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Be together, not the same: Spatiotemporal organization of different cilia types generates distinct transport functions JANNA NAWROTH, Harvard Univ, HANLIANG GUO, USC, EDWARD RUBY, University of Hawaii at Manoa, JOHN DABIRI, Stanford Univ, MARGARET MCFALL-NGAI, University of Hawaii at Manoa, EVA KANSO, USC — Motile cilia are microscopic, hair-like structures on the cell surface that can sense and propel the extracellular fluid environment. Cilia are often thought to be limited to stereotypic morphologies, beat kinematics and non-discriminatory clearance functions, but we find that the spatiotemporal organization of different cilia types and beat behaviors can generate complex flow patterns and transport functions. Here, we present a case study in the Hawaiian bobtail squid where collective ciliary activity and resulting flow fields help recruit symbiont bacteria to the animal host. In particular, we demonstrate empirically and computationally how the squid's internal cilia act like a microfluidic device that actively filters the water for potential bacterial candidates and also provides a sheltered zone allowing for accumulation of mucus and bacteria into a biofilm. Moreover, in this sheltered zone, different cilia-driven flows enhance diffusion of biochemical signals, which could accelerate specific bacteria-host recognition. These results suggest that studying cilia activity on the population level might reveal a diverse range of biological transport and sensing functions. Moreover, understanding cilia as functional building blocks could inspire the design of ciliated robots and devices.

Janna Nawroth
Harvard Univ

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