Determining the Role of Epigenetics in the Variations of Thermal Tolerance and Plasticity Between Populations of *Tigriopus californicus*

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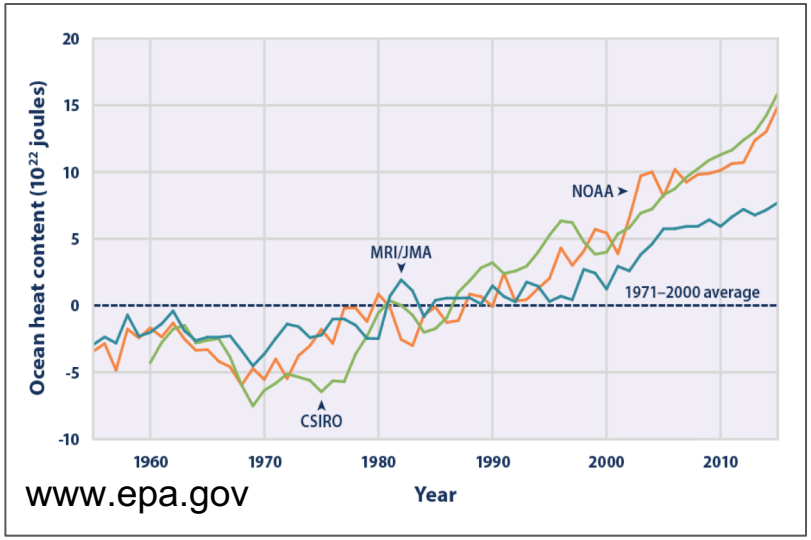
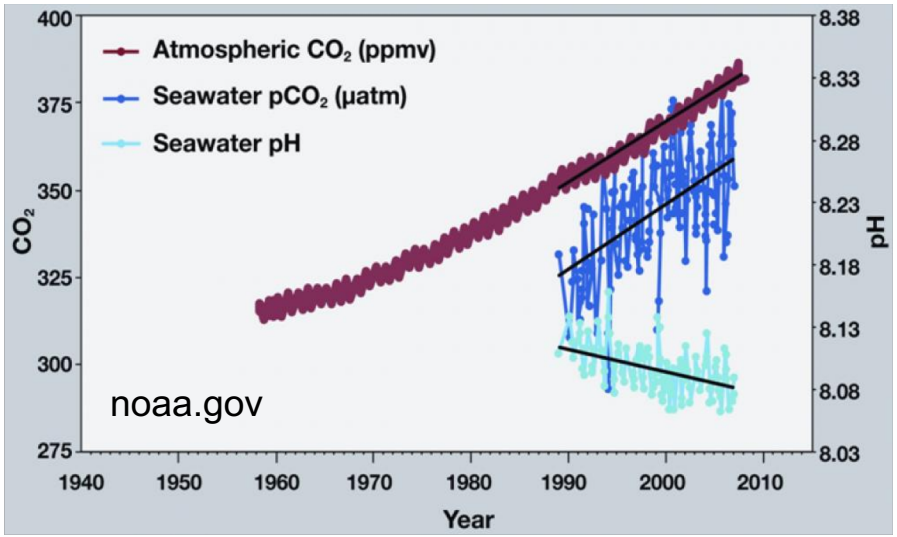
Changing Climate Creates Stressful Ocean Conditions

Ocean temperatures increasing over time



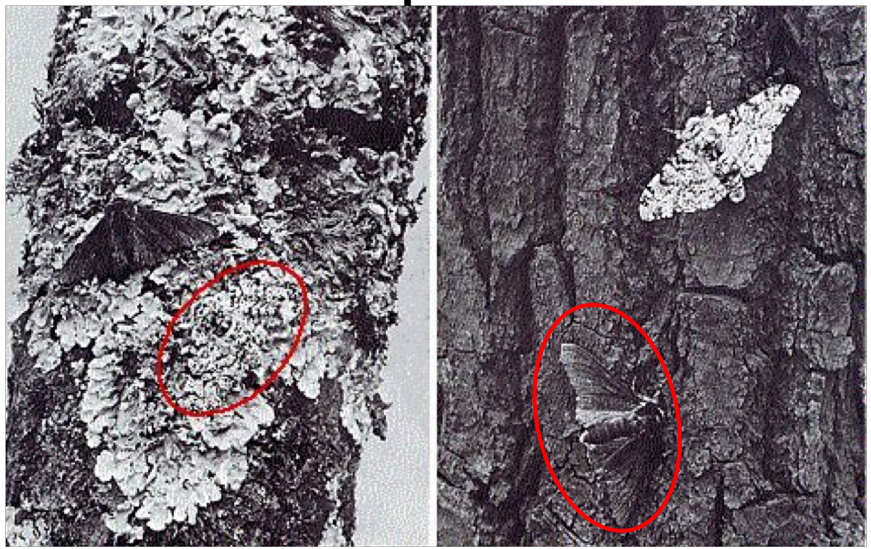
Ocean pH drops as CO_2 emissions rise



So how do marine organisms deal with this kind of stress?

