



United States Department of Agriculture

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Natural  
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# Slugs & Voles in Cover Crops & No-till

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



## Slimy! Need moist habitats



- About 80,000 slug species, 20 in Ohio.
- Various colors
- Most American slug pests came from Europe or North Africa.
- Slugs related to snails. Slugs are snails without a shell.





## Likes

100% Humidity (Moist)  
Low Wind: <5 mph  
Cracks & Crevices  
Surface Residue/No-till  
Well-drained Soils (Tile)  
Green Vegetation: Food  
Temperature: 40-70°F (60°F)  
Light Rain & Fog  
Dark & Shady  
Acid Soils, Clay  
Cotyledons, Young Vegetation  
Insecticides (don't harm), beer  
Lack of Predators

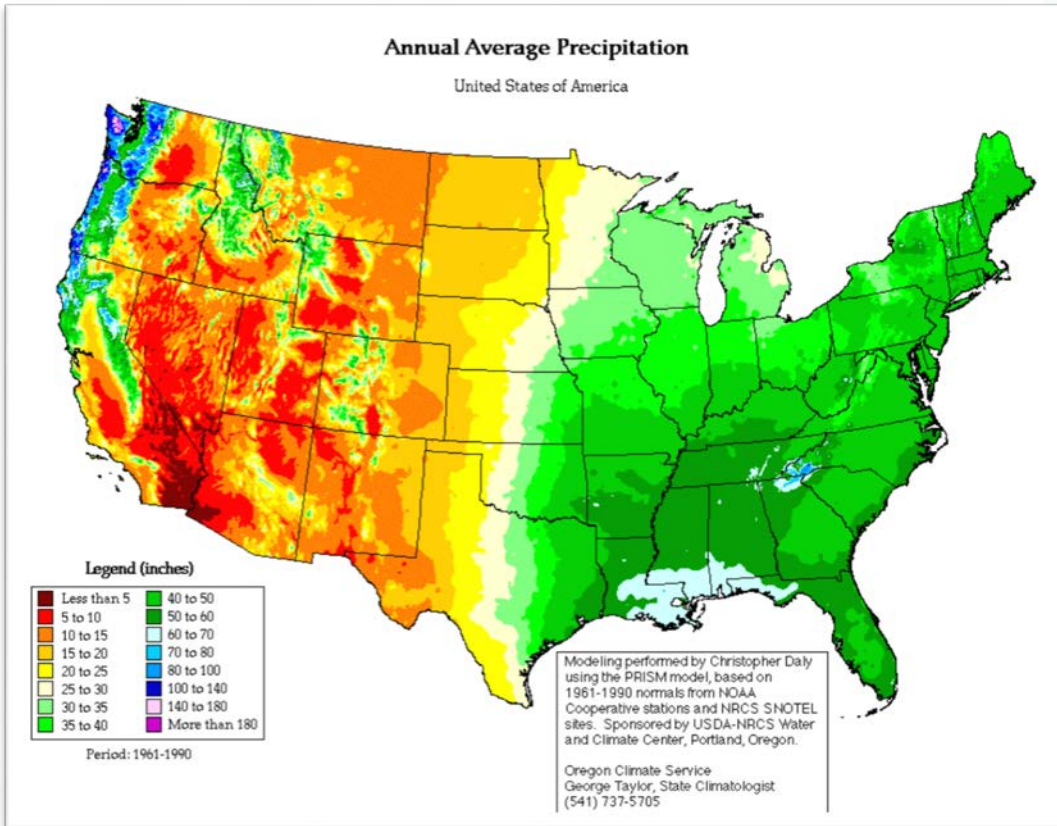
## Dislikes

Dry Conditions  
Winds: >5-10 mph  
No Hiding Places  
No Surface Residue/Bare soil  
Poorly drained soil (Flooded)  
No Vegetation: Lack of Food  
Temperature: <34°F, >85°F  
Heavy Driving Rains  
Bright Sunlight  
High pH(Lime), Sand  
Established plants, High Lignin  
Salt, Copper, Sulfates, Vinegar, Garlic  
Predators



# Slugs are more common in...

- Eastern corn belt
- Middle Atlantic
- Places with high no-till adoption AND moisture



“Turned out nice again.”

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From:  
Kelley Tilmon  
OSU Entomologist

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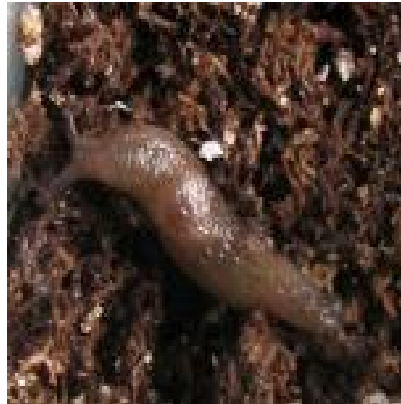




The Gray garden slug has the largest number and is the most important slug species pest of Midwest agriculture!



Gray garden slug  
*Deroceras reticulatum*



Marsh slug  
*Deroceras laeve*



Banded slug  
*Arion fasciatus* group



Dusky slug  
*Arion subfuscus* group



**All these slugs were imported from Europe, except for the Marsh Slug.**

From: Kelley Tilmon  
OSU Entomologist



## Slug Parts

Slugs are mostly water & need to stay in cool, moist, dark environments to survive.

