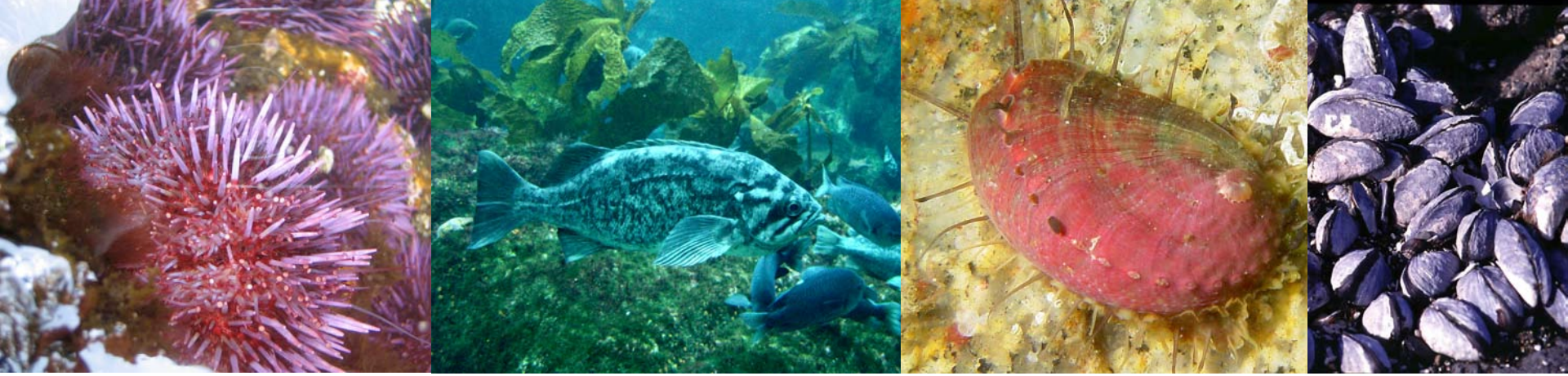


Our Energy Mix

What are the consequences for coastal marine ecosystems? An Organismal Perspective

Gretchen E. Hofmann
UC Santa Barbara

UCSB
UNIVERSITY OF CALIFORNIA
SANTA BARBARA

Global Change Biology

Newly settled juvenile oyster

- Single species responses – e.g., resilience, tolerance
- Vulnerabilities: How tolerances influence decision making – long-term & acute
- Multiple stresses – understanding the consequences – what happens when we layer on stress to a particular habitat?

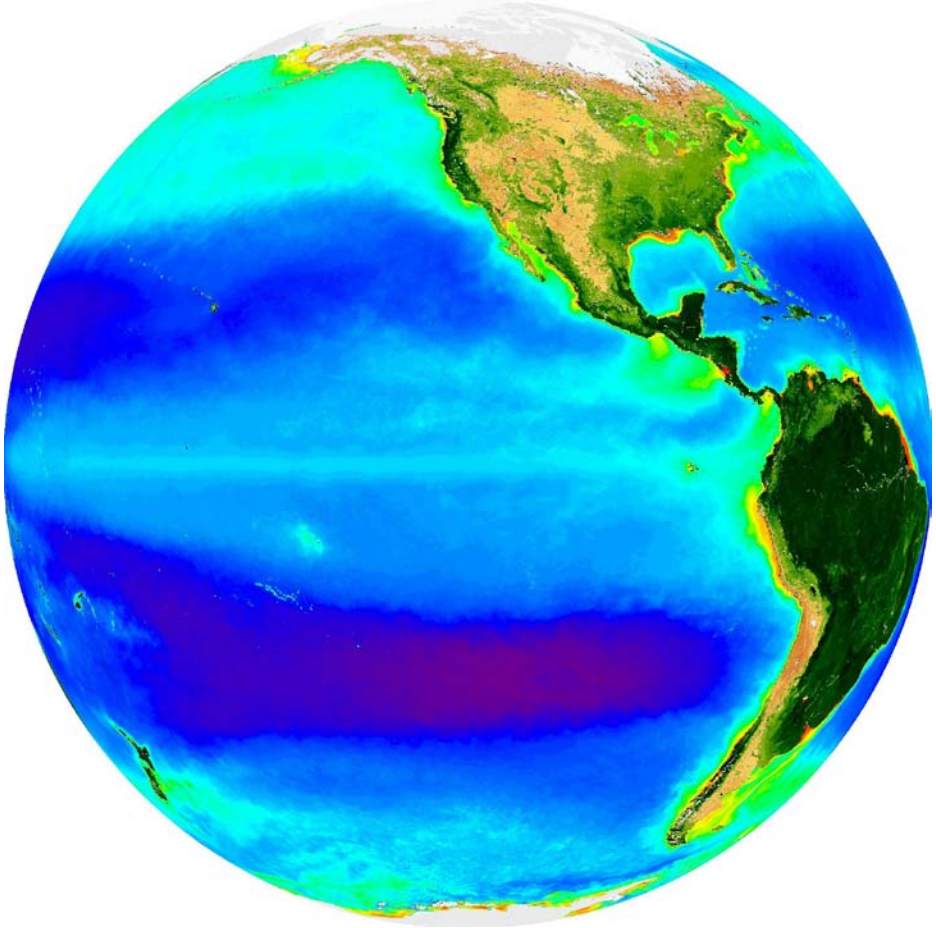
As Global Change Biologists, we think there are three options of response…

Migration

Tolerance

Adaptation

[Move, Acclimate, Adapt or Die]



