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Elevated micro-topography boosts growth rates in *Salicornia procumbens* by amplifying a tidally-driven oxygen pump: Implications for natural recruitment and restoration

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Abstract:

Background and Aims: The growth rate of pioneer species is known to be a critical component determining recruitment success of marsh seedlings on tidal flats. By accelerating growth, recruits can reach a larger size at an earlier date, which reduces the length of the disturbance-free window required for successful establishment. Therefore, the pursuit of natural mechanisms that accelerate growth rates at a local scale may lead to a better understanding of the circumstance under which new establishment occurs, and may suggest new insight with which to perform restoration. This study explores how and why changes in local sediment elevation modify the growth rate of recruiting salt marsh pioneers.

Methods: A mesocosm experiment was designed in which the annual salt marsh pioneer *Salicornia procumbens* was grown over a series of raised, flat and lowered sediment surfaces, under a variety of tidal inundation regimes and in vertically drained or un-drained sediment. Additional physical tests quantified the effects of these treatments on sediment water-logging and oxygen dynamics, including the use of a planar optode experiment.

Key Results: In this study, the elevation of sediment micro-topography by 2 cm was the overwhelming driver of plant growth rates. Seedlings grew on average 25 % faster on raised surfaces, which represented a significant increase when compared to other groups. Changes in growth aligned well with the amplifying effect of raised sediment beds on a tidally episodic oxygenation process wherein sediment pore spaces were refreshed by oxygen-rich water at the onset of high tide.

Conclusion: Overall, the present study suggests this tidally-driven oxygen pump as an explanation for commonly observed natural patterns in salt marsh recruitment near drainage channels and atop raised sediment mounds and reveals a promising way forward to promote the establishment of pioneers in the field.

Keywords: micro-topography, salt marshes, establishment, restoration, drainage, oxygen penetration, *Salicornia procumbens*