Thermal tolerance of *Lessonia corrugata* and the effect of nitrogen enrichment on physiological performance

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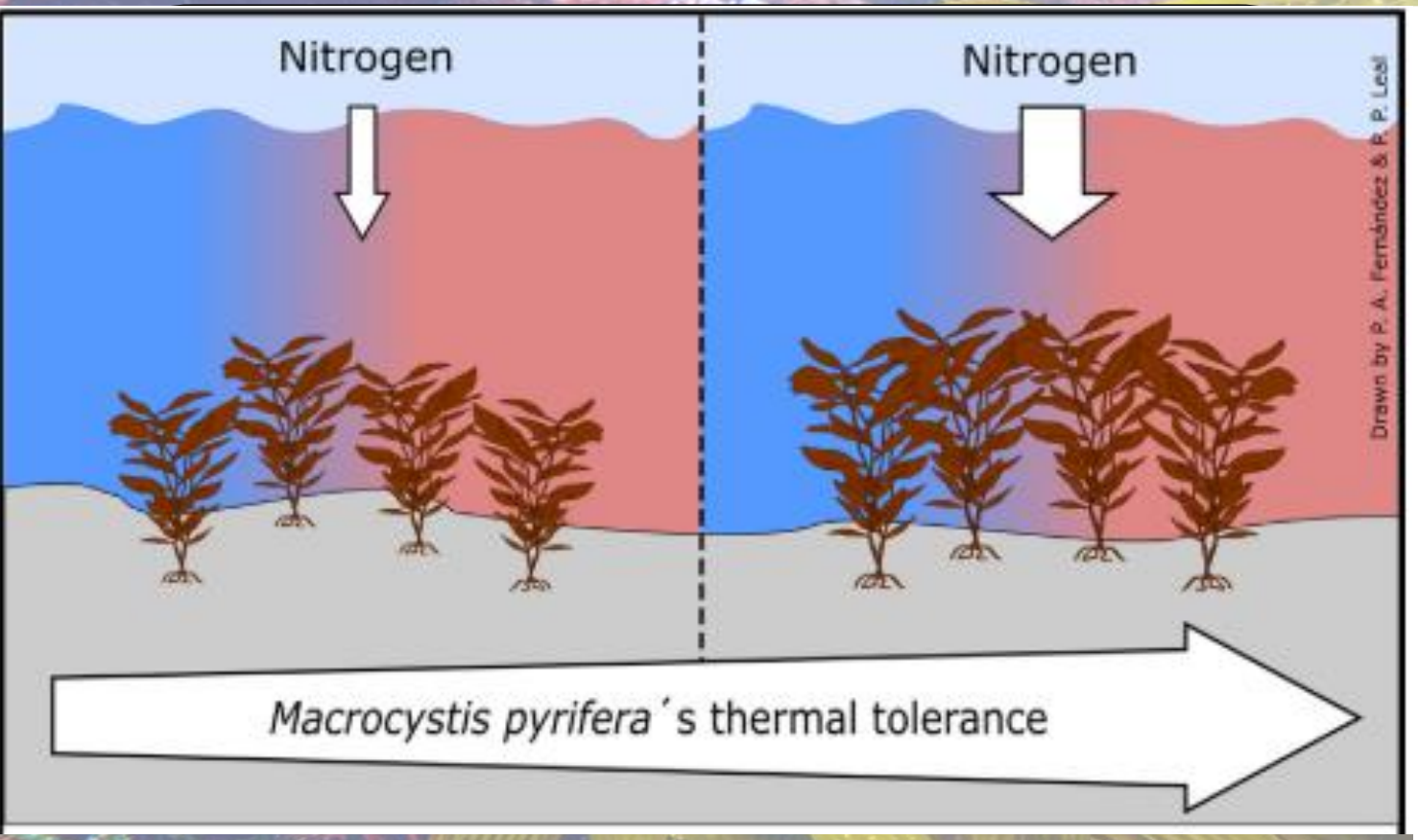
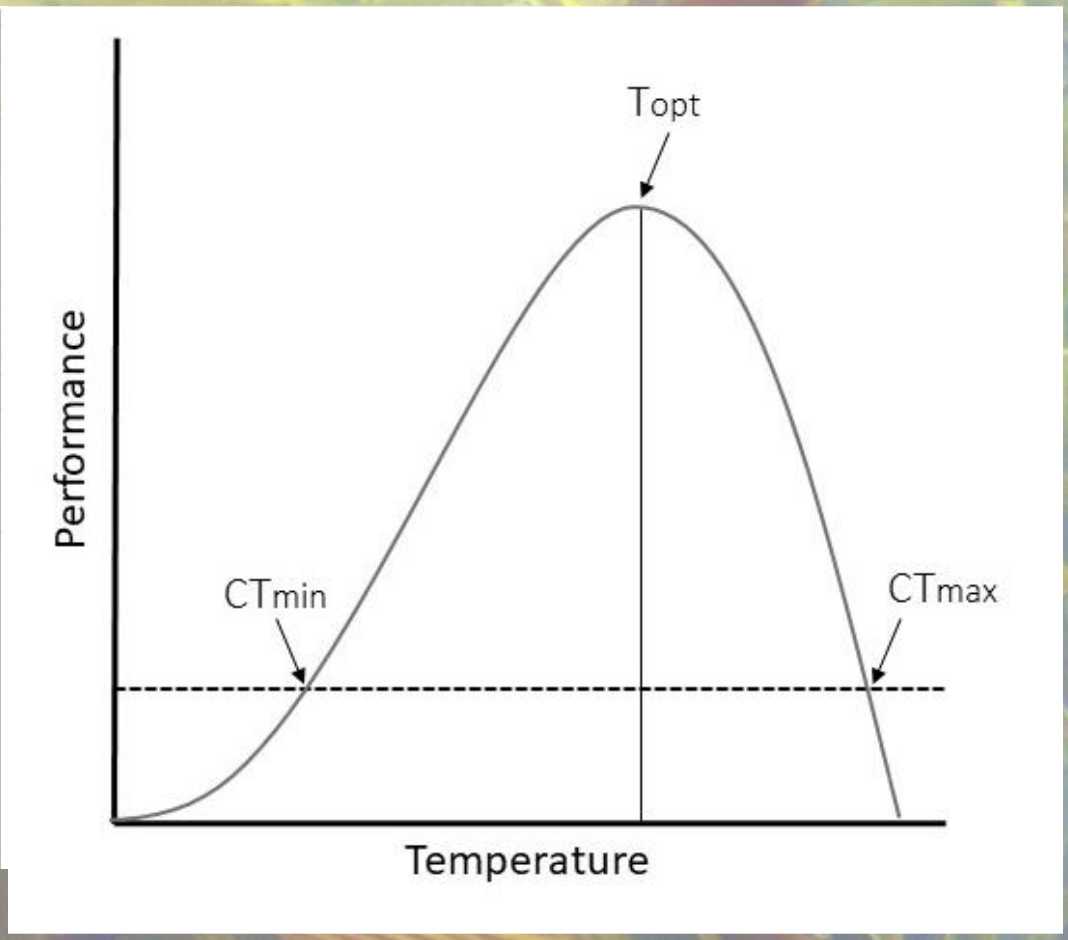
Lessonia corrugata

- Endemic to Tasmania
- One of the dominant species on shallow (<5 m) exposed reefs along Tasmania's coasts
- Eastern Australia is a global ocean warming hotspot

Thermal Performance Curves (TPCs)



(Fernández et al., 2020)



Nitrate enrichment can increase thermal tolerance in kelps…

Experiment 1: Thermal performance curves.

