Northwestern | McCORMICK SCHOOL OF ENGINEERING

Determinism and Contingency in Microbial Communities

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Biological systems are influenced by random processes at all scales, including molecular, demographic, and behavioral fluctuations, as well as by their interactions with a fluctuating environment. We present long-term measurements of population dynamics using replicate digital holographic microscopes that maintain closed ecosystems (CES) under precisely controlled external conditions while automatically measuring abundances of three microbial species via single-cell imaging. We measure spatiotemporal population dynamics in more than 60 replicate CES over periods of months. We observe strongly deterministic population dynamics in replicate systems. Furthermore, we show that previously discovered statistical structure in abundance fluctuations across replicate CES is driven by variation in external conditions, such as illumination. We confirm the existence of stable ecomodes governing the correlations in population abundances of three species. The observation of strongly deterministic dynamics, together with stable structure of correlations in response to external perturbations, points towards a possibility of simple macroscopic laws governing microbial systems. Finally, we will present recent experimental results demonstrating strong historical contingency in the recovery of bacterial populations from nutrient fluctuations - a dependence we suspect arises from phenotypic heterogeneity in the population.

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For further information see http://esam.northwestern.edu

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