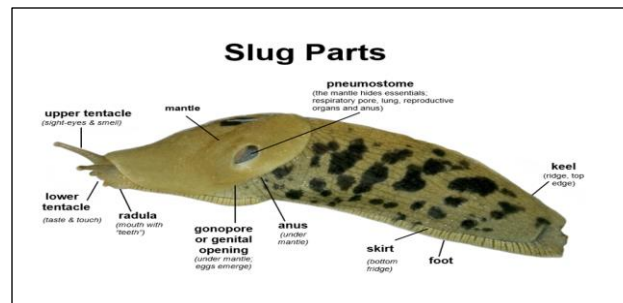


Slug Biology

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Introduction

Slugs have become a major agricultural pest, especially in no-till and cover crop fields. Worldwide, there are an estimated 80,000 slug species which are related snails (slugs lack a shell). Slugs need to live in a moist habitat so they predominate in the Eastern Corn belt and Middle Atlantic states, places with high no-till, lush vegetation, and adequate moisture.

In the Midwest, four species of slugs have been identified which cause a majority of the agricultural crop damage. These species include: gray garden slug (*Deroceras reticulatum*), the native March slug (*Deroceras leave*), Banded slug (*Arion fasciatus* group) and the Dusky slug (*Arion fasciatus* group). The gray garden slug causes the most agricultural crop damage. All these slugs were imports from Europe or North Africa except for the Marsh slug which is native to North America.

Increased Slug Numbers

Several major factors have contributed to increased slug numbers and slug damage to agricultural crops. Some of these factors include:

- More long-term No-till: Stable slug environment
- Cool, wet springs: Leads to higher slug populations and slow plant growth
- More green vegetation (cover crops, weeds): More food and habitat
- Mild winters: Less slug mortality, higher number egg laying slug adults in the spring.
- More Neonicotinoids: Kills off the slug predators but slugs survive with fewer predators.

Slugs thrive under certain conditions and have certain preferences. Slugs consist of mostly water and need to stay in cool, moist, dark environments to survive.

Table 1: Slug Preferences (Likes and Dislikes) (Oregon State University)

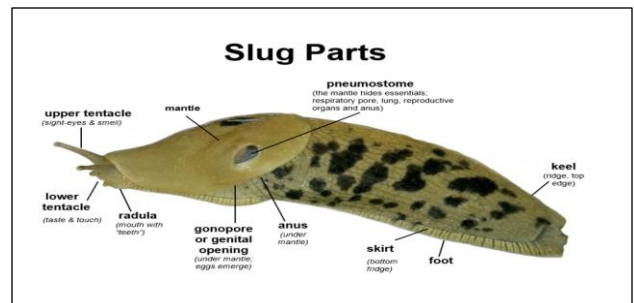
<u>Likes</u>	<u>Dislikes</u>
100% humidity (Moist)	Dry conditions
Low wind: <5 mph	Winds: >5-10 mph
Cracks & Crevices	No Hiding Places
Surface Residue/No-till	No Surface Residue/Bare soil
Well drained soils (Tile)	Poorly drained soil (Flooded)
Green Vegetation: Food	No Vegetation: Lack of Food
Temperature: 40-70F (60F)	Temperature: <34F, >85F
Light Rain & Fog	Heavy Driving Rains
Dark & Shady	Bright Sunlight
Acid soils, clay	High pH(Lime), Sand
Cotyledons, Young Vegetation	Established plants, High Lignin
Insecticides (No harm), beer, grapefruit	Salt, copper, sulfates, vinegar, garlic
Lack of Predators	Predators

Excess Mulching may increase slug numbers but natural predators also occupy the same habitat. Tilling the soil destroys holes and cracks but also exposes slugs to predators. Good air circulation promotes a drier environment which is detrimental to slugs. Slugs thrive under cool, moist conditions, with good food/shelter. Extremely cold winters may kill adults and juveniles however thick snow may act as an insulator. Adult and Juvenile slugs burrow deep in the soil below the frost line to survive the winter. In the spring as rainfall increases and the water table moves upwards, so do



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the slugs. Slug populations tend to build over time. However, their populations are somewhat cyclical (2 to 5 years cycles) depending on weather, food, shelter etc.

