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Biogeochemistry and biodiversity interact to govern N2 fixers (Fabaceae) across Amazon tropical forests

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Dinitrogen (N2)-fixing trees in the Fabaceae fulfill a central role in tropical rainforests by supplying nitrogen from the atmosphere, yet whether they will support a forest CO_2 sink in the future by alleviating nitrogen limitation may depend on whether and how they are controlled by local environmental conditions. Theory predicts that soil nutrients govern the function of N2 fixers, yet there have been no large-scale field-based tests of this idea. Moreover, recent findings indicate that N2-fixing species behave differently in biogeochemical cycles, suggesting that any environmental control may differ by species, and that the diversity of N2-fixing trees may be critical for ensuring tropical forest function. In this talk, we will use the RAINFOR dataset of 108 ($\sim$1.0 ha) lowland tropical rainforest plots from across the Amazon Basin to test whether the abundance and diversity of N2-fixing trees are controlled by soil nutrient availability (i.e. increasing with phosphorus and decreasing with nitrogen), or if fixer abundance and diversity simply follow the dynamics of all tree species. We also test an alternative – but not mutually exclusive – hypothesis that the governing factor for fixers is forest disturbance. Results show a surprising lack of control by local nutrients or disturbance on the abundance or diversity of N2 fixers. The dominant driver of fixer diversity was the total number of tree species, with fixers comprising 10% of all species in a forest plot (R2 = 0.75, linear regression). When considering the dominant taxa of N2 fixers (Inga, Swartzia, Tachigali) alone, environmental factors (nitrogen, phosphorus and disturbance) became important and clearly governed their abundance. These taxa, which contain >60% of N2-fixing trees in the data set, appear to have evolved to specialize in different local environmental conditions. The strong biogeochemistry-by-biodiversity interaction observed here points to a need to consider individual species or taxa of N2 fixers and their differential constraints and roles in biogeochemical cycles across tropical forests. Such an individual-based perspective may improve our understanding of the ability of N2 fixers to overcome any future nitrogen constraints as CO_2 levels rise in the atmosphere.