Rodents as carriers of tick-borne zoonotic diseases and their ecological impact

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Abstract

Rodents as pests are known to be reservoirs of tick-borne zoonotic infection of viral, bacterial and protozoan origin and are important hosts of the immature stages of *Ixodes* ticks. A total 493 rodents were live-trapped in different habitat in two biogeographical regions Lithuania and Norway. The ecological impact of different species of rodents in particular habitats was evaluated according to their infestation with ticks and presence of *Borrelia burgdorferi* s.l. and *Anaplasma phagocytophilum* infection. Results of the present study demonstrate that although the infestation rate varied between rodent species it was dependent on sampling location and not correlated with infection prevalence in rodents. We observed that mice in Lithuania were more frequently infested with ticks than voles, but, the higher prevalence of *B. burgdorferi* s.l. infection was detected in voles, than in mice. The overall prevalence of infection in Lithuania was higher than in Norway. In Norway, prevalence of infection in *A. flavicollis* and *M. glareolus* was not significantly different. The present study confirmed evidence that the rodent impact on maintenance of Lyme borreliosis depends on biogeographical region and habitat type, and that the zoonotic reservoirs of *B. afzelii* are *M. arvalis*, *M. glareolus*, and *A. flavicollis* in Lithuania, and *A. flavicollis*, *A. sylvaticus* and *M. glareolus* in Norway. In our present study *A. phagocytophilum* was not detected in any of the rodents.

Keywords: *Anaplasma phagocytophilum*, *Borrelia burgdorferi* s.l., PCR, rodents, tick-borne zoonosis

Introduction

Rodents as pests are known to be reservoirs of tick-borne zoonotic infection of viral, bacterial and protozoan origin and are important hosts of the immature stages of *Ixodes* ticks. Different rodent species, however, vary in their susceptibility to infection, infestation with ticks, propensity to infect feeding vectors and consequently vary in their importance for pathogen transmission and impact on human and animal health. Recent studies in Europe have demonstrated a role of rodents, especially *Apodemus* mice and *Myodes* voles, in the epidemiology of tick-borne bacterial zoonoses, such Lyme borreliosis and anaplasmosis (Humair et al., 1999; Hanincová et al., 2003; Sinski et al., 2006; Bown et al., 2006). However, the knowledge concerning abundant zoonotic reservoirs is still limited and scarce in Lithuania and in other European countries. The aim of present study was to assess the importance of different species of rodents as carriers for both the ticks and bacteria and their ecological impact.

Materials and methods

Rodents were live-trapped in deciduous, pine and mixed forest, and ecotonal areas in two different biogeographical regions of Lithuania and Norway in 2005, 2006, 2009 and 2010. Attached engorged and all moving ticks were carefully removed from rodents, counted and identified. DNA from ticks and rodent ear tissue samples was extracted. The presence of bacteria *B. burgdorferi* s.l. and *A. phagocytophilum* were identified by polymerase chain reaction (PCR). *B. burgdorferi* s.l. genospecies was identified using Multiplex PCR, nested PCR and sequencing. Targets for amplification of *Borrelia* DNA were the *fla* gene, the rrs–rrlA intergenic spacer (IGS) and the *ospA* gene. For detection of *A. phagocitophilum*, fragments of *msp2* and 16 rRNR genes in *A. phagocytophilum* genome were amplified. The prevalence of infestation, abundance of infestation with ticks and the prevalence of infection in different rodent species were estimated.

Results

A total 493 (248 in Lithuania and 245 in Norway) small rodents belonging to ten species (*Apodemus flavicollis* , *A. agrarius*, *A. sylvaticus*, *Microtus arvalis*, *M. agrestis*, *Myodes glareolus*, *Rattus norvegicus*, *Mus musculus* and *M. oeconomus*) were collected. In Lithuania, the overall prevalence of infestation with I. ricinus was 52% for *A. flavicollis*, 40% for *A. agrarius*, 31% for *M. arvalis*, and 28% for *M. glareolus*. Abundance of infestation was higher on *A. flavicollis* (2.4), a little lower on *M. glareolus* (2.3), followed by *A. agrarius* (1.7) and *M. arvalis* (0.9). In Norway, the overall prevalence of infestation with *I. ricinus* was 79.2% for *A. flavicollis*, 58.5% for *A. sylvaticus* and 94% for *M. glareolus*. The ranges of numbers of immature *I. ricinus* tick infested individual hosts in Norwegian locations were 1–108 for *A. flavicollis*, 1–13 for *A. sylvaticus* and 0-73 for *M. glareolus*. Rodent infestation between sampling sites ranged from 0% to 92% and from 33.3% to 98% in Lithuania and Norway, respectively. The overall prevalence of *B. burgdorferi* s.l. in rodents from Lithuania was 23.4% (58 out of 248) and 8.3% (24 out of 245) in Norway. The prevalence of *B. burgdorferi* s.l. in Lithuania varied considerably between species: 53% of *M. arvalis*, 22% of *M. agrestis*, 21% of *M. glareolus*, 11% of *A. flavicollis*, 7% of *A. agrarius*, and in addition the single captured *M. musculus*, were infected. In Norway, the prevalence of infection of *B. burgdorferi* s.l. was 9.2% in *A. flavicollis*, 4.3% in *A. sylvaticus*, and 10.9% in *M. glareolus*. Genotyping of *B. burgdorferi* s.l. revealed that *B. afzelii* was the single genospecies detected in rodents from Norway. In Lithuania almost all rodents harbored only *B. afzelii*, but *B. garinii* was detected in *M. musculus*, *M. glareolus* and *M. arvalis*. *A. phagocytophilum* was not detected in any of the tested rodents.

Discussion

In Lithuania, *A. flavicollis* and *A. agrarius* were more frequently infested with immature *I. ricinus* ticks than *M. arvalis* and *M. glareolus*. However, a higher prevalence of *B. burgdorferi* s.l. infection was detected in voles, than in mice. In Norway, rodent infestation with ticks was depended on sampling sites than on rodent species. The prevalence of *B. burgdorferi* s.l. infection varied between species and sampling sites in both countries. The overall prevalence of infection in Lithuania was higher than in Norway. In Norway, infected rodents were captured only in locations situated in the southern part. The prevalence of infection in *A. flavicollis* and *M. galreolus* not significantly different, but in *A. sylvaticus* was at least twice lower. Some other studies conducted in Europe, in contrast with our, reported higher *B. burgdorferi* s.l. prevalence in mice, than in voles, or suggested only limited participation of these species of rodents in the circulation of the pathogen (Gray et al., 1999; Hanincová et al., 2003; Siński et al., 2006). These findings suggest that the impact of rodents on maintenance of Lyme borreliosis depends on habitat type and biogeographical region. Although our present study did not recognize rodents as carriers of anaplasmosis, the study conducted in UK showed that rodents can maintain *A. phagocytophilum* in woodland habitats (Bown et al., 2006). *A. flavicollis* are natural hosts for tick-borne encephalitis. Although the TBE virus was detected in *M. glareolus* and *M. agrestis*, the experimental data show that bank voles develop lower viremias and transmit TBE viruses to a lesser extent than do rodents of the genus *Apodemus* (Dobler, 2010; Tonteri et al., 2011).

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