Stochastic community dynamics and time scale dependent turnover rates

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The current rate of biodiversity change is widely debated because of the pivotal role biodiversity plays for the functioning of ecosystems. Based on time series of planktonic foraminifera (amoeboid protozoans), sampled at different sites across the globe, and by using different community metrics we show how community turnover rates vary with respect to the temporal distance. While pronounced changes are found on the time scale of years to decades and on the millennial time scale, community evolution seems to slow down on intermediate time scales.

To assess the significance of these observations we employ a stochastic model of the community dynamics that preserves all linear correlations by constructing a surrogate ensemble of multivariate time series. Combining spectral information from different data sets (recent and palaeontological) we can model evolving ecological communities consistently across time scales ranging from seasons to millennia. Each realization of the modeled multivariate stochastic process is then transformed to the same format as related sample time series which includes at each instant the transition from concentrations to sample abundances and normalization yielding a sample distribution. Applying the same community metrics as before we can relate time scale dependent turnover rates to underlying mechanisms of ecological and evolutionary processes.

At the same time we highlight the importance of choosing adequate measures for quantifying community changes beyond the plain but widely used species diversity. While the latter may remain essentially unchanged either the rank-abundance curve or the species identity in rank assignment can change. While dominance shifts result quite naturally from species succession on the seasonal time scale, species origination and extinction are typically effective on the millennial time scale.

Finally, by using the available database we compare the temporal and spatial variability, thus challenging the space-for-time substitution frequently invoked in biodiversity change research.

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