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Effects of Dehydration Stress on the Dark Adapted Fluorescence (Fv/Fm) of Giant Bladder Kelp (Macrocystis pyrifera)

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Introduction

Beach wrack on the coast of California is often seen as unsightly bio-trash that detracts from the aesthetic pleasure of the beach. However, various alga's and sediment are only temporarily suspended along the coast. California's tidal system operates as a semi-diurnal cycle with two high and low tides of varying amplitudes[1]. As a result of this tidal configuration, seaweed is deposited by the lesser high tide and is retaken into the ocean by the greater high tide which occurs in 6 hour intervals[2]. This cycle provokes the question: is beach wrack, more specifically *Macrocystis pyrifera,* a viable, photosynthesizing, part of the aquatic community even after dehydrating on the shores during the gap between the low and high tides? *Macrocystis pyrifera*, commonly known as Giant Bladder Kelp, is one of the more abundant species of kelp present along the California coast[3] and is commonly seen distributed as wrack along the coast. Although it is known that these collections of costal wrack are an essential part of the costal ecosystem, providing sustenance and shelter to a plethora of organisms, is this kelp a functioning part of the aquatic ecosystem after being rehydrated? This experiment will test the hypothesis that partially dehydrated fronds of *Macrocystis pyrifera*, found along Malibu beaches, are viable marine commodities that decrease functionally when drying, but are able to rehydrate and regain functionality within the six hour period between the high and low tides of California's mixed semi-diurnal tidal cycle.

Materials & Methods

Sample specimens of eight individual *Macrocystis pyrifera* (Giant Bladder Kelp) that were floating in the water at a private beach in Malibu, California were obtained and immediately submerged in bags of seawater for transport to the lab. Once back at the lab, each specimen was removed from the seawater, dabbed with kimwipes, massed on an electronic scale and separated into plastic bins labeled 1-8. Two random fronds from each individual were selected for the placement of a dark-adapted leaf clip and labeled 'A' and 'B'. The clip was placed towards the mid-center of each frond. A pulse-modulated fluorometer was used to measure Fv/Fm for each individual at clips A and B. Measurements for Fv/Fm and mass were collected in the same manner every hour for six hours. After the sixth hour measurement the individuals were rehydrated in their bins with seawater. The florescence and mass of the rehydrated plants were measured every hour for the next 3 hours. The measurements of Fv/Fm for an A and B of each individual were averaged. These values were used to compare the change in Fv/Fm over time.

Abstract

The unique semi-diurnal tide system of Southern California suspends beach wrack along the beaches for approximately six hour periods before being washed back into the ocean. It has been noted in prior research that beach wrack is an essential part of Southern California's costal ecology but not much research has been done to learn about the viability of beach wrack as it dehydrates on the beach. To better understand the viability of wrack as it travels through these hydration changes, this study tested the effect of dehydration and rehydration on the fronds of *Macrocystis pyrifera* as they have been partially dehydrated and re-hydrated. This was tested by measuring the Fv/Fm, using a pulse-modulated fluorometer, and the change in water mass of selected fronds over a six hour dehydration period, and three hour re-hydration period. It was found that there was a significant increase of Fv/Fm and water mass after rehydration. However our studies showed that Fv/Fm surprisingly continued to increase as the plant was dehydrated and a chi-square test verified that the values of the rehydrated plants were not independent of the dehydrated values.

