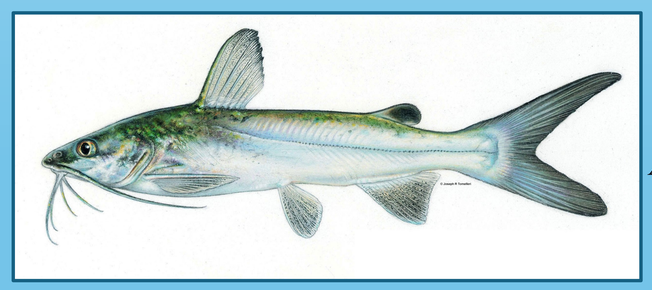
A Comparison of Atlantic Stingray and Hardhead Catfish Thermal Tolerance

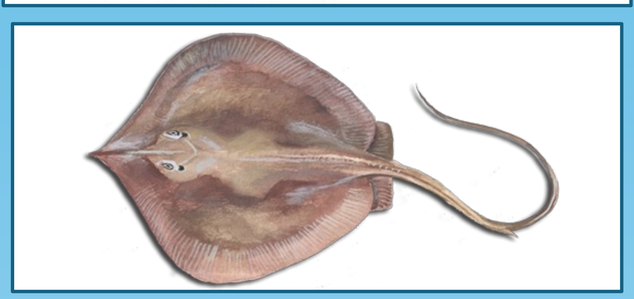
Jenna Haupert and Dr. Alyssa Andres

Introduction

- As ocean temperatures continue to rise under climate change, it is imperative to understand how different fish populations will respond.
- This study focuses on species in the Eastern Gulf of Mexico, as it is among the most rapidly warming bodies of water on Earth.
- Warming waters threaten shifts in the energy budgets of fish, loss of habitat, and species survival for marine ectotherms.
- The Atlantic stingray, *Dasyatis sabina*, and Hardhead Catfish, *Ariopsis felis*, are two coastal fish species that have been chosen as models for examining differences in thermal tolerance.
- While these two species inhabit similar habitats, they differ in energetic demands, activity levels, physiology, and family lineage (i.e., elasmobranch vs teleost).
- These differences can lead to varied thermal sensitivities and tolerances, causing different ecological responses.
- In order to predict degrees of impact or how to manage resources in an era of climate change, it is imperative to understand differences in fish thermal tolerance and identify metrics that represent the best predictors of tolerance thresholds across species diversity.
- This study aims to identify differences in thermal tolerance between Hardhead Catfish and Atlantic Stingrays by comparing critical threshold temperatures known to limit fish survival.
- Critical Thermal Maximum (CTmax) is the temperature at which an organism's ability to control movement and behavior is critically impaired, compromising survival.



Hardhead Catfish, *Ariopsis felis*

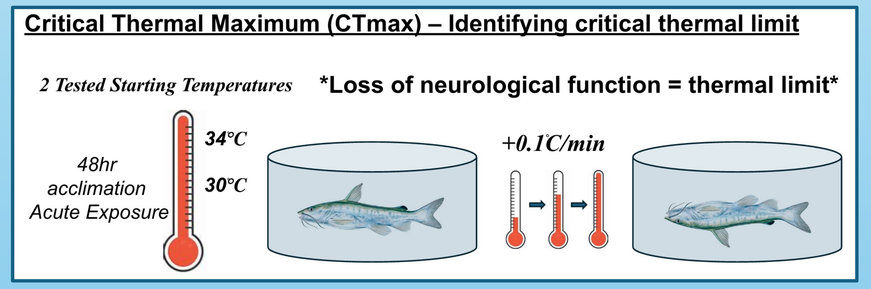


Atlantic Stingray, *Dasyatis sabina*

Methods

6 Atlantic stingrays (disc width: 20-37 cm) and 12 hardhead catfish (fork length 27-44 cm) were collected from St. Teresa, Florida in the summer of 2025.

1. Subjects were exposed to acute 48-hour acclimations at two starting water temperatures, 30ºC and 34ºC.
2. Water temperature was then increased by 0.1ºC every minute.
3. Throughout this heating phase, behavioral observations were conducted every 5 minutes to assess changes in orientation, ventilation, color, swimming, rest, and movement.
4. The trial concluded when the subject reached its CTmax, as determined by loss of equilibrium, an unsustainable decline in ventilation rate, or muscle spasms.



