

Ocean Acidification Leads to Physiological Trade-offs in the Pacific Oyster, *Crassostrea gigas*

Kevin Thomson, Edith Bruneau, Nathan English, Andrew Ross, Sarah White, Tony Anderson, James Roberts

The University of Washington
The College of Arts and Sciences



- What are the effects of ocean acidification?
- How does ocean acidification affect the (mechanical) stress response?

Exposure to ocean acidification caused:

- no dramatic phenotypic effect (acute heat shock, fatty acids)
- weakened integrity of shell structure
- significant impacts on important molecular physiological processes
- disruption of response to mechanical stress

Project in France

Deeper investigation of proteins of interest.

- enzyme activity (glutathione S-transferase and other antioxidant enzymes)
- protein expression and phosphorylation (MAP kinase-activated protein kinase)

Acknowledgements

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 Sean Young, Mike Ivey
Suggesters on BioRxiv, NCARS, SakonnoB Kennedy great

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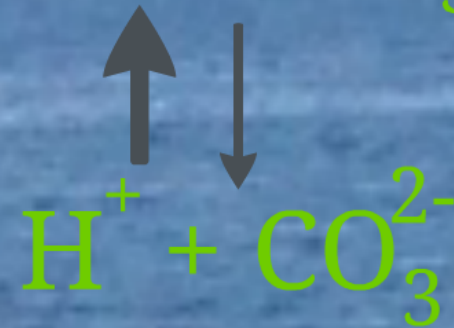
Ocean Acidification Leads to Physiological Trade-offs in the Pacific Oyster, *Crassostrea gigas*

*Emma Timmins-Schiffman, William Coffey, Wilber Hua,
Brook Nunn, Gary Dickinson, Steven Roberts*

*University of Washington
The College of New Jersey*



CO₂





Human influences

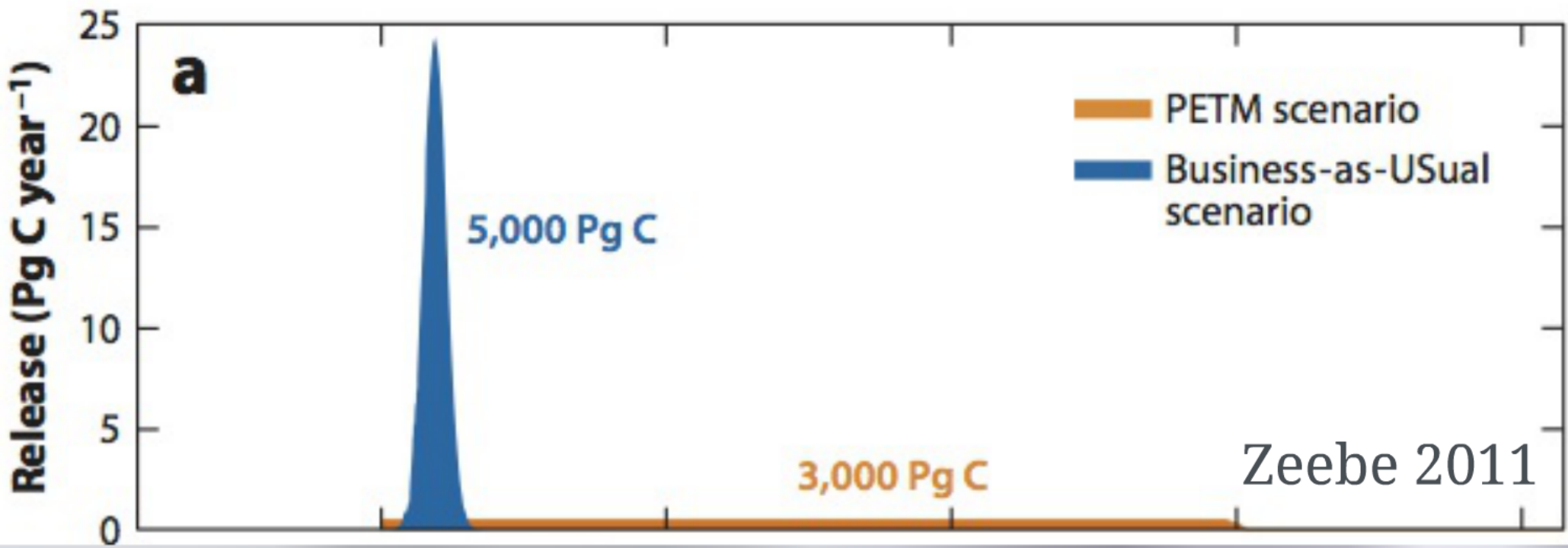
- deforestation
- river flow
- mining
- agriculture



respiration

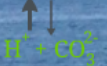
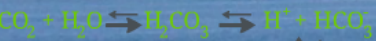
upwelling







CO₂



Human influences

- deforestation
- clear flow
- mining
- agriculture

respiration

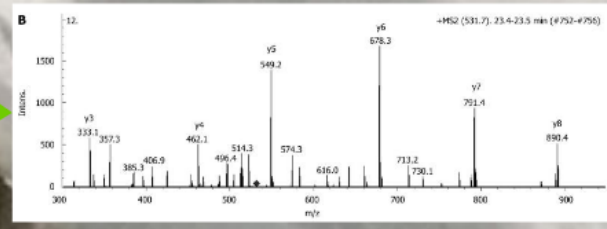
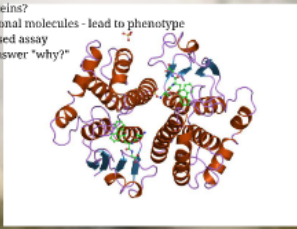


upwelling



Why proteins?

- functional molecules - lead to phenotype
- unbiased assay
- can answer "why?"

