Surviving in a warming world: servicing altered metabolic requirements

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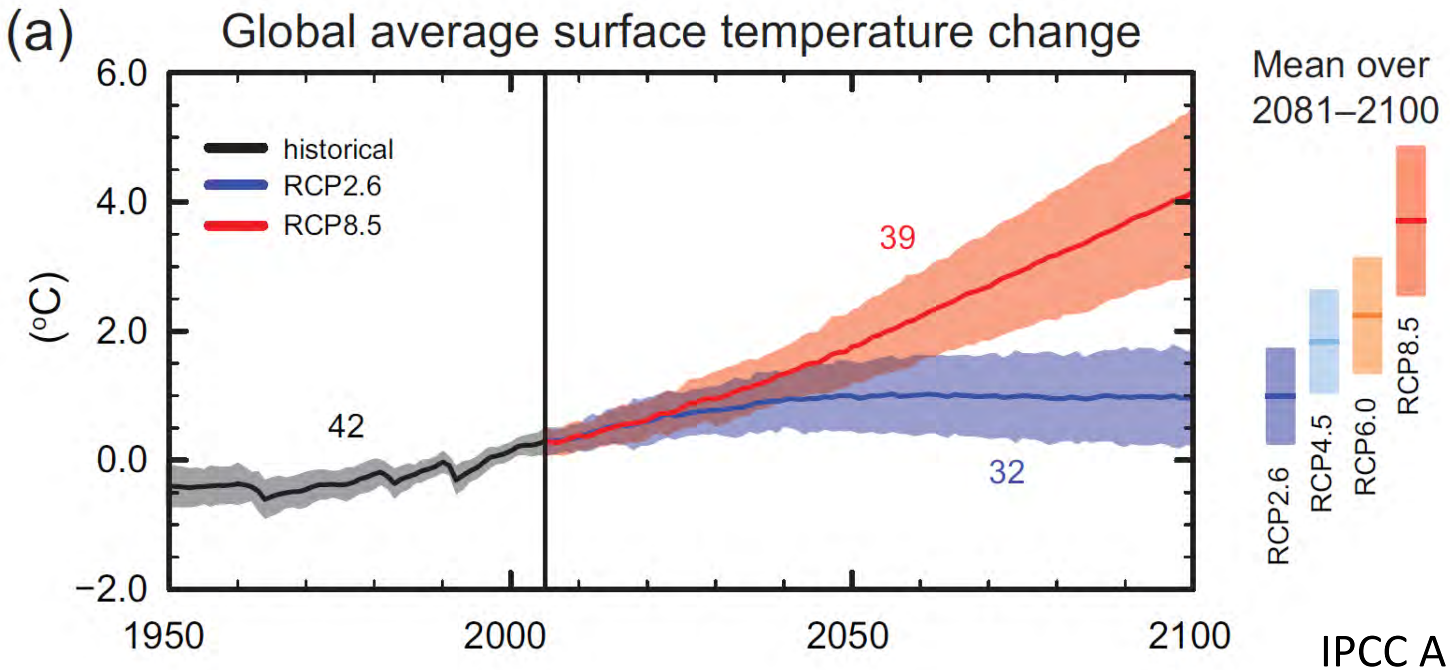
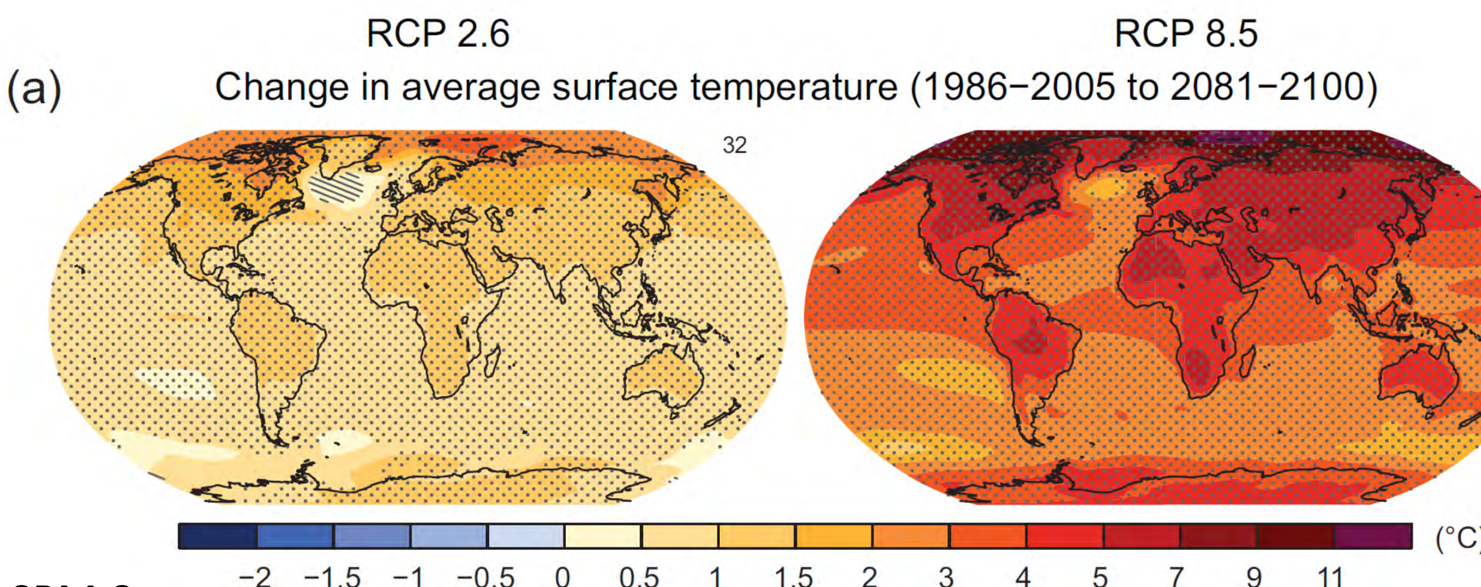


