Scale-dependent effects of plant diversity drivers in grasslands

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Abstract

Understanding what governs grassland biodiversity across different spatial scales is crucial for effective conservation and management. However, current evidence often focuses on single sampling grain sizes, leaving the mechanisms of biodiversity drivers and their scale-dependency unclear. Here, we investigated the impact of climate, soil properties, abiotic disturbance, and land use on plant diversity across fine spatial scales in various grassland types. We collected spatially explicit data on species presence, relative cover, and total community cover at two grain sizes (α- and γ-diversity) to assess the mechanisms driving scale-dependent diversity patterns (β-diversity). In our study, the most influential factors of plant diversity at both scales (grain sizes) were climate variables, followed by soil humus content, litter cover, and soil pH. The effects of soil and litter were primarily driven by the response of rare species, while climate and grazing effects were driven by locally common species. The strength of most of these effects varied between spatial scales and therefore affected β-diversity. We identified three key mechanisms through which these drivers affect the scale-dependency of biodiversity: total plant cover, species relative cover (commonness or rarity of species and species evenness in the community), and species intraspecific aggregation. Climate effects operated through changes in species relative cover and intraspecific aggregation. Soil humus influenced β-diversity by altering the total cover of the plant community and by increasing intraspecific aggregation, resulting in stronger effects of soil productivity on plant diversity at larger than smaller spatial scales. Microhabitat patchiness by litter altered distributions in the relative cover of species due to reduced asymmetric competition, and affected the total cover of the plant community. Our results underscore the importance of incorporating the scale-dependency of biodiversity drivers in conservation efforts, management strategies,

and analyses of global change impacts, which would enhance our ability to predict potential biodiversity change.

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