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Early stages of biofilm formation of Pseudomona syringae on leaves surfaces

Bacterial aggregates observed on leaf surfaces can be compared to biofilms in aquatic and medical environments due to their nutrient heterogeneity, and constantly changing water conditions. Bacteria on leaves surface are found forming aggregates of a wide range of sizes. A localized high level of density of cells may foster genetic and metabolic exchange; furthermore epiphytic survival of bacteria during desiccation is likely enhanced when they are aggregated. Aggregates may also locally facilitate coordinated bacterial population responses for traits expressed in a density-dependent manner through quorum sensing. We developed a stochastic model to describe the frequency, size, and spatial distribution of the gram-negative bacterium Pseudomonas syringae aggregates on bean leaf surfaces. Our model, a logistic birth-death model with migration (time-homogeneous Markov process), is able to elucidate two factors fostering aggregate formation: migration and variability of the leaf surface environment. Our results successfully explain quantitative experimental data available. We discuss how to analyse the joint distribution of the numbers of aggregates of different sizes at a given time and explore how to account for new aggregates being created, that is, the joint distribution of the family size statistics conditional on the total number of aggregates. Through simulations we examine several migration regimes in order to find out how this affects the aggregates size distribution. We discuss the ecological significance of the large aggregates formed on leaves as early stages of biofilm formation. Aggregation formation is thought to be the first step towards pathogenic behaviour of this bacterium; understanding aggregate size distribution would prove useful to understand the switch from epiphytic to pathogenic behaviour.

References

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