The effects of varying temperature and harvest on the respiration of *Heterandria formosa*

Ruby Moore, Matthew Schumm, Daniel Okamoto
Department of Biological Science, Florida State University

Introduction

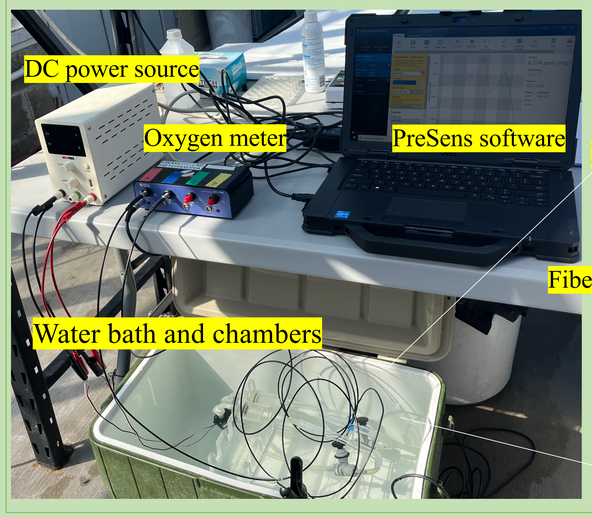
- Effects of temperature exposure, food variability, and harvest on respiration rates of *Heterandria formosa*
- Temperature as a variable:
  - Oxygen consumption of fish increases with temperature [1]
  - How short term (heat sticks) versus long term (seasonal) temperature change affects *H. formosa* was studied
  - Expected that *H. formosa* will be able to thermally acclimate because it is found in areas with short-term thermal variation like *Bathygobius cocosensis,* a fish able to thermally acclimate [2]
- Harvest as a variable
  - Types of harvest used: size-selective, random, and no harvest
  - Possibly useful in predicting the effects of commercial harvest on fish populations
  - Largemouth bass in lakes open to fishing have lower levels of oxygen consumption compared to Largemouth Bass in lakes closed to fishing [3]

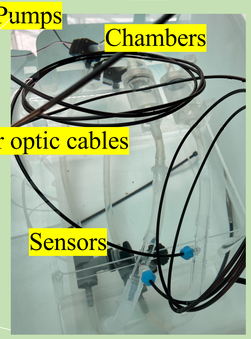
My research question: how do differences in temperature exposure and harvest affect the respiration of *H. formosa*?

Methods

Fish bred from Trout Pond and Wacissa River fish collected in 2021

- Harvest in tanks varied from size-selective, random, and none
- Fish were isolated within their tanks using a plastic bin filled with the tank water and were left for about 24 hours before respiration was measured
- Respirometry setup:
  - Two chambers, one chamber used as a control
  - Measured using PreSens software

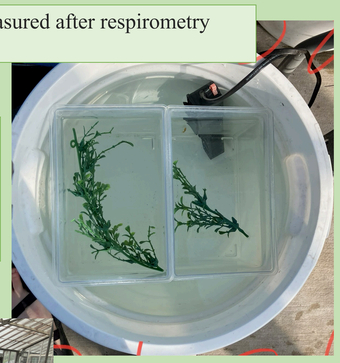


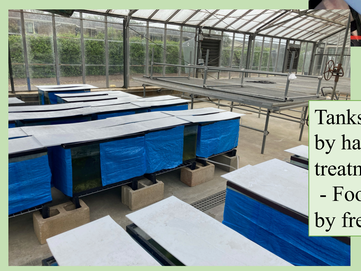


Body dimensions were measured after respirometry using ImageJ software

Heat sticks:

- Fish left without food for 48 hours
- Acclimated for an hour in bucket before measuring



