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Oxygen transport in periodically ventilated polychaete burrows

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Abstract:

Burrowing organisms play a critical role for the functioning of coastal marine sediments, in part due to their pumping of oxygenated water through the burrow. In cohesive sediments, oxygenated burrows water allows for the diffusive flux of oxygen across the burrow wall and into the sediment, where it is consumed. In this study, we quantified the burrow excurrent velocities, volume of water ventilated and oxygenation patterns within the burrow of the polychaete *Alitta succinea*. We determined that periodic ventilation of the burrow results in oscillations of the flux of oxygen across the burrow wall and oxygen concentration within the sediment near the burrow wall. Additionally, we investigated the effects of temperature changes on oxygen dynamics in the burrow. The volumetric flow rate and frequency of burrow ventilation increased with temperature. Correspondingly, the frequency of the oscillations in oxygen flux across the burrow walls also increased with temperature. However, the time-averaged flux of oxygen across the burrow wall did not change with temperature (1.5 ± 0.3o l m^{-2} d^{-1}), and the distance of oxygen penetration into the burrow wall decreased with temperature (from 3.4 ± 0.5 at 6 °C to 1.6 ± 0.1 at 33 °C). Thus, seasonal changes in the volume of oxygenated sediment, as well as the pattern of oxygenation that sediment experiences, are expected to be significant while the total oxygen flux is expected to remain relatively uniform. We show that burrower ventilation behavior mediated the effects of temperature on sediment oxygen uptake.

Keywords: Particle image velocimetry, polychaete, volumetric flow rate, oxygen flux, intertidal mudflat