The Dynamics of Temperature, Humidity and Cluster Size and Their Impacts on Viability of Moose Tick Eggs.

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Abstract/Introduction

The moose or winter tick, *Dermacentor albipictus*, is a one-host species, feeding on moose and other ungulates. Most ticks spend most of their lives off-host, but as a one-host species, the only stages off-host are the eggs and larvae. In specific, females will feed on a host, and then fall off to lay their eggs in the surrounding environment, where the eggs will hatch, and the larvae will then quest for the next host. This indicates that where the female ticks lay their eggs is vital to their survival as a population since the eggs must be able to thrive in the environment in which they have been laid (Holmes et al. 2017)[3]. Little is known about the effects of temperature, humidity, and the number of eggs laid on the viability of tick eggs. In this experiment, we investigate how these dynamics between the specific relative humidity, temperature, and clutch size affect the survivability of tick eggs. Our data shows that the best conditions for moose tick egg survivability are in larger groups of eggs, higher humidity, and lower temperatures allowing the moose tick to thrive in areas with these conditions. There are many species of ticks, however, the *D. albipictus* is particularly of interest due to the lack of knowledge about their survivability within various environments and their ability to find a new host.

Methods

Sample Collection and Analyses: Female *D. albipictus* (obtained from Kerrville., TX) and deposit eggs. Eggs were randomly selected and separated into tubes containing 1, 5, 50, or a cluster of eggs (~2,000). The clusters counting is still in process and is not analyzed in the poster. These tubes were then placed into varying conditions of 20ºC, 24ºC, and 28ºC, as well as 33%, 75%, 85%, 93% and 100% relative humidity and monitored until larval emergence. Two weeks after the first larval emergence within the tubes, samples were frozen, and analyzed by counting each set of 1, 5, and 50 counts three times. This data was used to calculate the average egg viability within each of the conditions. Figures and statistics were generated using R and, which were used to analyze egg viability data collected to determine the trends of the data based on the given dynamics.

Figure 1. Female winter ticks feeding and depositing eggs. Thousands of tick eggs are produced after a female tick has fed and has fallen off the host. Below

Figure 2. Samples 1, 5, and 50 eggs from 93% relative humidity after larval emergence, freezing, and being placed into petri dishes. Viability was assessed by the number of larvae emerged.

Results

Our results show that for best viability, winter tick eggs should be deposited in areas with a higher relative humidity and within clusters. We observed this within the average viabilities and compared the dynamics using heat maps to determine which conditions resulted in the best overall survivability of the tick eggs (Benoit et al. 2021)[1].

Relative Humidity and Egg Cluster Size

In the comparison between the relative humidity and cluster size, we found the trend for increased survivability was with greater clutch size and increased humidity. In the study we found that in a clutch size of 1 and 33% relative humidity, there is no viability, but in a clutch size of 50 and 100% relative humidity, there is a high viability. These samples are a good representation of the gradient observed within our data as a whole. This trend continues overall throughout all temperatures and supports the previous study performed on the relationship between relative humidity and winter tick egg cluster size.

