PHOTOSYNTHETIC PERFORMANCE IN ANTARCTIC PLANTS: EFFECTS OF *IN SITU* WARMING

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Introduction

Deschampsia antarctica and *Colobanthus quitensis*, the only two vascular plant species that have naturally colonized Maritime Antarctica, have developed diffusive and biochemical mechanisms that maximize their photosynthesis during the growing season. The intriguing question now is how these species will face warming?, whether these mechanisms, and their ability to survive in extreme conditions, will be sufficient to respond to future changes in temperature. To assess the effect of warming on *in situ* photosynthetic performance of Antarctic vascular plants, we conducted a climate manipulation experiment in King George Island (62° 09' S, 58° 28' W) during three growing season (February 2013 – March 2015), to test the effect of higher temperatures on photosynthesis and the underlying diffusive and biochemical limitations. We hypothesize that higher temperatures induce changes in photosynthetic limitations promoting higher rates of photosynthesis and, therefore, more growth under warmer conditions.

Materials and Methods

Study site:
King George Island (62° 09' S, 58°28' W). From December 2012 to March 2015.

Leaf gas exchange
Relative humidity: 40 and 50%
Leaf temperature: 10 ºC and 15 ºC

Relative growth:
Increase in the basal rosette area (during three months) and regression of the individual biomass as a function of the rosette area.

Mesophyll conductance (g_m):
Determined from combined gas-exchange and chlorophyll *a* fluorescence measurements and anatomical modeling.

Results

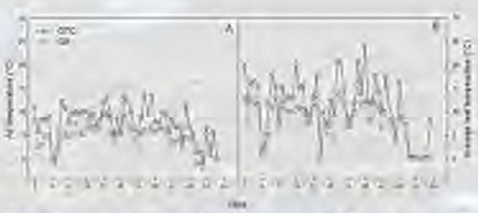

Fig. 1. Air temperature (A) and leaf temperature of *D. antarctica* and *C. quitensis* (B) recorded in open areas (OA) and inside warming chambers (OTC) since January 10th to March 5th, 2015.

Fig. 2. The relationship between the mesophyll CO_2 conductance (g_m) and the maximal Rubisco carboxylation rate (V_{cmax}) with the CO_2 assimilation rate (A_N) of *D. antarctica* and *C. quitensis* growing in open areas (OA) and warming chambers (OTC). Regression coefficient and the significance of the relationship are shown. Data are means ± S.E. (n = 6).

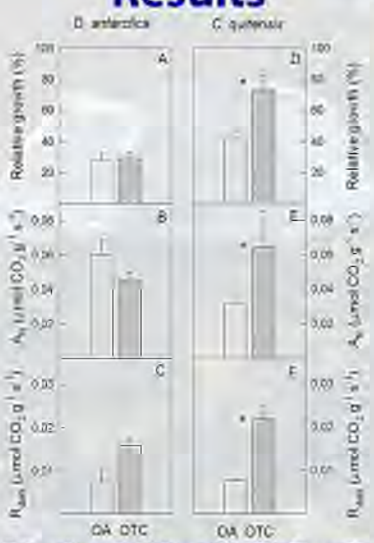

Fig. 3. The relative growth (%), the net photosynthetic CO_2 assimilation rate (A_N) and the dark respiration (R_{dark}) of *D. antarctica* and *C. quitensis* growing in open areas (OA) and warming chambers (OTC). Values are means ± S.E. (n = 6). * denotes significant differences between OA and OTC (P < 0.05).

Table 1. Stomatal (g_s) and leaf mesophyll (g_m) conductance, the maximum rate of Rubisco carboxylation (V_{cmax}), the chloroplast CO_2 concentration (C_c), the intrinsic water use efficiency (A_N/g_s) and the ratio of the electron transport rate and the gross photosynthesis (ETR/A_G) of *D. antarctica* and *C. quitensis* growing in open areas (OA) and warming chambers (OTC).

Parameter	*D. antarctica*		*C. quitensis*	
	OA	OTC	OA	OTC
g_s	[illegible]	[illegible]	[illegible]	[illegible]
g_m	[illegible]	[illegible]	[illegible]	[illegible]
C_c	[illegible]	[illegible]	[illegible]	[illegible]
V_{cmax}	[illegible]	[illegible]	[illegible]	[illegible]
A_N/g_s	[illegible]	[illegible]	[illegible]	[illegible]
ETR/A_G	[illegible]	[illegible]	[illegible]	[illegible]

Table 2. Leaf mass area (LMA), the leaf density (LD), the mesophyll thickness between the two epidermal layers (T_{mes}), the average distance between the chloroplasts and the cell wall (ΔL_{cyt}), g_m modeled from leaf anatomical measurements, the intercellular air space (g_{ias}), the liquid phase (g_{liq}), the mesophyll (S_m/S) and chloroplast (S_c/S) surface area facing intercellular air spaces per leaf area of *D. antarctica* and *C. quitensis* growing in open areas (OA) and warming chambers (OTC).

Parameter	*D. antarctica*		*C. quitensis*	
	OA	OTC	OA	OTC
LMA	[illegible]	[illegible]	[illegible]	[illegible]
LD	[illegible]	[illegible]	[illegible]	[illegible]
T_{mes}	[illegible]	[illegible]	[illegible]	[illegible]
ΔL_{cyt}	[illegible]	[illegible]	[illegible]	[illegible]
g_m modeled	[illegible]	[illegible]	[illegible]	[illegible]
S_m/S	[illegible]	[illegible]	[illegible]	[illegible]
S_c/S	[illegible]	[illegible]	[illegible]	[illegible]
g_{ias}	[illegible]	[illegible]	[illegible]	[illegible]
g_{liq}	[illegible]	[illegible]	[illegible]	[illegible]

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Conclusions

D. antarctica did not show differences either in leaf anatomy or photosynthetic parameters between OA and OTC. This species seems to be well adapted to Antarctic conditions and less limited by low temperature. In contrast, *C. quitensis* under OTC experienced several modifications in leaf anatomy that correlate with a higher g_m, ultimately leading to a higher photosynthetic performance (A_N) and respiration rate (R_{dark}). This associates directly with higher relative growth of *C. quitensis* under experimental warming. Our results suggest that