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Lyme disease in suburban regions

Key words: Lyme borreliosis, *Ixodes* ticks, game animals, dogs

Introduction

Urbanization is currently one of the dominant directions in the development of human society and a factor responsible for irreversible transformation of natural landscapes, land and water resources, and animal wildlife. Animals that were previously found only in wildlife have recently been finding their way to urbanized areas with ever-increasing frequency.

The urban fox phenomenon have been shaping for many years in large cities of Europe (Copenhagen, Paris, Berlin, Rome, Oslo), Australia (Melbourne, Sydney), the USA (Los Angeles, New York) and Japan (Sapporo) becoming a factor to be counted with (Harris et al. 2001). Russia is no exception as it currently has all the background and even a visible tendency toward synanthropization for many species of wild animals. These are, first of all, foxes, hares, wild boars, raccoon dogs, muskrats, beavers and other animals (Animals in urban areas, 2003).

The green belt of Kirov and other towns of Kirov region, for instance, are abundant in game animals. A recent count of animals in these areas demonstrated that the density of moose, wild boar, polecat, squirrel, marten, fox, mountain hare, wolf, muskrat, stoat, black grouse and hazel grouse exceeds the average regional value in their usual habitats (Grebnev 2011).

Wild animals frequently take residence in many Russian cities. In this situation, the biological threat that wild animals pose in urban or suburban areas cannot be underestimated. These animals and their parasites spread many diseases dangerous for humans, agricultural and domestic animals.

Now the problem of Lyme disease is becoming urgent. Lyme borreliosis is counted among the most frequently encountered natural focal infections in the world. The incidence of this disease in the Russian Federation is reported everywhere, from the Baltic coast to the Pacific. The carriers of this infection are *Ixodes* ticks. These ticks may feed on practically any mammal species, as well as many bird and reptile species. The infection is transmitted to humans and domestic animals by the bite of infected ticks (Obert et al. 2001).

Therefore, the research of epizootological aspects of Lyme disease natural focality in urbanized and suburbanized areas is of importance and interest to science and practical application.

Material and methods

The research was conducted using *Ixodes* ticks adults (n = 707). The ticks were collected using the established procedure starting from late

April to early June in 2006–2010 in urban recreational areas such as public gardens, parks and suburban area near Kirov city. *Borrelia* in ticks were identified using direct microscopy, cultural technique and PCR.

Samples from game animals were collected during the hunting season or at another time pursuant to the special hunting license for scientific collection.

Blood serum for serological testing were collected from the following species (n = 318), in heads: mountain hare *(Lepus timidus* L.*)* – 95, red fox *(Vulpes vulpes* L.) – 24, raccoon dog *(Nyctereutes procyonoides* Gray) – 37, moose *(Alces alces* L.) – 67, wild boar *(Sus scrofa* L.) – 11, wolf *(Canis lupus* L.) – 2, dog *(Canis familiaris* L.) – 24, grouse birds *(Tetrao tetrix* L., *Tetrao urogallus* L.*, Bonasa bonasia* L.) – 34, Eurasian woodcock *(Scolopax rusticola* L.) – 24.

Fluorescent serum targeting immunoglobulins of agricultural and domestic animals selected by their genetic relationship was used to identify antibodies in wild animals.

Viscera (heart, kidneys, spleen, liver) from the following species were used for bacteriological tests, in heads: mountain hare *(Lepus timidus* L.) – 5, wild boar *(Sus scrofa* L.) – 3, European badger *(Meles meles* L.) – 7, capercaillie *(Tetrao urogallus* L.) – 2 (n = 17).

Results

The results of analysis of carrier ticks from Kirov suburban area show that the rate of *Borrelia* infection incidence in Ixodes ticks was 37.8 %. The highest *Borrelia* infection level was found in mountain hare – 39.9 % and red fox – 36.9 %. A slightly lower level was identified in raccoon dog – 12.5 % and moose – 14.8 %. The lowest infection level was detected in grouse birds (*Tetrao tetrix* L., *Tetrao urogallus* L., *Tetrastes bonasia* L.) – 5.8 %. No antibodies to *Borrelia* were identified in woodcock blood serum (fig. 1).

54 viscera samples taken from wild animal species were cultivated on BSK-H medium, and following that, *Borrelia* were detected in the heart of European badger, in liver and spleen of wild boar, i.e. in 5.5 % of the samples.

