Systems Genetics of cold tolerance in a natural population of Drosophila melanogaster

Jasmine N. James1,2, Nicholas M. Teets2, Daniel A. Hahn2

1 Department of Biology, Claflin University, Orangeburg, South Carolina 29115
2 Department of Entomology and Nematology, The University of Florida, Gainesville, Florida 32611

Cold Tolerance is an important phenotypic trait that determines where many insects and other ectotherms are able to live. However, very little is known about the degree of genetic variation in cold tolerance within populations and the associated genetic and physiological mechanisms that drive variation.

Objective 1: Determine the degree of genetic variation in cold tolerance in a natural population

Objective 2: Identify genes that are associated with variation in cold tolerance

5-8 day old Drosophila melanogaster female flies from 18 of the DGRP lines were exposed to temperatures from -1 to -7°C for 1 hr at each temperature. Survival was checked 24 h post exposure.

5-8 day old Drosophila melanogaster female flies from 18 of the DGRP lines were exposed to temperatures from -1 to -7°C for 1 hr at each temperature. Survival was checked 24 h post exposure.

Lines Varied in Cold Tolerance

Fig. 1 Latitudinal variation in normal January low temperatures for the last 30 years. This map illustrates the strong selective pressure on cold tolerance as insect populations move from south to north.

Fig. 2. Variation in subzero temperature survival in 54 lines from the DGRP. While no lines are capable of surviving at -7°C, there is considerable variation in cold shock survival at higher temperatures. Lines in red were measured this summer, lines in grey are from previous experiments.

Fig. 3 Cold tolerance among 54 DGRP lines. The x-axis is the proportion of flies that survived across all subzero temperatures measured. There was ~10-fold variation in cold tolerance between the best and worst performing lines.

Fig. 4. Manhattan plot showing association of single nucleotide polymorphisms (SNPs) with cold tolerance. This plot only shows the X chromosome. Each dot shows a SNP, we consider those with -log(p-value) > 4 significantly associated with cold tolerance.

Summary & Conclusions

There is substantial variation in cold tolerance among lines of the DGRP, suggesting genetic potential for adaptation in cold tolerance. Data collected this summer will be combined with existing data (see Fig. 2) to strengthen our confidence in GWAS results. This work can identify candidate genes and physiological mechanisms that drive local adaptation in cold tolerance.

Long-Term Applications:
- Invasive Species Predictions
- Pest Control
- Human Health
- Beneficial Species Enhancement

Ultimate Goal: To understand how genotype works through physiology to shape the expression of complex traits like cold tolerance

Funded by: National Science Foundation to DAH, National Science Foundation REU National Mag Lab Program, University of Florida Entomology and Nematology, Florida Ag Experiment Station. Special thanks to: Megan Laughrey, Emily Richter, members of the Hahn lab, and Satchel’s Pizza.


References and Acknowledgements

Drosophila Genetic Reference Panel

Natural population of flies from Raleigh, North Carolina

Isofemale lines inbred to produce isogenic lines that reflect natural genetic variation

Each line fully genome sequenced to produce a living population genomics resource for studying complex traits