Light intensity shapes the thermal niche of the successful worldwide macroalgae invader *Codium fragile*?

Dwi Wai Shan Jaimie
Ecology and Biodiversity

Summer Research Fellowship (SRF) 2020 for Science Students

Poster No: F4
Name: Dwi Wai Shan Jaimie
University No: 3035538599
Student's Major: Ecology and Biodiversity

Abstract

Codium fragile, a worldwide-common invasive macroalgae, persists across wide temperature ranges using thermal physiological plasticity (TPP). The adaptation on seasonal fluctuations may allow them to spread wider geographical distribution with their ecologically advantageous growth strategy. This study investigated the physiological responses of *C. fragile* under thermal stress with high and low light intensity. The study shows that the physiological responses were mostly affected by temperature, with a minor influence from light intensity. While understanding TPP of *C. fragile*, the distribution of the seaweed invasion can be more predictable. This opens up to the study of genetic explanation of successful invasion occurred in *C. fragile*.

Introduction

- Natural fluctuation of environmental temperature is a major challenge for the survival of most marine organisms.
- TPP is the adaptive trait of species, allowing them to colonize in wider geographical distribution with seasonal trends
- Highly invasive *C. fragile* can cope with various environmental stresses[3] (e.g. stressful thermal and saline conditions)
- Interaction between environmental factors (e.g. light, salinity, nutrients) with temperature may explain the temporal and spatial dynamic changes of *C. fragile*[4,6].
- Since *C. fragile* contains chlorophyll, factor of light is crucial in energy production, irradiance level can constrain vertical and latitudinal dynamics for *C. fragile*, influencing survival, growth and photosynthesis.
- Limited studies on physiological mechanisms by which light interacts and modulates TPP, thermal tolerance and successful invasion *C. fragile*.

