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Life in a drop of Ocean: microfluidic insights into microbial ecology

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Bacteria are the most abundant and successful form of life on Earth. Their physico-chemical interactions with their fluid environment are surprisingly complex and have enormous implications, which we can only hope to grasp if we learn to study microorganisms within realistic microenvironments. Microfluidics for the first time enables us to create microhabitats, including chemical and fluid mechanical landscapes, while visualizing bacterial behavior at a single-cell resolution. Here I focus on the application of microfluidics to gain insight in the life of marine bacteria. In their quest for nturients, marine bacteria often experience the Ocean as a desert, where rare and ephemeral nutrient patches represent transient resource oases. In this patchy seascape, swimming and chemotaxis represent critical assets, but effective patch utilization is constrained by energetic requirements. And then there are predators and viruses... These interactions form the basis of the 'microbial loop', the ensemble of microbial processes known to directly impact the productivity of marine ecosystems and the rates of carbon turnover in the Ocean. I will show how fundamental new insight on selected aspects of microbial life in a drop of Ocean can be achieved by a combination of microfluidic experiments and theoretical modeling.