Friends with benefits

Meet your **new BFFs** when it comes to grub control, though white grubs may disagree with the term "beneficial nematodes."

by Rob Thomas

Nematodes, often vilified for their propensity to negatively affect turfgrass conditions while feeding on the roots, are enjoying some positive recognition. Not the parasitic varieties, mind you. Rather their cousins... the beneficial nematodes.

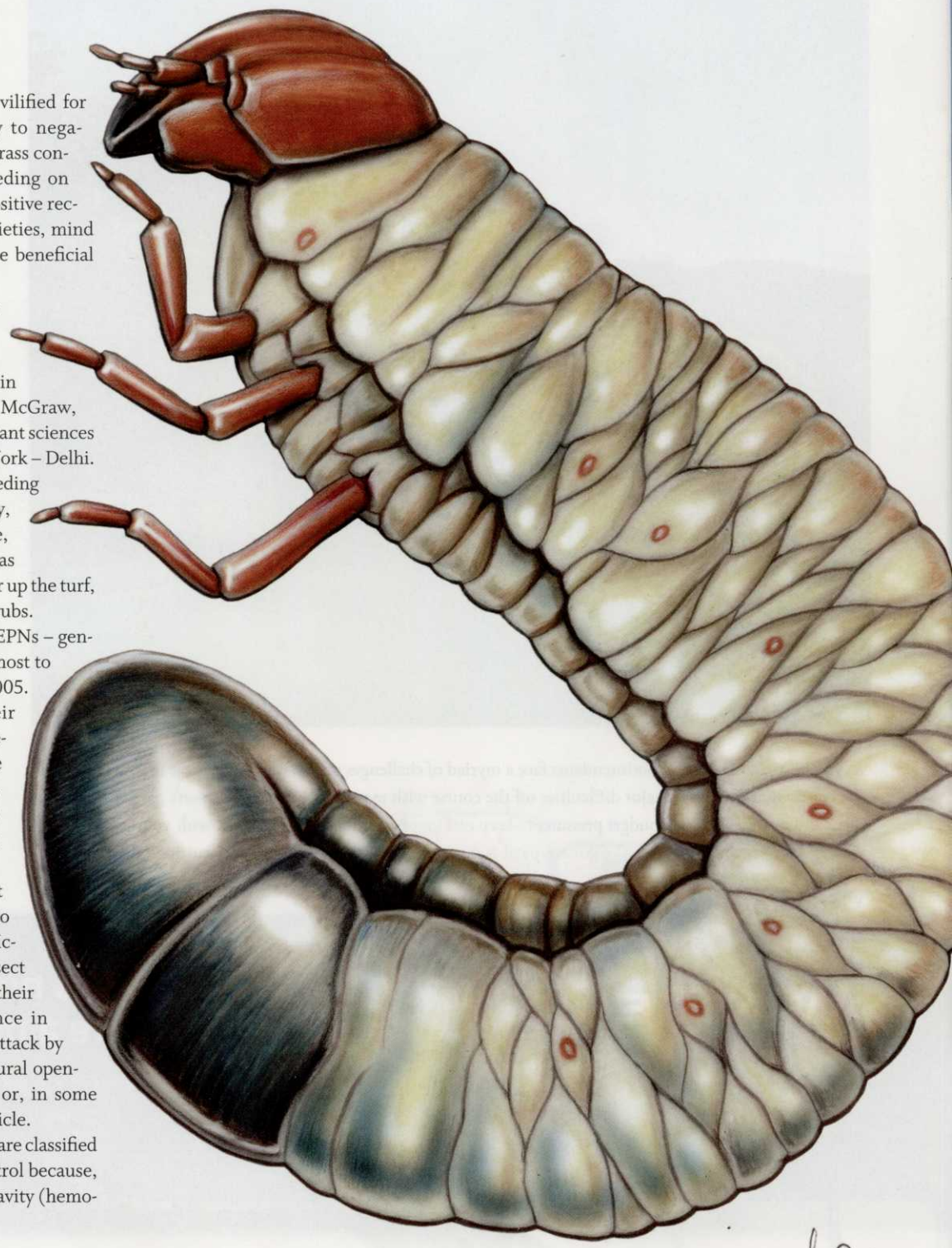
White grubs may disagree with the term "beneficial."

