Grouping Behaviors of the Red Flour Beetle

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Abstract

We studied the link between genetic and environmental factors affecting the behaviors of Red Flour Beetles. The research conducted was important because Red Flour Beetles are considered a damaging pest to the agricultural sector due to their colonization of food resources, specifically in the grain industry based upon the Agricultural Research Service, Center of Grain and Animal Health Research of the USDA. Understanding how genetic and environmental factors affect the hereditability of grouping mechanisms within the Red Flour Beetle will benefit the agricultural sector on controlling pests within their operations. At the beginning of this experiment, we believed if different strains of beetles were placed in the same conditions, then an equal delegation of genetic and environmental factors would affect the grouping of Red Flour Beetles. Based from a statement in an article from Breed and Sanchez from the Department of Ecology and Evolutionary Biology for the University of Colorado at Boulder, stating "Genes, via their influences on morphology and physiology, create a framework within which the environment acts to shape the behavior of an individual animal," we came to the hypothesis of the experiment. Based upon the data collected, we determined that genetics alone had increasingly more of an effect of grouping behavior. These results are important because once we can determine the factors that play a role in grouping behaviors of the Red Flour Beetle, we could form products and practices that can eliminate or control their groupings within the grain industry.

Purpose

The purpose of this research was to find a correlation between the impacts of genetics and environment on two different strains of the Red Flour Beetle, and conclude how these impacts affect the pheromones used to monitor the presence of the Red Flour Beetle in food products like "flour, cereals, pasta, cake mix "due to its grain origin as described by both the Agricultural Research Service, Center of Grain and Animal Health Research of the USDA and the University of Florida Entomology and Nematology Department.

Questions, Hypotheses, and Predictions

Question: Do genetic and environmental factors affect the grouping behavior of the Red Flour Beetle?

Hypothesis: We believed if different strains of beetles were placed in the same conditions, then an equal delegation of genetic and environmental factors would affect the grouping of Red Flour Beetles.

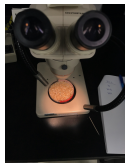
Prediction: Genetic and Environmental factors working together will have a stronger effect of grouping mechanisms than genetic, environmental, or neither working alone.

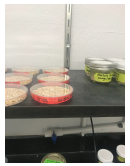
Study System

The organism studied was the Red Flour Beetle. The Red Flour Beetle has an Indo-Australian origin, so the southern states of America create a suitable environment for the Red Flour Beetle due to the more consistent heat as explained by the Entomology and Nematology department of the University of Florida. The beetle as a red coloring to its exoskeleton, approximately 1/8th inch long, antenna described as "three-segmented club, a curved thorax, and visible head to the naked eye. All biology descriptions of the Red Flour Beetle were supplied through the Entomology and Nematology department of the University of Florida.

Methods and Experimental Design

The process for experimentation first began with deciding strains of beetles and colors of nail polish to be used throughout the experiment. The Arkansas and Goliath strain of the Red Flour Beetle was used. The Arkansas strain was assigned the colors of blue and orange. The Goliath strain was assigned the colors of yellow and white. 20 beetles were painted for each color. For example: 20 Arkansas beetles were painted blue while another 20 were painted orange. 20 Goliath beetles were painted yellow while another 20 were painted white. Two jars were used to house the beetles for 2 weeks which was filled with blended wheat seed as a food source. The blue and yellow painted beetles were placed in jar A, while beetles painted orange and white were placed in jar B. After two weeks, we came into the lab and began separating the beetles out per color in four sperate petri dishes. Once the beetles were separated into the appropriate petri dishes, they were counted to see how many living beetles were present. The lowest number of live beetles were used to determine the number of beetles per color per petri dishes for three trials. The petri dishes were clearly labeled with Trial 1, Trial 2, and Trial 3. A thin layer of blended wheat seed covered the bottom of the dish. The beetles were then placed in these petri dishes. Petri dishes labeled as Trial 1 and Trial 2 contained 5 live beetles of each other, while Trial 3 contained 4 beetles of each color. We came into the lab on November 8th, 12th, and 14th to collect data. On the day of data collections, the petri dishes were examined under a microscope to visualize the groupings of colors in the petri dish. The examinations were plotted until all groups were accounted for. This process continued for two other separate data collection days. Once the data collections were complete, diagrams of the interactions were plotted and then tallied in a chart. After all the interactions were accounted for, the average percentage for each trial under each day was calculated. The options of interactions included genetics, environment, genetics and environments, or neither. Data was organized and inputted in an excel spreadsheet. Excel then formulated graphs to clearly interpret the data.

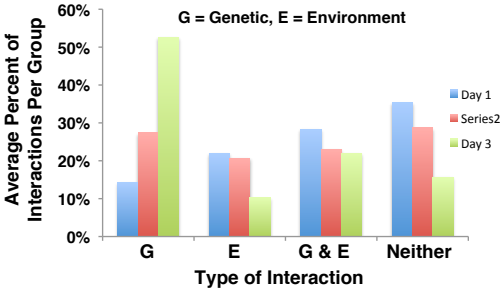





Results

Genetics increasingly has more of an effect of grouping behaviors of the Arkansas and Goliath strain Red Flour Beetle over a period.