IPCC AR5 SPM.7



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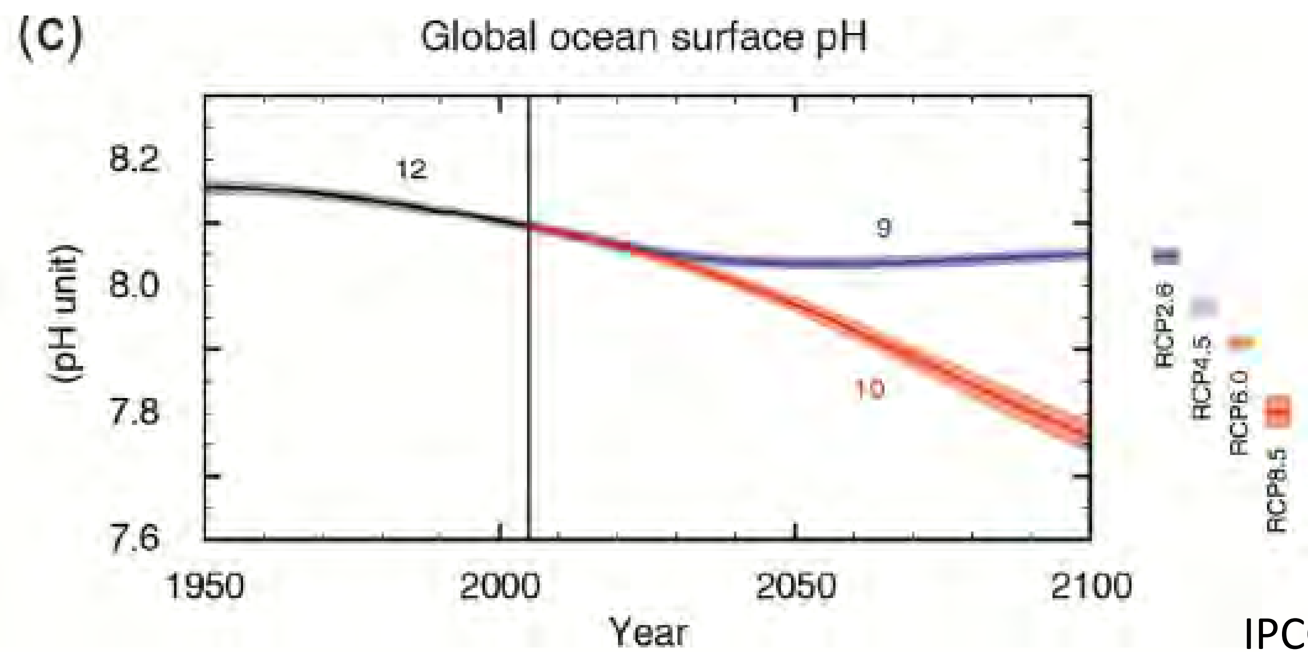
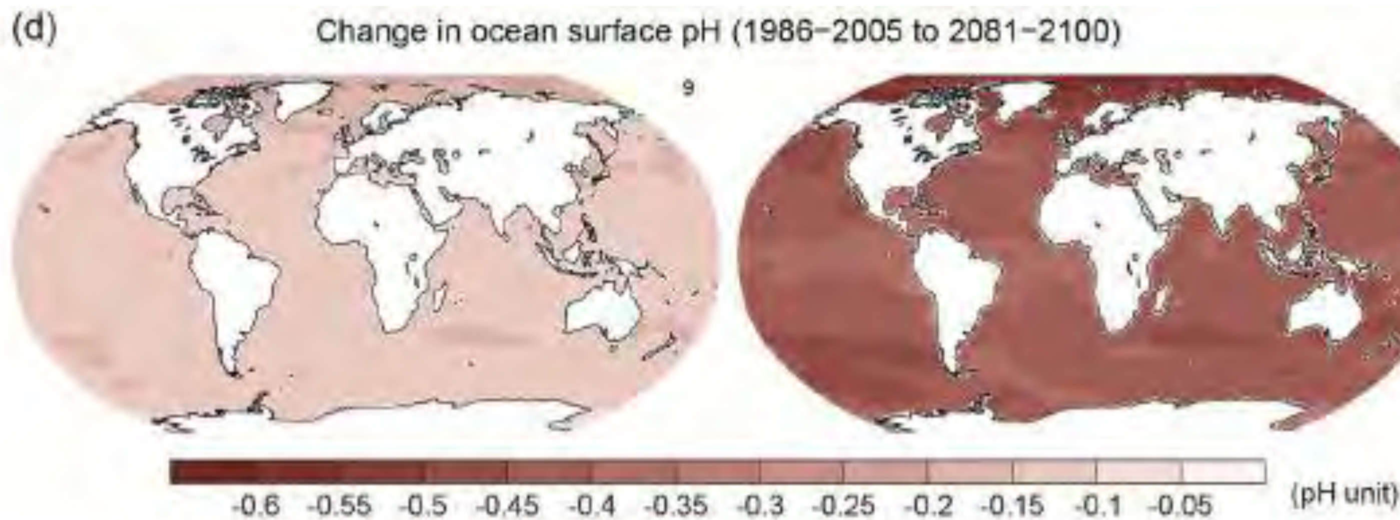


IPCC AR5 SPM.7

RCP 2.6

RCP 8.5



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