## Slug Parts

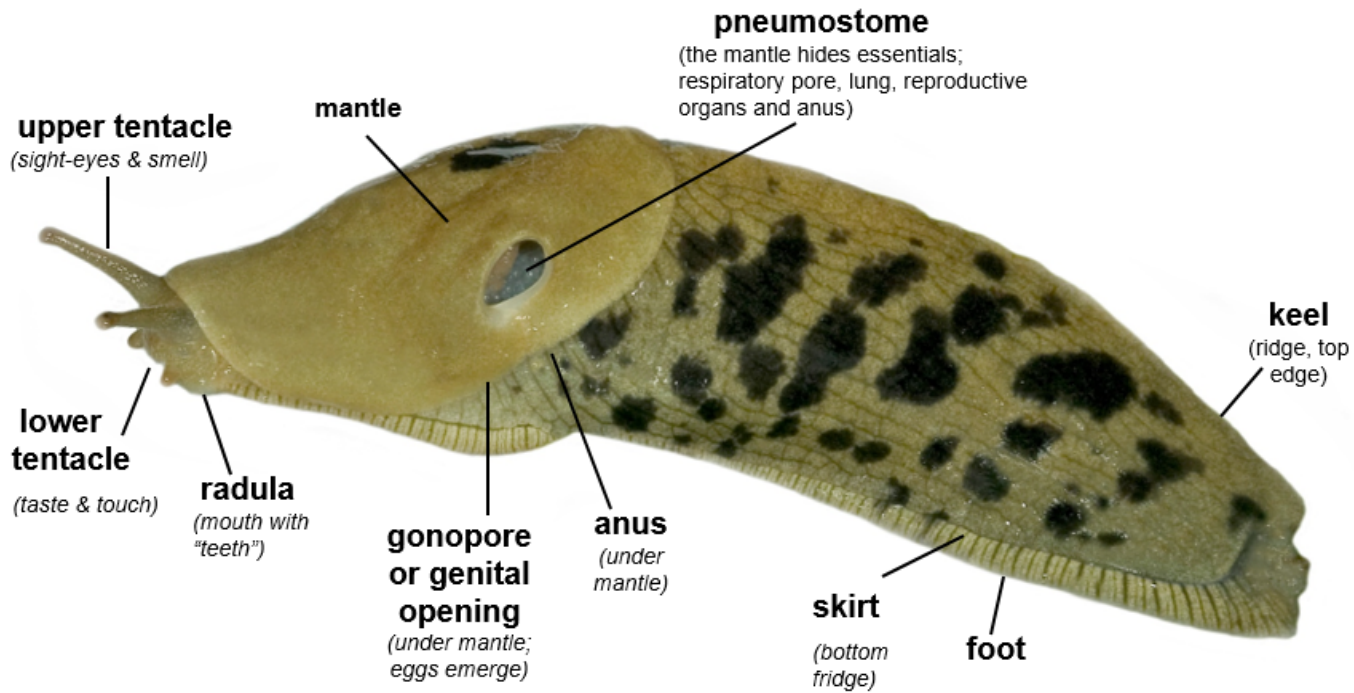


photo by Jeffrey C. Miller, OSU Emeritus; Diagram created by Amy J. Dreves, OSU Research and Extension Entomologist



- Slugs produce copious amounts of slime for either defensive measures or to rid their bodies of toxins.
- For the Gray Garden slug, defensive slime is white.



Photo from My Temple of Nature





# Slug Life Cycle



Adults may live more than 1 year



Most slug species lay 30 to 50 eggs per year.

Gray Garden Slugs may lay 500 eggs per year!



Small, Tiny





Fig. 6: Slug eggs in the soil. Photo by Nick Sloff

**Gray Garden slug came to USA  
(Massachusetts) before 1840s from Europe.**  
From: Penn State: [Slugs as Pests of Field Crops](#)

**If all off-spring survived, one  
gray garden slug would have  
90,000 grandchildren and 27  
million great grandchildren  
(Symondson, 1996)**





