Warmth under climate change has cascading effect, destabilizing forest ant communities

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As warmth was added, thermophilic ant species dominated the nesting boxes, making the community less stable. Credit: By Lauren Nichols, *Science Advances*

Adding warmth predicted in climate-change models destabilized forest

ant communities east of the Appalachian Mountains, a possible harbinger of disruption to the broader ecosystem, researchers, led by a Case Western Reserve University biologist, have found.

The five-year study in the Harvard Forest of Northeast Massachusetts and Duke Forest in the Piedmont Region of North Carolina suggests the loss of stability makes communities less resilient and slower to rebound when disturbed.

The results run counter to:

- Published studies suggesting animal communities will quickly shift to a different but stable state under climate change.
- Investigations that have suggested communities will maintain resilience as the Earth warms.

The research is published today (Wed. Oct. 26) in the journal *Science Advances*.

"We've had a unique opportunity to look under the hood of how these ant communities function,and how experimental warming affects their overall stability under climate change," said Sarah Diamond, an assistant professor of biology at Case Western Reserve and leader of the study.

"We've looked at not only at the direct effects of warming but at indirect effects mediated by altered species interactions," Diamond said. "There's good evidence the altered species interactions are affecting the stability of communities, making them more fragile and susceptible to environmental change."

By their numbers, ants comprise more than half the macroinvertibrates in North American forests. Harvard and Duke forests are home to 60 species.

The study focused on floor dwellers, which are important to the forest ecosystem as scavengers and seed dispersers. The insects aerate the soil and are regular prey to other animals. The species studied compete for food and nest sites and typically forage within a yard of their nest.

Heaters raised the temperature inside the chambers from 1.5 degrees Celsius to 5.5 degrees Celsius above ambient temperature in regular increments during the 5-year study. Credit: Lauren Nichols

The experiment

The scientists erected in each forest 15 chambers—pens 5.5 yards across, encircled with plastic sheets and left open wide at the top and open enough at the bottom to allow crawling insects to migrate in and out. The researchers installed four nest boxes with Plexiglas tops at the beginning of the experiment and four more halfway through.

At nine chambers at each site, heaters incrementally raised the temperature from 1.5 degrees Celsius to 5.5 degrees Celsius above ambient temperature during the study.

The researchers took censuses and collected other data monthly—except when snow covered the ground—and built a statistical model called a Markov model.

The results

In the unheated chambers, colonies of different ant species were frequently coming and going. Stability for the community as a whole was characterized by near-constant overturning of nesting sites with no vacancy between occupants.

"In the heated chambers, thermophilic queens and colonies were moving in and parking," Diamond said. "Other species couldn't take advantage of the nesting spaces, which had the overall effect of making the community less stable and slower to return to equilibrium—in the long run, this may make them susceptible to climate change."

Although the forests are separated by about 6.5 degrees in latitude and a mean average temperature difference of 5.8 degrees Celsius, warming destabilized the ant communities in both, the statistical model showed.

While loss of community stability translates to longer return times to equilibrium after disturbances, the long-term biological consequences

remain an area for future exploration. Within the timescale of the experiment, relative abundance of thermophilic species grew while heat-intolerant species declined in the warmed chambers. At the warmest, southernmost site in Duke Forest, the composition of ant communities already appears to be changing.

The researchers are investigating fine-scale interactions among species and correlating them with thermal tolerance. They are also extending the Markov model forward to try to answer whether communities return to equilibrium over a long period of time or never under climate change.

More information: "Climatic warming destabilizes forest ant communities," *Science Advances*, advances.sciencemag.org/content/2/10/e1600842

Provided by Case Western Reserve University