Flow Matters: How a Coral Can Divert Currents and Suffocate Corals Nearby

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Coral reefs are one of Earth's most valuable ecosystems, but they are in decline, fueling a surge of restoration activity across the global tropics. Yet, despite significant scientific advances and financial investment, reef restoration remains cost-intensive and difficult to scale, with the majority of plots surviving just a few years. Reef-building corals depend on fine-scale currents to deliver oxygen, nutrients and food, regulate temperature and dispense waste. This study investigates the impact of coral colonies of different morphologies on the water flow around them, and examines, for the first time, the potential for corals to disrupt the delivery of critical nutrients to neighboring colonies. Coral models representing branching and massive morphologies were placed in a rotating water tank and exposed to turbulent flow conditions across Reynolds numbers ranging from 1439, 2878, and 4496. Altimetric Imaging Velocimetry (AIV) was used to visualize the disruption of flow as water moved across the colonies and to quantify the water exchange mechanisms. Across all morphologies, results show that increased flow velocities were positively correlated with enhanced influx of nutrient-rich water. However, in low flow environments, brain corals retained nutrient-depleted water for longer due to large eddy formations, whereas branching corals facilitated rapid exchange via turbulence-enhanced flow. Nevertheless, in two-coral experiments, brain corals did not negatively affect their neighbors, but branching corals did. These experiments demonstrate that placement of coral colonies, morphological diversity, and flow dynamics must be considered in the design of restoration plots, and provide critical guidance for optimizing restoration practices.

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