Vaucheria – a xanthophycean alga from Svalbard intertidal zone

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Introduction

The xanthophycean alga *Vaucheria* forms large amounts of biomass in the estuary of the Adventelva, Longyearbyen, Svalbard, representing thus the main primary producer in this ecosystem. The occurrence of this alga seems to be restricted to the intertidal zone, since it forms green belt along the coastline (Fig. 1). Therefore, it must be adapted to changes in temperature, irradiance (photosynthetically active radiation, PAR, and ultra-violet radiation, UVR), water availability and salinity, especially with respect of tidal rhythms.

The aim of this study was to characterize the *Vaucheria* community, to test the instrumentation for measurement of its photosynthetic activity, to measure *Vaucheria* photosynthetic activity and to define relations between encountered environmental conditions and *Vaucheria* photosynthetic activity and the in late Arctic summer.

Fig. 1. Locality in Adventelva estuary, Svalbard.

Material and Methods

The *Vaucheria* community was collected in the estuary of the Adventelva, Longyearbyen, Svalbard (78° 13' 22.51'' N, 15° 40' 7.39'' E) during low tide. The structure of the community was evaluated using Olympus BX-53 light microscope (Olympus, Japan) and the microphotographs were taken by Olympus DP-72 digital camera (Olympus, Japan). The images were processes using QuickPhoto 2.3 software (Pro Micra, Czech Republic).

The ecophysiological measurements were performed *ex situ* at the Payer's house, Czech Arctic Research Infrastructure "Josef Svoboda Station (Fig. 2) from August 12 to August 23, 2016. A piece of the *Vaucheria* community was placed into a plastic dish of 25 cm in diameter and were submerged in ca 5 cm of seawater ("The Yard"). The dish was positioned in front of the house. The air temperature (T_{air}) and PAR were measured using Mini-

kin QT datalogger (EMS Brno, Czech Republic). The photosynthetic activity was measured as the actual quantum yield using Monitoring Pens handheld fluorometers (blue and red versions, Photon Systems Instruments, Czech Republic), and as dissolved oxygen concentration using three Clark electrodes with thermometers positioned in the sediment, near the alga at depth of ca 3 cm and just under the water surface. The electrodes were connected to a datalogger (Gryf, Czech Republic). The environmental and physiological data were collected in 15min intervals, and the UTC was used as the reference time.

The statistical analyses were performed using Statistica 13 (Dell Inc. 2015) and CANOCO 5 (Ter Braak et Šmilauer 2012) softwares. The results were considered statistically significant for $P < 0.05$.

Fig. 2. "The Yard" experimental set-up.

Results

Community structure: The *Vaucheria* genus was dominant in the community. Small numbers of marine pennate diatoms were also observed.

Environmental conditions: During the ecophysiological measurements, the air temperature ranged from 3.8°C (recorded in the morning on August 21) to 13.2°C (recorded in the afternoon on August 18); the temperature mean value was 7.8°C. The PAR dropped to 0.7 µmol m^{-2} s^{-1} at local midnight on August 18, and reached up to 817 µmol m^{-2} s^{-1} at local mid-day on August 1; the PAR mean of 67 µmol m^{-2} s^{-1} indicated prevailing low-light conditions. In "The Yard", the temperature in bottom sediment (mean 8.0°C, minimum 3.5°C, maximum 13.4°C) was comparable to the air temperature. The temperature near the *Vaucheria* thalli were slightly higher (mean 8.7°C, minimum 4.3°C, maximum 17.0°C) and temperature at the water surface was even higher (mean 11.0°C, minimum 6.5°C, maximum 22.2°C).

Instrumentation tests: Both proposed methods provided data on photosynthetic activity in *Vaucheria* (Fig. 3). The data from red and blue Monitoring Pens were correlated tightly ($r = 0.839$, $P<0.001$), however the quantum yield measured by the blue version of the instrument were slightly lower.

Photosynthetic measurements: The diel changes in the quantum yield and dissolved oxygen in *Vaucheria* thalli followed the PAR course. The dissolved oxygen concentrations revealed anoxic conditions in the sediment (Fig. 3). The values of the quantum yields were negatively correlated to PAR and water temperature, while the changes in oxygen concentration were not dependent significantly on any of studied environmental variables. Nevertheless, all environmental variables explained 37.15% of total variation, and PAR was the most important one.

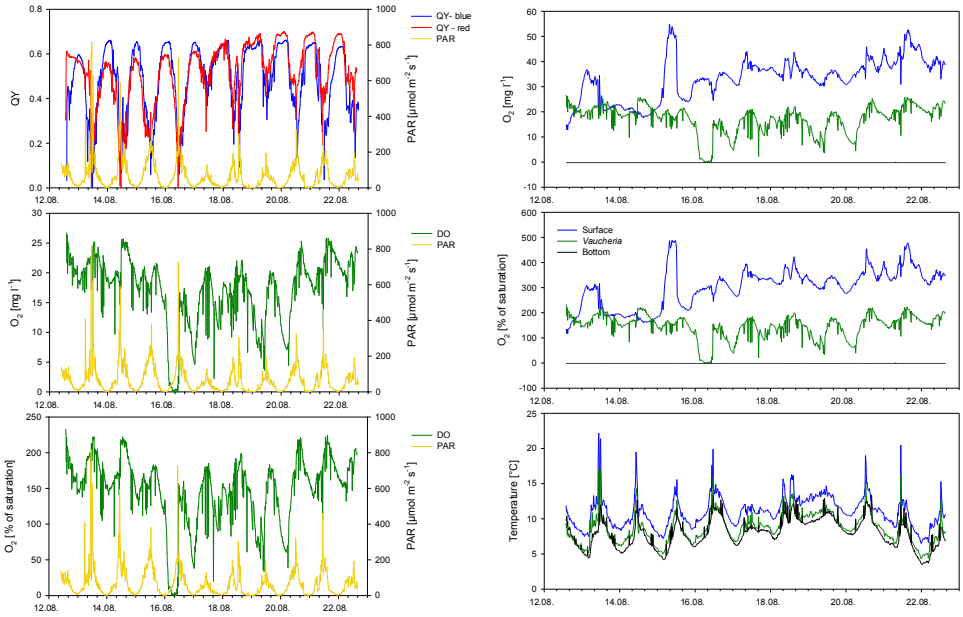

Fig. 3. The record of (left) the photosynthetic activity of *Vaucheria*, and (right) the oxygen concentrations at the water surface, near the *Vaucheria* thalli and in the bottom sediment.

Discussion

The values of PAR and air temperature corresponded to late Arctic summer. The proposed methodology using "Yard" proved to be suitable for photosynthetic activity measurements in *Vaucheria*. However, the tides that further affect the photosynthetic activity *in situ* due to thalli desiccation and interference with the diel courses of temperature and PAR, cannot be simulated in the "Yard" experimental set-up. Since the used instrumentation cannot not be applied in the intertidal zone directly due to instrument technical limitations and high turbidity there, we plan to develop more sophisticated cultivation unit for tide simulations.

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Key words: *Vaucheria,* oxygen evolution, variable chlorophyll fluorescence

References

DELL Inc. (2015): Dell Statistica (data analysis software system), version 13. software.dell.com.
TER BRAAK, C.J.F., ŠMILAUER, P. (2012): Canoco reference manual and user's guide: software for ordination, version 5.0. Microcomputer Power, Ithaca, USA.