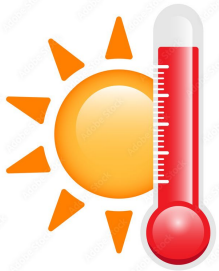
# The Ecophysiological Effects of Water Temperature and Ibuprofen on *Hemigrapsus oregonensis*

**Jolee Thirtyacre, Jason Ray, Alexias Thao**

# Introduction

Topic:

- Combined effects of increased water temperature and ibuprofen and the effect it has on *H. oregonensis* physiology

Importance:

- Presence of pharmaceuticals have been in aquatic systems for decades, only recently has there been a push to closely examine the concentrations (Fernandes et al. 2021)
- *H. oregonensis* face multiple stressors in their natural environment
  - Low tide → increased temperatures
  - Runoff → contaminated water + accumulation of pharmaceuticals in water and sediment

# Background/Relevance

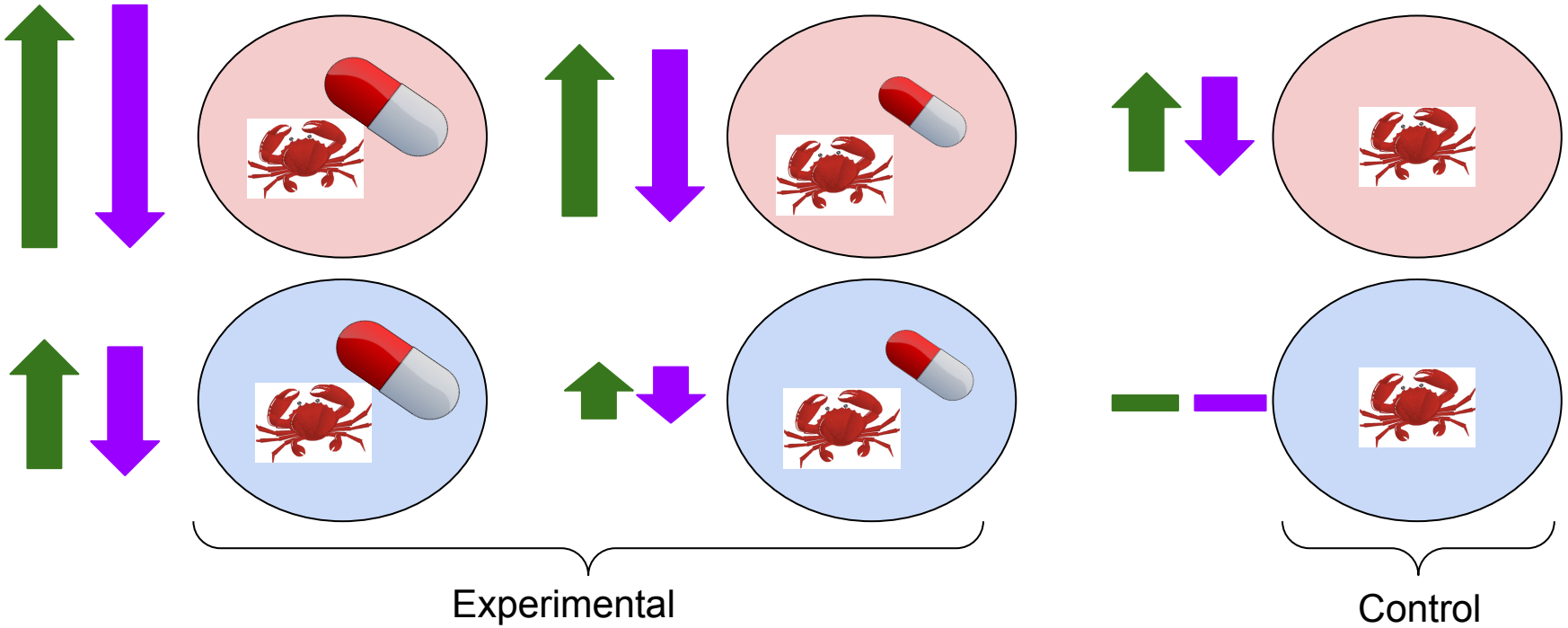
- Temperature
  - Global increases in temperature
  - Near-shore species are strongly impacted
- Ibuprofen
  - Consumed at high rates (180 tons per year - Germany)
  - After wastewater treatment, residual ibuprofen is still prevalent
- Combined Effects
  - Temperature is known to impact toxicity of chemicals
  - Other NSAIDs designated at “harmful” have “toxic” statuses with increased temperatures
  - Lack of research on the combined effects - most research is temperature OR ibuprofen

