

## **Research Question**

How does temperature affect the rate of activity of ants?

## **Background Information**

Ant colonies have social orders and rely on all members of their colonies for survival. Several classes exist in ant colonies; each class has specialized duties that contribute to the colony as a whole. Some ants are responsible for staying in the nest and feeding larvae, while other ants known as "foragers" seek food for the colony. The sole responsibility of queen ants is to mate with males for reproduction. After mating with males, queen ants fly away from the colony and find a location to start a new colony.

When communicating, ants rely on their sense of smell for relaying messages to one another. Ants release chemical signals known as pheromones. Other ants are able to detect these pheromones by using their antennae. Once their antennae receive the pheromones, ants determine which direction the rest of the ant colony is going. Also, ants leave pheromones on the ground if they are foraging for food; allowing other ants to know which trail to follow to find food. Pheromones are also for rallying other ants to defend their colony or attack other insects.

## **Hypothesis**

The rate of activity of a population of ants will increase as the temperature increases. This is because ants are cold-blooded (unable to generate body heat), and must control the temperature of the surrounding environment in order to perform tasks efficiently. This is accomplished by digging underground, where the temperature is constant due to heat rising to the surface of the ground.

## **Variables**

My independent variable is temperature. I will vary this variable by using jars of differing temperatures (approximately 20° F above and below room temperature) as environments that each group of ants will inhabit for 3 hours. This can be accomplished by placing the "cold jar" in a refrigerator for 1 hour before adding the ants to it, and the "hot jar" under a heating lamp for 1 hour prior. A jar that is left at room temperature will be used as a control.

My dependent variable is the rate of activity of each group of ants. I will measure this variable by measuring and approximating (in inches) how deep each group dug a tunnel in their habitat, which will consist of dry sand.

My controlled variables are:

- time
- dimensions of jar containers
- type and amount of sand used

I will control these variables by using a uniform time to heat and cool the two glass jars, allow the each population ants to adapt to their environment and begin digging for the same time, use the same type and size of glass jars for the three populations, and use the same type and amount of sand for each group.

### **Materials**

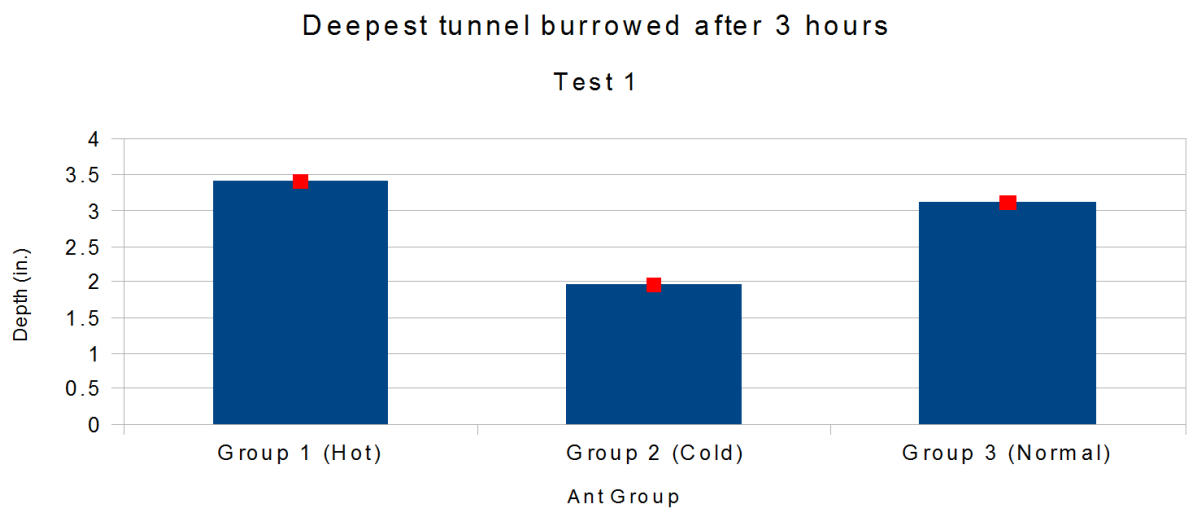
- 150 ants
- three 6" x 3" glass jars
- a 50-watt heat lamp (with red filter)
- a refrigerator or cooler
- dry sand
- timer
- thermometer
- ruler

### **Procedure**

1. Fill three 6" x 3" glass jars with dry sand until each reaches 5 inches from the base. Mark each glass at the sand's highest surface point
2. Place one container in the refrigerator, one under the heat lamp, and leave one at room temperature as a control. Allow each container to sit for 1 hour prior to performing the experiment.
3. Retrieve the three containers and insert a thermometer in the sand. The "hot" and "cold" glass jars should be approximately 20°F above and below the room temperature glass jar, respectively. If they are not, allow them to sit in either the refrigerator or the heat lamp for another 30 minutes, checking at 15 minute intervals until the designated temperature is achieved.
4. Add approximately 25 ants to each jar containing dry sand. Label each container with what type of climate is used for each glass environment. Place each jar in its respective environment (hot, cold, or normal). Set a timer for 3 hours and begin recording
5. After the specified time is reached, observe container for the rates of activity of each population by measuring the depth of the tunnels dug, using the 5" mark on the jars as your reference point. If the ants did not dig toward near the sides of the glass, you will need to remove sand from the top of the container until you reach the bottom of the tunnel, and then approximate the tunnel's depth.
6. Record data and repeat the test again. Compare the results.

