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Ixodes ricinus infestation in free-ranging cervids in Norway—A study based upon ear examinations of hunted animals

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ABSTRACT

Prevalence, abundance and instar composition of *Ixodes ricinus* as found on one ear collected from 1019 moose (*Alces alces*), red deer (*Cervus elaphus*) and roe deer (*Capreolus capreolus*), shot during hunting (August–December) 2001–2003, are reported. The animals originated from 15 coastal municipalities (CM), seven municipalities bordering to coastal municipalities (BCM) and four inland municipalities (IM), in Norway, between latitudes 58–66° N. *I. ricinus* occurred endemically in all CM and BCM up to 63°30′ N, whereas it was non-endemic further north and in the IM. This geographical distribution of the tick along the coast of southern Norway was largely in accordance with that reported as far back as the 1940s. Our results therefore did not indicate any large scale northwards expansion of *I. ricinus* in Norway during the 60 year-period between the two studies. However, the prevalence of infestation and tick abundance were significantly higher in CM as compared to BCM. The prevalence and abundance by month were highest during August and September, gradually decreasing towards December. The considerable prevalence of ticks in November, as well as findings in December, would seem to indicate a prolonged tick season as compared with the studies carried out 60 years ago.

A total of 8920 ticks were isolated from 439 of the 603 animals examined in endemic municipalities, and the maximum number of ticks found on one single ear was 204. Attached adult ticks were primarily found among the long hairs at base of the ear, whereas nymphs and larvae were seen all over the outer surface of the pinna, for larvae especially at the edge and tip of the ear. Nymphs were the dominant instar, constituting 74% of the total tick count. The proportion of larvae and adult ticks was 13% and 12%. A significantly higher proportion of adult ticks and lower proportion of immature stages were found in moose, as compared to red deer and roe deer. The same apparently size-associated preference of adult ticks was also found for adult animals (all species) as compared to calves.

Other grossly detected ectoparasites included the lice *Solenopotes burmeisteri* in red deer and *Damalinia meyeri* in roe deer, and the deer ked fly, *Lipoptena cervi*, in moose and roe deer. This is believed to be the first systematic study on the instar composition by *I. ricinus* infestation in free-ranging cervids. The examination of ears from hunted cervids should be recognized as a rational way of obtaining data on the geographical distribution and abundance of this tick in nature.

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1. Introduction

Ticks (Acari, Ixodidae) are important ectoparasites and vectors of disease both in man and other vertebrates and 8 endemic species have been recognized in Norway (Mehl, 1983). The most abundant species, *Ixodes ricinus*, has long been found along the coast of southern Norway (Tambs-Lyche, 1943). Here, it is a well-known vector of various diseases recognized both in humans (Bjørnstad and Mossige, 1955; Skarpaas et al., 2002) and other mammals (Tambs-Lyche, 1943; Jenkins et al., 2001; Stuen, 2003). *I. ricinus* is not normally found in typical inland regions, or northernmost parts, of Norway, reflecting climatic limitations for its free-living stages (Tambs-Lyche, 1943; Mehl, 1983). However, climate change is likely to expand the living area and abundance of *I. ricinus* in northern Europe (Gray et al., 2009). Studies in Sweden have indicated an increased geographical distribution and density of this tick since the climate started to noticeably change in the 1980s (Tälleklint and Jaenson, 1998; Lindgren et al., 2000), and in Norway, indications of a spread into regions at higher latitudes and altitudes were recently reported (Jore et al., 2011).

In Norway, there are large populations of free-ranging red deer (*Cervus elaphus*), roe deer (*Capreolus capreolus*), and moose (European elk, *Alces alces*), acting as hosts for *I. ricinus*. During the past few decades there has been an enormous growth within these populations (Solberg et al., 2009; Statistics Norway, 1975–2011). Climate change along with these higher reported densities of suitable hosts may result in greater local tick abundance and a wider tick distribution in Norway.

