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Locomotion by microscopic organisms in turbulent ambient water flow

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How is the locomotion of microscopic organisms swimming or moving across the substratum affected by turbulent ambient currents and waves in marine habitats? We addressed this question using larvae of marine invertebrates. Many benthic animals produce microscopic larvae that swim and respond to environmental factors (e.g. odors). Larvae are dispersed to new sites by ambient water currents and land on surfaces in suitable habitats exposed to wavy, turbulent water flow. Using fouling communities and coral reefs as study systems, we measured water flow across them in the field and recreated it in flumes where we could quantify on the scale experienced by larvae (mm's, ms's) the instantaneous water velocities and concentrations of odors released from surfaces where larvae settle. We used these data to determine the temporal patterns of water velocities and odor concentrations encountered by larvae as they swim in the water and land on surfaces. We found that larvae have rapid on-off encounters with odors while swimming through fine filaments of odor swirling in unscented water, experience varying shear, and after landing are exposed to rapidly fluctuating hydrodynamic forces with peaks that depend on their location within the fine scale habitat topography. These data enabled us to design small-scale experiments in which larval locomotion could be analyzed in realistic, rapidly varying patterns of water movement and odor.