Quantifying spatial patterns of species diversity: integrating methods of spatial and diversity analyses

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Abstract

Spatial pattern of ecological diversity may result from the combine effects of various ecological processes: species migration/colinisation, dispersal of propagules, inter-individual competition/facilitation, habitat preferences, etc. While powerful methods exist for quantifying species diversity on the one hand and spatial patterns on the other hand, current methods do not take full advantage of an integrative approach that could improve robustness of inferences about ecological processes at the origin of observed patterns. We propose here such an integration based on Rao quadratic entropy for a flexible quantification of species diversity accounting for non-uniform between species differences (such as phylogenetic or functional differences) and well established methods of spatial pattern analysis. For the case of fully mapped data (for instance, trees beyond a given threshold in an exhaustively sampled forest plot), a distance-dependent quantification of the spatial variation in alpha diversity is obtained by combining Rao quadratic entropy with Ripley's *K*-function of second-order

neighbourhood analysis. For the case of discontinuous spatial samples (for instance, a network of independent forest plots), a distance-dependent quantification of the spatial variation in beta-diversity results from integration of Rao quadratic entropy within the framework of the variogramms. Beyond methodological consistency for quantifying spatial patterns of species diversity, this integration also allows the development of statistical tests of meaningful ecological mechanisms based on reference null hypotheses about either the spatial arrangement of individuals/samples, or the between-species relatedness as introduced in Rao quadratic entropy. Illustrations are provided based on simulated patterns as well as on observed patterns from tropical forest data.

Keywords:

Community structure and dynamics, indicators of biodiversity, measures of biodiversity, monitoring of biodiversity, multispecies models, spatial ecology, survey design and analysis