White grubs – in particular the larval stages – damage turf in two ways, says Dr. Benjamin A. McGraw, associate professor – golf and plant sciences at the State University of New York – Delhi. Primary damage comes from feeding directly on the roots. Secondary, which may cause more damage, occurs when vertebrates, such as skunks, raccoons and birds, tear up the turf, searching for a good meal of grubs.

McGraw has been studying EPNs – generalist parasites that require a host to live and reproduce – since 2005. They can live outside of their hosts in an immature stage referred to as an Infective Juvenile (IJ). This stage is a free living, non-feeding stage that can be found in most soils, in most ecosystems.

"They live outside a host, but require a thin film of moisture to move around and to persist," McGraw says. "They seek out insect hosts to infect by cueing into their breathing (CO_2) release. Once in contact with the insect, they attack by entering the host through natural openings (mouth, spiracles, anus) or, in some cases, directly through the cuticle.

These beneficial nematodes are classified as pathogens in biological control because, once inside the insect's body cavity (hemo-



coel), the IJs release a symbiotic bacterium that causes the host to die from septicemia, McGraw says. "The bacteria also convert the host's tissues to a substrate for nematode development to the adult stage and ultimately reproduce," he says. "After [the] cadaver has been depleted (and nematodes have developed through one to three generations), potentially hundreds to hundreds of thousands of new IJs emerge to seek out new hosts."

Beneficial nematodes are found naturally, says Julie Graesch, nematode field development specialist at Becker Underwood, but not at the levels needed for effective grub control.

Describing them as "driven organisms whose sole purpose is to find a grub," Graesch says there are two types of beneficial nematodes – ambush and cruiser.

"Ambush don't move as much and wait for the organism to come to them," she says. "Cruisers seek their host..."

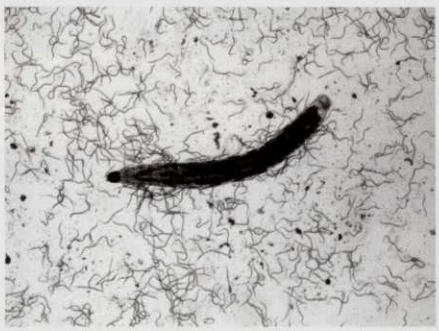
Because beneficial nematodes are live organisms, they're very sensitive and need to be handled in a delicate, specific manner.

According to Graesch, they are shipped "priority overnight" with cold packs and should be put immediately into a refrigerator upon receipt, but be sure not to freeze. And because energy is the only thing they have to move, if set on the counter, they'll still be moving, which will result in loss of energy and effectiveness.

When applying them, keep the nematodes agitated, not letting them settle to the bottom of the tank. Keep the water cold, as well. If applying in the heat of August/September, put the cold packs in the freezer and then place in the water when mixing, Graesch says.

Once applied, the nematodes need water to survive and move. When watering in, they'll sit on the grass blade. As soon as the blade dries, so does the nematode ... and dies. Sufficient watering will prevent that. Once in the soil, they need moisture, so irrigate abundantly for two weeks after application.

McGraw warns that the beneficial nematode's level of effectiveness can vary considerably, since they're living organisms, compared to their chemical counterparts. They may provide quite a high level of control, or provide multi-year suppression if they recycle or reproduce in great numbers, or may be ineffective if the wrong species are used. For example, if the nematodes attack strategy fails to match the grub's behavior or position in the soil or activity across the soil surface, then they won't be effective. Likewise, if the beneficial nematodes are mishandled – exposed



Top: Beneficial nematodes emerge to seek out a new host.
Bottom right: In addition to root damage, grubs are a favorite snack of skunks and raccoons.
Bottom left: Tiny, but deadly if you're a grub.

Beneficial nematodes: the positive and the negative

Pro

- Biological control
- No effects on humans
- Water quality
- Can provide rapid host death (48 hours or less after infection)
- Can be applied through standard chemical sprayers and PSI requirements
- No chance of resistance development

Cons

- Expensive
- Variable levels of control
- Sensitivity to environmental conditions (UV, drought, heavy rainfall – moved away from host)
- Must be handled with great care
- Nematodes are typically generalists – and not specific to attack

A fungus gnat nematode.

Inside one of these plump wax moth cadavers are thousands of wiggly nematodes, ready to serve as biocontrols against soil-dwelling pests.