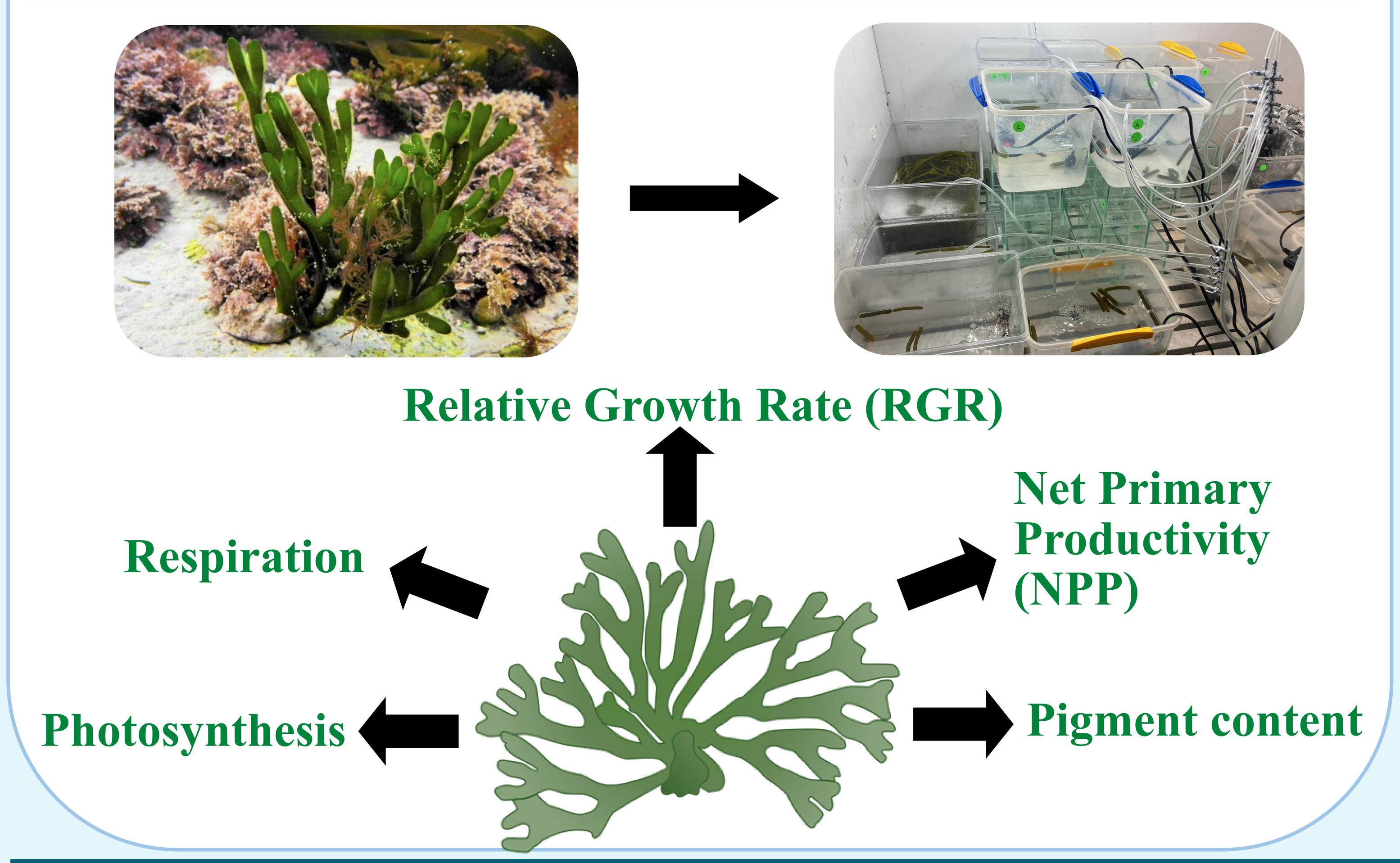
Hypothesis

Increasing light intensity would provide higher growth rate & photosynthetic performance to *C. fragile* as a result of increased tolerance to thermal stress.

Materials & Methods

Field collection, gradual laboratory acclimation to temperature and light (1 week), experiments 1 week:

Total sample size = 120 individuals		Temperature (°C)					
		17		21		25	
Light intensity (μmol m^{-2} s^{-1})	Low (60)	n=10	n=10	n=10	n=10	n=10	n=10
	High (120)	n=10	n=10	n=10	n=10	n=10	n=10



