The Evolution of Starvation Resistance in Relation to Nutrient Availability

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Abstract

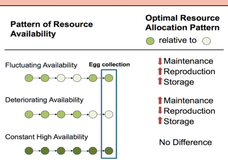
An animal's ability to withstand prolonged periods of food deprivation is called starvation resistance. Starvation resistance (SR) is a phenotypic trait of great environmental significance. In environments where there are shortages of food, those who can resist starvation for longer periods of time to thrive compared to other organisms. The purpose of this project is to study the underlying mechanisms in starvation resistance using *Drosophila melanogaster* as a model. We used a large- scale experimental evolution design, placing fruit flies on 3 different selection treatments, constant high, fluctuating, and deteriorating nutrients availability, for over 50 generations each with 12 replicates. For the first treatment, constant high availability (CHA), flies are given a high sugar diet their entire lifespan. In the second treatment, fluctuating availability (FA), flies on this regime are fed a standard diet then a low yeast diet then back to a standard diet to the end of their lifespan. In the final treatment, deteriorating availability (DA), flies are given a standard diet then are fed a low yeast diet to the end of their lifespan. Flies 12 days po, post oviposition, from each nutrient regime were placed on a maintenance diet, and then transferred to vials containing only nutrition less agar. These vials were checked approximately every twelve hours, beginning at 8:30am and 8:30pm daily. The number of flies confirmed dead in each period was then recorded until all flies were confirmed dead over the span of roughly two weeks. Flies on the fluctuating availability treatment are expected to exhibit higher levels of SR due to evolved higher rates of lipid and carbohydrate storage than the DA and CHA treatments. We link these phenotypic changes to changes at the genetic level in these lines. These results have implications for understanding the conditions that might select for higher or lower starvation resistance and the underlying genetic mechanisms determining those changes.

Objectives

The purpose of this project is to study resource allocation and starvation resistance in *Drosophila melanogaster*. Assay differences in starvation resistance between males and females based on the resources allotted from the nutrients available between 3 distinct diet regimes.

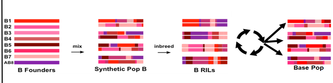
Background

Selection Treatments



Schematic of the experimental evolution regimes showing changing diets and predictions for the evolved pattern of plasticity in resource allocation.

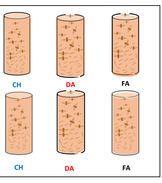
Drosophila Synthetic Population Resource



The *Drosophila* Synthetic Population Resource (DSPR) is two separate populations derived from 8 inbred founder lines. Each synthetic population was created by interbreeding the founder lines over 50 generations. Full-siblings are then breed for 25 generation creating over 800 recombinant inbred lines (RILS). This populations genomes is a fine-scale mosaic of segments from the parental lines (segment sizes average ~3 cM)

Methods

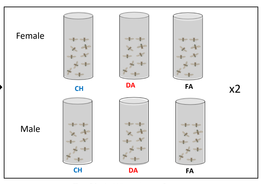
Multiple pairs of males and females were placed on a maintenance diet where they lay eggs for 24 hours. Then they were disposed of. Larvae survive on this food for 12 days.



Maintenance

2 replicates of flies from each selection regime lay eggs on a maintenance diet. 12 days post oviposition flies are then placed on nutrition less agar, separated by sex and selection regime.

12 days



On Nutrition less Agar

Deaths are observed in 12 hours intervals until all flies in vials are dead.

Data and Results

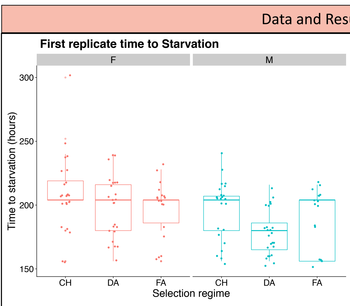


Figure 1. Time to starvation for the fly that survived the longest per vial in the 1st replicate.

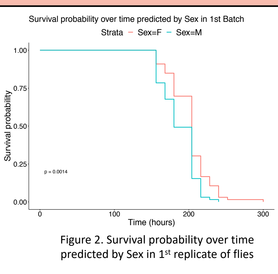


Figure 2. Survival probability over time predicted by Sex in 1st replicate of flies

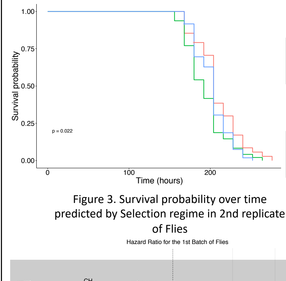


Figure 3. Survival probability over time predicted by Selection regime in 2nd replicate of Flies

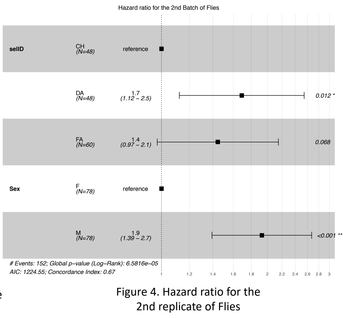


Figure 4. Hazard ratio for the 2nd replicate of Flies

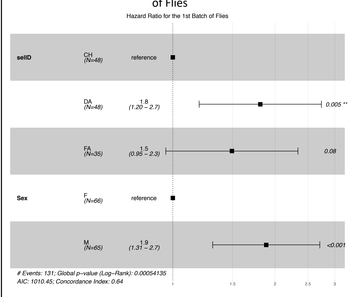


Figure 5. Hazard Ratio for the 1st Replicate of Flies

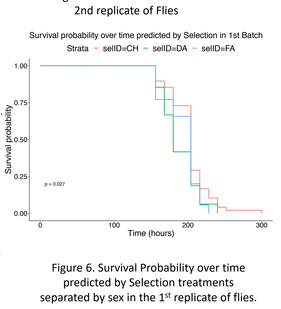


Figure 6. Survival Probability over time predicted by Selection treatments separated by sex in the 1st replicate of flies.

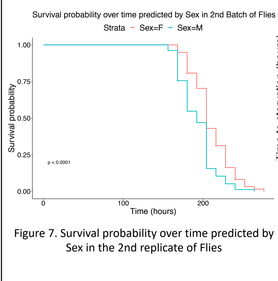


Figure 7. Survival probability over time predicted by Sex in the 2nd replicate of Flies

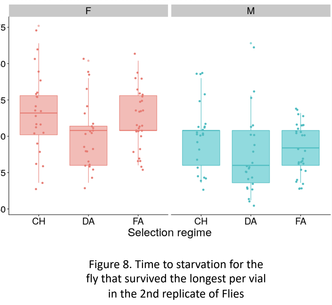


Figure 8. Time to starvation for the fly that survived the longest per vial in the 2nd replicate of Flies

Conclusions

Based on these results flies on the constant high availability diet express the highest survival probability and the longest survival time. So it is reasonable to conclude they express the highest starvation resistance . A possible explanation for this could be that the diet with the constant high sugar availability has the highest carbohydrate concentration. Flies on a higher carb diet tend to store more lipids (Lee, K., & Jang, T), this increased lipid storage allows them to store the highest energy reserves. A better and prolonged ability to store resources helps with survivability. Among Sexes Females are shown to have the higher starvation resistance

Acknowledgments

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