



Slime time: Frontiers in slug and snail management in North America

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Gastropods = Slugs + Snails




Our relationship with slugs and snails


- Traditionally a repulsive organism



- Slug phobias - American Journal of Clinical Hypnosis

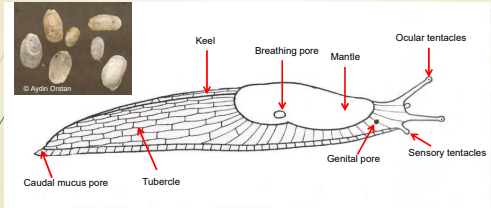
Shell-less snails!

- Slug = snail minus an external shell!

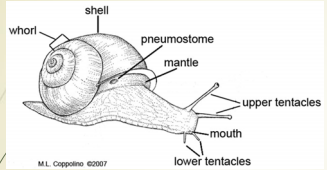



- Advantages of no shell:
 - Squeeze through very tight spaces
 - Live in environments that snails cannot
 - Move more quickly i.e. 14.4 meters/hour!

Slug Body Plan

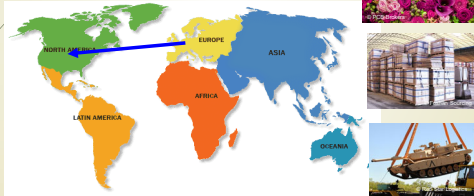


Snail Body Plan

Slugs and snails in the US

- What species are causing the most damage?
- Invasive slugs and snails
- Predominantly from Europe



Question block 1

Shelled Slug - *Testacella haliotidea*



Current control options

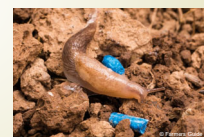
- Chemical molluscicides
 - Metaldehyde e.g. Slug-Fest®, Metarex
 - Iron Phosphate e.g. Sluggo®
 - Sodium Ferric EDTA e.g. Slug Kill®
 - Methiocarb e.g. Mesurol 75-W®
- Tillage
- Handpicking
- Traps



Question block 2

General tips for management

- Ensure a uniform distribution of baits to maximize likelihood a slug/snail will encounter a pellet
- Never** pile metaldehyde bait into mounds
- Ideal conditions: 50 - 65° F, high humidity but no rain, overcast, wind <5 mph, and moist soil
- Water in the morning not in the evening
- Broad spectrum insecticides can kill predators (e.g. ground beetles) and this can cause a significant increase in slug/snail numbers
- Minimizing weeds will reduce alternative food sources and shelters



General tips for management

- Work the first 4 to 6 inches of soil
- Use a trap e.g. boards/shingles, beer trap
- Consider using slug/snail resistant plants e.g. ferns, nasturtium, foxglove



New approaches to control

- Novel attractants
- Biological control using natural enemies

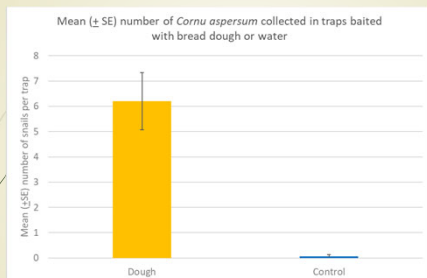


1. Novel attractants

- Chemical cues play roles in feeding, predator avoidance, alarm responses, species recognition, and reproduction in gastropods
- Cornu aspersum* - odor of carrots (Baker et al., 2012)
- Can we exploit this behavior to detect and control pest species?

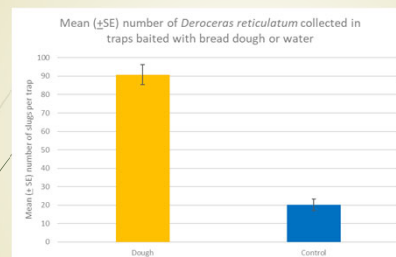


Novel attractants



- Significantly ($P < 0.001$) more snails collected in dough traps compared to controls

Novel attractants

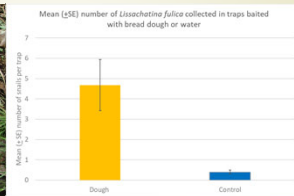


- Significantly ($P < 0.05$) more slugs collected in the dough traps compared to controls

Novel attractants



20 dough traps and 20 water control traps; 24hrs

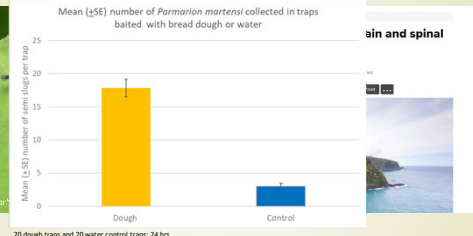


- Significantly ($P < 0.01$) more snails collected in the dough traps compared to controls

Novel attractants



20 dough traps and 20 water control traps; 24 hrs

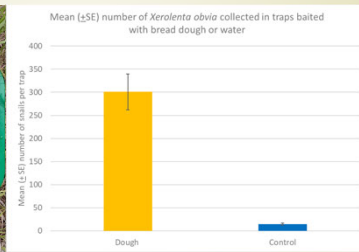


- Significantly ($P < 0.001$) more semi slugs collected in the dough traps compared to controls