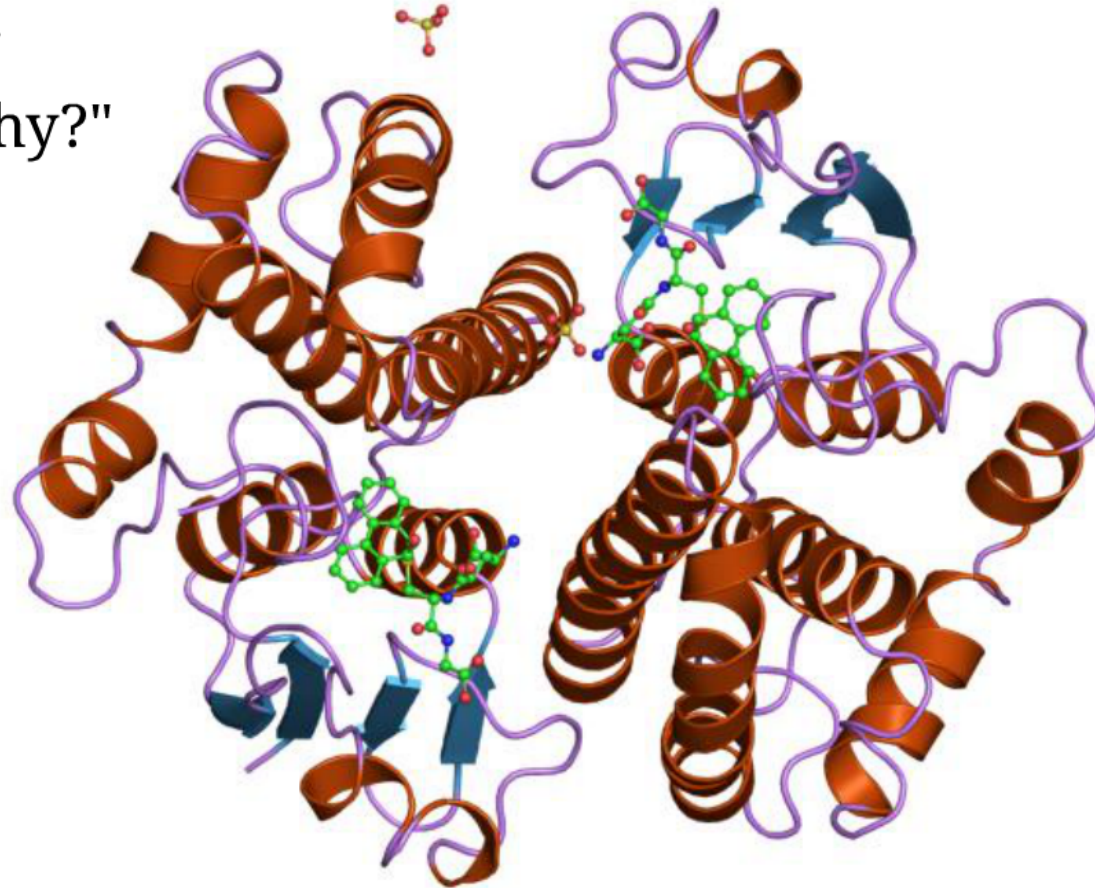


Gill tissue



Why proteins?

- functional molecules - lead to phenotype
- unbiased assay
- can answer "why?"





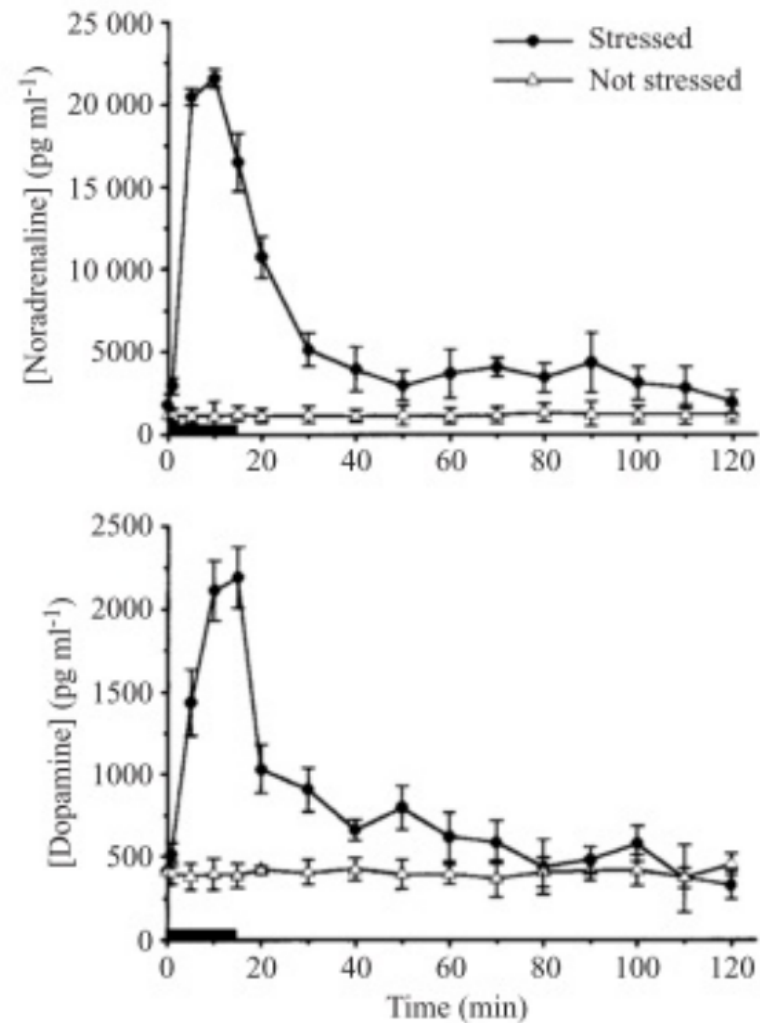
- *What are the effects of ocean acidification?*
- *How does ocean acidification affect the (mechanical) stress response?*



EVIDENCE FOR A FORM OF ADRENERGIC RESPONSE TO STRESS IN THE MOLLUSC *CRASSOSTREA GIGAS*

A. LACOSTE*, S. K. MALHAM, A. CUEFF, F. JALABERT, F. GÉLÉBART AND S. A. POULET
Station Biologique de Roscoff, CNRS, INSU, Université Pierre et Marie Curie, Paris 6, BP 74, F-29682 ROSCOFF, France

*e-mail: lacoste@sb-roscoff.fr



t_0 : shell weight

pCO₂ (μatm)