SeaWiFS

Cold-adapted organisms in high-latitude seas

Migration may not be an option

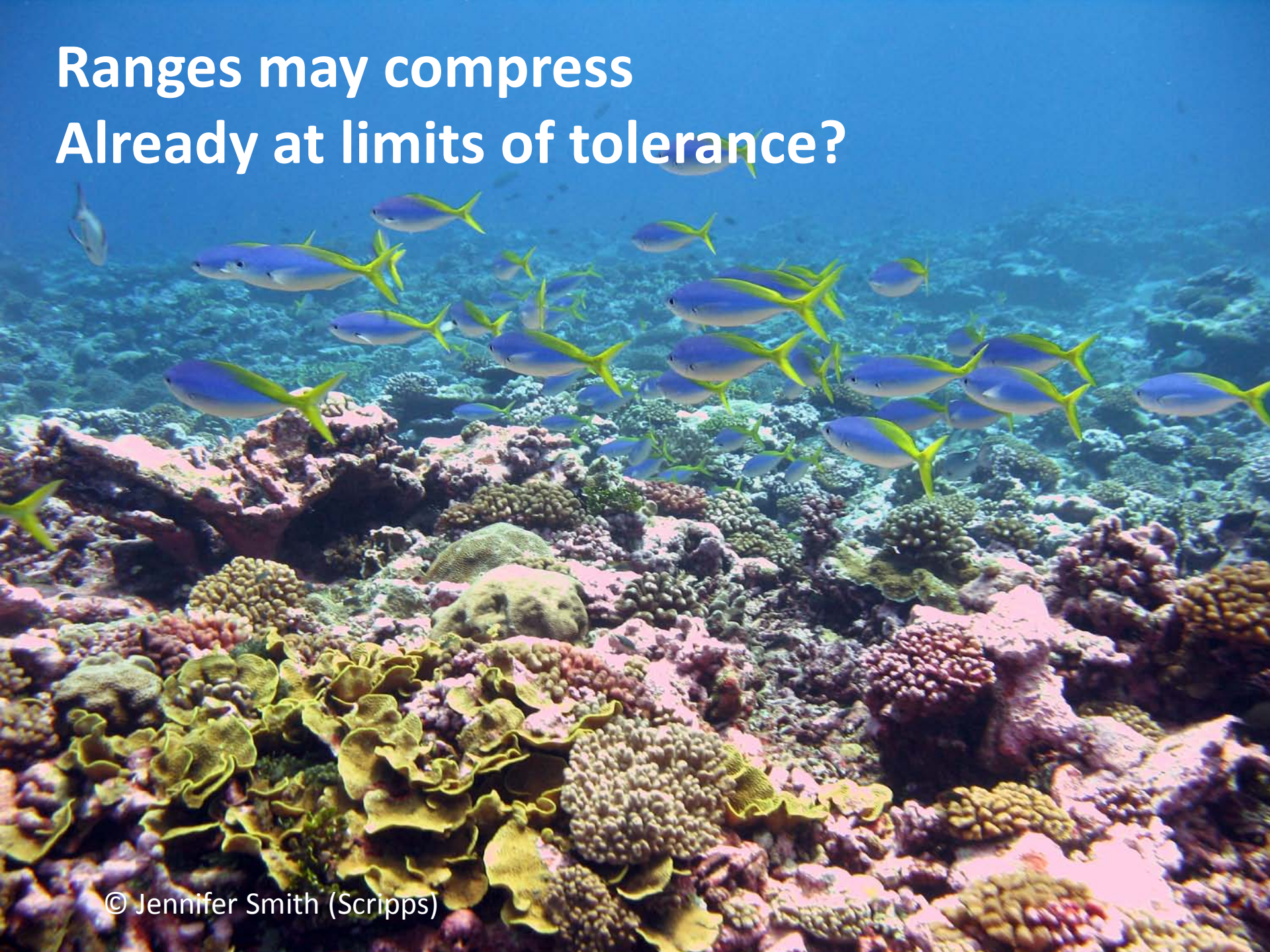
Limacina helicina

Key part of foodweb

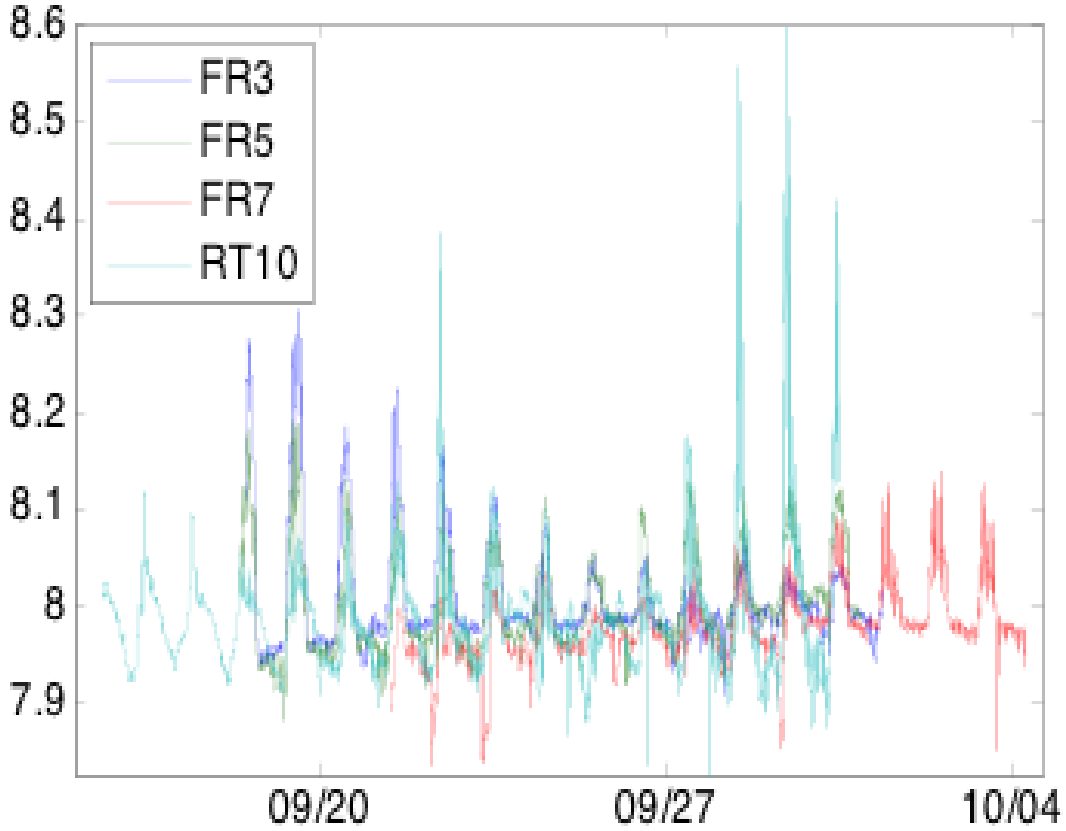
Pteropods from McMurdo Sound
Ross Sea, Antarctica

In contrast, for tropical corals…

Ranges may compress
Already at limits of tolerance?



Todd Martz et al., 2010. *L & O: Methods*.



But there is natural variability of pH

- Durafet loggers
- Continuous pH data collected simultaneously at several sites on the reef benthos in Palmyra