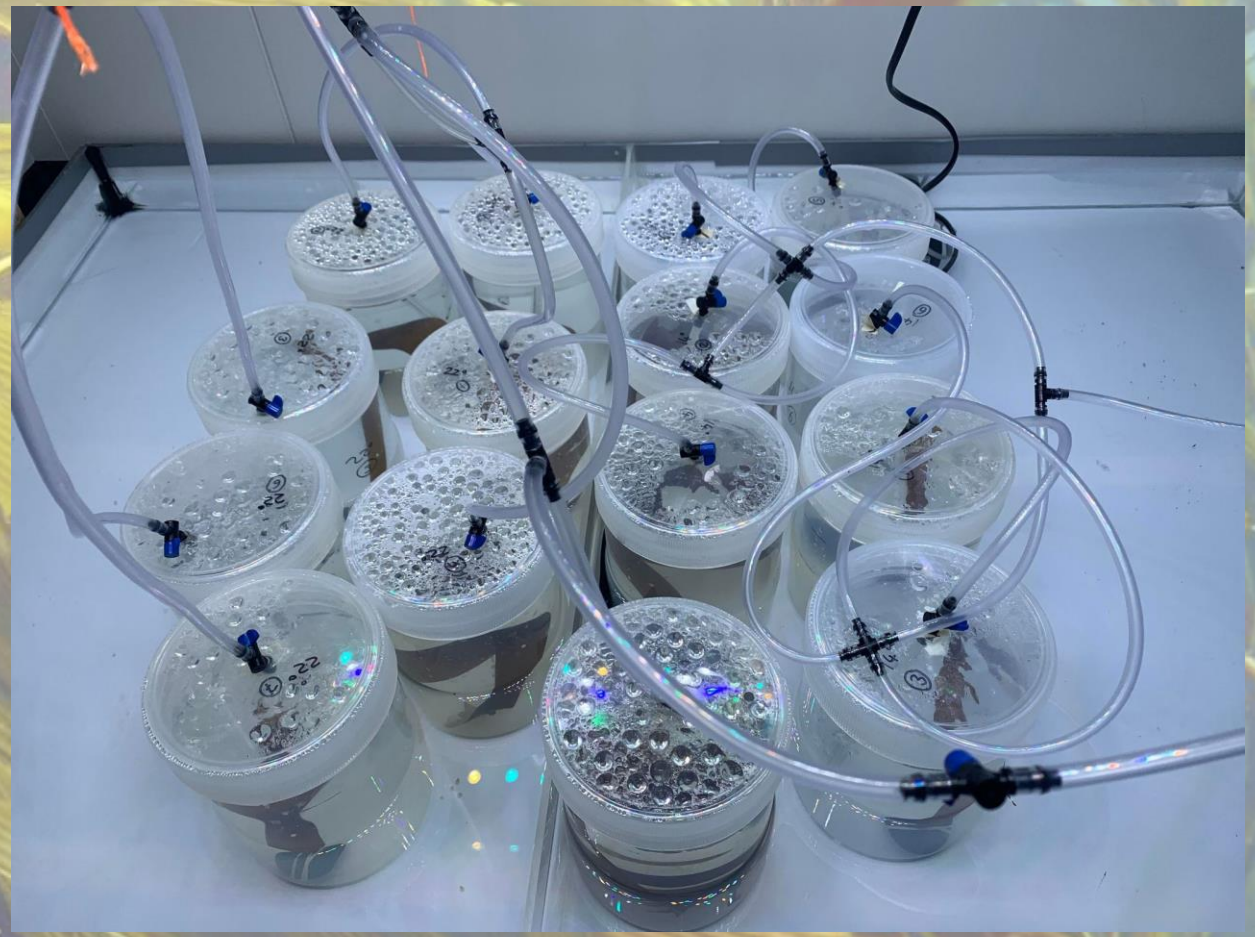
Identify *L. corrugata's* thermal optima for growth and photosynthesis by constructing thermal performance curves (TPCs)

Experiment 2: Temperature and nutrient interactions.

Examine if the species perform better at upper temperatures when inorganic nitrogen is enrichment

Methods: *Experiment 1: Thermal performance curves*

- *Lessonia corrugata* juveniles collected from Coal Point, Bruny Island Tasmania.
- Temperature treatments: 4, 7, 10, 14, 17, 20, 22 °C

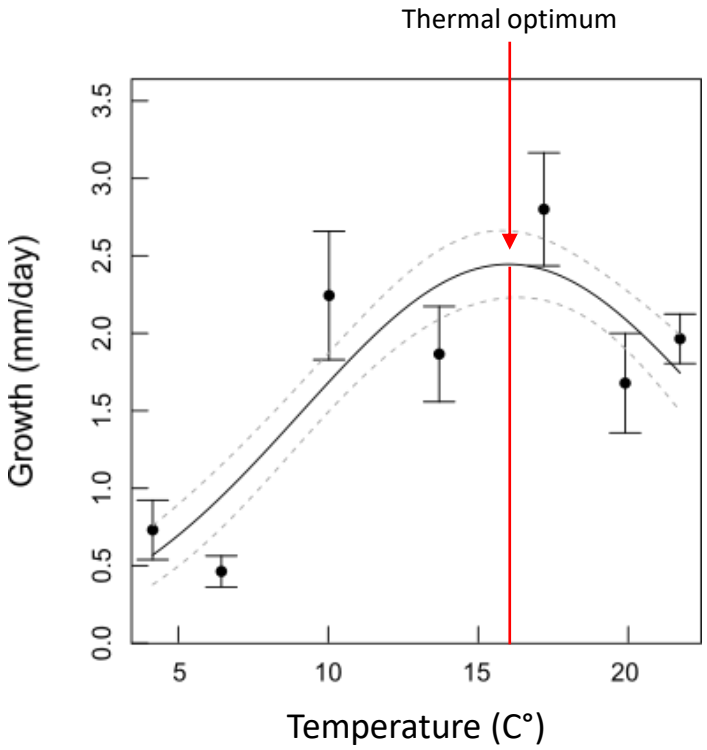


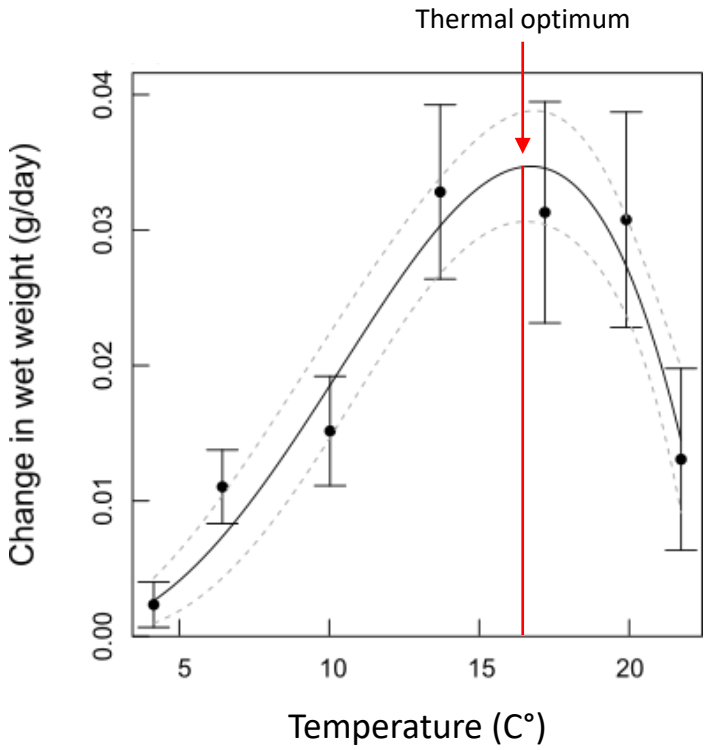
Methods: *Experiment 1: Thermal performance curves*