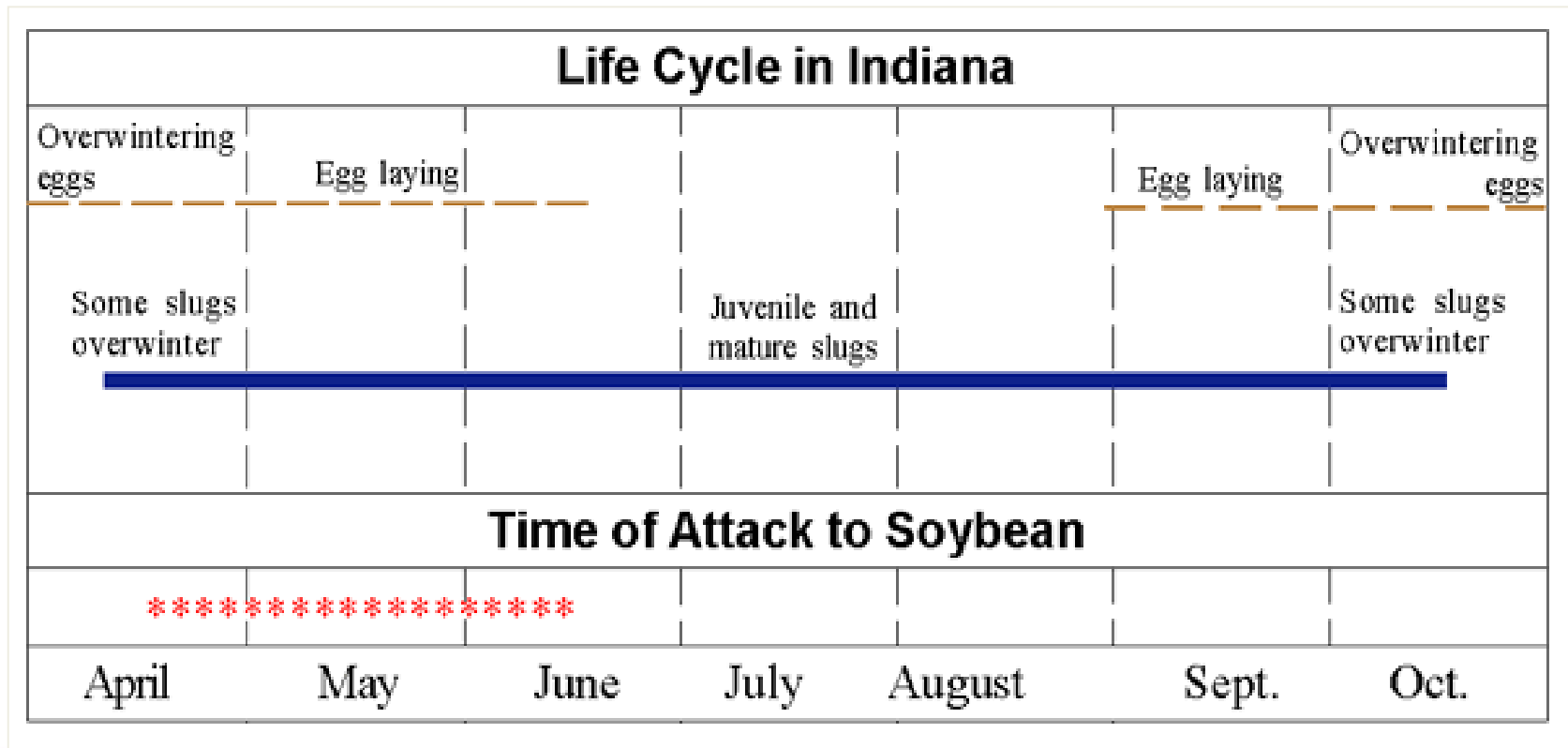
- **Neonate:** Newly hatched slug (1-10 mg)
  - Food Choice: Algae & Fungus, but as they grow they start feeding on vegetation. Not very mobile.
- **Juveniles:** Feed throughout spring and sometimes into the summer.
  - They do a lot of damage, eating 2.5X their weight daily.
- **Juveniles** (11-100mg) and **Adults** (200-500mg) under hot dry conditions, will rest (aestivate) under clods, and debris, in burrows, and cracks (1-2 feet down).
  - They can survive without food for several months.
  - Slugs mature in 5-6 months and can live 6-18 months.





