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Broad Survey of Fine Root Traits to Investigate the Root Economic Spectrum Hypothesis and Plant-Fire Dynamics Worldwide

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Abstract : Prairies, grasslands, and forests cover an expansive portion of the world's surface and contribute significantly to Earth's carbon cycle. The largest driver of carbon dynamics in some of these ecosystems is fire. As the global climate changes, most fire-dominated ecosystems will experience increased fire frequency and intensity, leading to increased carbon flux into the atmosphere and soil nutrient depletion. The plant communities associated with different fire regimes are important for reassimilation of carbon lost during fire and soil recovery. More frequent fires promote conservative plant functional traits aboveground; however, belowground fine root traits are poorly explored and arguably more important drivers of ecosystem function as the primary interface between the soil and plant. The root economic spectrum (RES) hypothesis describes single-dimensional covariation between important fine-root traits along a range of plant strategies from acquisitive to conservative – parallel to the well-established leaf economic spectrum (LES). However, because of the paucity of root trait data, the complex nature of the rhizosphere, and the phylogenetic conservatism of root traits, it is unknown whether the RES hypothesis accurately describes plant nutrient and water acquisition strategies. This project utilizesplants grown in common garden conditions in the Cambridge University Botanic Garden and a meta-analysis of long-term fire manipulation experiments to examine the belowground physiological traits of fire-adapted and non-fire-adapted herbaceous species to 1) test the RES hypothesis and 2) describe the effect of fire regimes on fine root functional traits – which in turn affect carbon and nutrient cycling. A suite of morphological, chemical, and biological root traits (e.g. root diameter, specific root length, percent N, percent mycorrhizal colonization, etc.) of 50 herbaceous species were measuredand tested for phylogenetic conservatism and RES dimensionality. Fire-adapted and non-fire-adapted plants traits were compared using phylogenetic PCA techniques. Preliminary evidence suggests that phylogenetic conservatism may weaken the single-dimensionality of the RES, suggesting that there may not be a single way that plants optimize nutrient and water acquisition and storage in the complex rhizosphere; additionally, fire-adapted species are expected to be more conservative than non-fire-adapted species, which may be indicative of slower carbon cycling with increasing fire frequency and intensity.

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