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Forming Stable Complex Communities: Random vs. Evolved Interactions

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We examine the problem of constructing a stable complex community of competing species. We first investigate the case of a randomly generated set of interactions and investigate the different regimes. Here, May showed that if the interactions are not very weak, the system typically does not a steady-state with all species present. We show from simulation that the system typically goes to a non-steady state for interaction strengths above an order 1 multiple of the critical May strength. When demographic stochasticity is added, the system typically jumps from one invadable state to another. For extremely strong competition however, the system does revert to one of a number of steady state. Our model contains, as special cases, the celebrated neutral island theories of Wilson-MacArthur and Hubbell. Moreover, we show that slight deviations from perfect neutrality may lead to each of the phases, as the Hubbell point appears to be quadracritical. If, however, the system is allowed to evolve its set of interactions, each new species inheriting its interactions from its parent species, then the system can produce an interaction matrix which is capable of supporting a large number (¿ 100) of coexisting species. The key to evolutionary success turns out to be how the child species interacts with its parent.