Results

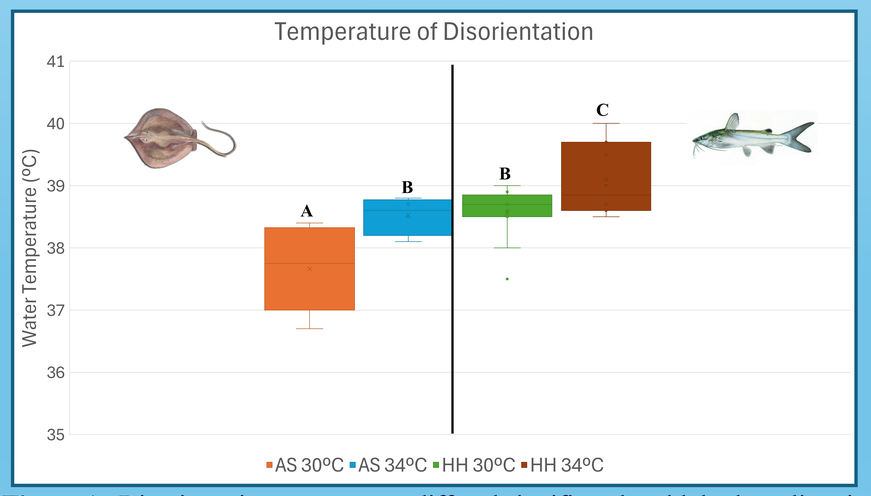


Figure 1: Disorientation temperature differed significantly with both acclimation temperature and species (Gaussian linear mixed model, Acclimation temperature $p<0.001$; Species $p<0.001$). Hardhead catfish exhibited higher disorientation temperatures than stingrays across both acclimation temperatures. Both species also exhibited higher disorientation temperatures after 34ºC acclimation than after 30ºC acclimation. Letters A-C represent a compact letter display based on planned post hoc comparisons.

Results Continued

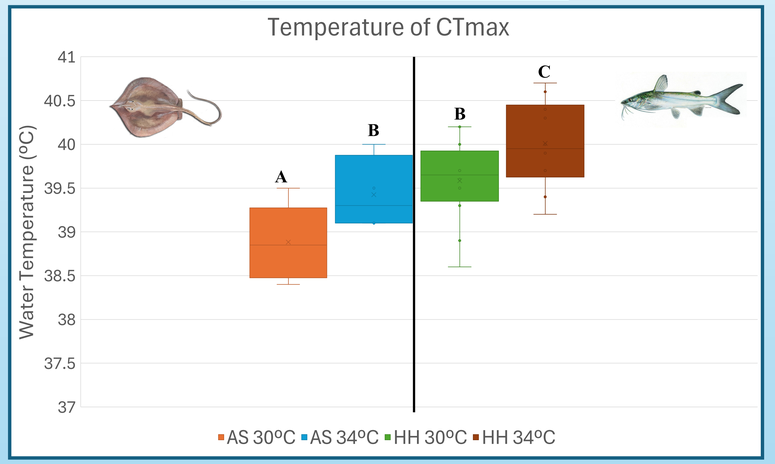


Figure 2: CTmax differed significantly with both acclimation temperature and species (Gaussian linear mixed model, Acclimation temperature $p=0.003$; Species $p<0.001$). Hardhead catfish exhibited higher CTmax temperatures than stingrays across both acclimation temperatures. Both species also exhibited higher CTmax temperatures after 34ºC acclimation than after 30ºC acclimation. Letters A-C represent a compact letter display based on planned post hoc comparisons.

Conclusions

- Atlantic stingrays appear more sensitive to temperature and would likely vacate their habitat sooner.
- Thermal thresholds for both species are sensitive to short-term acclimation.
- Both species can bolster thermal tolerance with higher acclimation temperatures, but only up to a certain point.
- All individuals demonstrated disorientation at a temperature significantly below the CTmax endpoint, suggesting Atlantic stingrays and hardhead catfish will likely be limited by temperatures below CTmax in the wild.
- Future research will look at 14-day thermal acclimation, larger sample sizes, analysis of heat shock proteins, and even different species like pompano and bonnetheads.
- This research can be used to improve the predictability of species and ecosystem dynamics models in an era of climate change.

References:: *Ariopsis felis summary page*. FishBase. (n.d.). https://www.fishbase.se/summary/Ariopsis-felis. *Ariopsis felis*. AQUASYMBIO. (n.d.). http://aquasymbio.fr/en/ariopsis-felis#:~:text=Habitat:%20Adults%20inhabit%20continental%20waters,Reproduction_mode:%20sexual. Fangue, N. A., & Bennett, W. A. (2003). *The Gulf of Mexico is getting warmer*. National Centers for Environmental Information (NCEI). (2024, November 15). https://www.ncei.noaa.gov/news/gulf-mexico-getting-warmer Thermal Tolerance Responses of Laboratory-Acclimated and Seasonally Acclimatized Atlantic Stingray, Dasyatis sabina. *Copeia*, *2003*(2), 315–325. http://www.jstor.org/stable/1448673. Florida Museum. (n.d.). *Atlantic Stingray*. Discover Fishes. https://www.floridamuseum.ufl.edu/discover-fish/species-profiles/atlantic-stingray/. *Image of Atlantic Stingray (Dasyatis Sabina)*. (2021). Georgia Department of Natural Resources. Retrieved February 15, 2026, from https://marinefishesofgeorgia.org/atlantic-stingray/. Lutterschmidt, W. I., & Hutchison, V. H. (1997). The critical thermal maximum: history and critique. Canadian Journal of Zoology, 75(10), 1561–1574. https://doi.org/10.1139/z97-783. Seibel, B. A., Andres, A., Birk, M. A., Burns, A. L., Shaw, C. T., Timpe, A. W., & Welsh, C. J. (2021). Oxygen supply capacity breathes new life into critical oxygen partial pressure (p_{crit}). *Journal of Experimental Biology*, *224*(8). https://doi.org/10.1242/jeb.242210. Tomelleri, J. R. (n.d.). *Image of Hardhead Catfish (Ariopsis felis)*. Tennessee Aquarium. Retrieved February 15, 2026, from https://tnacifin.com/fish/hardhead-catfish/. Acknowledgments: FSU Provost Postdoctoral Fellowship Program, FSU Coastal and Marine Laboratory staff, FSU/MISS 2024 interns, FSU Directed Independent Study students, FSU provost postdoctoral fellowship, Dr. Grubbs.