The influence of age on differences in tolerances to extreme environmental conditions in *Fundulus heteroclitus* populations from Maine and Massachusetts

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**Background**

Summary: Otoliths are used to age fish from populations that experience different habitat temperatures, and correlate age with metabolic and thermal tolerance traits.

- *Fundulus heteroclitus* live in brackish water habitats that experience a wide range of temperatures.
- For ectotherms, temperature may impact growth, metabolic rate, and thermal tolerance.
- Critical Thermal Maximum (CTMax), is the highest temperature at which the fish lose their ability to control their movements but are still able to respire.
- This temperature is considered deadly because the fish is unable to escape predation or any other factors that might kill it.
- In teleost fish, growth and age can be measured using otoliths (inner ear stones), which deposit seasonal rings that are darker in winter during periods of slow growth and lighter in summer during periods of more rapid growth.

**Methods**

1. Measure critical thermal maximum (CTMax)
2. Extract and photograph the otolith using the MicroPix Application
3. Measure the ring distance using ImageJ
4. Assign ring distances to age groups
5. Statistical analysis in R studio used linear models to examine how age influenced body mass and critical thermal maximum.

**Results**

**Body Mass**

<table>
<thead>
<tr>
<th>Temperature</th>
<th>Age 1</th>
<th>Age 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>12°C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>28°C</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**CTMax**

<table>
<thead>
<tr>
<th>Temperature</th>
<th>Age 1</th>
<th>Age 2</th>
</tr>
</thead>
<tbody>
<tr>
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</tbody>
</table>

**Conclusions**

- Age has a significant influence on mass at both acclimation temperatures with two-year old’s being larger than one-year old’s. This demonstrates that the otolith method works well in determining fish age in this species.
- Age has a significant influence on CTMax at both acclimation temperatures. CTMax is higher at age 1 than age 2 for both acclimation temperatures. The smaller, younger fish have a higher thermal tolerance than the bigger, older fish.

**Future Applications**

- May be applied to other species facing similar environmental conditions.
- May help in a larger understanding of species adaptations to a changing environment due to climate change.

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