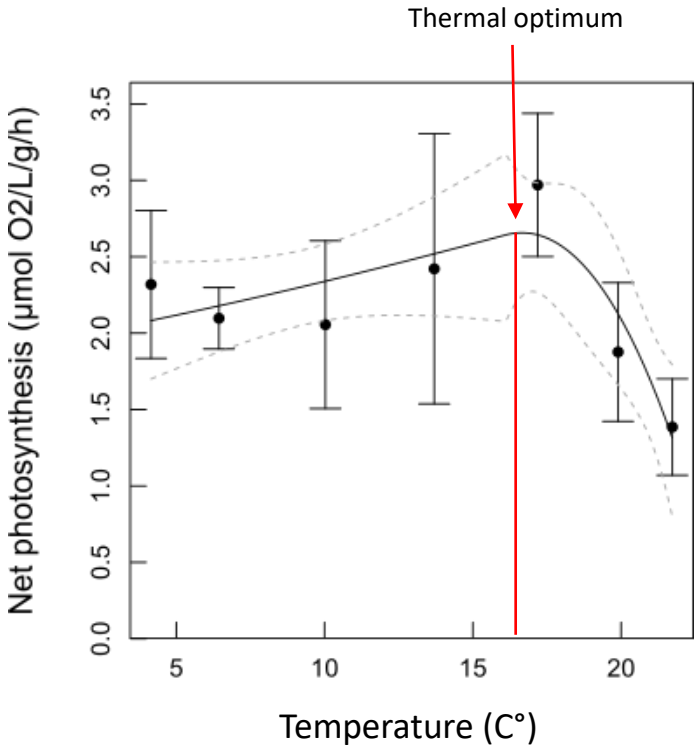
Response variables:

- Growth (linear extension)
- Weight
- Photosynthesis and respiration

Results: *Experiment 1: Thermal performance curves*







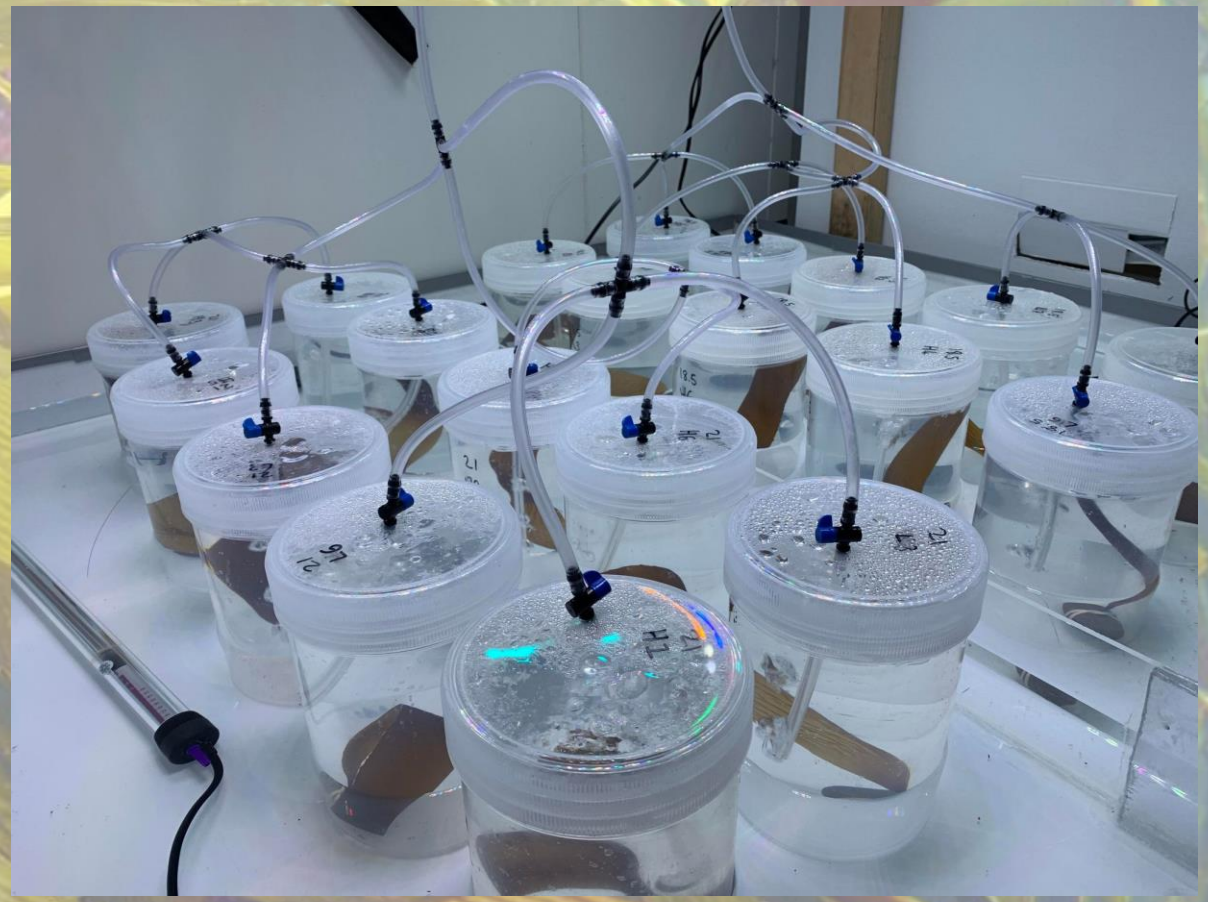
- *L. corrugata's* thermal optimum is approximately 16 °C
- Thermal maximum is 23 °C (this temp is beyond the range of the measured data so this estimate should be treated with caution)

Methods: *Experiment 2: Temperature and nutrient interactions*

- Temperature treatments: 16, 18.5, 21, 23.5 °C
- 2 nutrient levels:

- Low (2.5 µmol/L/per day)

- High (50 µmol/L/per day)



Methods: *Experiment 2: Temperature and nutrient interactions*

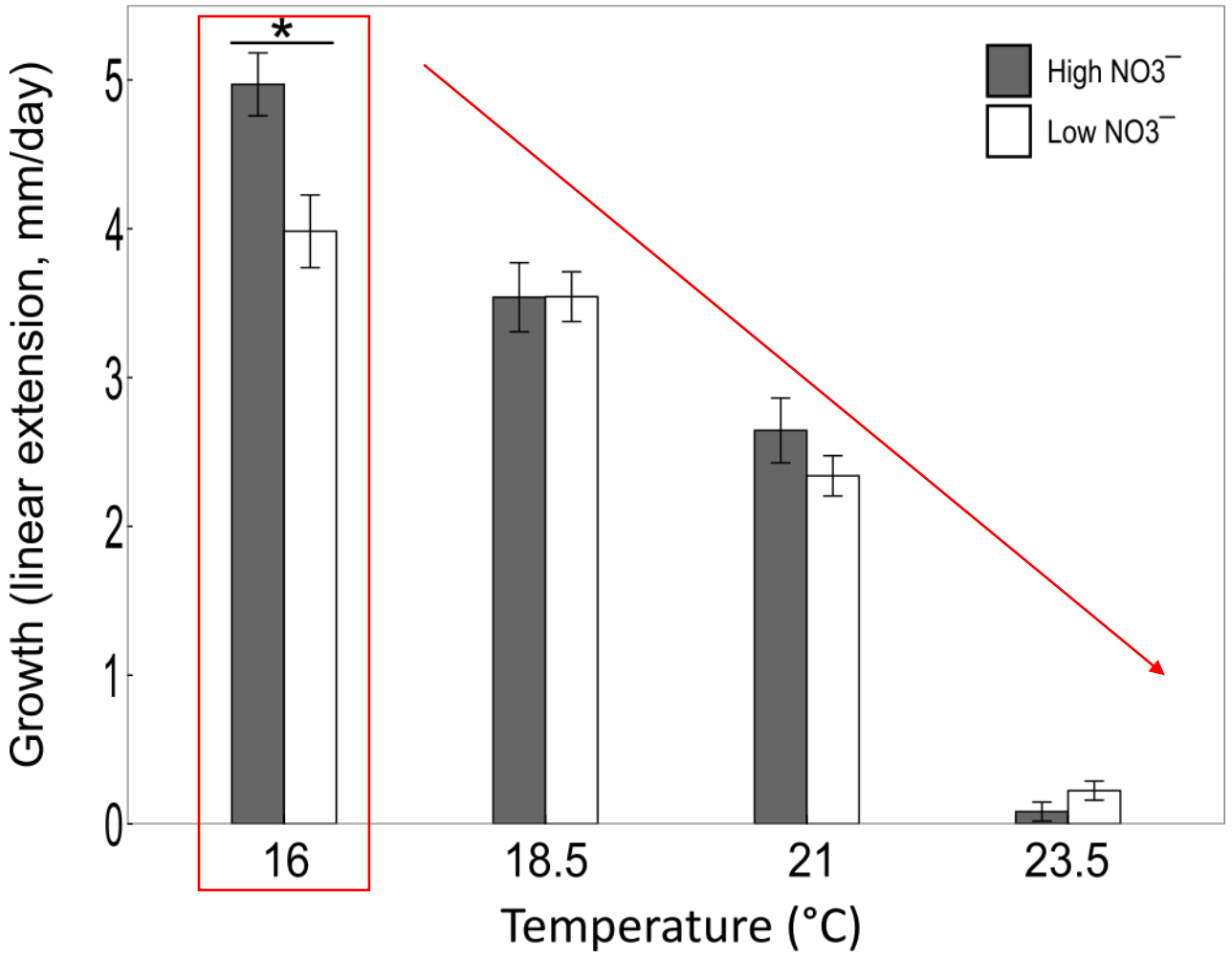
Response variables:

