

# Slug Predators FS-3

## Introduction

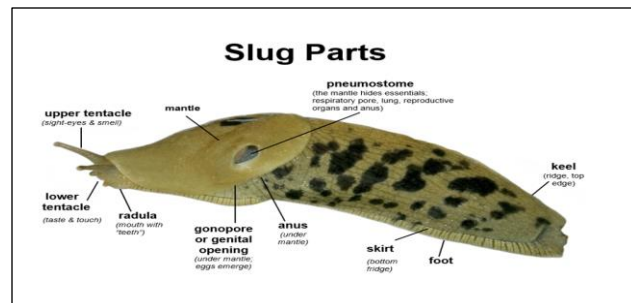
Slugs are a favorite meal of ground beetles and fireflies and several other insect species. Many other predators such as owls, hawks, kestrels, snakes, shrews and foxes to name a few are also natural slug predators. Creating beneficial habitat for these predators may significantly reduce slug numbers and the associated agricultural economic damage from reduced crop yields. This fact sheet will discuss natural slug predators and management practices that may increase slug predation by these species.

## Major Slug Predators:

### Ground beetles (*carabidae*) and other Predators

According to Dr. John Tooker, Pennsylvania State University Entomologist; ground beetles are the lions of no-till and cover cropped fields. Ground beetles consume the five major pests found in no-till fields: black cutworms, true armyworm, corn stalk borer, wireworms, and slugs. Ground beetles and fireflies are major predators of slugs but they also eat caterpillars, aphids, and weed seed; consuming their body weight daily in these agricultural pests. Slug eggs are a favorite food of these predator species, helping to keep slug numbers under control.

Tillage strongly influences soil dwelling insects. While tillage may reduce slug numbers by 80%, it also destroys the predator's home and usually the slugs can repopulate faster than the predators. No-till plus cover crops supports higher populations of predators and decomposers by providing a stable food source, shelter, and habitat that promotes a resilient environment for predators.



There are approximately 40,000 ground beetle species worldwide (estimated) with 2,000 species in the Midwest USA region. Ground beetles are nocturnal and live 1-3 years. Ground beetles breed in the fall and spring, laying 5-10 eggs/female, and it takes 5 days for the eggs to hatch. Spring tillage is extremely disruptive to ground beetle populations. Eggs hatch into larva that pupate and turn into adult beetles. Ground beetle larva feed on fly larva, slug eggs, and weed seeds. Adult ground beetles also consume juvenile and adult slugs. There are five black ground beetle species in Ohio.

Other species that consume slugs are fireflies, rove beetles, Soldier beetle, centipedes, and spiders: Wolf spider and Daddy Long Legs. Fireflies have over 2,000 species (150 USA) are nocturnal and consume many aphids and slug eggs. The firefly is actually a beetle that lives in moist soil where the larva consume slug egg. Firefly adults, eat very little and will lay 100 eggs/ female and then die. Firefly populations are declining worldwide due to insecticides and night lights that confuse adult fireflies when they mate. There are 63,000 species of rove beetles which eat fly larva, aphids, slug eggs, and adult slugs. The young larva of Soldier beetle eat slugs and aphids. Centipedes (over 8,000 species) are nocturnal (may live 1-6 years laying 10-50 eggs per year) also consume slug eggs.

Several spider species consume slugs including the Wolf Spider and Daddy Long-Legs. There are 150 species of Wolf Spiders in in North America, they are nocturnal and they eat beetles, grasshoppers, and slugs. Daddy Long Legs (6,000 to 7,000 species) are related to scorpions, molt every 10 days as they grow and eat aphids, slug eggs, small slugs, caterpillars, mites, and flies. Other slug predators include the Praying Mantis, which eat slugs but slugs are not their preferred diet. Lady bugs and lacewings consume aphids, but do not eat slugs.

Other predators of slugs include frogs and toads which consume slugs as 25% of their diet. Ants, worms,

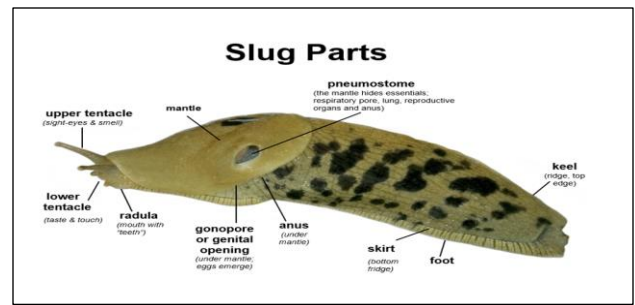


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nematodes, and snakes consume slugs. Birds are major predators including owls, hawks, robins, blackbirds, thrushes, starlings, rooks, crows, jays, ducks, chickens, and sea gulls. Approximately 6% of a starling diet are slugs (Symondson, 1996).

