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Effects of Climate Change on the Viability of the Devils Hole Pupfish
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Abstract
Devils Hole is a unique pupfish habitat in the Mojave.

Seasonal temperature variation

Preliminary data show unusual oxygen consumption patterns for 33°C acclimated fish.

Methods
Using flow-through respirimetry, we determine oxygen consumption as a function of temperature and mass.

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Our investigation includes measuring resting aerobic metabolic activity based on oxygen consumption at various temperatures. Due to the endangered nature of C. diabolis, we use a possible hybrid fish of C. diabolis and its closest relative, C. nevadensis mionectes for testing purposes. The basis of our experiments is flow-through respirimetry. We place the fish in a clear plastic chamber that has water pulled through it by a peristaltic device and a series of tubes. An electrode that senses changes in oxygen pressure takes measurements before the fish enters the chamber to establish a baseline and then continually measures the oxygen pressure over a course of 2-5 hours to determine how much oxygen the fish requires at rest. After determining how much oxygen the fish consumed at rest at various temperatures, we chart those data to determine which temperatures are stressful for the fish in an acute setting. By using fish that are acclimated to different temperatures, 20 and 33°C, we can see what is happening to the fish metabolically under chronic conditions. We can also hypothesize what effects global climate change will likely have on this population and even use this species as a model for climate change's effects on fish population around the world.

Pupfish acclimated to 28°C were tested at various bath temperatures.

The above graph demonstrates that at temps. between 25 and 31°C, the mass-specific metabolic rate decreases, as expected; however, at 34°C, the rate is essentially flat, indicating that as mass increases, the fish struggle to meet oxygen needs.

While most of the 28°C acclimated fish showed consistent oxygen consumption patterns when tested at 28°C bath, testing on 33°C acclimated fish shows erratic patterns and in some cases, a complete halt to all oxygen consumption for long periods of time.

Summary and Conclusions
• Increased metabolic activity in medium and large fish tested at 34°C suggests temperature may be limiting size, fecundity, and the ability to thrive in Devils Hole.
• A minimal change in mass-specific metabolic rate on the population level over a wide range of temperatures may indicate a redirection of metabolic resources in order to simply survive, precluding the ability to thrive.
• New data are showing that fish acclimated to 33°C are very unstable in their metabolic activity and a further increase in habitat temperature may lead to the extinction of C. diabolis.
• As a model, C. diabolis may tell us what will happen to fish populations around the world if human-caused climate change is not controlled.

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