- Growth (linear extension)
- Weight
- Photosynthesis and respiration

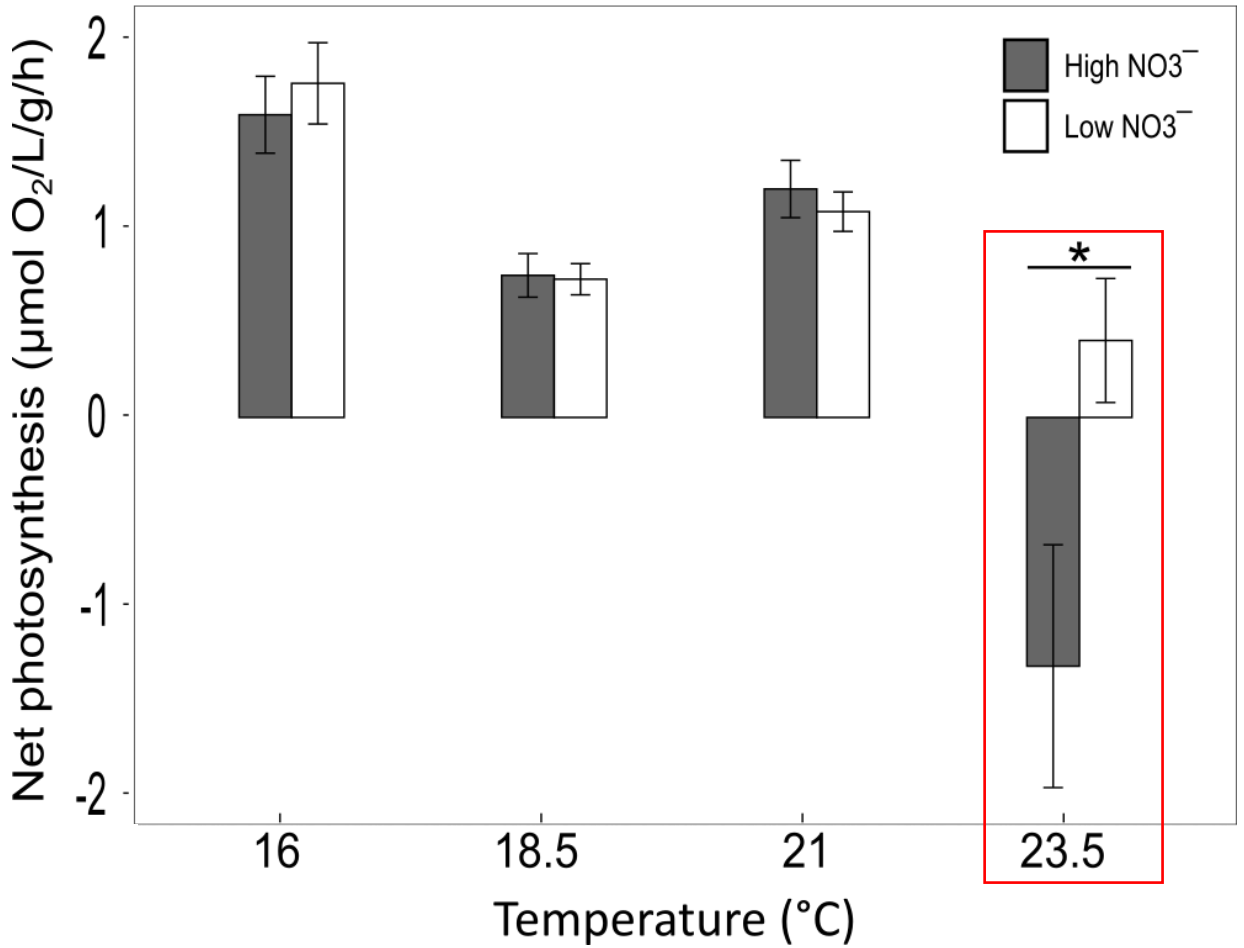
Samples of kelp tissue analysed for:

- % tissue nitrogen
- Soluble tissue nitrate

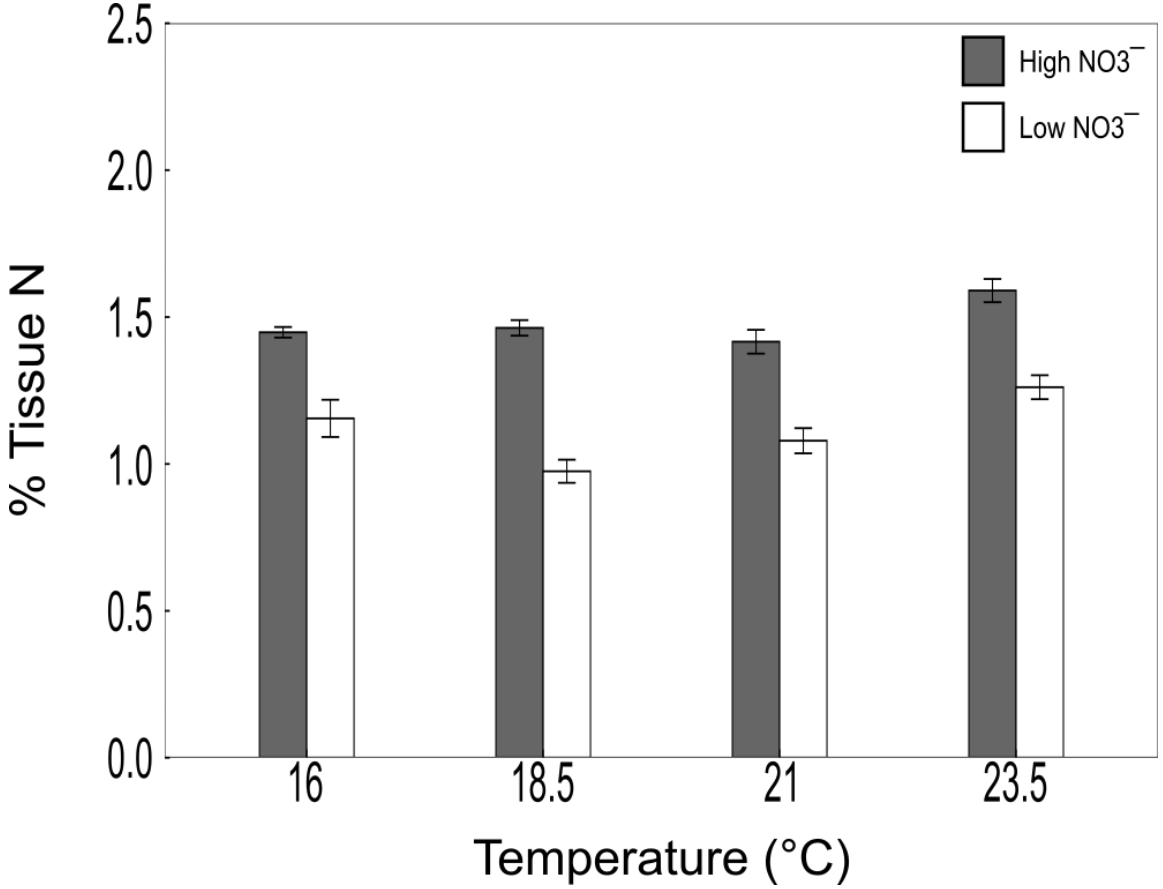
Results: *Experiment 2: Temperature and nutrient interactions*

