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Microbiome of forest soils: biodiversity, function and responses to global change

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Abstract:

Forests influence climate and mitigate global change through the storage of carbon (C) in soils. This is possible through the interplay of activities of trees – the dominant primary producers in forests and the microbiome in forest soils that have complex roles in ecosystem processes. The microbiome of forest soils consists of symbiotic fungi forming associations with tree roots (ectomycorrhiza or arbuscular mycorrhiza), saprotrophic fungi that mediate decomposition of organic matter in soil and bacteria that largely regulate the nitrogen cycling in soils. The health of the soil microbiome is partly expressed in its taxonomic and functional biodiversity that reflects the health and stability of tree stands. The intimate interplay between trees and the microbiome reflects the fact that tree-derived compounds are the major source of carbon for all soil microorganisms, received either in the form of dead plant biomass or directly through the mycorrhizal associations. As a consequence, the activity of the forest microbiome reflects the dynamics of the tree activity across the year. At present, forest ecosystems face multiple challenges associated with global change. These include increases in carbon dioxide, warming, drought and fire, pest outbreaks and nitrogen deposition. The response of forests to these changes is largely mediated by microorganisms, especially fungi and bacteria. The effects of global change differ among boreal, temperate and tropical forests. The future of forests depends mostly on the performance and balance of fungal symbiotic guilds, saprotrophic fungi and bacteria, and fungal plant pathogens. Drought severely weakens forest resilience, as it triggers adverse processes such as pathogen outbreaks and fires that impact the microbial and forest performance for carbon storage and nutrient turnover. Nitrogen deposition also substantially affects forest microbial processes, with a pronounced effect in the temperate zone. The understanding of plant–microorganism interactions helps to predict the future of forests and identify management strategies to increase biodiversity, ecosystem stability, C storage and mitigation of the greenhouse gas production.