

Searching for signs of resilience in over-wintering juvenile pteropods to ocean acidification and deoxygenation

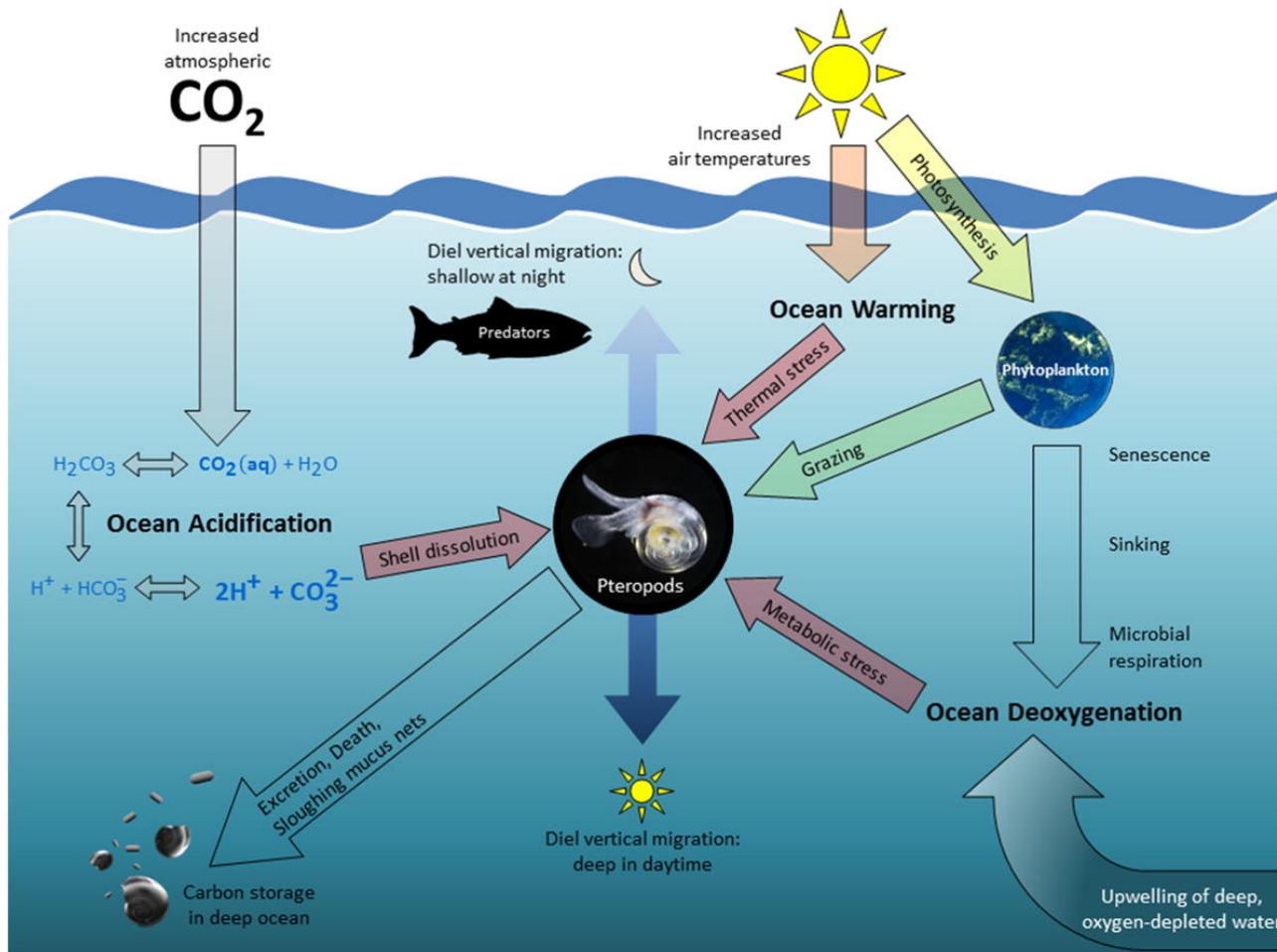
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How does ocean change affect juvenile Pteropods (*L. helicina*)?



