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Litterfall phenology effects on microbial community assembly and function

Research Highlights

- Longer and warmer summers have extended growing seasons and delayed the timing of leaf fall for temperate forests in the past few decades.
- Not all species of trees respond in concert, leading to a change in the order of leaves with different chemical and physical properties layering the forest floor
- Study on how leaf properties from three tree species (red oak, black birch, and sugar maple) affect the microclimate in which fungi and bacteria decompose
- Higher microbial biomass in leaf litter correlates with faster decomposition rate after 5 and 9 months.

Research Summary

In temperate forests, leaf fall provides both a pulse of nutrients into the soil system and a conversion of organic carbon into carbon dioxide (CO_2). This pulse of nutrients is vital to the growth of decomposer organisms and recycle nutrients back into the plants. Simultaneously, as these decomposers are breaking down organic carbon, they respire a majority of CO_2 that returns to the atmosphere. During these winter months and without leaves, deciduous trees also are not removing CO_2 from the atmosphere and further respiring CO_2.

The timing when plants lose their leaves affects annual CO_2 flux, however we observe that warming temperatures are not causing trees to hold onto their leaves longer in all species. Some, like oaks (*Quercus*), are holding on to their leaves longer, while others are losing their leaves at the same time of the year regardless of temperature. The different species have leaves with a range of chemical and physical properties: oak leaves, for example, have less available nutrients leading to slower decay with physical properties that trap moisture while beech (*Betula*) leaves have more available nutrients, faster decay, and are more prone to drying out.

Dr. Fiona Jevon takes plot measurements for moisture and temperature before collecting litterbags that have been in the field for four months.

Research Summary cont.

Locally, the rate of decomposition is controlled by moisture and leaf qualities, which are modified by the order of layering on the forest floor. How the layering of different types of leaf litter influences the microclimate and the ability for decomposers to break down the organic material is the subject of this research.

Dr. Fiona Jevon set up an experiment in the fall of 2020 to manipulate the order of leaf fall, creating hypotheses for different future scenarios where leaves from red oak (*Quercus rubra*), sugar maple (*Acer saccharum*), and black birch (*Betula lenta*), fall at different times in the autumn. For those species, we created treatments where the top layer of leaves was one of each of those species or itself being the top layer. After five and nine months, we removed the leaves and measured their decomposition rate and their microbial biomass along with site characteristics such as soil moisture and temperature. We additionally sampled the decomposing leaves for DNA signatures of what fungi and bacteria are actively colonizing the leaves.

Some preliminary results identify the magnitude of microbial biomass colonizing the leaves as a strong determinant of the rate of decomposition, but we are excited to learn about how the conditions created by the timing of leaf fall can modify the diversity and abundance of microbial decomposers.

Quercus rubra (red oak) leaves in a litterbag.