Results

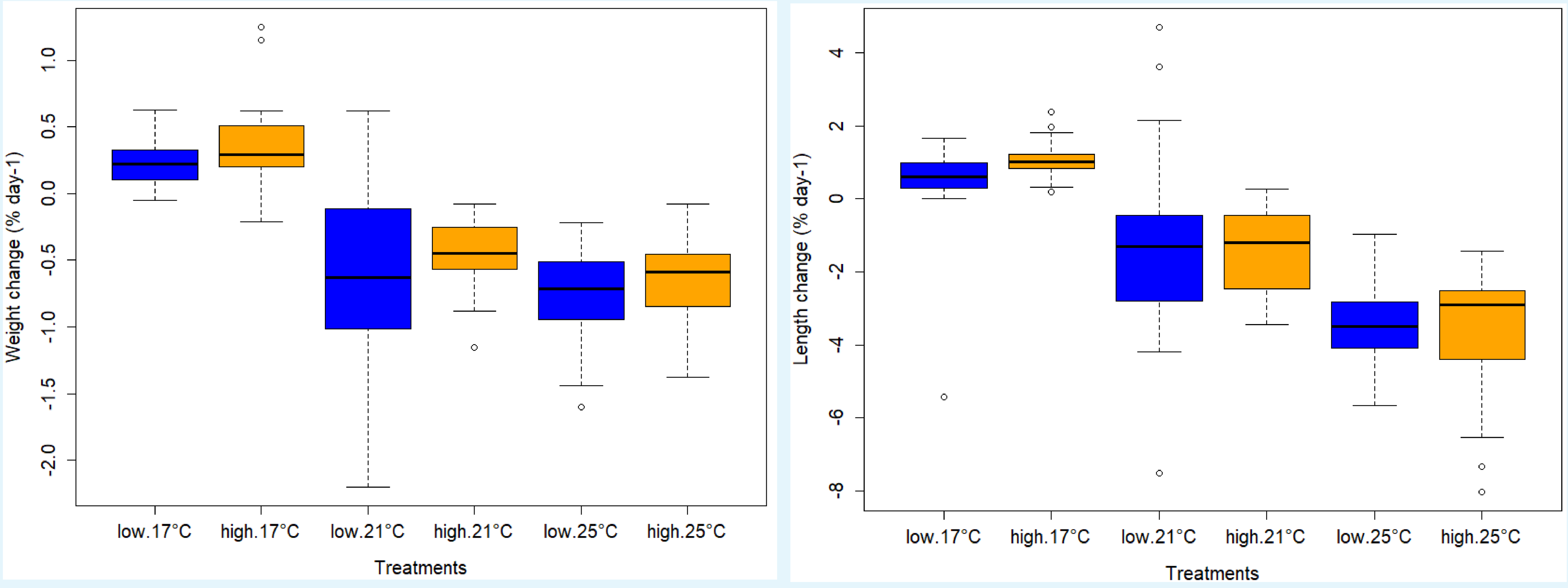


Fig. 1. Wet biomass and length changes (% day^{-1}) of *C. fragile* in 6 treatments after 8 days.

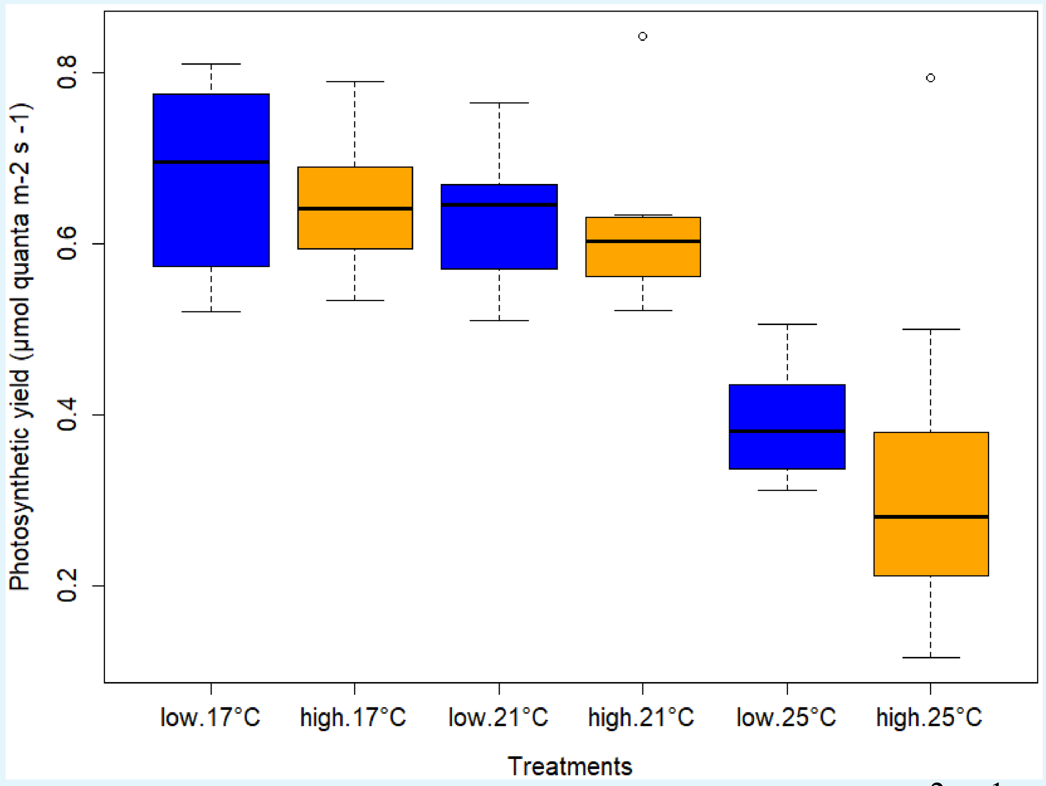


Fig. 2. Photosynthetic yield (μmol quanta m^{-2} s^{-1}) of *C. fragile* after 8 days of experiment.

