs. As with any pest control product, read and follow all the instructions that come with the nematodes you purchase.

For questions about pesticide use, regulations, and safety:

Cornell Pesticide Management Education Program:
607-255-1866 or pmep_webmaster@cornell.edu.

For questions about biocontrol:

Amara Dunn, NYS IPM, arc55@cornell.edu

For questions about integrated pest management:

New York State Integrated Pest Management Program,
nysipm.cornell.edu

Curious about the science behind all this?

References include:

Shapiro-Ilan D, Hazir S, Glazer I. Basic and applied research: Entomopathogenic nematodes. In: Lacey LA, ed. *Microbial Control of Insect and Mite Pests*. Boston; 2017:91-105.

Lacey LA, Georgis R. Entomopathogenic nematodes for control of insect pests above and below ground with comments on commercial production. *Journal of Nematology*. 2012;44(2):218-225.

Koppenhöfer AM, Fuzy EM, Crocker RL, Gelernter WD, Polavarapu S. Pathogenicity of *Heterorhabditis*

bacteriophora, *Steinernema glaseri*, and *S. scarabaei* (Rhabditida: Heterorhabditidae, Steinernematidae) against 12 white grub species (Coleoptera: Scarabaeidae). *Biocontrol Science and Technology*. 2004;14(1):87-92.

Koppenhöfer AM, Grewal PS, Fuzy EM. Virulence of the entomopathogenic nematodes *Heterorhabditis bacteriophora*, *Heterorhabditis zealandica*, and *Steinernema scarabaei* against five white grub species (Coleoptera: Scarabaeidae) of economic importance in turfgrass in North America. *Biological Control*. 2006;38(3):397-404.

Gyawaly S, Koppenhöfer AM, Wu S, Kuhar TP. Biology, ecology, and management of masked chafer (Coleoptera: Scarabaeidae) grubs in Turfgrass. *Journal of Integrated Pest Management*. 2016;7(1):1-11.

Wickings K. Inoculative release of *Heterorhabditis bacteriophora* Poinar (Oswego) and *Steinernema feltiae* Filipjev (NY04) mixture can enhance biological control of soil-dwelling pests in turfgrass production systems. *Biocontrol Science and Technology*. 2018;28(4):388-403.

Bélair G, Koppenhöfer AM, Dionne J, Simard L. Current and potential use of pathogens in the management of turfgrass insects as affected by new pesticide regulations in North America. *International Journal of Pest Management*. 2010;56(1):51-60.

Power KT, An R, Grewal PS. Effectiveness of *Heterorhabditis bacteriophora* strain GPS11 applications targeted against different instars of the Japanese beetle *Popillia japonica*. *Biological Control*. 2009;48(3):232-236.

Produced by the New York State Integrated Pest Management Program, which is funded through Cornell University, Cornell Cooperative Extension, the New York State Departments of Agriculture and Markets, Environmental Conservation, Health, and Education; and USDA-NIFA. Design by Karen English, New York State IPM Program. Any recommendations in this fact sheet are not a substitute for pesticide labeling. Read the label before applying any pesticide. Cornell Cooperative Extension provides equal program and employment opportunities. © 2020 New York State IPM Program and Cornell University. Posted 1/2020. Search for this title at the NYSIPM Publications collection: hdl.handle.net/1813/41246