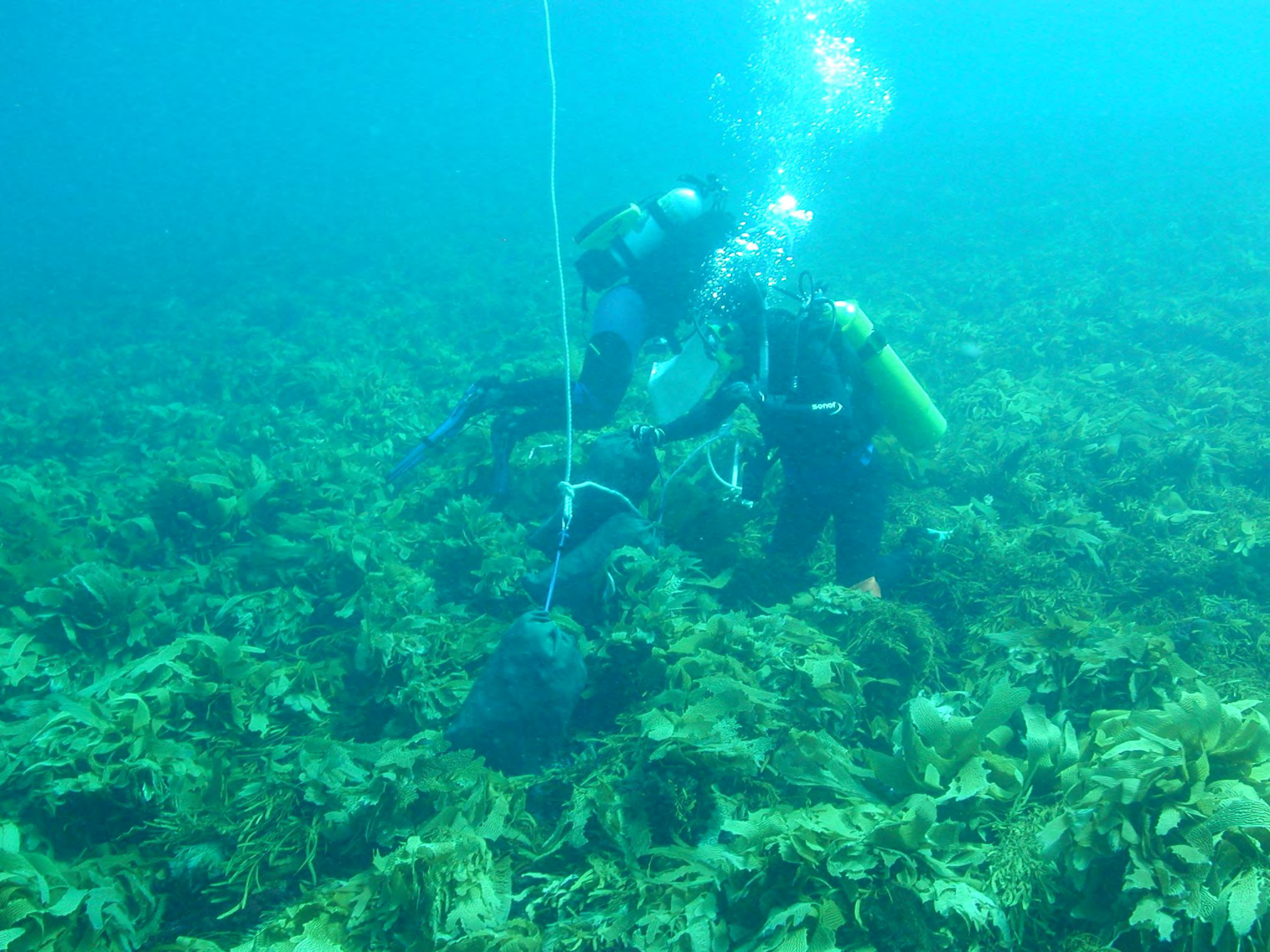
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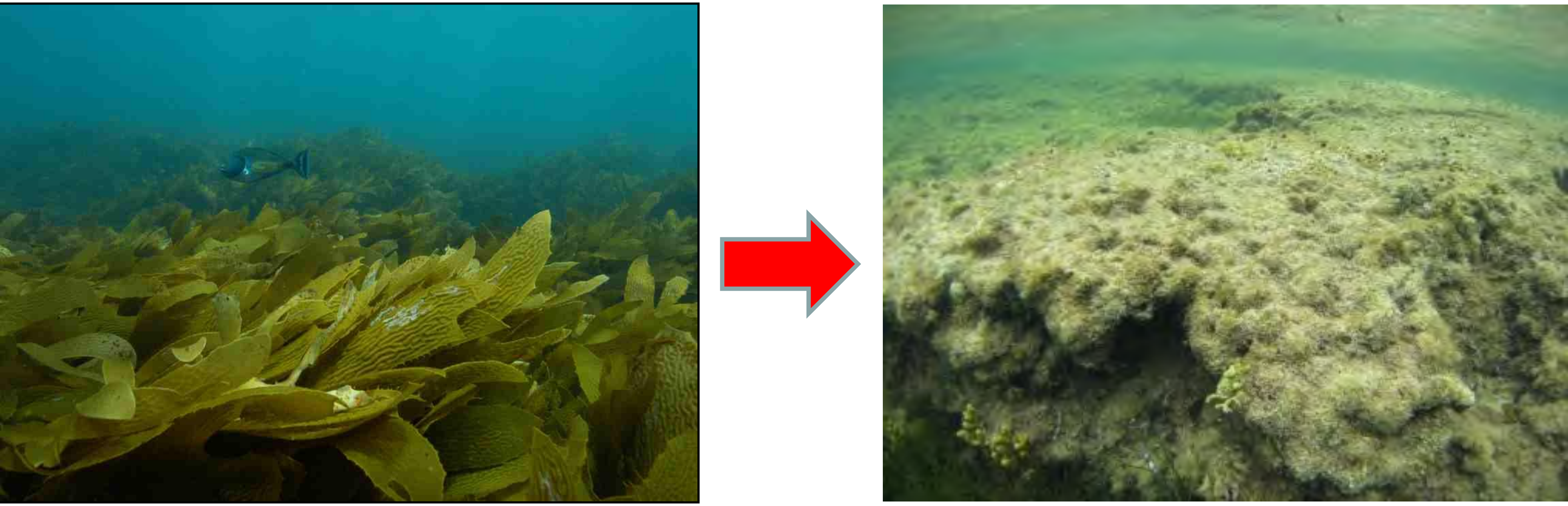
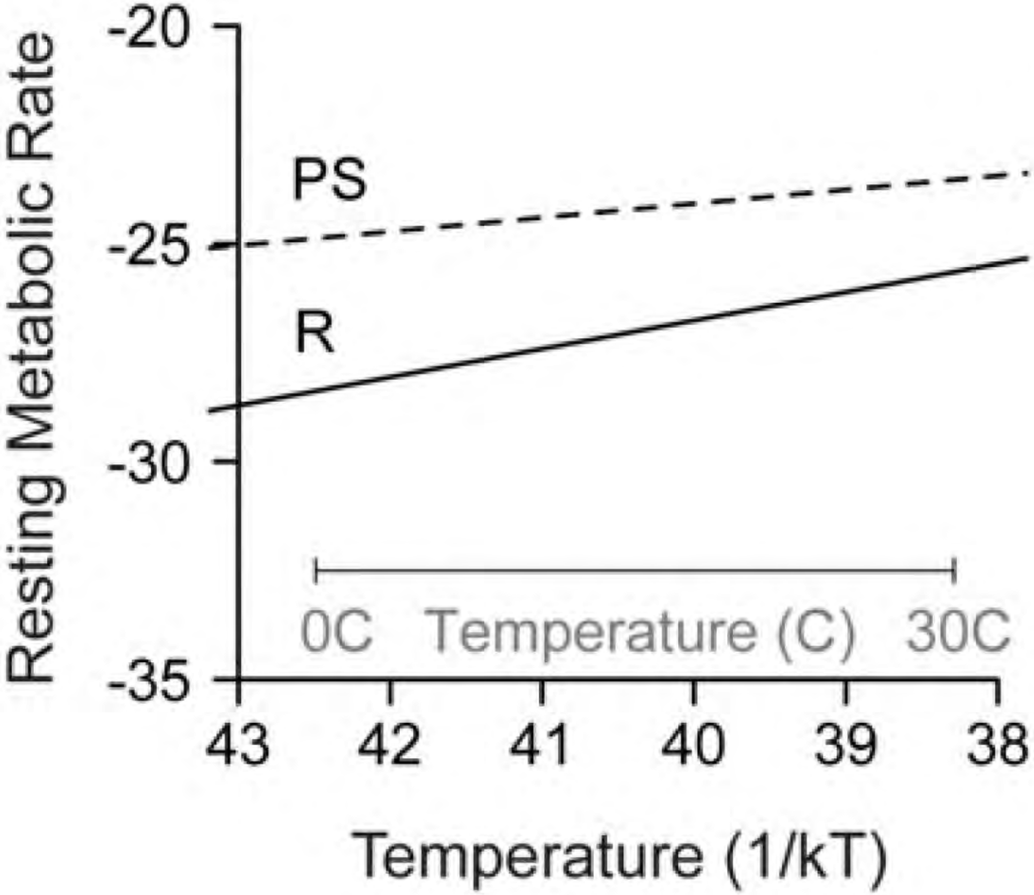
e.g. Ling (2008) Oecologia



