Associations of blacklegged ticks and European fire ants on Mount Desert Island

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Abstract

The blacklegged tick (*Ixodes scapularis*) and the European fire ant (*Myrmica rubra*) are notable pests on Mount Desert Island (MDI) and across coastal and southern Maine. The aim of this project is to determine the effect of *M. rubra* on *I. scapularis* abundance and pathogen infection prevalence, which will help improve the development of management practices for both species. Ticks were sampled at eight ant-infested (treatment) sites and eight uninfested control sites on MDI. We will conduct laboratory bioassays to measure *M. rubra* aggression against adult, nymphal, and larval ticks. In addition, we will use track plates to measure small mammal activity and test ticks for the Lyme-causing bacterium *Borrelia burgdorferi*. We hypothesized that *I. scapularis* abundance would be lower at treatment sites, due to predation by *M. rubra,* but found no significant difference. We also hypothesize a decreased infection prevalence at treatment sites, due to altered behavior and lowered host-encounter frequency of the small mammal reservoir hosts of *B. burgdorferi*.



Figure 1: European fire ant nest



Figure 2: Female blacklegged tick (1)

Introduction

Blacklegged tick background:

- *Ixodes scapularis* abundance has been rising in Maine for nearly 30 years (2).
- 1,769 cases of Lyme were reported in Maine in 2017(Center for Disease Control and Prevention)—a drastic increase from previous years.

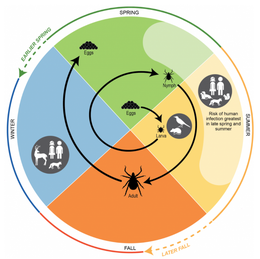


Figure 3: Blacklegged tick life cycle (3)

European fire ant background:

- *Myrmica rubra* is a species of ant native to Europe. It was introduced to North America sometime in the early 20th century.
- First reported on MDI as early as the late 1960s, now infested in very high densities within isolated areas of the island (4).
- An aggressive, stinging ant species that attacks and depletes native ant colonies.

What we know about ants and ticks:

- Ants are some of the most prominent tick predators (5).
- Blacklegged ticks and European fire ants are active at the same time, and they both tend to inhabit leaf litter and underbrush in deciduous forests.

What we want to find out:

- Does *M. rubra may* prey on one or more life stages of blacklegged ticks?
- Does *M. rubra* disturb the natural behavior patterns of small mammals enough to affect the exposure of small mammals to ticks (vector-host encounter frequency) and reduce pathogen infection prevalence?

Methods

Site establishment:

- We selected eight sites on the east side MDI where *M. rubra* was present in high density. Ant presence was determined by turning over logs to expose nests and by using density estimates from a previous study (4).
- We then determined eight control sites that had no detectable *M. rubra* presence to pair with the treatment sites. The control sites were located between 50 and 1500m from their treatment sites to minimize climate variation. The sites also had similar vegetation, canopy composition, and groundcover.

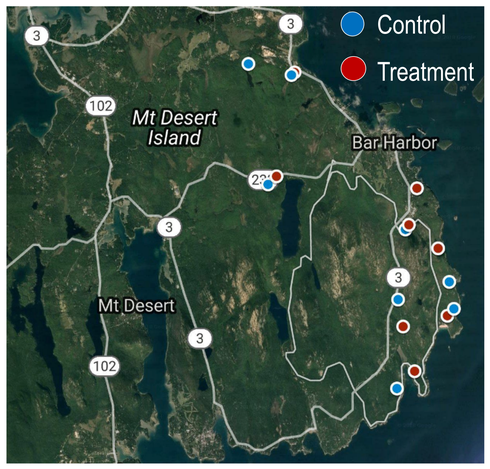


Figure 4: Map of study site locations on MDI

Tick collection:

- We dragged a 1m^2 piece of cloth across the ground.
- We dragged at each site for one man-hour (1 hour÷ number of people collecting).
- Nymphs were stored in 70% ethanol for subsequent species ID and pathogen testing.
- Larvae were removed with a lint roller.
- The first round of collecting took place between 7/3/18 and 7/11/18.
- The second round took place between 8/20/18 and 8/21/18.
- Paired sites were sampled on the same day.



