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Cyclic competition of four or more species: Results from mean field theory and stochastic simulations¹

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Population dynamics is a venerable subject, dating back two centuries to Malthus, Verhulst, Lotka, Volterra, and many others. Nonetheless, new and interesting phenomena are continually being discovered. For example, the recent discovery of “Survival of the Weakest” in cyclic competition between 3 species with no spatial structure (Berr, Reichenbach, Schottenloher, and Frey, Phys. Rev. Lett. 102, 048102 (2009)) attracted considerable attention, e.g., <http://www.sciencedaily.com/releases/2009/02/090213115127.htm>. Considering a similar system with 4 or more species, we find a more intuitively understandable principle which appears to underpin all systems with cyclically competing species. We will present several interesting aspects of the 4 species system – from non-linear dynamical phenomena in a deterministic mean-field approach to remarkable extinction probabilities in the stochastic evolution of a finite system. Some insights into the deterministic dynamics, gained from generalizing this system to one with any number of species with arbitrary pairwise interactions, will also be discussed.

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