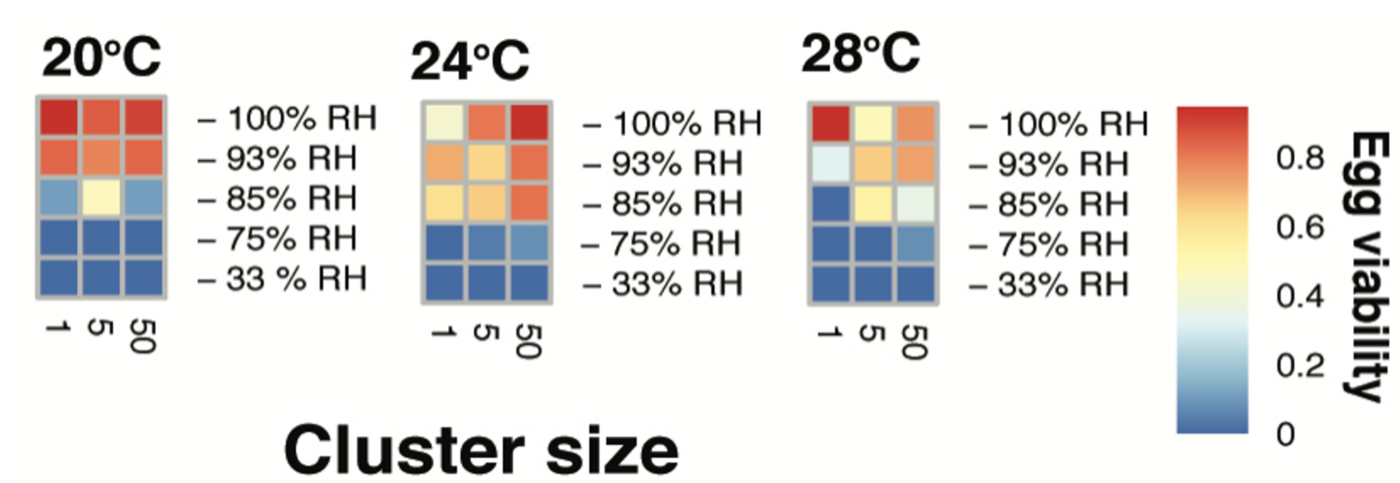

Figure 3. Heat maps of egg viability when comparing relative humidity with egg cluster size. This heat map confirms the trend within all temperatures that viability increases as relative humidity and cluster size are increased. Each square above represents a set of 20 individual tubes counted 3 times. An average of the viability was taken from each count and recorded as the egg viability.

Effect of Temperature and Cluster Size on Viability

When temperature and cluster size were compared to determine their effect on the viability of the winter tick eggs, there is a trend for increased egg viability with increased cluster size, but an overall decrease in temperature. In our study we observed this across all temperatures. Increasing the clutch size and humidity increased viability in all the temperatures. The highest viability in each temperature setting was found in the groups with the highest humidity and the highest clutch size.

