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Recording High Resolution 3D Lagrangian Motions In Marine Dinoflagellates using Digital Holographic Microscopic Cinematography
J. SHENG, E. MALKIEL, J. KATZ, The Johns Hopkins Univ., A.R. PLACE, R. BELAS, Center of Marine Biotechnology, UMBC — Detailed data on swimming behavior and locomotion for dense population of dinoflagellates constitutes a key component to understanding cell migration, cell-cell interactions and predator-prey dynamics, all of which affect algae bloom dynamics. Due to the multi-dimensional nature of flagellated cell motions, spatial-temporal Lagrangian measurements of multiple cells in high concentration are very limited. Here we present detailed data on 3D Lagrangian motions for three marine dinoflagellates: *Oxyrrhis marina*, *Karlodinium veneficum*, and *Pfiesteria piscicida*, using digital holographic microscopic cinematography. The measurements are performed in a 5×5×25mm cuvette with cell densities varying from 50,000 $\sim$ 90,000 cells/ml. Approximately 200-500 cells are tracked simultaneously for 12s at 60fps in a sample volume of 1×1×5 mm at a spatial resolution of 0.4×0.4×2 μm. We fully resolve the longitudinal flagella ($\sim$200nm) along with the Lagrangian trajectory of each organism. Species dependent swimming behavior are identified and categorized quantitatively by velocities, radii of curvature, and rotations of pitch. Statistics on locomotion, temporal & spatial scales, and diffusion rate show substantial differences between species. The scaling between turning radius and cell dimension can be explained by a distributed stokeslet model for a self-propelled body.

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