Empirical and theoretical challenges to reconciling divergent perspectives on the diversity-disease relationship

Maxwell B. Joseph, Pieter T. J. Johnson

OOS: "The Community Ecology of Host-Symbiont Interactions: Breaking Boundaries and Crossing Scales"

Background/Questions/Methods:

Controversy has erupted in the field of disease ecology over the effect biodiversity on disease. Some of this controversy can be attributed to a relative paucity of empirical data, but some may also be due to an incomplete synthesis between empirical results and theoretical expectations. Theoretical and empirical investigations of this topic have proceeded in relative isolation, with some critical theoretical results being used little, and key empirical challenges being commonly overlooked by theoreticians. Here, we aim to identify opportunities for better integrating empirical and theoretical treatments of the effect of biodiversity on disease, using a combination of literature review and targeted mathematical modeling.

Results/Conclusions:

Based on published literature on diversity-disease relationships, we have identified three key issues that currently limit efforts to integrate theoretical and empirical findings. One of the first and most essential issues involves terminology. While disease risk and biodiversity are often of primary interest, both are multidimensional concepts. Explicit decompositions of these dimensions will help to clarify key questions in this field. For example, the perceived effect of biodiversity on disease risk is likely to vary depending on what components of diversity (e.g. host richness, host functional diversity, habitat heterogeneity) and disease risk (e.g. transmission rates, prevalence, incidence, parasite invasion, parasite richness) are being considered. Disease risk in particular suffers from an additional problem: some components may be easy to investigate theoretically (e.g. R0), but difficult to estimate empirically. Second, there is a common misconception that the dilution effect is only expected when species extirpations result in communities dominated by competent hosts (those with a high potential to acquire and transmit infections). While this is an intuitive expectation, recent theoretical work has deepened our understanding of conditions for disease dilution vs. amplification. To illustrate this point, we show the expected effect of community disassembly on disease risk in the context of recent empirical and theoretical work on covariance between extirpation risk and host competence. Finally, some proposed mechanisms of dilution and amplification are related to contact rates and transmission, independent of reductions in host health due to infection (i.e. disease). As a result, the emerging framework for understanding diversity-disease relationships is well positioned to serve as a foundation for a more general perspective relating host diversity and symbiont diversity, inclusive of parasites, commensals, and mutualists.