# Research Questions

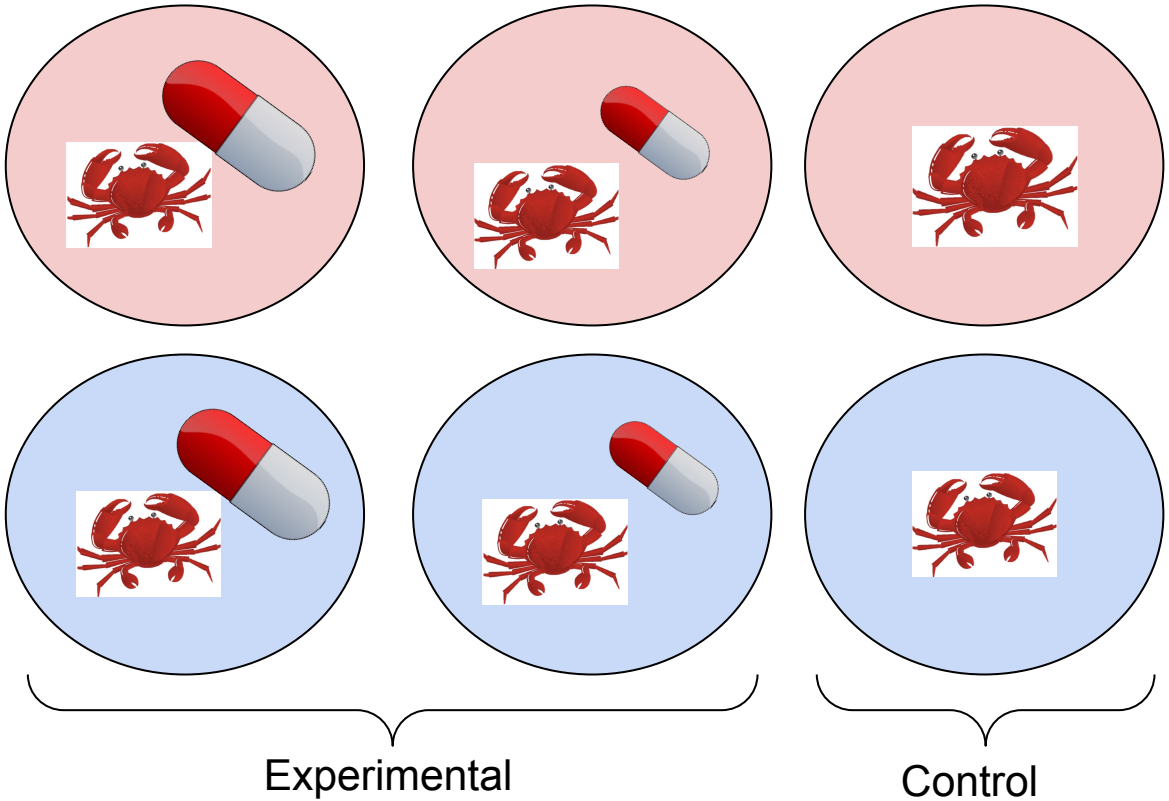
1. How will increasing concentrations of ibuprofen affect **glucose** and **respiration** rates in *H. oregonensis*?
2. How will an increase in temperature affect **glucose** and **respiration** rates in *H. oregonensis*?
3. How will the combined effects of ibuprofen concentrations and increased temperature affect **glucose** and **respiration** rates in *H. oregonensis*?

Glucose
Respiration

# Hypotheses



# Experimental Design




High Temperature (27 ºC)

Ambient Temperature (13 ºC)

Ibuprofen -
low dose (6.25 µg/L)

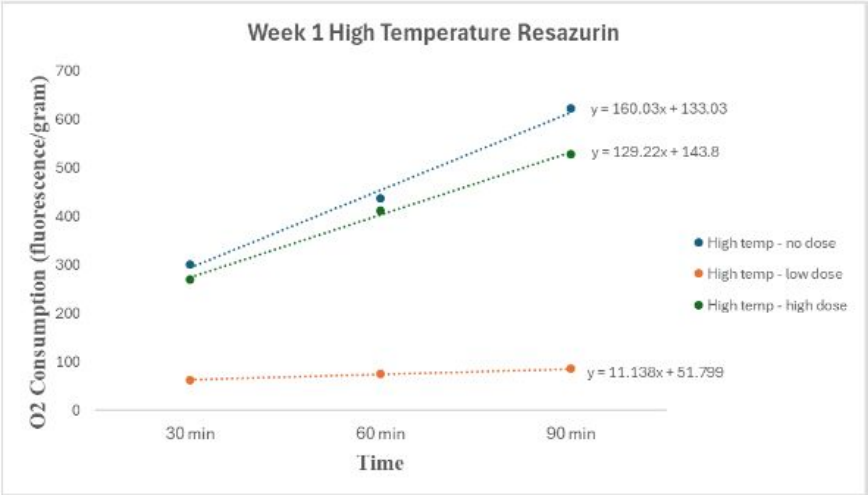
Ibuprofen -
high dose (31.25 µg/L)