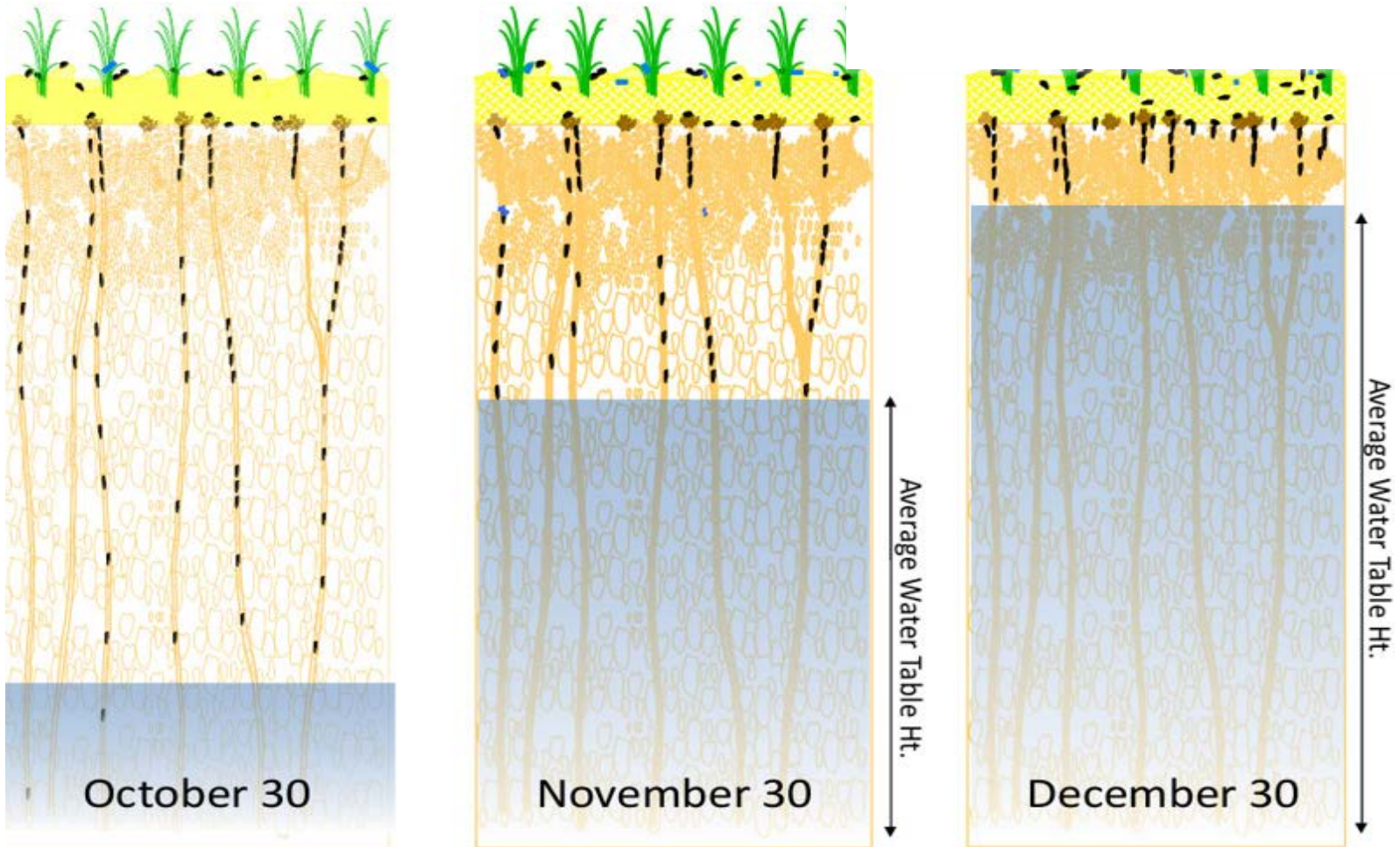
# Slug Life Cycle: Midwest

- Life cycles are not well synchronized – various life stages occur at the same time
- The bigger the slug, the greater the feeding





# How Rainfall Affects Slugs



As rainfall increases and the water table moves upwards, so do the slugs!



# Slugs Affect almost all Crops

Slugs can damage virtually all crops



Canola



Corn

Slugs have 27,000 teeth!  
Slugs can eat 2X their weight daily!

Soybean



Alfalfa &  
Sm. grains

Juvenile slugs feeding begins 1-2 weeks after hatching.

~20% of no-till acreage loses yield (~600,000 acres)





- **Yield loss in no-till estimated at ~20% in Mid-Atlantic**
- **Final damage can be worse in soybean**
  - Exposed growing point, if eaten, seedling won't recover
  - Greater chance of stand loss
- **Can also feed on weeds and organic matter**



**Shredded  
ragged  
holes**



*Slug feeding scars on corn leaf.*

**Hollowed  
out seeds**



*Slug damage to soybean seedling.*

**Photos from a Purdue  
Univ. Newsletter**

**Kill the  
growing  
point  
below  
ground.**



*Corn seedling severely damaged by slugs*

Photo from Oregon State  
University



Scar roots and tubers



## Slugs



- Potentially the most challenging pest in continuous cover crops
- They feed on both decaying and fresh plant tissue (e.g., corn, soybean, etc.)
- Most stand losses are attributed to poor seed slot closure, compromised growing point





Open slots allow slugs to feast



Slug in planted soybeans & wheat residue

**Avoid planting when slot will not close!**



# Slug Damage in Soybean

**Slugs prevent soybean establishment and lower yields!**

**Damage below the cotyledon and to the growing point often results in death like in this field.**





## Corn yield damage above the growing point is less damaging than below growing point.

Damage above growing point less important

Cool temperatures slow plant growth – slugs still active



Vegetation modification

Slugs like:

- Seedlings
- Succulent foliage





# Slug Damage in Corn

**Corn slug damage is most severe from emergence to the 4 leaf stage.**

**Later, slugs may feed on corn brace roots, but damage is small and not economically significant.  
(Purdue University)**



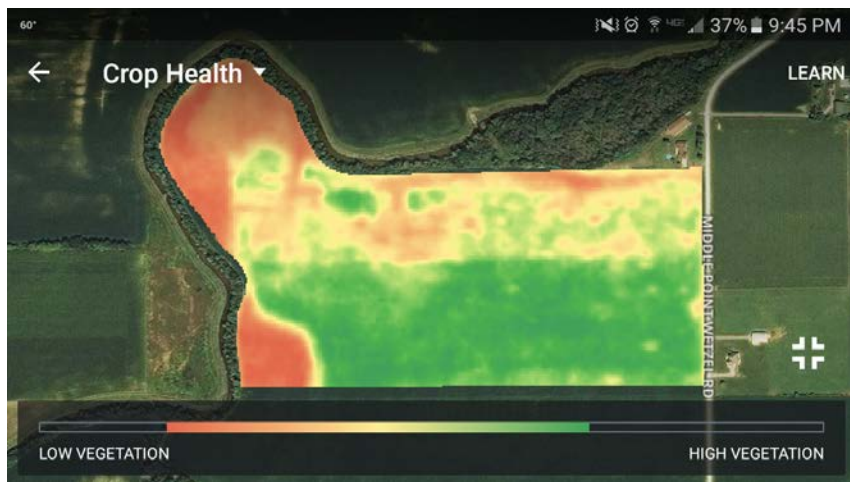
## Slugs Considerations

- Plant Early
- Get crops growing quickly
- Avoid matted, grassy cover crops
- Tillage
  - Zone/strip
  - Field hot spots



Oregon State Extension

## Time of Planting



**Top: Corn harvested early (Sept. 28) and planted to cereal rye**

**Bottom: Corn harvested 3.5 weeks later then planted to cereal rye.**

**Difference in color is due to slug damage. Early planted rye was thicker and taller and had more slugs.**



**Red=Low  
Corn Yield, High  
Slug damage**

**Green= High  
Corn Yield, Low  
Slug Damage**

Photos by  
Bruce Renner  
(Delphos, Ohio)  
and  
James Hoorman,  
NRCS Soil Health  
Specialist

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- Use a good crop rotation and diverse cover crop species to increase predators.
  - To reduce cereal rye seeding rate, add another cover crop like kale, or radish. Soil dries out better. Or add oats or 50% cover crops species that die out. Less dense stands equal less food/shelter.
  - Aerial seeded/broadcast cover crops are a food source. Drilled seed is better.
- Kill cover crop early in the spring (30 days before planting) to reduce slug food and shelter OR
  - Use cover crop as a trap crop, plant later for faster emergence, and kill cover crop late after main grain crop has grown enough to out-compete the slugs.



