Physiological acclimation of an Antarctic endemic macroalga, *Desmarestia anceps* (Phaeophyceae), along a depth gradient

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Introduction

The seasonal degradation of the stratospheric ozone layer over the Antarctic leads to increased irradiance of ultraviolet radiation (especially UV-B) on the earth's surface and in oceanic and coastal waters. Therefore, sessile marine organisms like macroalgae may be particularly affected by enhanced UV-B-radiation which necessitates effective strategies to counteract. Here, habitat-specific acclimation in context to photosynthesis and the antioxidative potential of an Antarctic endemic macroalga collected along a depth gradient was investigated.

Material & methods

Individuals of the Antarctic endemic brown macroalga *Desmarestia anceps* (Phaeophyceae) were collected in 5.5, 9.1, 13.6 and 15.4 m water depth at “Peñon de Pesca” near the Antarctic scientific base Jubany (62.2°S, 58.6°W) on King George Island (Fig. 4). Individuals were transferred to a laboratory and were exposed to 15 µmol m^{-2} s^{-1} PAR (400-700 nm) supplemented with 15 W m^{-2} UV-A (320-400 nm) and 2.1 W m^{-2} UV-B (280-320 nm). By the use of various cut-off filters, individuals were exposed either to PAR alone (control), PAR+UV-A and PAR+UV-A+UV-B-radiation for 4 hours. A recovery phase of 4 hours in dim white light (15 µmol m^{-2} s^{-1} PAR) followed subsequently.
Photosynthetic activity was measured as optimal PS II quantum yield (Fv/Fm) with a PAM-2100 (Walz, Germany) chlorophyll fluorometer. Spectroradiometric measurements were performed using a Ramses ACC Hyperspectral Sensor (TriOS, Germany) at different water depths at the same time and site of sampling. Catalytic activities of superoxide dismutase (SOD) were determined according to a modified protocol of McCord & Fridovich (1969) and Udilova (1999).

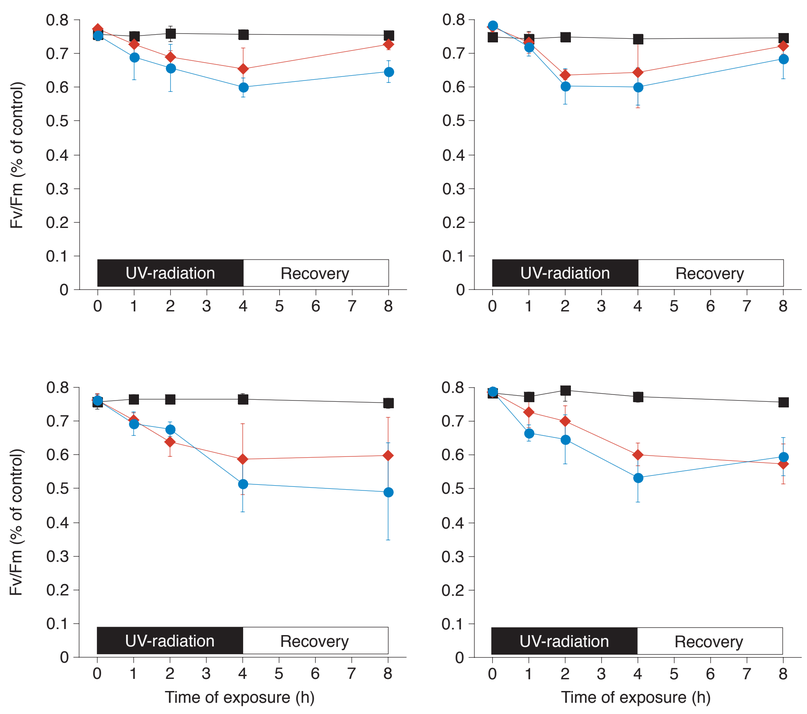

Fig. 1: Changes of Fv/Fm during a 4 hours exposure (black bars) to PAR alone (black squares), PAR+UV-A (red diamonds) and PAR+UV-A+UV-B (blue circles) and a subsequent recovery of 4 hours (white bars) in dim white light.

