SPECIAL FEATURE: Ecosystems, Evolution and Plant Soil Feedbacks

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Eco-evolutionary feedbacks in an invasive plant

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Ecological and evolutionary processes are often assumed to operate at very different speeds. People typically think of ecological interactions as fast (such as a predator hunting for prey or two plants competing for water). In contrast we usually think of evolutionary change as very slow (for example, it took many millions of years for mammals to evolve from reptiles). But these processes can, in fact, both work relatively quickly and affect each other on mutually relevant time scales. We call these eco-evolutionary feedbacks. Our study shows how an eco-evolutionary feedback between population growth and plant chemistry shapes the invasion process in a weedy invasive plant, garlic mustard (*Alliaria petiolata*).

Garlic mustard produces a chemical called sinigrin that it releases into the soil, where it acts as a competitive "weapon" against other plant species early in the invasion process. We show that garlic mustard plants that produce more sinigrin have higher survival rates early in their life cycle, particularly as seedlings and during the summer. These life history stages are important drivers of population growth. Populations that produce more sinigrin grow and spread faster and ultimately reach higher plant densities. Once an established population has pushed out other competitors though, garlic mustard plants primarily compete with each other. Because sinigrin is only useful to garlic mustard in competition with other species, populations evolve to produce less sinigrin as they age. These lower-sinigrin

Photograph provided by authors.

populations grow and spread more slowly and have lower average plant densities.

Our results illustrate how the evolution of a trait (sinigrin production) can influence the ecology of a species over periods from just a few years to decades, altering its trajectory of population growth and interactions with other species in the soil and the plant communities it invades. They confirm predictions that eco-evolutionary feedbacks occur in natural populations. Furthermore, they improve our conceptual understanding of what drives population growth, by highlighting the relationship of survival and reproduction to a critical competitive trait whose advantages decrease as populations age.