EEB 485 Discussion 08: Complex Dynamics

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Lever, J. J., van Nes, E. H., Scheffer, M. & Bascompte, J. The sudden collapse of pollinator communities. *Ecol. Lett.* 17, 350–359 (2014).

Lever et. al. examine how nestedness and connectedness of pollinator-plant networks impact network resistance to environmental change. They combine theory on alternative stable states with the idea that plant pollinator networks are largely driven by positive feedback mechanisms. They generate an algorithm to model nested networks which selects an interaction between species *a* and *b,* which is then changed into an interaction between *a* and *c* when *c* has more interactions with *b*. In this way, the species with more interactions initially accumulate even more over time and become more nested, a mechanism the authors call the 'rich getting richer.' Their model explores the relative influence of mutualistic and competitive interactions on population dynamics and community collapse. They examine the response of pollinator populations by manipulating an arbitrary driver of pollinator decline. They found network nestedness to significantly improve resistance to systemic collapse. They also found that recovery of a nested network required a more dramatic decrease in the driver of the decline than in un-nested networks. The authors maintain that their results have implications for the sustainability of plant-polinator networks. Though nestedness and connectivity can delay the point of final collapse, it can also make recovery from a community-wide collapse of the entire network more difficult, and increase the difficulty of predicting such a collapse before it happens.

Pre-Discussion Questions

1. Equation 3 is the authors' model for plant and pollinator population growth and decay. These equations are structurally very similar to the Lotka-Volterra competition equations, but with some modifications. What additional interaction term do they account for, and how do they model it? Also, what is the significance of the last term, μ?

Additional Questions

- The authors mention the 'stress-gradient hypothesis': what is this, and how do their results show support for it in plant-pollinator networks?

Scheffer, M. & Carpenter, S. R. Catastrophic regime shifts in ecosystems: Linking theory to observation. *Trends Ecol. Evol.* 18, 648–656 (2003).

Scheffer and Carpenter present a synthesis of evidence regarding alternative attractors in ecosystems by combining theory, field data, and experimental evidence. Evidence for alternative attractors is considered as a mechanism for large, often unexpected regime shifts which have occurred in many ecosystems. The authors argue that alternative stable states are actually functionally dynamic regimes, and the characteristics of these alternatives can have profound influence over how the system responds to disturbances and environmental variation. The review gives evidence for how systems can shift regimes following perturbations or changes in the system. The authors state that although field observations can provide hints for alternative states and clues for catastrophic regime shifts, they may not always be detectable. Experimental evidence and theoretical models and inference, therefore, are essential to grasping the concept of regime shifts in an ecosystem, and for predicting possible alternative states.

Pre-Discussion Questions

1. Based on the evidence synthesized by Scheffer and Carpenter, what are the strengths and weaknesses of field evidence and experimental evidence for alternative attractors? When might one approach to studying alternative attractors and complex dynamics be more appropriate over the other?
2. Slow-fast cycles often manifest as dramatic transitions between regimes as a result of interacting ‘slow’ and ‘fast’ variables. Give an example of a slow-fast cycle, and describe how the slow and fast variables could lead to large, cyclical regime shifts.

Additional Questions

- What is the concept of hysteresis? What are the implications of hysteresis in a biological context?