400 600 800 1000 1200 2800



1 month exposure

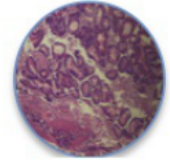
No additional stress

Mechanical stress

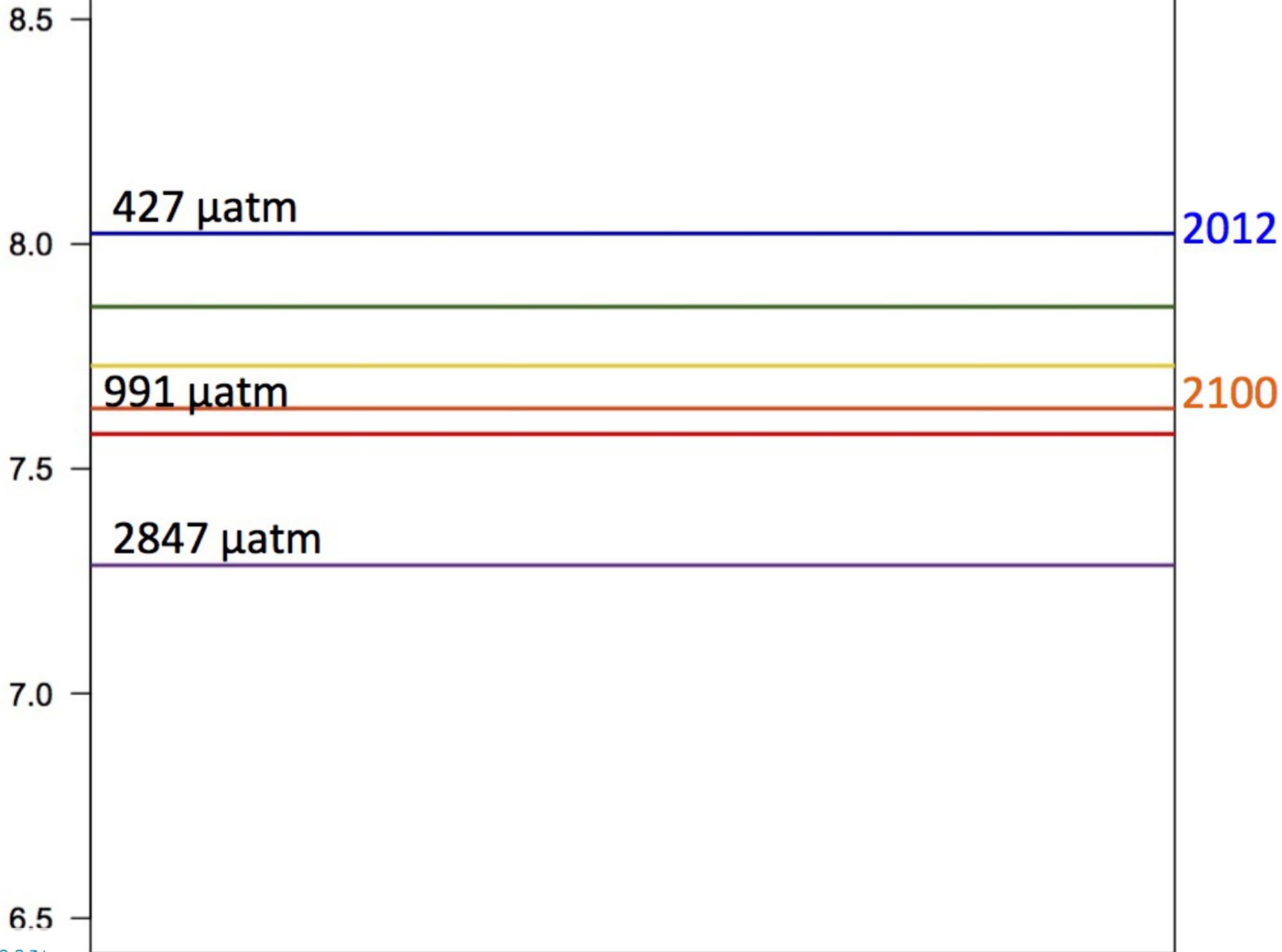
Heat shock

- 2 sublethal temperatures: 42 & 43°C
- 1 lethal temperature: 44°C

- Shell weight
- Gill tissue:
 - Proteomics
- Shell structure/strength
- Whole body
 - Fatty acids
 - Histology



Average pH



2012

2100

t_0 : shell weight

pCO₂ (μatm)

400 600 800 1000 1200 2800



1 month exposure

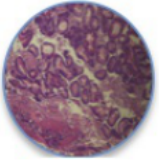
No additional stress

Mechanical stress

Heat shock

- 2 sublethal temperatures: 42 & 43°C
- 1 lethal temperature: 44°C

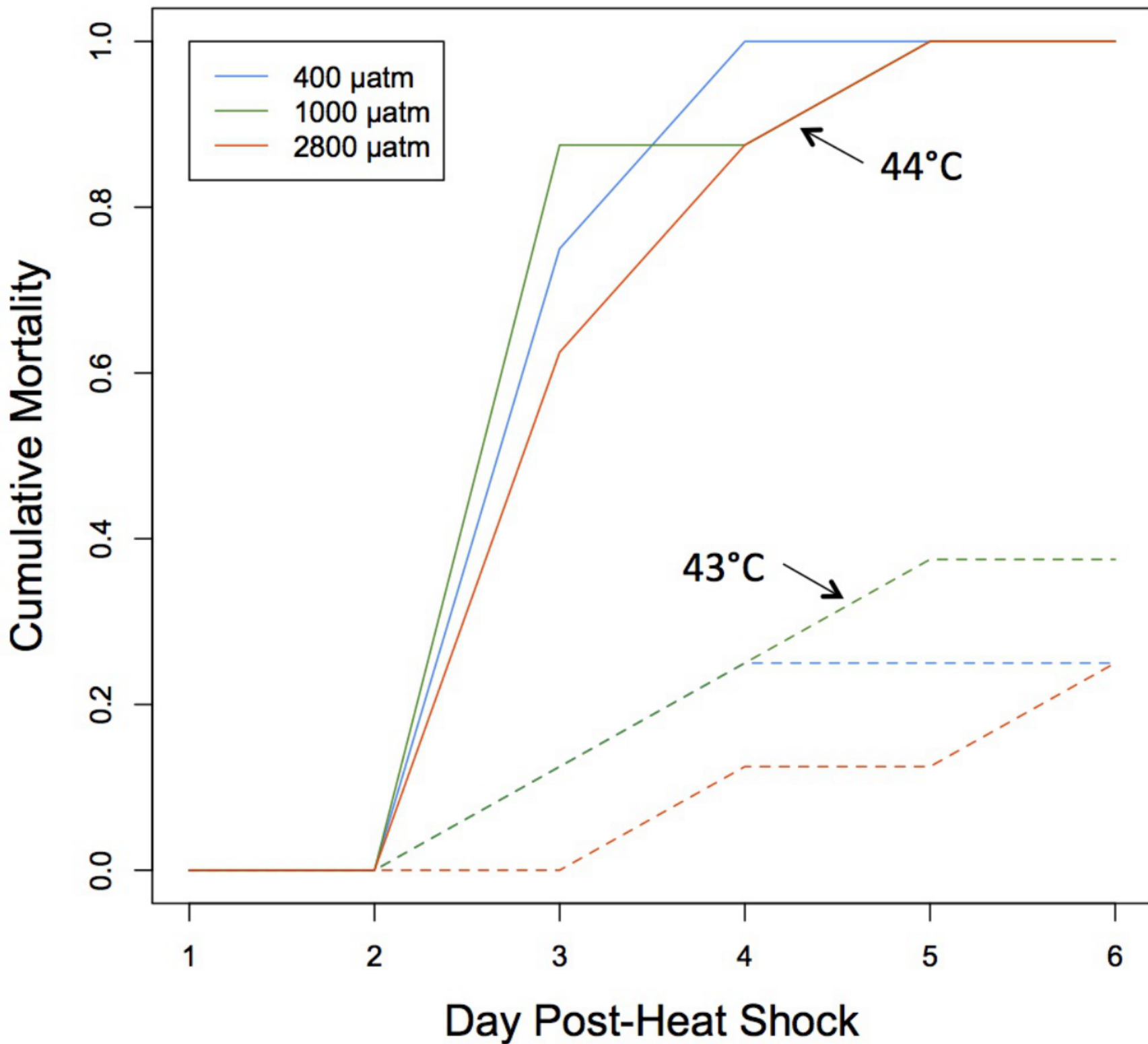
- Shell weight
- Gill tissue:
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- Whole body
 - Fatty acids
 - Histology





Heat shock

- 2 sublethal temperatures:
42 & 43°C
- 1 lethal temperature:
44°C





Shell weight

Gill tissue:

Protozoa:

Oysters grew in all treatments, but growth rates were not different.