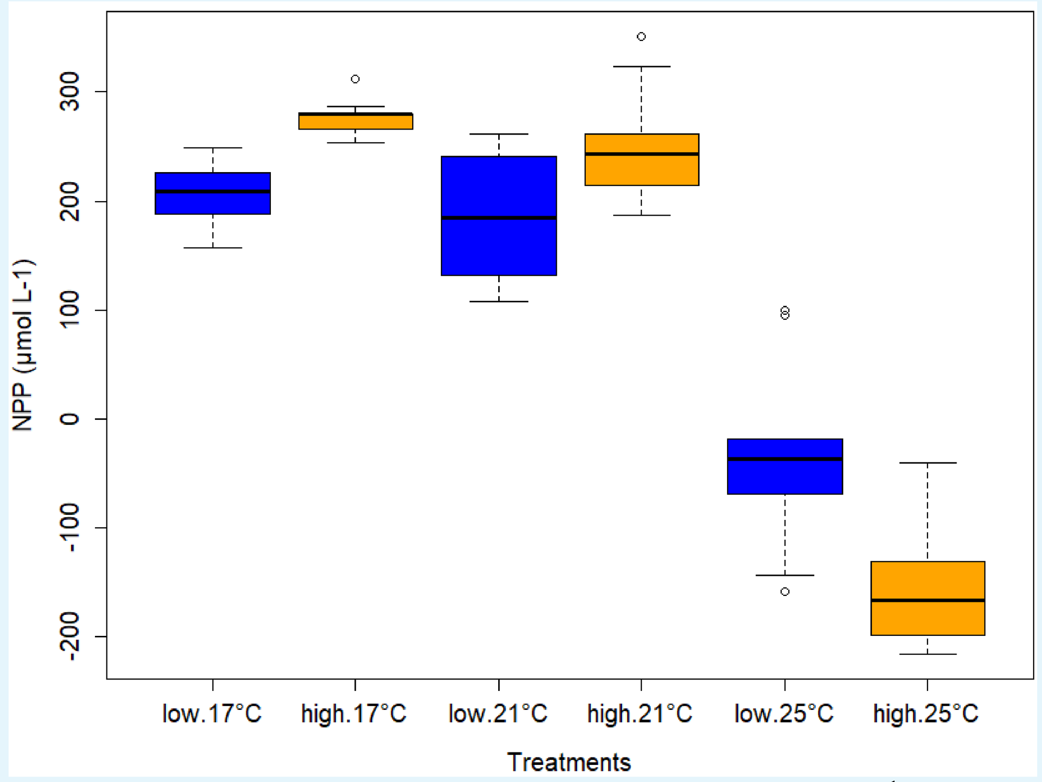


Fig. 3. Net primary productivity (μmol L^{-1}) of *C. fragile* after 8 days of experiment.