Data courtesy of Drs. Jennifer Smith & Todd Martz

Summary

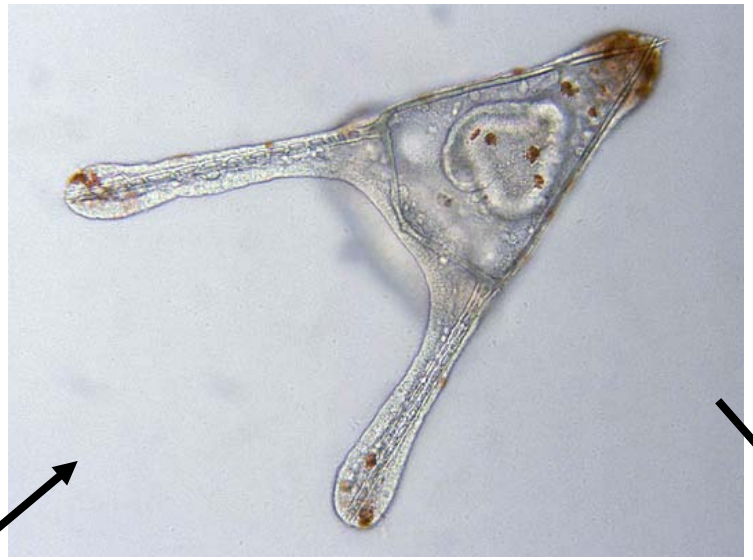
- **Generalizations for all species do not apply**
- **Especially for coastal waters, environmental conditions may not be the same as 'global averages'**

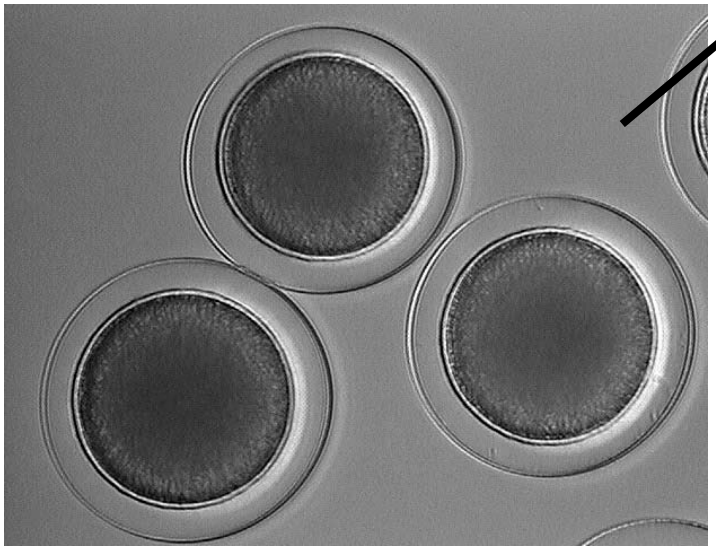
- **Assess vulnerability,** getting ready, avoiding "emergency room science" *Peggy Lubchenco*

- Example of research - Life history vulnerabilities & ocean acidification

How will contemporary urchins and oysters respond to future high CO_2 waters?

