Genetic correlations associated with body coloration, aggression, and activity levels in *Drosophila melanogaster*

Paulina A. Montes Mendez, Samuel C. Miller, Sarah N. Ruckman, and Kimberly A. Hughes

Introduction

- One long standing question in evolutionary biology is whether pleiotropy (a single gene that controls multiple traits) limits adaptive evolution (1,2).
- For example, the dopamine synthesis pathway is plausibly linked to color, aggression, and activity level (1-3). Selection on one of these traits could therefore, lead to correlated evolution in other traits.
- Having found correlated evolution in aggression when selecting on cuticle color (unpublished data), we asked if other behaviors also evolved.

Hypothesis:

- We hypothesized that the dopamine synthesis pathway may modulate cuticle color and other behaviors leading to correlated evolution.
- We predicted that artificial selection on cuticle color would lead to correlated evolution of activity level. Specifically, dark selected flies should exhibit higher activity levels than light selected flies.

Methods

- After 12 generations of cuticle color selection, we tested for activity level and photographed each individual.
- To test for activity, we recorded the number of lines an individual crossed in 1 minute after a 12 minute acclimation period (Figure 1; n = 50 per sex per line).
- Next, we photographed each individual and used ImageJ to determine the average grayscale value of the dorsal thorax of the fly (Figure 2).
- We used a general linear model with poisson distribution to test if the activity levels differed for each selected line.

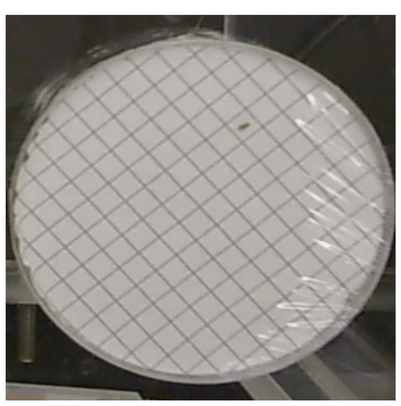

Figure 1: Activity Arena

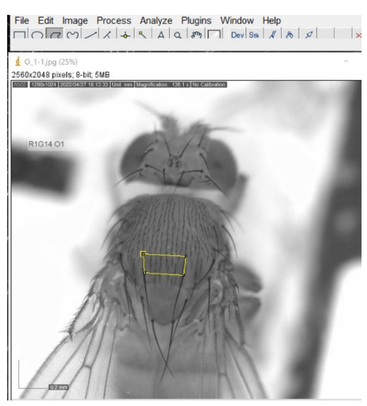

Figure 2: ImageJ of Fly Color Regions

Results

- After 12 generations, flies selected for darker color, are significantly darker than control and light lines for both sexes (Figure 3).
- The light line is significantly lighter than the control and dark selected lines for both sexes (Figure 3).
- Flies selected for darker pigmentation showed increased activity levels (Figure 4). Darker selected flies are significantly more active than light and control lines for both sexes.
- Light selected lines were not significantly less active than the control lines for both sexes.

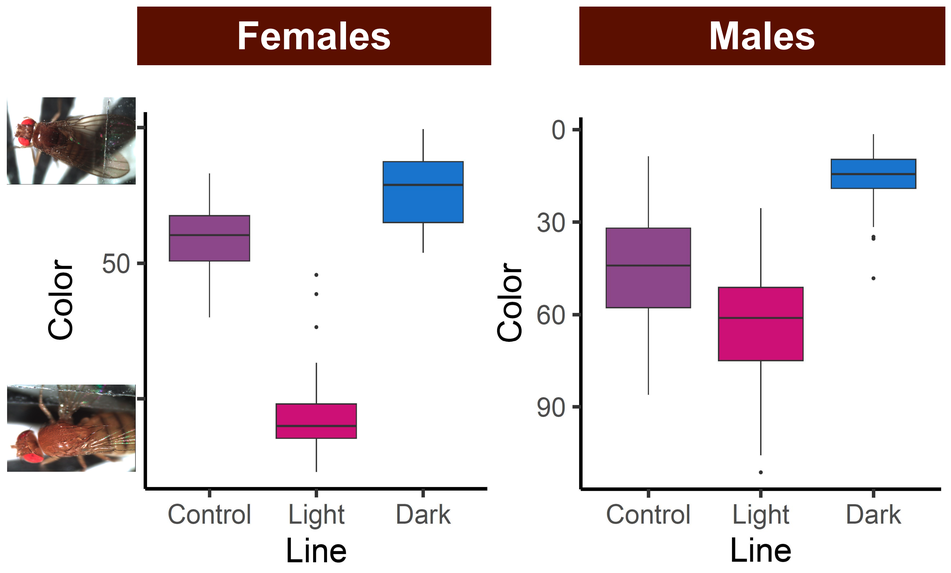

Figure 3: Color of dorsal thorax based on sex at generation 12.

