Study helps clarify role of soil microbes in global warming

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(PhysOrg.com) -- Current models of global climate change predict warmer temperatures will increase the rate that bacteria and other microbes decompose soil organic matter, a scenario that pumps even more heat-trapping carbon into the atmosphere. But a new study led by a University of Georgia researcher shows that while the rate of decomposition increases for a brief period in response to warmer temperatures, elevated levels of decomposition don't persist.

"There is about two and a half times more carbon in the soil than there is in the atmosphere, and the concern right now is that a lot of that carbon is going to end up in the atmosphere," said lead author Mark Bradford, assistant professor in the UGA Odum School of Ecology. "What our finding suggests is that a positive feedback between warming and a loss of soil carbon to the atmosphere is likely to occur but will be less than currently predicted."

Bradford, whose results appear in the early online edition of the journal *Ecology Letters*, said the finding helps resolve a long-standing debate about how unseen soil microbes respond to and influence global climate change. Other scientists have noted that the respiration of soil microbes returns to normal after a number of years under heated conditions, but offered competing explanations. Some argued that the microbes consumed so much of the available food under heated conditions that future levels of decomposition were reduced because of food scarcity. Others argued that soil microbes adapted to the changed environment and reduced their respiration accordingly.

Bradford and his team, which included researchers from the University of New Hampshire, the Marine Biological Laboratory at Woods Hole, Duke University and Colorado State University, found evidence to support both hypotheses and revealed a third, previously unaccounted for explanation: The abundance of soil microbes decreased under warm conditions.

"It is often said that in a handful of dirt, there are somewhere around 10,000 species and millions of individual bacteria and fungi," said study co-author Matthew Wallenstein, a research scientist at Colorado State University. "Our findings add to the understanding of how complex these systems are and the role they play in feedbacks associated with climate change."

The researchers studied soil microbes at Harvard Forest in Massachusetts, the site of a soil warming experiment that began in 1991. Scientists took soil samples from two plots, one in which buried cables heat the soil to five degrees Celsius above the ambient soil temperature (a condition that is expected to occur around 2100) and a control condition in which cables are buried but not producing heat.

In the first set of experiments, the scientists compared microbial respiration in the two groups and found lower rates of decomposition in the heated plots. This finding supported the idea that respiration decreases after a few years of warming, but didn't explain whether the cause was substrate depletion in the warmer soils or adaptation by the microbes.

In the next set of experiments, they added the simple sugar sucrose to both sets of soils to alleviate any food limitation for the microbes. They found that microbes from both conditions increased their respiration, but that the increase was greater in the unheated control soils than in the heated soils. "That finding told us that substrate depletion played a role," Bradford said, "but it also told us that there were other factors involved."

The researchers then measured microbial biomass and found that there were fewer microbes in the heated soils. To test whether thermal adaptation occurred, they measured respiration while keeping temperature constant. They found that respiration rates were indeed lower in the heated versus the control soils, even when adjusting for microbial biomass.

Wallenstein pointed out that the study is among the first to demonstrate that microbes, like many plants and animals, can adapt relatively quickly to changes in climate. "This research presents a new challenge to scientists trying to predict effects of climate change on forest ecosystems because it shows that these soil microbial communities are very dynamic," Wallenstein said. "We cannot simply extrapolate from the short-term responses of soil microbes to climate change, since they may adapt over the longer-term."

Bradford notes that there is still much to be learned about how soil microbes respond to global warming. His team is currently working to understand whether the reduced microbial respiration in heated soils is caused by the adaptation of individual microbes, by shifts in species composition or a combination of the two factors. He warns against minimizing the role of soil microbes in global warming, even though his findings suggest that current models overstate their contribution.

"Although our results suggest that the impact of soil microbes on global warming will be less than is currently predicted," Bradford said, "even a small change in atmospheric carbon is going to alter the way our world works and how our ecosystems function."

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