How Organisms Respond to Environmental Change

Adaptation



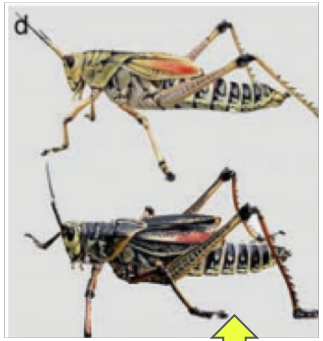
- A change in the genetics of a population due to environmental stress
- Can result in new species over long periods of time

Acclimation

- The ability to change physical traits without changing genetics
- How much a trait can change is a measure of plasticity

We Want to Understand How Plasticity Evolves

Research has found that plasticity, an organism's ability to alter a given trait, can evolve and change



Whitman and Agrawal 2009

Similar responses to being raised at lower temperatures

However, not all species display this kind of response

Sometimes populations of the same species won't either

Problem: We don't understand what causes the differences in plasticity between species and/or populations

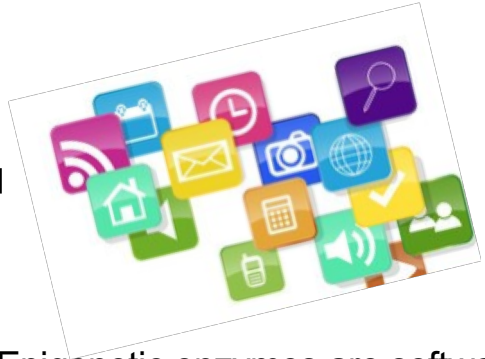
Epigenetics Could Play a Role in Adaptive Plasticity

Epigenetics is the regulation of genes and their products to express different traits

DNA is reshaped and modified by epigenetic enzymes in order to change the activity of a gene

This can result in multiple different variations of a trait being produced without changing genetics

DNA is the hardware

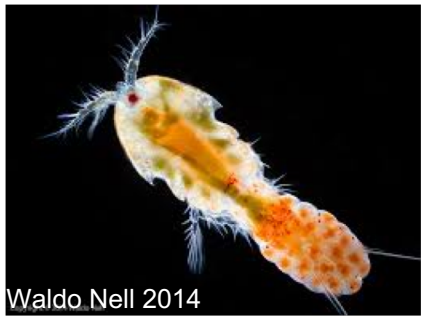


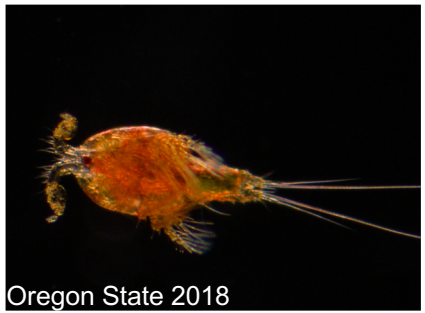
Epigenetic enzymes are software

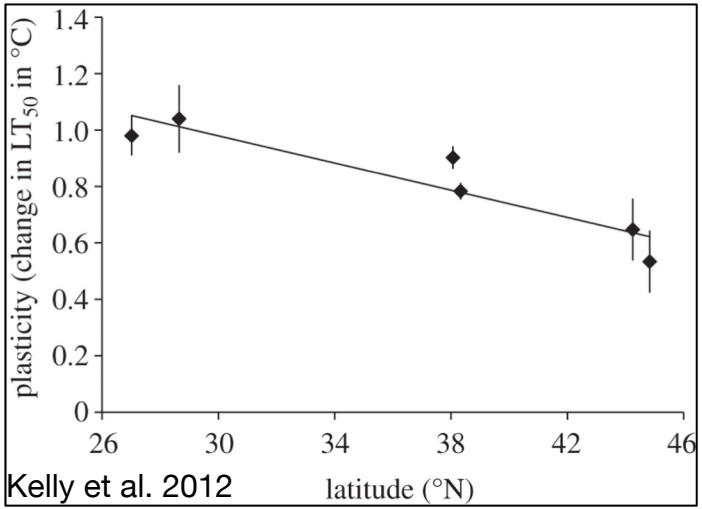
The hardware is used in multiple different ways without ever being changed

Some epigenetic modifications are so stable that they're passed on to later generations!

