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Microbial landscapes: new approaches to upscale biodiversity and environmental impacts in biofilms

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We consider biofilms as micro-scale landscapes and place biofilm research in an explicitly spatial context with solid rooting in the more "traditional" ecology. Landscapes and biofilms have much in common. They both consist of discrete patches of biomass and resources often embedded in a hostile matrix, and with fluid dynamics as a major determinant for the flow of genetic information, energy and materials between these patches and through boundaries. Landscape ecology is the study of structure and function in heterogeneous spatial systems and of their ecosystem consequences; the beauty of landscape ecology is that it can be applied to any spatial scale — ranging from real landscapes ($>$km^2) to microscapes (μm^2).

Borrowing knowledge from landscape ecology, we will present a conceptual framework to investigate the relationship between biodiversity and function of microbial biofilms and their environmental consequences. We will start with the simplest assumption that completely random community assembly from a homogeneous source community explains biofilm diversity, and systematically add complexity to the framework by factoring hydrodynamics, architecture, cell-to-cell signaling, and dispersal as we move up in scale. We believe that this approach will significantly contribute to bridge the gap that has developed between microbial ecology and "true" ecology, and that it will be of relevance to biotechnology.