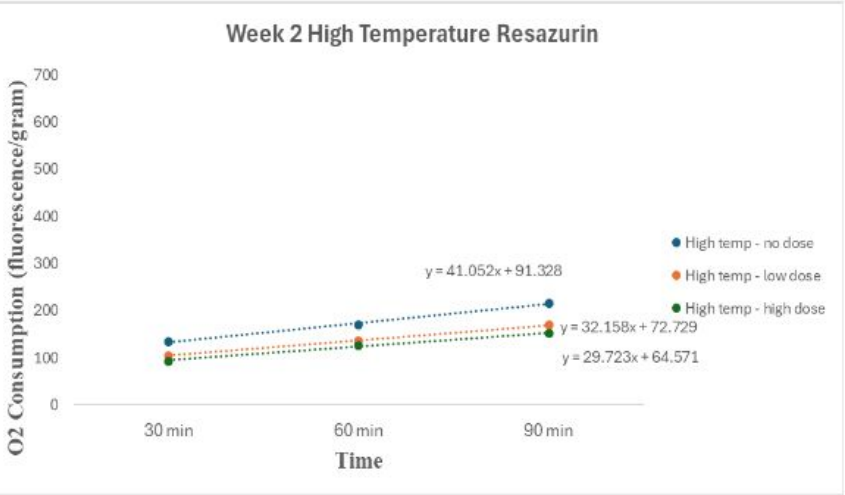
3 replicates
6 crab in each drug treatment

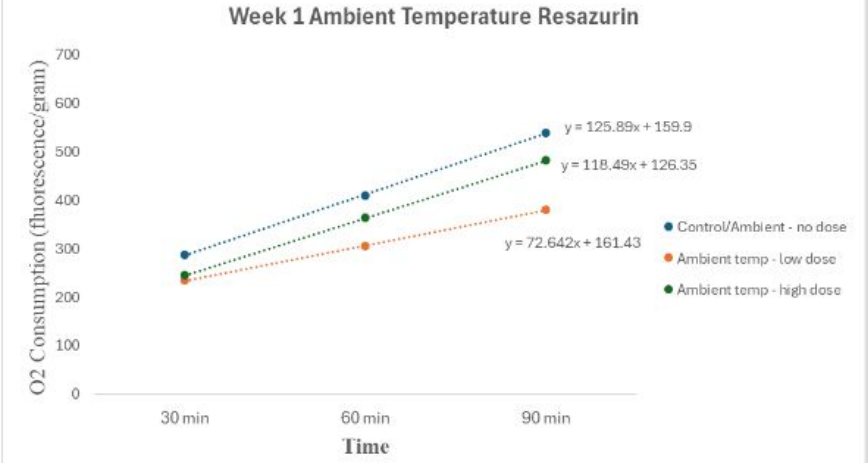
# Methods

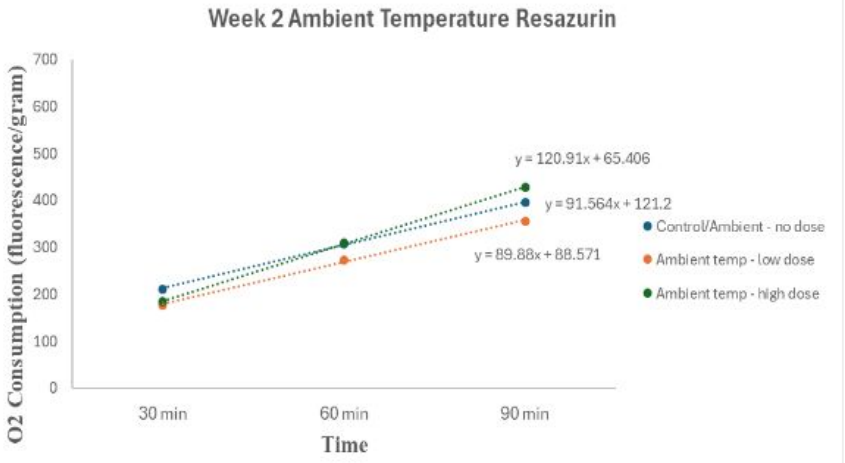
- Oxygen consumption → resazurin each week
  - 30 min
  - 60 min
  - 90 min
  - Used 1 crab from each treatment as representative
  - Graphed for visualization of results across weeks
- Glucose levels → hemolymph extraction on the last day
  - Average of all crabs from each treatment
- Tank cleaning each week
  - Re-dosed tanks after cleaning

