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Direct and Indirect Mechanisms for Collective Behavior in the Spatial Dynamics of Plankton

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Plankton are the dark matter of life in the sea. Though they are poorly understood and usually unseen, plankton dominate the biological dynamics that ultimately determine characteristics important to humans ranging from sustainable fish harvests to rates of carbon sequestration. Through a variety of social, sensory and biophysical mechanisms, plankton display collective behaviors that profoundly alter ecological systems. These collective behaviors include formation of large, coherent social groups (e.g. swarms and schools); alteration of water's mechanical properties (e.g. viscosity) and motion (e.g. bioconvection); and induction of self-organized spatial heterogeneity. In this talk, I will describe recent individual-level observations of collective plankton behaviors. I will develop mathematical descriptions that link some of these behaviors to spatio-temporal patterns in plankton populations. Finally, I will outline some important unsolved problems in plankton ecology that can be addressed using analytical and computational approaches.