Examining the Effects of Varying pH Conditions on the Early Development of the Painted Sea Urchin, *Lytechinus pictus*

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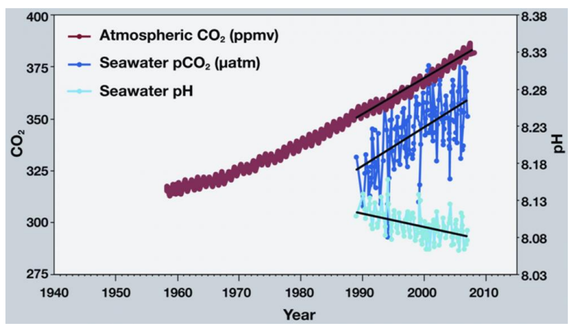
Global Climate Change Threatens the Survival of Marine Organisms



NOAA PMEL Carbon Program

- Climate change results in events such as ocean acidification and ocean temperature rise
- Increase in pCO_2 levels result in a decrease in seawater pH, resulting in more acidic conditions for marine organisms
- Calcifying organisms, like sea urchins, are particularly vulnerable to ocean acidification and heat stress events
- *Lytechinus pictus* is a great model organism
  - Ecologically relevant species
  - Good developmental model
  - Summer spawning

Picture of Lytechinus pictus
Photo from: diverkevin.com

Question: Does early exposure to varying pH alter the tolerance *of Lytechinus pictus* larvae to an acute heat stress event?

Result: Individuals That Develop in More Acidic Conditions Show Higher Tolerance to Thermal Stress

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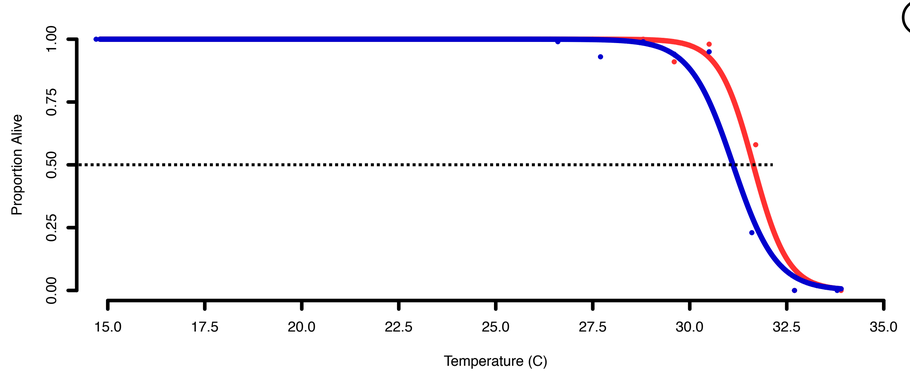
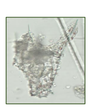


- Lethal Thermal Limit (LT50)
  - Larvae that developed under high pCO_2 conditions had an LT50 of 31.6℃
  - Larvae that developed under low pCO_2 conditions had an LT50 of 31.1℃

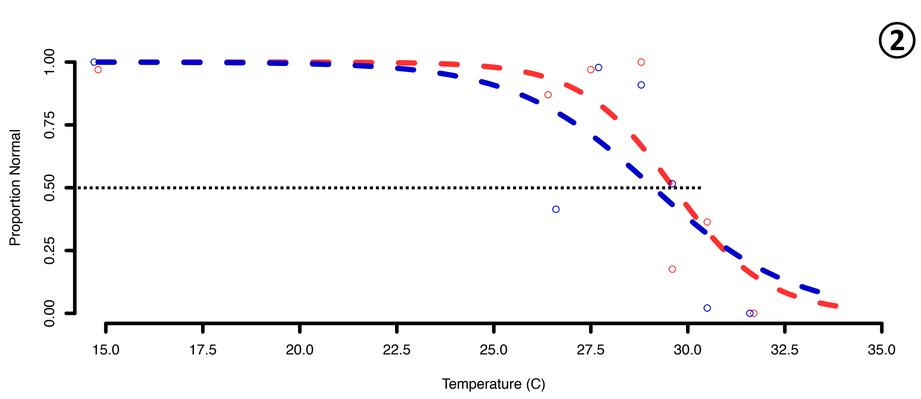
High pCO_2 Conditions
Low pCO_2 Conditions

②

Normal Larvae



Abnormal Larvae



- Abnormal Thermal Limit (AT50)
  - Larvae that developed under high pCO_2 conditions had an AT50 of 29.6℃
  - Larvae that developed under low pCO_2 conditions had an AT50 of 29.1℃