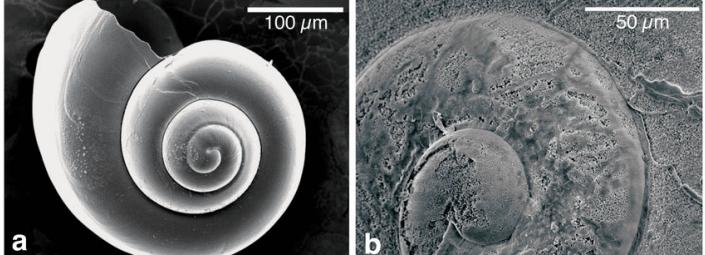
[Bednaršek et al. 2016](#)

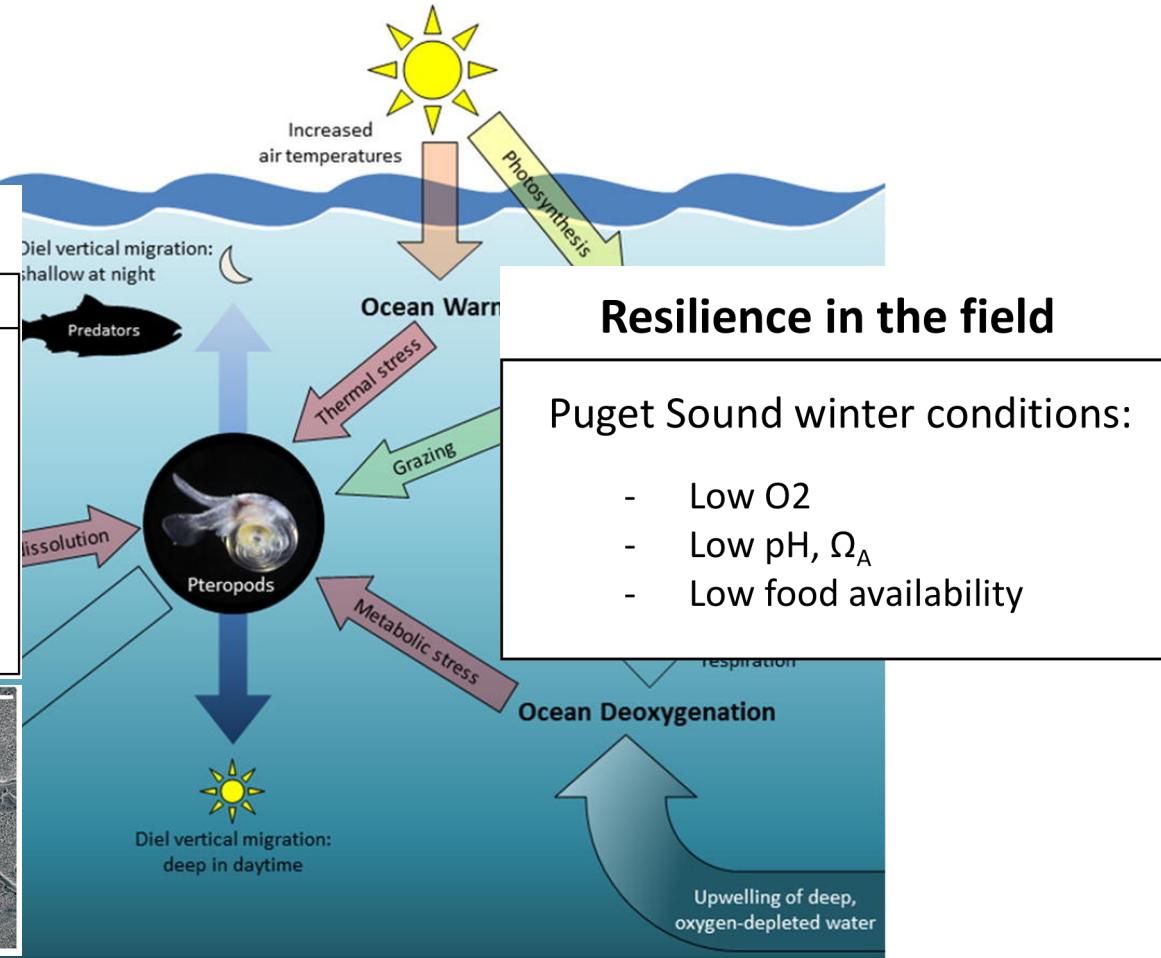
How does ocean change affect juvenile Pteropods (*L. helicina*)?

