Systems Biology Research Symposium
Oral Presentation Session

Grand Ballroom
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Spatiotemporal Modulation of Biodiversity in a Synthetic Chemical-Mediated Ecosystem

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Biodiversity is a critical determinant of the structure, functionality, and persistence of ecological systems. Its maintenance and modulation, however, is poorly understood due to difficulty in studying this phenomenon in natural ecosystems. In particular, the influences of cellular motility and segregation on biodiversity in chemical-mediated ecosystems remain confounding. To this end, we used a synthetic predator-prey ecosystem as a model system to examine effects of cellular motility and spatial configuration on biodiversity. This system consists of two engineered Escherichia coli populations that compete for nutrients and regulate each other's gene expression and survival by quorum sensing. We found that cellular motility had negligible impact on the biodiversity when the predator and prey cells were well-mixed in either liquid phase or soft agar. In contrast, decreasing cellular motility caused increased biodiversity when the predator and prey cells were inoculated at a sufficient segregation distance on soft agar. The seemingly discrepant role of cellular motility on biodiversity could be attributed to the existence of two critical segregation distances between the predator and prey cells, as revealed by a mathematical model that accounts for the spatiotemporal dynamics of the system. Within the segregation distance bounded by the two critical distances, biodiversity scales almost linearly with cellular motility; below or above these critical distances, however, cellular motility has a negligible effect on biodiversity. Our results highlight the coherent interplay between cellular motility, spatial segregation, and communication in modulating biodiversity in chemical-mediated ecosystems, revealing the different characteristics of chemical- and contact-based ecosystems in their biodiversity modulation by cellular motility.