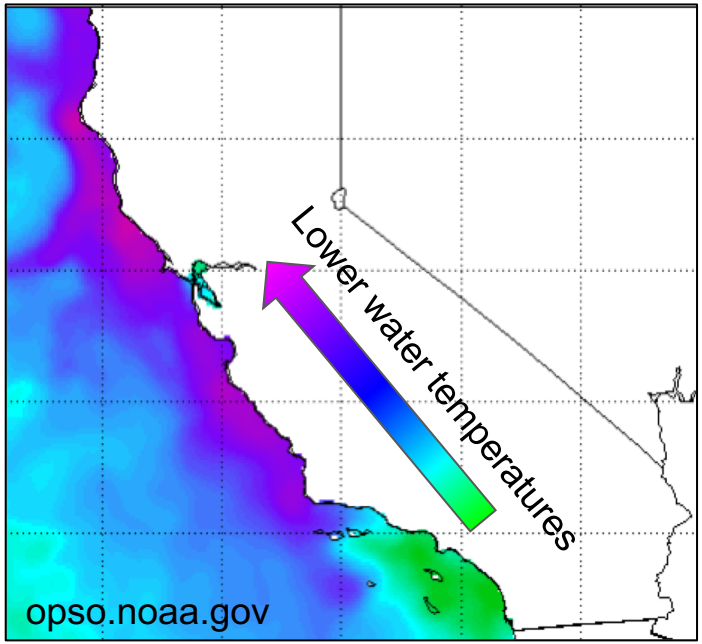
Tigriopus californicus as a model for studying adaptive plasticity







Their ability to withstand higher temperatures is related to latitude



The Plasticity of Thermal Tolerance has Evolved to Fit the Environment

Our Hypothesis:

Epigenetics plays a role in evolved differences of plasticity between populations of *T. californicus*

Establishing a Benchmark: Body Lengths

Collection

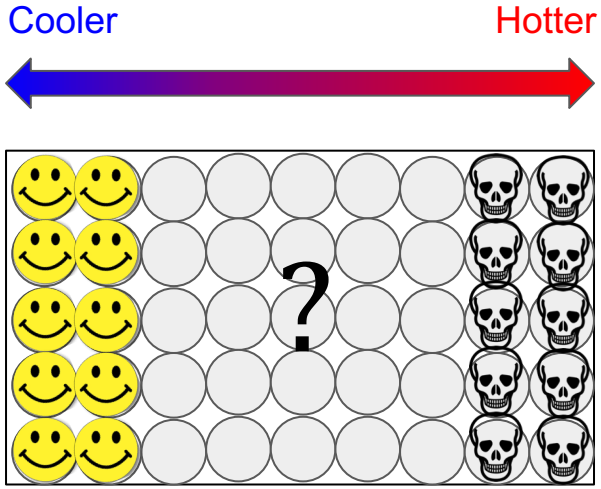
Our collection sites
across California

Measurements

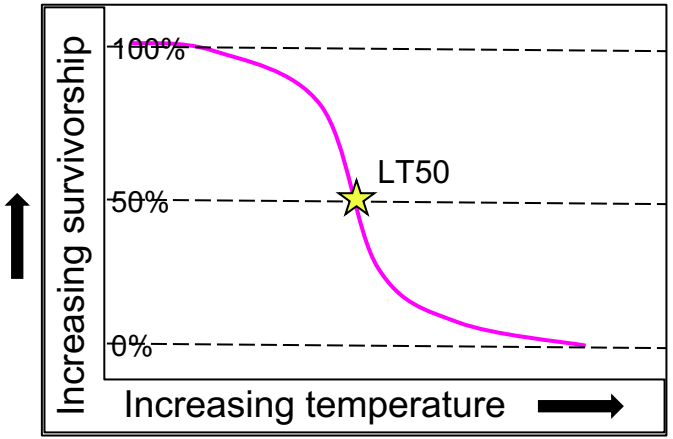
Measuring mean population lengths will help
us adjust later data with respect to size

Establishing a Benchmark: Thermal Tolerances

A vital step in comparing the plasticity of each population



Samples of *T. californicus* are loaded into a gradient heat block

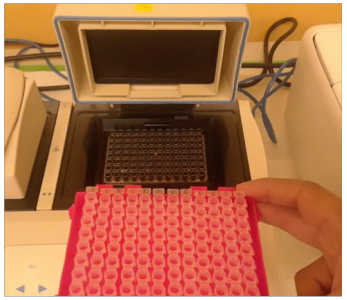


Survivors are counted and plotted against temperature to calculate Lethal Temperature 50 (LT50)