Increased atmospheric CO_2

Studies show sensitivity to low Ω_A

Field:	Lab and Field:
↓ survival ↓ shell condition ↓ shell growth Fall and winter N. Atlantic (Lischka et al. 2011) (Lischka and Riebesell 2012)	↑ shell dissolution Summer Antarctic, CA Current (Bednaršek et al. 2012) (Bednaršek et al. 2014) (Busch et al. 2014)





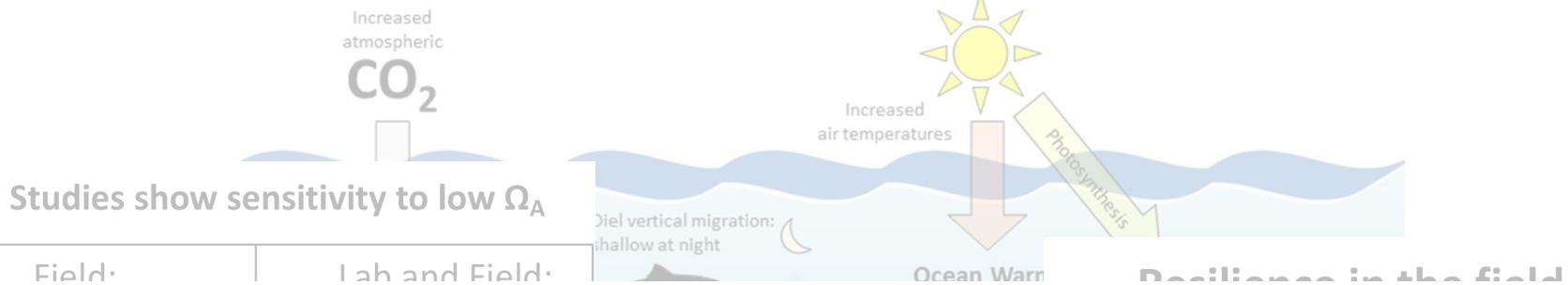
Resilience in the field

Puget Sound winter conditions:

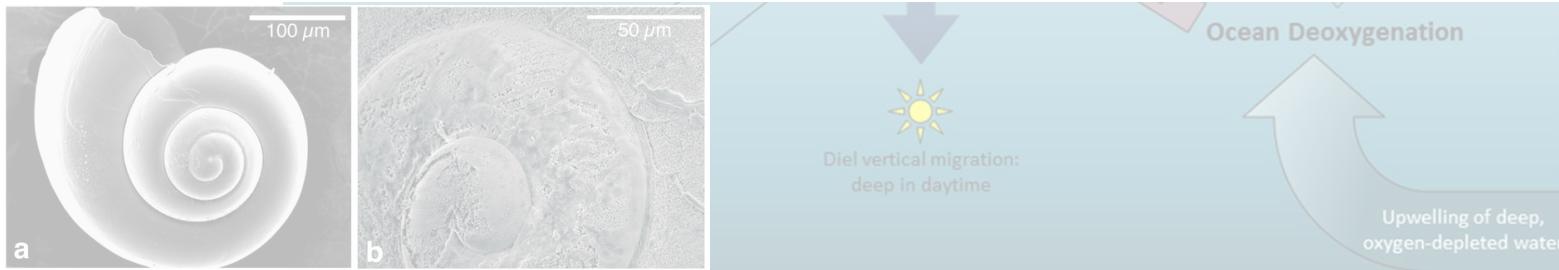
- Low O₂
- Low pH, Ω_A
- Low food availability

[Bednaršek et al. 2016](#)

How does ocean change affect juvenile Pteropods (*L. helicina*)?



