Abstract Submitted
for the MAR17 Meeting of
The American Physical Society

Synchronization and survival of connected bacterial populations

SHREYAS GOKHALE, AROLYN CONWILL, Massachusetts Institute of Technology, TANVI RANJAN, Harvard University, JEFF GORE, Massachusetts Institute of Technology — Migration plays a vital role in controlling population dynamics of species occupying distinct habitat patches. While local populations are vulnerable to extinction due to demographic or environmental stochasticity, migration from neighboring habitat patches can rescue these populations through colonization of uninhabited regions. However, a large migratory flux can synchronize the population dynamics in connected patches, thereby enhancing the risk of global extinction during periods of depression in population size. Here, we investigate this trade-off between local rescue and global extinction experimentally using laboratory populations of *E. coli* bacteria. Our model system consists of co-cultures of ampicillin resistant and chloramphenicol resistant strains that form a cross-protection mutualism and exhibit period-3 oscillations in the relative population density in the presence of both antibiotics. We quantify the onset of synchronization of oscillations in a pair of co-cultures connected by migration and demonstrate that period-3 oscillations can be disturbed for moderate rates of migration. These features are consistent with simulations of a mechanistic model of antibiotic deactivation in our system. The simulations further predict that the probability of survival of connected populations in high concentrations of antibiotics is maximized at intermediate migration rates. We verify this prediction experimentally and show that survival is enhanced through a combination of disturbance of period-3 oscillations and stochastic re-colonization events.

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Date submitted: 28 Oct 2016 Electronic form version 1.4