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Stability criteria of complex ecological networks

Stability of large ecological systems has been a focus of theoretical ecology for more than forty years. Through qualitative analysis, ecologists seek to develop stability criteria for biodiversity maintenance in communities. Dispersal and density dependence have been well studied in the field but their contribution to stability is still unclear. Most inference were done using rather simple models, thus it remains to be seen how model realism, e.g., by considering nonlinear population growth and functional response, could affect stability. Following systems stability analysis, we here develop stability criteria for metacommunities with predator-prey interaction and provide numerical demonstrations for the derived criteria for such bipartite ecological networks. We demonstrate how dispersal and density dependence jointly affect the stability of metacommunities by way of eigenvalue distributions in the complex plane. We further highlight how a more realistic model could affect the stability criteria. This is done by considering the Holling type II functional response as a key factor in the trophic interactions. We investigate these factors by enumerating basic dynamical properties that bring a clear understanding on how stability of large antagonistic ecological networks could be improved. We found that both dispersal and density dependence of species were stabilising while nonlinear functional response destabilising the system. Our results highlight that metacommunities with antagonistic interactions are more stable than randomly assembled well-mixed communities.