How sensitive are pteropods to low O_2 AND pH, Ω_A ?



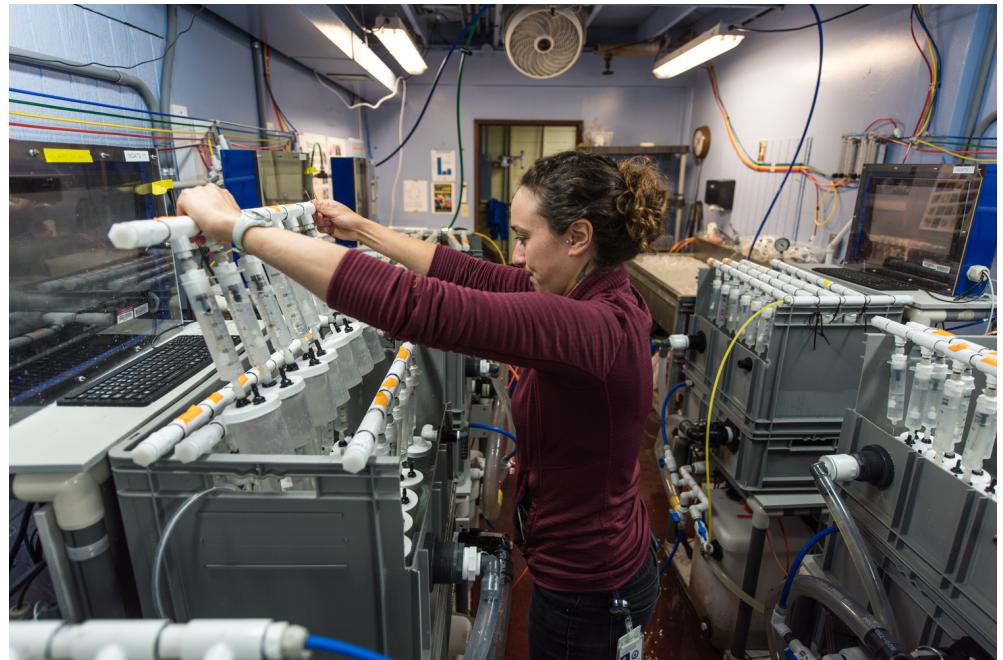
[Bednaršek et al. 2016](#)

Pteropods in lab altered pH and O₂

**juveniles exposed
for 9 days**

pH, Ω _A	
O ₂	
Norm pH Norm O ₂ 100% O ₂ pH 7.95, Ω _A 1.1	Low pH 100% O ₂ pH 7.55, Ω _A 0.5
Low O ₂ 40% O ₂ pH 7.95, Ω _A 1.1	Low pH Low O ₂ 40% O ₂ pH 7.55, Ω _A 0.5

MOATS
(Mobile ocean acidification
treatment systems)



