Light and temperature impact on growth in two HBI-producer *H. ostrearia* strains: Further development on sea-ice HBI biomarker proxies

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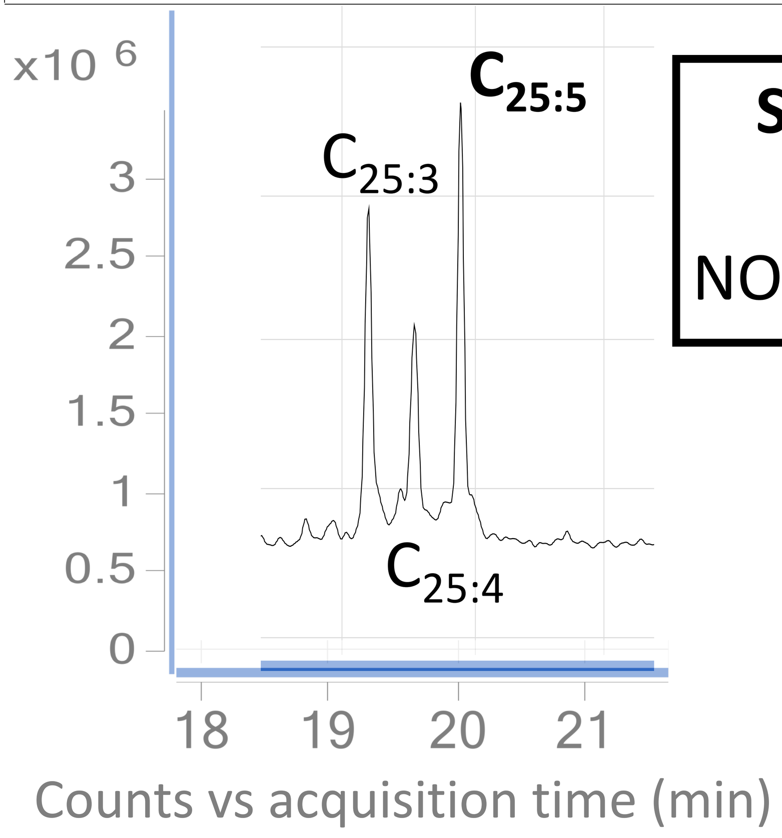
SUMMARY

Arctic sea-ice and Arctic ecosystems are **disappearing due to climate change**, disrupting weather and food-web patterns. **Understanding sea-ice natural variability** would help in assessing sea-ice resilience and identifying key mechanisms **to preserve it**. Highly Branched Isoprenoids (**HBI**) **in sea-ice living diatoms** provide a **method for reconstructing the history of Arctic and Antarctic sea-ice extent**. Beyond HBI composition, **HBI-specific stable isotope analyses could reveal additional past sea-ice characteristics i.e. sea-ice thickness.** In this early study, we test the **effect of different light settings on growth in two strains of the HBI-producer diatom *Haslea ostrearia*** and hypothesise environmental advantages of HBI configurations**:**