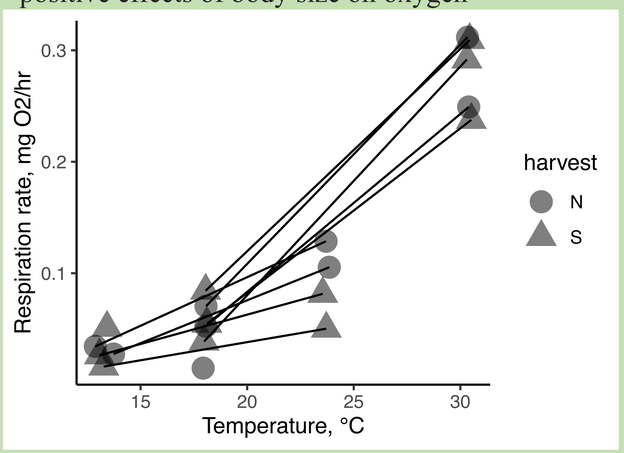


Tanks in greenhouse organized by harvest type and food treatment

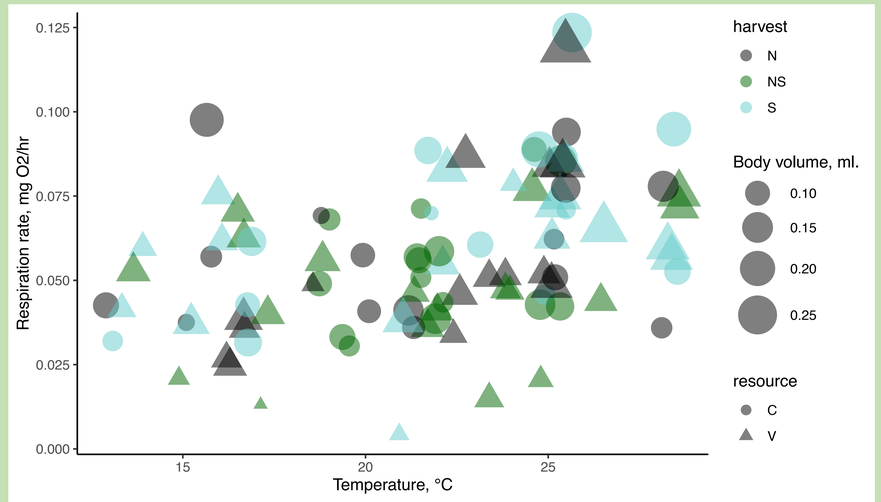
- Food varied per tank group by frequency and amount

Results

We used generalized linear mixed effects models for statistical inference and to control for the positive effects of body size on oxygen



Paired data from the heat stick experiment: lines connect individuals between measurements without heat sticks and measurements with heat sticks. Temperature increased respiration with a scaling exponent of 2.62 (credible interval 2.15-3.12)



Relationships between fish volume, temperature, harvest type (none, nonselective, and selective), resource (constant food versus variable food) and respiration (over a year of data collection). Scaling exponent for temperature was 0.35, and was insignificant (credible interval -0.05 to 0.75), while body volume was significant (scaling exponent 0.56), and harvest was insignificant

Conclusion

- *H. formosa* can thermally acclimate, seen by the large change in respiration with a short term temperature increase versus the small change in respiration with long term exposure to gradual seasonal temperature change
- There could be a cost to thermal acclimation as temperatures increase and respiration rates remain relatively constant
- Differences in harvest didn't affect respiration rates significantly, yet it affected body size, which was controlled for in the statistical analysis
- Higher respiration rates can correlate to greater mortality from predation; an increase in respiration rate can negatively impact performance [4]
- With rising temperatures, oxygen concentration in water decreases and respiration increases, which may cause oxygen deficiency for aquatic ectotherms as climate change progresses [5]

References

[1] Glencross, B.D. and Felsing, M. (2006). Influence of fish size and water temperature on the metabolic demand for oxygen by barramundi, *Lates calcarifer* (Bloch), in freshwater. Aquaculture Research, 37: 1055-1062. https://doi.org/10.1111/j.1365-2109.2006.01526.x

[2] da Silva, Carmen & Riginos, Cynthia & Wilson, Robbie. (2019). An intertidal fish shows thermal acclimation despite living in a rapidly fluctuating environment. Journal of Comparative Physiology B. 189. 10.1007/s00360-019-01212-0.

[3] Hessenauer JM, Vokoun JC, Suski CD, Davis J, Jacobs R, et al. (2015). Differences in the Metabolic Rates of Exploited and Unexploited Fish Populations: A Signature of Recreational Fisheries Induced Evolution?. PLOS ONE 10(6): e0128336. https://doi.org/10.1371/journal.pone.0128336

[4] Jørgensen, Christian & Holt, Rebecca. (2013). Natural mortality: Its ecology, how it shapes fish life histories, and why it may be increased by fishing. Journal of Sea Research. 75. 8–18. 10.1016/j.seares.2012.04.003.

[5] Holt, Rebecca E. and Jorgensen, Christian (2015). Climate change in fish: effects of respiratory constraints on optimal life history and behavior. *Biol. Lett.* 11: 20141032.20141032. http://doi.org/10.1098/rsbl.2014.1032

Acknowledgements

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