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A mathematical model for wound healing in reef-building coral Pocillopora damicornis

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A Mathematical Model for Wound Healing in Reef-Building Coral *Pocillopora damicornis*

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Coral reefs, among the most diverse ecosystems in the ocean, currently face major threats due to multiple stressors such as pollution, unsustainable fishing practices, and perturbations in environmental parameters brought on by climate change. Reefs also sustain regular wounding from other sea life and anthropomorphic practices, adding to the list of environmental stressors. Recent reef preservation practices have even involved intentional wounding by systematically breaking coral fragments and relocating them to revitalize damaged reefs. Despite its importance, very little research has explored the inner mechanisms of wound healing in corals. Some reef-building corals have been observed to initiate an immunological response similar to those observed in humans and other vertebrates. Utilizing past models of inflammation and early proliferation and remodeling, we formulated a mechanistic model for wound healing in corals. The model consists of four differential equations mediating wound debris, inflammation, proliferation, and wound closure. The model is coupled with experimental data for linear and circular shaped wounds on *Pocillopora damicornis* fragments. A preliminary parameter set was obtained by fitting to the wound closure times obtained empirically and to expected temporal trends observed in other coral species and in vertebrates. A variety of mathematical and statistical methods were applied for model analysis including local sensitivity analysis. Results were used to define an identifiable set of parameters. Alternative model behavior was also demonstrated by varying parameter baseline values and the biological relevance was explored.

Keywords: wound healing, coral reefs, mathematical modeling, differential equations, parameter estimation, sensitivity analysis