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

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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- Having found correlated evolution in aggression when selecting on cuticle color (unpublished data), we asked if other behaviors also evolved.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.

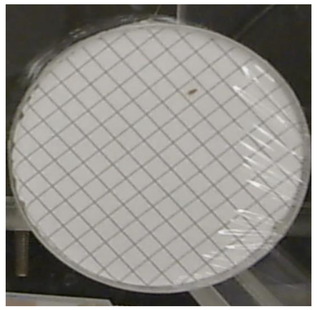

Figure 1: Activity Arena

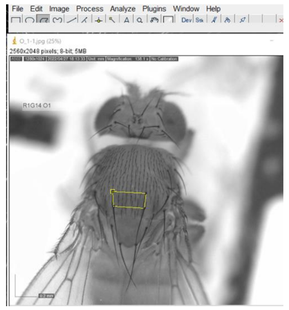

Figure 2: ImageJ of Fly Color Regions

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.

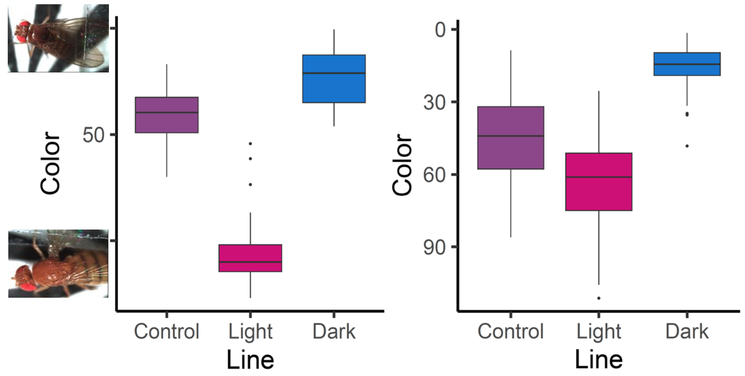

Figure 3: Color of dorsal thorax based on sex at generation 12.

	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

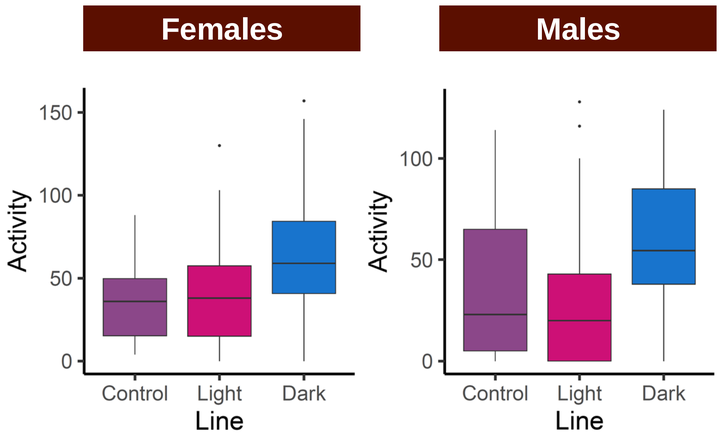

Figure 4: Activity levels for each line.

	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).

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