The effect of iron on the heat tolerance of *Acropora* sp.

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Background

Heat stress often leads to coral bleaching: a response in which the endosymbiotic algae leave the corals. The overproduction of reactive oxygen species (ROS) through Photosynthesis by the algae is considered to be a reason. Superoxide dismutases (SODs) convert ROS into less harmful chemicals such as hydrogen peroxide. One kind of SODs uses iron as a cofactor.

$$2O_2^{\cdot -} + 2H^+ \xrightarrow{(SOD)} H_2O_2 + O_2$$

Fv/Fm

To test if photoautotrophs are under stress, Fv/Fm (variable chlorophyll fluorescence divided by maximum chlorophyll fluorescence) is a parameter wildly used. It reflects the photosynthetic efficiency of photosystem II and can be measured in a short-term response on dark-adapted samples.(Larcher, 1994)

Motivation

Previous study in our lab shows that *S. kawagutii*, a kind of endosymbiotic algae, attains high growth rate under 500 pM bioavailable iron (Fe') (Rodrigues et al, 2016) , which is much higher than in ocean surface seawater.

Based on this study, we wonder if high [Fe'] would help iron-SOD in endosymbiotic algae in corals to convert superoxide faster, thereby further increase the heat tolerance of corals.

Our research focuses on the hard coral genus – *Acropora,* which is an abundant kind of corals known to be subject to heat stress.

Methods

Experiments were performed in a biochamber set to 24°C . **(Figure 1)**

Corals were set into a 1 liter tank with 0 pM or 500 pM [Fe'] seawater.

