**Two-phase functional redundancy in plant communities along a grazing gradient in Mongolian rangelands**

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The concept of functional redundancy is at the core of theory relating changes in ecosystem functioning to species loss. However, few empirical studies have investigated the strength and form of the relationship between species and functional diversity (i.e., the presence of functional redundancy in ecological communities) in this context. In particular, we know little about how local extinctions in real communities might impact functional diversity. Here, we examined the relationship between species and functional diversity in plant communities along a grazing gradient across Mongolian rangeland ecosystems. We applied a recently described measure of functional diversity that incorporates species' dissimilarities defined from plant functional traits and tested several hypothesized forms of the relationship between species and functional diversity using linear and nonlinear modeling techniques. We found a significant sigmoid logistic relationship between species richness and functional diversity in relatively benign environmental conditions. This indicates high functional redundancy at low levels of species richness followed by a rapid increase at intermediate levels, until functional diversity reaches an asymptote at high levels (i.e., two-phase functional redundancy). In contrast, we generally observed a positive linear relationship between these parameters in relatively harsh environmental conditions, indicating low functional redundancy. Observed functional redundancy probably resulted from two factors, intrinsic redundancy in species' functional traits and extrinsic redundancy caused by nonrandom compositional change that is nonrandom with respect to functional traits. Lack of either intrinsic or extrinsic redundancy may result in low functional redundancy. Two-phase functional redundancy suggests that functional traits are abruptly lost from a community below a certain level of species richness, and a community then shifts into a contrasting state that has a few limited functional groups characterized by disturbance-resistant traits, as a consequence of disturbances such as livestock grazing. This study represents a major step forward in predicting the consequences of livestock grazing on the functioning of Mongolian rangeland ecosystems.

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