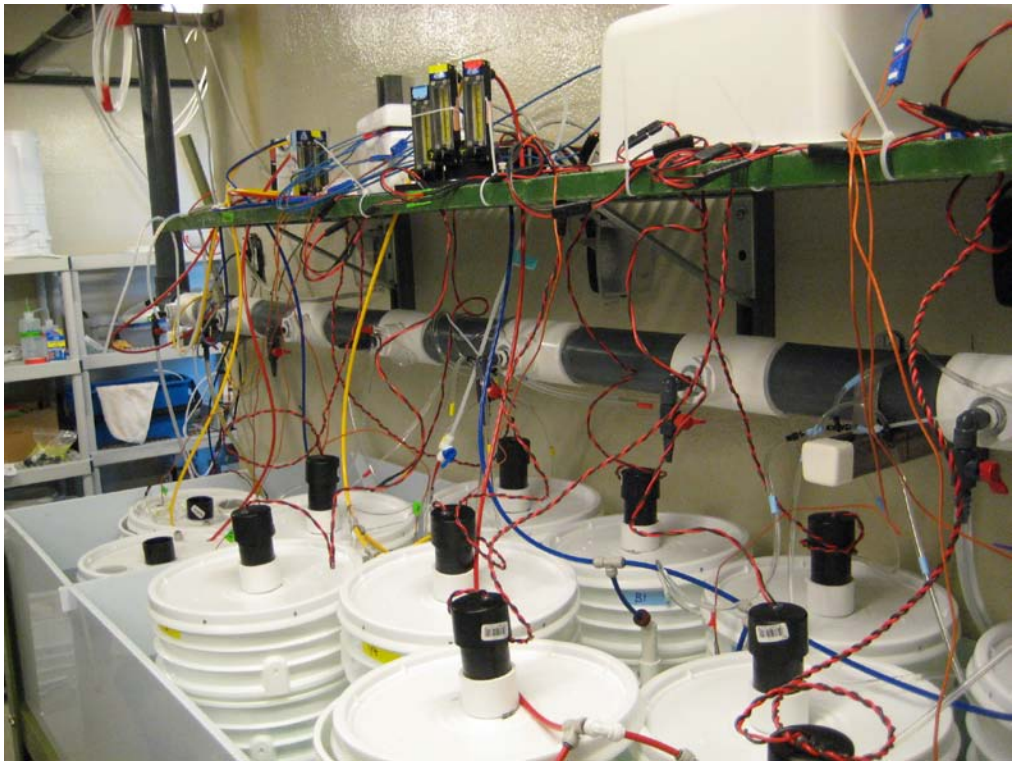
Life cycle of a purple sea urchin

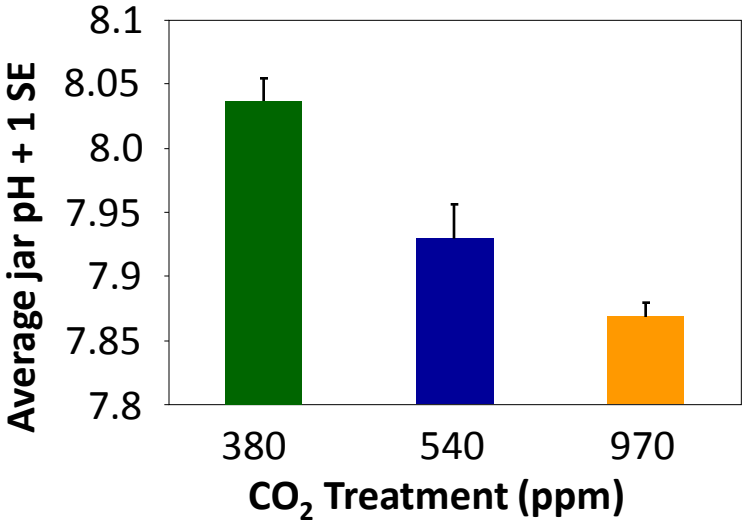




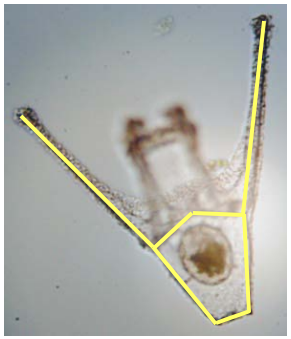
Larval cultures

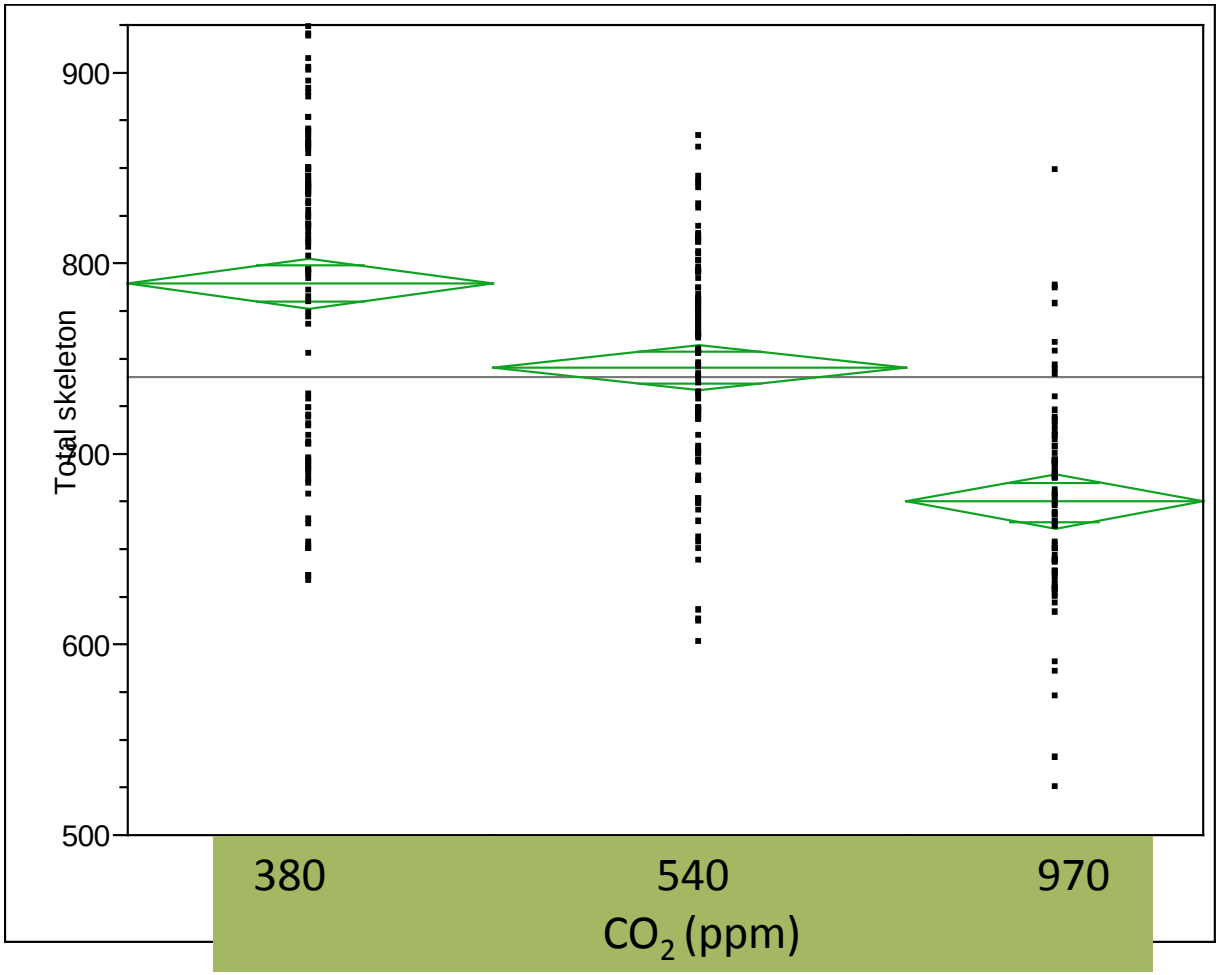
Raised at varying CO_2 levels