High pCO_2 Conditions
Low pCO_2 Conditions

Acknowledgments

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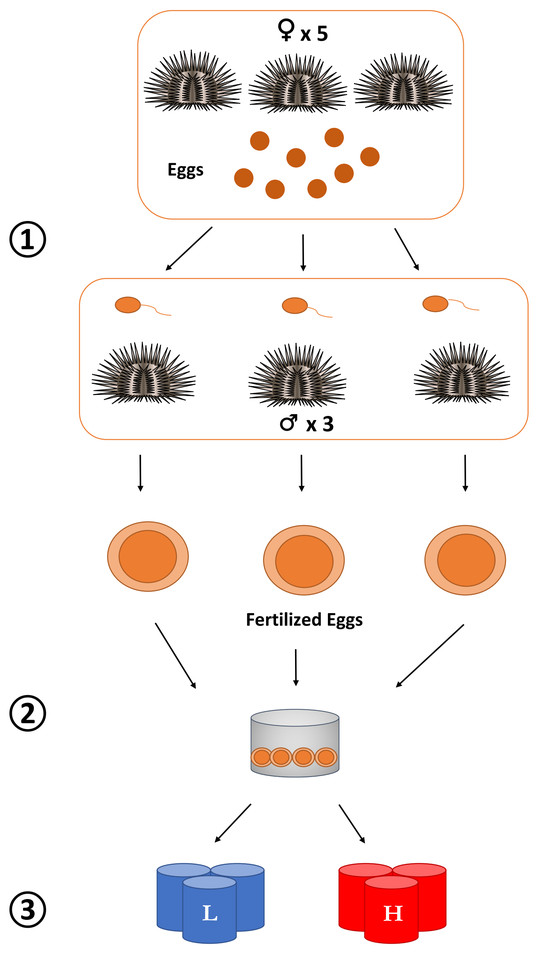
References

Padilla-Gamino et al. (2013) Proc R Soc B 280; O'Donnell et al. (2009) Mar Biol 156:439-446; O'Donnell et al. (2010) Mar Ecol Prog Ser 398:157-171; Hammond & Hofmann (2010) Mar Biol 157:2677-2687.

Methods



Santa Barbara Channel (UCSB Department of Anthropology)

① Crossed adult urchins

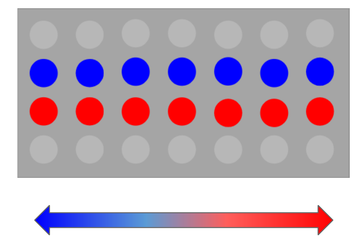
② Pooled them into one beaker

③ Embryos separated into triplicate buckets maintained at either High (H) or Low (L) pCO_2 conditions

- Sea urchins collected from Santa Cruz Island at a depth of 10-15m
- Measurements:
  - Thermal tolerance (LT50 and AT50)
  - Morphometrics (spicule length)
  - Developmental success

Low pCO_2 treatment (L) : 586.2 µatm, 15℃
High pCO_2 Treatment (H) : 1136.4 µatm, 15℃

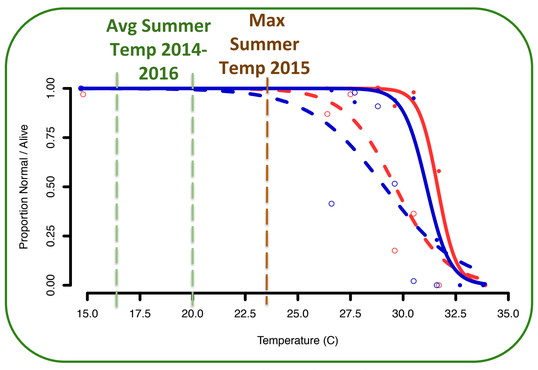
- Thermal heat block was used to induce heat shock stress event at urchin larval stage
  - Larvae for each pCO_2 treatment put into 8 vials and distributed across block
  - Exposed to heat stress for 1 hour



Temp Range: 26.5℃ - 33.9℃

Conclusions

- Thermal tolerance trials revealed urchins that had developed under high pCO_2 conditions had higher tolerance to a thermal stress event than those that developed under low pCO_2 conditions
- Potential cross tolerance exhibited in *Lytechinus pictus* larvae individuals
  - Exposure to one stressful event had better prepared *Lytechinus pictus* larvae for another stressful event
- *Lytechinus pictus* larvae are extremely resistant to high temperature stress



Temperature Data Collated by Cailan Sugano

- LTER data shows Santa Cruz average summer temperatures of 16-20℃ and max summer temperature of 23℃
  - Temperatures recorded fall within the range of where abnormal development can occur
- Future Directions
  - Measure and analyze morphometrics, gene expression, lipids, and proteins for further understanding of the impacts of environmental stressors on the physiological performance of *Lytechinus pictus*