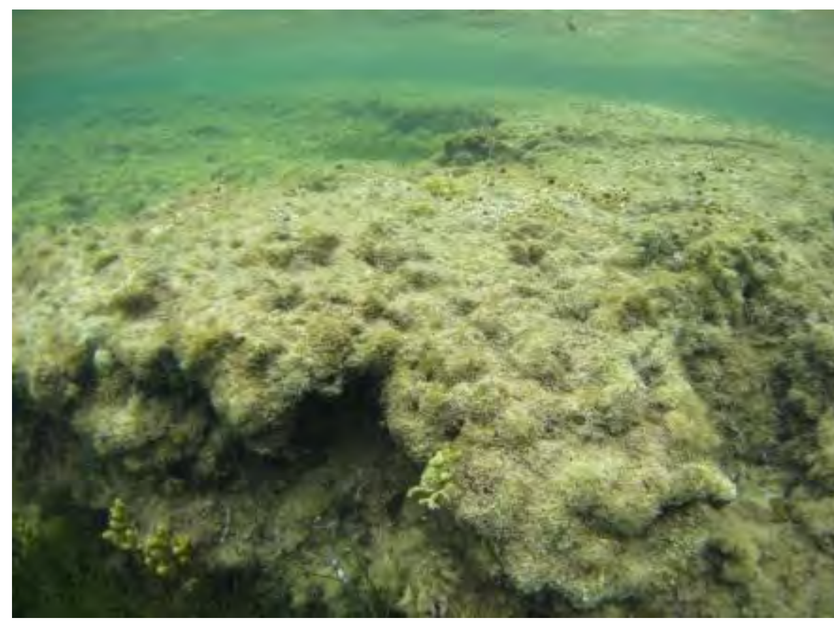
e.g. Russell et al. (2009) GCB

Metabolic Theory of Ecology



O'Connor et al. 2009, PLoS Biology

e.g. Ling (2008) Oecologia



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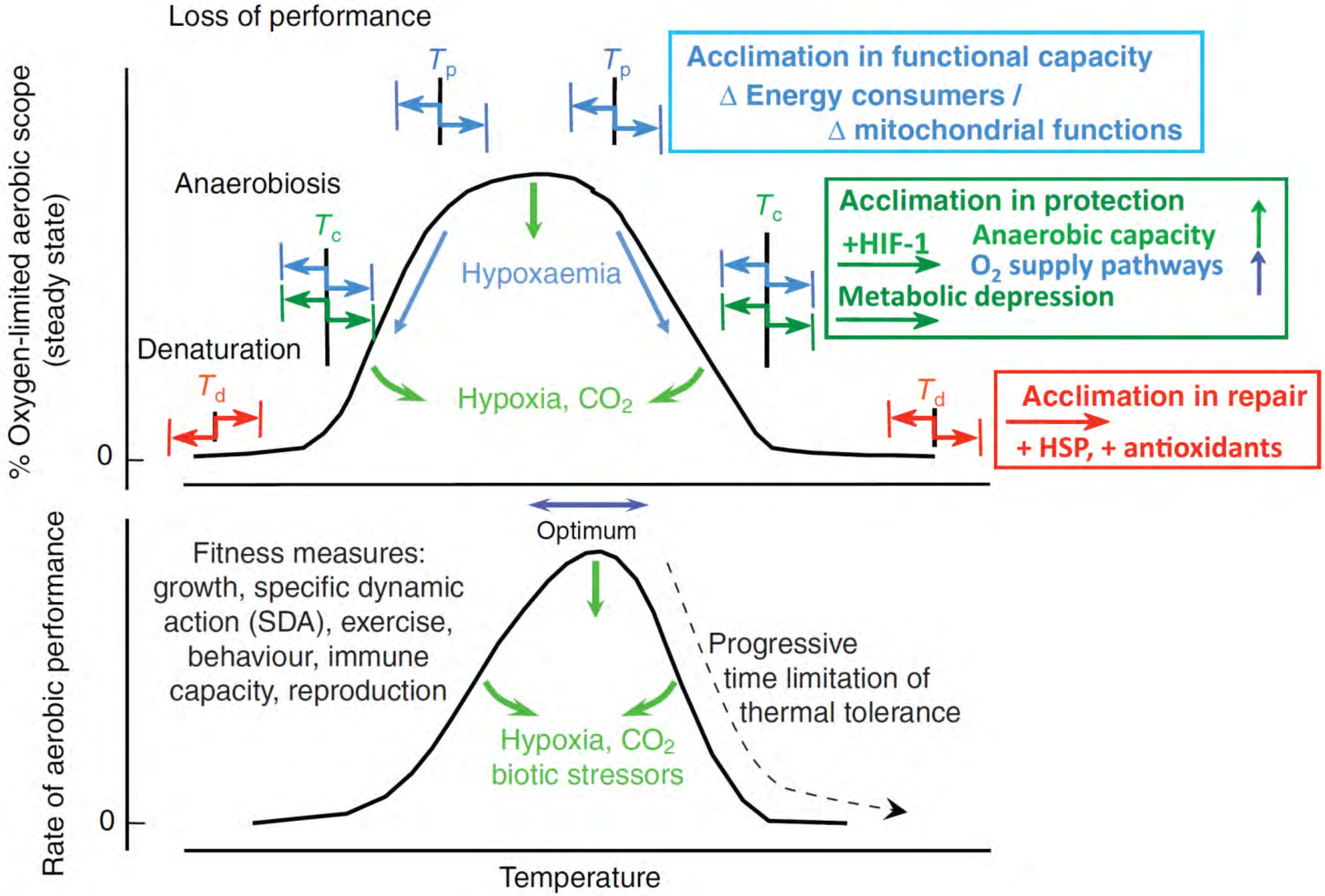
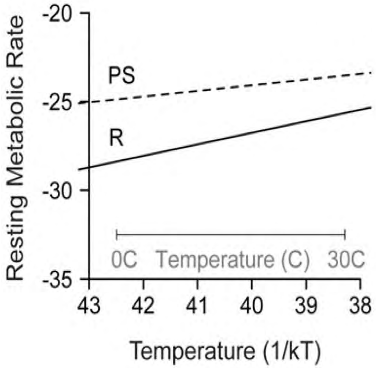


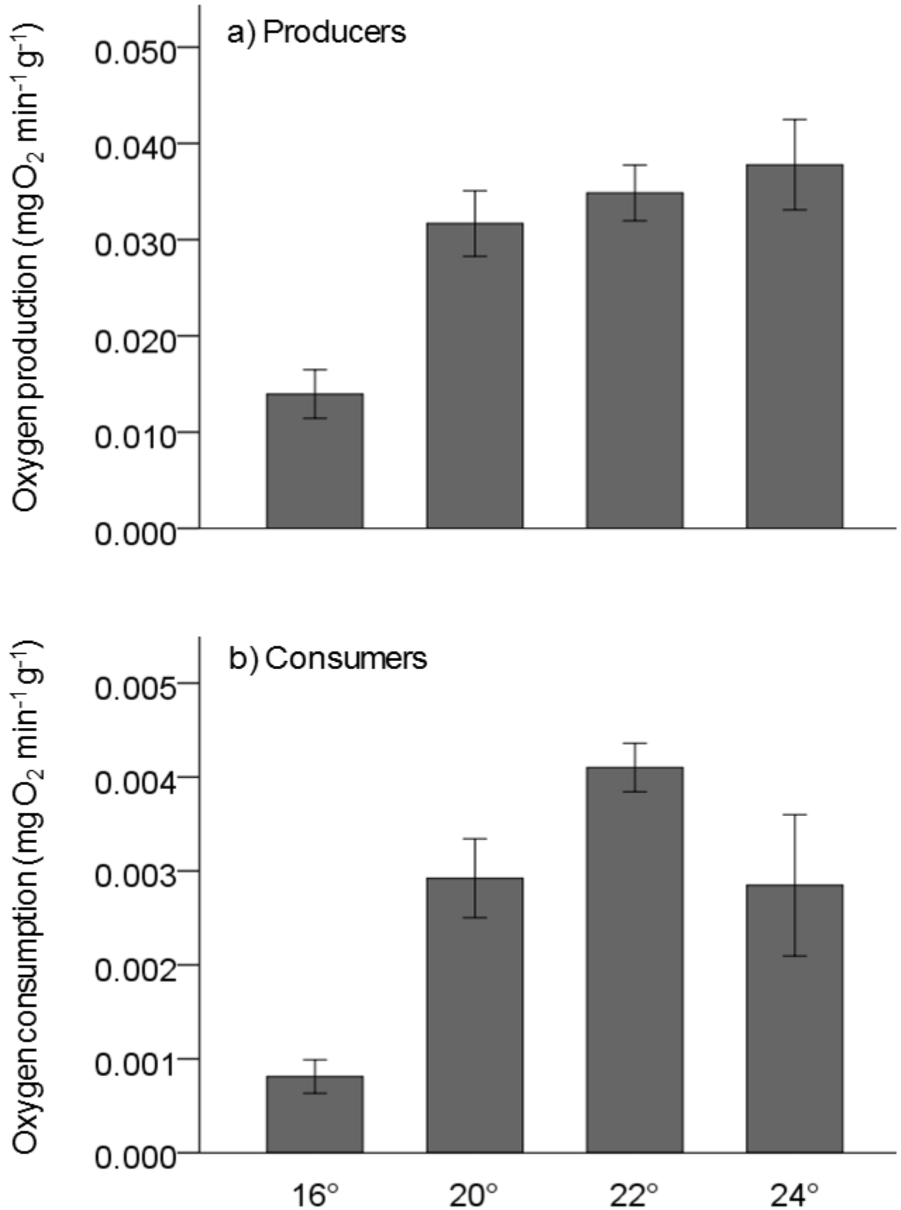
Portner (2010) J Exper. Biology

What happens when you apply metabolic theory to producer-consumer systems?

