In return for these *Aphaenogaster* ants dispersing its seeds, bloodroot attaches a tasty "handle" that gives the ants a reward and a way to carry the seed to their nest. ALEX WILD

Don't crush that ant—it could plant a wildflower

By **Elizabeth Pennisi** | Aug. 11, 2020 , 12:00 PM

Trilliums, bloodroot, violets—many wildflowers of spring in eastern North America bloom thanks to ants. The tiny six-legged gardeners have partnered with those plants as well as about 11,000 others to disperse their seeds. The plants, in turn, “pay” for the service by attaching a calorie-laden appendage to each seed, much like fleshy fruits reward birds and mammals that discard seeds or poop them out. But there’s more to the ant-seed relationship than that exchange, researchers reported last week at the annual meeting of the Ecological Society of America, which was held online.

Far from just transporting the seeds, the ants are active gardeners, preferring some seeds over others and possibly keeping their charges safe from disease. “It’s becoming clear that it’s not a simple two-way interaction,” says Douglas Levey, an ecologist at the National Science Foundation.

The importance of this partnership is coming into focus as well. In forests disturbed by human activity, where ants can be scarce, seeds may not find their way to fertile ground, and ecosystems can suffer. “If ants are lost, then there’s a real chance that we will lose plants, as well as the other species that depend upon ants and plants,” says Judith Bronstein, an evolutionary ecologist at the University of Arizona.

Many ants eat seeds, but in deciduous forests in Europe and North America, Australian dry woodlands, and South African shrublands called fynbos, a few dozen ant species spare the seeds in favor of something better. Certain plants attach a nutritive glob called an elaiosome to their seed coats, which serves as lunch for the ants’ young and gives ants a handle on seeds that can be bigger than their head. Until now, researchers assumed the ants simply carry the seeds to their nests, feed the elaiosome to their broods, and deposit the seed either outside or inside at the colony’s “garbage dump,” which provides a fertile environment for sprouting. But Charles Kwit, an ecologist at the University of Tennessee, Knoxville, thought ants might help seeds with more than just transportation.

The common seed-dispersing ants in the genus *Aphaenogaster*, like others, secrete antimicrobial chemicals to clean themselves and fellow ants. Kwit wondered how those

disinfectants might affect the seeds' microbial communities—and their health. He and his graduate student Chloe Lash teamed up with Melissa Cregger of Oak Ridge National Laboratory to isolate and sequence DNA from microbes on the seed coats of three common ant-dependent plants: wild ginger, bloodroot, and twinleaf. To start, each species' seed had a complex and unique microbiome—its community of bacteria and fungi. But after an ant handled a seed, its microbiome shrank and became more similar to those of other handled seeds of different species, Lash reported at the meeting—apparently because of the antimicrobial treatment. Wild ginger and twinleaf also harbored fewer plant pathogens. The microbiome changes, Levey says, "could affect postdispersal seed predation, dormancy, seed viability, timing of germination, and health of the resulting seedlings."

Kwit's lab has also found that when it comes to seeds, ants have preferences that may influence the plants' success. In both the field and the lab, his student Chelsea Miller presented ants with seeds from various trillium species and found the ants were quick to pick up some species' seeds while leaving others to rot, Miller told the meeting. "So being less preferred really has consequences," Bronstein says.

To find out how ants make their choices, Miller and Susan Whitehead at the Virginia Polytechnic Institute and State University (Virginia Tech) used mass spectroscopy and other techniques to analyze the chemical makeup of elaiosomes. They found that ants pick seeds based on the specific combination and concentrations of oleic acid and other compounds made by the plant, 20 of which are unique to trilliums. The ants' tastes may affect plant species' distributions, says Kirsten Prior, an ecologist at Binghamton University: "Widespread trillium species [are] preferred by seed-dispersing ants compared to rare trillium species."

Human activities, too, can influence ant-seed partnerships. Many researchers assumed ants survive disruptions such as forest clearing and quickly move back into disturbed areas. But Katie Stuble, an ecologist at the Holden Arboretum in Kirtland, Ohio, found otherwise. "Land-use history impacts ant communities," she said at the meeting. Her arboretum covers 1416 hectares, much of it cleared for farmland at different times over the past century before the trees regrew.

Even in areas cleared decades ago, her team found higher concentrations of invasive

earthworms and lower concentrations of seed-dispersing ants than in forests that were never cleared. Earthworms break down fallen leaves and organic debris, possibly leaving too little cover for ants. “This suggests that there are huge impacts of past land use that probably run deeper than we previously suspected,” Stuble says. Those impacts could explain why secondary forests lack dense undergrowth, and why plants that rely on ants to disperse their seeds are scarce there.

At the meeting, Prior and her student Carmela Buono reported that a survey of 20 sites in northeastern North America showed a similar trend. Compared with never-cleared forests, secondary forests had fewer *Aphaenogaster* ants, which disperse up to 70% of seeds in a deciduous forest, Buono said. The secondary forests had less leaf litter and fewer decaying logs for ants to colonize. They also had more invasive slugs, which compete with ants by eating the elaiosomes—and leaving seeds behind, rather than dispersing them. The loss of seed-carrying ants “has major implications for forest communities and restoration,” Prior says. “To restore understory plant communities, we might also need to think about having to restore this important species interaction.” For example, it might help to ensure there are plenty of decaying logs and leaf litter for the ants to thrive in.

Bronstein notes that in the past, ecologists deciphered ants’ role as gardeners through painstaking observations. Now, she says, “There are exciting testable hypotheses, well-designed experiments, serious phytochemical analyses, and sophisticated statistical approaches,” as well as genome sequencing and fine-scale chemical analyses.

Melissa Burt, an ecologist at Virginia Tech, hopes these studies bring ants new respect. “Many people that I talk to about ants only know them as pests that are taking over their kitchens, but many ants perform important functions in ecosystems,” she says. “Seed dispersal is just one of those.”

Posted in: **Plants & Animals**
doi:10.1126/science.abe2802

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