2018

Strain NCC 525
Collected:
NOVEMBER 2018

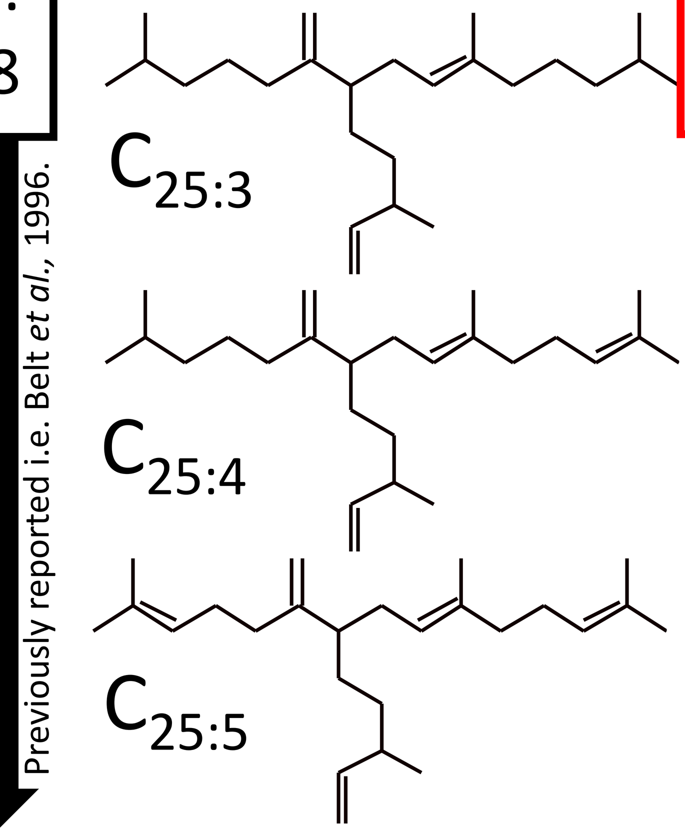


HBI: $C_{25:5}$ > $C_{25:3}$ > $C_{25:4}$

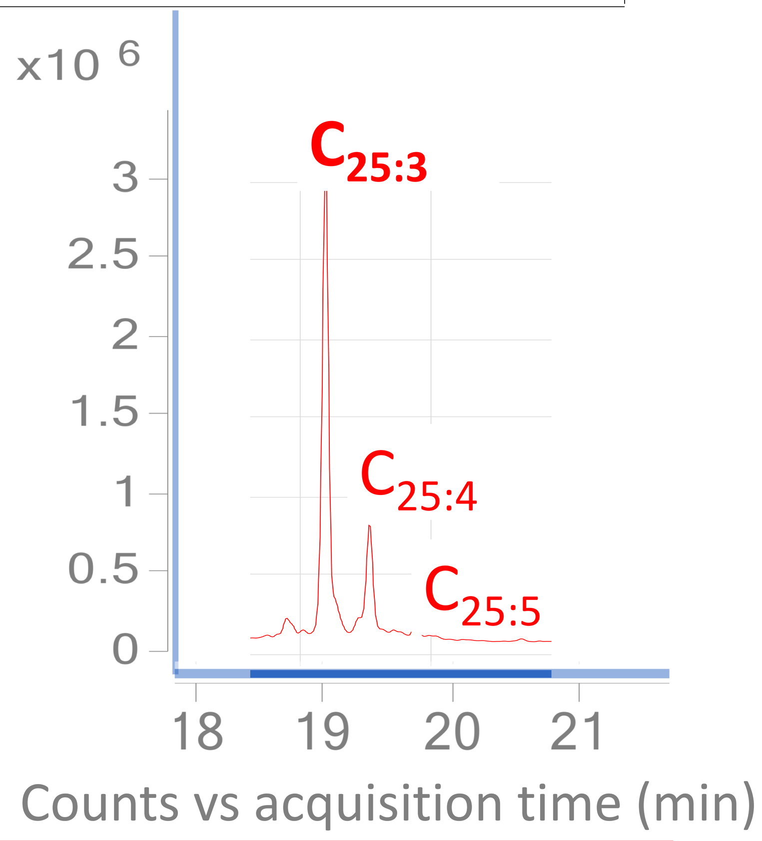
2019

HASLEA OSTREARIA

HBI

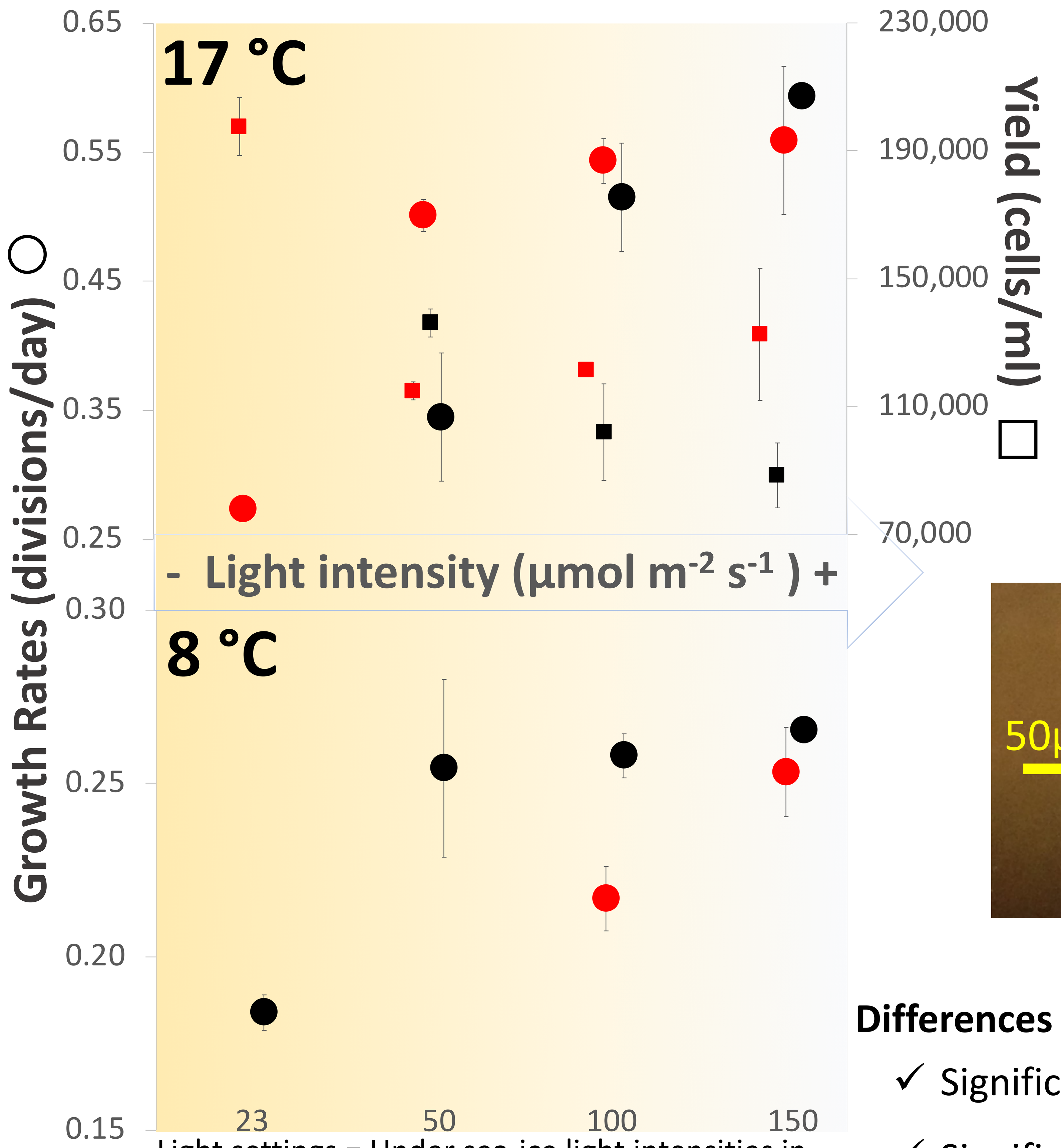


Strain NCC 538
Collected:
MARCH 2019



HBI: $C_{25:3}$ > $C_{25:4}$ > $C_{25:5}$

LIGHT EXPERIMENTS

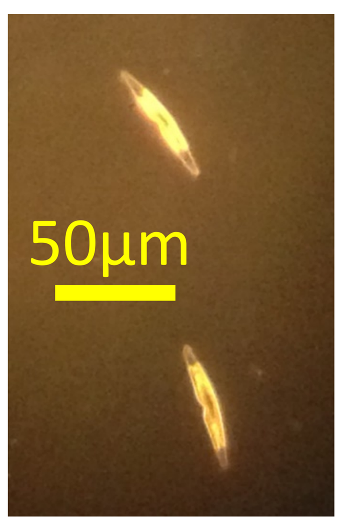


Light settings = Under sea-ice light intensities in Svalbard (Leu *et al.,* 2010).

➢ RESEARCH QUESTIONS

1. Would **environmental changes impact differently** the **growth and the initial HBI-configuration** of *Haslea ostrearia* **NCC525** and **NCC538**?
2. Does **a particular pre-configuration of HBI unsaturations increase the success** in thriving **in a particular environment** (light, T)**?**

PRELIMINARY RESULTS *HASLEA OSTREARIA*



Similarities across **NCC538** and **NCC525** strains

- ✓ Significantly **faster growth rates (twice faster)** at **17 °C** than at 8 °C (p-vales <0.001).
- ✓ Significantly **faster growth rates at higher light intensities** than at lower **light intensities at 17 °C** (p-values <0.01) **and at 8 °C** (p-values <0.05).
- ✓ Significant **increases in yield with decreasing light intensities** (p-values<0.0005) at 17 °C.

