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Influence of blade motion on mass flux to a model seagrass blade[1]

JIARUI LEI, HEIDI NEPF, Massachusetts Inst of Tech-MIT — Seagrass and other freshwater macrophytes can acquire nutrients from surrounding water through their blades. While we anticipate that blade motion and reconfiguration may impact mass flux at the blade surface, this topic is an area of open discussion and research. We seek to better understand the interaction of individual blades with both unidirectional and oscillatory flows and how this interaction impacts mass flux. The degree of reconfiguration can be quantified by two dimensionless numbers, the Cauchy number, Ca, and the buoyancy parameter, B. For unidirectional currents (U), a theoretical model for the transfer velocity (K) was constructed assuming the boundary layer on the blade surface remained laminar and developed like that over a flat plate, which predicts $K \propto U^{0.5}$. When the blades were bent-over, the model predicted the measured flux well; when the blades remained upright, the flux to the blade diminished relative to the model. Preliminary wave experiments show that blade motion increased with wave amplitude, and that there are two distinct regimes. In the first regime ($Ca<15$), the maximum reconfiguration was associated with the peak velocity (wave crest), so that the blade velocity leads the wave velocity by 90 degrees. The second regime occurred when $Ca>15$. In this regime, the phase difference was approximately zero and the blade moved passively with the wave.

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