Pteropod survival in lab altered pH and O₂

**juveniles exposed
for 9 days**

pH, Ω_A

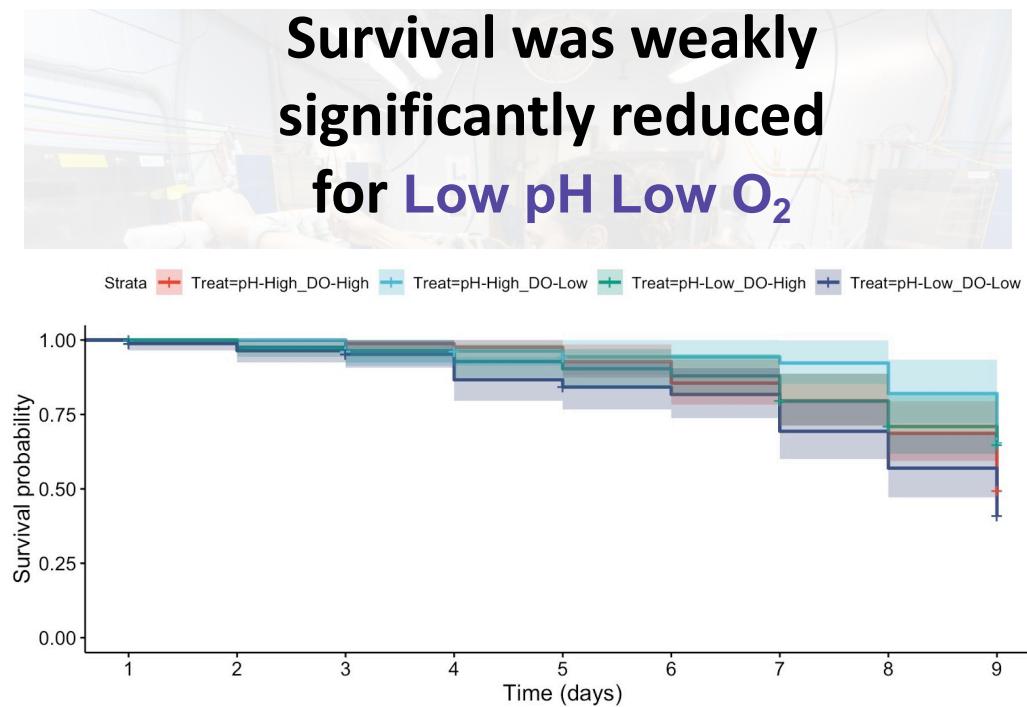
		Norm pH Norm O ₂	Low pH
		100% O ₂ pH 7.95, Ω _A 1.1	100% O ₂ pH 7.55, Ω _A 0.5
O ₂	Low O ₂	Low pH Low O ₂	Low pH Low O ₂
		40% O ₂ pH 7.95, Ω _A 1.1	40% O ₂ pH 7.55, Ω _A 0.5

