



Ohio State HCS News

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Worm Behavior May Play Role in Weed Survival



Weed scientists at OSU have discovered that nightcrawlers play a role in weed survival by burying seeds in their burrows.

Common nightcrawlers, earthworms used for fish bait or seen squirming along sidewalks after a heavy rain, have been found to play a role in weed survival by seeking out and "collecting" seed, according to Ohio State University research.

The findings mark the first recorded associations between earthworm behavior and the dispersal of weed seeds by pulling and burying them in their burrows in crop fields. Such behavior may help explain the prolific nature of certain weeds in Ohio, such as giant ragweed.

Giant ragweed exhibits all the characteristics of a poor success rate: large seeds (.4 centimeters-1.5 centimeters), which means less seed production per plant and difficulty in becoming buried in soil to ensure successful germination and seedling establishment; overall poor seed quality; high losses due to consumption by mice and other granivores; and low longevity in the soil (one to nine years after establishment as opposed to 20 to 100 years for some other weeds). Yet, the native annual is so successful, it has been labeled as one of the most stubborn weeds in Ohio to control.



Dr. Emilie Regnier is researching how earthworms play a role in weed survival by seeking out and "collecting" seed.

"The discovery was rather accidental," said **Dr. Emilie Regnier**, an Ohio State University weed scientist with the Horticulture & Crop Science Department. "In a study to analyze why giant ragweed is so successful in crop fields, we found that earthworms were collecting the seed around their burrows, for reasons we have yet to determine." She and H&CS colleague **Dr. Kent Harrison** have spent the past five years studying such behavior.

Earthworms have been known to disperse small weed seeds by ingesting them and ejecting them in their casts, but their dispersal of seeds too large to ingest - by pulling them and burying them in their burrows - is relatively unknown.

"A research group in Germany recently reported that earthworms buried seeds through this same mechanism in laboratory studies, which suggests that this earthworm species commonly interacts with large seeds," said Regnier. "The association in the midwestern United States is all the more intriguing because nightcrawlers are an exotic earthworm species brought by settlers from Europe, and giant ragweed is a native plant, so the association of the two species is relatively new on the evolutionary scale."



Regnier estimates that about two-thirds of giant ragweed seeds buried by earthworms are capable of producing seedlings that emerge from the soil.

Regnier, who also holds an appointment with the Ohio Agricultural Research and Development Center, said that previous studies showed that animals, especially mice, would consume most of a giant ragweed seed crop. But the weed continued to pop up more frequently than anticipated, and even established itself in abandoned fields, meadows, and forest borders, which are ideal habitats for mice.

The primary means by which seeds escape detection by

granivores is burial in the soil. In field experiments conducted at Ohio State's Waterman Agricultural and Natural Resources Lab to record how long it took for giant ragweed seeds to disappear from the soil surface and become buried, Regnier noticed that the seeds were being moved and eventually found their way into small piles embedded around, and in some cases, inside what she realized were earthworm burrows.

"To verify that it was earthworms moving the seed, giant ragweed seeds were scattered on the soil surface inside plots that were fenced along the sides and top to exclude all other animals. The seeds were placed on the soil surface in a grid pattern in the evening and checked the following day," said Regnier. "We observed that most of the seeds had been moved during the night and piles of them were grouped around earthworm burrows."



An earthworm always leaves its tail in the burrow and reaches out to forage closeby.

Nightcrawlers live most of their lives in permanent burrows. At night they emerge to feed, foraging for organic debris that they drag inside their burrow where it decomposes and becomes digestible to the earthworms. Researchers have found that this earthworm species will gather all sorts of items -- stones, twigs, organic matter. In 1881, Charles Darwin, in his book "The Formation of Vegetable Mould, Through the Action of Worms with Observations on Their Habits," reported earthworms collecting glass beads and tile fragments.

"We are in a state of speculation as to why earthworms even collect seeds," said Regnier. One theory is that the outer woody hull that protects the seed serves as a food source, much like any other plant debris. "Earthworms have a highly developed chemosensory apparatus, and to them the seed may have the same 'taste' as plant litter," said Regnier. "We found that earthworms collect ragweed seeds as readily as they collect fragments of ragweed stems and leaves. It could be that they perceive the seed as a bit of organic matter they can use for food."

Another speculation is that the earthworms find the items appealing as a structural

element in strengthening their burrows.

Regnier is collaborating with Ohio State earthworm biology expert **Clive Edwards** to determine what factors attract earthworms to seeds and what benefit earthworms may derive from them. Whatever the reason, giant ragweed seed seems to be an earthworm's favorite item to collect, although they will collect other weed seeds, as well. In burrows at the Waterman Lab, researchers have found an average of 130 ragweed seeds per burrow and estimated that earthworms buried about 70 percent of all the seeds dispersed to the soil surface.

According to Regnier, seeds are buried by earthworms anywhere from on the surface to over 20 centimeters deep in the soil. Giant ragweed seeds germinate best from 1-4 centimeters in the soil, but can emerge from as deep as 16 centimeters.

"We estimate that about two-thirds of giant ragweed seeds buried by earthworms are capable of producing seedlings that emerge from the soil," said Regnier. "When a typical density of earthworms is 30-40 per square meter, and approximately 5,000 seeds are buried by earthworms per square meter, one could see how easily giant ragweed can survive and spread."

But why the high interest in giant ragweed seeds? Regnier said that unique seed design might play a factor in an earthworm's ability to grip and drag the seed back to its burrow.

"Giant ragweed seeds have a lot of variation in their shape and size, and they have ridges along the sides and a 'beak' at the tip of the seed, which might make it easier for the earthworm to grip it," said Regnier, equating how an earthworm grabs items to that of how something is grabbed with a sock puppet. "Things that are more round and smooth, like soybeans, may be more difficult for the earthworm to grip, although earthworms can also apply suction to move smooth objects."

Researchers are discussing whether the relationship between seeds and earthworms might be one of co-evolution. By burying the seeds, the earthworm may increase the chances of a seed's survival and establishment. In exchange, burial of the seed in the burrow may reward the earthworm by providing nutrients as the outer coverings of the seeds decompose, by strengthening burrow walls, or, ultimately, by providing a future supply of plant litter upon which the earthworm feeds.

"This relationship may explain why giant ragweed is able to establish itself, especially in no-tillage crop fields and undisturbed areas where granivores are plentiful and there are few means by which a large seed can become buried on its own," said Regnier. "With these findings we are able to better understand the factors that come into play as to why some plant species are successful and how they are able to better adapt to given conditions."

Researchers from the University of Illinois are contributing to the project. Research supported by the U.S. Department of Agriculture National Research Initiative Program on the Biology of Weedy and Invasive Species in Agroecosystems will continue on earthworm behavior and its relationship to seed dispersal and survivability.

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