Shell weight

Gill tissue:

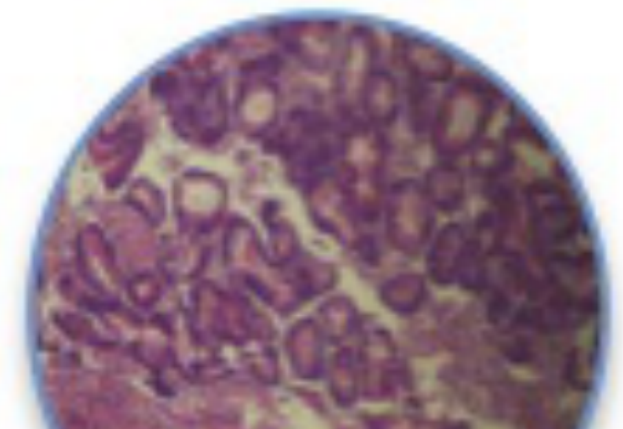
- Proteomics

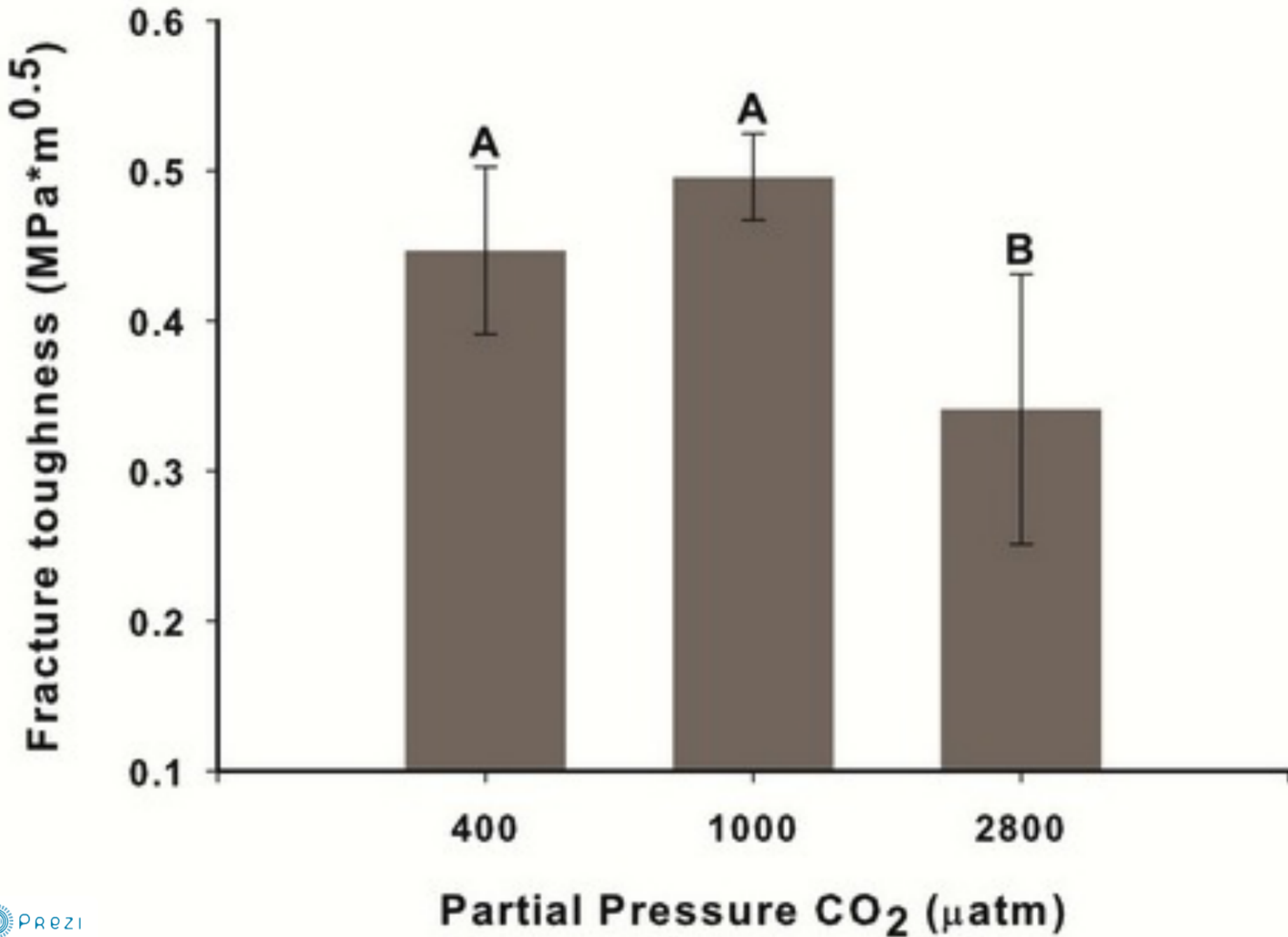


Shell structure/strength

Whole body

- Fatty acids
- Histology

