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# Tick infestation in Roe Deer (*Capreolus capreolus*) from Thuringia (Germany)

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**Abstract:** A total of 4027 ticks were collected from 103 deer pelts by means of the nested white tray technique. All ticks were identified morphologically as *Ixodes ricinus*. The frequency distribution of tick infestation levels is aggregated, infested deer hosting up to 504 ticks. 67% of the deer examined between May 2008 and December 2009 hosted ticks during the hunting season (May to January), the tick-free period being restricted to cold winter months. Most importantly, all three tick instars actually feed on deer, thus providing a very strong potential for cofeeding transmission of tick-borne pathogens between instars.

**Key words:** *Capreolus capreolus, Ixodes ricinus*, tick infestation, cofeeding, Germany

## Introduction

Roe deer (*Capreolus capreolus*) is a very common mammal in the European landscape, where it actually is the most abundant wild ungulate species (Sempéré *et al*. 1996). This species moves between various habitat types, dwelling in woodland during daytime and foraging in fields and meadows during night time (Blant 1995). Deer thus move ticks and the pathogens they harbour between these various habitats. Deer is actually considered to be a prime maintenance host for tick reproduction (Perkins *et al*. 2006; Skotarczak *et al*. 2008). There is however thus far no exhaustive quantitative study of ticks from deer. A study in the UK examined severed forelegs (Alberdi *et al*. 2000) while a German one (Vor *et al*. 2009) screened the head and neck only. The aims of the present study were therefore to identify and quantify the ticks found on roe deer in Germany.

## Material and Methods

Entire pelts from 103 roe deer culled in Thuringia between May 2008 and December 2009 were collected for quantitative tick sampling using the nested white tray technique (Heyl, de Mendonça 2009). Briefly, each pelt was individually spread out inside a white plastic tray. This first tray was then placed in the middle of a second white tray filled with water (Fig. 1). Ticks crawling away from the pelt eventually fell into the water where they were easily detected and collected. Double-sided sticky tape on the rim of the external tray prevented any tick from escaping. Estimates of deer abundance were obtained by the distance transect method as described by Caughley (1977) along a 10.4 km long transect. Tick questing activity was monitored by dragging a white 1 $m^2$ flannel flag over soil and vegetation on a monthly basis over a 125 m long transect line located within

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the hunting grounds. Ticks were collected from the flag and counted every 2.5 m.

## Results

A total of 4027 ticks were collected from 103 deer pelts. All ticks were identified morphologically as *Ixodes ricinus*. The frequency distribution of tick infestation levels was aggregated (K=0.32, Fig. 2), however, it did not follow a negative binomial distribution (goodness of fit test: $p < 0.001$). 67.0% of all deer examined were infested with ticks, hosting between 1 and 504 ticks per deer. Adult ticks were more frequent than nymphs, which in turn were more frequent than larvae, being found on 65.1%, 59.2% and 50.5% of the inspected deer respectively. Nymphs were numerically dominant (up to 210 nymphs per deer), followed by larvae (up to 199 larvae per deer), whereas adults were the least abundant, although the most frequent instar (up to 128 adult ticks per deer). Most interestingly, all stages actually fed on deer. 36.1% of the larvae, 30.5% of the nymphs and 68.5% of the female ticks were engorged. Infestation levels peaked in May, matching the peak of tick questing activity (Table 1). Tick-free deer were observed during cold months only, from the second half of October until January. Amongst adult deer, males hosted significantly more ticks than females ($p<0.01$, $U=178.0$, $n=74$), whereas there was no statistically significant difference between immature male and female deer ($p>0.05$, $U=100.5$, $n=29$) (Table 2). Although there is a positive correlation between tick questing activity (expressed as the number of ticks collected by flagging over 100 $m^2$) and levels of tick infestation, the proportion of observed variability explained by any model remains low: 4.5% for larvae, 14.8% for nymphs, and 43.4% for adult ticks (Fig. 3). Estimates of deer density ranged between 1.0 and 7.3 individuals per $km^2$. No relation could be found between estimates of deer density and levels of tick infestation.

## Discussion

The present study is the first detailed quantitative description of tick burden on German roe deer. Only *Ixodes ricinus,* which readily bites humans and domestic animals, was found on deer. There is thus a potential for pathogen transfer from deer to other host species. The nested white tray technique

