GROWING KNOWLEDGE

Series content is coordinated by Dr. Jay Pscheidt, professor of botany and plant pathology at Oregon State University in Corvallis, Oregon.

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Slugs and snails can leave behind more than just slime. The trail of destruction these pests impart includes unsightly holes on plants, such as the damage shown on this hosta.
PHOTO BY ROBIN ROSETTA

Got slime?

By Rory McDonnell & Robin Rosetta

THE COLLECTIVE SCIENTIFIC name for slugs and snails is *Gastropoda*, which goes a long way towards explaining the headaches these invertebrates cause nursery owners throughout the Pacific Northwest.

Literally meaning "stomach foot" from the Greek words *gastér* and *podòs*, gastropods make light work of a large number of nursery plants. What's more, these slime machines can vector many damaging plant diseases, such as bacterial soft rot, and there have also been reports of them transmitting human pathogens such as *Escherichia coli*.

To top things off, their unsightly mucus and feces reduce the aesthetic quality of plants.

There are 124 different slug and snail species living in the state of Oregon. Of these, 28 are exotic or non-native and are considered

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pests. Many species infest nursery plants but some of the most important include the following:

European brown garden snail (*Helix aspersa*)

As its name suggests, this snail is originally from western Europe but was accidentally introduced to the West Coast in the 1850s. This species is a highly prized food item (escargot) in Europe, particularly in the Mediterranean region.

It currently presents one of the greatest risks to nurseries, given its status as a quarantine pest and its establishment in sites around Oregon and Washington. It feeds on both living and dead plants.

Amber snails (*Succinea* spp.)

These semi-aquatic species are usually found in the wetter parts of nurseries, such as drainage areas, but also on low areas of planting beds at the interface of wet and dry areas, on the container lip of well-watered plants and in foliage of ground covers.

Most species of amber snails found in nurseries feed on decaying plants, algae and moss, but some also eat plants. The most common hosts affected appear to be hibiscus, hydrangea and *Phormium* in western nurseries.

In late summer and fall, amber snails have been found in the canopies of shade trees as they escape the heat. Increasingly they are considered a contaminant pest species in shipments, whether direct feeding damage is observed or not.

Gray field slug (*Deroceras reticulatum*)

This slug is one of the most damaging and widespread invasive slugs on the planet. It lives in a wide range of environments but is most abundant

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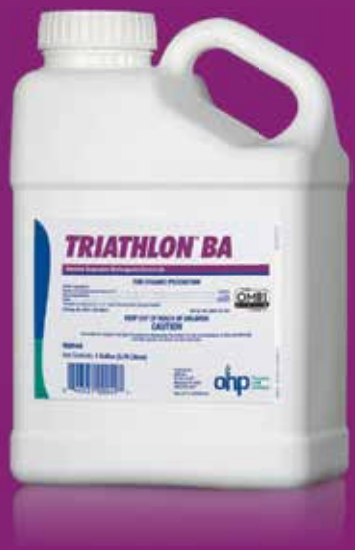

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in disturbed areas such as nurseries, garden centers, gardens, garbage piles, parks, roadsides, hedges, ditches, pasture and arable land.

It is a very serious agricultural and horticultural pest, targeting seedlings, leaves, flowers and bulbs.

European red slug (*Arion rufus*)

This, the largest invasive slug in Oregon, can reach a length of 7 inches when fully grown. It ranges in color from orange to reddish brown and has a distinct orange foot fringe with black lines.

The European red slug is an omnivore and will happily feed on live plants, dead plants, fungi, animal feces and carrion.

Three banded slug (*Lehmannia valentiana*)

A medium-sized slug (up to 3 inches), it has distinct, dark "tram" lines on its back, often running the full length of the body. This species is originally from Spain and Portugal, but is a pest of garden centers, nurseries and greenhouses throughout North America.

It is a particularly serious pest of flowers, such as orchids, and is thought to be intolerant of cold climates.

Greenhouse slug (*Milax gagates*)

This slug was reported as an important greenhouse pest in Oregon as far back as the 1940s. It is a medium-sized slug (up to 2 inches) and is thought to live primarily underground.

It continues to be common in nurseries and probably spends most of its time within the soil of potted plants and plant trays. It is thought to be sensitive to frost and consequently, the mild winters in western Oregon likely promote its survival here.

Management and control

Similar to other plant pests, risks from snails and slugs are best managed with an integrated pest management program.

An IPM program for slugs and snails contains key elements including correct identification of these pests, an understanding of their biology, consistent monitoring activities, and a multi-tactic strategy that includes cultural, physical, biological and chemical controls.

Control begins with knowledge of which species are present. Some slugs like cool temperatures and some like warm temperatures. Growers must effectively schedule management activities for the whole array of damaging species present, which might be active at different times of the year.