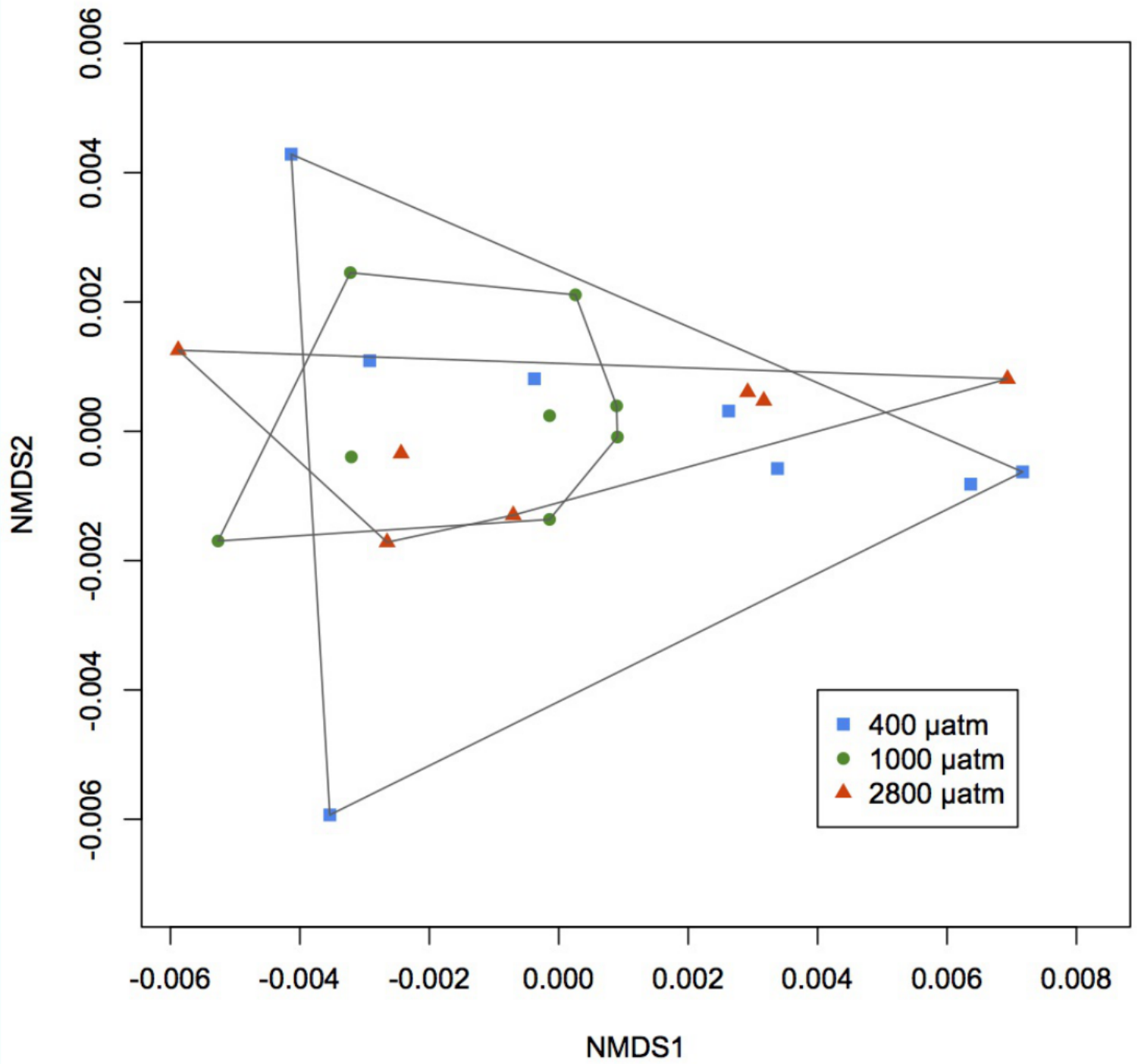




ole body

Fatty acids

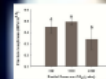
Histology



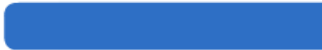
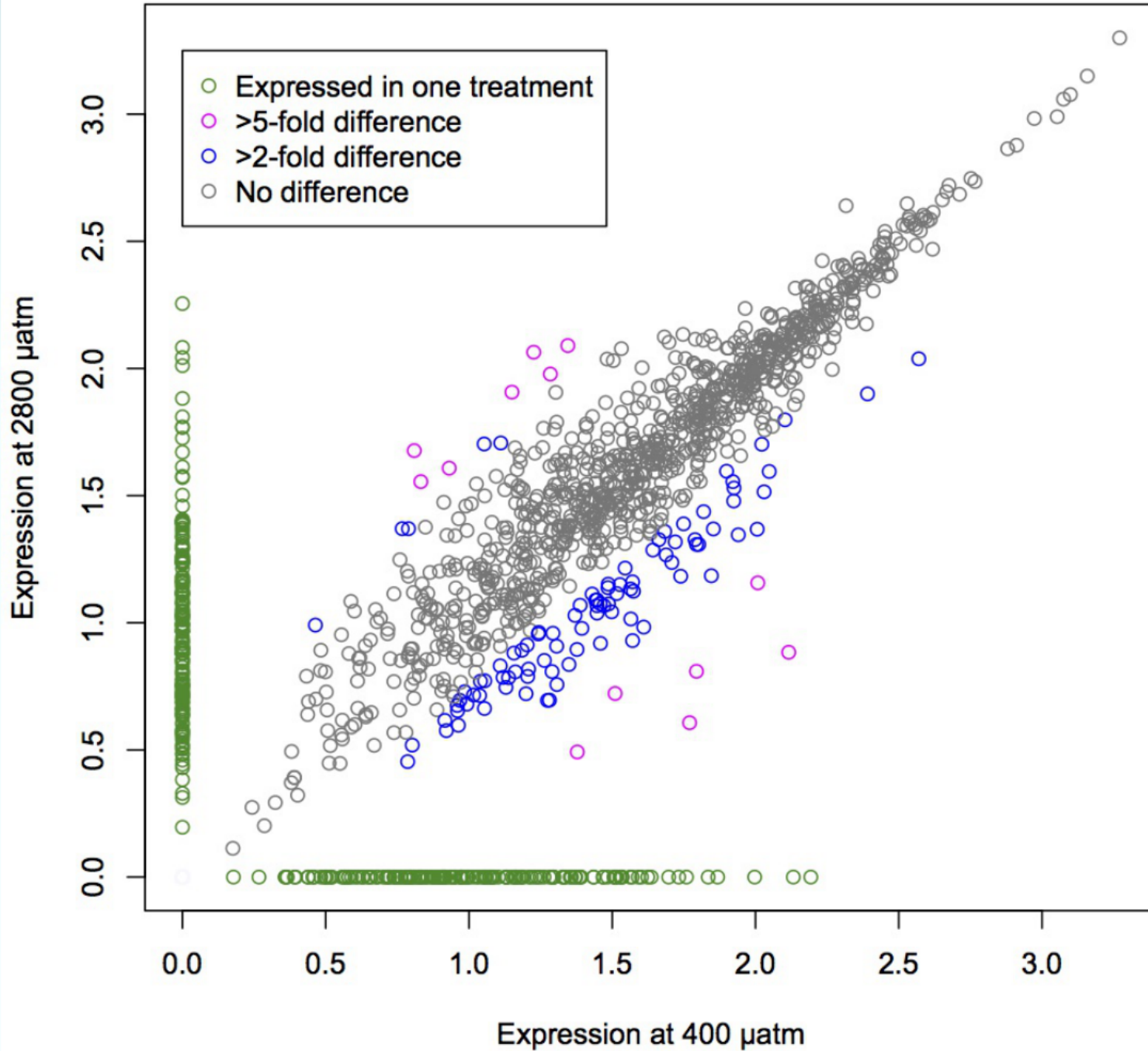
issue:

