Fluctuations-induced coexistence in public goods dynamics

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Cooperative interactions between individuals in a population and their stability properties are central to population dynamics and evolution.Weintroduce a generic class of nonlinear dynamical systems describing such interactions between producers and non-producers of a rapidly equilibrating common resource extracted from a finite environment. In the deterministic mean field approximation, fast-growing non-producers drive the entire population to extinction. However, the presence of arbitrarily small perturbations destabilizes this fixed point into a stochastic attractor where both phenotypes can survive. Phase space arguments and moment closure are used to characterize the attractor and show that its properties are not determined by the noise amplitude or boundary conditions, but rather it is stabilized by the stochastic nonlinear dynamics. Spatial Monte Carlo simulations with demographic fluctuations and diffusion illustrate a similar effect, supporting the validity of the two-dimensional stochastic differential equation as an approximation. The functional distribution of the noise emerges as the main factor determining the dynamical outcome. Noise resulting from diffusion between different regions, or additive noise, induce coexistence while multiplicative or local demographic noise do not alter the outcome of deterministic dynamics. The results are discussed in a general context of the effect of noise on phase space structure.

References

[1] H Behar, N Brenner, G Ariel and Y Louzoun *Fluctuations-induced coexistence in public goods dynamics*. Physical Biology 2016, 13(5) 056006