Mammals are predators to slugs and include moles, shrews, badgers, fox, raccoons, and possum. The North American Least Shrew is a major predator to slugs. Shrews have reddish-gray-brown thick fur, a pointed snout and short tail. Shrews live in wetter environments in grasslands, fencerows, meadows, and marshes in the Great Lakes region. They are a threatened species. Shrews forages after sunset and have poor eyesight and smell and will eat its weight daily. This shrew's main diet consists of caterpillars, beetle larva, centipedes, slugs, sow bugs, earthworms, and voles. Shrews need to consume 43% more food in the winter to survive the cold. The shrew breeding period is March to November, with 2-3 litters per year and 3-6 pups/litter. Shrews live about 1 year.

The real question is can predators help reduce slug numbers? Managing slugs with predators should be a proactive tool and not a reactive tool. Residues, ground covers, and plants increase the diversity of soil inhabiting organisms. The challenge is keeping a healthy balance between pests and predators. Many slug predators are also vole predators. (See fact sheet on managing vole predators). Locate perches, bird houses, reduce hunting (fox), improve the habitat (keep den trees for owls, hawks, and other birds), and reducing vegetation height (mowing) will increase predator success. Another important consideration is to keep as many fields as possible seeded to cover crops every years to provide a consistent food source for large numbers of predators, both small and large.



## Pennsylvania Research on Soybeans, Slugs, and Neonicotinoids

(Dr. John Tooker, PSU Entomologist)

Dr. John Tooker, PSU Entomologist conducted a study on the effect of a neonicotinoid seed treatment (Cruiser (thiamethoxam) a systematic insecticide on slug populations, ground beetles, and soybean yields. Neonicotinoids (Cruiser (thiamethoxam); Poncho (clothianidin); Goucho (imidacloprid) ) are highly water soluble seed treatments used on almost 95% of all seeds planted including corn, soybeans, wheat, alfalfa, cotton, rice, vegetables, etc. Since 2004, the use of these seed treatments has increased significantly, including not only the rate but also the concentration. The estimated agricultural use for Poncho (clothianidin) alone is >1 pound of active in the Midwest region. Neonicotinoids as a seed treatment are deadly to most beneficial insects including ground beetles, spiders, and ants.

Tooker's research found that the neonicotinoid seed treatment was taken up by the plant and ingested by the slugs. Slugs are immune to insecticides because they can exude toxins in their bodies and excrete the toxins into their slime. High ground beetle populations were correlated with low slug populations and low slug soybean damage. Where the neonicotinoid seed treatment was used, low beetle populations were found because the slugs had high concentrations of neonicotinoids in their bodies and slime which was toxic to the natural slug predators. As neonicotinoid levels increased, beneficial slug predators decreased along with a reduction in slug death from predation. Laboratory studies revealed that slugs feeding on Cruiser-treated soybeans became 'Cruiser-Slugs' which resulted in 60% less ground beetles and more slug soybean feeding. The net result was that neonicotinoids reduced predators which led to increased slug feeding and a 19% reduction

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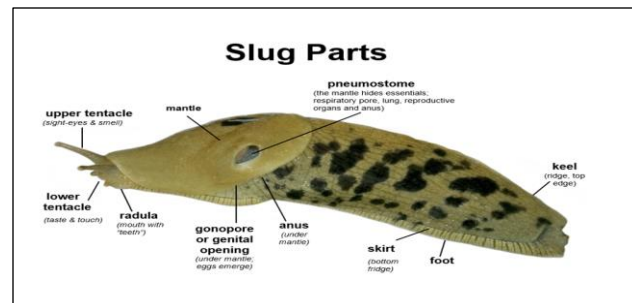
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in soybean populations and a 5% soybean yield reduction.

Overuse of insecticides are having a negative effect on crop yields if predators are eliminated or reduced. Worldwide, the population of insects has declined 75% however most of this decline is in beneficial insects and not agricultural insect pests. Insect pests generally rebound faster and in greater numbers than beneficial insect species. Another Penn State University crop rotation study found that a two-year (corn-soybean) crop rotation utilizing Bt, seed treatments, pyrethroid insecticides (broadcast) had higher levels of insect pests than a diversified six year rotation utilizing cover crops with no Bt, seed treatments, and minimal insecticides. The healthier soils had enough predators to control the insect pests.