Determining the Effects of Acute Heat Stress on LT50 and Epigenetic Enzyme Activity

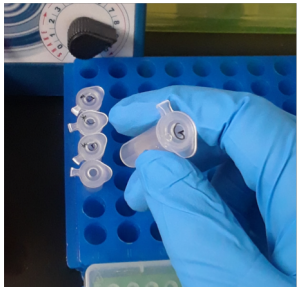
Heat Stressing

Three temperature treatment baths at 22°C, 25°C, and 28°C



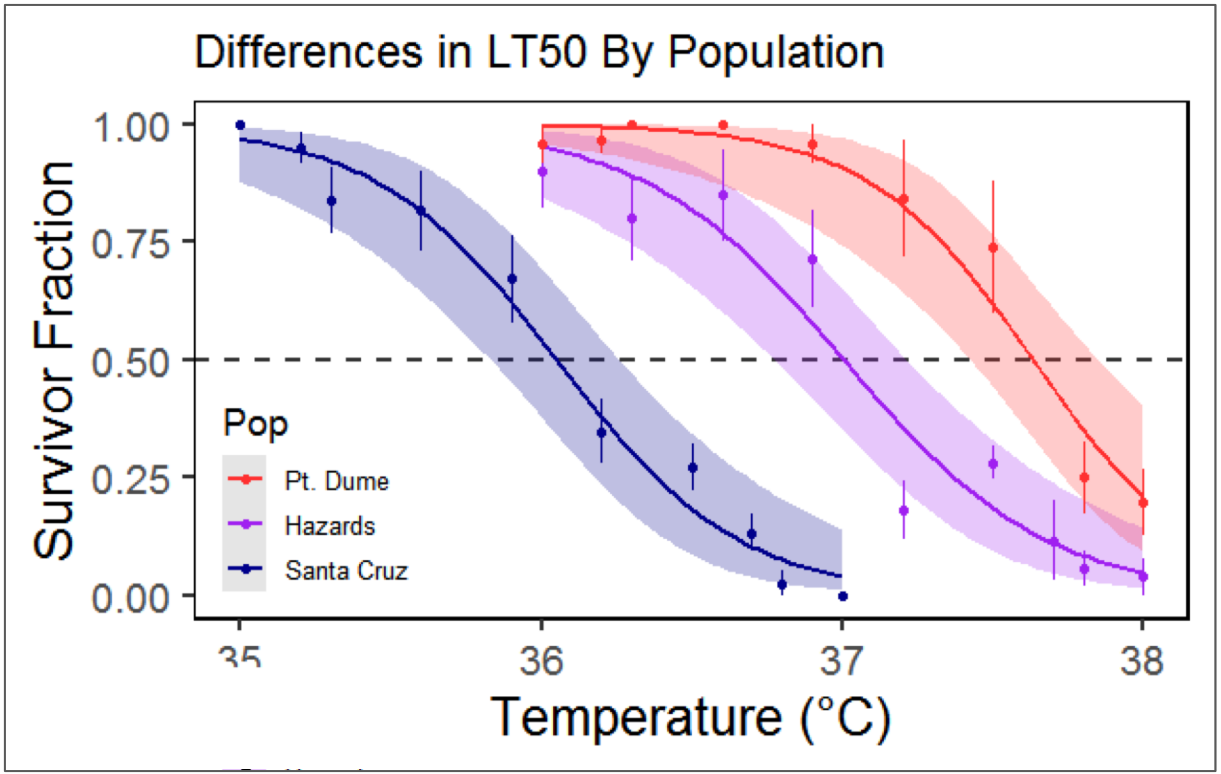
Measure Thermal Tolerance
Does LT50 change with stress?

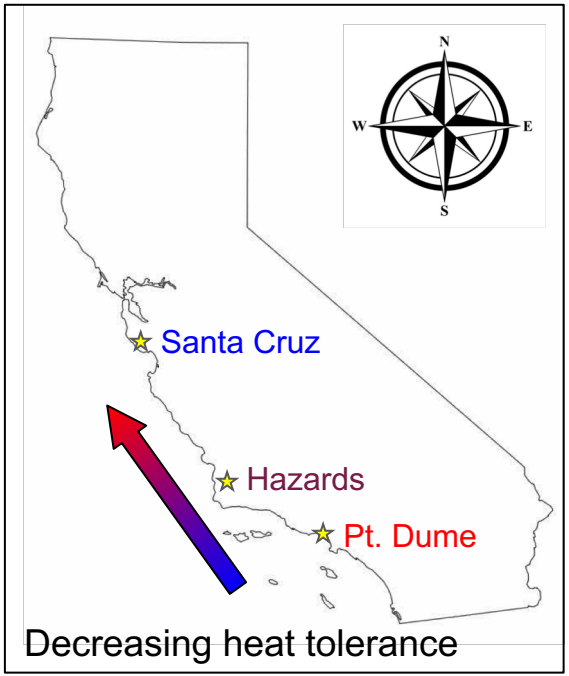
Measure Respiration Rates
Important in measuring enzyme activity and stress levels