Results

Photosynthetic activities did not exhibit differences between Fv/Fm at any time of PAR+UV-A and PAR+UV-A+UV-B-exposure. In contrast, the velocity of recovery was different: specimens occurring at 5.5 and 9.1 m depth recovered within 4 hours but individuals collected from 13.6 and 15.4 m depth did not reach the values of control within the same time (Fig. 1).
Activities of SOD of unstressed (t_0) individuals were dependent on water depths where the individuals occur: an exponentially decrease became apparent (Fig. 2). SOD-activities measured in specimens collected from 5.5 and 9.1 m depth were very high (2760 and 1389 U mg^{-1}, respectively) whereas SOD-activity of samples from 13.6 m water depth was lower (273 U mg^{-1}, 1-way ANOVA, Tukey’s HSD). However, SOD-activities in all individuals did not change after 4 hours of UV-exposure compared to t_0.
Spectroradiometric measurements revealed an 1%-depth of UV-B-radiation on 11 m depth on 20th January 2005 while photosynthetically active (PAR) and UV-A-radiation penetrated deeper into the water column: 19 and 16 m, respectively (Fig. 3).

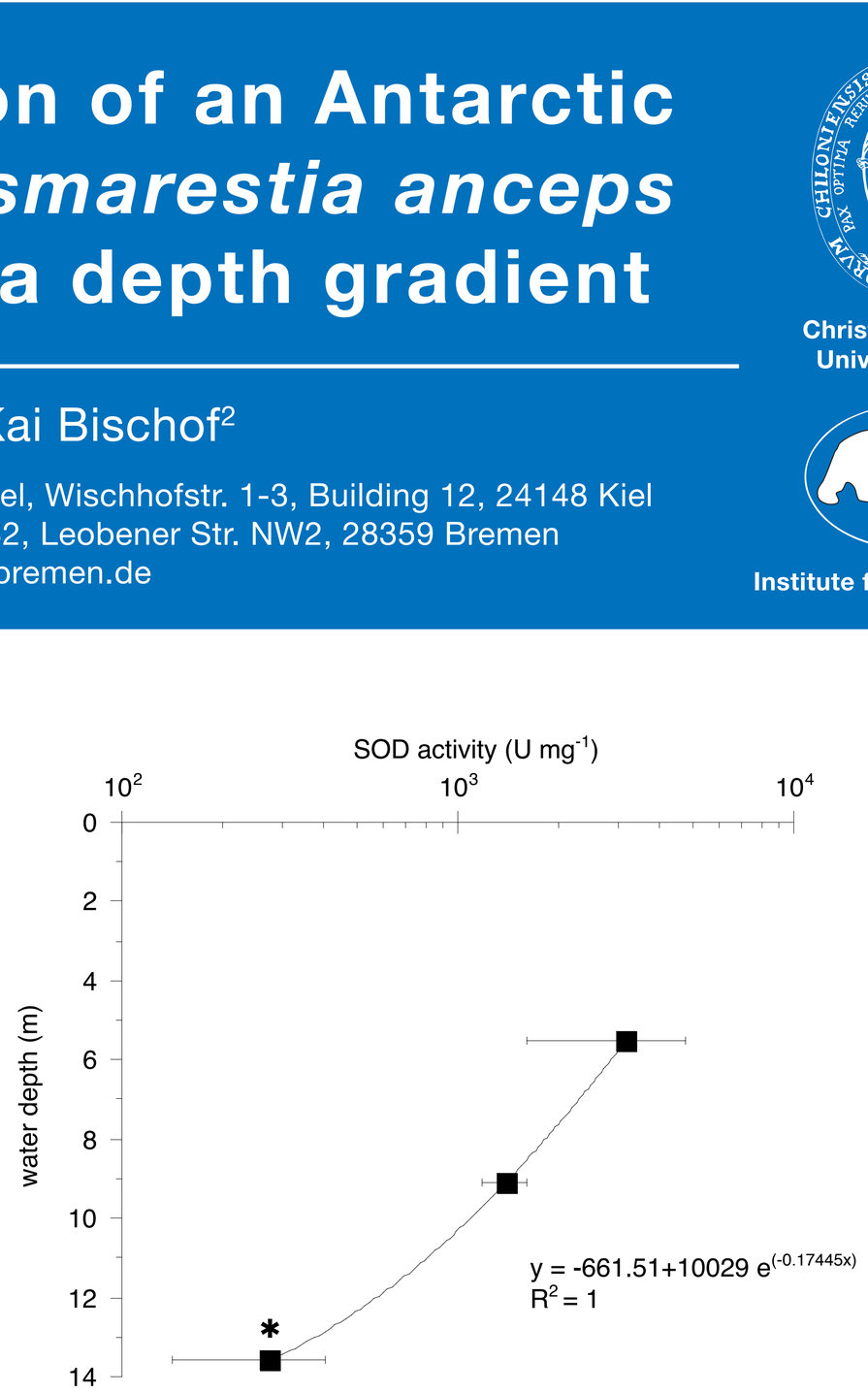

Fig. 2: Activities of superoxide dismutase (SOD) depending on water depth where individuals of *D. anceps* occur. The asterisk represents a statistical difference (1-way ANOVA).