PEGGY GREB, USDA AGRICULTURAL RESEARCH SERVICE, BUGWOOD.ORG

Fun fact

Though initial discovery and subsequent development of Steinernema glaseri – a species of entomopathogenic nematodes (EPNs) – as a biological control agent can be traced back to the early 20th century, research and use increased dramatically in the 1980s. This was preceded by the discovery of the beneficial nematode (Heterorhabditis bacteriophora) by entomologist George Poinar, Jr. in 1975.

to UV light, formulations or excessive heat – they can die before they have the opportunity to enter a host.

As for timing, when battling white grubs, McGraw recommends timing applications for when larvae are between their second and third instars. "In the northeast, this works out to also be the time when soils and moisture are favorable for nematode survival, infecticity and persistence," he says.

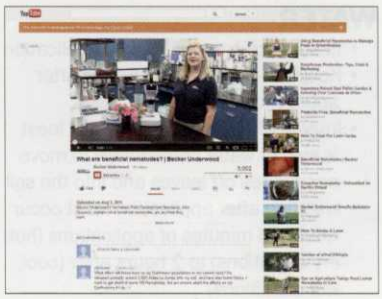
Frequency of beneficial nematode use is largely dependent on budgetary restrictions.

"Most people, given their higher costs relative to chemicals, will apply at a standard rate of 1 billion IJs per acre one time," McGraw says. "Few people have examined split rates, but for some insect pests this strategy might be preferred."

The higher cost may deter some superintendents from using beneficial nematodes, Graesch says, but she knows buyers are often drawn to the environmental upside."If it's a progressive, green golf course that wants to get away from chemicals, nematodes work

Video

Check out these great videos from Becker Underwood about using beneficial nematodes to control turf grubs. Just enter **bit.ly/Z6IEQZ** and/or **bit.ly/16eAhXB** into your Web browser. If you're viewing this article via the iPad or iPhone app, just tap the screen pictures to activate the videos.



Above: Two white grub larvae killed by *Heterorhabditis bacteriophora* next to two healthy larvae Left: A white grub larva killed by *Heterorhabditis bacteriophora* next to two healthy larvae

just as well," she says. "[They] just have to justify the extra cost."

The "industry standard" application rate of 1 billion per acre would be appropriate for most white grub species, McGraw says, though good control could be achieved at lower rates with some, possibly lessening the overall cost.

Doing Internet searches, McGraw says costs for beneficial nematodes ranged anywhere between $500 per billion all the way up to $2,000. Comparatively, chemicals are generally around $30-40 per acre.

Beneficial nematodes can be used in conjunction with chemicals containing the active ingredient imidacloprid, Graesch says, pointing out that chemicals can't always get down deep enough to reach grubs, whereas nematodes have their own propulsion.

So what are the drawbacks to enlisting the help of beneficial nematodes to control grub populations? Perhaps the biggest con, McGraw says, is there are seemingly few producers. "Supply and demand is not in the nematode producers favor, or the person wanting to get into applying EPNs," he says, circling back to the high cost.

Dr. Jennifer Grant, co-director of the New York State Integrated Pest Management Program at Cornell University, acknowledged the pricey nature of beneficial nematodes, but says it could be worse. "Because they are considered predators, entomopathogenic nematodes are exempt from registration by the United States Environmental Protection Agency (US EPA)," Grant says. "This exemption from long-term safety and water-quality studies has greatly reduced the costs and risks typically associated with registering a new insecticide."

Still, paying more than 10 times what a chemical would cost to do the job needs justification. In the Northeast beneficial nematodes are often used for curative control – after the eggs have hatched and grubs are present, Grant says.

"If you find out too late (for preventative options) that you have a grub problem, it's an excellent option," she says, noting that there is at least one curative chemical on the market, though it's "fairly harsh, as far as toxicity."

Realizing you missed an area or if grubs break through chemical control are often cited as other justifications for using the higher-cost nematodes. They're fast acting, as well, doing much of their work within a week. And vertebrate feeding stopped almost immediately – within a day or two, Grant says.

As for advice for superintendents who may consider incorporating beneficial nematodes into their grub-control routine, McGraw says there may be strength in numbers.

"The market is not in your favor, but you should be commended for wanting to integrate nematodes into your management plan," he says. "Group discount? Get more

Keys to success

The tops tips to successfully enlist beneficial nematodes to battle grubs.