Proteomics

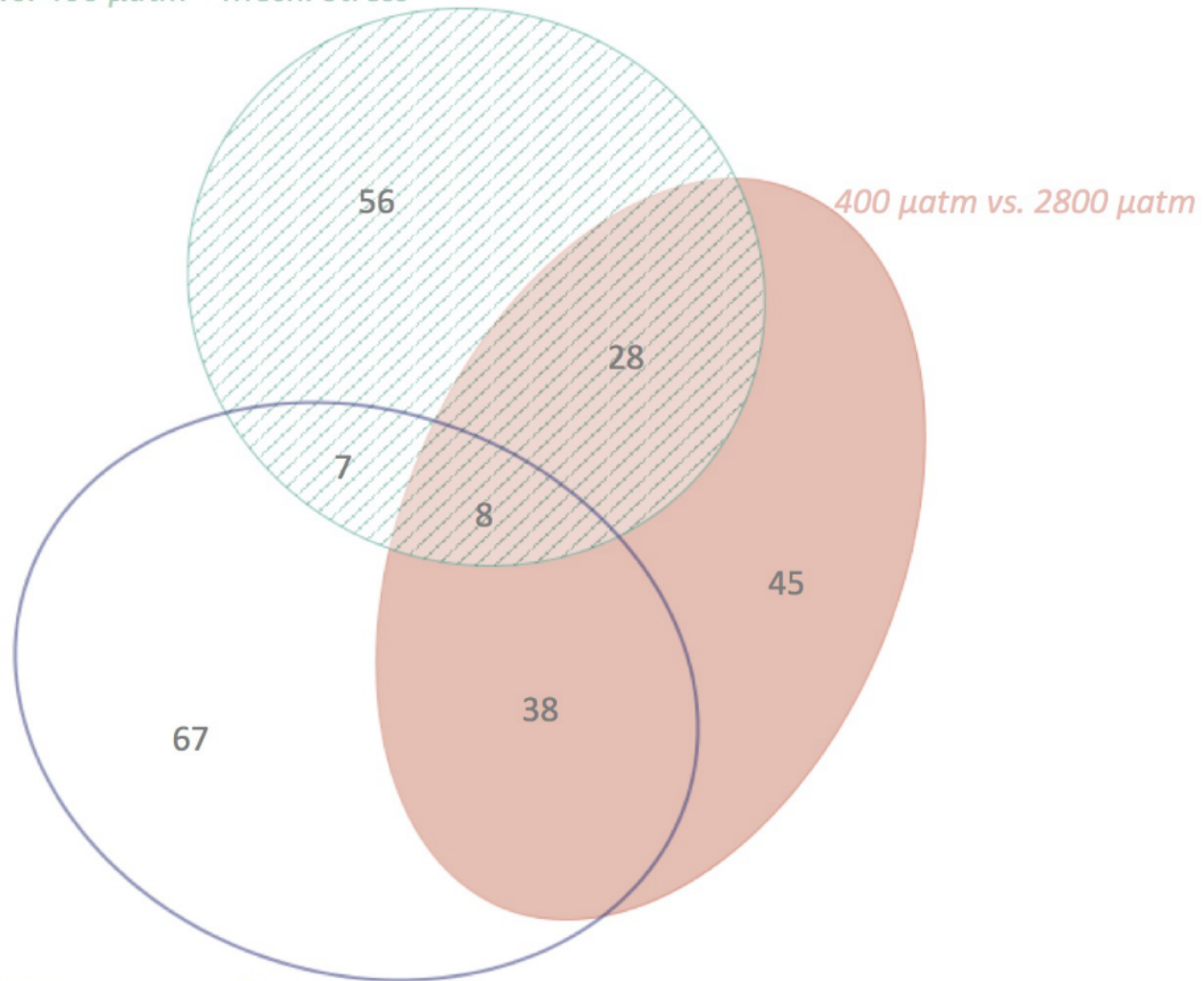
structure/st



8
5



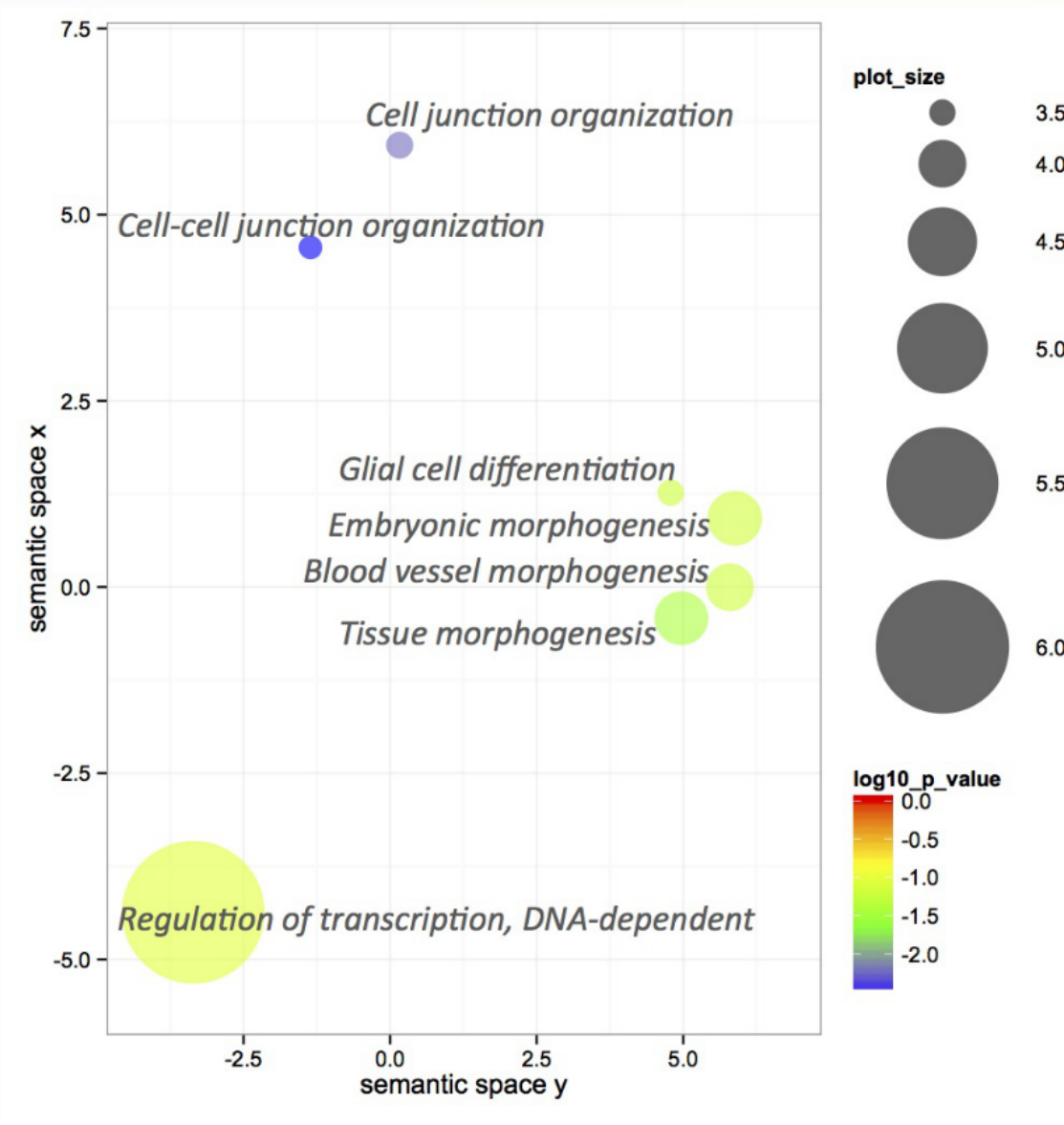
400 μatm vs. 400 μatm + Mech. Stress



2800 μatm vs. 2800 μatm + Mech. Stress



Ocean acidification



semantic space x

1

0