# Results - Resazurin

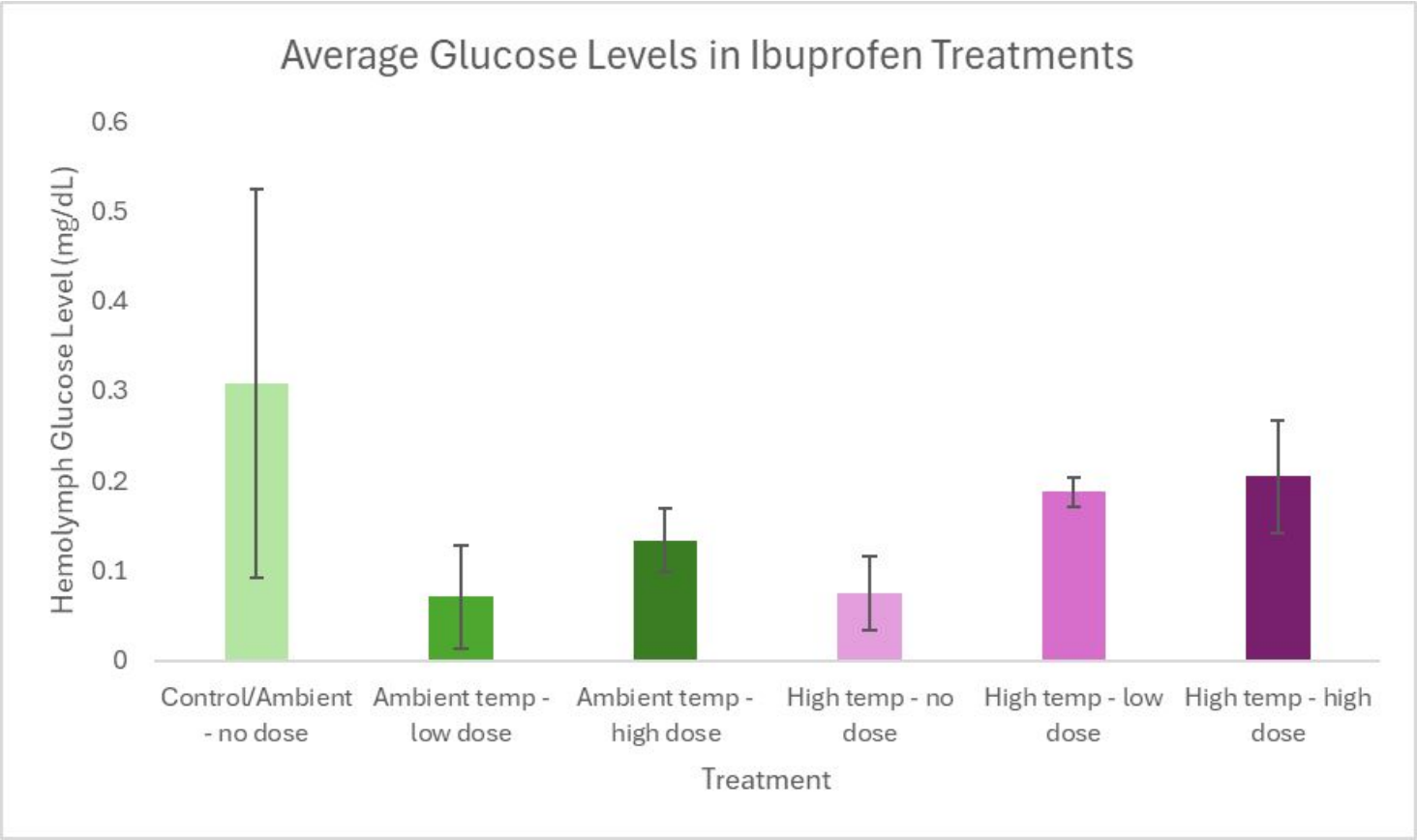


# Results - Hemolymph Glucose



# Interpretations/Conclusions

- NSAIDS combined with thermal stress reduce oxygen consumption due to fatigue and energy depletion.