TIMING

- The goal is to prevent drying out of the nematodes
- It's best to apply before, during or after rain
- Avoid direct sunlight during application
- Apply in the early morning – if immediate irrigation is available – or late afternoon/evening

APPLICATION

- Use immediately after mixing
- Agitate constantly during application
- Apply when soil temperatures are between 54 and 86 F at application and at least two weeks after application
- Do not use the product past the expiration date
- Never mix fertilizers or pesticides with Nemasys G in the spray solution.

WATER

- Ensure soil is moist prior to application
- Keep soil moist for two weeks after application
- Irrigate after application with at least ⅛ inch of water immediately to move nematodes off leaves and into the soil
- Irrigation after application must occur within 30 minutes of applications (hot, dry conditions) to 2 hours after (cool, wet conditions)

WHITNEY CRANSHAW, COLORADO STATE UNIVERSITY, BUGWOOD.ORG

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people to buy into the practice and the industry should respond."

Grant takes the same stance she would if a superintendent asked about chemical use on their course.

"I'd recommend to anyone to try a small area [first], regardless of what their strategy is for the next season," she says. "Take an acre or small area of rough.

"This is a good one to have in your back pocket," she adds about beneficial nematodes.

Start by thinking of beneficial nematodes as the live organism they are, comparing the purchase to buying a pet, Graesch says. "You need to take care of them when you get them... Need to take care of them during application... Need to take care of them after application," she says. "They have to be properly stored, properly mixed, properly applied, and properly handled after application." **GCI**

Rob Thomas is a Cleveland-based freelance writer and frequent GCI contributor.

Want more?

Check out this great research article, which first appeared in the September/October 2009 edition of the USGA Green Section Record, about enlisting Mother Nature's help in controlling white grubs on golf courses in the transitional climatic zone. According to the study, researchers found insect-pathogenic nematodes, Tiphia wasps, milky disease, and other pathogens accounted for moderate to high natural mortality at some sites. Enter **bit.ly/Wvf1LA** into your Web browser to read the report. If using the iPad/iPhone app, just tap the image.

By Katie Tuttle

Whac a Grub

Aerification may allow you to more effectively control your white grub problem.

Rather than targeting adult beetles, consider controlling the grubs feasting on your turf's roots with aerification.

In fact, this is a concept Benjamin McGraw, Ph.D., associate professor of golf and plant sciences at the State University of New York (SUNY)-Delhi, has been studying since 2009 and his research has produced some intriguing results.

There's some solid reasoning behind this research. For example, larvae typically damages turfgrass in the fall, the same time superintendents are going through the aerification process.

"We've wondered what the impact of running these machines over the area would have on something that was feeding close to the surface," McGraw says. "So the added benefit (of the research) is that we were able to document some pretty good control of larvae at the same time as doing these practices that are done to reduce compaction and all these other beneficial things outside of pest control."

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McGraw looked at three different types of cultivation treatments for his study: hollow- and solid-tine aerators using a Toro ProCore 648, solid vibratory tines using First Products UA 60 Area-vator, and air-injection systems using a Cambridge Liquid/Air Injection Systems (R).

The hollow- and solid-tine aerators move vertically, and some inject a core while others have a spike to dig directly into the ground. The solid vibratory tines rotate on a drum and vibrate side-to-side. The air-injection systems injected air, liquids or a solid material into the soil at a high pressure, fracturing the soil.

Of the three types, McGraw found the last two did not work as well as they had hoped. "Once the (solid vibratory tine) goes in the ground, it kind of wiggles and we thought it might crush some of the grubs off to the side," McGraw says. "That didn't really work too well, and it was very traumatic to the turf."

As for the air-injection systems, they did kill grubs, but McGraw did not find it to be overly measurable in the field.

"It didn't really look any different from the untreated control plots" he says.

The traditional method of hollow- and solid-tine aerators seemed to have the most impact on controlling the grubs. "We were able to document some pretty moderate to high levels of control just by aerifying, either in single or multiple passes over the turf," McGraw says.

But before you go out and dump your pesticides, you need to consider the variables.

"It's variable," McGraw says. "From one year in the field to the next you might get great control and you might get poor control. It is dependent on several factors like grub spacing and density, as well as aerator tine diameter, tine spacing, and frequency."

However, McGraw does have confidence that his findings will be effective. "Will it give you 100 percent knockdown? No way," he says. However, the potential exists to get a level of control comparable to that of applying chemical insecticides curatively, thereby eliminating an application. **GCI**

Left: a white grub speared from one of the aerification processes. Inset: the tines of First Products UA 60 Area-vator.