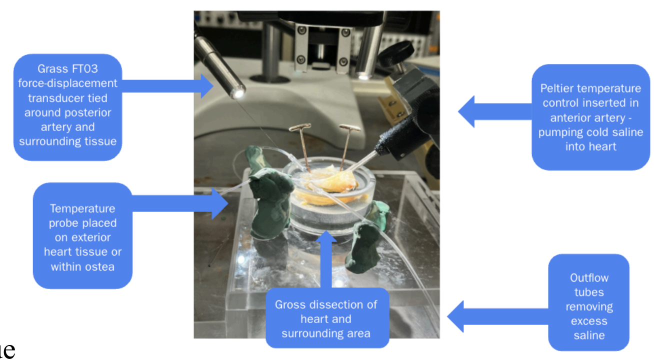
Mitochondrial x nuclear genomic interactions and impacts on cardiac physiology in C. maenas

Eleanor Hoff, 2026

The invasive green crab has established two populations along the eastern coast of the United States, with the northern population adapting to cold temperatures and the southern group adapting to warmth. These two populations are intermixing and forming a hybrid zone in the Gulf of Maine, providing a unique opportunity to study the relationship between mitochondrial and nuclear genomes and the effects on physiology. Previous research in salmon indicates that epistatic interactions between the two genomes may impact an organism's metabolic rate (Consuegra et al. 2015). Other work done with anchovies points to the role of selective pressures, such as temperature, in forming subgroups with shared mitochondrial variation (Silva et al. 2014). These subgroups are referred to as haplogroups and in the crab species *Carcinus maenas*, the Carlon lab has identified three primary haplogroups: the warm-adapted A group and the cold-adapted B and C groups. Past work has shown increased locomotive fitness at low temperatures in B/C crabs, suggesting mitochondrial-driven physiological differences between the northern and southern populations (Coyle et al. 2019). My research aimed to examine the link between metabolic ability at cold temperatures and mitochondrial haplotype by using cardiovascular fitness as a proxy for cellular respiration levels.

In order to achieve this aim, I collected 180 *Carcinus maenas* specimens of varying size from the intertidal zone at two separate beaches in Beals, Maine. Haplotypes were determined from leg or lung samples using DNA extraction kits and a restriction digest procedure created by Jared Lynch. Crabs that were sufficiently large for cardiovascular data–approximately 4 cm from outer spike to outer spike–were acclimated in 10℃ sea water in the Bowdoin Vivarium for minimum one week before being anesthetized with ice and used for cardio preps. I performed isolated whole-heart preparations under direction of Dan Powell and placed the beating heart on a force-transducer rig to measure each contraction. A saline line was cannulated into the anterior artery and was cooled by 1℃, staying at each degree for 10 minutes, down to 4℃. This minimally invasive technique helped ensure the heart was fully cooled to the desired temperature without disrupting contractive force. Heart rate and force was measured continuously for each specimen and preliminary analysis was done using Matlab.



At the final temperature of 4℃, the average heart rate for each haplotype was the same. However, the average heart rate at the acclimation temperature differed for the three haplotypes, with C crabs at 32 bpm and B crabs at 48 bpm. The different heart rates at acclimation and identical rates at the coldest temperature suggest there may be non-mitochondrial factors influencing thermal adaptation. However, our results are not conclusive and only serve as a proxy for metabolic processes like oxidative phosphorylation. Future directions may include measuring oxygen consumption in mitochondria to more accurately examine metabolic differences between the haplogroups.

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