Under starvation conditions

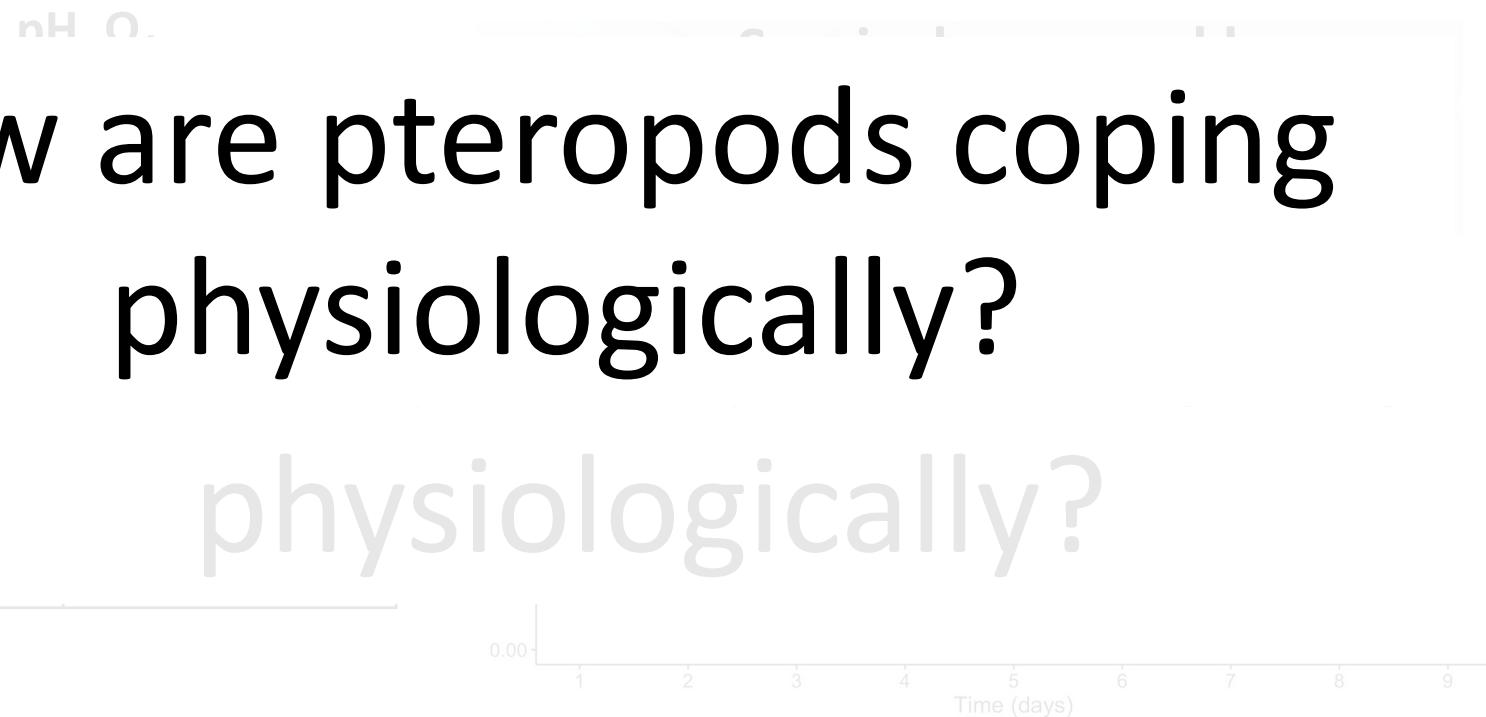
MOATS

(Mobile ocean acidification
treatment systems)