Total Skeleton after 48h of growth



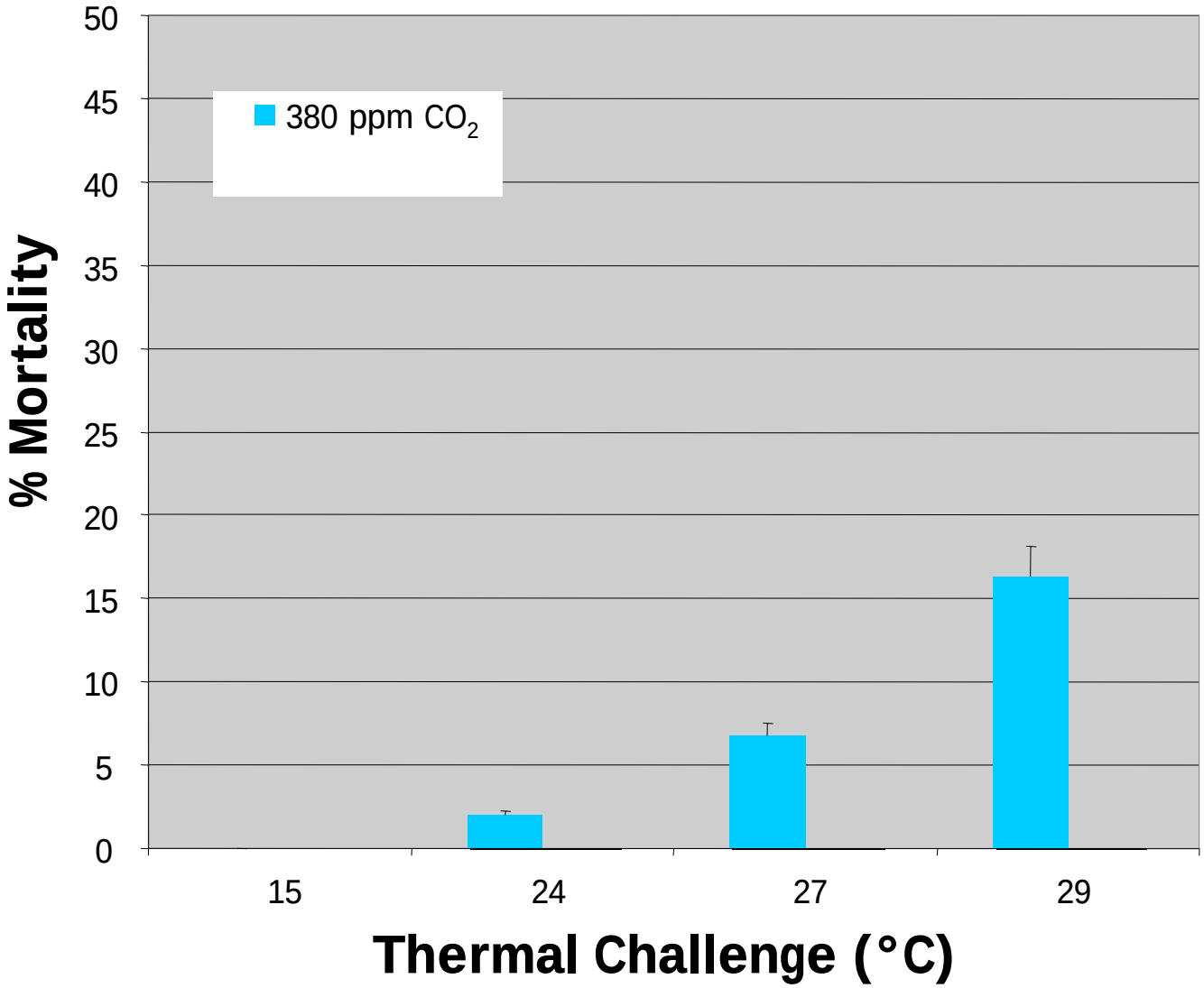


Although growing slower, perhaps more resilient

O'Donnell et al, (2010*) Mar. Ecol. Prog. Ser.*

Thermal Challenge(1h) of 4-Arm Purple Urchins