Data/Results

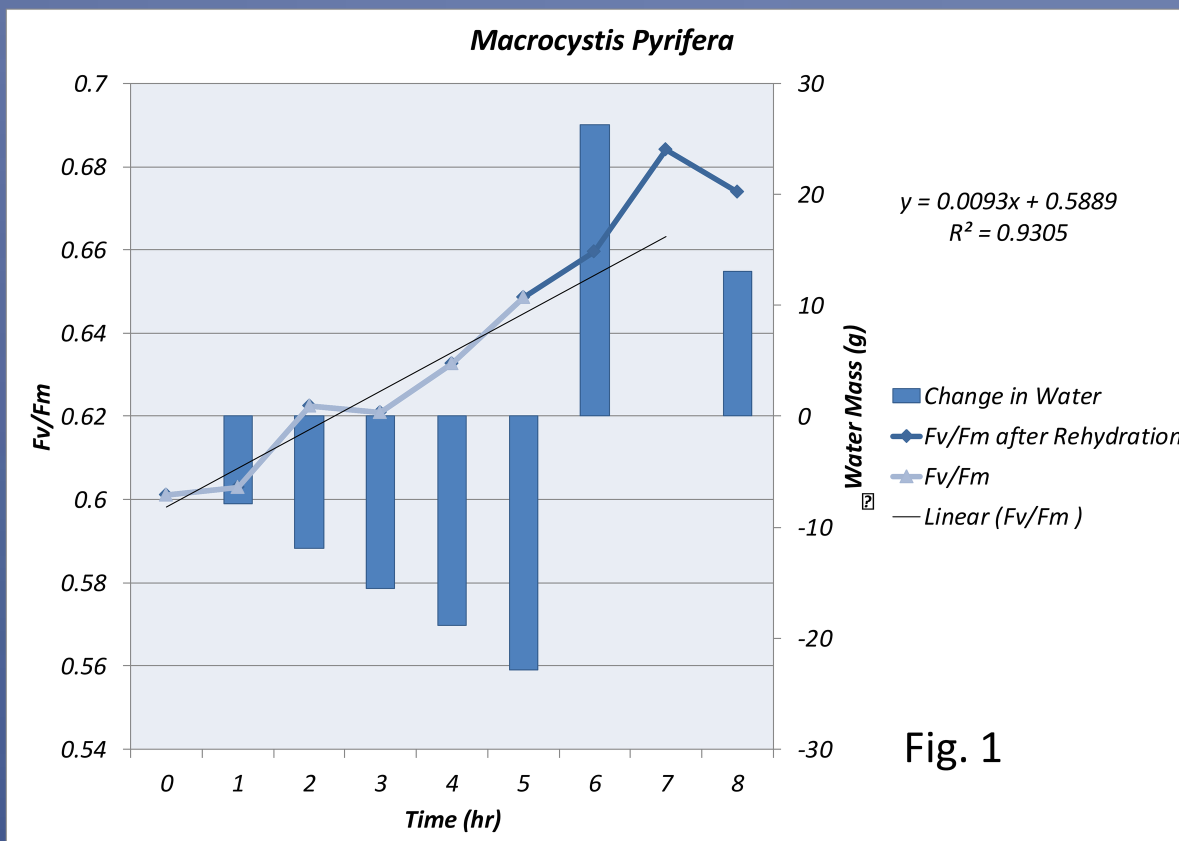

Fig. 1

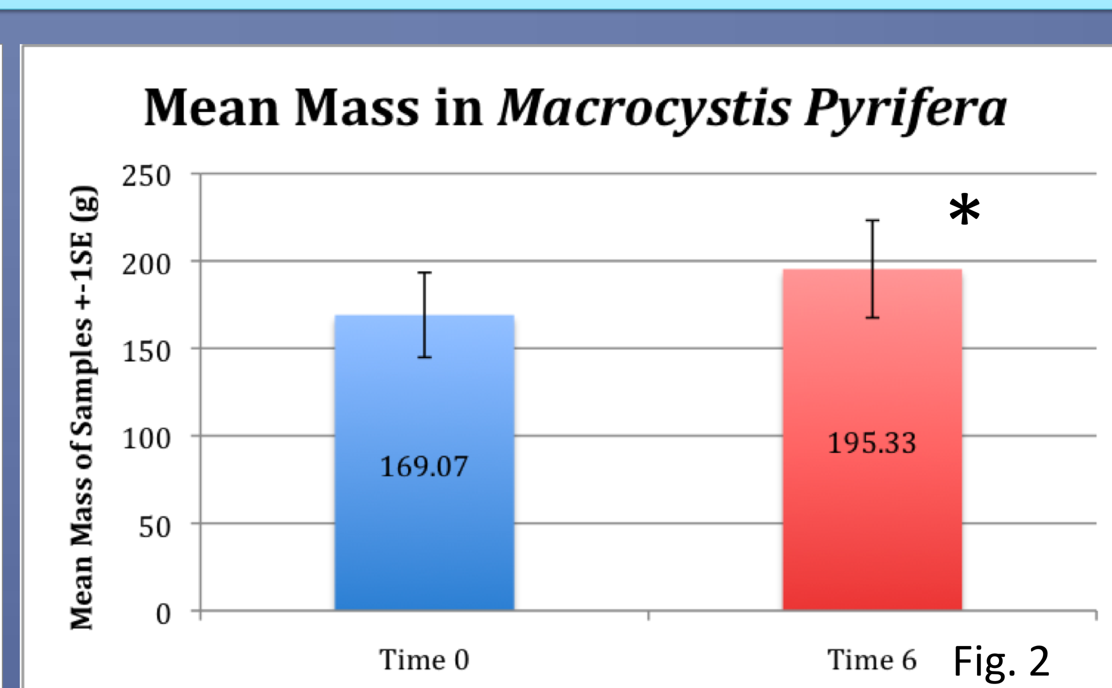

Fig. 2

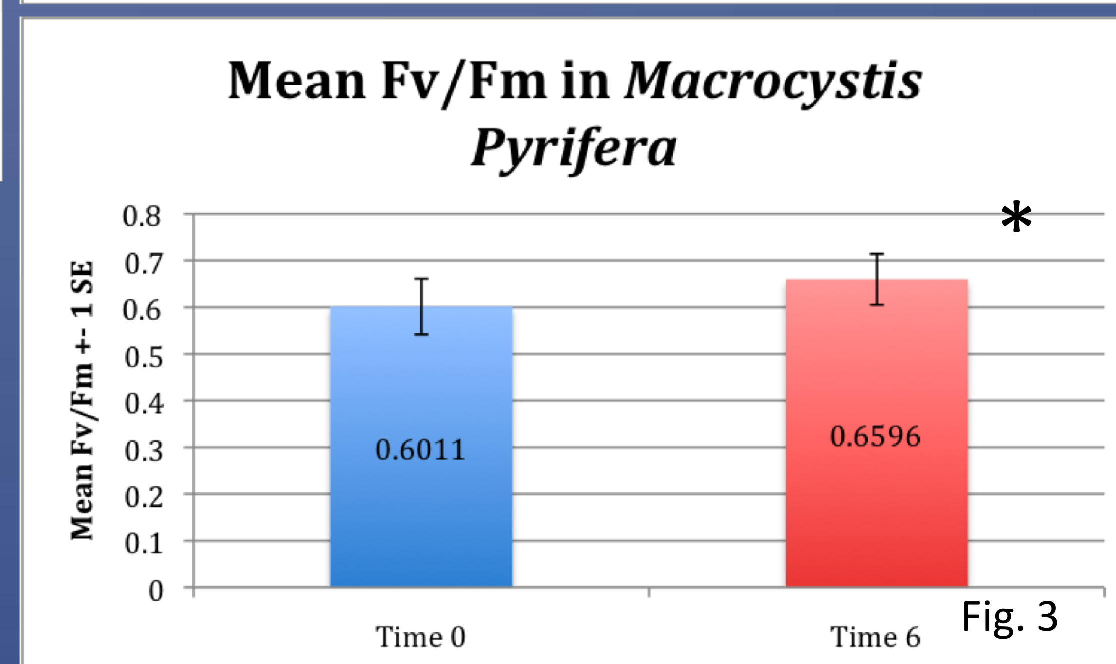

Fig. 3

Table 1 Test	P-Value
Chi-Square of Rehydrated	0.99905
Paired t-test for mean mass	0.0029 *
Paired t-test for mean Fv/Fm	0.0011 *

Figure 1: This graph shows the mean values for change in water and Fv/Fm for an 8 hour time period. The trendline is consistent with the data before rehydration and has a r^2 value of 0.93053.

Figure 2: This graph shows the results of a paired t-test for the mean mass of the samples at hour zero of dehydration and hour six, the first hour of rehydration. The significant p-value was 0.0029.

Figure 3: This graph shows the results of a paired t-test for the Fv/Fm for the mean of the samples at hour zero of dehydration and hour six, the first hour of rehydration. The significant p-value was 0.0011.

Table 1: Shows the p-values for the different tests used. For the t-tests n = 8 was used. For the chi-square test the df = 2.

* Denotes significance

Discussion

The two paired t-tests performed comparing the Fv/Fm and water mass at hour zero of dehydration and hour one of rehydration demonstrated that there was a significant difference in the Fv/Fm and in the change in water mass for the specimens. However, when the average Fv/Fm for each hour throughout the dehydration and rehydration process were placed on a graph and a trendline was fitted to the dehydrated values there was a strong positive linear increase in Fv/Fm as it became more dehydrated. Due to these surprising results a chi-square test was used to reveal whether the rehydrated values were independent of the dehydrated values using the expected values as those projected by the trendline. The chi-square had a p-value of 0.99905, revealing that the rehydrated values were definitely not independent of the dehydrated values.