Slug Anatomy (From Oregon State University)

Slugs have some unique anatomy characteristics.

- Body:** Made of water to avoid desiccation.
- Mantle:** Protects the Lung (pneumostome).
- Lower Tentacle:** For Taste & Touch
- Head:** Covers the radula (snail mouth) and tentacles
- Radula:** Slug mouth for grinding food, lots of special sharp little teeth
- Pneumostome (Lung):** A respiratory organ on side of mantle
- Mantle:** Covers the genitals, anus, and lungs behind the head
- Gonopore (genitals):** Opening under mantle where eggs and sperm released
- Anus:** Found under the mantle
- Skirt:** Found above the foot, aids in locomotion
- Foot:** Bottom side (base) of foot, rhythmic waves with mucus (slime) for slug to move
- Keel:** Ridge along the middle of the tail
- Tail:** Part of slug that trails the mantle
- Slime:** Protects foot from damage, color and density varies by slug species

Slugs produce copious amounts of slime for either defensive measures or to rid their bodies of toxin. For the gray garden slug, defensive slime is white.

Slug Life Cycle

Slugs are hermaphrodites but may also self-fertilize. Mating occurs from August to October with egg laying

occurring 30-40 days later. Some species (gray garden slug) lay eggs in the spring or throughout the year under favorable conditions. In the fall, most Juveniles have completed their development and may start laying eggs. Fall egg laying occurs with the first fall rains before temperatures decline. Adults lay eggs in moist soil high in SOM or under residue. Most slugs lay 20-100 eggs (average 20-30 eggs). The gray garden slug may lay 500 eggs per year. Eggs may hatch at 40°F and may remain viable if dry conditions prevail until moist conditions return. Slug eggs hatch within about 1-2 weeks. Eggs laid in the fall may take 5 months to hatch. Slugs may die after laying eggs. In Central Ohio, slugs start hatching in Late-April, and in Northern Ohio Mid-May to Late-May.

Neonates are newly hatched slugs weighing 1-10 mg each. The neonate food choice is algae and fungus but as they grow they start to feed on vegetation. Neonates are not very mobile. **Juvenile** slug feeding begins 1-2 weeks after hatching and continues throughout spring and sometimes into the summer. They do a lot of damage eating 2.0-2.5X their weight daily. **Juveniles** weigh 11-100mg each and **Adults** weigh 200-500 mg each. Slugs will rest (aestivate) when hot dry conditions prevail under clods, and debris, in burrows, and cracks (1-2 feet down) and may survive without food for several months. Slugs mature in 5-6 months and may live 6-18 months. Since slug species vary, stages of development vary and are hard to predict. Life cycles are not well synchronized – various life stages occur at the same time, however, the bigger the slug, the greater the feeding.

Slug Habitat

Prime slug habitat is anywhere with permanent herbaceous cover. Slugs are commonly found in: hay fields, grass ditches, waterways, buffers, lanes, fence lines, edge of woods, and no-till and cover crop fields.



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Slug Food Sources (Likes/Dislike)

Preferred Forages & Legumes: Alfalfa, red clover, Soybeans (seeds and cotyledons)

Preferred Grains: canola, oats, wheat, barley, corn (least preferred due to high C:N ratio)

Preferred Cover Crops: cereal rye, winter peas, rape, winter peas, and radish (natural fumigant)

Preferred Vegetables: Nearly all vegetables including Cabbage, Lettuce, Broccoli, Spinach, Carrots, Radish, Melons, Cucumbers, Sweet Corn, Strawberries, All Beans (Tender) & Peas, Tomatoes, Potatoes