(Mortality assessed after 1h recovery)

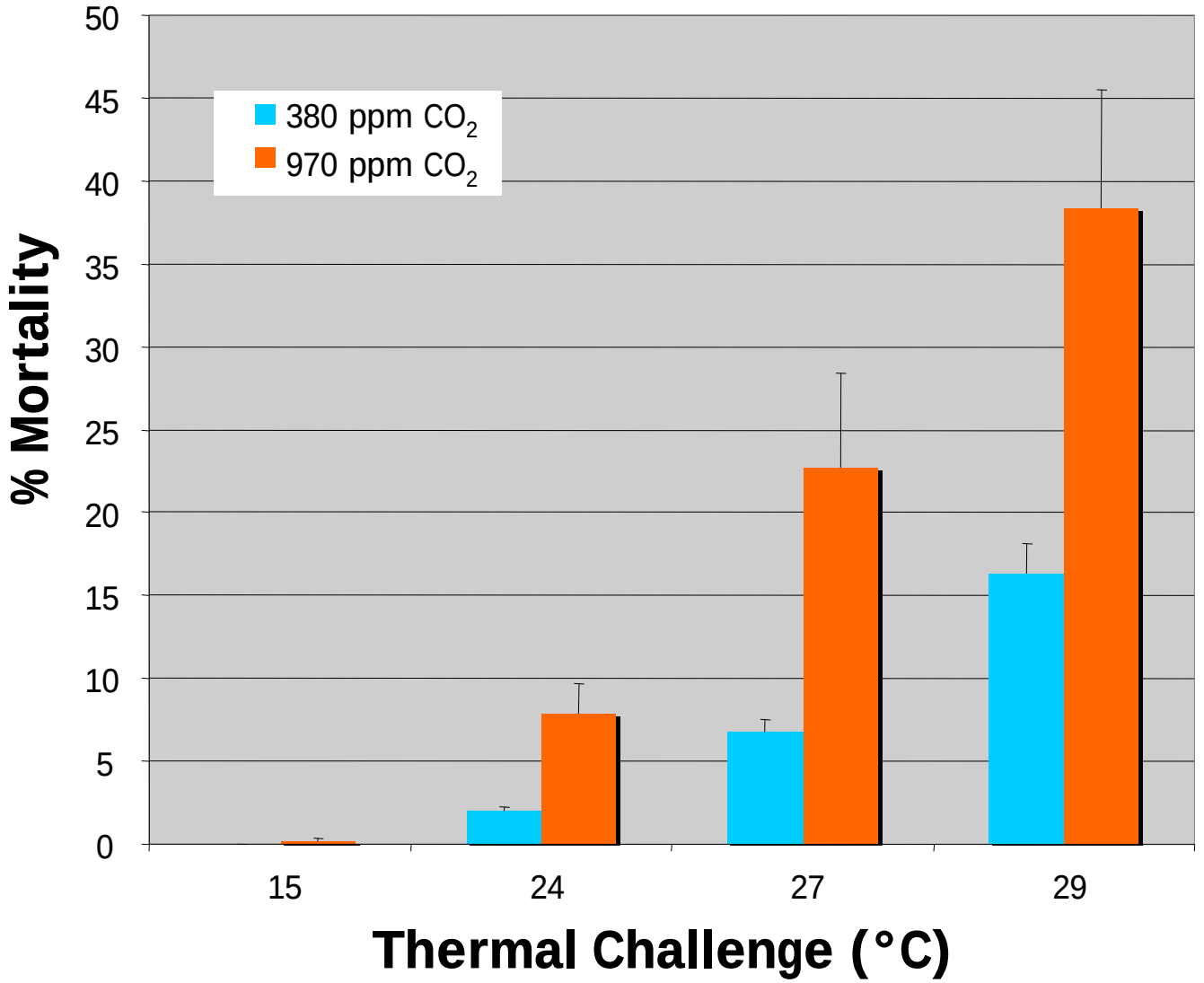


Fangue & Todgham, unpubl. results

Dr. Nann Fangue
NSF Postdoc Fellow
Asst. Prof. UC Davis

Thermal Challenge(1h) of 4-Arm Purple Urchins

(Mortality assessed after 1h recovery)