Cryopreservation of Samples
For future protein extraction and quantification

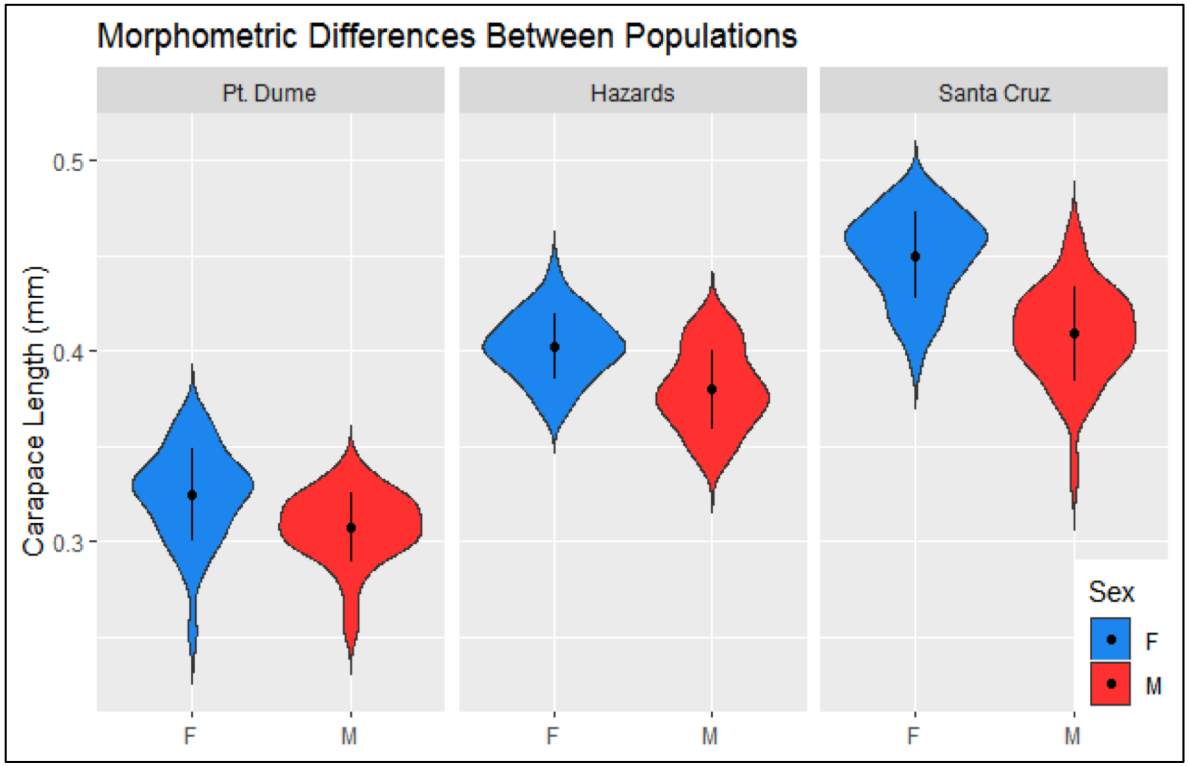
Thermal Tolerance is Inversely Related to Latitude