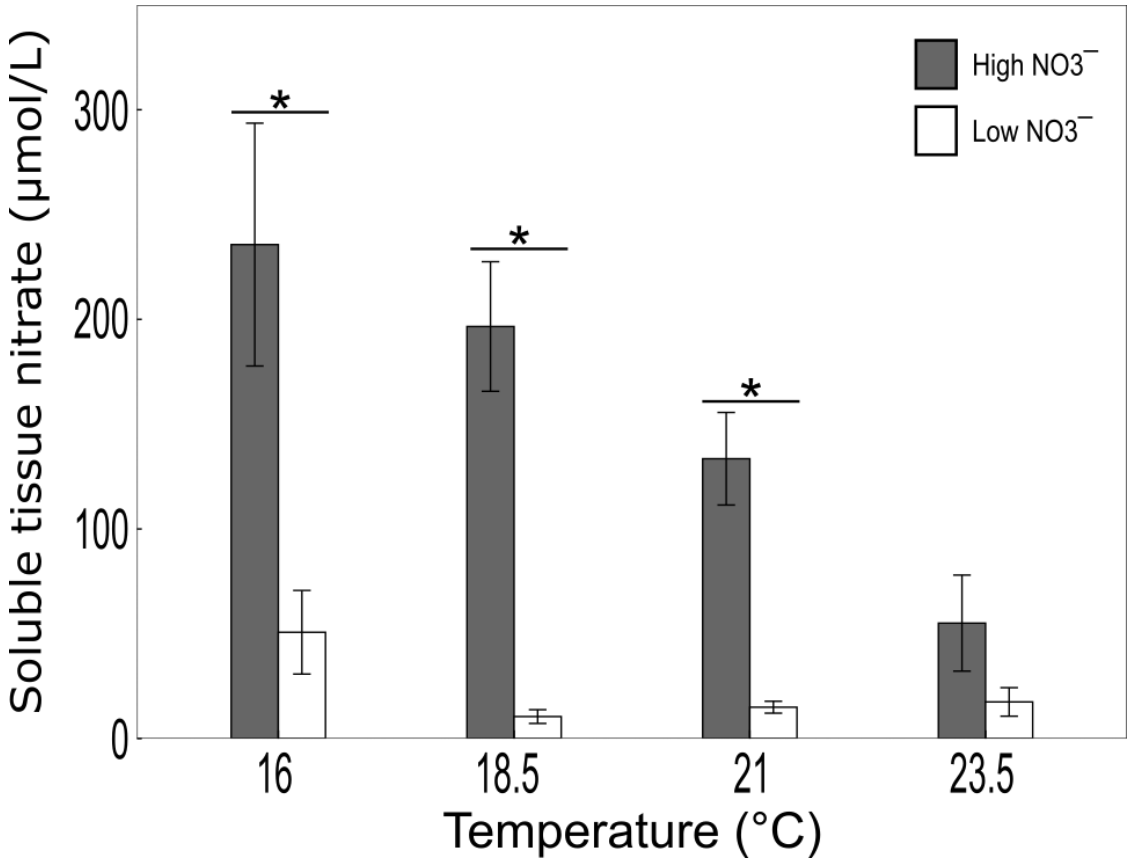


- No significant interaction between nutrient level and temperature, except at the optimum
- Growth rates were significantly higher when nitrogen was enriched at 16 °C



- No significant interaction between nutrient level and temperature, except at the upper temperature limit (23.5 °C)
- Photosynthetic rates were low in the low nutrient treatment but negative in the high nutrient treatment
- Possibly driven by bacterial respiration





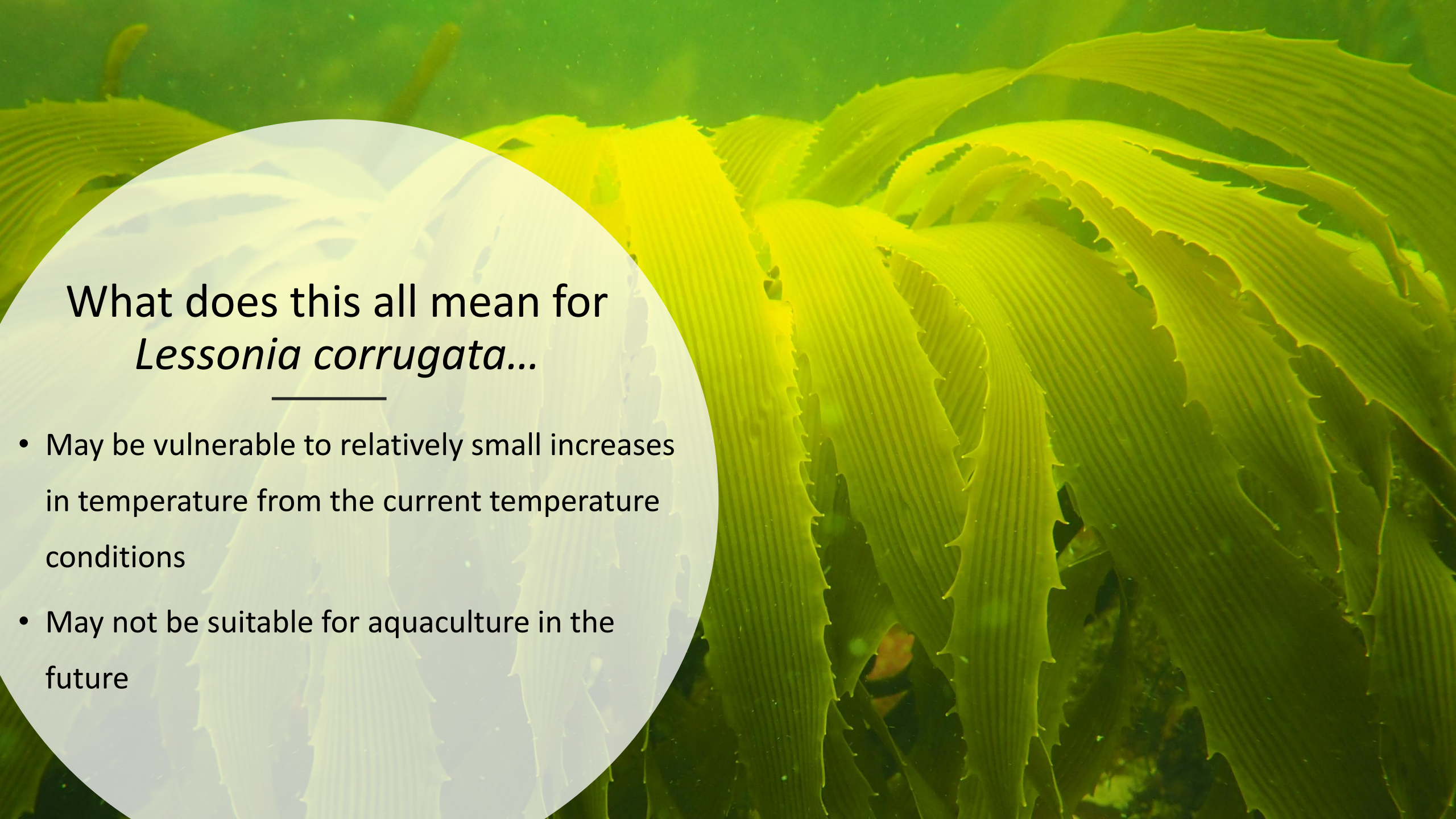
- Stored and took up inorganic nitrogen at greater rates in the high nitrate treatment than in the low nitrate treatment
- They did not use the nitrogen increase growth rates, except at the optimum (16 °C)
- To cope with heat stress, kelps implement mechanisms including heat shock proteins and antioxidants, in which nitrogen plays a critical regulating role