Day	Trial	Group	N	G	E	G & E	Neither
Day 1	t1	g1	3	0.67	0.00	0.33	0.00
		g2	4	0.17	0.33	0.17	0.33
		g3	4	0.00	0.67	0.33	0.00
		g4	4	0.33	0.33	0.00	0.33
		g5	2	0.00	0.00	0.00	1.00
		g6	2	0.00	0.00	0.00	1.00
	t2	g7	2	0.00	0.00	1.00	0.00
		g1	3	0.00	0.00	1.00	0.00
		g2	3	0.00	0.00	0.33	0.67
		g3	2	0.00	0.00	0.00	1.00
		g4	3	0.00	0.67	0.33	0.00
		g5	2	0.00	0.00	1.00	0.00
		g6	3	0.00	0.00	0.33	0.67
		g7	3	0.33	0.33	0.00	0.33
	t3	g8	5	0.30	0.30	0.30	0.10
		g1	4	0.00	0.50	0.50	0.00
		g2	2	0.00	0.00	0.00	1.00
		g3	3	0.00	0.00	0.33	0.67
		g4	2	0.00	1.00	0.00	0.00
		g5	5	0.60	0.00	0.40	0.00
		g6	3	0.33	0.33	0.00	0.33
		g7	3	0.33	0.33	0.00	0.33
Day 2	t1	g1	2	0.00	0.00	1.00	0.00
		g2	2	0.00	0.00	0.00	1.00
		g3	2	0.00	1.00	0.00	0.00
		g4	2	0.00	1.00	0.00	0.00
	t2	g5	2	1.00	0.00	0.00	0.00
		g1	3	0.00	0.00	0.50	0.50
		g2	5	0.40	0.00	0.60	0.00
		g3	2	0.00	0.00	1.00	0.00
		g4	3	0.00	0.50	0.50	0.00
		g5	2	0.00	0.00	0.00	1.00
		g6	3	0.67	0.00	0.33	0.00
	t3	g1	2	1.00	0.00	0.00	0.00
		g2	2	0.00	0.00	0.00	1.00
		g3	2	1.00	0.00	0.00	0.00
		g4	2	0.00	0.00	0.00	1.00
		g5	3	0.33	0.67	0.00	0.00
		g6	3	0.33	0.67	0.00	0.00
Day 3	t1	g1	2	1.00	0.00	0.00	0.00
		g2	4	0.50	0.00	0.50	0.00
		g3	3	0.67	0.00	0.33	0.00
	t2	g1	2	0.00	1.00	0.00	0.00
		g2	2	1.00	0.00	0.00	0.00
		g3	2	1.00	0.00	0.00	0.00
		g4	2	0.00	0.00	1.00	0.00
		g5	3	0.67	0.00	0.33	0.00
	t3	g1	3	0.67	0.00	0.33	0.00
		g2	3	0.33	0.33	0.00	0.33
		g3	2	0.00	0.00	0.00	1.00



Conclusions

Our hypothesis was not supported because it wasn't an interplay between genetics and environment that influenced grouping. Genetic background alone affected the behaviors of the Red Flour Beetle. This result is significant because we have better knowledge of how the Red Flour Beetle congregate and can develop products and practices to limit grouping behaviors.

Future Directions

Now that I know the Red Flour Beetle has tendencies to group together based off genetic merit, it leads me to think how influencing genetics of the beetle can limit and/or cease grouping behaviors. Limiting or ceasing the groupings of these beetles will positively affect the grain industry, therefore creating better products to be placed on the markets. Targeting effects of genetics will provide a greater result then other possible tactics, as it was proven that genetics alone effects grouping behaviors the most. To begin with the new topic at hand, I would begin by altering the current procedure while keeping its foundation. I would continue to use trial petri dishes with the same number of beetles in each, collect data on a set schedule over a set period, and diagram grouping behaviors. Color identification for the different strains of beetles will be utilized again as well so additional data could be collected if different strains have different grouping behaviors. I would add gene targeting to the new procedure. A control group and a testing group would need to be present, therefore doubling the beetles used. Ones in the target group would represent a suppression of genes linked to grouping behaviors. Once an isolated gene is located, different properties of pesticide ingredients will be formed to eradicate grouping behaviors. We will then be able to test which combinations of ingredients yields the greatest results of limiting grouping behavior. I would need to account for viability. In order to do this, adequate living conditions must be available. I noticed as my current experiment continued throughout time, the beetles began to die off. It would be important to ensure that viability of the beetles would only be affected by the testing of different ingredients and not off living conditions in the lab. Color identification would need to be altered. During my current experiment, nail polish was used for marking and some colors did not work well. The polish began to wear off throughout the trial therefore hindering the accuracy of data collections. After the procedure is complete, my goal for the new project would be to link gene suppressions and products together to eradicate grouping behaviors. to link gene suppressions and products to eradicate grouping behaviors altogether.

References

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Acknowledgements

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