Fangue & Todgham, unpubl. results

Adult oysters collected in Tomales Bay, CA

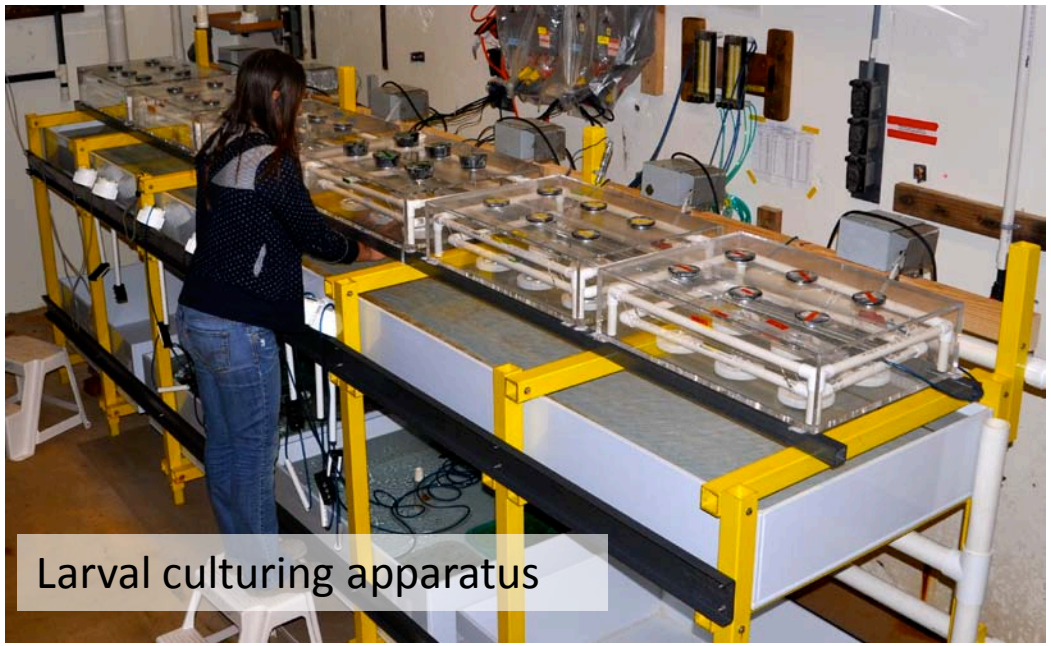
Mark Arnoff

Adults held until larvae released (48hr)