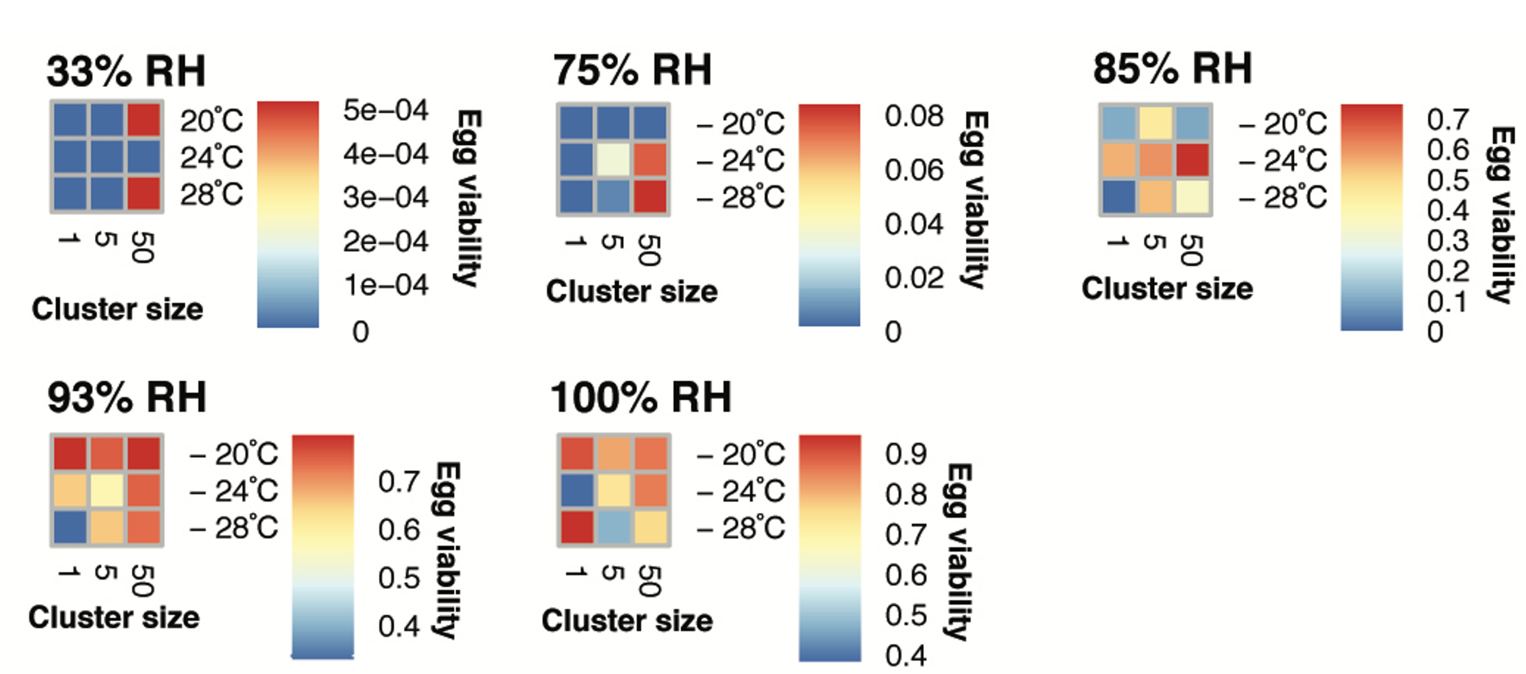

Figure 4. Heat maps comparing the relationship between temperature and cluster size on egg viability. The heat map agrees with the trend of increasing cluster size and decreasing temperature increases the viability of winter tick eggs. Each square above represents a set of 20 individual tubes counted 3 times. An average of the viability was taken from each count and recorded as the egg viability.

Impacts of Temperature and Humidity on Viability.

The comparison of temperature and humidity showed a predictable pattern based on the data trends from the temperature vs cluster size and humidity vs cluster size heat maps. We found that the trend for winter tick viability when comparing temperature and humidity is that viability is increased when the relative humidity is higher, but temperature is lower. This agrees with the values we found, where the highest viability is found in the sample with a temperature of 20ºC and 100% relative humidity. These results also remained in agreeance with the other trends. These figures make it possible to see the trends between all three of the investigated dynamics.

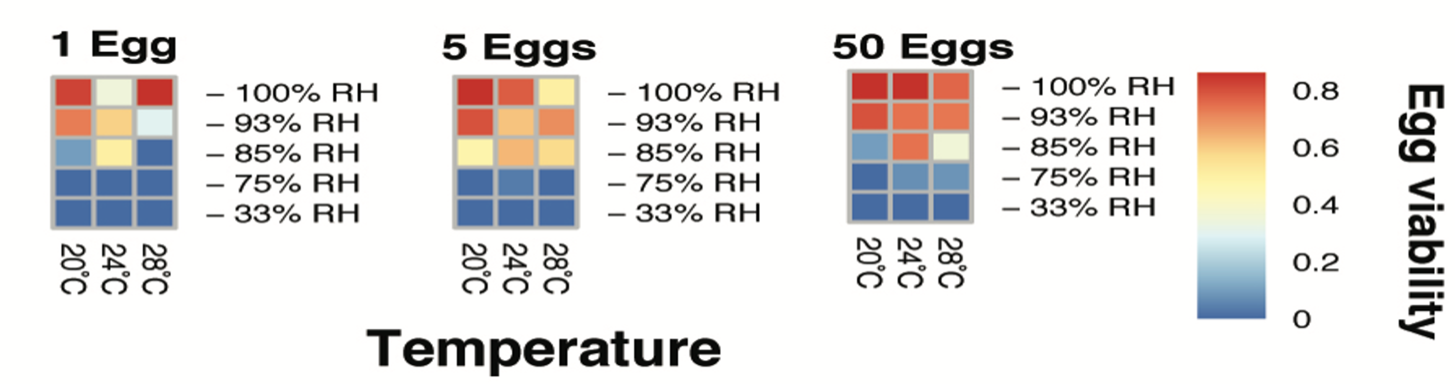

Figure 5. Comparison of temperature and humidity and their impact on egg viability. These heat maps provide a visual indication of the increase in viability at lower temperatures and higher humidity. Each square above represents a set of 20 individual tubes counted 3 times. An average of the viability from each count was taken and recorded as the egg viability.

Summary & Future Directions

We found that the optimal conditions for a female winter tick to lay her eggs were within the parameters of lower temperature, higher humidity, and higher cluster sizes. We know that where winter tick eggs lay their eggs are essential to their survival (Holmes et al 2017)[3], and the conditions in which the eggs are exposed to can make a significant difference in the rate at which they survive and therefore contribute to the population of winter ticks in a given area. The knowledge about a population of winter ticks can also be useful in determining the health of a population of moose. The winter tick has a significant impact on moose survival as they will attach to a host in thousands, greatly reducing the amount of nutrients an individual moose is receiving and contributing to a large amount of blood loss (Rosenblatt et al. 2017)[4]. These factors can be detrimental to moose as an individual and as a population. This data will give us insight as to where the most vulnerable and stable populations of winter ticks are located providing a pathway to future studies on the environment in which winter ticks thrive in and how this may affect the moose population in the area. In specific, we will combine experiments on temperature and relative humidity detection by female ticks in relationship to where they deposit and the survival of the eggs.

References

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