Genetic Effects on Aggregation Behavior of Beetles

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Abstract

Aggregations of insects can often cause problems because they consume large amounts of resources. Species like the Red Flour Beetle are particularly damaging because they can invade locations where humans store food (Lles 2018). Interestingly, different genetic strains of the Red Flour Beetle produce different amounts of aggregation pheromone (Gerken, Scully, Campbell 2018). Here, we tested if two different genetic strains of Red Flour Beetle formed aggregates based on their genetic background or their recent living environments. We found that beetles aggregated based on genetic factors, with environmental conditions being relatively weak. These data suggest that understanding the genetic background of pest insects can shed light on their behavior.

Questions, Hypotheses, and Predictions

Question: How is aggregation behavior influenced by genetic and environmental factors?

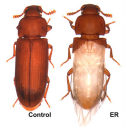
Hypothesis: Genetic factors will influence aggregation behavior more than environmental factors.

Study System

The Red Flour beetle is a small beetle that feeds on various grains, including wheat which is why it is a significant pest of stored grain. This beetle originated from Australia and the Indian subcontinent. It is located in more temperate locations, and is found more commonly in the southern U.S (Baldwin and Fasulo 2003). Its lifespan is about two to three years, but adults can sometimes live longer than this (Baldwin and Fasulo 2003). The Flour beetle is about 1/8 of an inch long and reddish brown in color. It is a highly studied species, with greater than 11,000 publication referenced in Web of Science. It has become a model system in genetics, functional genomics, and developmental biology.

Red Flour beetle

Range in U.S.



Developmental Biology

Methods and Experimental Design

1. First, I selected two strains of the Red Flour Beetle, the Goliath and Costa Rica.
2. I painted a singular green dot on the abdomen of 30 beetles of the Costa Rica strain.
3. I repeated step 2, but painted with white paint.
4. I painted a singular teal dot on the abdomen of 30 Goliath beetles
5. I repeated step 4, but painted with orange paint.
6. I put the white (Costa Rica) beetles in the same jar as the teal (Goliath) beetles, and I put the green (Costa Rica) beetles in the same jar as the orange (Goliath) beetles.
7. After 3 weeks, I separated out all the beetles into 4 petri dishes according to their color. I counted how many beetles I have in each petri dishes.
8. I put 6 beetles of each color into a single petri dish as Trial 1.
9. I repeated step 8 two more times to make Trial 2 and Trial 3
10. For three consecutive days afterwards, I observed and recorded what clusters formed and which beetles they consisted of.

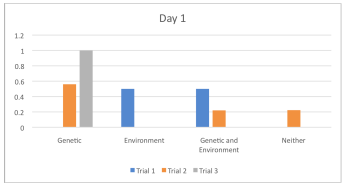
Steps 2-4

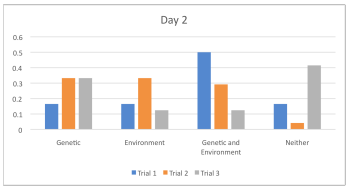
Step 6

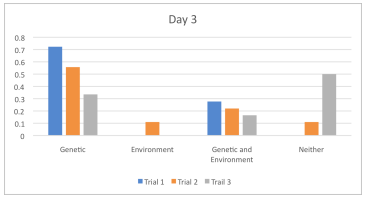
Step 7

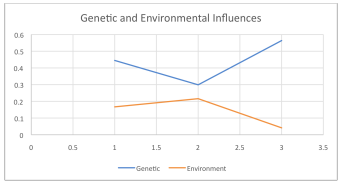
Step 10

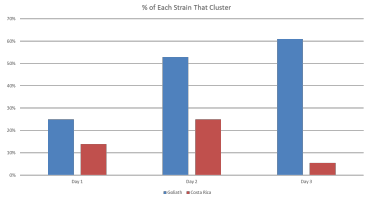
Results











Conclusions

Genetics played a significant role in aggregation behavior, both initially and on the final day. Environmental effects were relatively weak on most days. These data suggest that genetic factors influence aggregation behavior more than environmental factors.

The Goliath strain formed clusters at a much higher percentage than the Costa Rica strain. For each day, the percent of Goliath beetles that formed groups was about two times larger than the Costa Rica percentage. Over the days, the aggregation behavior increased in both strains.

Future Directions

If I were to continue my research, I would observe a different specie from locations similar to the genetic strains I studied in this experiment. A possible specimen I could use is a certain specie of ant. Ants are social animals like beetles, so they would have aggregation behaviors as well. I would have the same general steps as this experiment, but I would change how I marked each strain. The paint sometimes rubbed off and made it hard for the beetles to walk around. I learned from this experiment that different strains of Red Flour beetles secrete different amounts of pheromones, which is why different strains may aggregate in unique ways. Is this true of species of ants as well? At the end of this future experiment I could observe whether or not the strains of ants in the same location as the strains of beetles have similar aggregation behaviors. This future research would give information not only about specific strains of ants, but also about ant and beetle behaviors as a whole.

References

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Acknowledgements

I would like to thank Dr. Marshall, my research advisor, for helping me throughout my project.