Quantifying pairwise relationships in biodiversity through time and space using long term data

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Abstract

Understanding the strength and predictability of changes in global biodiversity is critical for quantifying how taxa will respond to global change. By analyzing the relationships in population trends among taxa exposed to both biotic and abiotic pressures, we may be able to discern these patterns, potentially facilitating the formulation of predictive frameworks for their future shifts. However, the extent to which these pressures can describe changes in abundances over large spatial and temporal scales is vastly understudied. We use two global datasets containing abundance time-series (BioTIME) and biotic interactions (GloBI) to fit a series of hierarchical models testing whether the yearly change in abundance of any given genus is associated with the yearly change in abundance of another geographically proximal genus (i.e. genus pairs) within the same study. We then use posterior predictive modeling to assess the predictive accuracy for each genus pair from the modeled output. Finally, we test how associations and predictive accuracy are influenced by site latitude, GloBI interactions, disturbance, time-series length, and taxonomic classification to assess what ecological factors explain differences in associations and/or predictability. Generally, we find that abundance changes between genus pairs tend to be neutral to weakly positively associated over time and have good predictive accuracy as long as yearly changes in abundance are not exceedingly large (<=39%). Associations and predictive accuracy across genus pairs vary systematically across ecological factors and taxonomic identity, increasing with longer time-series, towards the equator, and in disturbed habitats. Our results show that global time-series data can illustrate meaningful, albeit variable, relationships between genera and that these patterns are shaped by known ecological factors. Overall, this suggests that by incorporating broad and accessible ecological information, we can improve forecast methods to mitigate biodiversity loss in an era of global change.

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