Figure 5: Checking a drag cloth for ticks



Figure 6: Lint-rolling larvae

Small mammal track plates:

- Acetate sheets were coated with a mixture of graphite powder, 80% ethanol, and mineral oil, then fixed to pieces of plywood.
- We baited the plates with sunflower seeds and deployed five plates at each site for one night.



Figure 7: A small mammal track plate with bait

Results

Table 1: Mean, range, and STDEV.S of *I. scapularis nymphs* collected in control and treatment groups

Data set	Total (*I. scapularis* nymphs)	Mean	Range	STDEV.S
July control	71	8.875	14	6.266
July treatment	106	13.25	32	10.124
August control	28	6.222	10	4.106
August treatment	29	6.444	10	3.292

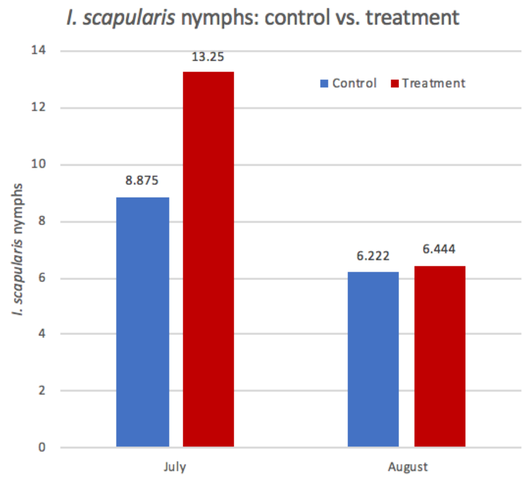


Figure 8: Mean Blacklegged tick nymphs collected at control and treatment sites (t-test: P_{July}= 0.3779, P_{August}=0.9191).

Future Work

Track plates:

- We will identify the footprints on the track plates to determine whether the activity of tick hosts, such as white footed mice and chipmunks, was significantly impacted by *M. rubra.*

Pathogen testing:

- Although we found no significant difference in tick abundance, there could still be a difference in the percent of nymphs infected with *B. burgdorferi.*
- This winter, with guidance from Dr. Anne Lichtenwalner, I will perform pathogen testing on a 50 of the collected *I. scapularis* nymphs to determine whether *M. rubra* effects the prevalence of *B. burgdorferi.*

Aggression bioassays:

- Ants and ticks will be placed in plastic "arenas," and the behavior of the ants will be observed and measured using an aggression formula.
- Trials will include *I. scapularis* larvae, *I. scapularis* nymphs, *I. scapularis adults*, and lone star (*Amblyomma americanum*) adults as an outgroup.
- Caterpillars = positive control
- Empty arena = negative control
- The aggression score will be calculated by tallying different behaviors in order of violence: 1) threatening, 2) grasping, 3) carrying, and 4) fighting/stinging (6).

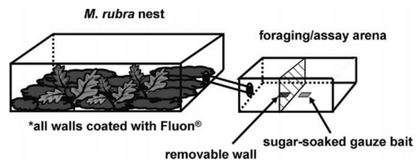


Figure 9: Arena structure (4)

Conclusion and Anticipated Results

Preliminary conclusions:

- Results do not support the hypothesis that *M. rubra* would reduce *I. scapularis* abundance.
- Suggests two possibilities: one, that European fire ants do not prey on blacklegged tick nymphs; and two, that the effects of predation were negligible in this study.

Looking ahead: aggression bioassays

- *Myrmica rubra* may prey on all life stages, contradicting our results from the field study; this would suggest that the effects of such predation on the blacklegged tick abundance are very small
- *Myrmica rubra* may prey on *I. scapularis* adults, but not nymphs or larvae, supporting the results of the field study. We did not collect any adult ticks—a third round of collection in September, when adults are active, would be relevant to this scenario

Pathogen testing:

- We predict a smaller percentage of positive results from treatment sites than from control sites, due to reduced host-vector encounter frequency.
- After analyzing the track plates, we will hopefully have a means of showing whether small mammal activity really differed between control and treatment sites.

An understanding of *I. scapularis* ecology—including interactions between ticks, ants, and small mammals—is vital to the management of ticks and the pathogens they transmit. I hope that the conclusions drawn at the culmination of this project will be helpful in managing both blacklegged ticks and European fire ants.

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Figure 10: The Gardner Lab team

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