Introduction

- Teleost fish form carbonate precipitates in the intestine as an osmoregulatory process that allows them to stay hydrated (1)
- Teleosts comprise 3-15% of the marine inorganic carbon cycle, with production when acclimated to high CO2 but would increase production with high temperature
- The fate of teleost carbonates upon excretion under climate change conditions can have implications for global carbon cycling (3)

Hypotheses:

- We hypothesized that Gulf toadfish would exhibit no change in carbonate production under high CO2 and high temperature
- This was the first study to examine the combined effects of high CO2 and high temperature
- Teleost fish form carbonate precipitates in the intestine as an osmoregulatory process that allows them to stay hydrated (1)

Methods

Carbone Production and Intestinal Physiology

- Toadfish were acclimated in one of four treatments:
  - Control: 410 µatm CO2; 26-28°C
  - High CO2 (HCO3-): 1900 µatm CO2; 26-28°C
  - High Temperature (HT): 410 µatm CO2; 32°C
  - High CO2 and Temperature (HCO3-HT): 1900 µatm CO2; 32°C

Results

- Dissolution was significantly higher in HCO2 and HCO2-HT groups, and there was no evidence of interactive effects on production in the HCO3-HT group
- There was no significant increase in carbonate production in the HCO2 group (4,5)
- There was no evidence that temperature increased carbonate production in the intestine (Trial 1) which could be based on an increased drinking rate associated with increased metabolic rate (2,5)
- Trial 2 HT production was not significantly different from other treatments, and the reason behind this different result is unknown
- There was no evidence of interactive effects on production in the HCO3-HT group

Discussion

- Intestinal Physiology
  - There was a slight trend for a decrease in osmolality in the HCO2 group (4,5)
  - The significant increase in total CO2 in the HCO2 group compared to the control may indicate increased HCO3- secretion
  - None of the metrics suggest that the HCO3-HT group displays evidence of interactive effects

Carbone Production

- There was no significant increase in carbonate production in the HCO2 group (4,5)
- There was some evidence that temperature increased carbonate production in the intestine (Trial 1) which could be based on an increased drinking rate associated with increased metabolic rate (2,5)
- Trial 2 HT production was not significantly different from other treatments, and the reason behind this different result is unknown
- There was no evidence of interactive effects on production in the HCO3-HT group

Dissolution

- Dissolution rate did not significantly change in HT
- Dissolution was significantly higher in HCO2 and HCO2-HT groups, and there was a trend to suggest interactive effects for dissolution rate
- Under future climate change conditions, carbonates could dissolve more rapidly, raising the saturation state in near surface waters and potentially making it easier for calcifying organisms to maintain their carbonate skeletons (6)

Future Directions

- Increasing the sample size and running more trials would confirm if trends could have some validity
- Examining the activity or expression of other transporters in the intestinal epithelium under the same conditions could aid in understanding physiological mechanisms
- Differences between trials could potentially be reduced if future studies select fish of similar sizes, sample fish the same number of days post feeding, and control flowthrough seawater temperatures more tightly
- Results from this study suggest that ichthyocarbonates may be of increasing importance to the marine inorganic carbon cycle in future climate change conditions

References


Acknowledgements

I would like to thank Dr. Rachael Heuer for her continuous flexibility and patience as she supported me throughout this research project. I would also like to thank Dr. Martin Grosell and Dr. Amanda Oehlert for supporting me as committee members. Lastly, I would like to express my gratitude for Jonathan Cordle, Brett Marek, Sarah Walls, Katie Hastings, and Sydney Cloutier for assisting in data collection.