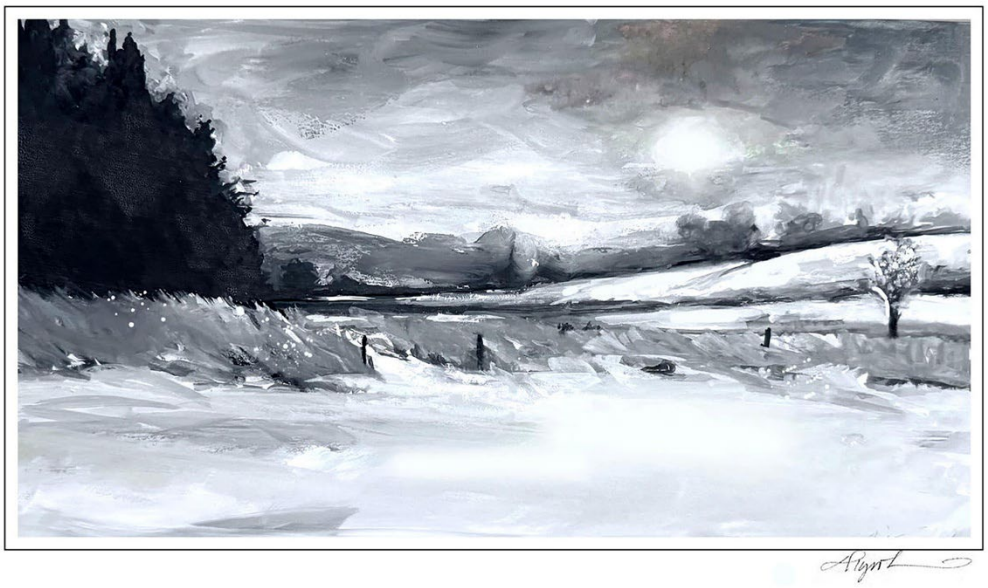
The Outside Story

Bundling Up: Soil Microbes in Winter

By Maggie Weng



Like any good animal, we sense the change of seasons through a hundred subtle clues. Leaves change and shed, becoming crispy piles underfoot. Geese cross the bright sky. Other signs of winter are harder to define: the morning chill deepens its bite, the afternoon light becomes pale. Although we may be aware that other creatures are preparing for the cold, building their nutritious stockpiles and cozy dens, few of us think about the ground beneath our feet. Yet here as well a whole world is getting ready for winter.

A handful of soil contains an invisible ecosystem as complex as the forest aboveground. Its citizens are microbes, mostly single-celled organisms. Microbes exist across all three domains of life: Eukarya, Archaea and Bacteria. Although they are often associated with dirtiness and disease, most microbes are indifferent to humans and thrive in every kind of natural environment. In forests they are guardians of soil health, responsible for breaking down dead matter and recycling nutrients. Forests store about one-third of our carbon emissions thanks in no small part to microbes, which help draw down carbon dioxide from the atmosphere and fix it in stable forms. But like most creatures, microbes are vulnerable to icy temperatures. How do they survive the harsh New England winters?

Many rely on a thick coat of snow to stay warm. It may seem counterintuitive, but snowpack actually helps insulate the ground beneath it, preventing the soil from freezing solid. Sheltered from the elements, microbes can continue the important work of decomposition, breaking down fallen leaves and recycling nutrients that will soon be needed by growing plants in the spring. But despite recent snowfall, snow here doesn't come like it used to; in the Northeast, warming temperatures have accelerated three times faster in winter than in spring and summer. To better understand how declining snowpack impacts forest soils, researchers at Dartmouth have set up an ongoing experiment called DeFROST that melts snowpack in experimental plots. By comparing their measurements to plots of

undisturbed forest, they found that removing snowpack allowed moisture in the ground to freeze, filling up the pore space and blocking the movement of oxygen and other gases. In other words, the soil couldn't breathe.

These changes altered the way microbes lived their lives as well. "[We found] a shift away from decomposition and nutrient recycling towards low-oxygen processes that could lead to the destabilization of stored carbon," said Joanna Ridgeway, a PhD student at Dartmouth and the lead author of the study. The lack of oxygen meant that microbes got their energy from processes that didn't require it, producing potent greenhouse gases such as methane and nitrous oxide. Longer term, Ridgeway worries that continued winter warming could decrease the ability of forests to store carbon by creating less nutrient-rich soils and increasing emissions.

"I feel like it's my job to bear witness to the end of winter," said Dr. Caitlin Hicks Pries, whose lab runs DeFROST. "We're losing winter really fast, and we don't even know what exactly is being lost. That's what we hope this project can help us figure out." She pointed out that the loss of winter snow also affects the rest of the year. Typically, winter microbial activity leads to a surplus of just the right nutrients during the growing season. If these processes are slowed or altered, plants will take longer to put out fresh growth, dragging stick season into mud season and leading to increased uncertainty about when to plant crops.

When snow does come to the Upper Valley, its dazzling surface makes the day after the storm a celebration. As a kid, I would sometimes lie on it – not to make snow angels or go sledding, but just to feel the way it cupped my body like memory foam. I would stay there until the snow started melting in my hat, sharing the silence with the hemlocks who tucked their roots in the hardworking dirt. I was warm in my winter coat and, though I didn't yet know about them, the microbes were too: safe, protected, bundled up.

Maggie Weng is a writer and scientist currently working as a NASA postdoctoral fellow. Illustration by Adelaide Murphy Tyrol. The Outside Story is assigned and edited by Northern Woodlands magazine and sponsored by the Wellborn Ecology Fund of New Hampshire Charitable Foundation: nhcf.org.

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