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Prevalence of Ticks Infected with Human Pathogens in the Lehigh Valley: Collection and Assessment of Tick Abundance

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BACKGROUND / INTRODUCTION



The black-legged tick (*Ixodes scapularis*) is a vector of several important human pathogens including *Borrelia burgdorferi*, *Anaplasma phagocytophilum*, *Babesia microti*, and *Borrelia miyamotoi*.

When black legged tick larvae feed on infected reservoir hosts,

predominately white-footed mice (*Peromyscus leucopus*), they can become infected with the pathogens. During subsequent blood-meals the nymphs can transmit these pathogens to humans during a bite lasting longer than 24 hours.

This study focuses primarily on the prevalence of ticks infected with these pathogens, principally *B. burgdorferi*, which is the causative agent of Lyme disease. Our working hypothesis is that there is a correlation between the abundance of *B. burgdorferi* infected ticks and the prevalence of reported case of Lyme disease. In order to test this hypothesis, it is first necessary to collect the relevant data using methods that will allow for year to year comparisons.

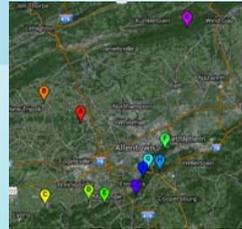
Clearly at the extremes, there is a clear correlation between tick abundance and infection rates and human cases of Lyme disease. However, it is not yet clear if seasonal variations in the prevalence of human disease in places where *I. scapularis* and *B. burgdorferi* are known to be established can be correlated with field and lab-based tick studies. Very few long-term studies have been done in this field.

Determining the infection rates of ticks with other pathogens may also be helpful in providing infectious disease physicians with locally-relevant information about the relative likelihood of being bitten by an infected tick.

METHODS

Ticks were collected and logged from sites around the Lehigh Valley (Figure 3), tracking distance traveled, location, and time spent collecting for future calculations. 841 ticks were collected from 11 sites and the data were recorded in a way that the abundance of ticks could be assessed with respect to time and area sampled.

Figure 2. (right) Removing ticks from cloth and placing in vial



- A. Trexler Nature Preserve
- B. Raker Wildlife Preserve
- C. Park in Topton
- D. Alburts Mountain Road Tract
- E. Reimert Memorial Bird Haven
- F. Lehigh Uplands Preserve
- G. South Mountain Preserve
- H. Scholl Woodlands Preserve
- I. Robert Rodale Reserve
- J. Burkhardt Preserve
- K. Graver Arboretum

Figure 3. Collection sites from around the Lehigh Valley

While collecting, distance traveled, time spent dragging, and GPS location was monitored using the Trails app (Figure 4). Keeping track of distance traveled and area covered allows for calculation of the Entomological Risk Index (ERI), which takes into account tick abundance and infection rate. Additionally, GPS allows monitoring of location in relation to collections from previous years.



Figure 4. Screenshot from Trails app

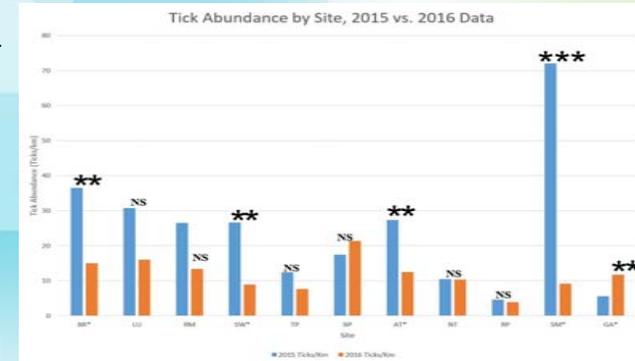
The goal of each of the collections is to obtain at least 50 ticks. This number takes into account the credible interval, sample size, and the time expense of the tick DNA extractions. The lower the sample size, the larger the range for credible interval. As shown in Table 1, increasing the sample size from 5 to 50 samples, decreases the credible interval range by 34.63%, a very considerable tightening of the range. Doubling the samples from 50 to 100 decreases the credible interval by 6.1%, with double the extractions per site. Considering the extractions take 3-4 hours for 15 ticks, this difference was deemed insufficient to justify the greater time expenditure.

Sample Size	N Positive	Percent Positive	Lower 0.95 Credible Interval*	Upper 0.95 Credible Interval*	Credible Interval Range
5	1	20%	0.17%	56.4%	56.23
10	2	20%	2.3%	46.2%	43.9
25	5	20%	6.9%	36.7%	29.8
50	10	20%	10.1%	31.7%	21.6
100	20	20%	12.7%	28.2%	15.5
500	100	20%	16.6%	23.6%	7.0

Table 1. Determination of ideal sample size for tick extraction

White, 1 x 1-meter corduroy sheets were dragged along the ground, periodically checking for ticks and removing them with forceps. After removal, ticks were placed in vials of 70% ethanol and kept frozen for DNA extraction and analysis.

RESULTS



CONCLUSIONS

- We were successful in collecting a sufficient number of ticks for analysis from the same 11 field sites in the Lehigh Valley that were investigated in Summer 2015.
- Ticks at the nymphal stage were abundant at all sites, emphasizing the need to encourage the public to use appropriate measures to avoid exposure to ticks.
- Differences in overall tick abundance at all sites are not significantly different in comparison to 2015 data (P-value: > 0.05).
- Extraction of tick DNA has been completed and PCR analysis of DNA samples is in progress.
- Future work will be directed towards tracking trends in tick abundance and infection rates, and also analyzing our data in the context of clinical data reported to the State of Pennsylvania.

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