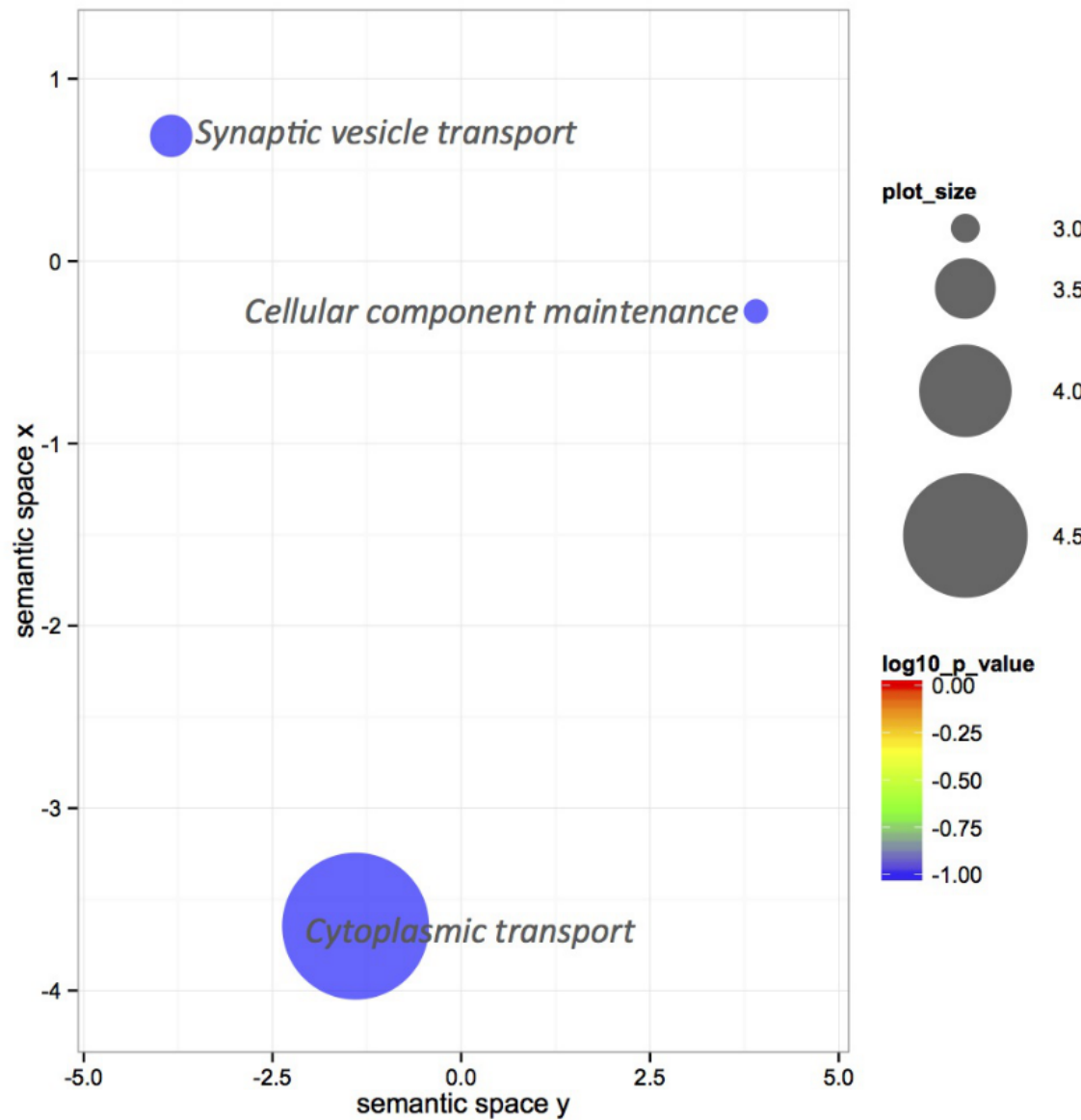
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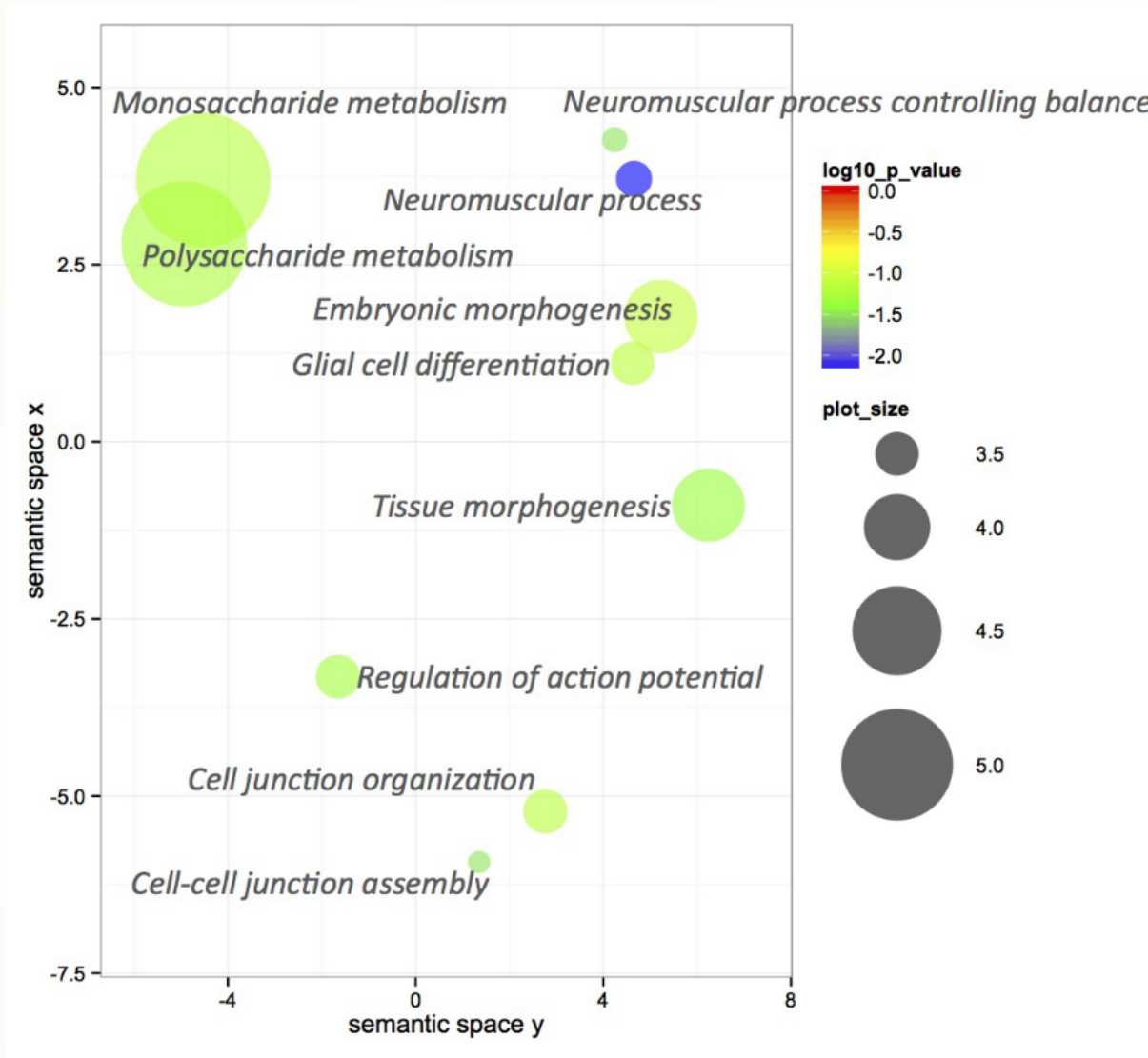
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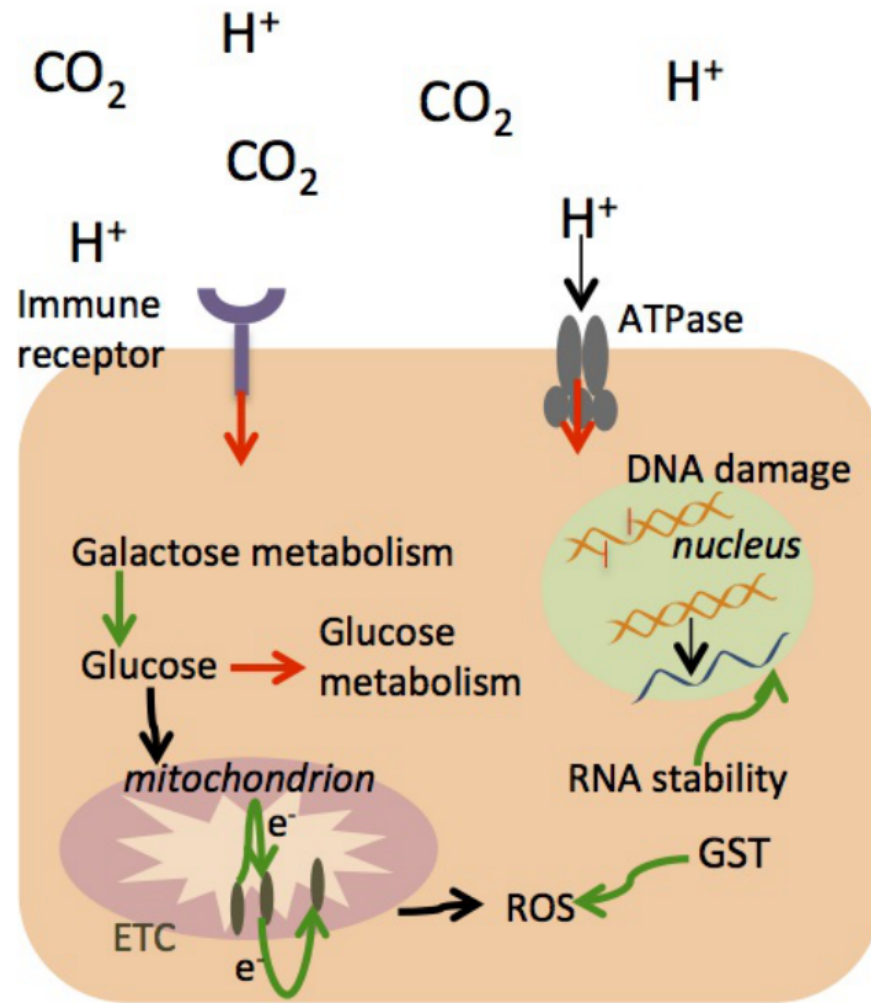
Mechanical stress



