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:

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-values <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_{25:5} > C_{25:3} > C_{25:4}) 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
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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).

Fig 1: Light experiments on H. ostrearia strains NCC538 and NCC525 growth rates (divisions/day) and yield (cells/ml) at 17 and 8°C.

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

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.

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.

Our RESEARCH QUESTIONS are:

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 increase the success** in thriving in a particular environment (light, T)?
Methods

• We have obtained two *H. ostrearia* strains, **NCC538** and **NCC525**, from the Nantes Culture Collection.
• We have analysed **NCC538** and **NCC525** HBI composition after delivery.
• We have (so far) grown **NCC538** and **NCC525** under different light intensities (23-150 µmol m\(^{-2}\) s\(^{-1}\)) and temperatures (17°C and 8°C).
• We have daily monitored the cell counts and harvested the cultures at exponential and stationary phases for future HBI analyses.
Results

Similarities across NCC538 and NCC525 strains

✓ Significantly faster growth rates (twice faster) at 17 °C than at 8 °C (p-values <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).

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: C₂₅:₃>C₂₅:₄>C₂₅:₅) over NCC525 at higher temperatures (17 °C), and NCC525 (HBI: C₂₅:₅>C₂₅:₃>C₂₅:₄) over NCC538 at lower temperatures (8 °C)? → Future HBI analyses could confirm these preliminary hypotheses.
Conclusions

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).

This 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.