Novel attractants



60 dough traps and 60 water control traps; 48 hrs



- Significantly ($P < 0.001$) more snails collected in dough traps compared to controls

Synthetic bread dough odor

- Lots of interest from industry
- Incorporating yeast into slug pellets likely to be problematic even though most baits already contain flour
- Can we recreate the odor of bread dough using lab chemicals?
- Synthetic bread dough blend would give us more control over attractant



- More attractive and more effective slug and snail baits



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2. Biological Control

- Use of natural enemies to suppress pest population
- Under researched for gastropods even though:
 - Diverse range of natural enemies
 - Biological control agent is available in Europe

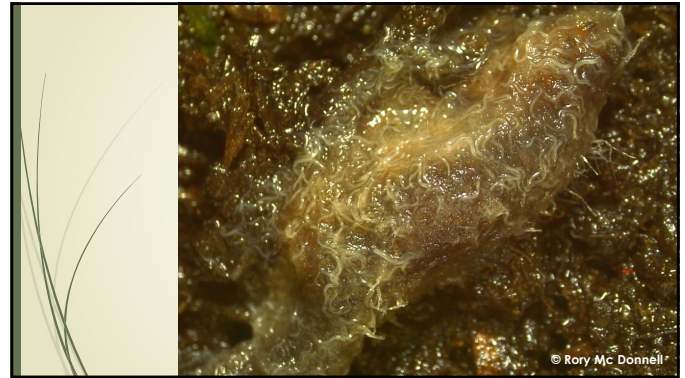
European commercial product



- Nematode: *Phasmarhabditis hermaphrodita*
- Lethal to pest slugs and some snails
- 12 million infective juveniles in clay
- Easy to apply
- Gastropod specific
- 89% reduction in damage to winter wheat
- >95% reduction in orchid damage

Nematode Surveys

- Not currently available in North America
- 2014: Nematode discovered in California
- Surveys in crops throughout PNW
- 7,500 slugs and snail from 60 sites
- Slugs kept in containers with moist paper and organic carrot
- Checked for cadavers every other day



Nematode surveys - Oregon



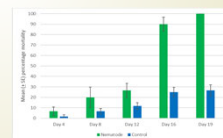
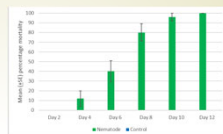
- How lethal is the U.S. strain to key gastropod pest species?

Nematode infectivity

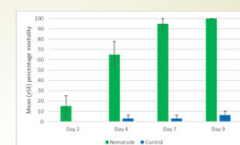


- Infectivity trials with *P. hermaphrodita*
- 20,000 nematodes per arena, or no nematodes (control)
- Target pest slugs or snails
- Five replicates
- Mortality recorded daily

Infection trial results



Infection trial results

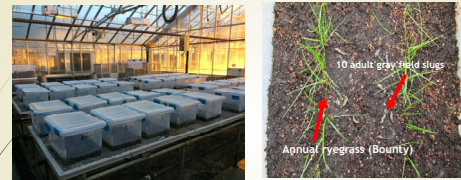


Three of the most damaging slug species in PNW agriculture are highly susceptible to the U.S. strain of *Phasmarhabditis hermaphrodita*

Additional infection trial results

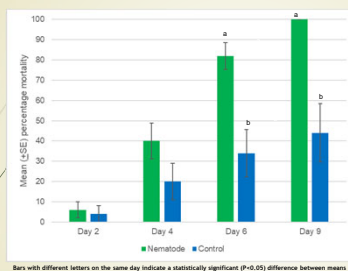


Microcosm



- Nematode at recommended rate for Nemaslug® (30 IJs/cm²) or water
- Five replicates per treatment/control
- Slug mortality recorded daily

Microcosm



Data confirm that U.S. strain of *Phasmarhabditis hermaphrodita* is lethal to the gray field slug

Next step!

- Are native non-pest slug and snail species susceptible to the U.S. strain of *Phasmarhabditis hermaphrodita*?



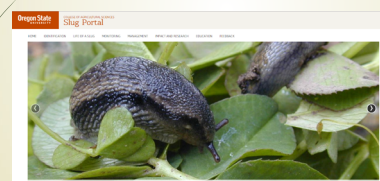
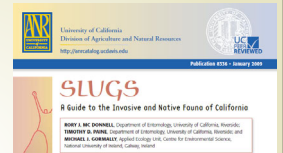
Native species not susceptible

Pathway to commercialization will be easier

Question block 3

Additional information

- Free guidebook:
<https://anrcatalog.ucanr.edu/pdf/8336.pdf>
- Slug Portal:
<http://agsci.oregonstate.edu/slug-portal>



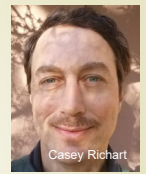
Question block 4

Acknowledgements

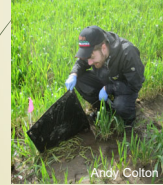
- U.S. Department of Agriculture
- Oregon Department of Agriculture
- California Department of Agriculture
- European Union
- Oregon Seed Council
- Oregon Association of Nurseries



Chrissy Dodge



Casey Richart



Andy Colton

- | | |
|-------------------------|-----------------------|
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