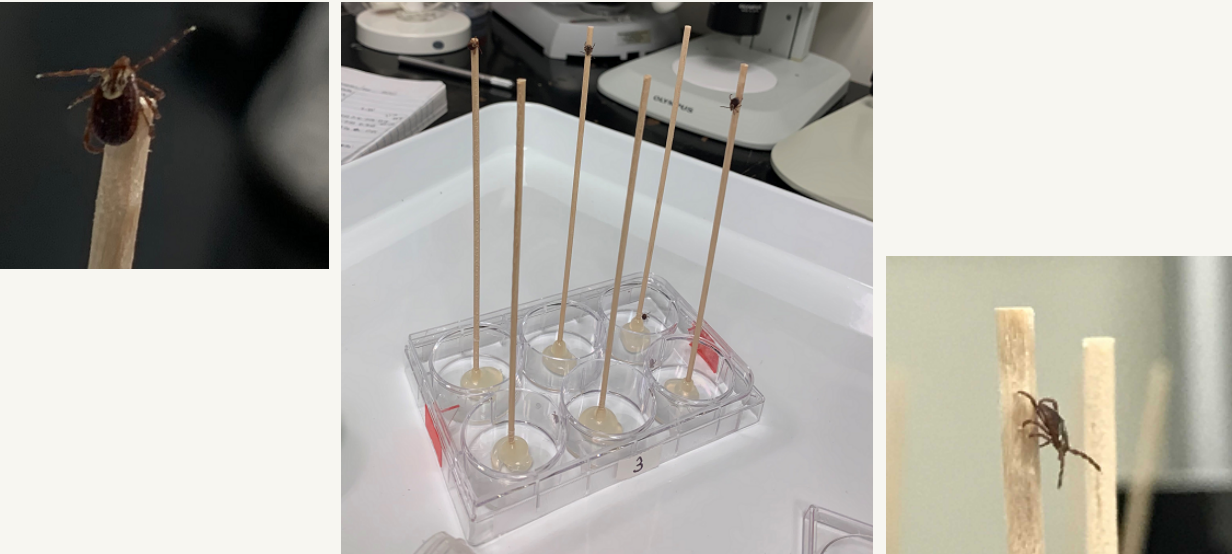


The impact of dehydration and starvation on tick questing behavior

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Abstract

The American dog tick, *Dermacentor variabilis*, is a parasitic and hematophagous arthropod, native to regions of North America lying east of the Rocky Mountains. Similar to other hard-tick species, they have a relatively irregular feeding pattern. As blood feeding animals, they must find a host to obtain a bloodmeal. Between bloodmeals, ticks must survive long periods of starvation. As starvation progresses, ticks may increase their activity levels and questing behaviors to locate a host. Other factors such as changes in humidity will influence tick questing behavior, as ticks (being small in size) are particularly vulnerable to dehydration. However, information regarding how starvation and dehydration influences tick questing behavior is not extensive. As ticks are vectors for several disease-causing pathogens, understanding how abiotic conditions influence questing may provide insights into ticks as disease vectors. We measured the effect of dehydration and starvation on questing times of *Dermacentor variabilis* at 2 (un-starved) and 6 months (starved) post-ecdysis. Ticks were exposed to either 0% or 93% relative humidity (RH) for 24 hours preceding questing trials. The time required to assume a questing pose was measured for both starved and un-starved ticks exposed to low and high humidity, following a host-cue. Our results show that starvation strongly influences the time to quest, with starved ticks assuming a questing pose significantly faster than un-starved ticks. Dehydration did not influence time to quest estimates for ticks, however, this could be due to the relatively short exposure time. Our results provide insights into the host-seeking behavior of ticks.



Pictured above (left to right): *Dermicentor variabilis* atop a wooden pole exhibiting questing behavior, tick questing arena, *Dermicentor variabilis* descending wooden pole.

Methods

- Removed 24 adult ticks from the 93% RH large desiccator within the incubator.
- Placed 12 ticks in each of the small desiccators: one set at 93% RH, the other at 0%.
- Placed ticks back in incubator to adjust to the RH for 16 hours
- Removed ticks from desiccators and quickly placed one in every well of all four culture dishes.
- Sealed the culture dishes and placed one tick in each of the 4 plastic bins. Placed the bins back in the incubator for another 4 hours
- Removed the first bin from the incubator and opened the culture dish
- Provided host que by breathing hot air onto culture dish. Repeated every 5 minutes
- Closely monitored the ticks for 30 minutes, recorded observations and used tweezers to prevent them from escaping their wells
- When a tick mounted the pole in their well, the time it takes for them to reach the top and display questing behavior was measured.
- Repeated for the remaining 3 culture dishes.
- Repeated experiment until entirety of starved and un-starved ticks have been tested

Results

Although the relationship between starvation and time to quest is not significant ($p=0.07$; Figure 1), the trend suggests that starved individuals are much faster to assume a questing pose than unstarved individuals. Our smaller sample size (~50 per treatment group) might explain why this pattern was insignificant. In the future, we plan to increase the number of individuals in each group.

