Surviving in a warming world: servicing altered metabolic requirements

Bayden Russell and Sean Connell
e.g. Ling (2008) Oecologia

e.g. Russell et al. (2009) GCB
Metabolic Theory of Ecology

O’Connor et al. 2009, PLoS Biology

e.g. Ling (2008) Oecologia

e.g. Russell et al. (2009) GCB
What happens when you apply metabolic theory to producer-consumer systems?

- Long-term acclimated mesocosm systems
- Field based CO$_2$ vent system
Turbo undulatus

Algal turfs

Mertens et al. (in review) Oecologia
Turbo undulatus

Mertens et al. (in review) Oecologia
Control

Urchin Barrens

OR

Kelp forests

High CO₂ vents

Graph showing pH levels over time with two lines: one for vent and one for control. The graph indicates that the vent has higher pH levels compared to the control.
Evechinus chloroticus

Metabolic rate (mg O$_2$ g FW$^{-1}$ hr$^{-1}$)

- Ambient CO$_2$
- High CO$_2$

20 °C
24 °C

Loss of performance

- Acclimation in functional capacity
  - Δ Energy consumers
  - Δ mitochondrial functions

Acclimation in protection
- +HIF-1
- Anaerobic capacity
- O$_2$ supply pathways
- Metabolic depression

Acclimation in repair
- + HSP
- + antioxidants

Fitness measures:
- Growth, specific dynamic action (SDA), exercise, behaviour, immune capacity, reproduction
- Hypoxia, CO$_2$
- Biotic stressors

Rate of aerobic performance

Temperature

Optimum
Progressive life limitation of thermal tolerance
Evechinus chloroticus

Metabolic rate (mg O$_2$ g FW$^{-1}$ hr$^{-1}$)

- 20 °C
- 24 °C

Ambient CO$_2$
High CO$_2$

% of food eaten

- Ambient CO$_2$
- High CO$_2$
Urchin Barrens

OR

Kelp forests

Control

High CO₂ vents