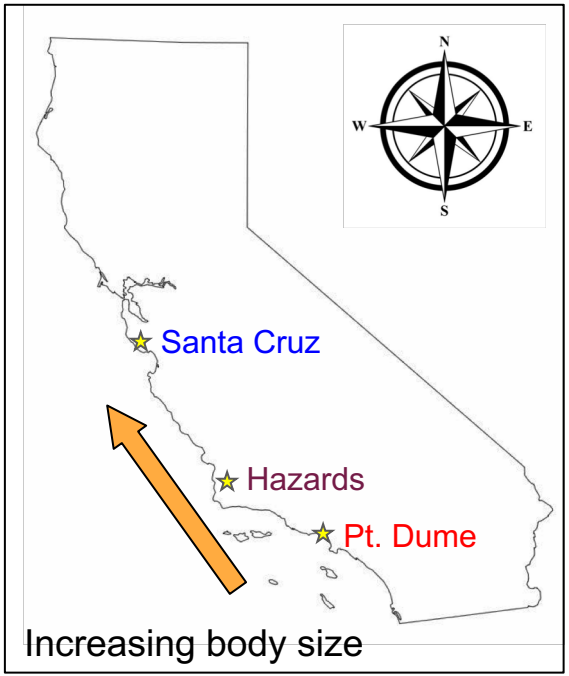




Confidence intervals show us the temperature range we can find LT50

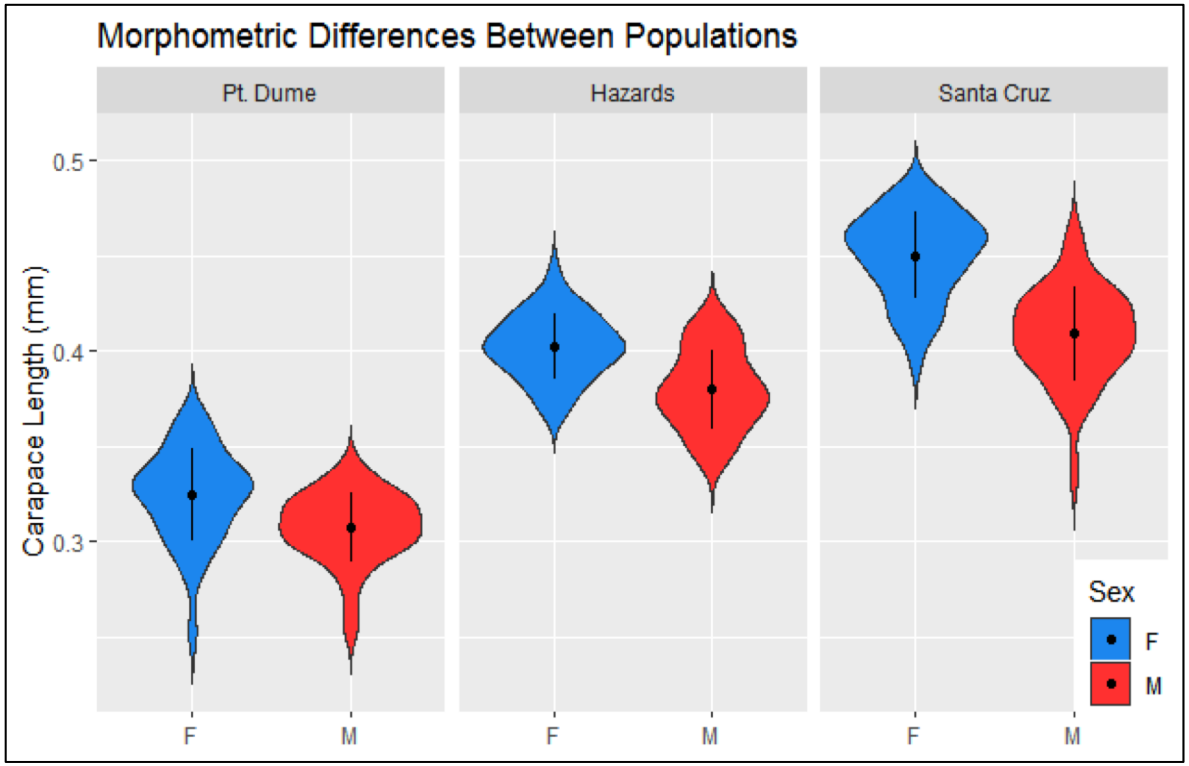
Body Length of *T. Californicus* Varies by Latitude