**Survival was weakly
significantly reduced
for Low pH Low O₂**



Pteropod survival in lab altered pH and O₂



Under starvation conditions

Metabolomics for physiological insight

Animals exposed to different conditions



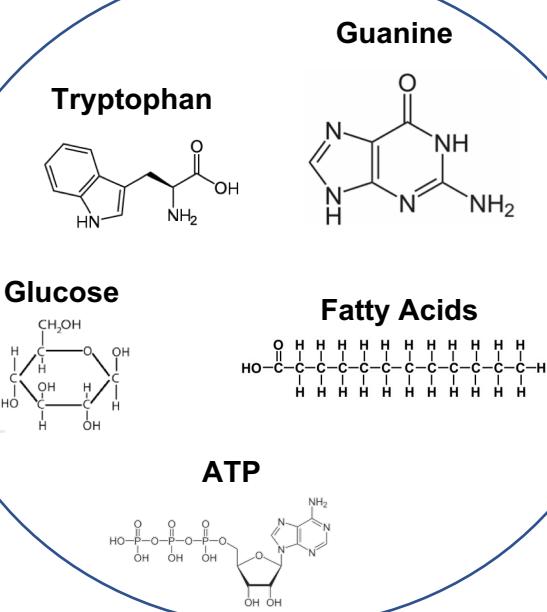
Norm pH
Norm O₂

Low O₂

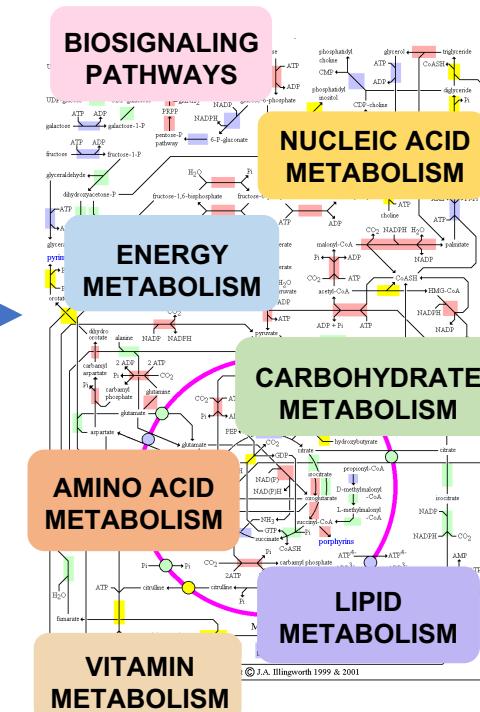
Low pH

Low pH
Low O₂

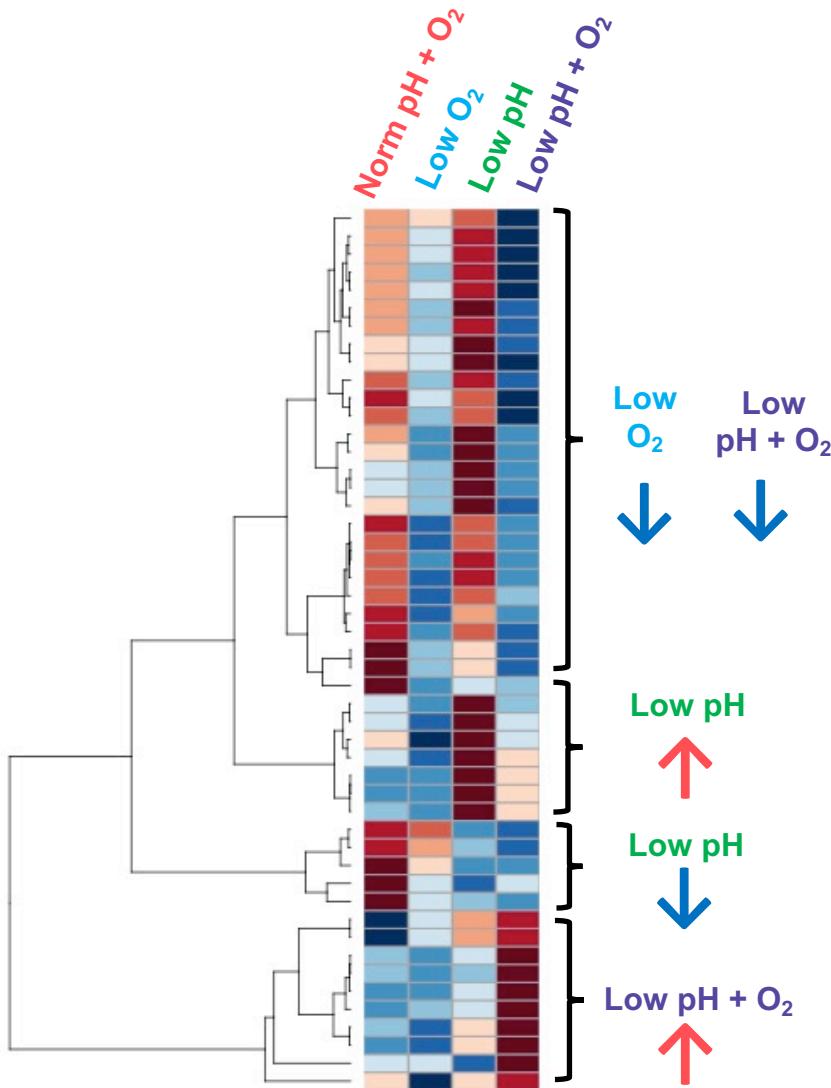
Identify all metabolites



Infer activity of pathways



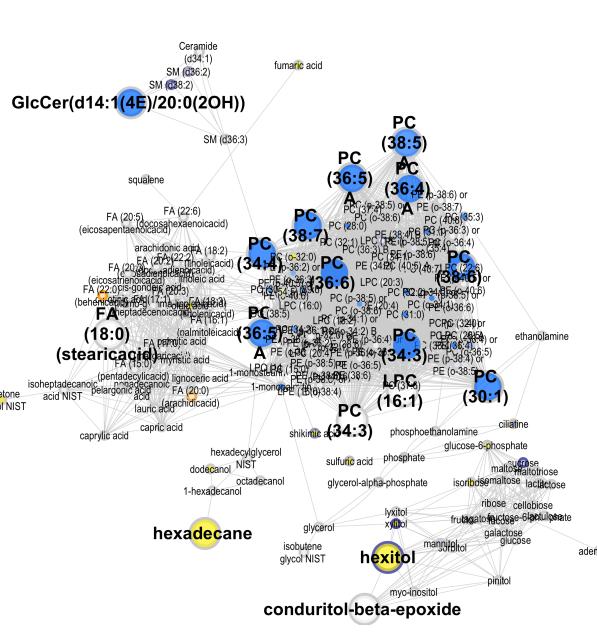
Condition-specific effects on metabolites



