New metrics of species' ecological niche to assess relationships between biodiversity and ecosystem processes

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Abstract

How biodiversity influences ecosystem processes, such as plant productivity, is still a challenging question. Among leading hypotheses proposed to explain the diversity-productivity relationship, Tilman's diversity hypothesis postulates that ecosystem processes are enhanced in more diverse communities because of complementary use of available resource between species, via niche partitioning. But surprisingly, niche complementarity has been mostly examined indirectly, via taxonomic, functional or phylogenetic facets of biodiversity, but not via species' habitat requirements. Here we propose two straightforward metrics to assess niche complementarity via species' ecological characteristics. It quantifies the diversity of ecological distances between local environmental conditions prevailing in a given habitat and the key synthetic parameters (optimum and margins) of the realized ecological niche of all species co-occurring within this focal community. We tested the effect of 'ecological-niche diversity' on productivity of the herb layer of contrasted forest ecosystems in N France at different spatial scales. We related aboveground biomass to various measures of species dominance, taxonomic, functional and phylogenetic diversity indices in addition to our newly elaborated index. We show that the abundance and traits of the most dominant species matter more than taxonomic, functional or phylogenetic diversity of the forest herb layer in explaining its aboveground biomass. Our ecological-niche diversity metrics also positively affects aboveground biomass, indicating that the latter increases with the divergence of species' closest realized-niche margin from the focal habitat conditions. We conclude that these metrics offer a new perspective on the relative importance of biodiversity for ecological processes.

Keywords: Ecological niche, Plant community diversity, Forest herb layer, Aboveground biomass, Biomass ratio hypothesis, Diversity hypothesis

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