Monitoring should take place on a regular basis. During the day, slugs and snails retreat to moist areas where they are protected from the sun. Look under containers, particularly the drainage holes and under the side rims. Check for slugs and snails under plant debris, wood and along the edges of fields.

The best time to see slugs is early in the morning or just after sunset, particularly if there is moisture from rain, irrigation or dew. Slime, black fecal remnants and rasping feeding damage may indicate slug activity.

Cultural management is generally aimed at reducing or eliminating moisture, a key requirement for slugs and snails. Focus irrigation only where you need it, such as by use of drip irrigation. Where that option is not practical, work on quick drainage by having the proper slope, tiles or sufficient gravel to dry quickly. Reduce any debris areas and standing weeds that could provide moist habitat.

Sanitation efforts such as cleaning up pruning debris, raking or blowing leaves, and reducing moss buildup can greatly reduce the food and habitat available, particularly for amber snails. Physical barriers, such as copper strips, can be used

ONLINE RESOURCES FOR THE IDENTIFICATION OF SLUGS AND SNAILS

- The new OSU Slug Portal — **http://agsci.oregonstate.edu/slug-portal**
- The PNW Nursery IPM website — **http://oregonstate.edu/dept/nurspest/mollusks.htm**

<< "Slugs and Snails in Oregon: A guide to common land molluscs and their relatives" — **https://www.oregon.gov/ODA/shared/Documents/Publications/IPPM/ODAGuideMolluscs2016ForPress.pdf**

around legs of greenhouse benches and other smaller areas. Cultivation can be very effective at reducing slug numbers.

Chemical management often begins in the winter in the Pacific Northwest as mild winters allow activity of cool temperature-adapted slugs, such as the gray garden slug. For many years, growers have relied on a few key active ingredients, such as metaldehyde (e.g. Deadline®) and methiocarb (Mesurol®).

Metaldehyde is best used when sunny, dry conditions develop shortly after a wet period when slugs and snails have been feeding. This product may present a risk if pets are around, particularly dogs.

Methiocarb works effectively even when cool, damp conditions are present but is a restricted-use pesticide.

The choices of snail and slug pesticides, known as molluscicides, have expanded with the introduction of iron phosphate (e.g., Sluggo®) and sodium ferric EDTA products (e.g., Ferroxx®) and combination products with spinosyn (Bug-N-Sluggo®). With these products, the slugs generally stop feeding, crawl away and die from starvation. One is less likely to find a poisoned slug or snail carcass, so efficacy is determined by assessing damage reduction.

Sulfur (Bio-Sul Slug and Snail Bait) and boric acid-based (Revenge Granular Ant Bait) products are also available. Additionally, there are slug repellents on the market, such as the wool-based product (Slug Gone), copper, cinnamon and garlic-based products.

Naturally occurring biological control agents for slugs and snails include birds, snakes, amphibians and insects, such as carabid beetles, but no commercially available product is currently available for use in U.S. nurseries.

However in Europe, a commercially available agent called Nemaslug® is being used by nursery owners to protect high-value plants, such as orchids, from slug and snail damage. The active agent in this product is a nematode (*Phasmarhabditis hermaphrodita*), which is lethal to a wide range of pest slugs and snails including many of the species causing damage in Oregon. However, because this nematode was not known in the U.S. until 2014, it is currently illegal to use Nemaslug here.

But, there is a bright spot on the horizon! Recently, Rory McDonnell and colleagues from the University of California discovered *P. hermaphrodita* from multiple locations in the northern part of »

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California, and the authors of this article have recently started screening slugs and snails collected throughout Oregon with the hope of finding the same nematode here. The ultimate goal is to open up the U.S. market for this effective biological control agent.

Also, recent and ongoing research by McDonnell has shown that certain essential oils, such as clove bud, could be used as a pre-shipment drench treatment for potted plants that are invested with eggs and juvenile European brown garden snails.

Essential oils and other plant extracts provide an important avenue for the development of novel molluscicides, because many plant extracts (e.g., clove oil, cinnamon oil) are exempt from pesticide registration requirements and pesticide residue tolerance requirements under Section 25(b) of the Federal Insecticide, Fungicide and Rodenticide Act. Such an exemption will greatly reduce the cost and time required for bringing a new molluscicide containing such oils to market.

In addition, plant extracts, such as essential oils, have a number of other advantages. For example, the primary component of many oils is non-persistent in fresh water, and in soils they are broken down to common organic acids by bacteria. Also, many essential oils are pleasant smelling and non-toxic to humans.

Although our battles with pest slugs and snails will likely continue long into the future, that future is getting brighter with the development of novel approaches to help growers tilt the scales more in their favor.

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Rory McDonnell is an assistant professor in the Department of Crop and Soil Science at Oregon State University.

Robin Rosetta is an assistant professor at Oregon State University's North Willamette Research and Extension Center.