Symbiosis or capitalism? A new view of forest fungi

May 22 2014

A new study suggests that symbiotic relationships between trees and the mycorrhyzae that grow in their roots may not be as mutually beneficial as previously thought.

The so-called symbiotic relationship between trees and the fungus that grow on their roots may actually work more like a capitalist market relationship between buyers and sellers, according to the new study published in the journal *New Phytologist*.

Recent experiments in the forests of Sweden had brought into a question a long-held theory of biology: that the fungi or mycorrhizae that grow on tree roots work with trees in a symbiotic relationship that is beneficial for both the fungi and the trees, providing needed nutrients to both parties. These fungi, including many edible mushrooms, are particularly common in boreal forests with scarce nutrients. But in contrast to the current paradigm, the new research shows that they may be the cause rather than the cure for the nutrient scarcity.

In the recent experiments, researchers found that rather than alleviating nutrient limitations in soil, the root fungi maintain that limitation, by transferring less nitrogen to the trees when nutrients are scarce than when they are abundant in the soil.

The new study, led by IIASA Ecosystems Services and Management researcher Oskar Franklin in collaboration with the Swedish University of Agricultural Sciences, used a theoretical model to explain the new

experimental findings, by simulating the interaction between individual fungus and plant. It suggests that since each organism competes with others in trading nutrients such as carbon and nitrogen, the system as a whole may function more like a capitalistic market economy than a cooperative symbiotic relationship. The competition among trees makes them export excessive amounts of carbon to the fungi, which seize a lot of soil nutrients.

"The new theory pictures a more business-like relationship among multiple buyers and sellers connected in a network. Having multiple symbiotic trading-partners generates competition among both the fungi and the plants, where each individual trades carbon for nutrients or vice versa to maximize profits, not unlike a capitalistic market economy," says Franklin.

"Although doing business with fungi is a good deal from each tree's own point of view it traps the whole forest in nutrient limitation," he says.

Understanding boreal forest nutrient cycles is incredibly important for modeling climate change, because it influences how much carbon dioxide these regions can absorb, as well as how they are influenced by the increasing concentrations of greenhouse gases in the atmosphere. Franklin says, "This syndrome is aggravated by rising CO2. As more carbon becomes available to the trees, the limitation of nitrogen generated by mycorrhizae becomes even more important, possibly eliminating or even reversing the expected CO2 fertilization effect in boreal forest."

More information: Franklin O, Näsholm T, Högberg P, Högberg MN. 2014. Forests trapped in nitrogen limitation: an ecological market perspective on ectomycorrhizal symbiosis. *New Phytologist*. DOI: 10.1111/nph.12840

Näsholm T, Högberg P, Franklin O, Metcalfe D, Keel SG, Campbell C, Hurry V, Linder S, Högberg MN. 2013. Are ectomycorrhizal fungi alleviating or aggravating nitrogen limitation of tree growth in boreal forests? *New Phytologist* 198(1): 214-221.