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Oscillatory Dynamics in Rock-Paper-Scissors Games with Mutations

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We study the oscillatory dynamics in the generic three-species rock-paper-scissors games with mutations. In the mean-field limit, different behaviors are found: (a) for high mutation rate, there is a stable interior fixed point with coexistence of all species; (b) for low mutation rates, there is a region of the parameter space characterized by a limit cycle resulting from a Hopf bifurcation; (c) in the absence of mutations, there is a region where heteroclinic cycles yield oscillations of large amplitude (not robust against noise). After a discussion on the main properties of the mean-field dynamics, we investigate the stochastic version of the model within an individual-based formulation. Demographic fluctuations are therefore naturally accounted and their effects are studied using a diffusion theory complemented by numerical simulations. It is thus shown that persistent erratic oscillations (quasi-cycles) of large amplitude emerge from a noise-induced resonance phenomenon. We also analytically and numerically compute the average escape time necessary to reach a (quasi-)cycle on which the system oscillates at a given amplitude.

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