Differences across **NCC538** and **NCC525** strains

- ✓ Significantly **fastest growth rates of NCC538 at 17 °C** (p-values <0.005).
- ✓ Significantly **faster growth rates of NCC525 than NCC538 at 8 °C** (p-values <0.05).

CONCLUSIONS

Early results of ongoing lab-experiments show a **similar tendency of increasing growth rates with increasing temperature and light intensity and increasing yield with decreasing light intensity for both NCC538** and **NCC525 strains.** These results point to a **possible similar HBI evolution across different environmental conditions and diatom strains. In addition, it is possible that the initial HBI composition might present an advantage for an strain to thrive at a particular temperature:** NCC538 (HBI: $C_{25:3}$>$C_{25:4}$>$C_{25:5}$) at higher temperatures (17 °C) and **NCC525** (HBI: $C_{25:5}$>$C_{25:3}$>$C_{25:4}$) at lower temperatures (8 °C). **Future work could confirm these first hypotheses and** would target **developing a new sea-ice thickness proxy.**

REFERENCES

Belt, S. T., et al. (1996) Structural characterisation of widespread poly- unsaturated isoprenoid biomarkers: A C25 triene, tetra- ene- and pentaene from the diatom *Haslea ostrearia* Simonsen. Tetrahedron Letters 37, 4755±4758.
Leu, E., et al. (2010). Increased irradiance reduces food quality of sea ice algae. *Marine Ecology Progress Series* 411, 49–60, doi.org/10.3354/meps08647.

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Take Home Messages

- **Synchronised response** of *H. ostrearia* strains NCC538 and NCC525 growth **across a range of environmental conditions** (light: 23-150 μmol m^{-2} s^{-1}; temperature: 17°C and 8°C).
- **Increase growth success of NCC538** (HBI: $C_{25:3}$>$C_{25:4}$>$C_{25:5}$) over NCC525 **at higher temperatures (17 °C).**
- **Increase growth success of NCC525** (HBI: $C_{25:5}$>$C_{25:3}$>$C_{25:4}$) over NCC538 **at lower temperatures (8 °C).**