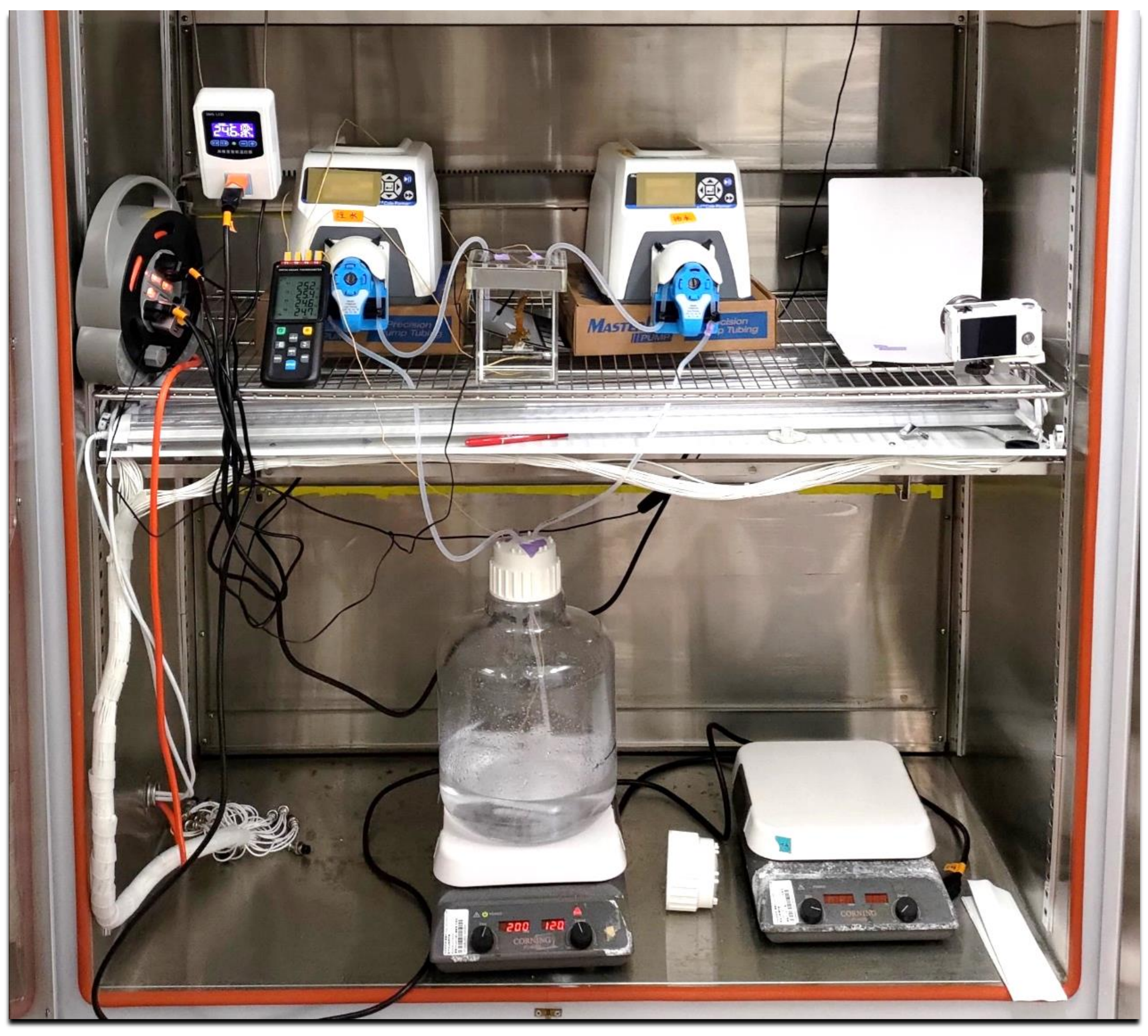

Figure 1. The experimental setup

1.Short-term Heat Stress Treatment

Seawater temperature was regulated by a hot plate connected to a thermo-regulator.

Treatment: Heating (1 hour) → Heat Hold (3.5 hours) → Cooling (1 hour)

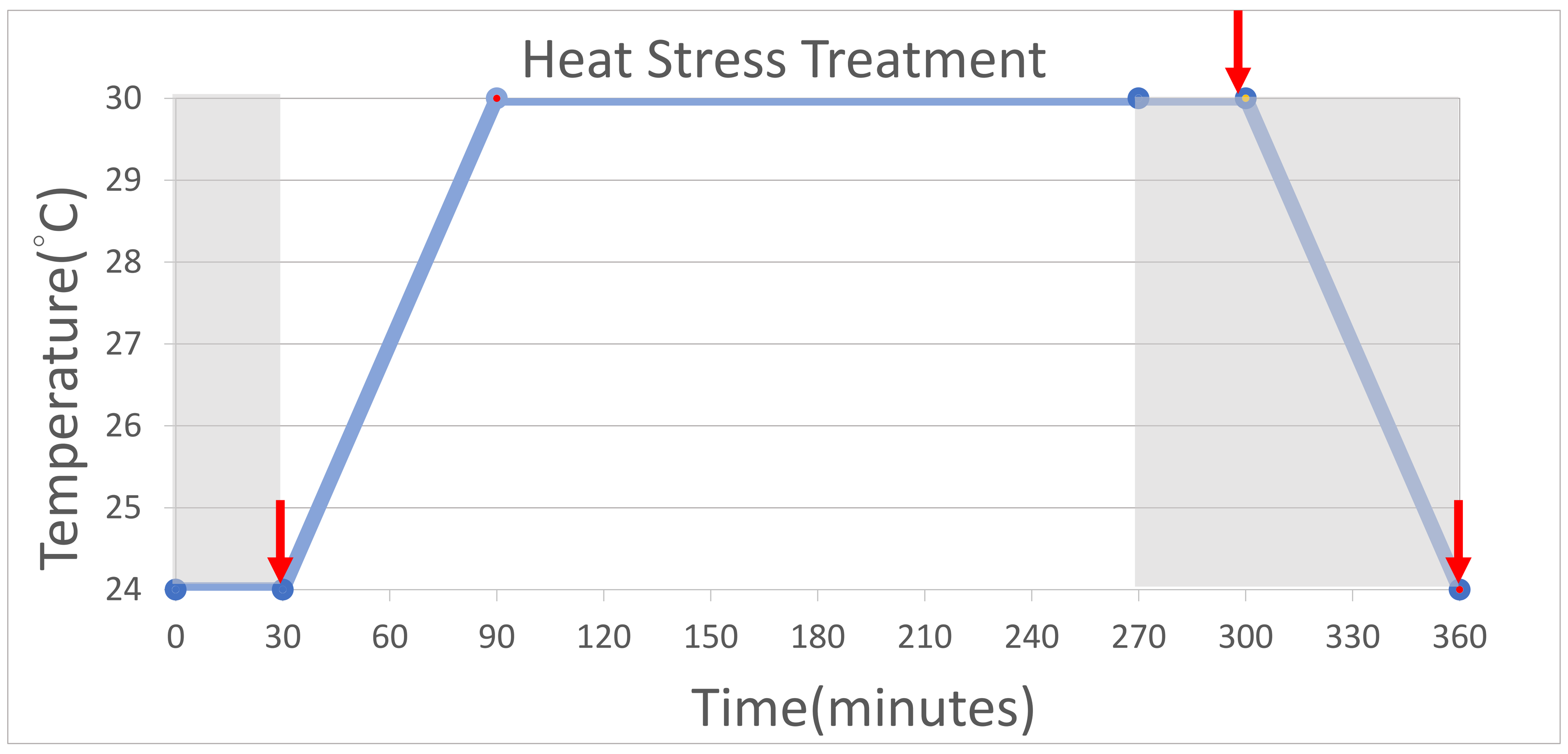

Figure 2. The temperature regulating process
The gray areas represent dark mode, otherwise the light was on.
The red arrows indicate the timing that we took photos and measured Fv/Fm