- Exposure to NSAIDS depletes glucose levels especially at ambient temperature OR glucose production is lower in ambient temperatures

- One week heat exposure elevates O2 consumption but two week heat exposure suppresses O2 consumption.

# Limitations

- Small amount of replicates could explain high variance
- Singular Hemolymph assay at the end of week two doesn’t give us a reference point for interpretation of results
- Sexes of crabs weren’t considered which could explain mixed results due to how females mobilize glucose during stress

# Future Work

Next steps:

- Long-term drug studies (chronic response - Fent et al. 2006)
- Drug mixture studies (how combined drugs change physiology - Nieto et al. 2016)
- Tissue response to drugs (gill, cell damage - Aguirre-Martinez et al. 2013)

Unanswered questions:

- Does the type of ibuprofen used impact crab response (e.g., liquid form)?
- Is there a threshold where ibuprofen appears to be beneficial?
- How might these crabs have responded over a longer period of exposure?

Potential applications:

- Shore crabs such as *H. oregonensis* are early signals for how marine organisms can be affected by both increased temperature and ibuprofen

# References


Articles:

- Aguirre-Martínez, G. V., Del Valls, T. A., & Martín-Díaz, M. L. (2013b). Identification of biomarkers responsive to chronic exposure to pharmaceuticals in target tissues of Carcinus maenas. *Marine Environmental Research*, *87–88*, 1–11. https://doi.org/10.1016/j.marenvres.2013.02.011
- Chang, E. S., Keller, R., & Chang, S. A. (1998). Quantification of crustacean hyperglycemic hormone by Elisa in hemolymph of the lobster,homarus americanus,following various stresses. *General and Comparative Endocrinology*, *111*(3), 359–366. https://doi.org/10.1006/gcen.1998.7120
- Fent, K., Weston, A., & Caminada, D. (2006). Ecotoxicology of human pharmaceuticals. *Aquatic Toxicology*, *76*(2), 122–159. https://doi.org/10.1016/j.aquatox.2005.09.009
- Fernandes, J. P., Almeida, C. M., Salgado, M. A., Carvalho, M. F., & Mucha, A. P. (2021). Pharmaceutical compounds in aquatic environments—occurrence, fate and bioremediation prospective. *Toxics*, *9*(10), 257.
- Nieto, E., Hampel, M., González-Ortegón, E., Drake, P., & Blasco, J. (2016). Influence of temperature on toxicity of single pharmaceuticals and mixtures, in the crustacean A. desmarestii. *Journal of Hazardous Materials*, *313*, 159–169. https://doi.org/10.1016/j.jhazmat.2016.03.061
- Rodrigues, A. P., Santos, L. H. M. L. M., Ramalhosa, M. J., Delerue-Matos, C., & Guimarães, L. (2015). Sertraline accumulation and effects in the estuarine decapod carcinus maenas: Importance of the history of exposure to chemical stress. *Journal of Hazardous Materials*, *283*, 350–358. https://doi.org/10.1016/j.jhazmat.2014.08.035
- Trombini, C., Kazakova, J., Montilla-López, A., Fernández-Cisnal, R., Hampel, M., Fernández-Torres, R., Bello-López, M. Á., Abril, N., & Blasco, J. (2021). Assessment of pharmaceutical mixture (Ibuprofen, ciprofloxacin and flumequine) effects to the crayfish procambarus clarkii: A multilevel analysis (biochemical, transcriptional and proteomic approaches). *Environmental Research*, *200*, 111396. https://doi.org/10.1016/j.envres.2021.111396
- Yang, C., Song, G., & Lim, W. (2020). A review of the toxicity in fish exposed to antibiotics. *Comparative Biochemistry and Physiology Part C: Toxicology & Pharmacology*, *237*, 108840. https://doi.org/10.1016/j.cbpc.2020.108840

Photos:

- https://www.kroger.com/p/kroger-ibuprofen-tablets/0004126001301?fulfillment=PICKUP&searchType=default_search
- https://wsg.washington.edu/hemigrapsus-oregonensis-jaws/
- https://stock.adobe.com/uk/images/thermometer-and-sun-hot-weather-and-high-temperature-illustration-vector-illustration/428993452