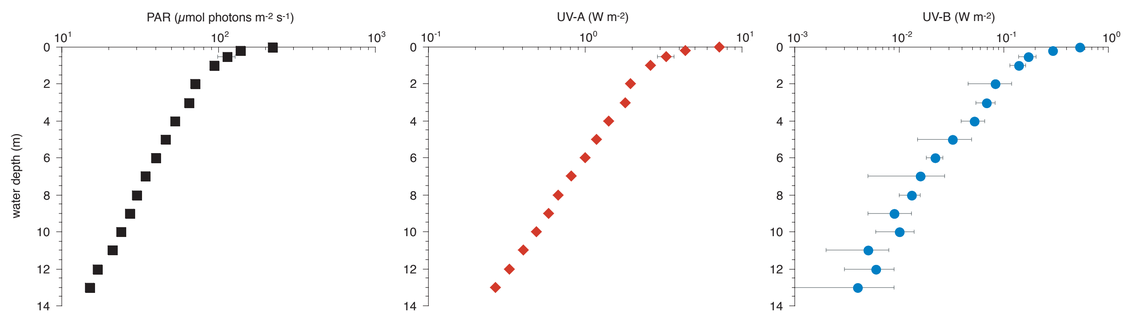

Fig. 3: Spectroradiometric measurements of water column at “Peñon de Pesca”.

Conclusion

This study could provide evidence to habitat-specific acclimation of the macroalga *D. anceps* distinct by a “transition zone” of UV-susceptibility between 9 and 13 m water depth:

1. The incomplete recovery of photosynthetic activity of individuals collected in water depths below 13 m refer to a greater UV-susceptibility than specimens occurring above 9 m.

2. Very high SOD-activities in individuals above 9 m may protect cells sufficiently against UV-induced oxidative Stress. In contrast, individuals growing below 13 m are exposed to less or no UV-B-radiation, thus comparatively “low” SOD-activities may not be defensive enough.

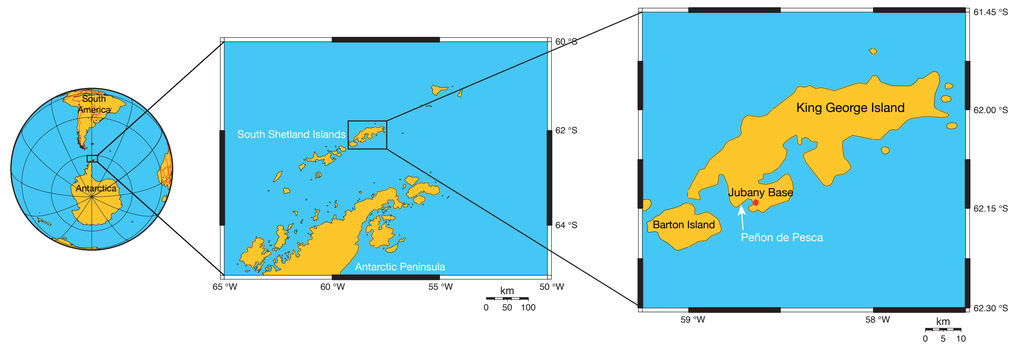

Fig. 4: Map of sampling site of *D. anceps* (“Peñon de Pesca” on King George Island).

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Udilova N (1999) Vergleichende Untersuchungen von Methoden zum Nachweis von Superoxidradikalen in biologischen und Modellsystemen. Doctoral thesis. Mathematisch-Naturwissenschaftliche Fakultät I der Humboldt-Universität zu Berlin, Berlin, 153 pp.