Preferred Weeds: Dandelion, Plantain, Purslane, Lambsquarter, giant ragweed

Preferred Flowers: Marigolds, Calendula, Zinnia, Comfrey leaves

Preferred Other: Fermented products, beer, grapefruit

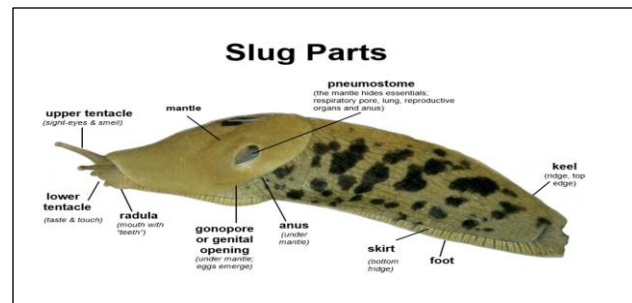
Slugs Dislike:

Crops: Corn is only eaten if no other food source is available, so baits are more effective in corn

Vegetables: Red Peppers and vegetables with red pigments: Lamb's lettuce, red cabbage, red lettuce

Cover crops: crimson clover, sunflower, chicory, radish (like sugar content but radish is a natural fumigant).

Vegetables and Spices: onions, chives, sage, ginger,



rosemary, mint, thyme, endive, lavender, saxifrage, foxglove, cayenne pepper

Flowers: roses, geraniums, ivy, fuchsias, Cora Bell, impatient, yucca

Other: Highly fragrant plants, shrubs or high C:N ration plants, egg shells, gritty habitats, large wood chips, tars, tannins, sand, hair, diatomaceous earth

Planting crops that slugs dislike or changing the habitat or environment are management practices that may be utilized to minimize slug populations.

Summary

Slugs have become an economic agronomic pest, especially with fields that are no-till and/or cover cropped. With minimal soil disturbance and adequate shelter and food, slug numbers may quickly explode. Slug density and slug numbers are cyclical, but they tend to build over time. Understanding the slug biology is the first step in finding agricultural practices that reduce slug numbers to an acceptable level. Scouting for slugs and reducing slug food and shelter is the second step in controlling slugs.

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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For the Gray Garden Slug:

The Gray Garden slug's preferred habitat is agricultural field crops, gardens, and grassy areas. The Gray Garden Slug came from Europe and was first discovered in Massachusetts in 1840's. Large numbers of gray garden eggs (up to 500 eggs per Gray Garden slug) hatch in mid-spring. Juveniles produced from the spring egg hatch grow through spring and summer and mature in late summer or early fall. Juveniles may start laying eggs in the fall which over-winter and hatch in the spring. Both juveniles and adults may survive the winter and lay eggs in spring and early summer under the right conditions (wet, moist, cool weather; food/shelter). Younger slugs lay more eggs than older slugs. Juveniles resemble adults only smaller. **If all offspring of one gray garden slug survived under an average lifespan, there would be 90,000 grandchildren and 27 million great grandchildren (Symondson, 1996).**

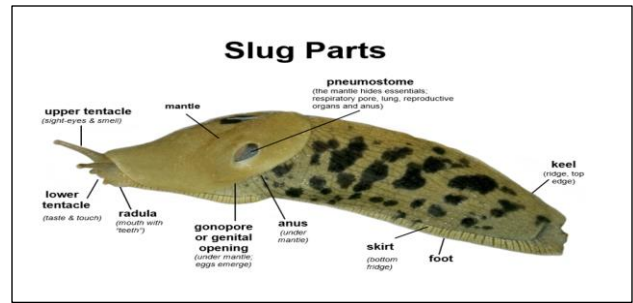
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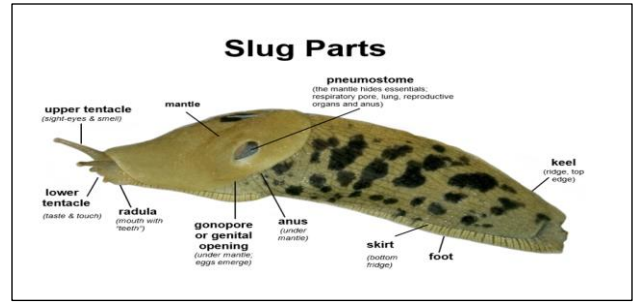
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