In another study in South Dakota University (Dr. Dwayne Beck), who utilized long-term no-till, cover crops, and minimal fungicides, seed treatment, and insecticides; found that corn rootworms which is the #1 insect problem in South Dakota, were no longer a problem. Researchers planted 1,000 rootworm eggs per foot of soil in the corn row. After several weeks they could not find any corn rootworms. Researchers estimated there were >1 billion predators per acre. Corn root worms are not very palatable to predators and few predators like to eat corn rootworms but when insect predators are hungry, they eat anything! Slug eggs are like caviar compared to corn rootworm eggs for predators. An important lesson is that 95% of insects and nematodes are beneficial! Keeping the soil healthy with diverse organisms makes the whole system more resilient to insect infestations.

Another important lesson on using neonicotinoids is that they are highly water soluble. Only 5% of these chemicals remain with the plant. The other 95% moves with the water into our waterways. Neonicotinoids are also being found in cover crop plants that scavenge the



insecticide and is having an effect on natural pollinators and bees. Neonicotinoids have been banned in Europe since 2016. Neonicotinoids provide good control of wireworms and seed corn maggot, only at the highest concentration. Many of these insects (seed corn maggot, wireworms) are also controlled by beneficial insects like ground beetles, rove beetles, fireflies.

A partial solution is to eliminate soybean neonicotinoid seed treatments. Leading entomologist say that neonicotinoids are vastly overused and not cost effective on soybeans. The neonicotinoid only lasts in the soil for 21 days because it is water soluble. Soybean pests like seed corn maggot and wireworm are relatively minor pests in soybeans. If these pests are a problem, consider using another insecticide or try to build up natural insect predator populations. Using an alternative insecticide or untreated soybean seed may allow beneficial insects to recover. To get untreated soybean seed, order the seed in the fall, because 95% of all seed is automatically seed treated.

In the Midwest, soybeans are planted at 140,000 to 210,000 seeds per acre which results in a large dead zone for beneficial insects. On corn, the typical corn population is 30,000 to 36,000 seeds per acre. Corn is more expensive and has more major insect pests, so treatment may be beneficial IF insect pest numbers are high. The only way to know is to regularly scout your fields for all insect pests, and then decide whether an insecticide is justified. Applying insecticides only when they are needed should allow insect predator populations to rebound. Using true integrated pest management and applying economic thresholds to only use insecticides when necessary should avoid disrupting natural slug insect predator control of slug populations.



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## Summary

Take home message: A rich diversified ecosystem is best for controlling any pest. Overuse of neonicotinoid seed treatments have been linked to increased slug feeding and reduced soybean yields. Eliminating or substituting a different insecticide may allow beneficial insect predators to recover. To promote large predators, utilize perches, maintain den trees, build bird houses and limit over hunting of predators (fox) to increase predators and reduce pest problems. Keep as many fields as possible consistently seeded to cover crops every year so that the predators have a consistent food source from year to year which will help increase predator populations. Other practices that may help control slugs include the use of repellants, alternative feeds, and toxicants (baits) which will be covered in Fact Sheet 4.

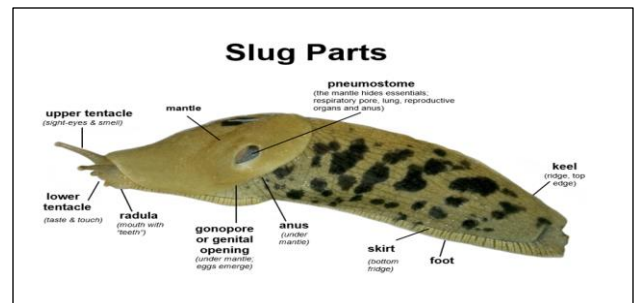
## Fact sheets in this Series:

- 1) Slug Biology FS-1
- 2) Slug Scouting FS-2
- 3) Slug Predators FS-3
- 4) Slug Repellants & Baits FS-4
- 5) Slug Management Practices FS-5

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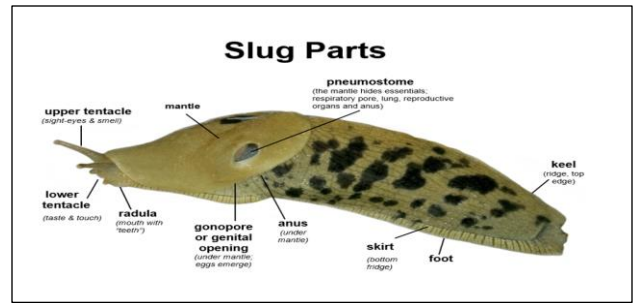
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