2.Fv/Fm Measurement

We Used Diving-PAM to measure Fv/Fm prior to heating, at the end of heat hold and after cooling.**(Figure 2.)**

3.The Degree of Coral Bleaching Analysis

We took photos at the same timing as measuring Fv/Fm.**(Figure 2.)**

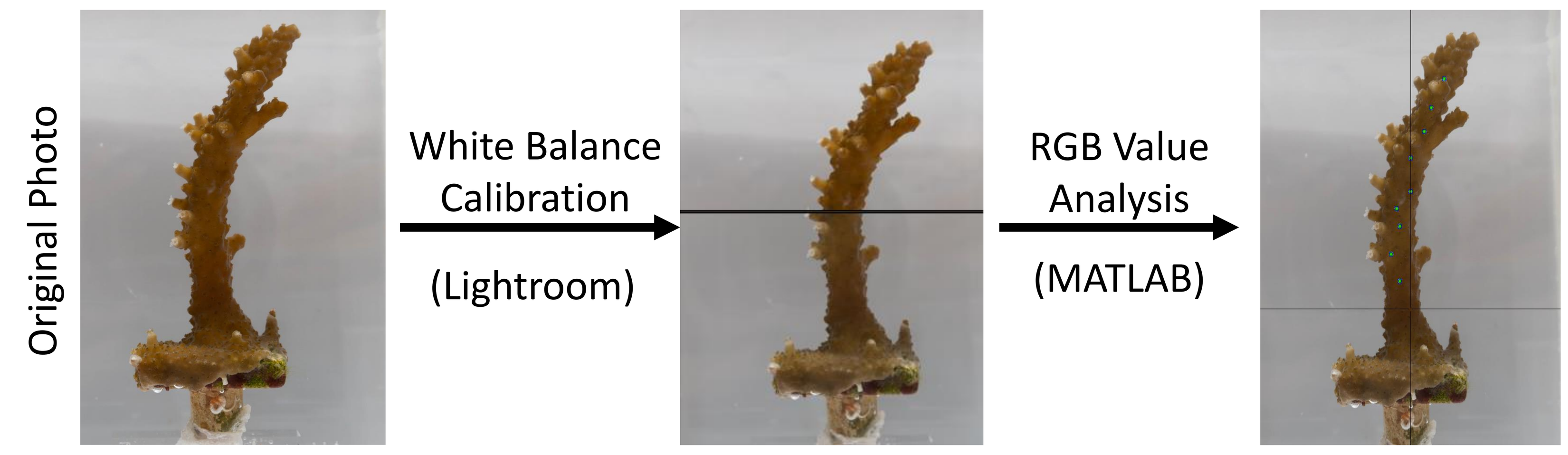

Figure 3. Degree of bleaching analysis process

Results & Discussion

1.Fv/Fm

Corals under 0 pM and 500 pM [Fe'] both showed a decreasein the Fv/Fm value. **(Figure 4.)** For the coral under 0 pM [Fe'], Fv/Fm kept decreasing, maybe the impact of heat stress continued, or endosymbiotic algae took some time to respond. While the value for coral under 500 pM [Fe'] remained unchanged after cooling compared to after heating.

Higher [Fe'] seems to help endosymbiotic algae in *Acropora* to maintain relatively higher photosynthetic efficiency under heat stress.

	Before heat stress	After heat stress	After cooling
0 pM [Fe']	0.67±0.04	0.54±0.04	0.49±0.03
500 pM [Fe']	0.67±0.01	0.56±0.01	0.56±0.01

Figure 4. Fv/Fm value under different [Fe'] in different timing

2.Degree of Coral Bleaching

Both the corals under 0 pM and 500 pM [Fe'] didn't show distinct change in color throughout the experiment process. **(Figure 5.)**

The heat stress might not reach the bleaching threshold, or the bleaching response wouldn't show in such a short time.

	Before heat stress		After heat stress		After cooling	
0 pM [Fe']		R:102 G:71 B:35		R:93 G:64 B:27		R:98 G:68 B:32
500 pM [Fe']		R:110 G:73 B:32		R:111 G:72 B:28		R:112 G:74 B:31

Figure 5. The color of corals under different [Fe'] in different timing.

Conclusion

Higher [Fe'] may help symbiotic algae to maintain higher photosynthetic efficiency compared to without Fe' under heat stress. However, the sample size was too small (only 1 for each concentration), further research should be done to test our hypothesis.

Future direction

For further research, experiments with a larger sample size should be done. Also, an analysis on the activity of iron-SODs should be caried out to check if it is indeed the impact of iron-SODs that helps the endosymbiotic algae in *Acropora* to maintain higher photosynthetic efficiency under heat stress.

Acknowledgement

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Reference

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