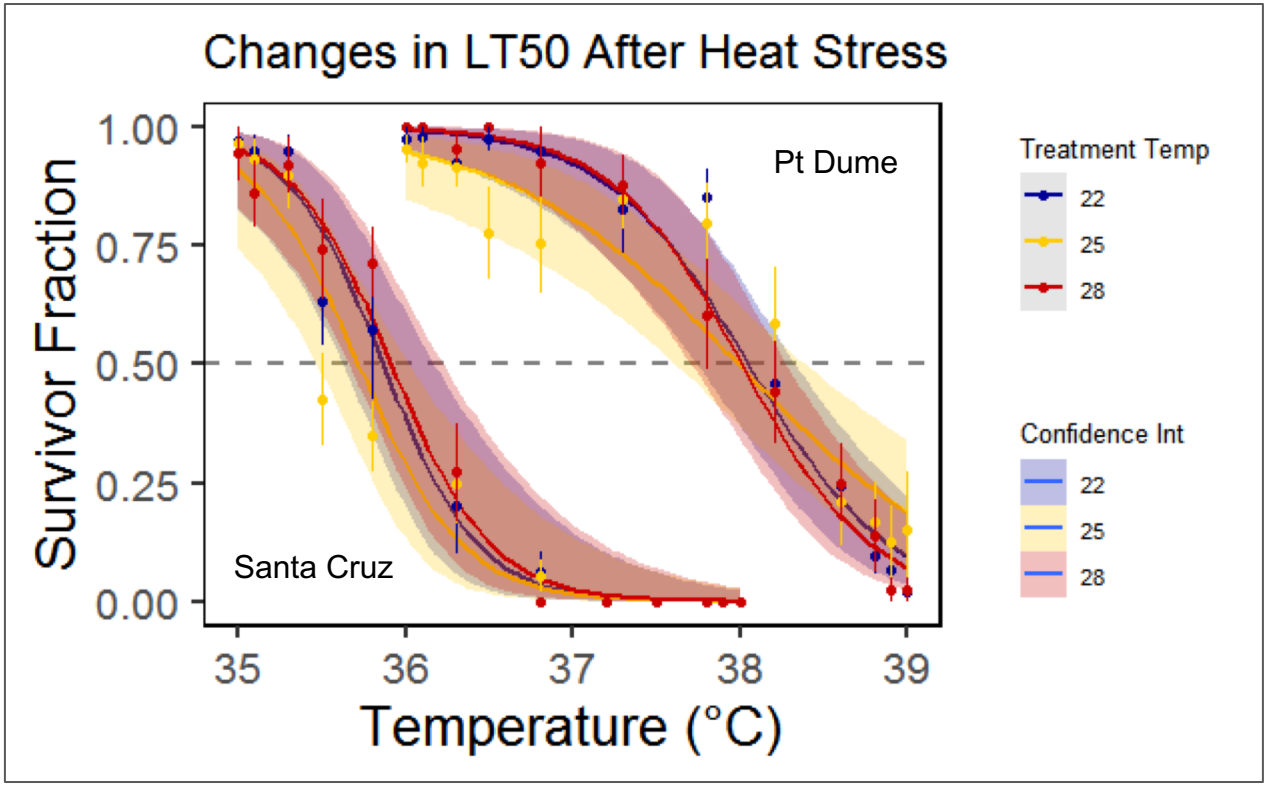
Smaller sizes: possibly for thermoregulation?

Body Length of *T. Californicus* Varies by Sex



The difference in size between sexes increases with latitude!

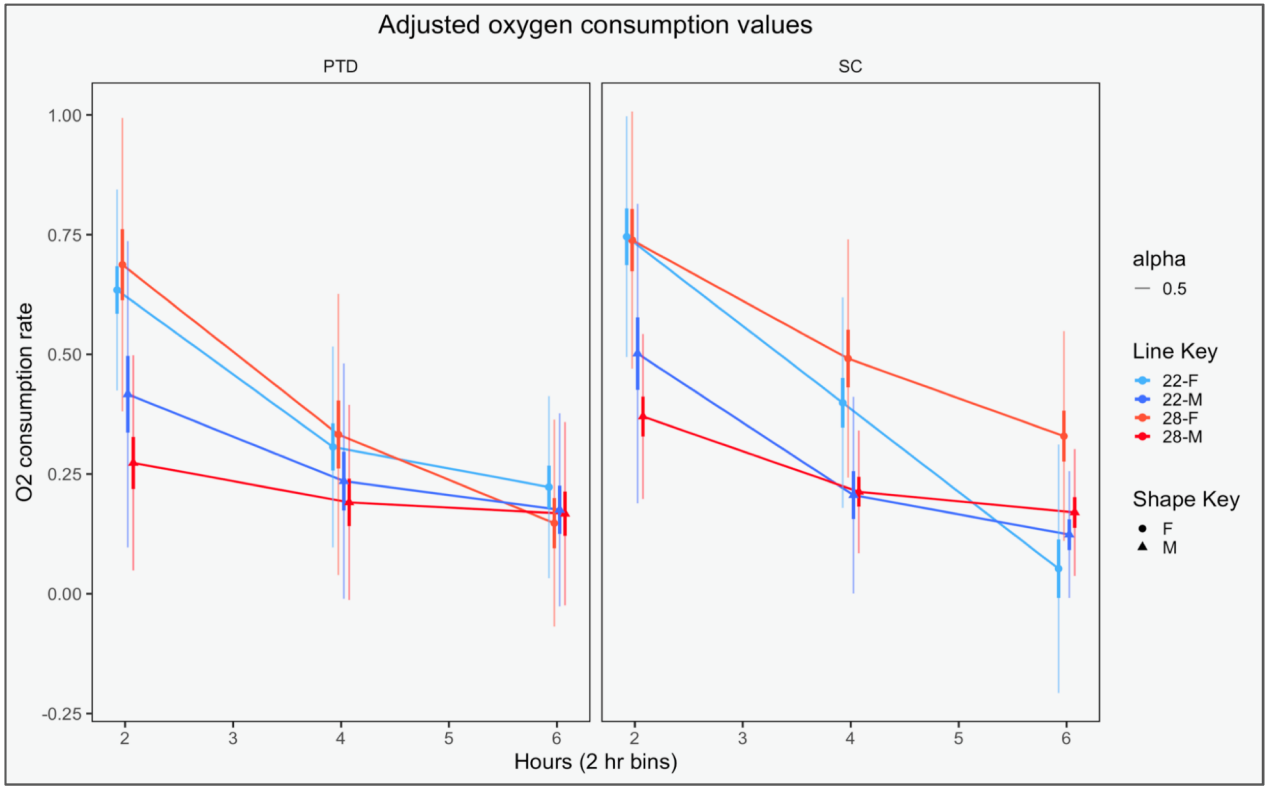
Acute Heat Stress Had No Effect on Thermal Tolerance