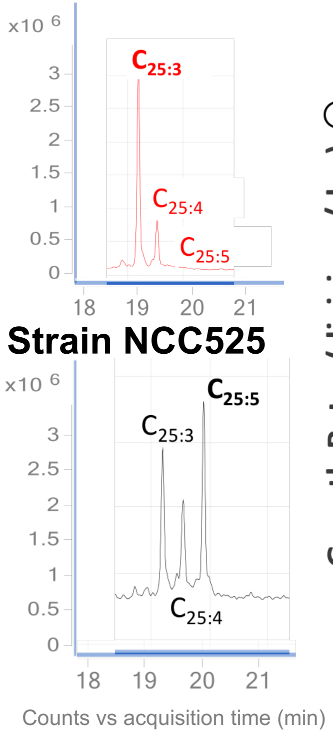

Fig 1: HBI composition of *H. ostrearia* strains **NCC538** and **NCC525.**

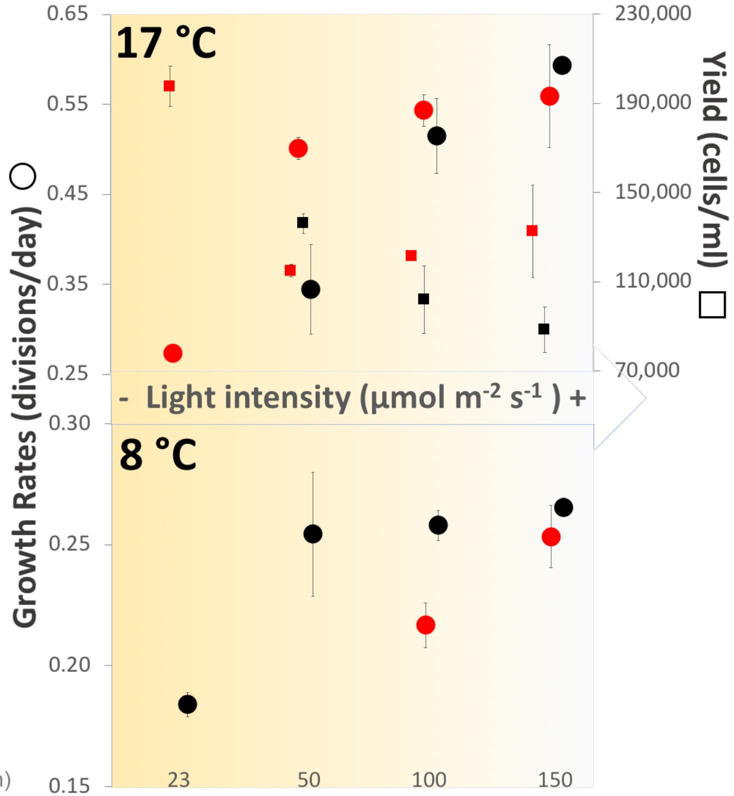

Fig 2: Light experiments on *H. ostrearia* strains **NCC538** and **NCC525 growth rates (divisions/day) and yield (cells/ml) at 17 and 8**°C.

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Light and temperature impact on growth in two HBI-producer *H. ostrearia* strains:

Further development on sea-ice HBI biomarker proxies

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Motivation for this Study

- **Arctic sea-ice** and Arctic ecosystems are **disappearing due to climate change**, disrupting weather and food-web patterns.
- **Understanding sea-ice natural variability** would help in assessing sea-ice resilience and identifying key mechanisms **to preserve it**.
- **Beyond** HBI composition for past **sea-ice extent** reconstructions, **HBI-specific stable isotope analyses could reveal additional past sea-ice characteristics i.e. sea-ice thickness.**

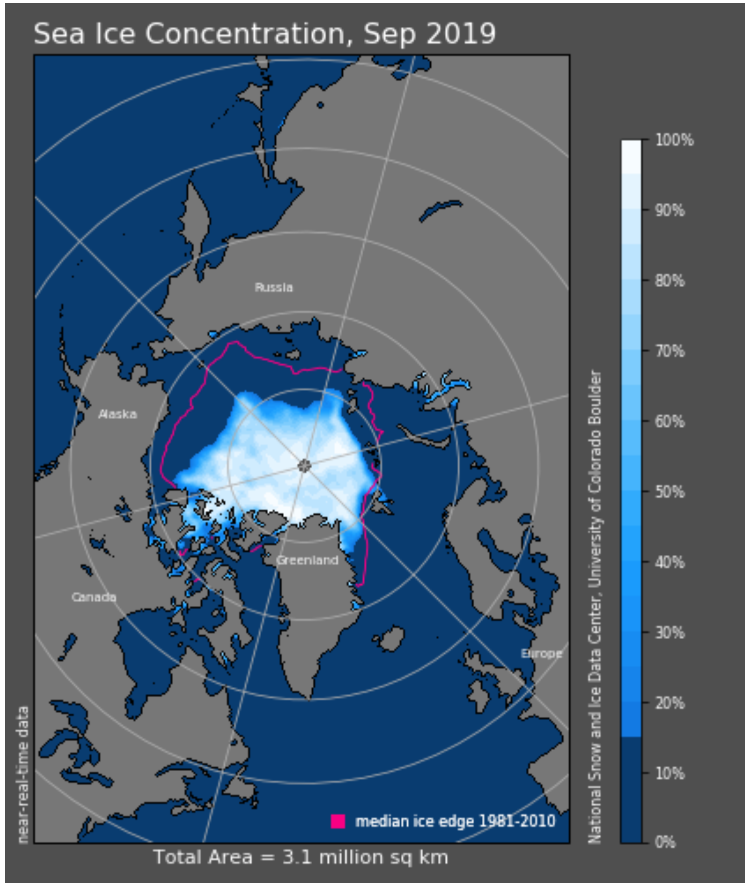

Figure 1: Average monthly sea-ice concentration in September 2019 compared with the median sea-ice extent in September during the period 1981-2010 (pink line). Maps from NSIDC http://nsidc.org/data/seaice_index/

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Research Questions

Our first test for developing a new sea-ice thickness proxy involves the comparison between the HBI-evolution of two HBI-producing diatom strains under different light intensities.