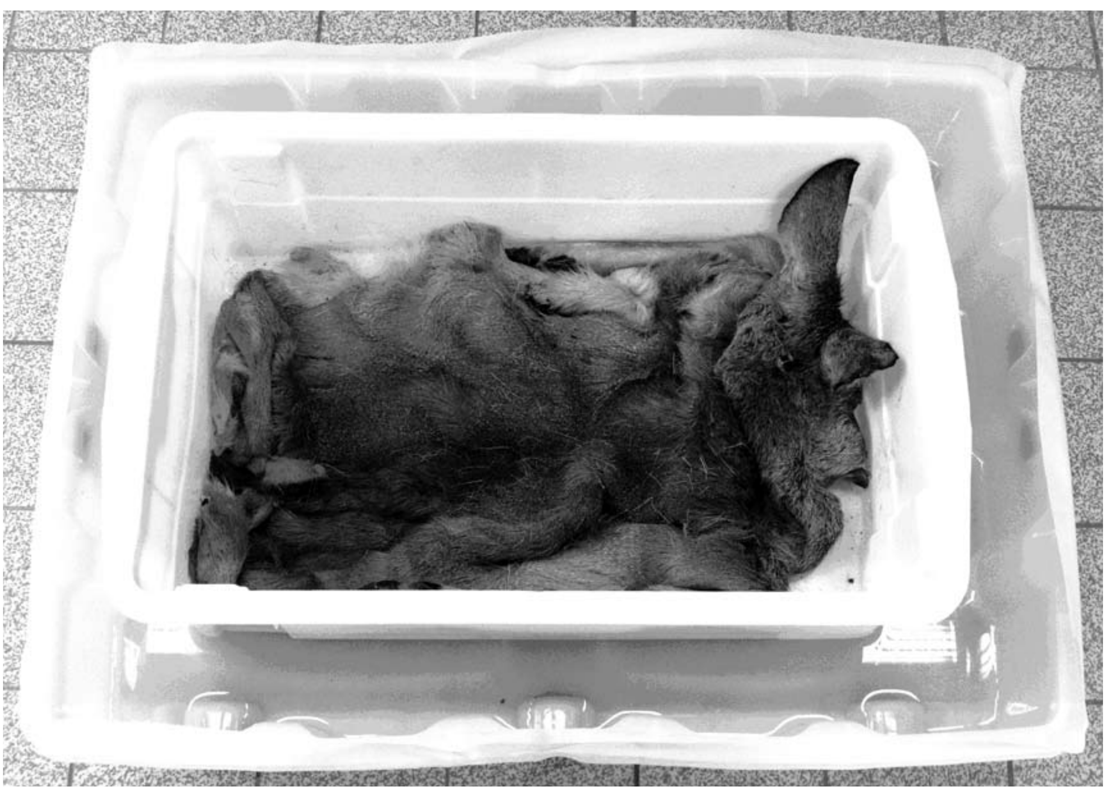

**Fig. 1.** Quantitative tick sampling from deer pelts by means of the nested white tray technique.

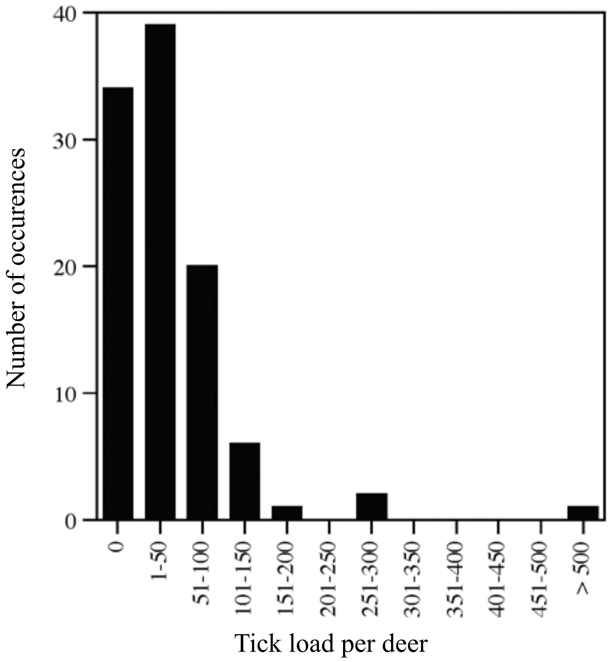


**Fig. 2.** Frequency distribution of tick burden on individual deer.

proved useful to quantitatively sample ticks from deer pelts. This method made it possible to demonstrate that deer is host not only to adult ticks but also to numerous larvae and nymphs, and that all three stages actually feed on deer blood. Larvae are thus not a simply phoretic stage on deer, they are actually true parasites of deer and may become infected with pathogens while feeding on deer. The pattern observed is therefore fully consistent with cofeeding transmission of *Anaplasma phagocytophilum* between instars feeding on deer (de Mendonça *et al*. 2008, Mogl *et al*. 2011). The fact that tick frequency distribution is aggregated implies that few individuals host most of the ticks parasitising deer, and are thus responsible for most of tick-borne pathogen transmission involving deer, although the 20-80 rule is not respected here. Based on our data, adult male deer host significantly more ticks than females do, whereas no statistically significant differences could be found between immature males and females. However, deer are traditionally hunted for trophy collection. There is therefore a strong biais in the age and sex ratio of animals shot, older males being preferentially targeted by hunters. Furthermore, young individuals are shot during the cold months when tick activity is minimal or nil. This corresponds to the sole period of the year when tick-free deer can be observed. We are therefore missing an important part of the picture, namely spring and summer, i.e. time when young display a ducking reflex (Blant 1995) thus exposing themselves yet more to questing ticks at a time when tick activity is high. There is

