Thermoregulatory Responses in Lamprophis Fuliginosis
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Abstract
Increased body temperature has been associated with increased immunological function in many animals. While humans and other endotherms can raise their body temperature through a physiological fever, ectotherms like snakes are unable to do this directly. Previous studies have shown that many ectotherms exhibit preference for warmer environments when infected with pathogens; this phenomenon has been aptly termed behavioral fever. Behavioral fever in snakes is an area of research with many areas still unexplored. Thermoregulatory responses to pathogens in African House Snakes (Lamprophis Fuliginosis) have only been investigated once before using a sample of just three snakes given injections of lipopolysaccharide (LPS). The finding of that limited study was that behavioral fever was not evident in Lamprophis Fuliginosis. This research project seeks to elaborate on that original study using a much larger sample as well as a diverse array of pathogens. In order to test for behavioral fever, 22 juvenile African House Snakes were placed in custom made chambers with a heat gradient ranging from 23 ºC to 40 ºC. Snake body temperatures were measured for 2 control groups and 3 experimental groups, each receiving a different order of UV killed strains of E. coli, S. aureus, and S. Enterica.

Methods
• Snakes were randomized into groups A, B, and C with each receiving bacterial injections in a different order
• Snakes from each group were injected and placed in the thermo chambers at 8:00 pm the night before each trial
• Cloacal temperatures were then taken every hour for 12 hours beginning at 8:00 am the following day
• The first control was run without any injection in order to determine baseline behavior and temperature
• A second control was an injection of PBS (Phosphate Buffered Saline) to control for the effect of the injection
• At the end of each run, snakes were fed a small mouse and given a week to recuperate before their next trial

Bacterial Strain Preparation
Three strains of bacteria were used:  
- E. coli: gram negative, bacillus  
- S. aureus: gram positive, coccus  
- S. enterica: gram negative, bacillus

Ultraviolet Light Killing Technique:
- Protocols for heat killing were varied and difficult to find
- Too much heat exposure risks denaturing integral membrane proteins, glycolipids, and cell surface antigens
- UV light was used because of its killing ability without risking damage to bacterial antigens
- Each vile was exposed to UV light for 6 hours
- Killed strains were plated to ensure efficacy of killing

Injection Doses
Each snake was given an injection of 1 mL per 20 grams body weight. PBS was used as the solvent for the bacteria

Data and Graphs

Graph 1: Examining the relationship between average temperature and trial

Graph 2: Examining the variance in mean temperatures for each trial

Graph 3: Examining the average temperature over the course of the day for all control and experimental groups

Results and Conclusion
• There was no statistical difference between the No Injection Control and the PBS Control, meaning the act of being injected did not account for any observed behavior
• Examining the two controls, male body temperatures were consistently about 1 degree cooler than female body temperatures (Graph 1)
• When looking at the average temperature of both sexes combined, there is no statistical difference between any of the 5 trials (Graph 2)
• There is no statistical difference in the variance between any of the 5 trials (Graph 2)
• Among male snakes, there was about a 1 degree increase in temperature between the Controls and S. enterica, and about a 0.5 degree difference between the Controls and S. aureus, although neither is statistically significant

Further Analysis
In the Control, PBS, and E. coli trials the average temperatures by sex remained essentially constant and seemed to be no effect on behavior. In the S. aureus and S. enterica trials there was a convergence of temperatures, with the females getting colder and the males getting warmer to meet at just about the same temperature. Behavioral fever may have been observed if the snakes adjusted their temperature to 27.7 degrees in order to most effectively fight off the bacteria. By taking blood samples from these snakes, bacterial killing assays can be performed at different temperatures to see if the killing efficacy is higher at this centralized temperature.

Data and Graphs

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