Measuring Atlantic Stingray (*Hypanus Sabinus*) Thermal Performance Using Metabolic and CTmax Studies

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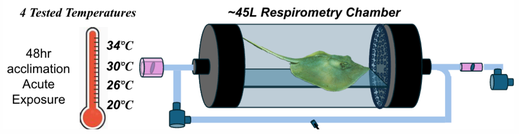
Introduction

- Atlantic stingrays (*Dasyatis sabina*) are greatly impacted by the temperature of their surroundings
- As climate change intensifies, ocean surface temperatures have reached unprecedented levels, causing uncertainty in how fish will adapt and respond to current and future temperature changes.
- Thermal performance curves, such as critical thermal maximum (CTmax) studies, which gauge an organism's upper thermal limits, are frequently used to assess how a species reacts to temperature variations.
- These investigations shed important light on how species might adjust—or not—to changes brought on by the environment.
- The thermal tolerance of marine organisms has been extensively studied, but little is known about the exact thermal performance limits of Atlantic stingrays.
- Thermal conditions have broad influences on the conditions of marine habitats as oxygen solubility decreases with higher temperatures, making oxygen less available for fish while simultaneously increasing fish oxygen demand.
- The Atlantic Stingray is especially responsive to fluctuations in temperature and tides, making them good indicators for how fish behavior and interactions with their environments will be subject to change with increases in oceanic temperatures.
- We tested for the critical thermal maximum at ecologically relevant temperatures while taking into account the concentration of dissolved oxygen and % oxygen air saturation.

Methods

- Defined Metabolic Terms
  - ***Intermittent Respirometry*** *– measures how much oxygen aquatic organisms consume*
  - ***MO2*** *– metabolic rate of oxygen consumption*
  - ***MMR*** *– Maximum Metabolic Rate - highest metabolic rate measured*
  - ***SMR*** *–Resting Metabolic Rate – lowest rate needed to sustain conscious organism at rest*
  - ***PcSMR*** *– Critical oxygen partial pressure – low oxygen level that limits resting metabolic rate, a level at which survival is time limited*
  - ***Alpha (α)*** *– Oxygen supply capacity – a measure of the maximum ability to supply oxygen to respiring tissues*
  - ***AS (Aerobic Scope)*** *represented as the difference/quotient of MMR and SMR, energetic scope for all life activities*
- Intermittent respirometry was measured in the respirometry chamber. – 10 min closed measure periods



- MMR after stimulating rays was measured, followed by undisturbed rest in chamber for 24 hoursB
- SMR was found by taking the average of lowest 10% of MO2 measures after first 5 hr of trial
- After 24 hours, intermittent flushing ceased - drew down O2 to PcSMR
- Slope of linear regression (O2 vs Time) used to calculate MO2 for each 10 min closed measure in MMR-SMR- PcSMR trial
- Thermal sensitivity (E) calculated of via Arrhenius relationships for all metrics

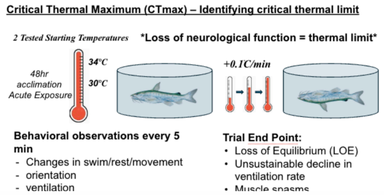
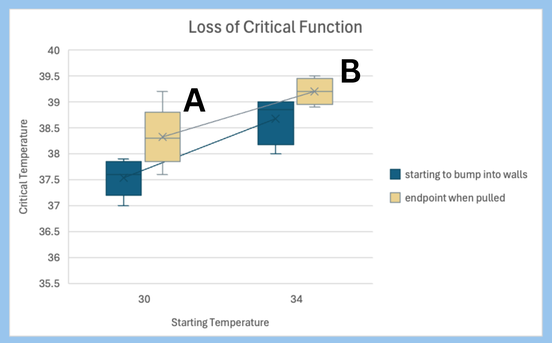
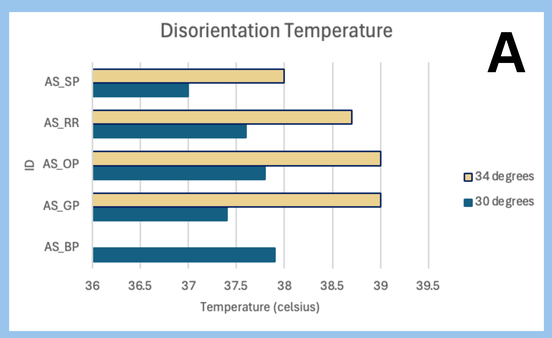
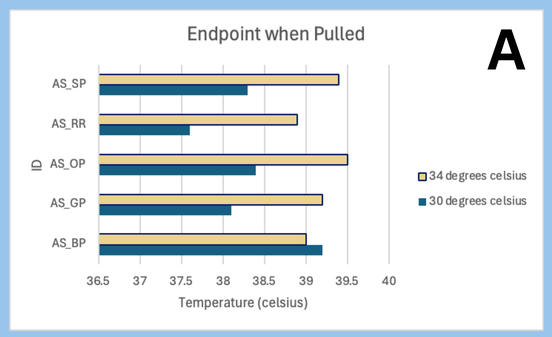


Fig. 3, 4 & 5: Letters denote statistical significance, with A denoting significance and B denoting marginal significance







Results

- The difference of disorientation temperature and endpoint temperature both demonstrated statistically significant differences between the two acclimation temperatures.
- The endpoint temperature was significantly higher than the disorientation temperature for the 30 degree acclimation group;.
- The difference in disorientation and endpoint for the 34 degree acclimation group did not demonstrate statistical significance.

Findings

- CTmax is sensitive to temperature of acclimation- short term acclimation to increasing average summer temperatures has potential to prime/increase threshold for critical thermal impacts to neurological performance up to a point: critical temperature thresholds are also known to be impacted by the length and severity of thermal exposure and increased length of thermal exposure at temperature extremes may also negatively alter CTmax and critical population limits. More data is needed!
- There was no clear thermal trend in HCT despite oxygen supply capacity increasing with temperature which likely means that while there are clear adjustments in the oxygen supply chain as temperatures increase, it is not clear that an increase in oxygen carrying capacity of the blood via increased red blood cells is one of the factors facilitating that change.

References

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Acknowledgements

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