Study finds fungi, not plant matter, responsible for most carbon sequestration in northern forests

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The study system consists of 30 islands of different sizes in the two large lakes, Lake Uddjaure and Lake Hornavan, near Arjeplog in northern Sweden. Credit: Karina Clemmensen

(Phys.org) —A new study undertaken by a diverse group of scientists in Sweden has found that contrary to popular belief, most of the carbon that is sequestered in northern boreal forests comes about due to fungi that live on and in tree roots, rather than via dead needles, moss and leaf matter. In their paper published in the journal *Science*, the team describes their findings after taking soil samples from 30 islands in two

lakes in northern Sweden.

Scientists have known for quite some time that northern forests sequester a lot of carbon—they pull in carbon dioxide after all, and "breath" out oxygen. But what the trees actually do with the carbon has been a matter of debate—most have suggested that it's likely carried to needles and leaves then eventually drops to the forest floor where over time decomposition causes it to leech into the soil. If that were the case, this new team of researchers reasoned, then the newest carbon deposits should appear closest to the surface of the forest floor. But this is not what they found—instead they discovered that newer deposits were more likely to be found at deeper levels in the soil. This was because, they learned, the trees were carrying much of the carbon they pulled in down to their roots (via sugars) where it was being sequestered by a type of fungi (*ectomycorrhizal*, aka mycorrhizal fungi) that eats the sugars and expels the residue into the soil.

Cortinarius armillatus forms mycorrhizal symbiosis with roots of birch trees. Credit: Karina Clemmensen

In their study they found that 47 percent of soil carbon found on large island samples came about due to fungi, as did a whopping 70 percent of carbon in small island soil samples. Thus far, the team is only able to guess why there are such differences in the soils, but theorize it's likely due to differences in decomposition rates.

The amount of carbon stored in northern forests and how, is important because such trees cover approximately 11 percent of the Earth's surface and recent research has calculated that they hold approximately 16

percent of all worldwide sequestered carbon. And that's important, of course, because as global warming occurs, more sequestered carbon is released due to faster decomposition rates of dead forest matter. What's still not clear, however, is whether an increase in new forest growth due to warmer temperatures in more northern areas is likely to offset the increase in release of the sequestered carbon.

More information: Roots and Associated Fungi Drive Long-Term *Carbon* Sequestration in Boreal Forest, *Science* 29 March 2013: Vol. 339 no. 6127 pp. 1615-1618 DOI: 10.1126/science.1231923

Abstract
Boreal forest soils function as a terrestrial net sink in the global carbon cycle. The prevailing dogma has focused on aboveground plant litter as a principal source of soil organic matter. Using 14C bomb-carbon modeling, we show that 50 to 70% of stored carbon in a chronosequence of boreal forested islands derives from roots and root-associated microorganisms. Fungal biomarkers indicate impaired degradation and preservation of fungal residues in late successional forests. Furthermore, 454 pyrosequencing of molecular barcodes, in conjunction with stable isotope analyses, highlights root-associated fungi as important regulators of ecosystem carbon dynamics. Our results suggest an alternative mechanism for the accumulation of organic matter in boreal forests during succession in the long-term absence of disturbance.