Molecular species composition and thermotropic behavior of the main polar lipids of *Ulva lactuca* during rapid and slow cold acclimation

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Introduction

The study of adaptive abilities of marine organisms, in particular algae, to temperature change is an important scientific task, that could be useful for mariculture. *Ulva lactuca* is a widespread and valuable commercial species of green algae, which grow in the intertidal zone and vegetates throughout the year.

According to the classical concept of **homeoviscous adaptation**, when seawater cools, the unsaturation of fatty acid residues of membrane lipids increases, which is aimed to maintaining an optimal liquid-crystalline state for the functioning of biomembranes.

Ulva lactuca (Chlorophyta), Peter the Great Bay

The most abundant polar lipids of *U. lactuca* are glycolipids which mainly compose photosynthetic membranes of chloroplasts: **monogalactosyldiacylglycerol (MGDG), digalactosyldiacylglycerol (DGDG), sulfoquinovosyldiacylglycerol (SQDG)**. Extraplastidial membranes of *U. lactuca* are composed of phospholipids and **betaine lipid 1,2-diacylglycero-O-4´-(*N,N,N*-tri-methyl)-homoserine (DGTS)**.

THE PURPOSE OF THIS RESEARCH: to study the changes in molecular species composition and thermotropic behavior of **glycolipids** and **DGTS** of *U. lactuca* at different rates of cold acclimation of algae.

Matherials & Methods

Cold acclimation experiment

19 °C → 4 °C

15 °C/day **rapid acclimation** (1 day)

2 °C/day **slow acclimation** (8 days)

We investigated:

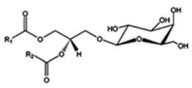
1. **Molecular species composition** of the individual major polar lipids by high-performance liquid chromatography – mass spectrometry (HPLC-MS)
2. **Crystal-to-liquid crystal phase transition** of the individual major polar lipids by differential scanning calorimetry (DSC)

Results

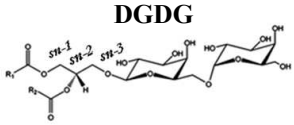
Abundant polar lipids of *Ulva lactuca*

Glycolipids

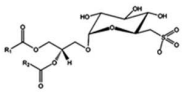
MGDG



DGDG

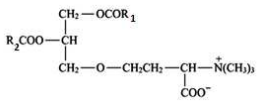


SQDG



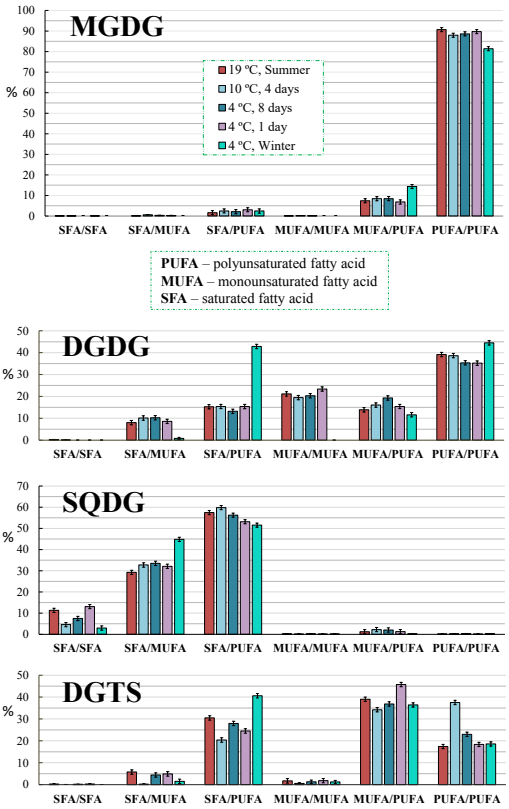
Betaine lipid

DGTS



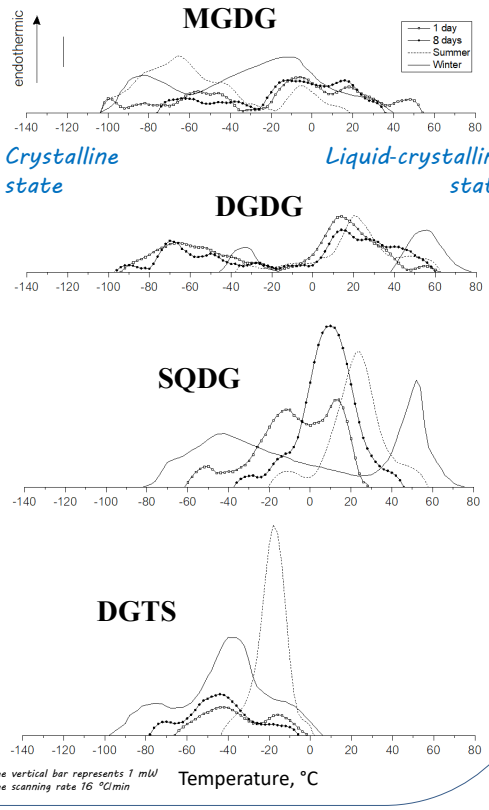
$R_{1,2}$ - hydrocarbon chains of various fatty acid residues

Molecular species composition



PUFA – polyunsaturated fatty acid
MUFA – monounsaturated fatty acid
SFA – saturated fatty acid

DSC calorimetry



Conclusions

1) During cold acclimation, as well as during seasonal temperature decrease, changes in the thermotropic behavior of the major photosynthetic lipid **MGDG**, in contrast to other glycolipids **DGDG**, **SQDG** and extraplastidial betaine lipid **DGTS**, were aimed at increasing the temperature of the crystal-to-liquid crystal phase transition. This effect contradicts the classical concept of homeoviscous adaptation and is possibly targeted to inhibit photosynthetic activity when cooling seawater.

2) In contrast to photosynthetic glycolipids, thermogram profiles of which were complex, the peak maximum temperature of thermal transition (T_{max}) of the extraplastidial lipid **DGTS** exactly reached the winter value at both rates of the cold acclimation.

3) Both the rapid and the slow acclimations had approximately the same effect on thermotropic behavior of the studied lipids, which was close to the seasonal changes.

4) At different rates of seawater cooling the redistribution in composition of molecular forms of the polar lipids was complicated. However, it was noticeable that in case of a longer cold acclimation the trends of changes in the composition of molecular forms of **MGDG** and, in part, **SQDG** were more similar to seasonal ones, than those in case of a 1-day acclimation.

5) The acclimation duration times chosen in this experiment were not sufficient to achieve seasonal effects.