Tick Sweats

Alyssa Arnsperger[1] Soheila Fatehi[2], and Dr. Yoonseong Park[2]

[1]Department of Animal Sciences and Industry,
[2]Department of Entomology, College of Agriculture, Kansas State University

Abstract

Ticks are obligatory ectoparasites of many vertebrate hosts including human. Osmoregulatory functions of ticks are crucial for the survival, especially, in the off-host ticks in arid area. We found that injection of water in the body cavity of tick immediately triggers excretion of solution through the exoskeletal cuticles, like sweating. This response occurred in a bilateral asymmetric manner; the injection on left side of the body induced the sweating on only the left half, while the injection into right side did not induce sweat. The sweating response was reduced in the injections of high osmolar NaCl (1 M). This is the first description of sweating physiology in maintenance of water homeostasis in the Lone star tick.

Purpose

The purpose of this experiment was to investigate the general mechanism that induces sweating in Lone star tick.

Questions and Hypotheses

Question:

1. Is tick sweating response local on the area of injection occur?
2. Is tick sweating response depending on the osmolarity of the injected solution?

Hypothesis: Tick sweats depending on the local osmolarity of the hemolymph.

Study System

The research project was based around “Amblyomma americanum” or the Lone Star Tick. It is indigenous to much of eastern United States. It is mostly found in woodlands with dense undergrowth and around animal resting areas. The distribution of this tick is mostly located in eastern United States but is also common in Arkansas. In Kansas, it is commonly found in the eastern half of the state but has been found in the western half of arid area as well. The basic biology of this tick are the adult females are reddish-brown in color and can be distinguished from other ticks by the presence of a single spot on top of the center of the back which is often white to cream or even a bronze color. The males do not carry the spot on the back, only the females.

Methods and Experimental Design

The experimental design began using equipment used for injections. The needle was filled with an oil to prepare the needle for the uptake of the sodium chloride solution. Using the NanoJect III, the needle was filled with a large droplet of the sodium chloride solution. A series of injections took place with an assortment of both male and female Lone Star Ticks. In the first round of data, 12 ticks were injected. 6 on the right side of the abdominal cavity and 6 on the left side. In the second round of data collected, only 6 ticks total were used. Statistics were using Fisher’s exact test on the 2x2 contingency table.

Results

The sweating response occurred in a couple of seconds after 100nL injections of water on the left side of the body cavity (Fig. 1), whereas injections on the right side did not induce any sweating response (Table 1). Injections of hypo- or norm-osmolar solution robustly induced sweating, whereas of hyper-osmolar (1000mM) NaCl, which is slightly hyperosmolar compared to the tick hemolymph (Kim et al, 2016), reduced the sweating response (Table 2).

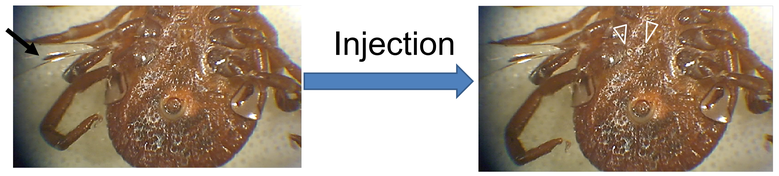

Fig. 1. Example of injection triggering the sweating. Left picture is before the injection with the arrow indicating the injection needle. Right is after the injection showing the sweating by empty arrow heads.

Table. 1. Bilateral asymmetric responses of the ticks injected on the left/right side of the body. Left side injection induced significantly higher rate of response with P=0.0003 in the Fisher’s exact test for 2x2 contingency table.

	Sweating	No response
Left	7	1
Right	0	10

Table. 2. Different rate of sweat responses to the injections with different osmolar solutions. The statistics were Fisher’s exact test for 2x2 contingency table.

mM NaCl	Sweating	No response	Statistics*
0	3	0	
100	3	0	NS
1000	2	4	P=0.17

Conclusions

The inferences I can make about this experiment are that the sweating of the tick is something that is quite unique. At a certain osmolarity pressure, the tick’s body secretes or “sweats”. This has never been documented before and is a huge step in research. Dr. Park wants to continue the research on this specific reaction. As we injected the sodium chloride solution at different molarities, there was a different reaction on different sides of the body cavity. If we inject on the left, there was sweating that occurred but no sweating if injected on the right. There must be some sort of mechanism within the osmolarity regulation that produces the sweating but only on the left side of the body cavity.

Future Directions

For future directions with an experiment like this, I would test some new variables in order to find why or how this secretion works. I would first test other molarities to specifically depict which solution causes the most sweat to secrete. I would also better test the male and female at different stages of their life cycle to see if the same secretion occurred. There needs to be further experimentation in all directions since this is something that is fairly unique and has not really been tested before. This is a unique phenomenon which is why further research needs to be done in every direction.

References

Kim D., J. Urban, D. Boyle, and Y. Park (2016) Multiple funcitons of Na/K-ATPase in dopamine induced salivation of the blacklegged tick, Ixodes scapularis. Scientific Reports 6, 21047

Tick Biology - The TickApp for Texas and The Southern Region, http://tickapp.tamu.edu/ticks/lonestartick.html

Acknowledgements and Announcement

I would like to thank Dr. Jeremy Marshall for roviding the research opportunity. Dr. Park is looking for a motivated undergraduate student who would continue this research. Contact @ ypark@ksu.edu