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Climatic controls of decomposition drive the global biogeography of forest-tree symbioses.

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Erratum in

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Abstract

The identity of the dominant root-associated microbial symbionts in a forest determines the ability of trees to access limiting nutrients from atmospheric or soil pools[1,2], sequester carbon[3,4] and withstand the effects of climate change[5,6]. Characterizing the global distribution of these symbioses and identifying the factors that control this distribution are thus integral to understanding the present and future functioning of forest ecosystems. Here we generate a spatially explicit global map of the symbiotic status of forests, using a database of over 1.1 million forest inventory plots that collectively contain over 28,000 tree species. Our analyses indicate that climate variables-in particular, climatically controlled variation in the rate of decomposition-are the primary drivers of the global distribution of major symbioses. We estimate that ectomycorrhizal trees, which represent only 2% of all plant species[7], constitute approximately 60% of tree stems on Earth. Ectomycorrhizal symbiosis dominates forests in which seasonally cold and dry climates inhibit decomposition, and is the predominant form of symbiosis at high latitudes and elevation. By contrast, arbuscular mycorrhizal trees dominate in aseasonal, warm tropical forests, and occur with ectomycorrhizal trees in temperate biomes in which seasonally warm-and-wet climates enhance decomposition. Continental transitions between forests dominated by ectomycorrhizal or arbuscular mycorrhizal trees occur relatively abruptly along climate-driven decomposition gradients; these transitions are probably caused by positive feedback effects between plants and microorganisms. Symbiotic nitrogen fixers-which are insensitive to climatic controls on decomposition (compared with mycorrhizal fungi)-are most abundant in arid biomes with alkaline soils and high maximum temperatures. The climatically driven global symbiosis gradient that we document provides a spatially explicit quantitative understanding of microbial symbioses at the global scale, and demonstrates the critical role of microbial mutualisms in shaping the distribution of plant species.

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