## Not Necessarily...



**If Low Slug Numbers**

**No crop damage**

**High Predation**

**Ecologically  
Balanced!**

**Do not mess with  
success!!**



**Terminating cover crop 30 days before planting  
may not be needed or even a concern!**



**Shingles, old boards, newspaper, and cardboard may be used to monitor slug numbers in the fall and spring.**

From Penn State: [Slugs as Pests of Field Crops](#)



**Slug Economic Damage --  
unknown for Ohio & Midwest**

**Infestation test from Oregon  
State Univ.**

**Put shingles in 5 locations in  
each field. Check after 1 week.  
Get it close to soil surface. Put  
in lower areas with high SOM.  
Need young growing plants for  
slugs to eat. Slugs do not  
tolerate flooding.**

**1-2 slugs Low**

**2-3 slugs Medium**

**4-5 slugs High**



And getting Economic Crop Damage...



Consider....

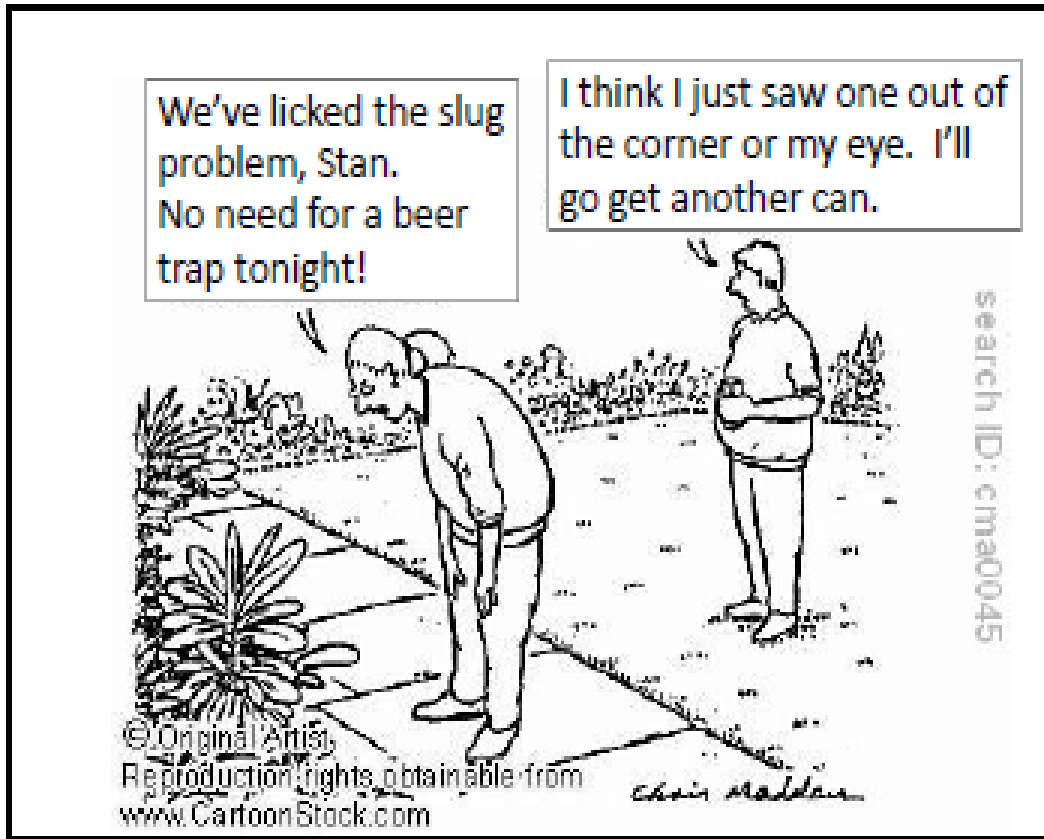
Reducing Neonicotinoids

Increasing Predation  
Perches & Bird Houses

Change cover crop mix

Mowing? Other practices  
to reduce slugs.





Slide from Kentucky Extension ENT 695



Slugs like fermented products with yeast!

Bury containers in the soil and the slugs will drown.

A 1987 Colorado State study found that slugs Prefer:

- 1) Kingsbury Malt
- 2) Michelob
- 3) Budweiser

Slugs have \$\$ tastes!



## Focus on these things:

**Food:** Plant crops or plants that slugs dislike  
OR use plants they like as trap crops.

**Shelter:** Alter the time of planting or the density and diversity of crops. Mowing and grazing are management strategies. Alter moist, wet, cool habitat.

**Predators:** Reduce insecticides, promote predators.

**Cultural Practices:** Rotary hoe, zone tillage, chaff spreaders, row cleaners, draper heads, harvesting height.

**Consider using Trap Crops/Baits/Chemicals:** Consider trap crops, baits, and chemicals to reduce slug populations.

**Effective slug control requires a combination of practices.  
Maximum control is only 60% with one practice.**



# Vole & Slug Control\* in Cover Crops and No-till



\*NRCS does not make chemical or biological pest suppression recommendations or change pesticide label instructions.

NRCS is only permitted to provide producers with the most current biological and chemical pest suppression references.



- True rodents
- Vole means “field”
- Once called volemouse, also known as field mice or meadow mice
- Roughly 60 species of *Microstis* (means “small ear”), but difficult to distinguish between them
- Voles DO NOT inhabit homes!