Main findings…

Thermal optimum: 16 °C

Critical thermal maximum: 22 – 23 °C

- Temperature was the critical factor regulating growth and photosynthesis beyond the species thermal optimum
- No consistent effects between nitrate and temperature



What does this all mean for *Lessonia corrugata…*

- May be vulnerable to relatively small increases in temperature from the current temperature conditions
- May not be suitable for aquaculture in the future

Thank you!

Acknowledgments

Thank you to:

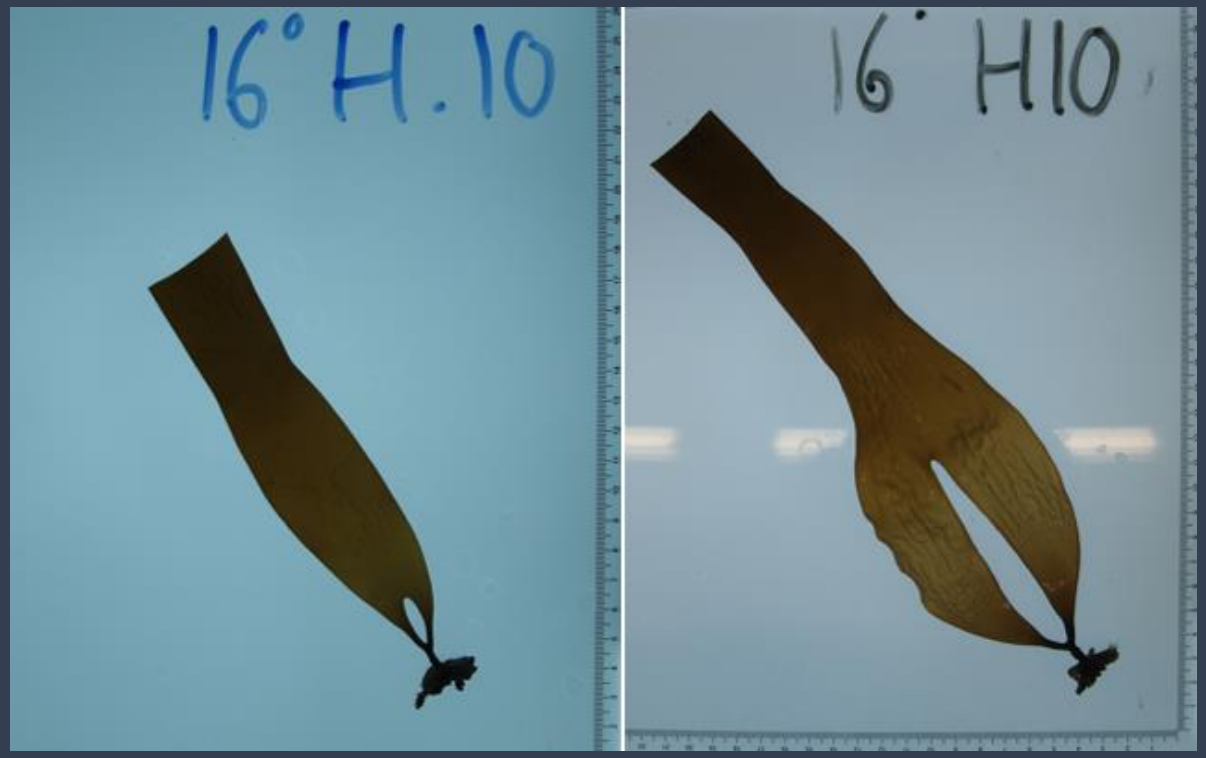
Eva Smid, Hunter Forbes, Olivia Wynn, Barbara Labbe, Pam Quayle, Axel Durand and the Hurd lab group!