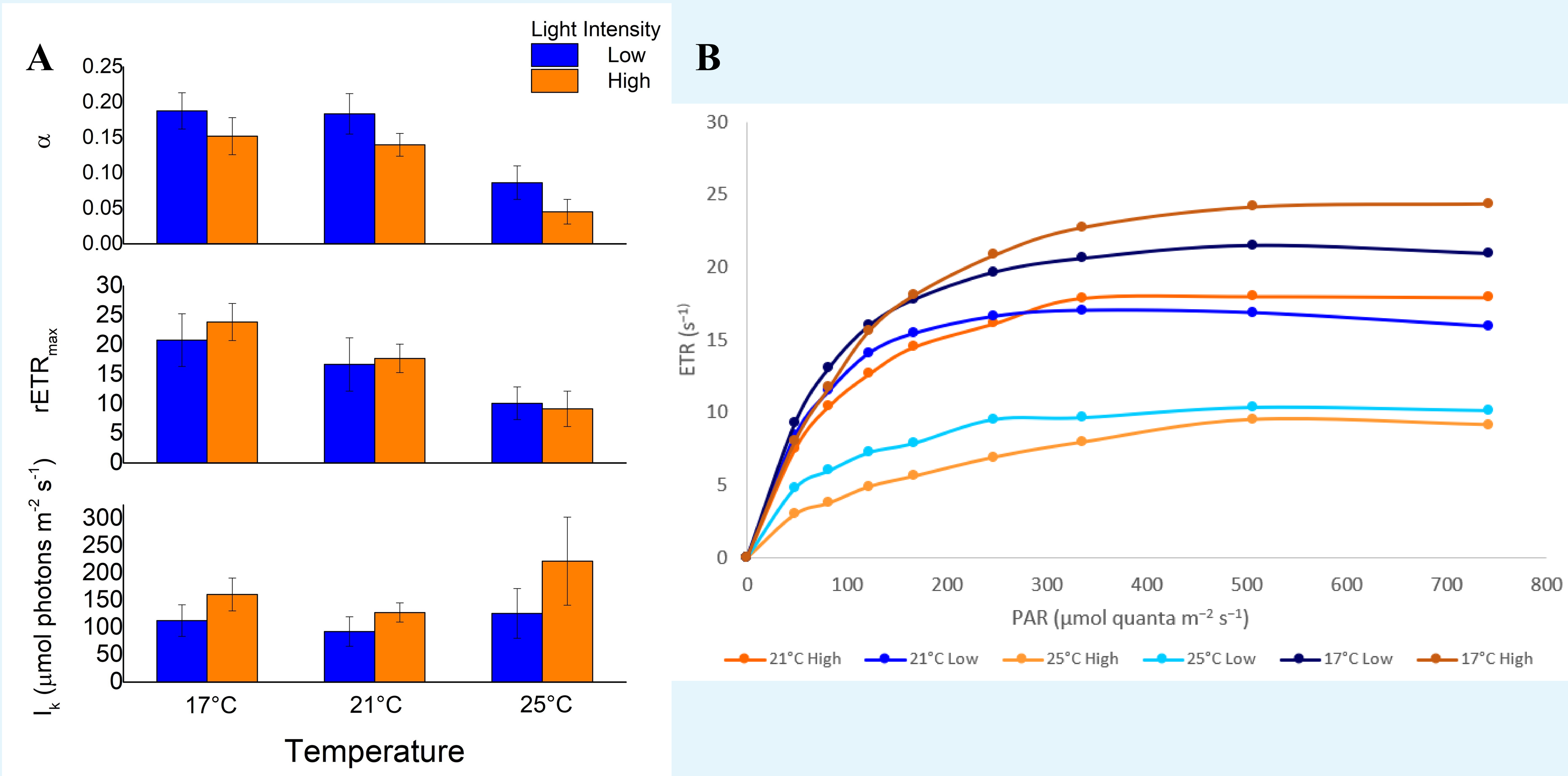


Fig. 4A. Photosynthetic response of treatments after 8 days of experiment. α represents the initial slope of curve, $rETR_{max}$ indicates potential maximum electron transport efficiency, and I_k is the light saturation point, reflecting the ability of light tolerance. 4B. ETR curves of the 6 treatments under the increasing scale of photosynthetically active radiation (PAR).

Discussion

- Temperature is the influencing factor on *C. fragile* growth[2], affecting most physiological responses (growth, NPP, respiration and photosynthetic yield)
- Light did not stimulate TPP in the experiment, thus no increased in the tolerance to thermal stress under accelerated light intensity
- However, light also influences the adaptation of *C. fragile* on thermal dynamics[1,4,5]
- Low intensity of light would stimulate photosynthetic efficiency of *C. fragile*
- Photosynthesis is the major physiological response impacting other responses (e.g. NPP)

References

1. Al-Qasmi, M., Raut, N., Talebi, S., Al-Rajhi, S., & Al-Barwani, T. (2012). A review of effect of light on microalgae growth. *Lecture Notes in Engineering and Computer Science*, *2197*(January 2017), 608–610.
2. Hanisak, M. D. (1979). Growth patterns of Codium fragile ssp. tomentosoides in response to temperature, irradiance, salinity, and nitrogen source. *Marine Biology*.
3. Hwang, E. K., Baek, J. M., & Park, C. S. (2008). Cultivation of the green alga, Codium fragile (Suringar) Hariot, by artificial seed production in Korea. *Journal of Applied Phycology*, *20*(5), 469–475.
4. Jofré Madariaga, D., Rivadeneira, M. M., Tala, F., & Thiel, M. (2014). Environmental tolerance of the two invasive species Ciona intestinalis and Codium fragile: their invasion potential along a temperate coast. *Biological Invasions*, *16*(12), 2507–2527.
5. Ramus, J. (1978). Seaweed anatomy and photosynthetic performance: the ecological significance of light guiges, heterogeneous absorption and multiple scatter. *Journal of Phycology*.
6. Singh, S. P., & Singh, P. (2015). Effect of temperature and light on the growth of algae species: A review. In *Renewable and Sustainable Energy Reviews*.