Flour Beetle Pheromones and Social Behavior

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Abstract

Being raised in a group or solitary can affect behavior of an animal. In this experiment, I am working with the red flour beetle, *Tribolium castaneum.* I am studying whether the way the beetles are raised affects their pheromone preference. I have been searching for similar studies and there are only a select few that are in a comparable format as my own. This is important, because it shows the connection between group living and solitary living and the preference for a certain scent. The question that I am asking for this study is if living in solitude or in groups can affect the insects behavior. My hypothesis elaborates on that question and reads: "my hypothesis is that living in groups will increase the preference for all pheromone types (other and self scent)". However, the results I found are not consistent with my hypothesis. Instead, I found that there is a significant difference between the pheromone preference for the group-scent in the beetles raised as a group as opposed to the ones raised solitary. These results are key because it shows that the beetles who have been raised in a social environment not only recognize the scent of their peers, but prefer the scent of their own group.

Purpose

The purpose of this research is to find out two things. First, I would like to see if there is a noticeable difference in behavior when the beetles are raised in a group or solitary. Next, I want to know if pheromones affect the beetles. For example, does the beetle raised in solitude want to sit on the paper with another beetles scent?

Questions, Hypotheses, and Predictions

Question: Does living in solitude or in a group affect behavior?

Hypothesis: My hypothesis is that living in groups will increase the preference for all pheromone types (other and self scent).

Study System

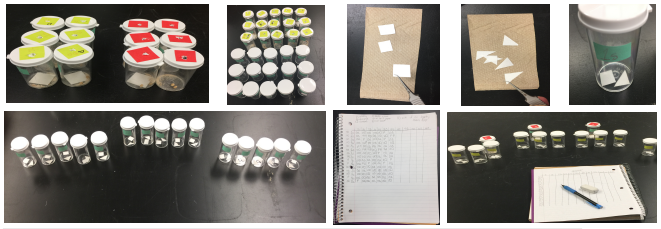
In this experiment red flour beetles, *Tribolium*, were used. These beetles are of Indo-Australian origin. They commonly live in dry areas. In the United States, they are found in the southern states, because of the warmer year-round climate. Usually, the adults are about 3-4mm in length and can live for up to three years. The females mating system is polyandrous. This means that the female will mate with many different males. But, these little beetles can be huge pest. They can be found in houses or grocery stores feeding and infesting the grain and flour sections.

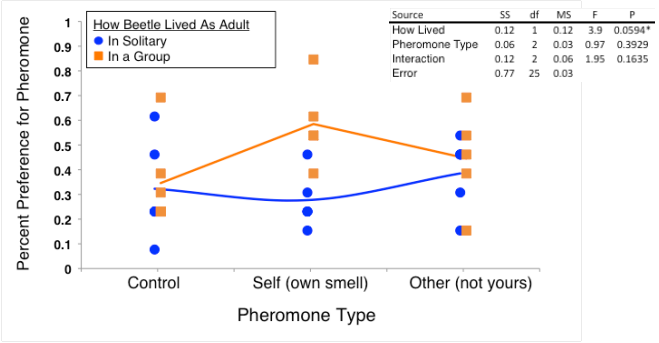
Methods and Experimental Design

I began by setting up my experiment. First, I needed the beetles to work with. So, I obtained many beetle pupae from Dr. Phillips' lab and sexed them. In this experiment, I only used males. Next, I cut small pieces of filter paper and put them in the bottom of the vile. The filter paper was used to absorb beetle pheromones. I had 15 beetles who I raised solitary and I had 18 beetles in which I raised in groups of three (six total groups). I then left them in the lab for four weeks so they could grown to their adult stage and periodically checked up on them.

Next, once all of the pupae had hatched and the adults lived for four weeks, I started the second part of the experiment. Specifically, I began by cutting the filter paper into small squares (to represent my control paper). Then for the "same" beetles, I took the filter paper out of the beetles vile and cut it into a triangle. Then I places the triangle and square into a new vile. For the "other" beetles, I took the paper from an other beetles vile and cut it into a triangle and then placed it into a new vile with the control. Then, lastly for the control, I cut up a triangle from the new filter paper and placed it in a new vile with a square paper. In that case, the triangle and square were both a control. I cut all of the filter paper on a paper towel to ensure that the scents would not get contaminated.

Once my experiment was set up, I began to move the beetles from their original vile to the new vile, while being sure that I put them with the correct vile (ex. 'same', 'other', 'control'). When the beetles were all in their correct vile I wrote down where they initially were (ex. On the triangle, under the square, on the plastic). Then I started my timer. I would check on them every five minutes and record where they were. I did this for a total of 60 minutes (13 checks). I had also decided that if the beetles was stuck on its back for ten minutes, then I would intervene and flip it on its feet again. To keep track of all of this, I had made a chart for both the solitary beetles and the group beetles (shown below).





Source	SS	df	MS	F	P
How Lived	0.12	1	0.12	3.9	0.0594*
Pheromone Type	0.06	2	0.03	0.97	0.3929
Interaction	0.12	2	0.06	1.95	0.1635
Error	0.77	25	0.03		

Results

As can be seen in the graph, there is a clear difference in how the beetles responded. The P-value for 'how lived' is about 0.05, which suggests there is a significant difference between "group" and "solitary". This means that the beetles preferred the pheromones more if they were raised in groups, but specifically the pheromones from their own group.

Conclusions

By looking at the data I collected with the group and solitary experiments, I can infer that the beetles raised in groups were more comfortable with their familiar group scent. These results, however, are not what I originally hypothesized. I thought that living in groups would increase the preference for pheromones of all types. This is different from what I found; the beetles preference for pheromones only went up for the self scent. The results found are very significant to my field of study, Biology. This is because it begins to show possibly what other animals group and solitary behavior would be like if this experiment were to be repeated on a different specimen.

Future Directions

If I were to continue this research, my next step would be to design a new experiment. This new experiment would piggy back off of what my results were in this experiment. Since this experiment was scent vs. no scent, I would change that aspect. I would add the factor of choosing between two scents to my experiment. Instead of having a control paper in the vials I would replace this with another choice. For example, I would place the scent of another beetle and its own scent in the same vile. This would allow for a direct test of the prefer your own group hypothesis.

References

Baldwin, Rebecca. "Red Flour Beetles - Tribolium Spp." *Red and Confused Flour Beetles - Tribolium Spp.* University of Florida, June 2003. Web. 5 Nov. 2016.

Halliday, William D., and Gabriel Blouin-Demers. "Male Aggregation Pheromones Inhibit Ideal Free Habitat Selection in Red Flour Beetles (Tribolium Castaneum)." *J Insect Behav Journal of Insect Behavior* 29.4 (2016): 355-67. Web.

Antony, Binu, Alan Soffan, Jernej JakÅ¡e, Mahmoud M. Abdelazim, Saleh A. Aldosari, Abdulrahman S. Aldawood, and Arnab Pain. "Identification of the Genes Involved in Odorant Reception and Detection in the Palm Weevil Rhynchophorus Ferrugineus, an Important Quarantine Pest, by Antennal Transcriptome Analysis." *BMC Genomics* 17.1 (2016): n. pag. Web.

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