1. Would **environmental changes** (light, T) **impact differently** the **growth and the initial HBI-configuration** of *Haslea ostrearia* strains **NCC525** and **NCC538**?

2. Does **a particular pre-configuration of HBI unsaturations represent an increase in the success** in thriving **in a particular environment** (light, T)?

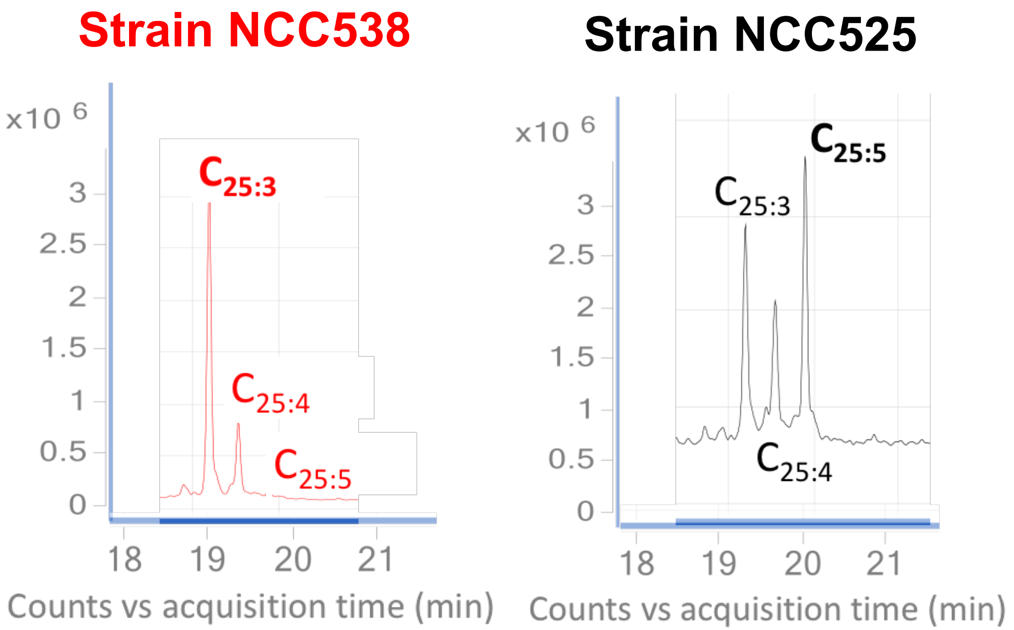

Fig 2: Initial HBI composition of *H. ostrearia* strains **NCC538** and **NCC525.**

Methods

1. Obtention of *H. ostrearia* strains **NCC525** and **NCC538** from Nantes Culture Collection.
2. HBI analyses.
3. Growth of **NCC525** and **NCC538** strains in triplicates under a combination of light and T:

   Light: 23, 50, 100 and 150 µmol m^{-2} s^{-1}.

   Temperature: 17°C and 8°C.
4. Daily monitoring of cell counts.
5. Harvesting cultures at exponential growth and stationary phases.
6. HBI and HBI-specific isotope analyses.

