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Growth and photosynthesis of *Chlorella* strains from polar, temperate and tropical freshwater environments under temperature stress*

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Abstract Elevated temperatures as a consequence of global warming have significant impacts on the adaptation and survival of microalgae which are important primary producers in many ecosystems. The impact of temperature on the photosynthesis of microalgae is of great interest as the primary production of algal biomass is strongly dependent on the photosynthetic rates in a dynamic environment. Here, we examine the effects of elevated temperature on *Chlorella* strains originating from different latitudes, namely Antarctic, Arctic, temperate and tropical regions. Chlorophyll fluorescence was used to assess the photosynthetic responses of the microalgae. Rapid light curves (RLCs) and maximum quantum yield (F_v/F_m) were recorded. The results showed that *Chlorella* originating from different latitudes portrayed different growth trends and photosynthetic performance. The *Chlorella* genus is eurythermal, with a broad temperature tolerance range, but with strain-specific characteristics. However, there was a large overlap between the tolerance range of the four strains due to their "eurythermal adaptivity". Changes in the photosynthetic parameters indicated temperature stress. The ability of the four strains to reactivate photosynthesis after inhibition of photosynthesis under high temperatures was also studied. The *Chlorella* strains were shown to recover in terms of photosynthesis and growth (measured as Chl *a*) when they were returned to their ambient temperatures. Polar strains showed faster recovery in their optimal temperature compared to that under the ambient temperature from which they were isolated.

Keyword: Antarctic; Arctic; F_v/F_m; microalgae; pigments; recovery

1 INTRODUCTION

Anthropogenic influences have led to significant changes in climate. The average global temperature has risen by about 0.8°C since 1880 and the average global surface temperature is expected to increase by 4–5°C over the next century (IPCC, 2007). In addition to higher average temperatures, global climate change is also resulting in higher temperature variability, thus increasing the risks to species' tolerance limits. Temperature is one of the major factors affecting the distribution and productivity of microalgae.

Understanding the growth and photosynthetic response of microalgae to the changes in their thermal environment is crucial to the characterization of their ecophysiology in nature. Temperature effects on the

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