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THESIS ABSTRACT

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Title Effect of Thermal Stress on the Red Algae *Gigartina exasperata* Harvey and Bailey

It is well known that the horizontal distribution of macroalgae is correlated with temperature. The ratio of red algal species to brown algal species increases with increasing temperature. It is also known that local algal populations are greatly affected by abrupt differences in temperature, such as caused by the warm ocean currents or effluent from a power plant. How temperature regulates distribution is not clearly understood. The present study was done to investigate the effects of high temperatures on three characteristics of *Gigartina exasperata*: (1) spore mortality and plant growth rate, (2) morphology, and (3) photosynthesis and dark-respiration.

Gigartina exasperata Harvey and Bailey is an economically important and widely distributed red alga. Chapter I describes experiments testing the effects of elevated temperatures on spore mortality rate and plant growth. Two geographically separated strains, a Seattle, Washington strain and a Berkeley, California strain, were tested for spore mortality rates at different temperatures in the first part of the experiment. The results suggest: (1) there is a significant difference in the spore mortalities at 15°C and 20°C; and also between those at 15°C and 25°C; (2) the spores of two strains responded in a similar way to 25°C; (3) no spores survived at 30°C. In a second set of experiments, sporelings were gradually exposed to higher temperatures. The results of these experiments indicate that best survival is obtained with a temperature sequence from 15°C through 20°C and room-temperature to 25°C. In the third set of experiments, aeration was found to be an alternative to the long-term adaptation method. By either aeration without preculture or long-term gradual adaptation, the plants can be made to reach a steady growth rate at 25°C. However, of the spores exposed directly to 25°C, all the survivors were dwarf plants in which growth rate measurement was difficult. No temperature-tolerant (25°C) mutants were obtained by treating spores with U.V. light. Plants grown at 25°C, then back-transplanted to lower temperatures were stimulated in their growth rates. However the growth rate of plants back-transplanted from 25°C to 15°C was only slightly higher than plants growing at 25°C.

Morphological and pigmentation changes associated with high-termperature growth were observed and are documented in Chapter II. Plants became dark red or black at high temperatures, and the plants developed flattened or cylindrical clusters of branches. These changes are described in detail. Plasticity of the morphological modification was demonstrated by back-transplanting the 25°C adapted plants to 15°C and 20°C. The result was a return to the normal bright red color and the foliose morphology of plants grown at normal temperatures.

Photosynthesis and respiration rates were studied in normal and high temperature plants and the results are reported in Chapter III. Net positive photosynthesis per 24-hour light/dark cycle was necessary to sustain growth. This could be achieved at 25°C and 28°C by adjusting light intensities. The high-temperature adapted plants had a higher capability to achieve net positive photosynthesis than the normal-temperature plants. M-11 was proved to be a plant less adapted to high temperature than the 25°C-adapted plants. The photosynthesis tests at 30°C predicted no plants can survive at this temperature. This agrees with the previous observation in Chapter I that 29.5°C is lethal for *G. exasperata*. Dark-respiration data showed a general trend with the rates increasing with increasing temperature; and 25°C-adapted plants had the lowest dark-respiration rates, 20°C-adapted plants had intermediate rates and 15°C-adapted plants had the highest respiratory rates at higher temperatures.

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