I. ricinus is a three-host tick and the life cycle usually requires three years (Randolph, 2004; Sonenshine, 2005). The tick feeds for only a few days each year (transient parasite); as a larva in the first year, a nymph in the second, and as an adult in the third. Predilection sites reported in domestic ruminants are the ears, head, neck, axilla, flank, udder and inguinal region (Milne, 1947; Evans, 1951; L'Hostis et al., 1994). The host preference is regarded to be small mammals (rodents) for larvae, somewhat larger animals like birds, rabbits and squirrels for nymphs, and larger mammals like sheep, cattle and cervids for adult ticks (Milne, 1949; Taylor et al., 2007). Detailed studies of *Ixodes* infestation and instar composition in European cervids are lacking, except for roe deer (Carpi et al., 2008; Vor et al., 2010; Kiffner et al., 2011). None of the published roe deer studies provide specific information about tick load on the ears of the examined animals. Matthee et al. (1997), on the other hand, carried out a thorough study of ixodid tick infestation in impala (*Aepyceros melampus*). They found that one third of the total body tick load was localized on the ears of the animals. Similarly a high tick load may also be expected on ears from cervids, which serve as effective antenna for questing ticks that are present in the greatly diverse vegetation eaten by these species.

The present study reports the prevalence, abundance and instar composition of *I. ricinus*, as found on ears collected from red deer, roe deer and moose shot in different regions of Norway during the hunting seasons 2001–2003.

2. Materials and methods

2.1. Cervids and ear examinations

The Norwegian populations of red deer are primarily found in West and Central Norway, roe deer in East and Central Norway, whereas moose are common in all parts of the country except for West Norway (Reimers et al., 1990; Solberg et al., 2009). The annual hunting bag is approximately 100,000 animals, almost equally distributed between the three species (Statistics Norway, 1975–2011). The licensed hunting periods are as follows: adult male roe deer from August 16 to December 23 and other age categories of roe deer from September 25 to December 23. Red deer hunting takes place from September 10 to November 15, whereas moose are hunted from September 25 to October 31.

In the present study one ear was collected from each of 440 moose, 263 red deer and 316 roe deer, shot during licensed hunting seasons in 2001–2003. The animals originated from 26 different municipalities located between latitudes 58° and 66° N of East (Nos. 1–17), West (18–21), Central (22–25) and North Norway (26) (Fig. 1 and Table 1). Fifteen of the municipalities have a coastal line and are defined as coastal municipalities (CM), a further seven are inland municipalities which share a border with one or more coastal municipalities, hereafter called bordering coastal municipalities (BCM), whereas the remaining four are true inland municipalities (IM) without any proximity to the coast. In the vast majority of municipalities only one species of cervid was sampled with the exception of 12 Tvedestrand and 22 Hitra where two species were sampled. Different cervid species were sampled during different years: red deer were sampled during the 2001 hunting season, roe deer were sampled in 2002, and moose were sampled, with the exception of 12 Tvedestrand (2002), in 2003.

The ear was cut at its base, wrapped and sealed in a plastic bag and sent in by the hunter as soon as possible after hunting. The submission was accompanied by a standardized form that gave information on the sex, age (calf, adult), location, and date of killing. Upon arrival at the laboratory, the ear and the inside of the plastic bag were studied under good light conditions in order to identify parasites. The complete pinna was carefully inspected and systematically palpated throughout its length, starting in the hair rim at the base of the ear and working towards the tip. All parasites found were placed in 70% alcohol, and all ticks were subsequently separated into instar categories (larvae, nymphs, adults) and counted. A minimum of 10 individual ticks from each instar stage and ear were speciated, where possible, according to descriptions given by Arthur (1963).

2.2. Statistical methods

The statistical analyses were performed using the R statistical software version 2.15 (R Development Core Team, 2011), with extension packages: lme4, mlogit and glmmADMB. A significance level of 5% was selected ($p \leq 0.05$) for the purpose of statistical analyses.