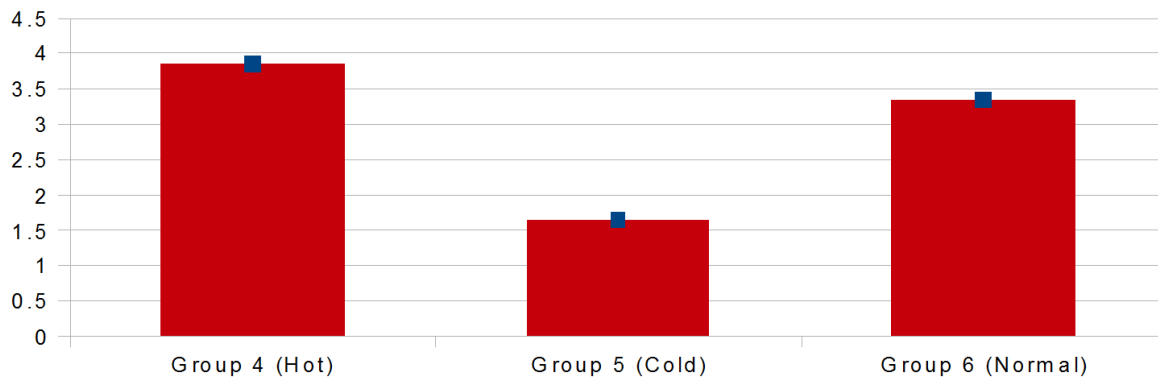
## Data

Ant Groups	Deepest tunnel burrowed after 3 hours (in.)
Test 1	
Group 1 (Hot)	$3.40 \pm 0.05$
Group 2 (Cold)	$1.95 \pm 0.05$
Group 3 (Normal)	$3.10 \pm 0.05$
Test 2	
Group 4 (Hot)	$3.85 \pm 0.05$
Group 5 (Cold)	$1.65 \pm 0.05$
Group 6 (Normal)	$3.35 \pm 0.05$



## Deepest tunnel burrowed after 3 hours

Test 2



### Conclusion

The data gathered from both tests of the experiment supported my hypothesis. However, it is evident that while heat does in fact result in increased activity, cold had a much more drastic effect. The respective temperatures of the hot and cold environments for test 1 were 89 °F and 51 °F, approximately 17° F above and 21° F below room temperature (72 °F). The respective temperatures of the hot and cold environments for test 1 were 92 °F and 52 °F, approximately 20° F above and 20° F below room temperature (72 °F). Despite the hot environment being below the designated temperature of at least 93 °F in test 1, it can be said that the change in activity was insignificant relative to the cold environment, when both are compared to the rate of activity at room temperature.

In test 1, the controlled group managed to dig a 3.10 in. tunnel in the sand; the group in the hot environment dug a 3.40 in tunnel (0.30 in. more than the control); and the group in the cold environment dug a 1.95 in. tunnel (1.15 in. less than the control). In test 2, the controlled group dug a 3.35 in. tunnel; the group in the hot environment dug a 3.85 in. tunnel (0.50 in. more than the control); and the group in the cold environment dug a 1.65 in. tunnel (1.70 in. less than the control). In test 2, the ant population inhabiting the cold environment dug significantly less than the population in test 1 (a 0.30 in. difference); this may be attributed to variation in behavior as a group, but does not make sense as there was only 2 °F in difference between the two environment, especially since test 2 was the warmer environment.. Additionally, the ant population in test 2 dug significantly more than test 1, with a difference of 0.45 in. between populations. This was expected, as the temperature of test 2 was 3 °F higher than in test 1.

## **Evaluation**

There were several sources of error in this experiment. First, the temperatures of the environments (excluding the controlled groups) experienced some variation. This may have been due to the differing compositions of each glass jar of sand (no glass had a uniform distribution of minerals in the sand), which would result in more heat being absorbed in one jar over the other; this had a mild effect on the results obtained. Second, the depth of the tunnels was approximated, as there was no way for me to properly measure the tunnel's length from outside the glass jars (the tunnels were within the center of the jars, rather than on the sides); this mildly affected the data (within tenths of an inch). Finally, only two tests were performed for this lab, and as such, the data does not reflect an accurate mean of all tests similar to this experiment; this significantly affected the data in terms of averaging variability of multiple tests.

## **Improving the Investigation**

In order to conduct this experiment correctly, it is recommended that testers: use flat glass containers (similar to those used in ant farms) so that recording measurements of ant tunnel depth are simpler and more accurate; perform multiple tests (at least 5) to account for variability between ant populations. Both recommendations are based on improving accuracy of the process of collecting data and the data itself.

## References

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- Davis, S. (n.d.). What Behavior & Structural Adaptions Does an Ant Have? | eHow.com. *eHow | How to Videos, Articles & More - Discover the expert in you.* | *eHow.com*. Retrieved March 15, 2013, from [http://www.ehow.com/info\\_10051135\\_behavior-structural-adaptions-ant-have.html](http://www.ehow.com/info_10051135_behavior-structural-adaptions-ant-have.html)
- The Behavior of Ants. (n.d.). *The Biology Project*. Retrieved March 15, 2013, from <http://biology.arizona.edu/sciconn/lessons2/shindelman/background.html>