	Control vs. Light	Control vs. Dark	Light vs. Dark
Females	p-value < 0.0001	p-value < 0.0001	p-value < 0.0001
Males	p-value < 0.0001	p-value < 0.0001	p-value < 0.0001

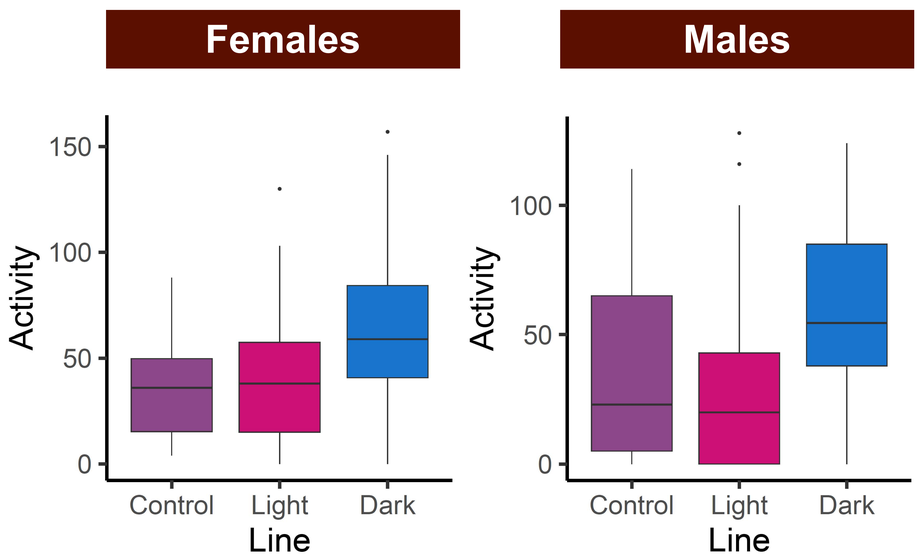

Figure 4: Activity levels for each line.

	Control vs. Light	Control vs. Dark	Light vs. Dark
Females	p-value = 0.5830	p-value < 0.0001	p-value = 0.0014
Males	p-value = 0.8615	p-value = 0.0011	p-value = 0.024

Conclusions

- The results support our prediction that activity level co-evolved with cuticle color.
- Darker selected flies are more active. However, light selected flies were not less active than controls. The relationship held for both males and females.
- Pleiotropy (genetic correlations) may constrain the independent evolution of color and behavior.
- In future experiments, we will include *D. simulans* and additional behaviors.

References

1. Takahashi, A. (2013). Pigmentation and behavior: Potential association through pleiotropic genes in *drosophila*. *Genes & Genetic Systems*, *88*(3), 165–17
2. Roulin, A., & Ducrest, A.-L. (2011). Association between Melanism, physiology and behaviour: A role for the melanocortin system. *European Journal of Pharmacology*, *660*(1), 226–233.
3. Shorter, J., Couch, C., Huang, W., Carbone, M. A., Peiffer, J., Anholt, R. R., & Mackay, T. F. (2015). Genetic architecture of natural variation in *drosophila melanogaster* aggressive behavior. *Proceedings of the National Academy of Sciences*, *112*(27).

Acknowledgements

The research is supported by the Hughes Lab and Saltz Lab in Rice University. Along with our fellow STEM students, Katelyn Mccaffrey, Addison Crews, Ashley March, Nicholas Tan, Lauren Campbell, Aidan Callender, Carter Dalili, Carys Delahanty, Lauren Kenny, Carlos Pereira, Erica Peters, Zoe Tsiapalis. We were supported by FSU SEED and COFRS as well as NSF DEB-2217558.