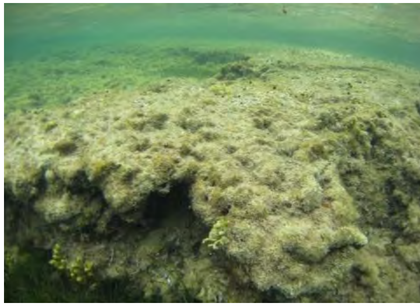
- Long-term acclimated mesocosm systems

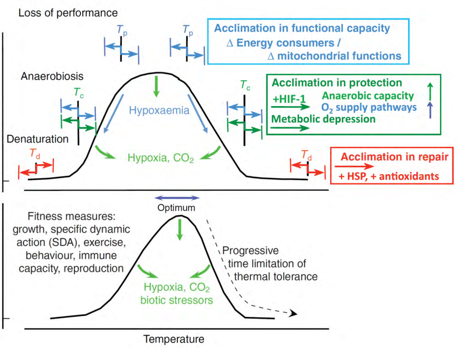
- Field based CO_2 vent system





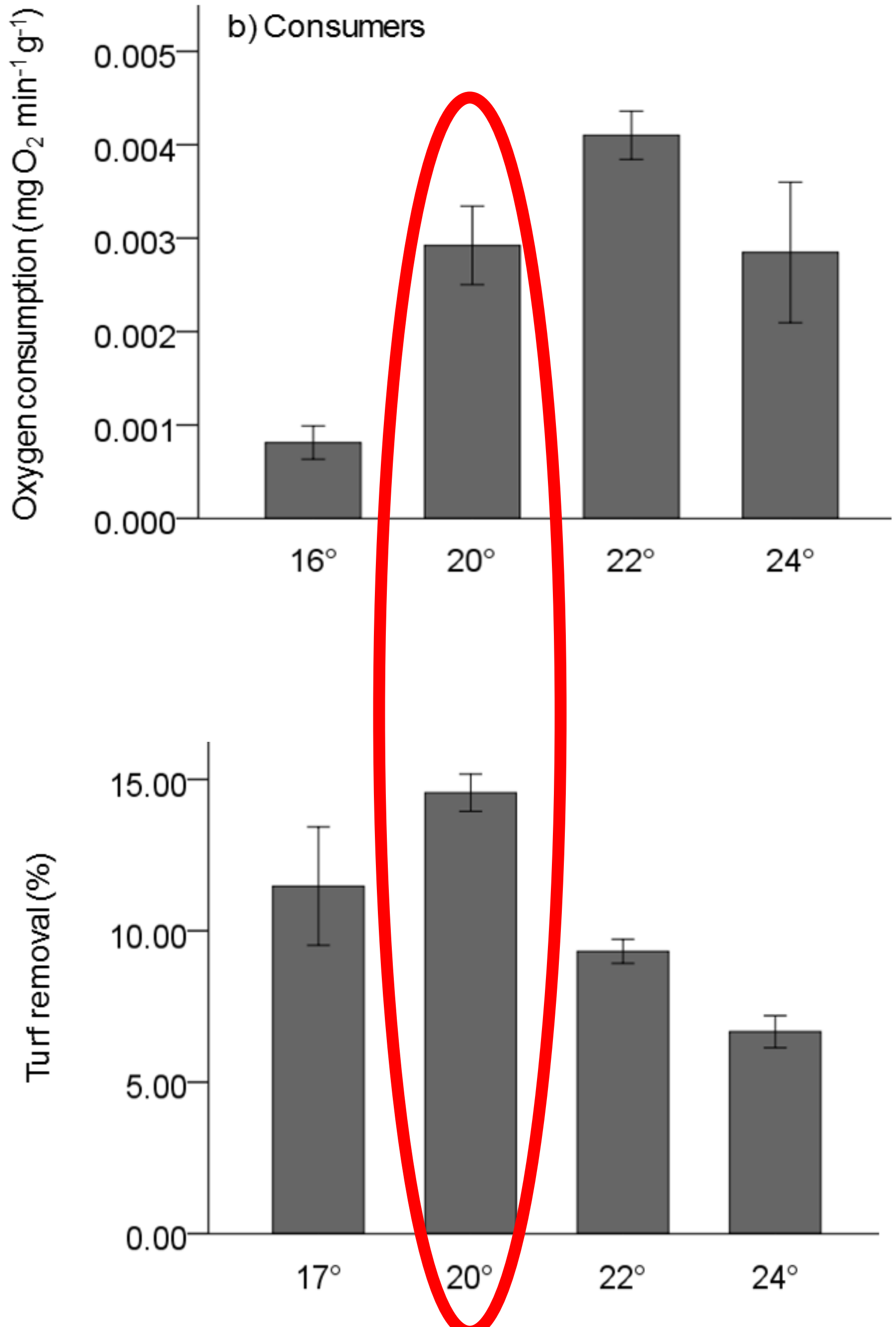
Algal turfs





Turbo undulatus

Mertens et al. (in review) Oecologia



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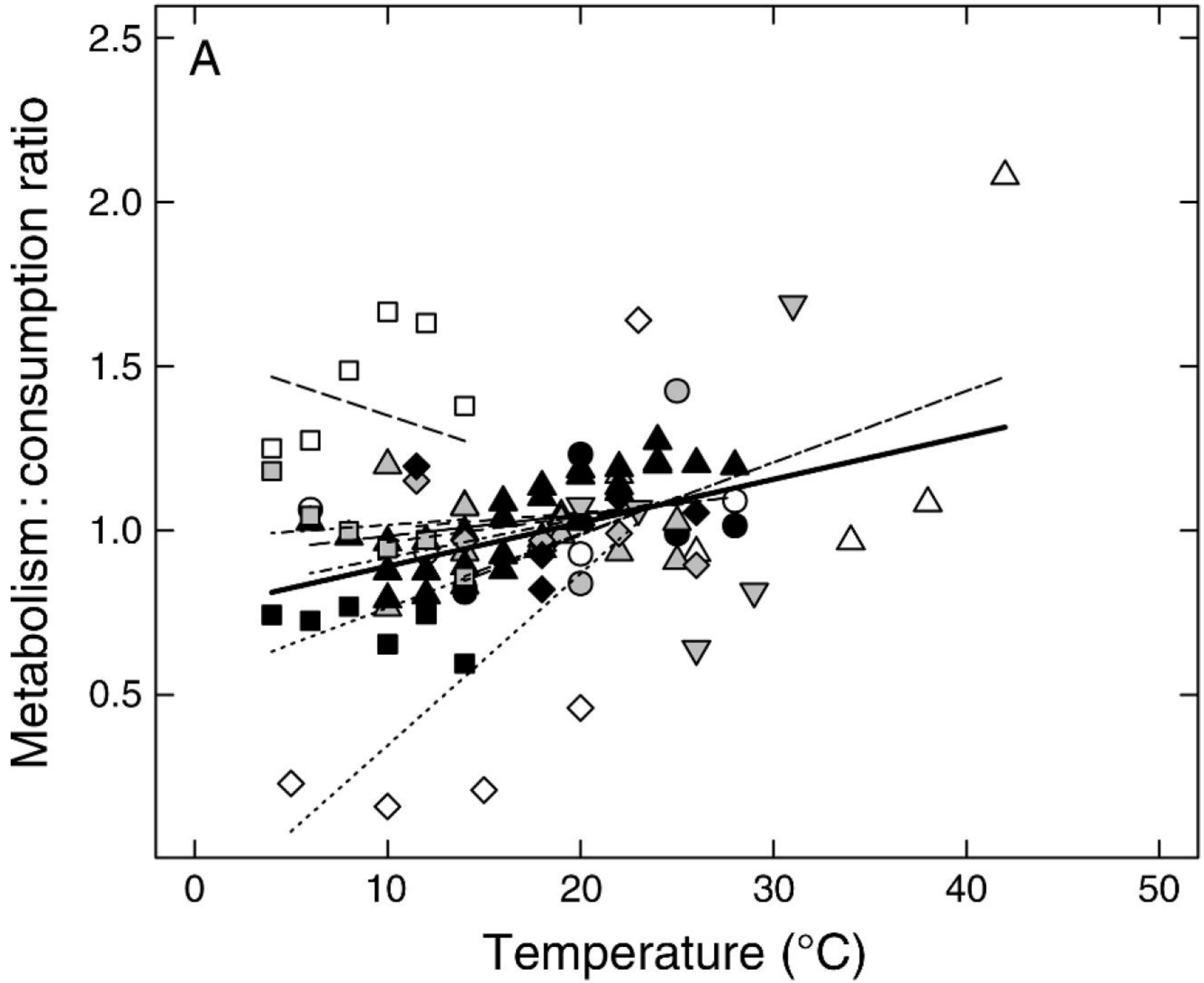
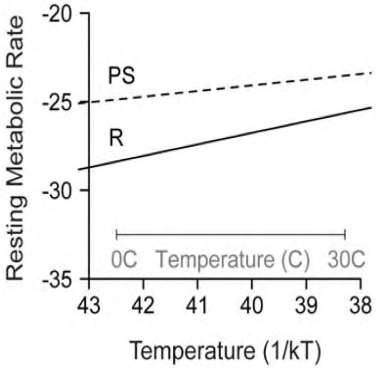
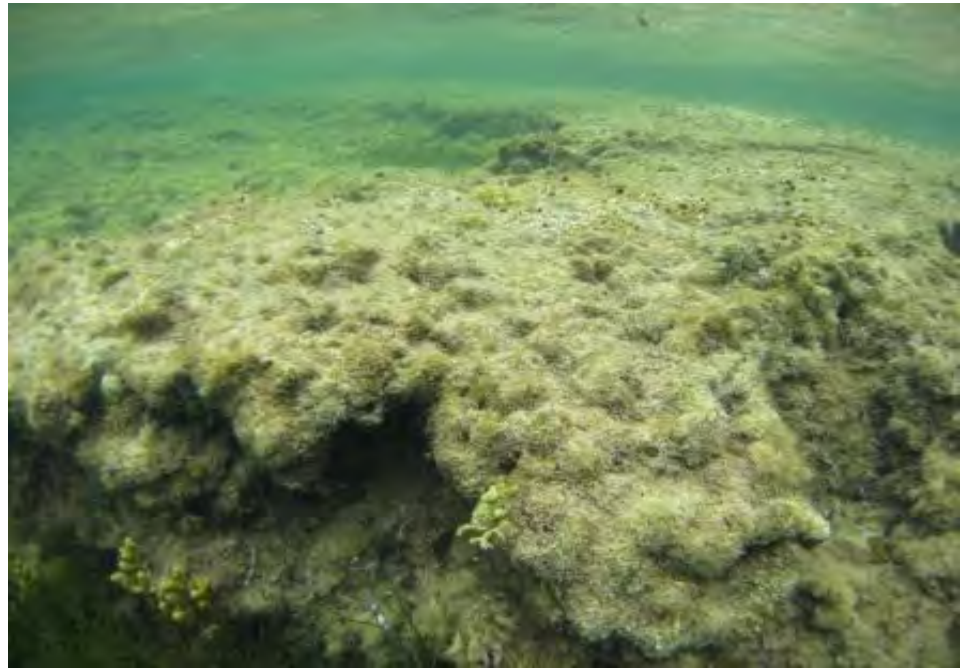
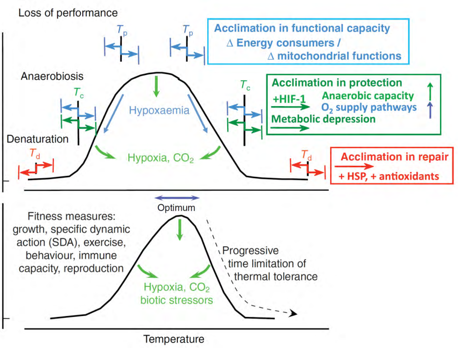
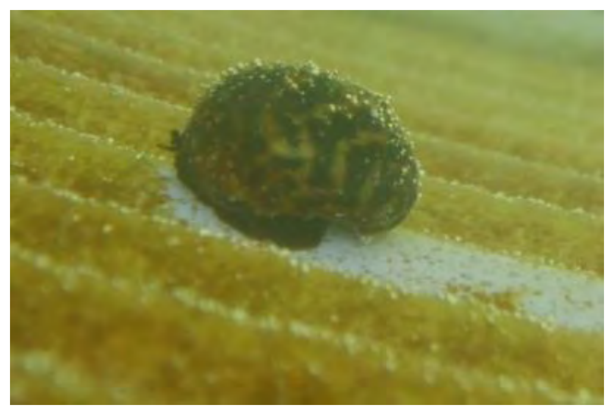