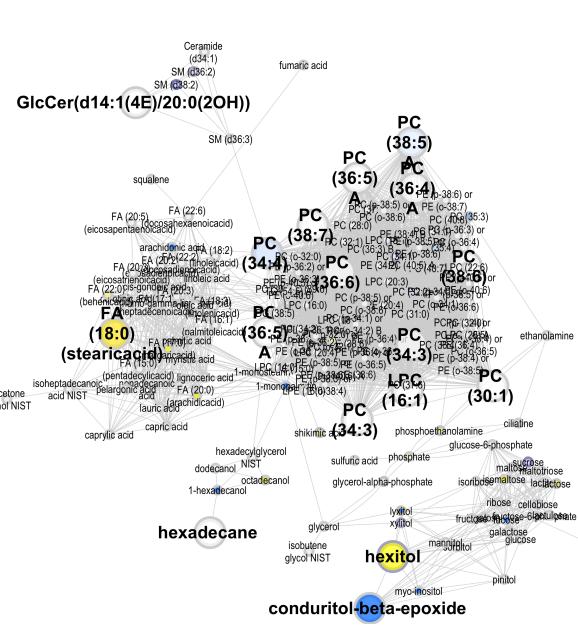
Low O₂ more strongly affects metabolite abundance

Phosphotidylcholines are significantly affected

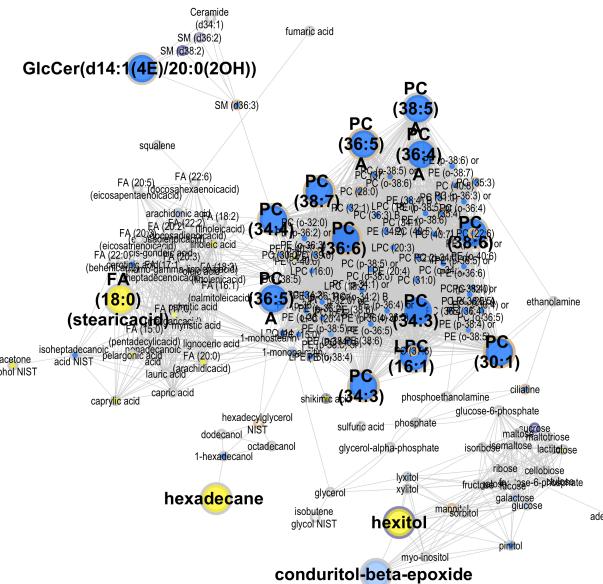
Low O₂



Low pH



Low pH + O₂



Signs of resilience

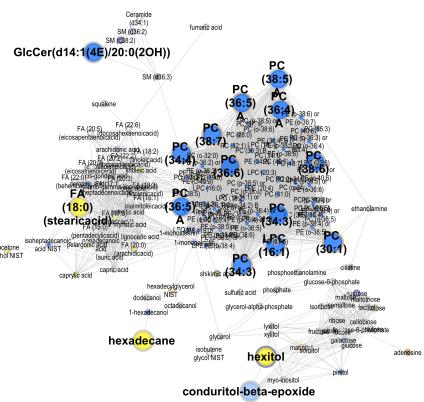
pH x O₂ metabolomics studies

Pteropods



- Both animals show resilience to pH and O₂ stress (no difference in survival across conditions)
 - Low O₂ has a stronger influence on metabolites
 - Low O₂ affects different pathways

Lipid metabolism



Dungeness crab



Trigg et al (2019)
Sci Reports

Amino acid metabolism