How can we tell if LT50 have changed?

Since the intervals overlap, LT50 remains the same in every treatment group!

Respiration Rates Were Higher in Less Plastic Populations



Santa Cruz population had higher initial respiration rates compared to Pt. Dume

Pt. Dume respiration rates converged near the end, while Santa Cruz did not

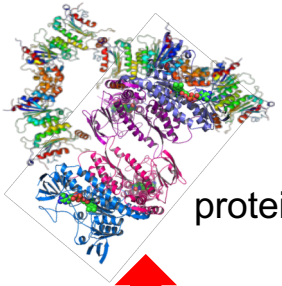
In both populations,, females had much higher initial respiration rates

Conclusions:

- Body size is affected by latitude, possibly as an adaptation for regulating temperature
- Body size is also affected by sex, implying there are sex-specific pressures that could affect plasticity and thermal tolerance
- Our samples from both populations were apparently unaffected by acute heat stress; LT50 did not change, which was unexpected
- Respiration rate varied with respect to sex and population, although sex had a much greater effect than latitude

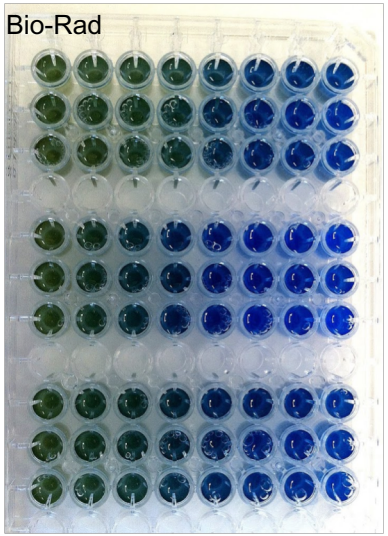
Future Plans: Measuring Differences in Epigenetic Enzyme Activity After Heat Stress

Extraction



proteins

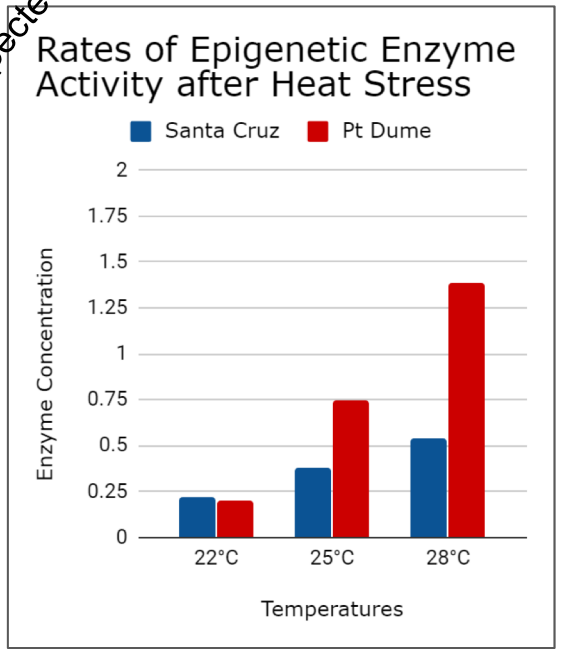
Quantification



higher enzyme concentration

Pop. Comparison

*expected



Lessons Learned

- Run repeatable thermal tolerance tests
- Perform protein extraction and quantification
- Accurately interpret physiological data
- Become confident in the R statistical environment
- Understand that plans change and things will go wrong at some point
- Understand the importance of open communication

Thank You!

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Logan Kozal

Asher Albrecht

NOAA NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION U.S. DEPARTMENT OF COMMERCE

CSEP

GORMAN RESEARCH SCHOLARS

NSF