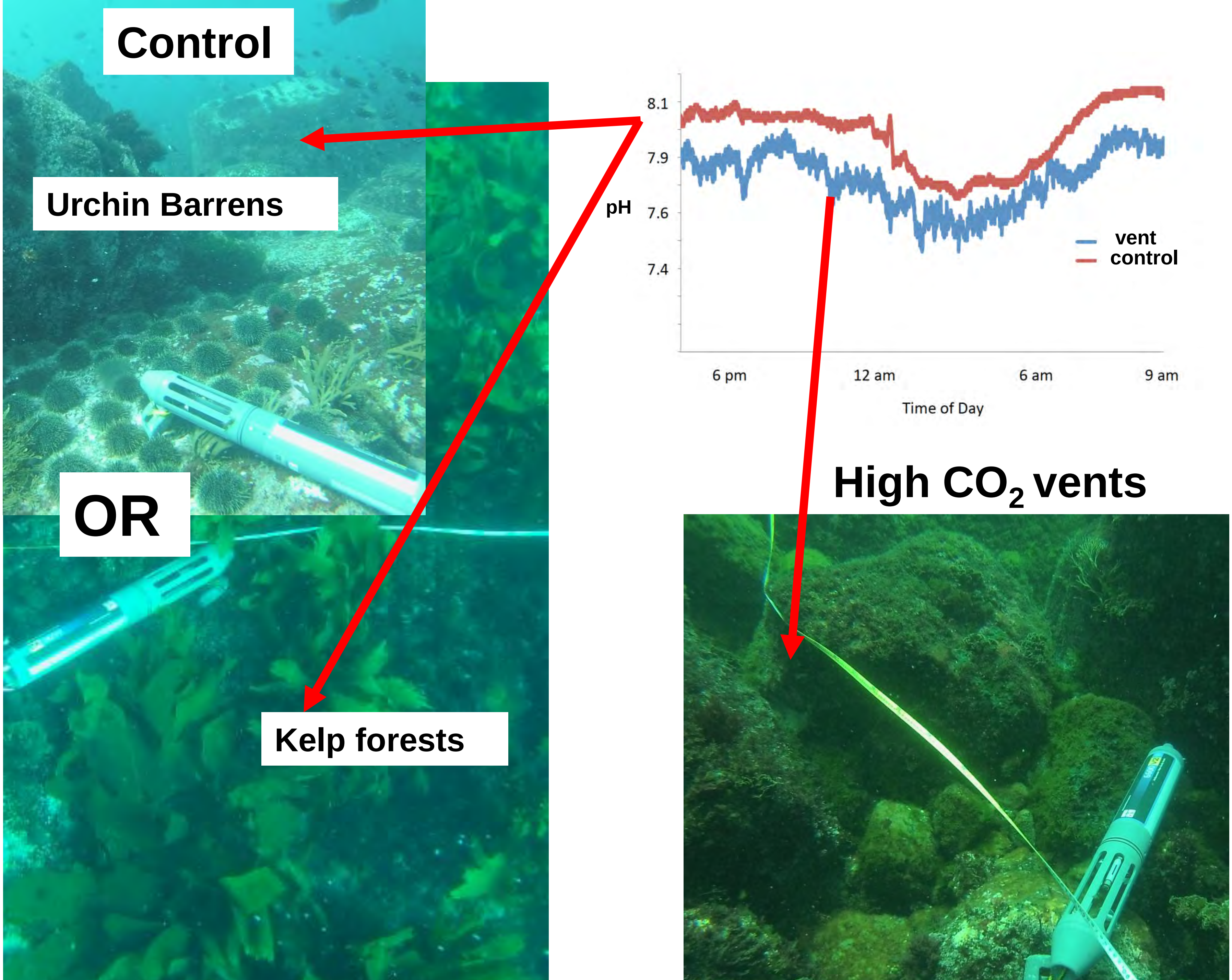
Lemoine and Burkepile (2012) Ecology

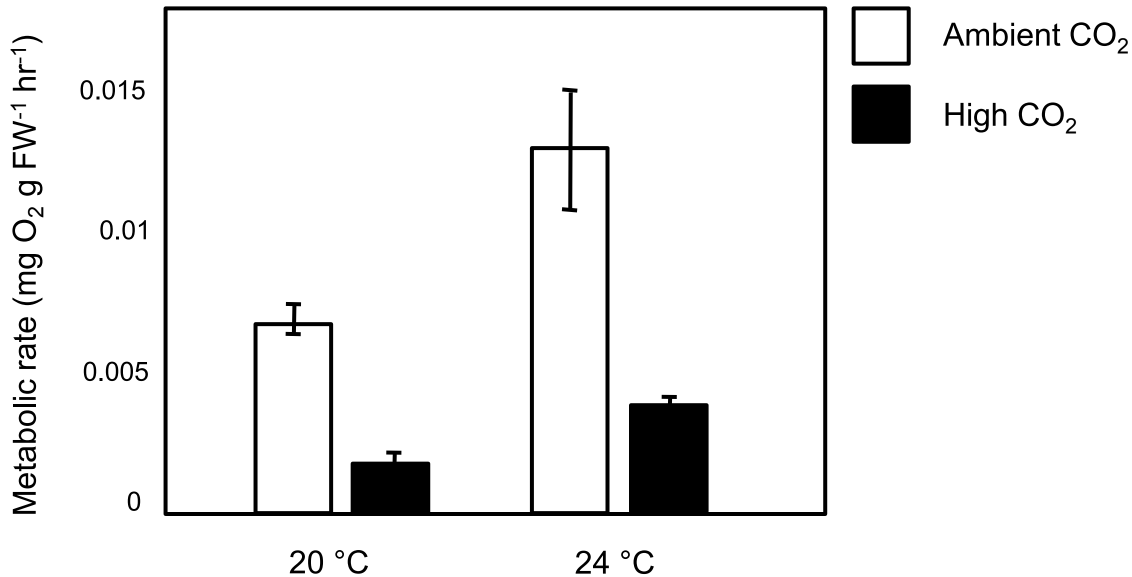

Resting Metabolic Rate
-20
-25
-30
-35
PS
R
0C Temperature (C) 30C
43 42 41 40 39 38
Temperature (1/kT)