The effect of relative humidity on time to assume a questing pose was insignificant ($p=0.17$; Figure 2), however, the time to quest was slightly shorter for dehydrated ticks compared with ticks exposed to 93%. Because only ~50% of the total number of ticks measured participated in the trails, we believe that increasing our sample size might lead to a more accurate estimate of the effect of dehydration on questing times in ticks.

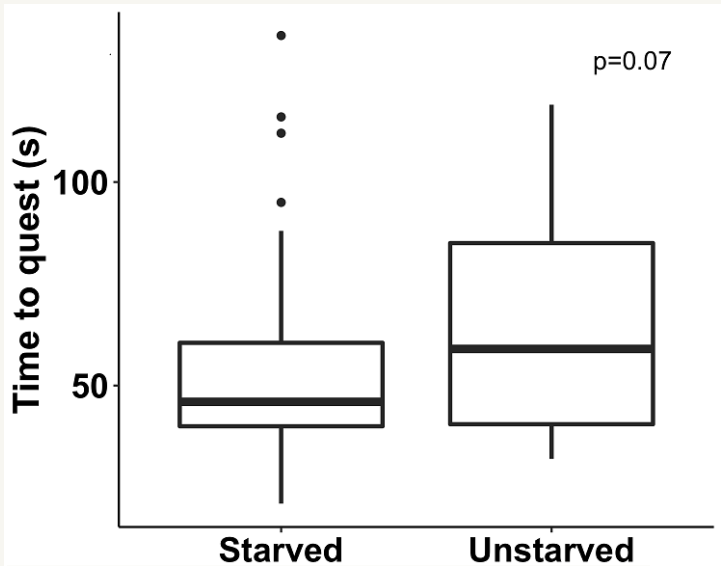


Figure 1: The amount of time in seconds that it took for ticks to ascend the pole and assume a questing pose for both starved and unstarved ticks.

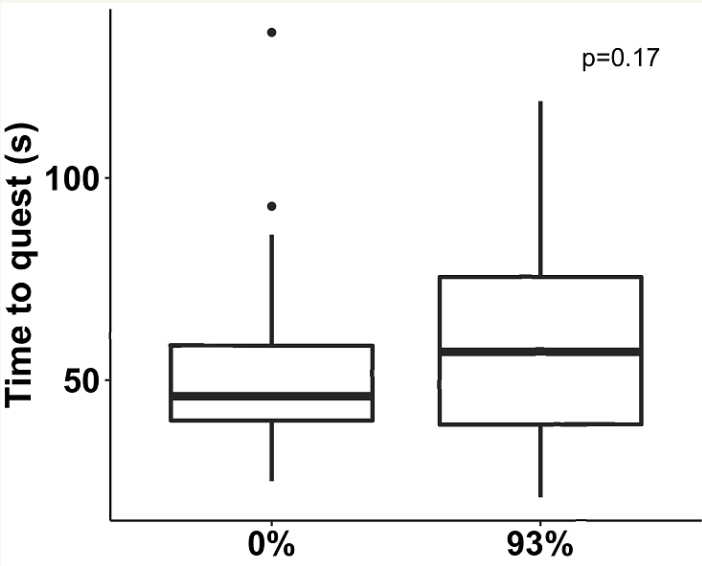


Figure 2: The amount of time in seconds that it took for ticks to ascend the pole and assume a questing pose for ticks treated with 0% and 93% RH for 24hrs prior to testing.

Conclusion

Our research indicated that starvation level strongly impacts the time to quest. Starved ticks were markedly faster in ascending the pole than their un-starved counterparts. This trend corroborates the current information regarding tick metabolic functions during periods of starvation. As its time without a blood meal increases, the expression rate of genes related to chemosensing and salivary gland proteins rise as well (Rosenthal 2018). The presumed impact of such metabolic activities would be an increased rate of questing activity, which is verified by the results. No correlation was observed regarding dehydration level with respect to questing time. This could be due to insufficient length of exposure to low RH. In the future, this experiment would be improved by using a greater sample size, and through adding intermediate starvation and RH treatment groups. Overall, this research has granted a clearer understanding of the host-seeking behavior of ticks.

Acknowledgements and References

Thank you to Dr. Oyen and Dr. Benoit, who trusted me to assist them in their work. Thank you to the University of Cincinnati and its professors for teaching me.

Andrew J. Rosendale, Megan E. Dunlevy, Marshall D. McCue, Joshua B. Benoit. 2018. “Progressive behavioural, physiological and transcriptomic shifts over the course of prolonged starvation in ticks.” Wiley Online Library . November 18. <https://onlinelibrary.wiley.com/doi/abs/10.1111/mec.14949>.