Plant productivity-diversity relationships: a modeling approach to understand the influence of species pool structure

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Abstract

The study of the relationship between the plant community diversity and productivity (here biomass) is a long standing subject in community ecology. However the shape of the relationship (positive, negative, unimodal) is a controversial issue that have raised considerable debates.
We present a theoretical model that simulates plant competition along a single resource gradient that we compare to empirical patterns. Plant species were characterized by four "traits": resource acquisition, mortality, tolerance to neighboring biomass and intraspecific competition. We evaluate the ability of the model to mimic community diversity and turnover along a resource gradient. We explore how the correlation between community diversity and biomass is influenced by trade-off among traits, size and the distribution of traits in the species pool.

Our study shows that species sorting along resource gradients is contingent on (1) a term of negative influence of neighboring biomass on plant relative growth rate and (2) trade-offs among theoretical traits that corresponds to classical functional trait syndromes.

Consistent with experimental results (e.g. Jena), increasing the size of the species pool at a constant resource level led to a positive relationship between biomass and community diversity showing the importance of complementarity effect among species. Yet, modifying the distribution of traits in the species pool along the resource gradient shapes distinct relationships between diversity and productivity such as positive, negative or unimodal.
Our model brings a theoretical milestone to the diversity-productivity debate: different structures of species pool can be a sufficient explanation to explain discrepancies among experimental and empirical studies.

Keywords: theoretical model, competition, resource, trait, species pool

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