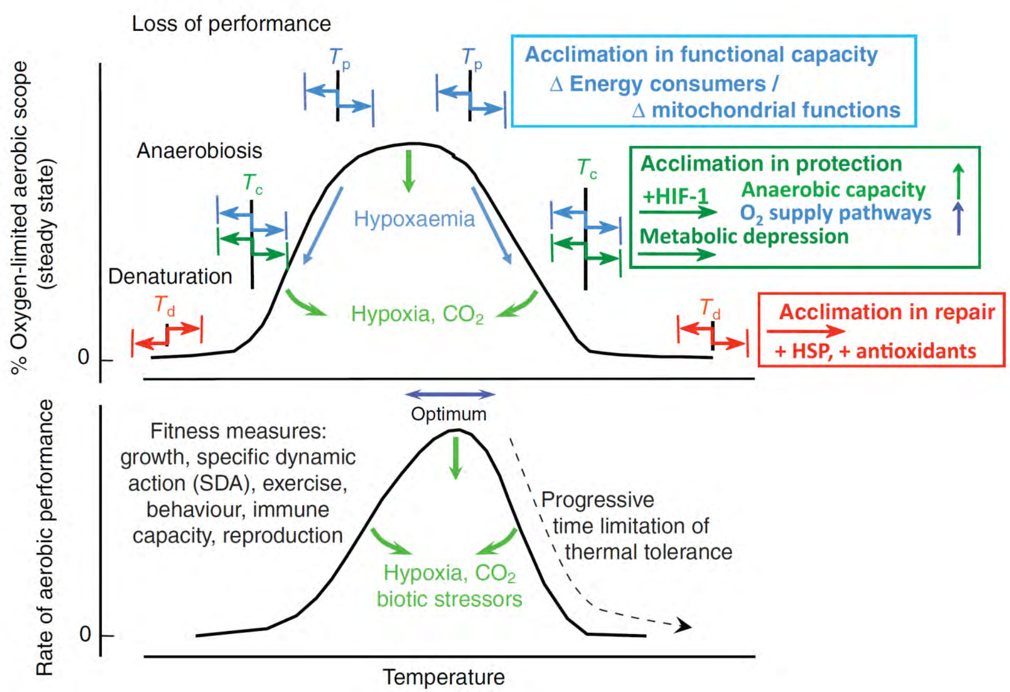

Loss of performance
Acclimation in functional capacity
Δ Energy consumers /
Δ mitochondrial functions
Anaerobiosis
Hypoxaemia
Acclimation in protection
+HIF-1
Anaerobic capacity
O_2 supply pathways
Metabolic depression
Denaturation
Hypoxia, CO_2
Acclimation in repair
+ HSP, + antioxidants
Optimum
Fitness measures:
growth, specific dynamic
action (SDA), exercise,
behaviour, immune
capacity, reproduction
Progressive
time limitation of
thermal tolerance
Hypoxia, CO_2
biotic stressors
Temperature

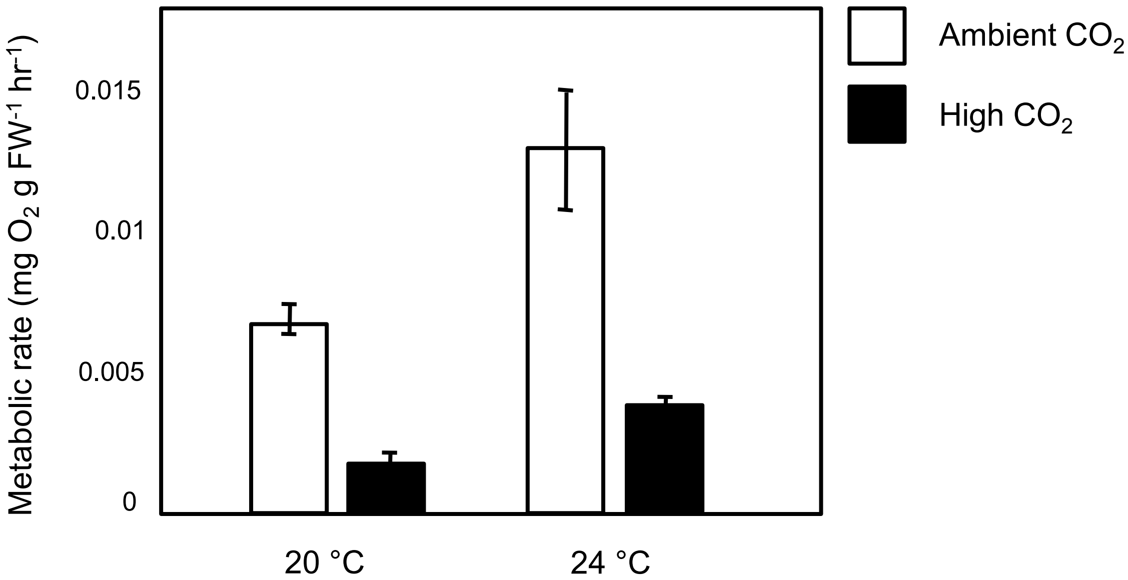



Control
Urchin Barrens
OR
Kelp forests
8.1
7.9
7.6
7.4
pH
vent
control
6 pm
12 am
6 am
9 am
Time of Day
High CO_2 vents



