Scientists put the heat on microbes

March 24 2020, by Val Osowski

Pictured from left to right: Research assistant Keara Grady and MMG graduate students John Chodkowski and Jackson Sorensen in Centralia, Pennsylvania. Sorenson lead the experiment featured in the paper. Credit: Ashley Shade

Hurricanes, floods, drought and fire. Extreme weather events are becoming more frequent as the climate changes and can destroy entire landscapes—both visible and invisible.

Like humans, microbes need disaster response strategies that facilitate the rescue and recovery of their ecologically crucial communities.

But what do microscopic rescue efforts look like, and can humans help?

In a new study, published in a special issue of *Philosophical Transactions of the Royal Society B*, researchers in the lab of Michigan State University microbial ecologist Ashley Shade put microbes under extreme heat to find out.

"We know microbes provide crucial functions for maintaining the health of their ecosystems—they cycle nutrients, carbon and have important feedback with climate change processes," said Shade, an assistant professor in MSU College of Natural Science's Department of Microbiology and Molecular Genetics, whose research is supported by an National Science Foundation Early CAREER Award. "We want to get a good handle on how their function might change by exploring how quickly microbes recover after the change takes place and what we might we be able to do to manage them back to stability."

Between 20 and 80 percent of all microbes in the environment exist in a dormant state, like microbial sleeping beauties waiting for the right moment to wake up and function. In fact, dormancy is a wide-spread, bet-hedging strategy against famine and other suboptimal conditions that has evolved separately along every major branch of life. Some microbes can exist in this suspended, but viable, state for thousands of years.

"We know that there are ways microbes recover after a disturbance by replenishing their populations through dispersal through air and water," Shade said. "What is special about this study is that we looked at the contributions of dormant microbes as well."

Using sterilized canning jars filled with soil and their microbial communities, Shade and graduate student Jackson Sorensen designed three separate treatments.

The control received no treatment, but the second and third treatments were cooked to a sweltering 60 degrees Celsius—the temperature of an underground coal fire in Centralia, Pennsylvania that Shade has been studying for six years. After cooling, the second treatment was given dispersed cells from the control jars to boost recovery.

"We reproduced what would happen in the environment after a disturbance where dispersal is most likely from the next neighborhood over," Shade said. "We used just a tiny bit of it, not comprising a substantial volume, and the microbes grew after the disturbance subsided, showing a little dispersal can go a long way."

The third treatment was denied outside assistance. Instead, Shade and her team watched the jars to see what role dormant microbes played in returning the microbial community to a healthy, stable state.

"What we found was that both reactivation and dispersal contributed to how microbes respond to the extreme event," Shade said. "This is an important finding because it suggests that it is not just outside cells rescuing the population but also dormant microbes in the disturbed environment that reactivate and support recovery."

The nearly year-long experiment was not long enough to see the communities of microbes fully recover, even with the combined tools of dormant reactivation and outside dispersal. Still, Shade found value in what she describes as dormancy dynamics.

"This experiment gives us another strategy to manage microbial communities," she said. "Think about taking antibiotics for an ear infection that, as a side effect, kills beneficial microbes in the gut. Dispersal might be analogous to eating yogurt to recover those beneficial microbial functions, but another strategy could be to encourage the already existing, viable gut microbes to wake up and contribute to healthy functionality."

Rousing dormant microbes and understanding why they go into dormancy is an area of active research.

"Controlling dispersal in the environment is hard," Shade said. "Microbes can travel through water, the air, on insects and inside insect guts, and by hitchhiking on other animals as well. But controlling when microbes wake up and go to sleep could be another interesting strategy for managing them to support a healthy environment as we face a changing climate. One day, we may be able to wake up local microbes to help environments recover even faster after extreme events."

More information: Jackson W. Sorensen et al. Dormancy dynamics and dispersal contribute to soil microbiome resilience, *Philosophical Transactions of the Royal Society B: Biological Sciences* (2020). DOI: 10.1098/rstb.2019.0255

Provided by Michigan State University

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