Maximization of functional diversity and ecosystem multifunctionality in global drylands

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Abstract

Differences in functional traits may allow competing species to coexist, and the Niche Complementarity Hypothesis has been proposed to explain the well-established relationship between biodiversity and ecosystem functioning. However, the mechanisms responsible for the biodiversity-ecosystem function relationship and the extent to which niche differences matter for ecosystem functioning remain largely unknown. Here we show that the abundance distributions for two key plant functional traits - specific leaf area (SLA) and maximum plant height - maximize ecosystem multi-functionality measured as plant productivity and surrogates of C, N, and P cycling. In a global study of 124 dryland plant communities, there was a strong relationship between the skewness and the kurtosis of the trait-abundance distributions. At the biome scale, two families of trait-abundance distributions predicted a strikingly high trait diversity to occur within dryland plant communities. Any departure from these distributions led to a sharp decline in local multifunctionality. Trait diversity had a much stronger impact on ecosystem function than did plant species richness, abiotic factors such as aridity, and other variables hypothesized to affect multifunctionality. These biome-scale distributions provide the first confirmation that niche complementarity maximizes multifunctionality and underpins the relationship between biodiversity and ecosystem functioning.

Keywords: Biodiversity, plant functional traits, ecosystem multifunctionality, Niche Complementarity Hypothesis, global drylands

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