The Effects of Species Exposure on Chemical Communication Behavior in Beetles

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Abstract

The *Tribolium castaneum* genome sequence contains a large number of odorant receptor (Or) genes when compared to the olfactory genomes of other insects (Engsontia et al., 2007). Evolved populations of the red flour beetle differ in their ability to detect chemical senses (Boake & Wade, 1984). Red flour beetles have been noted to release compounds via glands on their femurs (Olsson et al., 2006). This study observes the effects of chemical communication on behavior in beetles by comparing the response of the red flour beetles to areas predisposed to the chemical communication of other species. The purpose of this research is to study the effects of chemical communication in beetles by comparing the behavior of beetles exposed to life with only members of their own species to life in a group setting exposed to other species. If members of the species, *Tribolium castaneum*, were exposed to living with other species of beetles, then these beetles would be more likely to be present in areas predisposed to the other species. When accounting for edge behavior tendencies in beetles, this study observed that 80% of the tested individuals from the single species environment visited the red flour beetle chemical communication patch, while only 50% of individuals exposed to the group of multiple species were found on the patch chemically marked by species of red flour beetles. Results of this study support the notion that living alongside other species likely influences chemical communication preferences in beetles.

Purpose

The purpose of this research is to study the effects of chemical communication in beetles by comparing the behavior of beetles exposed to life in a group setting to those unexposed to other species.

Questions & Hypotheses

Question: Does living alongside other species influence chemical communication preferences?

Hypothesis: If members of the species, *Tribolium castaneum*, were exposed to living with other species of beetles, then these beetles would be more likely to be present in areas predisposed to the other species.

Study System

Types of organisms used included *Tribolium castanuem*, *Stitophilus oryzae*, and *Rhyzopertha dominica*.


Red Flour Beetle (*Tribolium castaneum*)


Rice Weevil (*Sitophilus oryzae*)


Lesser Grain Borer (*Rhyzopertha dominica*)



Red flour beetles tested lived either solely with members of their own species or in groups with other species for a two week period.

R = Red Flour Beetle, W=Rice Weevil, L=Lesser Grain Borer
C= Control, the sterile filter paper patch

Methods and Experimental Design

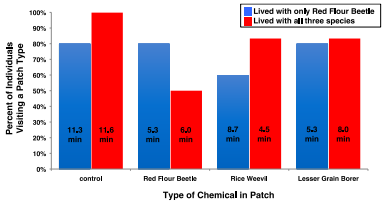
The behavior of *Tribolium* was tested in response to areas exposed to chemical communication. Data analyzed accounted for edge behavior of the beetles.
In a new environment with multiple scents, the behavior of *Tribolium* originating from a colony raised solely of their own species was compared to *Tribolium* raised alongside other beetle species capable of chemical communication.

•Environments for beetles living in the alone and group setting were established.
•Two groups of beetles lived alone and two groups with other species. The beetles lived off of wheat kernel, flour, and whole wheat kernel in an incubator at 25 degrees Celsius with the 16 light to 8 dark setting.
•For the test, 7 cm filter paper was divided into four sections using forceps to avoid human contact. Filter paper was exposed to each beetle species tested for a week.
• During testing, the red flour beetles were placed in a central tube to begin. After release from the central tube, the testing period lasted 30 minutes. Measurements were taken at two minute intervals. The closest proximity of the beetle to the filter paper section determined the recorded location.

Results

This graph shows the percent of individuals that visited a patch (i.e., a piece of paper with the smell on it) for each patch type (i.e., each beetle smell or the control). For example, 80% of "alone" individuals visited the red flour beetle patch, while only 50% of "group" individuals did. Also, edge effects were minimized by not including replicates where individual stayed on one patch the entire time or only changed once. The analysis only looks at individuals that moved from patch to patch.

The time in each bar graph is the "average length of time" a beetle stayed in that patch once it entered it. For example, "group" individuals entered "Rice Weevil" patches more often than "alone" individuals, but stayed there for shorter amounts of time.

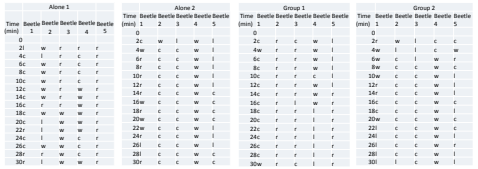


Alone Table

Alone Table for Beetles' Number of Times in Respective Area				
Beetle	Control	R Patch	W Patch	L Patch
1	11	3	0	1
2	0	2	8	5
3	0	8	7	0
4	7	1	7	0
5	0	15	0	0
6	1	8	4	2
7	14	0	1	0
8	14	0	0	1
9	0	0	15	0
10	6	0	0	9

Group Table

Group Table for Beetles' Numbers of Times in Respective Area				
Beetle	Control	R Patch	W Patch	L Patch
1	13	0	2	0
2	0	15	0	0
3	2	12	0	1
4	1	0	7	7
5	0	9	0	6
6	2	3	5	5
7	12	0	1	2
8	13	0	2	0
9	2	0	13	0
10	5	2	1	7



Conclusions

Research suggests that coexistence with other species impacts behavior in beetles. Based on the results of this study, inferences made include:

(1)Coexistence with a diverse assemblage of beetles can change the behavior of Red Flour Beetles (RFB).

(2) RFB living in diverse assemblages visit non-RFB patches more, and RFB-patches less

(3) RFB spend less time in patches with chemical cues than in control patches.

(4) Chemical cues from certain beetle species cause RFB to spend more or less time in a patch.

Future Directions

To continue this research, further steps to investigate chemical communication could test the behavior of beetle species in response to areas inhabited by other species capable of chemical communication. To conduct this follow-up experiment, predatory behavior of the additional species added to the test would need to be taken into consideration. In addition, future studies could test similar chemical compounds released by different species in comparison to compounds with drastically different structures.

References

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