Ocean acidification + Mechanical stress



Effects of Ocean Acidification



Elevated pCO₂

Effects of Mechanical Stress

ation

H⁺

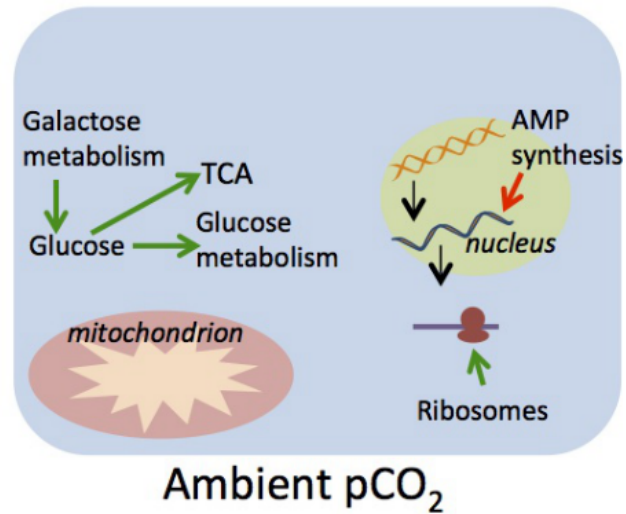
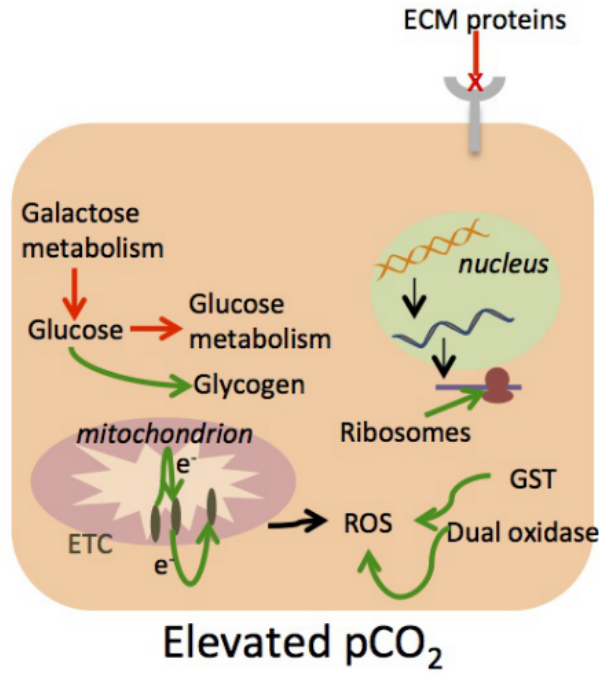
ATPase

DNA damage

nucleus

A stability

GST



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Acknowledgements

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