

# Forest canopies help determine natural fertilization rates

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In this week's issue of *Science*, a team of researchers from the United States and Sweden report on a newly identified factor that controls the natural input of new nitrogen into boreal forest ecosystems.

Nitrogen is the primary nutrient that dictates productivity (and thus carbon consumption) in boreal forests. In pristine boreal ecosystems, most new nitrogen enters the forest through cyanobacteria living on the shoots of feather mosses, which grows in dense cushions on the forest floor.

These bacteria convert nitrogen from the atmosphere to a form that can be used by other living organisms, a process referred to as "nitrogen-fixation." The researchers showed that this natural fertilization process appears to be partially controlled by trees and shrubs that sit above the feather mosses.

In the summer of 2006, the researchers placed small tubes, called resin lysimeters, in the moss layer to catch nitrogen deposited on the feather moss carpets from the above canopy and then monitored nitrogen fixation rates in the mosses. The studies revealed that when high levels of nitrogen were deposited on the moss cushion from above, a condition typical of young forests, nitrogen fixation was extremely low. In older, low-productivity forests, very little nitrogen was deposited on the moss cushion, resulting in extremely high nitrogen fixation rates.

Nitrogen fixation is an energy demanding process. Thus, when mosses

are exposed to high concentrations of bioavailable nitrogen, the cyanobacteria will consume this resident nitrogen rather than expending energy on fixing new nitrogen. Thus the nitrogen content of canopy throughfall acts as a regulator of newly fixed nitrogen into these boreal forests. For this same reason, elevated nitrogen deposition from pollution likely reduces moss nitrogen fixation rates. The moss would initially buffer the forest against the effect of nitrogen added as pollution or fertilizer; however, chronic elevated nitrogen inputs would ultimately eliminate this natural source of forest fertility.

The feather moss-cyanobacterial association provides a unique model system in which to study nitrogen feedback mechanisms. The cyanobacteria reside on the leaves, thus the nitrogen status of the canopy throughfall directly influences nitrogen fixation in the feather mosses. This direct expression of a nutrient feedback mechanism could not be detected in other nitrogen fixing plant species, such as legumes, that house their nitrogen fixing bacteria below ground and where soils and decomposing litter intercept and modify the nitrogen from throughfall before it reaches the bacteria.

These findings are important from a global standpoint, because feather mosses (and associated cyanobacteria) are the primary source of biologically fixed nitrogen in the boreal forest biome. The dominating feathermoss *Pleurozium schreberi* is also found in arctic and temperate biomes and thus may be the widest distributed individual nitrogen-fixing plant species on Earth. Understanding feed back mechanisms among dominating organisms that regulate fundamental ecosystem processes are integral to our ability to predict long term outcomes of global carbon dynamics.

Source: Swedish University of Agricultural Sciences

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