It is unclear why the Fv/Fm increased over the dehydration period, perhaps this is a stress response in which the Fv/Fm reaches a maximum before beginning to decrease. It is also possible that the removal of the plant from seawater increases the plants accessibility to the sun and therefore the Fv/Fm increases until the point at which the sun irreversibly harms the plant, at which point it would decrease.

The surprising increase in Fv/Fm creates many questions for further study. It would be interesting to continue to monitor Fv/Fm for more data points after rehydration as well as adjust the dehydration process. To perfect these studies some adjustments could be made through creating a more controlled habitat for the dehydration of the plants. By manipulating different intensities of light and temperature to mimic the six hour beaching period the relationship between Fv/Fm and dehydration could be better understood. Fully dehydrating the plant to an absolute dry state and rehydrating could also reveal much about the elasticity of the plant. Modifications to this project and further study could greatly improve our understanding of the apparent resilience of *Macrocystis pyrifera.*

Conclusions

Fv/Fm increased linearly as *Macrocystis pyrifera* continually dehydrated with a r^2 value of 0.9305.

The chi-square test revealed that the dehydrated Fv/Fm values were not independent of the dehydrated values with a p-value of 0.99905.

The two paired tests revealed that the means were significantly greater for the mass and the Fv/Fm after hour six than the mean values of hour zero, with p-values of 0.0029 and 0.0011 respectively.

Literature Cited

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2. *Wavecast tide reports*. (2011, April 18). Retrieved from http://wavecast.com/tides
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Acknowledgements

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