Stony Brook University
The Graduate School

Doctoral Defense Announcement

Abstract

Molecular evolutionary mechanisms of rapid adaptation in threespine stickleback

By

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Adaptation is central to Darwin's theory of evolution through natural selection. There are now numerous examples of adaptation that occurs within tens of generations, such as freshwater adaptation by oceanic ecotypes of threespine stickleback (*Gasteroteus aculeatus)*. These instances of rapid adaptation provide an opportunity to study evolution in complex eukaryotes outside of a lab setting. In this dissertation, I study recently founded freshwater populations of stickleback derived from anadromous ancestors to elucidate the molecular evolutionary mechanisms underlying rapid adaptation.

First, I analyze whole genomes from individuals sampled over the first few generations of freshwater adaptation by oceanic stickleback. I show that rapid adaptation depended on a few individuals with large haploblocks of freshwater-adaptive alleles (jackpot carriers) present among the anadromous founders at low frequencies. These individuals had an increased fitness in the freshwater environment and passed on large haploblocks of freshwater adaptive alleles to their offspring. I found limited role of recombination during this rapid adaptation.

Furthermore, I use pooled sequencing of ~2700 sticklebacks collected at 20 timepoints within a six-year period. This dense temporal sampling enabled inference of when in the life cycle of threespine stickleback natural selection occurs. I found evidence of varying selection regimes; whereby beneficial alleles predominantly were advantageous from the breeding season to end of winter, but impose fitness cost afterwards, possibly resulting from antagonistic pleiotropy.

I then investigate how signatures of selection affect gene expression at different stages of freshwater adaptation. The approach I employ enables the mapping of genotypes, including alleles of small effects to specific molecular processes that mediate specific phenotypes, hence, connecting genotypes, phenotypes and fitness.

Together, the body of work I present advances our knowledge of the molecular mechanisms of adaptation in threespine stickleback, with implications to evolutionary biology in general. This work is especially crucial at this moment when organisms must adapt to their rapidly changing environments.

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