Deer Mouse  
*Peromyscus maniculatus*



House Mouse  
*Mus musculus*



Woodland Jumping Mouse  
*Napaeozapus insignis*



Meadow Vole  
*Microtus pennsylvanicus*



Southern Bog Lemming  
*Synaptomys cooperi*



Northern Short-tailed Shrew  
*Blarina brevicauda*



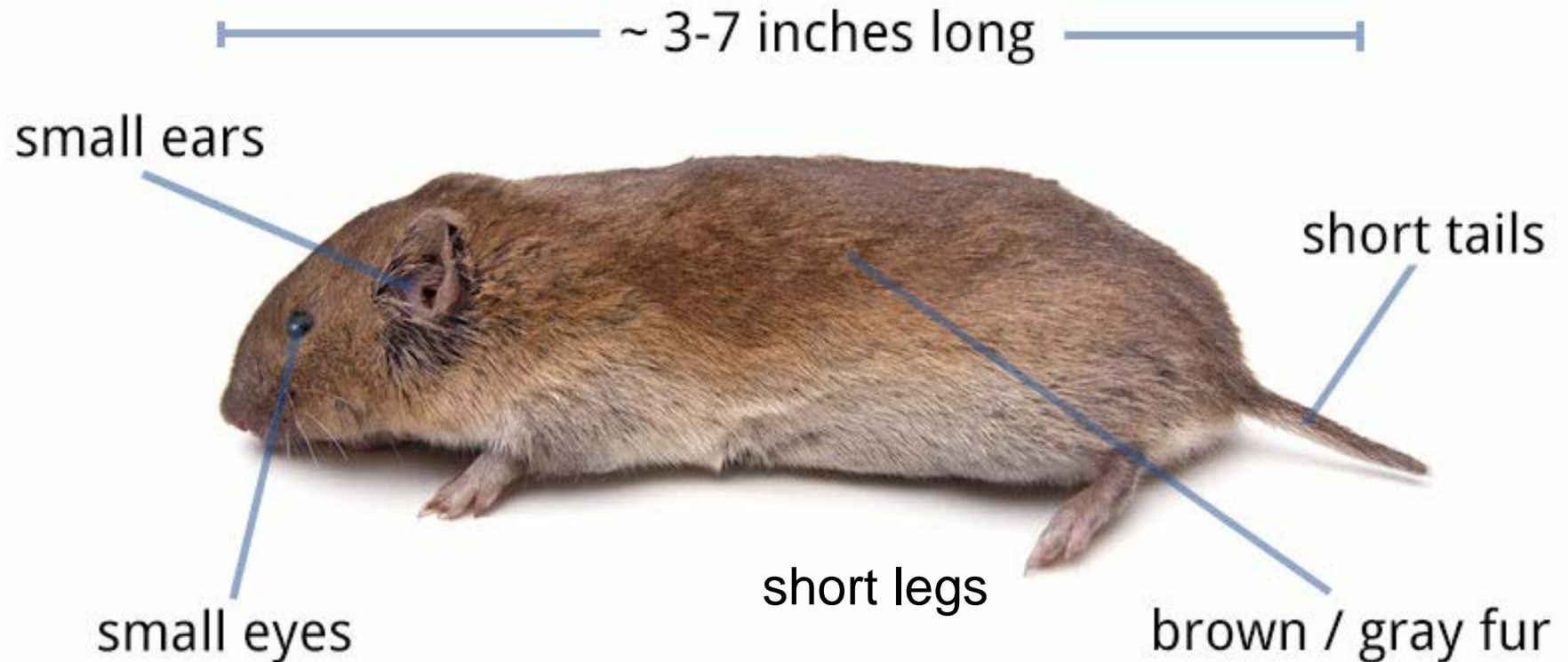
Hairy-tailed Mole  
*Parascalops breweri*





# Meadow Vole (*Microtus pennsylvaticus*)

## VOLE ANATOMY





# Distribution of Vole species in North America

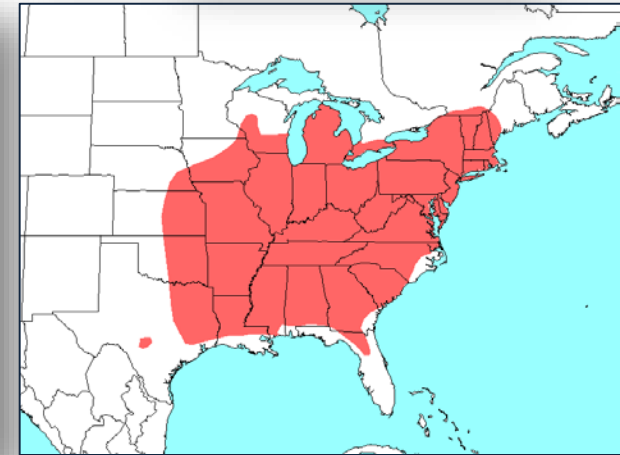
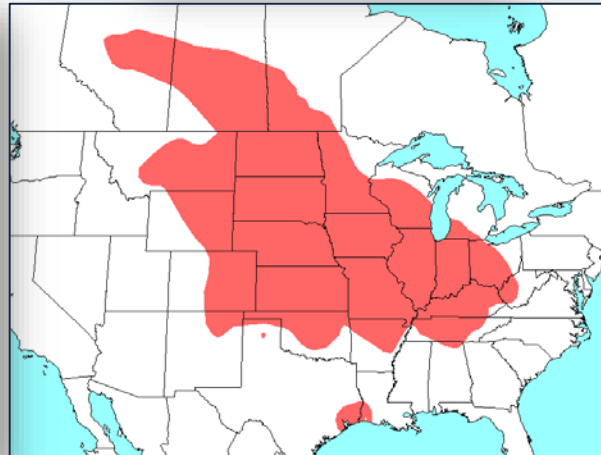
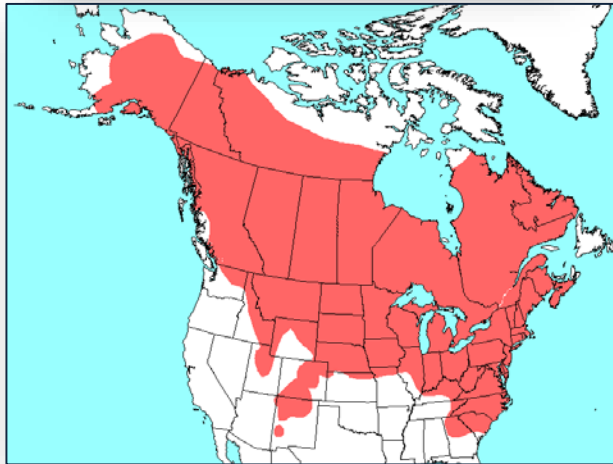
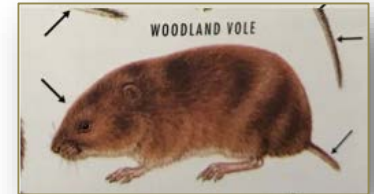
## Meadow vole