Images: Hunter Forbes

Results: *Experiment 2: Temperature and nutrient interactions*

Initial

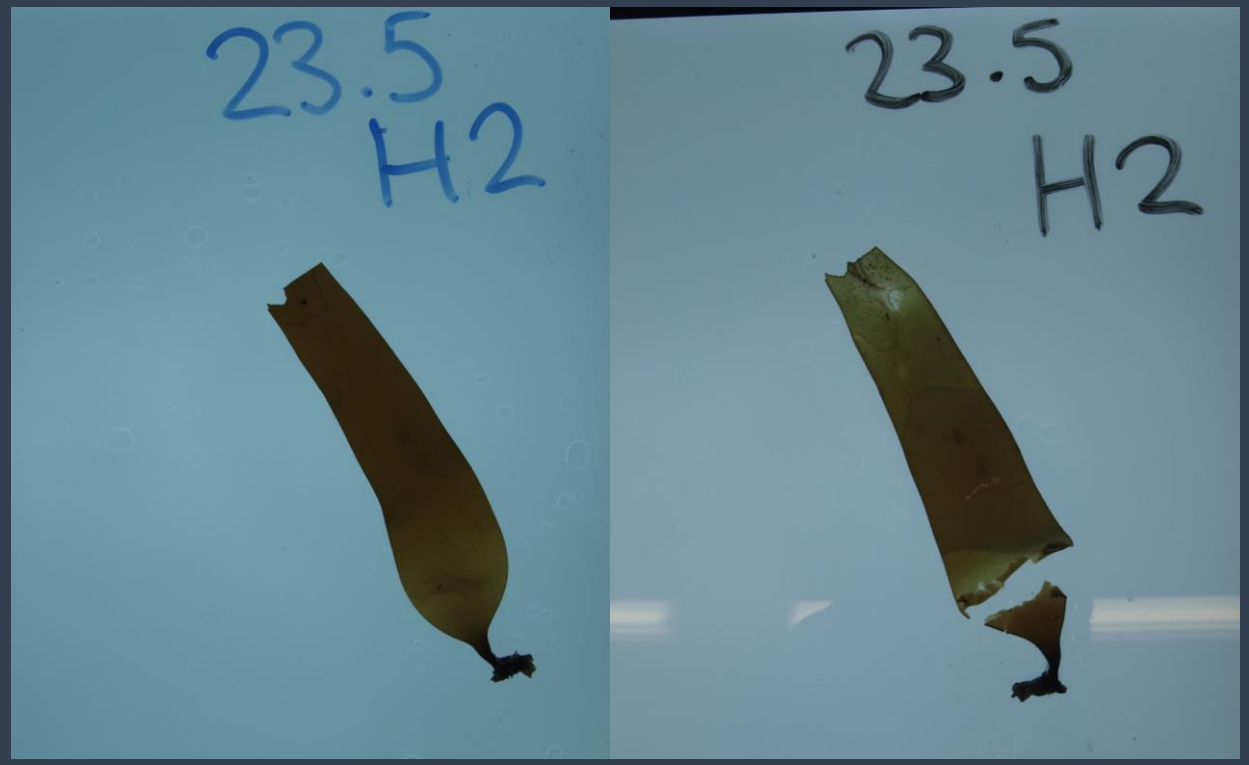
Final



Thermal optimum

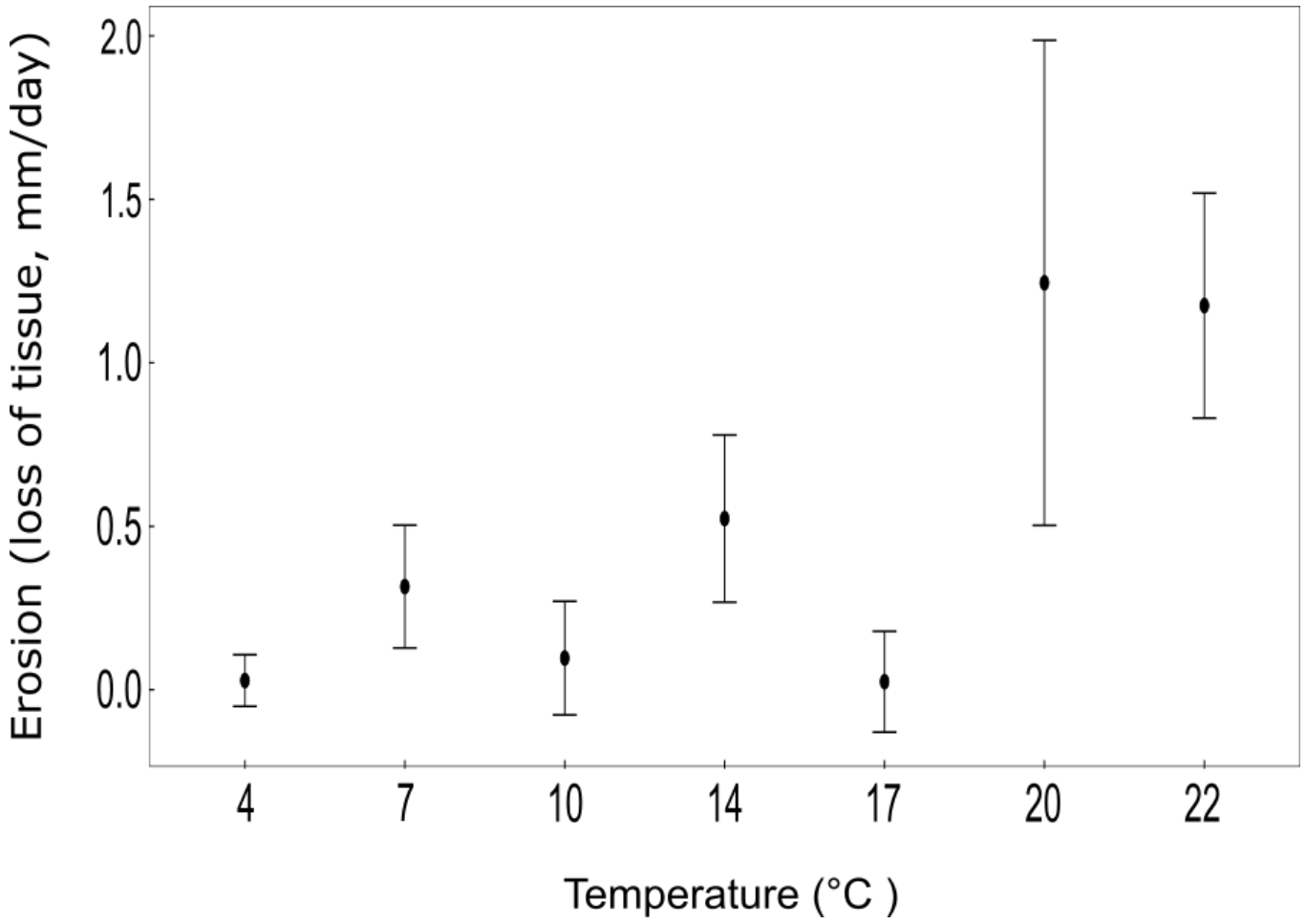
Initial

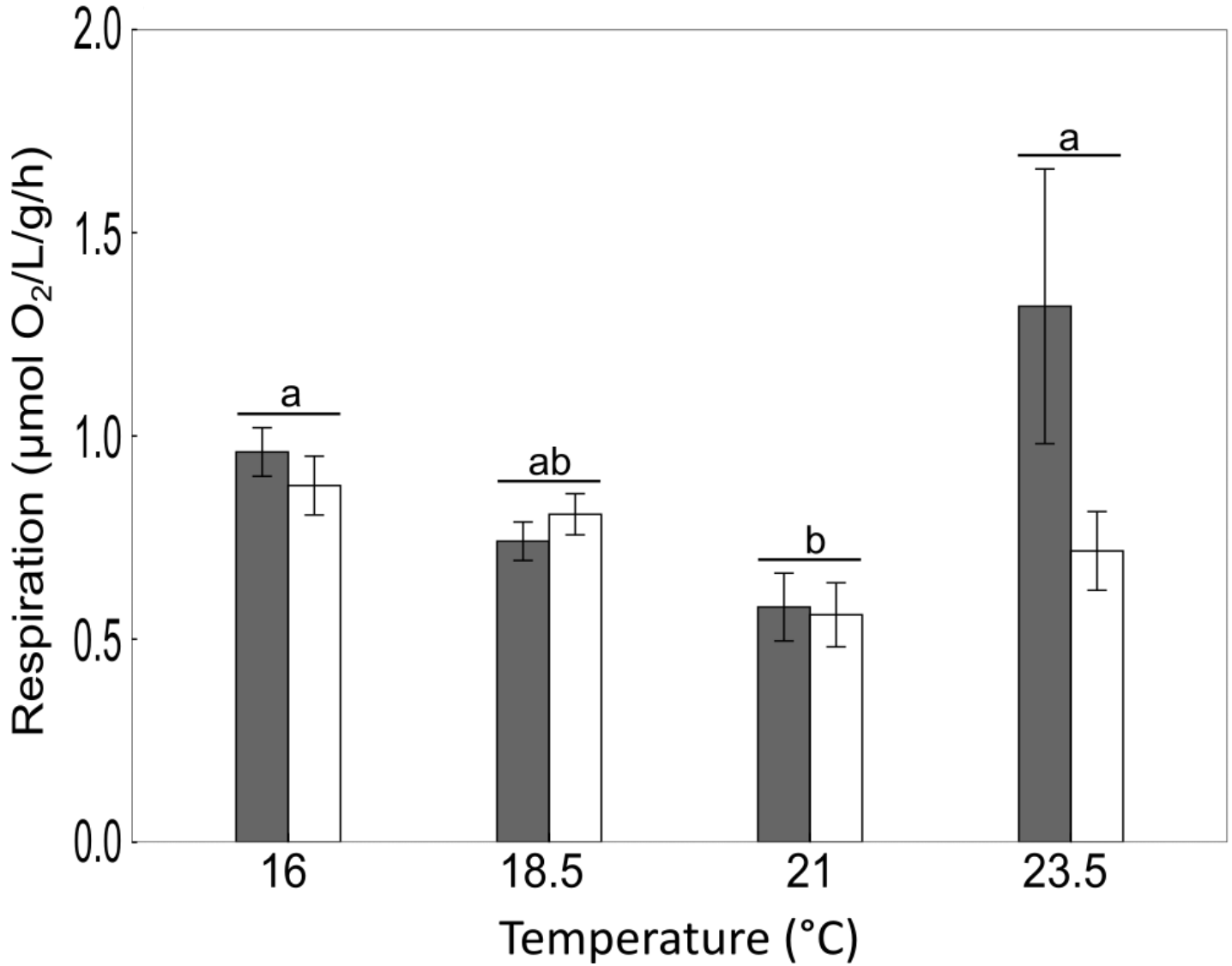
Final

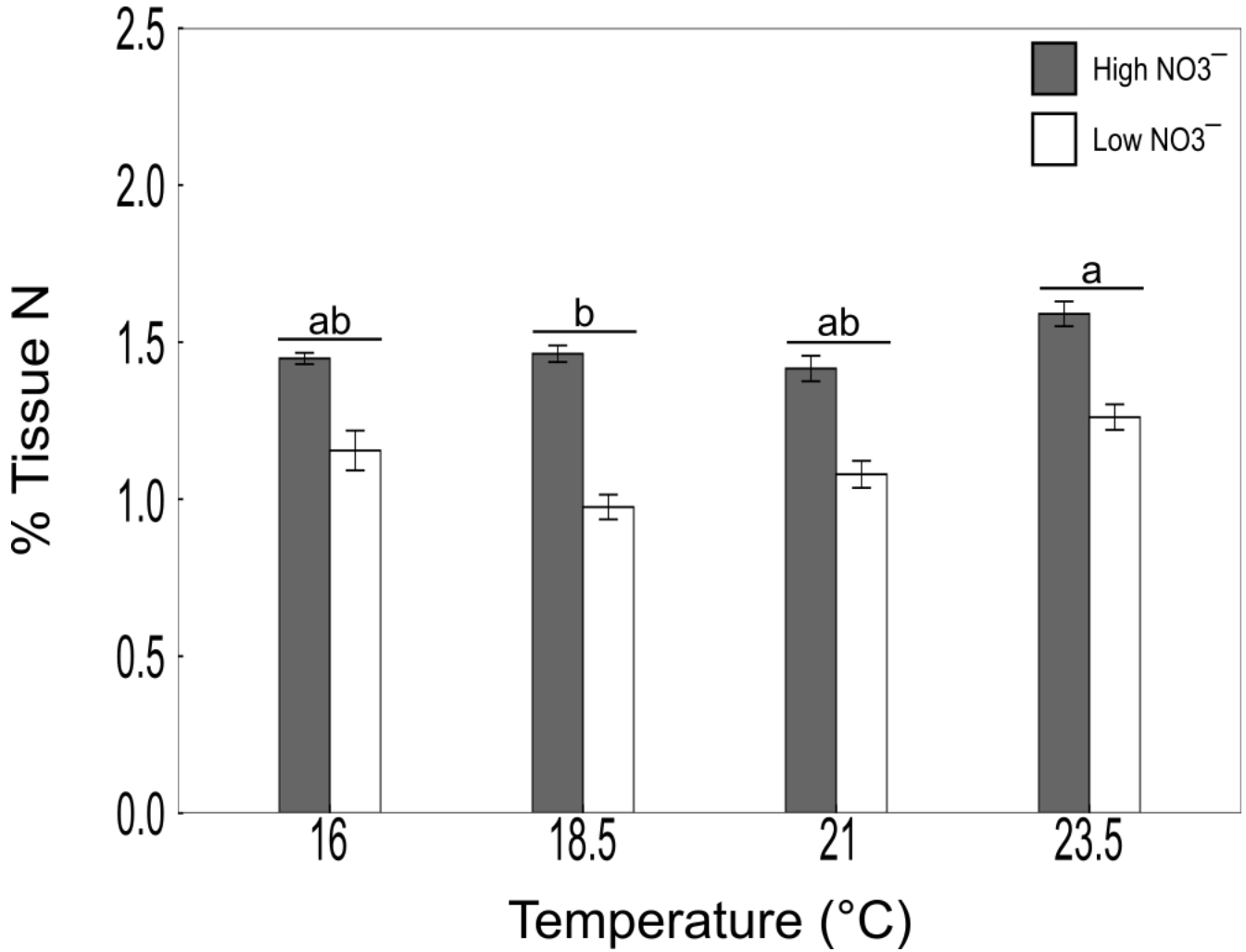


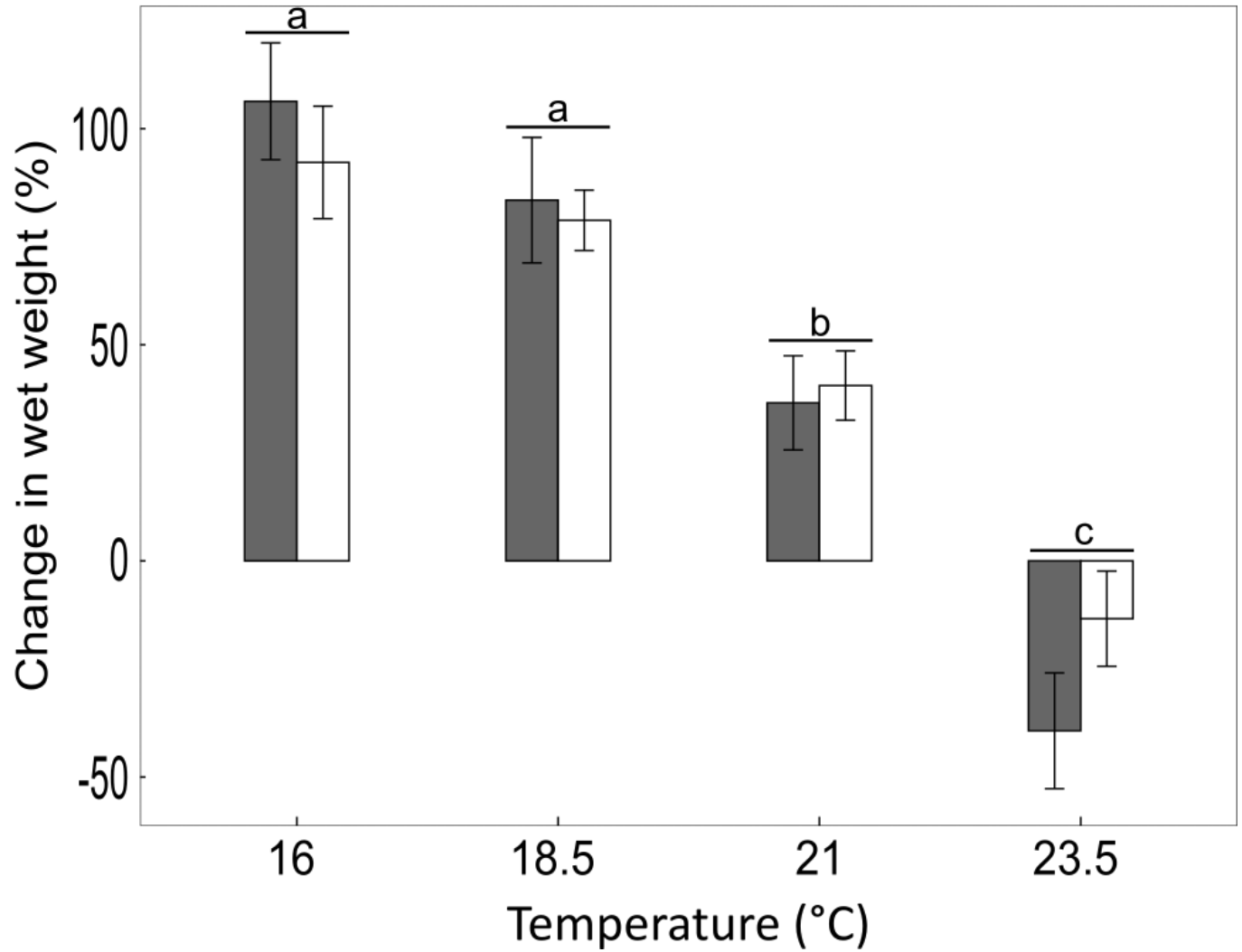
Critical thermal maximum

Appendix.


Erosion (loss of tissue, mm/day)
2.0
1.5
1.0
0.5
0.0
4
7
10
14
17
20
22
Temperature (°C)


2.0
1.5
1.0
0.5
0.0
Respiration (µmol O_2/L/g/h)
a
ab
b
a
16
18.5
21
23.5
Temperature (°C)


2.5
2.0
1.5
1.0
0.5
0.0
% Tissue N
High NO3−
Low NO3−
ab
b
ab
a
16
18.5
21
23.5
Temperature (°C)


a
a
b
c
100
50
0
-50
Change in wet weight (%)
16
18.5
21
23.5
Temperature (°C)