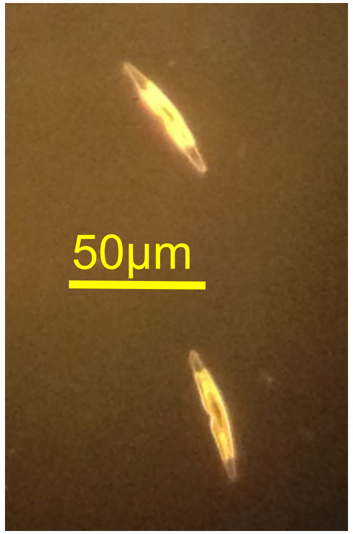

Fig 3: Microscope photograph of *H. ostrearia.*

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Preliminary Results

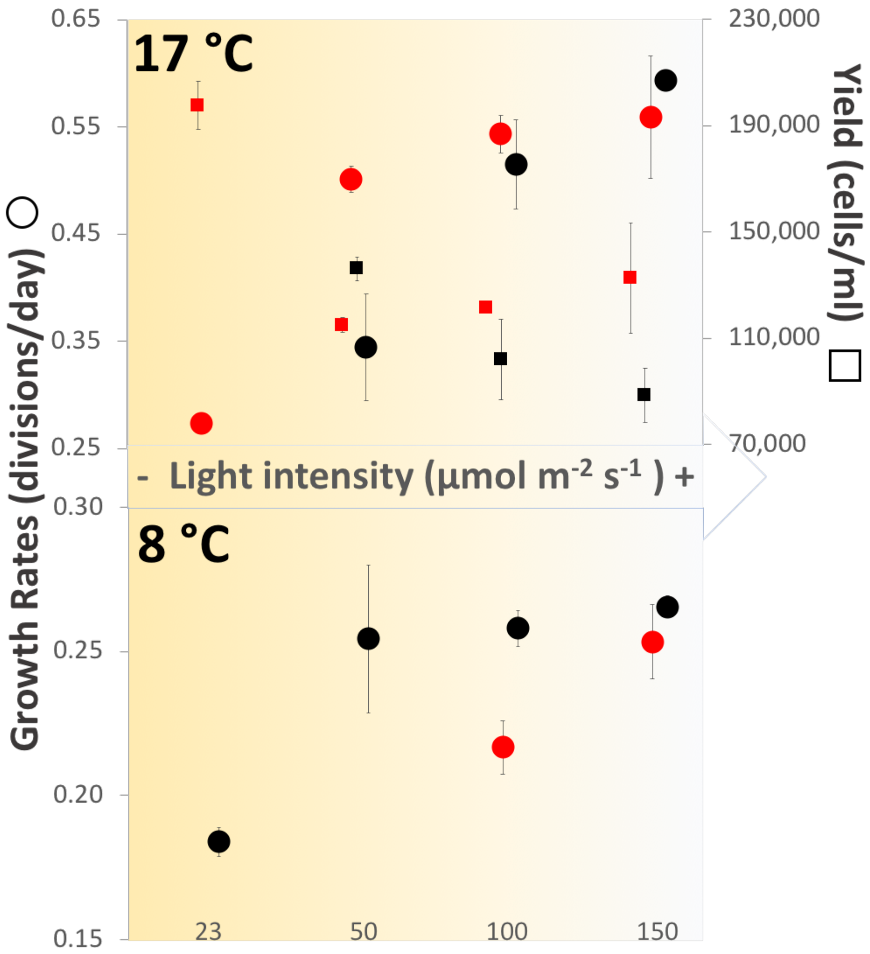

Fig 4: Light experiments on *H. ostrearia* strains NCC538 and NCC525 growth rates (divisions/day) and yield (cells/ml) at 17 and 8°C.

Similarities across **NCC538** and **NCC525** strains

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Differences across **NCC538** and **NCC525** strains

- ✓ Significantly **fastest growth rates of NCC538 at 17 °C** (p-values <0.005).
- ✓ Significantly **faster growth rates of NCC525 than NCC538 at 8 °C** (p-values <0.05).

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Answering our Research Questions

1. **Synchronised response of *H. ostrearia* strains NCC538 and NCC525 growth across a range of environmental conditions** (light, 23-150 µmol m^{-2} s^{-1}; and temperature, 17°C and 8°C).

2. **Increase growth success of NCC538** (HBI: $C_{25:3}$>$C_{25:4}$>$C_{25:5}$) over NCC525 **at higher temperatures** (17 °C), **and NCC525** (HBI: $C_{25:5}$>$C_{25:3}$>$C_{25:4}$) over NCC538 **at lower temperatures** (8 °C).

→Future HBI analyses would reveal how the HBI respond to these changes in growth.

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Final Remarks

This ongoing study is the first step towards the development of a new sea-ice thickness proxy, which would help in **quantifying past sea-ice** conditions **and assessing** the relative vulnerability and resilience of **current Arctic sea-ice decline**.

- Our next steps involve analysing HBI and HBI-specific stable isotopes from our light experiments.

Through biomarker research, acquisition of past sea-ice qualitative data has been achieved but **we need to develop ways to quantitatively characterise past sea-ice for a better understanding of current sea-ice decline. New quantitative data will help in modelling more accurately sea-ice dynamics and predicting future sea-ice trends.**