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The Effect of Temperature on the Performance of Veromessor smithi

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**Introduction**

Climate change can greatly alter the interactions between species of an ecosystem, giving advantages to certain species who perform better in the conditions created by climate change. It is of great importance to understand the effects of climate change on ecosystems so that we can predict how these changes and the resulting interactions will affect species abundance in specific areas. If one species does better than others in the changed environment, they could potentially increase their abundance, and lower the abundance of other species. At the Bernard Field Station, one specific species that could be affected by climate change is the *Veromessor smithi* harvester ant. According to *Dr. Eleanor’s Book of Common Ants of California*, *Veromessor smithi* is native to desert areas, and prefers very hot temperatures. Hurlburt et al. (2008) found that desert ants such as *Cataglyphis bicolor*, *Ocymyrmex barbiger*, and *Pogonomyrmex barbatus* performed best at temperatures up to 50 and 60 °C. With knowledge of this information, we posed a hypothesis that harvester ants would perform better at higher temperatures until peaking around 55 °C. In order to test this hypothesis, we placed *Veromessor smithi* harvester ants in environments of different temperatures and measured their oxygen intake levels.

**Methods**

The effect of temperature on *Veromessor smithi* ants was determined by comparing oxygen intake levels at 25, 30, 35, 40, and 45 degrees, at each of which one trial was done for a total of 5 trials. A piece of cotton was placed at the bottom of a vial and soaked with 0.75 mL of 15% KOH solution, which absorbed the CO$_2$ produced by the ants. A plastic barrier was placed on top of the cotton, physically separating the cotton and allowing ants to be placed in the vial.
without touching the KOH. The respiration apparatus was placed in a water bath of the appropriate temperature for 10 minutes to normalize the temperature of the air inside the vials. Two 1-mL syringes were pulled halfway open and attached to the ports on the rubber stoppers, and a 3-mL syringe was filled with colored water and attached to the opening at the back of the respiratory apparatus. 10 *Veromessor smithi* ants, collected in the Bernard Field Station at 34°6’30” N, 117°42’26” W on April 11th, were placed in the vial on top of the plastic, with, but separated from the KOH soaked cotton, and the stoppers were placed on top of the vials. The 3-mL syringe was pushed so that the colored water entered both sides of the apparatus, and the 1-mL syringes were adjusted so that the colored water was even on both sides. The starting level of the colored water was noted, and after 15 minutes, the difference between the starting level and the ending level was recorded. The final form of the data will be in measurements of total microliters of oxygen/ant per minute, which is calculated by dividing the microliters of water movement by the number of ants times the number of minutes. Linear regression was used to test for correlation between temperature and oxygen/ant per minute.

**Results**

The level of oxygen consumption at 45 ºC, the highest temperature observed, was about twice as much than at any of the other temperatures. The linear regression revealed a low correlation between the data points ($r^2 = 0.054$).
Figure 1. The effect of temperature on oxygen consumption (n = 1) in *Veromessor smithi*.

With the knowledge that generally, the performance of desert ants increases with an increase of temperature until peaking past 50 °C, an assumption can be made that the data point at 40 °C is an outlier. Examining the set of data as such, the level of oxygen consumption at 45 °C was about 1.5 microliters higher than at other temperatures. Treating the data point at 40 °C as an outlier, the linear regression revealed a much higher correlation between the level of oxygen consumption and the temperature than before, but the correlation was still relatively low ($r^2 = 0.496$).
Figure 2. The effect of temperature on oxygen consumption ($n = 1$) in *Veromessor smithi*.

Discussion

In this experiment, we observed the effect of temperature on *Veromessor smithi*. To determine this effect, the ants were placed in five different temperatures and the level of oxygen consumption was observed. The hypothesis was that an increase in temperature would lead to an increase in performance and activity of *Veromessor smithi*, and thus an increase in the level of oxygen consumption. In the test performed, our results did match our hypothesis. There was an increase in the level of oxygen consumption as the temperature increased, but linear regression showed that this correlation was not very strong.

One reason that the results might have generally matched the hypothesis, but not had a strong linear correlation is the limitations of the equipment used. The water baths used in the experiment were not digital, so the temperatures at which the trials were run were approximations, despite efforts to accurately set and keep those temperatures consistent.
Working with the respirometers used to measure the level of oxygen use was also not entirely straightforward, with the amount of change in colored water being difficult to record completely accurately. In addition, the data set that was collected was very small, with only one trial being done for each temperature measured. If the experiment were to be performed again, there should be many more trials done at every temperature point, so that inconsistencies, due to both equipment limitations and general variation in trials, would be accounted for.

Citations