Mark Arnoff

Eric Sanford

Effects of elevated CO_2 on *Ostrea lurida* larvae and juveniles

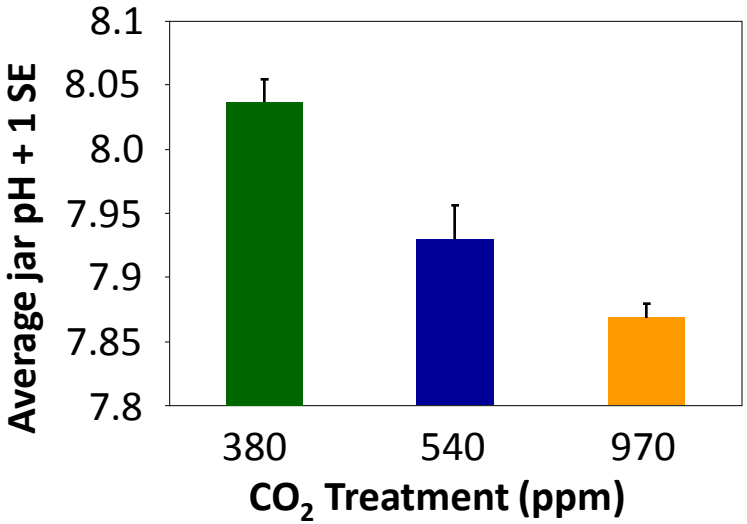

Larval culturing apparatus

pCO_2 levels

Control – 380 ppm

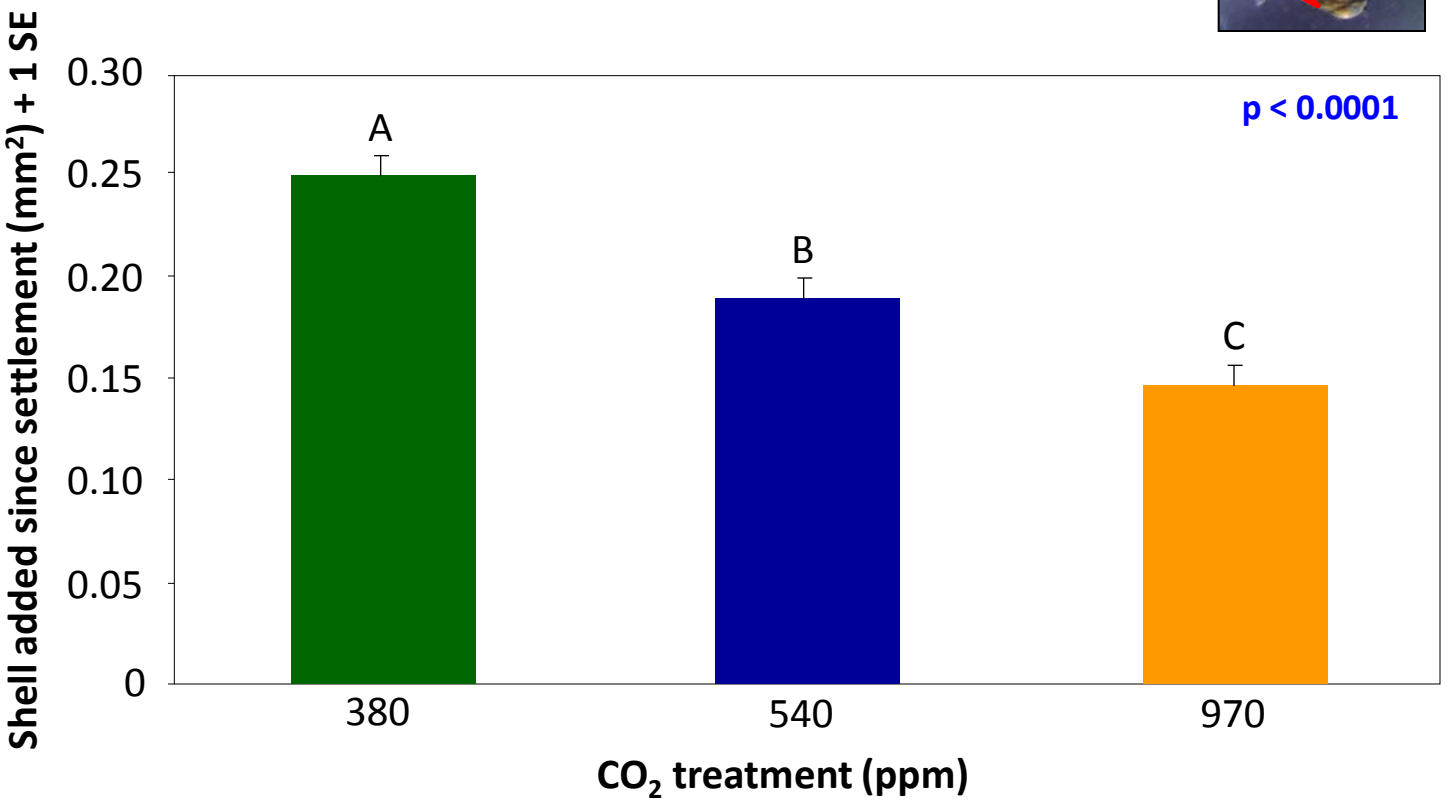
Elevated treatment 1 – 540 ppm

Elevated treatment 2 – 970 ppm



Effects of elevated CO_2 on *Ostrea lurida* juveniles

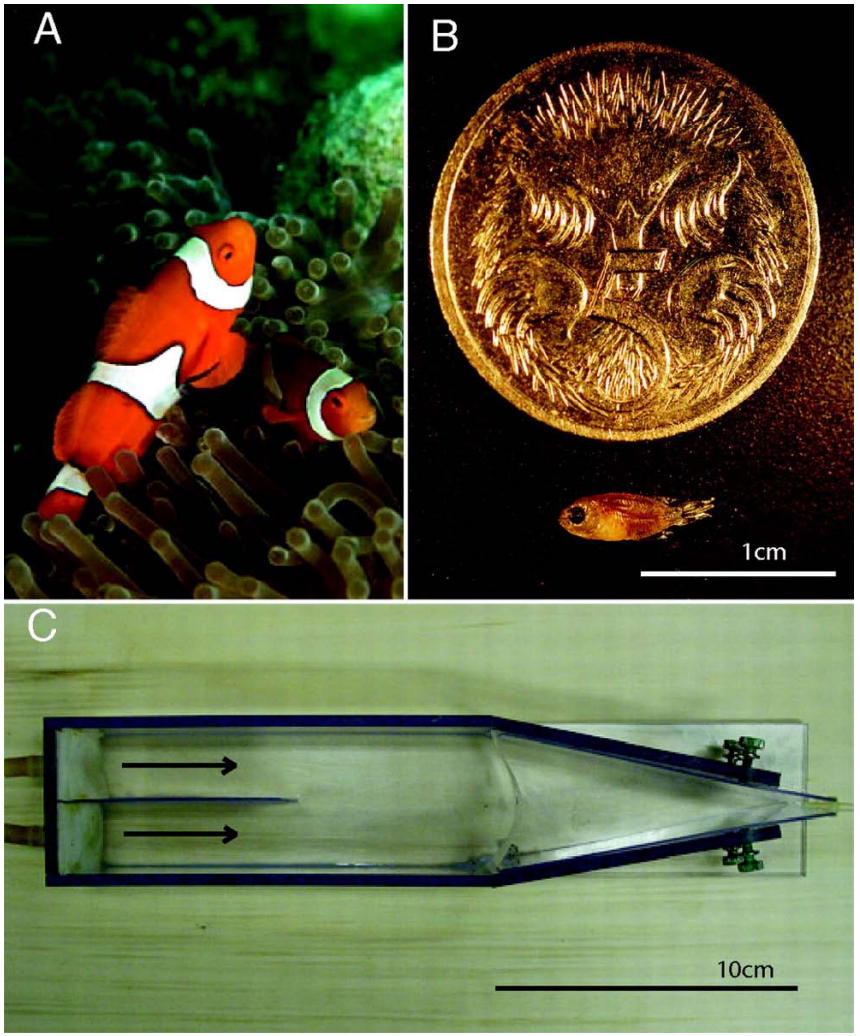
4-5 days later, juveniles had precipitated **42% less** shell area in 970 ppm relative to the control.



Data courtesy of Drs. Brian Gaylord, Eric Sanford, Tessa Hill

Not just physiology, but changes in behavior too

Orange Clownfish
A. percula



Changes in ability to detect homing cues under OA

Homing back to natal reef?

Munday P L et al. PNAS 2009;106:1848-1852

Summary

- **Tolerances** of contemporary organisms is relevant
  - If acclimatization or adaptation is possible, where and how?

- Ways to assess **vulnerability,** getting ready, avoiding "emergency room science" *Peggy Lubchenco*

Acknowledgments

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