## Prairie vole



## Woodland vole



Source: <https://naturalhistory.si.edu>.

Credit: Data provided by NatureServe in collaboration with Bruce Patterson, Wes Sechrest, Marcelo Tognelli, Gerardo Ceballos, The Nature Conservancy — Migratory Bird Program, Conservation International — CABS, World Wildlife Fund — US, and Environment Canada — WILDSPACE.





Ecology and Behavior	Meadow vole <i>(Microstis pennsylvanicus)</i>	Prairie vole <i>(Microstis ochrogaster)</i>
Habitat	<ul style="list-style-type: none"> <li>• Reliant on heavy cover</li> <li>• Usually low lying, wetter areas</li> <li>• Cool season and native warm season grasses</li> </ul>	<ul style="list-style-type: none"> <li>• Tolerates sparse cover</li> <li>• Fallow fields, fence rows, open, dry areas</li> <li>• High densities in alfalfa fields; low in prairies</li> </ul>
Lifespan	2 to 18 months; ~6 months due to predation	Up to 24 months
Activity	<b>Year-round; voles do not hibernate</b>	
Home range	0.25 to 1.5 acres	
Food choices	Seeds, vegetation, roots, bark, fruits, insects; gnaw on irrigation lines/field tile	
Mortality	High: predators, parasites, humans, food scarcity	
Unique Characteristics	Most widely distributed	“yellow belly”



Reproduction	Meadow vole ( <i>Microstis pennsylvanicus</i> )	Prairie vole ( <i>Microstis ochrogaster</i> )
Lifespan	2 to 18 months; ~6 months	Up to 24 months
Reproduction	Multiple mates (territorial)	Single to few mates (social)
Offspring	High offspring: 4 to 8+ litters per year; up to 11 young per litter	Lower offspring: 2 to 4 litters per year; up to 7 young per litter
Gestation	21 days	20-23 days
Weaned	12-14 days	14+ days
Reproduce	21 days	~35-40 days
Possible offspring	40-50+	20-30+



## Male and female prairie voles and their off

Source: [www.smithsonianmag.com](http://www.smithsonianmag.com) (Todd Ahren)



- Made from piles of mixed grasses, sedges, and weeds.
- Located above or below ground.
- Winter snow cover provides thermal insulation and protective concealment.
- 1-2" shallow runways extend from nests so voles can search for food.
- Burrows have common areas for feces.
- Voles are active at night during the summer and in the daytime during the winter.



## Vole Population Dynamics

- Large populations fluctuations
  - Pop. peaks every 2-5 years
  - Unpredictable
- Prairie vole populations in Illinois
  - Tallgrass prairie = 6 voles/ac; peak = 96 voles/ac
  - Bluegrass field = 21 voles/ac; peak = 150 voles/ac
  - Alfalfa field = 40 voles/ac; peak = 257 voles/ac
- At what density do voles begin to cause damage?
- Populations are influenced by...

\*Meadow voles are the most common type of vole. Live in the northern areas. Have more litters and offspring than prairie vole. Typically wean 2.6 voles per litter with >80% mortality rate

Meadow voles:  
Average: 15-45 per acre  
Peak: 600 per acre

Summer litters are larger and more successful.





- **Boom and bust cycles** – generally run in 2-5 year cycles
- **Weather/Season**
  - Active year round. Forage in winter and do not hibernate.
  - Short Food Supply = >80% Mortality
  - Smallest vole numbers in the spring, but rapidly repopulate
- **Habitat/Cover**
  - Tall Cover = Less Predators
- **Food quality**
  - Prefer grasses & seeds (corn, wheat, oats, rye)
  - Love high protein diets: Legumes (clovers and peas, soybean cotyledons)
  - Tend to eat every 2-3 hours. Meadow voles may need free standing water.
- **Predators**
  - Most active 2-3 hours after dawn and 2-4 hours before sunset during the day. Very active nocturnally in summer.





- A colony's range can extend 15 feet to ¼ acre
- Voles are good swimmers and may travel over a mile to migrate
- **Scout for voles 30 days before planting.**
  - Economic threshold: 4 to 5 vole colonies in close proximity
  - Voles will significantly reduce corn or soybean stands during the first **21 to 28** days after planting.
  - Voles dig up and eat newly planted seed, soybean cotyledons and plants until they reach **6-10” tall**.
  - Voles also eat weeds and close vegetation.



Fresh clippings or droppings by a slick open hole indicates an active burrow. Voles often migrate to new food sources.





