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Environmental spatial structure and competition determine the relative fitness of a multicellular aggregate in a young bacterial biofilm JAIME HUTCHISON, University of Texas at Austin, KASPER KRAGH, University of Copenhagen, GAVIN MELAUGH, University of Edinburgh, CHRISTOPHER RODESNEY, University of Texas at Austin, YASUHIKO IRIE, University of Bath, ALED ROBERTS, STEVE DIGGLE, University of Nottingham, ROSALIND ALLEN, University of Edinburgh, VERNITA GORDON, University of Texas at Austin, THOMAS BJARNSHOLT, University of Copenhagen — The canonical description of biofilm development begins with free-swimming, single bacterial cells which land on and adhere to a surface, mature into three-dimensional structures, and eventually disperse to form new biofilms. However, the interplay between single cells and larger, three-dimensional structures in early biofilm development has not been studied. We use timelapse confocal microscopy and quantitative measurements of biomass, combined with numerical, individual-based simulations to determine the relative fitness of single cells and preformed, multicellular aggregates. We find that the relative fitness of multicellular aggregates depends markedly on the density of surrounding single cells. We attribute this competition-dependent growth advantage to an interplay between a spatially-structured nutrient environment and the spatial distribution of cells in the aggregate. Our findings suggest that when competition for resources is high and there is spatial structure in the distribution of resources, aggregates of cells can outperform single cells and may be a preferred way to seed new biofilms.

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