**Table 1.** Tick activity, ticks infestation levels (minimum, maximum, median) on deer, and estimates of deer density (individuals per km²) for various sampling periods. Only one individual, a road casualty, could be sampled outside hunting season. Questing activity is expressed as the number of ticks collected by flagging over 100 m².

| Period | Tick activity | Minimal infestation | Maximal infestation | Median | Deer density |
|---|---|---|---|---|---|
| May 2008 | 46.7 | 2 | 504 | 87.0 | 3.9 |
| June 2008 | 53.3 | 97 | 97 | 97.0 | 1.1 |
| July 2008 | 20.0 | 76 | 76 | 76.0 | 7.3 |
| Aug. 2008 | 22.0 | 72 | 99 | 85.0 | 1.0 |
| Sep.2008 | 0.0 | 36 | 36 | 36.0 | 1.0 |
| Oct. 2008 | 0.0 | 39 | 39 | 39.0 | 2.8 |
| Dec. 2008 | 0.0 | 0 | 0 | 0.0 | 6.8 |
| Mar. 2009 | 0.0 | 0 | 0 | 0.0 | 2.4 |
| May 2009 | 103.3 | 8 | 268 | 73.0 | 2.1 |
| June 2009 | 26.7 | 11 | 74 | 17.0 | 0.7 |
| July 2009 | 42.0 | 7 | 185 | 25.5 | 3.8 |
| Aug. 2009 | 6.0 | 4 | 12 | 46.5 | 5.1 |
| Sep. 2009 | 2.7 | 0 | 54 | 26.5 | 0.4 |
| Oct. 2009 | 2.0 | 0 | 16 | 1.5 | 0.5 |
| Nov. 2009 | 0.0 | 0 | 14 | 0.0 | 2.2 |
| Dec. 2009 | 0.0 | 0 | 0 | 0.0 | 4.6 |

**Table 2.** Tick infestation on deer as a function of sex and age class of the host.

| | Minimum | Maximum | Median | n |
|---|---|---|---|---|
| Adult males | 2 | 504 | 56.5 | 48 |
| Adult females | 0 | 185 | 2.0 | 26 |
| Immature males | 0 | 36 | 0.0 | 15 |
| Immature females | 0 | 39 | 0.0 | 14 |

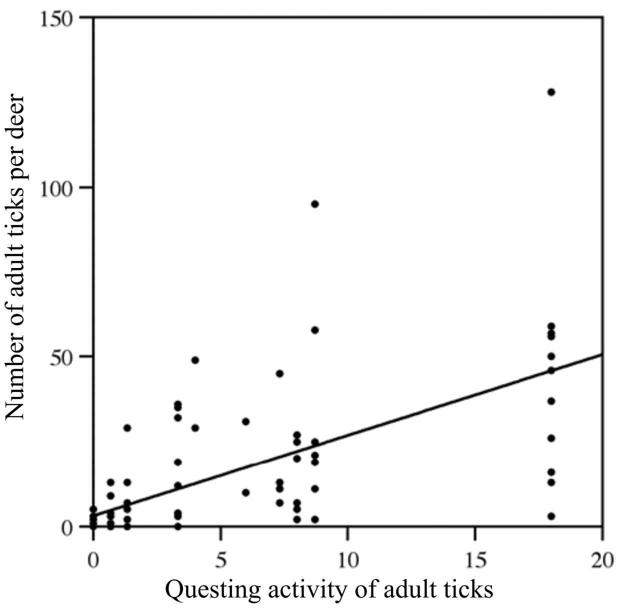


**Fig. 3.** Relation between tick questing activity and levels of tick infestation on roe deer for adult *Ixodes ricinus* (n=103, r=0.66). Questing activity is expressed as the number of ticks collected by flagging over 100 $m^2$.

indeed a positive relation between tick questing activity and levels of tick infestation on deer. Hunting tradition and regulations therefore strongly bias our estimates of tick infestation on the various age classes and sexes. This might explain why although tick frequency distribution was aggregated, it did not follow a negative binomial distribution which is a common frequency distribution for ectoparasites (Fowler *et al* 1998). No relation could be found between estimates of deer density and infestation levels with ticks. However, deer densities in Thuringia remain relatively low (1 to 7 individuals per $km^2$) compared to areas where hunting is prohibited, e.g. Geneva county in Switzerland, were densities of 10 to 20 individuals per $km^2$ were recorded (Ben Hadid 2009). If deer density plays a detectable part after a given threshold has been reached, we may have failed to detect this part if our deer population is below that threshold. It would therefore be most interesting to replicate this study in an area with higher deer densities.

## Individual contributions

Collection of ticks and deer pelts: JH.

Statistical analyses: PGM.

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