Forest and Geoscience
E-Science Information

Forest and Geoscience

Volume 1 & Issue 2
Editorial

Forces Behind Forest Succession—Arbuscular Mycorrhizal and Ectomycorrhizal Competition

Zhen Bai

Institute of Applied Ecology, Chinese Academy of Sciences, Shenyang 110016, China

Corresponding author: Zhen Bai, Institute of Applied Ecology, Chinese Academy of Sciences, Shenyang 110016, China.

E-**mail:** baizhen@iae.ac.cn

Received: November 10, 2023; **Accepted:** November 17, 2023; **Published:** November 25, 2023

Editorial

Forests serve as crucial nutrient sinks and hotspots of biodiversity. Tree species richness and evenness explain 30-32% and 42-50% variations of soil carbon and nitrogen (N) in forest organic and mineral horizons, respectively [1]. A distinct resource-economy spectrum is evolved among coexisting trees, especially between acquisitive and conservative strategies [2,3]. Generally, conservative ectomycorrhizal (EcM) gymnosperms improve nutrient storage due to the biochemical recalcitrance of their residues, whereas acquisitive arbuscular mycorrhizal (AM) angiosperms facilitate the chemical binding of enriched nutrients in soil aggregation [2]. Thus, mixed-species stands, which exhibit diverse nutrient utilization adaptations, engage in a range of plant-soil interactions that support long-term ecosystem sustainability, ultimately generating a greater amount of standing biomass and resulting in superior soil carbon and nutrient storage compared to mono-specific stands [1,2].

The interplay of plant-fungus-soil is a crucial focal point in the accelerated nutrient cycle within forest ecosystems. The symbiotic relationships involving AM or EcM play a vital role in releasing essential nutrients, enhancing plant nutrient absorption, defending against pathogens, and fostering interconnections that uphold the vitality and succession of forests [2,3]. Both AM and EcM fungi excel in mining for rock-derived minerals and organic nutrients, assisting host plants in prioritizing resource access in exchange of plant photosynthates, and stabilizing aggregate structure and promoting soil fertility via their secretions [2,3].

Even though both AM and EcM fungi assist in plant nutrient absorption and growth, they have unique impacts on the interactions between plants and soil. Typically, AM symbiosis is linked with rapid and acquisitive nutrient usage, being particularly relevant in nutrient-rich environments. AM fungi rely on free-living decomposers to liberate nutrients bound to organic matter, benefiting host trees by providing highly accessible inorganic phosphorus (P). Large amounts of easily available inorganic P can further prime saprotrophic growth and favor an open (interdependent) and inorganic economy in the AM associated soil-plant continuum [2,3]. Trees hosting AM fungi have a high leaf N:P ratio, reflecting a greater reliance on P in AM associated plant–soil feedbacks [3]. EcM symbiosis, however, is more conservative, utilizing sources more slowly and adapting to environments with less available nutrients. EcM fungi produce a variety of enzymes to release nutrients bound in recalcitrant organic matter and primary minerals from parent materials, outperforming free-living saprotrophs (Gadgil effect) and displaying a closed (self-reliant) and organic N-economy [2,3]. Such mycorrhizal associated nutrient economies are adapted to specific ecological niches: AM symbiosis is crucial in P-demanding situations, while EcM symbiosis is necessary for plants in N-demanding conditions.

AM and EcM fungi are essential to the nutrient acquisition dynamics within forest ecosystems. Their competition for nutrients greatly influences soil nutrient availability and resource stoichiometry, consequently determining the function traits of the plant community. By adapting to—or even creating—either P-demanding (AM) or N-demanding (EcM) environment, these fungi can promote their own survival and proliferation. For instance, EcM fungi are well-adapted to N-deficiency to outcompete and short-circuit nutrient access. The preference to N is strategic as N is essential to plants and abundant host-derived organic N can be preferentially and directly used by EcM fungi. The AM versus EcM competition and their impacts on N:P stoichiometry are largely dependent upon climatic factors and edaphic variables [2-4]. These competitive advantages and fitness constraints remarkably contribute to local habitat specialization and distributional patterns of tree species at the community scale.

The intricate plant-fungus-soil interactions are fascinating and essential components of ecosystem dynamics. Fungal symbiosis contributes to improved conditions by developing biogenic structures to maintain constant humidity (80%) and temperature (30 ºC), accumulate organic carbon and enrich vital nutrients [5]. By recognizing and leveraging the vital role of AM and EcM fungi, we can optimize sustainable forest management practices, restore degraded areas, and mitigate global warming via changing resource availability and stoichiometry. In particular, priority should be given to increasing mycorrhizal host pool available for colonizing and maintaining a balance between tree species that host AM and EcM fungi.

References

1. Chen X, Taylor AR, Reich PB, Hisano M, Chen HYH, et al. (2023) Tree diversity increases decadal forest soil carbon and nitrogen accrual. Nature 618(7963): 94-101.
2. Augusto L, Boča A (2022) Tree functional traits, forest biomass, and tree species diversity interact with site properties to drive forest soil carbon. Nat Commun 13(1): 1097.
3. Weemstra M, Peay KG, Davies SJ, Mohamad M, Itoh A, et al. (2020) Lithological constraints on resource economies shape the mycorrhizal composition of a Bornean rain forest. New Phytol 228(1): 253-268.
4. Wardle DA, Lindahl BD (2014) Ecology. Disentangling global soil fungal diversity. Science 346(6213): 1052-1053.
5. Van Thuyne J, Verrecchia EP (2021) Impacts of fungus-growing termites on surficial geology parameters: A review. Earth-Sci. Rev223: 103862.