SEDIMENT RESPONSES OF CORALS FROM INSHORE REEFS, GREAT BARRIER REEF, AUSTRALIA

Thesis submitted by
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Jeremy. J. Sofonia

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ABSTRACT

The role of turbidity and sedimentation is a key problem for nearshore coral reefs worldwide. However, little is known about how sedimentation interacts with other environmental factors such as hydrodynamics, temperature and light and how coral species vary in their sediment responses. Here, I investigate the response of corals to sediment under varying flow, temperature and light regimes in two controlled mesocosm experiments, and then preliminarily examine the role of sedimentation in structuring coral assemblages using a new method for manipulating sedimentation rates in field settings.

The first experiment was designed to test the specific hypothesis that coral stress (using the foliaceous *Turbinaria mesenterina* as a study species) associated with sedimentation is reduced under turbulent flow conditions that prevent long-term sediment deposition on coral tissues. To provide a rigorous assessment of the physiological response, three key physiological parameters were used: tissue lipid concentration, skeletal growth rate and photosynthetic performance (maximum quantum yield). The second experiment investigated interactions between sediment stress and stresses associated with high temperature and light – a problem highly topical in the context of climate change. Lastly, the field experiment consisted of an array of six erosive sediment blocks (plaster of paris and silicate-based sediment) suspended above the fringing reef at Pelorus Island (Queensland, Australia) to simulate replicate sediment gradients. The sediment responses of three coral species (*Acropora formosa, Montipora tuberculosa,* and *Porites cylindrica*) were followed and compared over a fifteen-day sedimentation even, using the relative surface area of tissue lesions/necrosis as the response variable.

Experiment 1 demonstrated that sediment concentrations (or sedimentation rates) of up to 110.7 ± 27.4 mg cm^{-2} d^{-1} had no effect on colony growth rate, lipid concentration or photosynthetic yield in *T. mesenterina* under high flow (23.7 ± 6.7 cm s^{-1}) or stagnant conditions. Also, interactions between flow and sediment treatments were non-significant. This is a surprising result that indicates that *T. mesenterina* is highly resistant to sediment deposition under low flow as well as sediment abrasion under wave action. Horizontal colonies subjected to sediment loads of up to 100 mg cm^{-2} under stagnant conditions were able to clear their surface within

two hours, suggesting that rapid and energy efficient clearing of sediment is a key mechanism of alleviating sediment stress. These results may explain the success of *T. mesenterina* on reef crests as well as deep reef slopes on highly turbid, inshore coral reefs in the Great Barrier Reef lagoon.

Results of experiment 2 showed that sediment treatments of up to 246 ± 47 mg cm^{-2} d^{-1} had no effect on colony growth rates, lipid concentrations or chlorophyll concentrations in either of the study species under the low (Control) light conditions (190 ± 60 μmol photons m^{-2} s^{-1}). In high light (270 ± 110 μmol photons m^{2} s^{-1}), however, lipid and chlorophyll concentrations declined significantly indicating a bleaching response. Interestingly, temperature treatments (25.5 ± 0.1 and 28.4 ± 0.1°C) had no effect on the lipid or chlorophyll responses of *T. mesenterina*. Also, sediment, temperature, and light treatments did not interact significantly, further demonstrating that the physiology of this species is highly robust to these environmental stressors. Of the three physiological responses measured, chlorophyll concentration proved to be the most sensitive.

The field experiment (experiment 3) showed contrasting sediment responses among the three study species, consistent with predictions based on growth forms. Specifically, the prevalence of tissue lesions in *M. tuberculosa* (flat, foliaceous) increased significantly with sedimentation rate, whereas *Acropora formosa* and *Porites cylindrica* showed minimal tissue lesions, which were not correlated with sedimentation rates. This result suggests that sediment can act as a selective pressure on coral reefs, potentially related to the functional morphology of the species in the assemblage.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES