Factors affecting tick burden in wild mice populations

Abstract

Understanding the interacting factors affecting parasitism of individuals is vital to understanding transmission and epidemiology in wild populations. There is literature to support factors such as sex, age, size, and food supply playing a role in parasitism. This analysis looks at whether individual demographics and food availability in wild wood mice (*Apodemus sylvaticus*) populations influence instances of tick presence, as well as if there is evidence of acquiring immunity to tick infection. The findings suggest relationships between food supply, age, and body length and tick presence, however no evidence of acquired immunity was found.

Introduction

Differences in tick parasitism between individuals in a population is driven by many different factors. In this study various variables including sex, age, reproductive status, body mass and length and food availability were examined in relation to tick presence in wild wood mice (*Apodemus sylvaticus)*. There is literature to support male sex bias in parasitism of mammals based on differences in body mass (Harrison et al, 2010), and immunity (Zuk and McKean, 1996) between males and females, however, sex differences in parasitism does not seem to be a hard and fast rule for across all populations (Schalk and Forbes, 1997). This study investigates the male sex bias hypothesis in parasitism as well as body size hypothesis (in which tick burdens increase with body mass and age) (Kiffner et al, 2010). It also examines whether reproductive status and food supplementation have an impact on tick presence. Finally, evidence of acquired immunity to tick infection between first and second capture is investigated.

Methods

Data collected from July - November 2020 was used for this study. Live trapping sessions on three consecutive nights were undertaken at two separate woodland sites around 10 miles outside of Edinburgh on a three-weekly rotation at each site. Each site consisted of five 6x6 grids with 2 traps at 10m intervals. Each site had 4 supplemented grids with different food (TransBreed) distribution (2 even and 2 aggregate) and 1 control grid. This report analyses 494 individual mice and 1260 total captures. Demographic data was collected including: age, sex, body mass, body length, tick numbers and reproductive status. Tick numbers were only counted to 10; mice with greater than 10 ticks were recorded as having 10. At the end of data collection, there was a total of 520 individuals and 1723 total captures.

To investigate the effect of the chosen demographic predictor variables (age, sex, body mass, body length, age, and reproductive status) and food supplementation type (even, aggregate and control), the data was fitted into a generalised linear model against a binary variable, tick presence/absence (with presence being numbers above 0). A binary variable for tick presence was chosen instead of using recorded numbers to improve validity. A type II ANOVA was then performed on the model.

A Welch's 2 sample t-test was performed between number of ticks on first and second capture to investigate evidence of acquired immunity, where a significant difference in numbers would indicate acquired immunity. Only mice with a burden below 10 were used in this test to preserve validity.

Results

The results at alpha value 0.05 show that body length has a weak but significant effect on tick presence ($Chi^2 = 4.47$ $p= 0.03459$, $df=1$) (Fig.1), with shorter individuals being more likely to have no tick burden. A partial significance was found between tick presence and treatment type (Chi^2 = 5.55, p= 0.062, df= 2) (fig.2) On grids with evenly spread TransBreed supplementation (TBE), a lower proportion of mice had tick presence. In the model, there was also a partial significance found between tick presence and age (Chi^2 = 4.98, p=0.083, df= 2) (fig.3), with a higher proportion of juveniles having no tick burden compared to sub adults and adults.

The results from the Welch's 2 sample t-test suggest no significance in tick numbers between first and second capture (t= 0.97, p=0.33, df= 590).

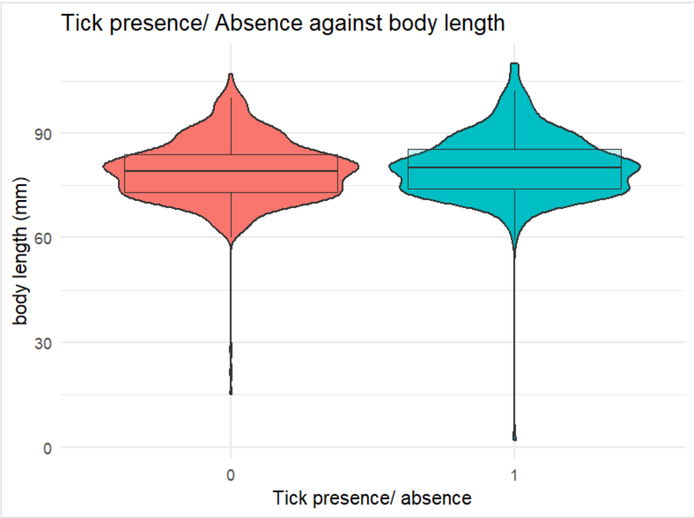

Figure 1. Violin plot with a box plot overlayed for both presence and absence of ticks against body length.

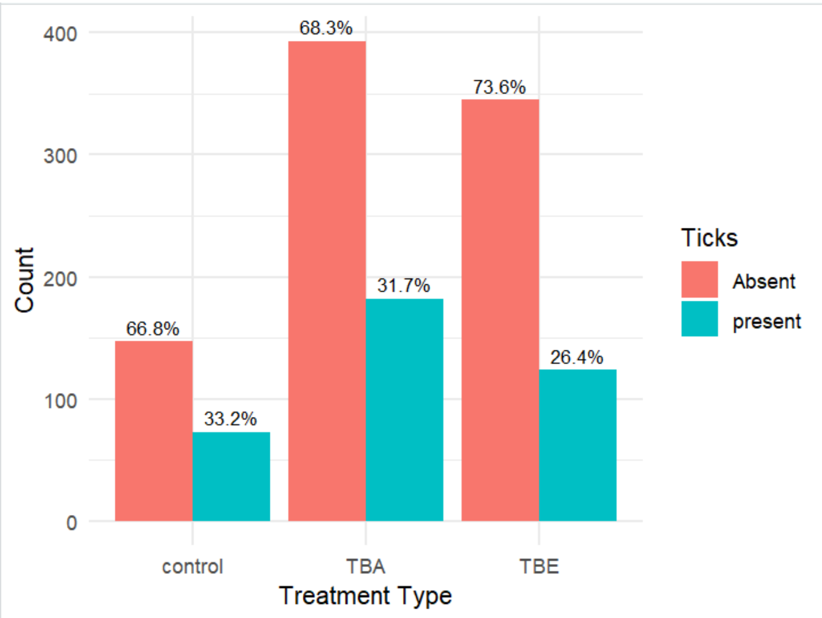

Figure 2. Bar plot of total count against Grid treatment type (control, TransBreed Aggregate (TBA), TransBreed Even (TBE)) for both presence and absence of ticks

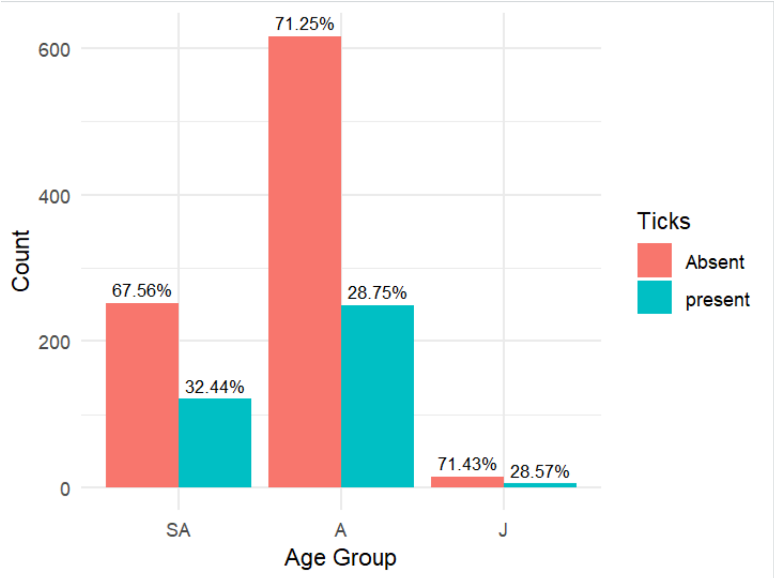

Figure 3. Bar plot of total count against Age Group (sub adult (SA), adult (A), juvenile (J)) in both presence and absence of ticks.

<u>Discussion</u>

This report assesses the effect of various demographic data as well as food supplementation on the presence of a tick burden in wild wood mice. It was hypothesised that sex, size (mass and length), reproductive status, age, and treatment (food supplementation) would influence instances of tick infection. Of the variables described, only body length produced a significant effect on tick presence. Age and Treatment produced marginal effects slightly above the alpha value, suggesting that they also may be influencing factors. It is important to consider that this study is of data from only one year and may not be as representative as if other years were included. Furthermore, because a binary variable was used instead of real tick numbers in the generalised linear model, the statistical power of this analysis is weaker due to limited information on actual tick numbers.

No evidence was found for male sex bias, in which larger males are commonly more heavily parasitised (Kiffner et al., 2011), (Harrison et al, 2010), (Perez, 2022), (Moore et al, 2002). Neither body mass or length were found to be correlated with sex, and neither body mass or sex had a significant effect on tick presence. However, body length did produce a small but significant effect on tick presence, with longer individuals being more likely to have a tick burden. This result suggests that body length is a weak predictor of tick presence. It is unclear from this study what is driving this effect and why body mass does not seem to produce a similar effect.

Age had a marginal effect on tick presence, with subadults having higher instances of tick presence than juveniles and adults. The reason behind this result is unclear but could be due to different grooming and roaming behaviours between subadults, adults and juveniles (Brunner and Ostfeld, 2008).

Mice on grids with evenly spread food supplementation had marginally lower instances on tick presence. One explanation for this could be that mice with a more readily available food supply have a smaller home range which reduces contact with ticks (Schradin et al, 2010). Another possibility could be that mice with a better diet have more energy to invest into immunity.

It is likely that host roaming and grooming behaviours plays a major role in rodent tick burden and that behaviour is influenced by factors like such as food availability age, sex, size, and personality (Brunner and Ostfeld, 2008), (Wauters et al. 2021), (Perez, 2022).

There was no evidence found of tick numbered decreasing between first and second capture, suggesting no evidence of acquired immunity. However, this test was done on a small sample size, due to mice with numbers of 10 being discarded, and differences in small numbers below 10 are likely to be difficult to distinguish. For this reason, more research is likely needed to further investigate whether mice acquire immunity to tick infection.

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