**PURDUE**  
EXTENSION

FORESTRY &  
NATURAL RESOURCES



Anywhere with permanent herbaceous cover



- Hay fields
- Hay bales
- Pasture
- Ditches
- Rock piles
- Lanes
- Roadside
- CRP
- Waterways
- Buffers
- Fence line
- Cover crops
- Wooded edge
- Logs
- Brush piles

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# Major Vole Food Sources

- 1) **Red Clover**
- 2) **Alfalfa**
- 3) **Dandelion**
- 4) Perennial ryegrass
- 5) Orchard grass
- 6) **Tall Fescue**
- 7) **Giant Ragweed**
- 8) Japanese Brome
- 9) **Curly Dock**
- 10) Timothy
- 11) Pennycress
- 12) Sedges
- 13) Bracted Lady Thumb
- 14) Multiflora Rose
- 15) Spotted Spurge
- 16) Asters
- 17) Velvetleaf
- Wild Strawberry

**(Dejeco & Batzli, 2013)**

## **Cover Crops Voles Like!**

- 1) **Cereal rye**
- 2) Oats/Barley
- 3) Wheat
- 4) Sorghum Sudan
- 5) Millets
- 6) Clovers
- 7) Winter peas
- 8) Canola/Rape
- 9) Sunflower
- 10) Buckwheat

## **Voles Dislike!**

- 1) **Crimson Clover**

## **Vole sometimes eat**

- 1) Insects, slugs, snails
- 2) Meat if hungry

## **Voles Love to Eat**

- 1) **Soybean seed**
- 2) **Soybean cotyledons**
- 3) Corn seed
- 4) Wheat seed
- 5) Broadcast seed
- 6) Weed seed

## **Vole food in winter**

- 1) **Stored seeds**
- 2) **Grain**
- 3) Bulbs
- 4) Bark on shrubs and trees





100%.

This 60 acre soybean field made 8 bushel per acre in Wood County, Ohio.

Alan Sundermeier  
OSU Extension  
James Hoorman, NRCS  
Soil Health Specialist

**No Midwest Threshold but > 5 vole colonies per acres is a concern!**





No-till soybean field in Putnam County. Replanted beans being eaten by slugs and voles. Photo taken on June 26, 2017.

# Drones may Identify Damage





Entrance holes to tunnels



- Voles represent 40% of mammals in agricultural areas.
- Major food source for most predators.
- Home range is 10-15 feet from burrows up to .25 acres in size.
- Juveniles may stay with adults for periods of time if food quality is high.



Vole tunnels under cover residue

Slide prepared by:  
Alan Sundermeier, OSU Extension & James  
Hoorman, NRCS Soil Health Specialist

Burrows are located under the fast growing circles, providing the voles with protection from predators. Fewer voles found along woods and fencerows **IF** predators are present.



Slide prepared by:  
Alan Sundermeier  
OSU Extension &  
James Hoorman,  
NRCS Soil Health  
Specialist





# Vole Damage



This barley field was tilled twice before planting 10/9/16, image taken on 1/1/17. Tillage helps control voles – but need to space out tillage passes and not create a green bridge. Over wintering cover crops should be evaluated before planting.

Red clover, alfalfa, and soybeans are favorite foods!

However... voles do not appear to eat or like Crimson Clover!





## Cover Crops (CC)

- Grass and clovers seem to be the most attractive to voles.
- Rotate mixes and **do not broadcast CC seed.**
- Selecting a cover crop mix that contains **50%** species that winter kill.
- Plant cover crops that are not food sources (**crimson clover**)
- Drill CC, do not allow any grass to mature or create a seed head as food sources.



- Increase exposure!
- Purdue University found that early termination + mowing were the two most effective vole control measures.
  - Use herbicides to terminate cover crops at least 30 days before planting (Minimum 21-28 days).
  - Mow vegetation/cover to less than 8 inches to open landscape up to predators.
  - Keep field borders mowed close as well
- For NRCS technical and financial assistance programs, discuss these practices with your conservation planner before implementing. Mowing may affect other resource concerns (wildlife, rabbits, quail) and practice requirements.





- Avoid planting cover crops that are too tall or thick, especially if high vole populations are present at harvest
- Avoid planting grasses and seeds that provide a food source; choose crimson clover.
- Keep the cover crop vegetation low by either mowing or modifying the cover crop seeding mixture. Plant 50% cover crop varieties that winter kill to reduce cover. Good mixture: Drilled oats, crimson clover, radish.
- For cereal rye, reduce the rate by adding another cover crop species: cereal rye + radish, cereal rye + crimson clover. Do not broadcast seed, drill all seed.
- May need to plant an early maturing grain crop in order to plant crimson clover.



Dwayne Beck, SD University soil health research

Long-term NT, Diverse Cover Crop Mixtures  
High residue, High SOM  
Zero Fungicides and Insecticides for 10 years  
This site had no corn rootworm damage, which is  
the #1 pest of corn in South Dakota. Why??



©MARLIN E. RICE

Inserted 1,000 rootworms eggs per foot in this Corn field,

Found that 19% of predators ate corn rootworm (11% is normal)

However, **Found 1 billion predators per acre!**

**Corn root worms are “yukkie”. Nothing likes 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.**

**95% of insects and nematodes are beneficial!**



- Oregon State University
- Purdue University
- Penn State University
- Ohio State University
- Kentucky Extension
- Missouri Extension
- Tennessee Extension
- University of Illinois
- Michigan State University
- NRCS Agronomy Crib Notes
- Dakota Lakes Research Farm



## Images

Universities listed on right

AgTalk

My Temple of Nature





United States Department of Agriculture

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