Evechinus chloroticus





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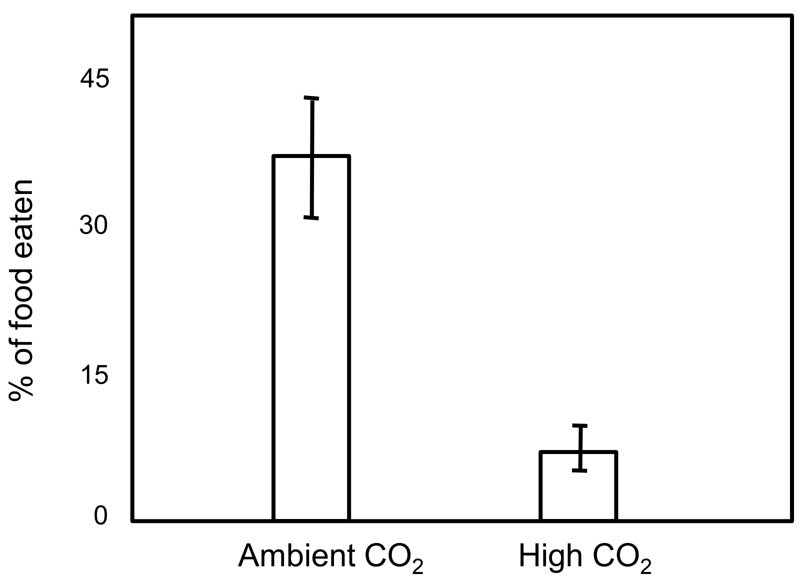
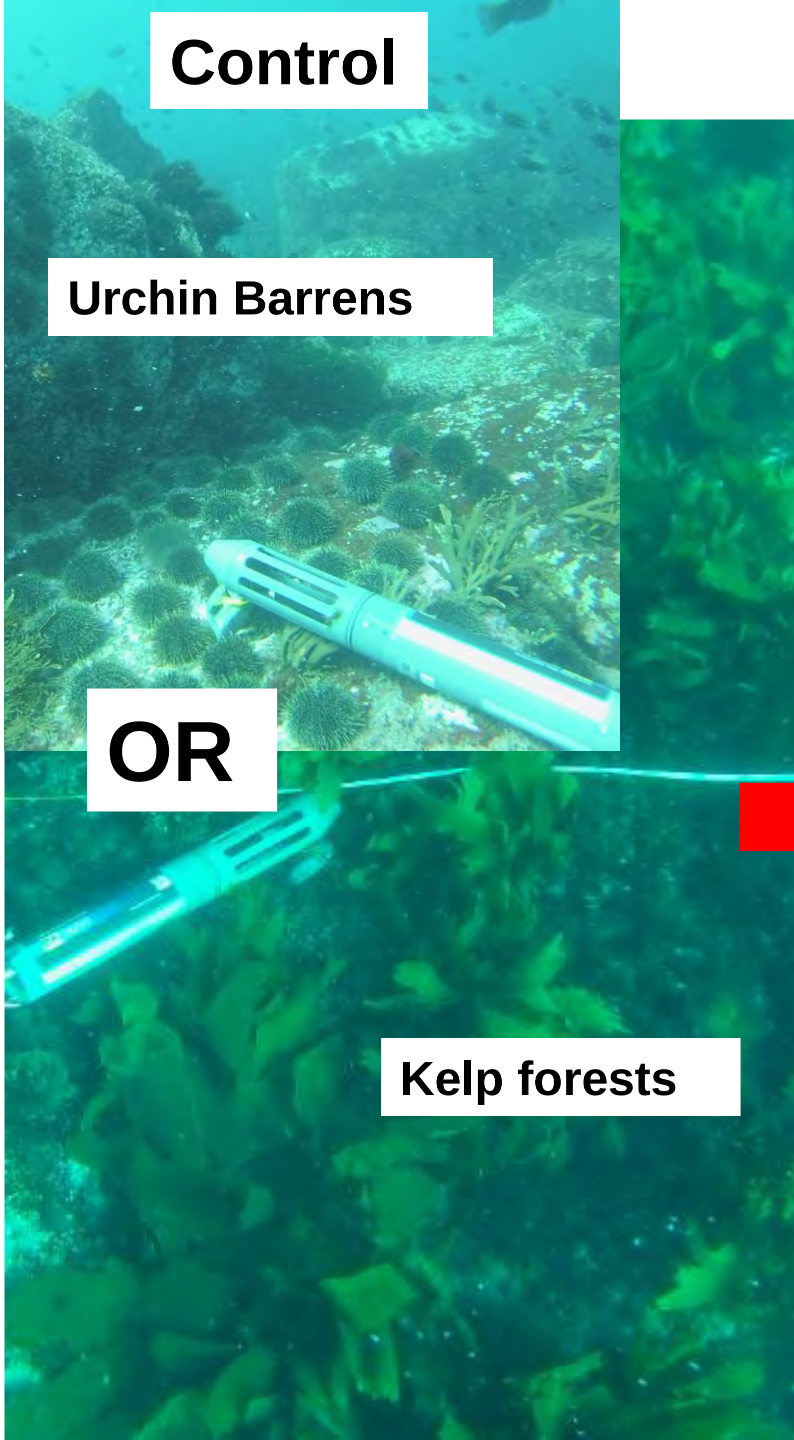
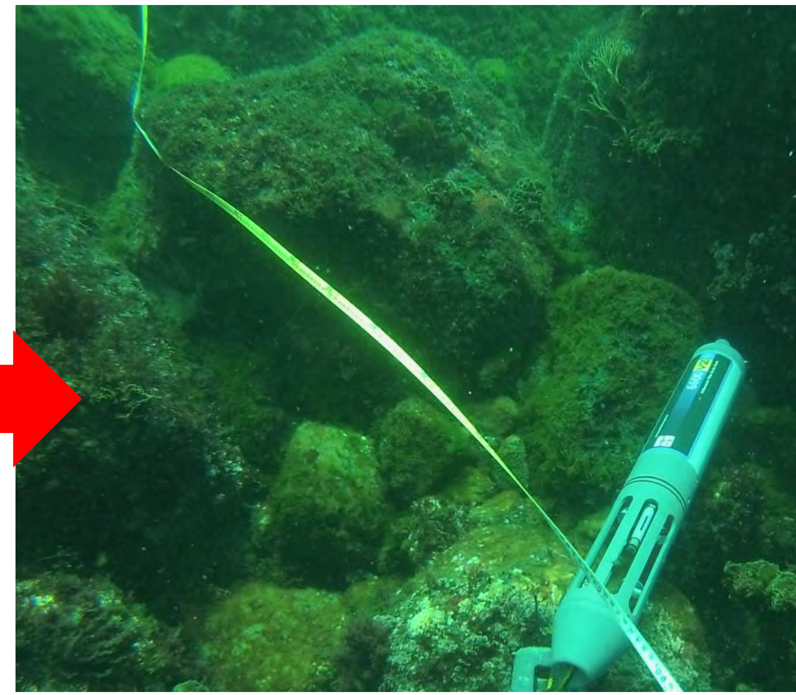
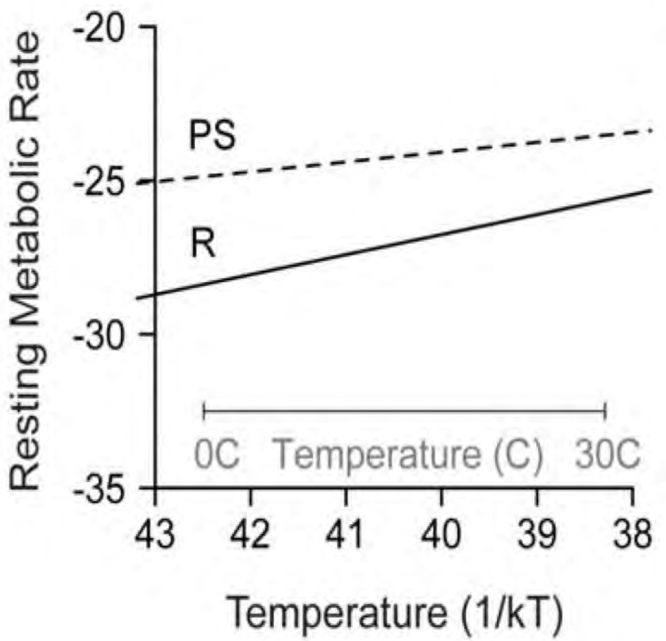




High CO_2 vents

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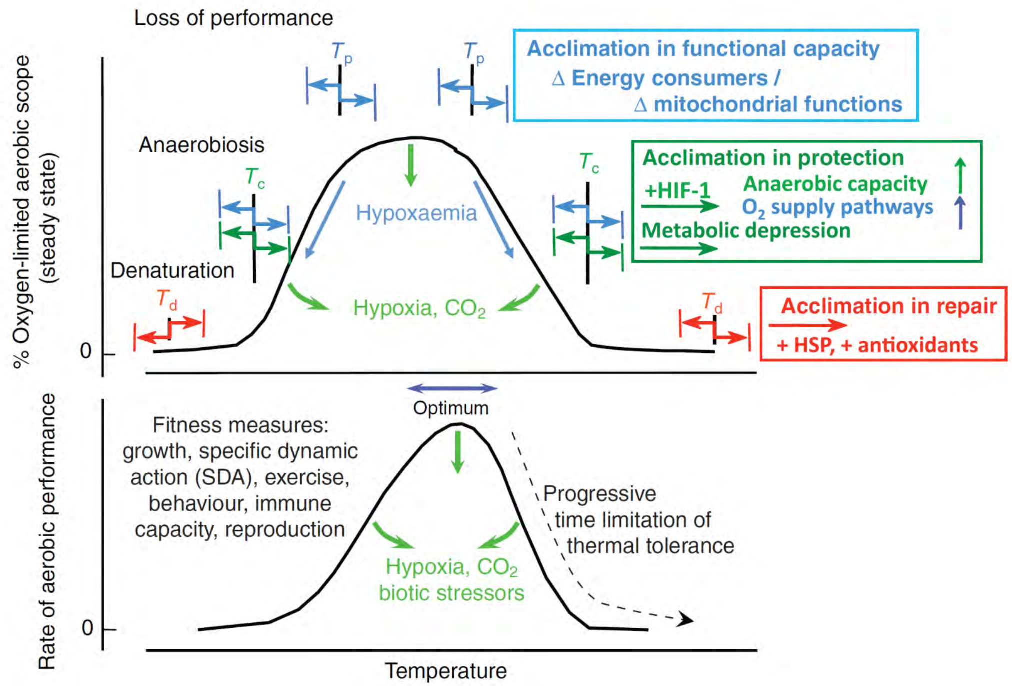
Loss of performance
% Oxygen-limited aerobic scope (steady state)
Acclimation in functional capacity
Δ Energy consumers /
Δ mitochondrial functions
Anaerobiosis
Hypoxaemia
Acclimation in protection
+HIF-1
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capacity, reproduction
Progressive
time limitation of
thermal tolerance
Hypoxia, CO2
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Temperature