Discussion and Conclusion

Lyme borreliosis is the leading natural focal infectious disease in Kirov region, its percentage being 66.8 % (fig. 2). As reported by Belousova et al. (2012) who studied the epidemiologic situation in Kirov region, the incidence of Lyme disease in humans in 2011 (fig. 3) remained high (35.57 cases per 100 thousand

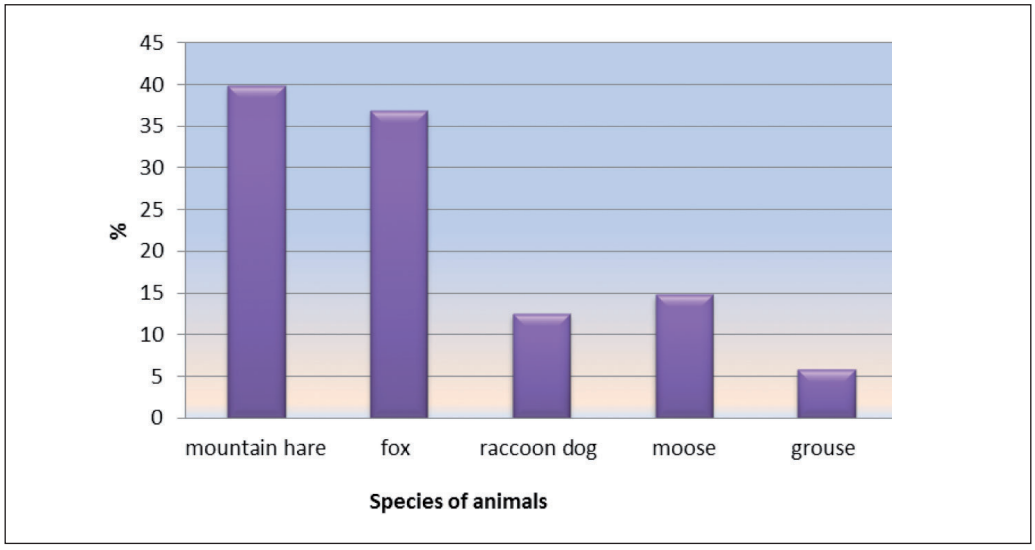

Figure 1 Borreliosis incidence level in game animals

inhabitants), which is 5 times as much as the average Russian level (7.02 cases per 100 thousand inhabitants). Lyme disease incidents were reported virtually in all districts of the region and in Kirov. The incidence in 12 districts and in Kirov exceeds the average regional value (e.g. Uni district – 126.12, Afanasievo district – 97.72, Falenki district – 71.28 per 100 thousand inhabitants) (Belousova et al. 2012).

As shown by the analysis of infection conditions, people get in contact with forest areas generally for everyday purposes. This is mostly characteristic of unemployed population including persons of retirement age, and of preschool and schoolchildren. This fact is directly reflected in age and social distribution of the disease incidents.

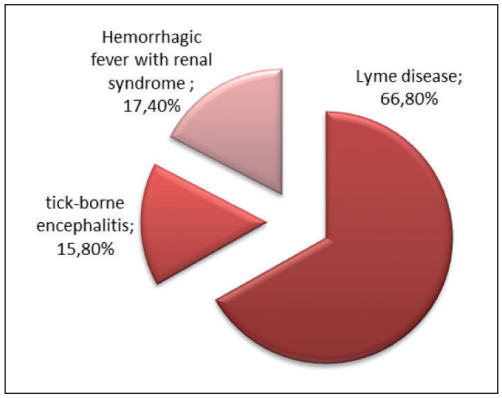

Figure 2 Composition of natural focal infections in Kirov region (2011)

The results of our research determined that Borrelia infection rate in Ixodes ticks in Kirov region was 37.8 %. Similar values were obtained by the Kirov Region Hygiene and Epidemiology Center. They report that the incidence of Borrelia infection in ticks in 2011 was 34.1 % (Belousova et al. 2012). According to Obert et al. (2001), the incidence of an infection over 25 % is classified as high.

This widespread unbridled growth of Ixodes tick population is attributed to the lack of acaricide treatment. Furthermore, the Ixodidae ticks have virtually no natural enemies in their habitat, therefore, the human factor remains the primary means of controlling the number of these arthropods (Shevkoplyas 2006).

The upward drift in the incidence of Lyme disease is explained by improvement of diagnostics and geographical expansion of natural foci of the disease due to such factors as abandonment of intensive agriculture, plow land reduction, creation of urban gardens and increase in suburban construction. The above factors led to patchy forest growth, an ideal habitat for ticks and their hosts (Vasilieva et al. 1996, Kiryanova 2005, Korenberg 1996).

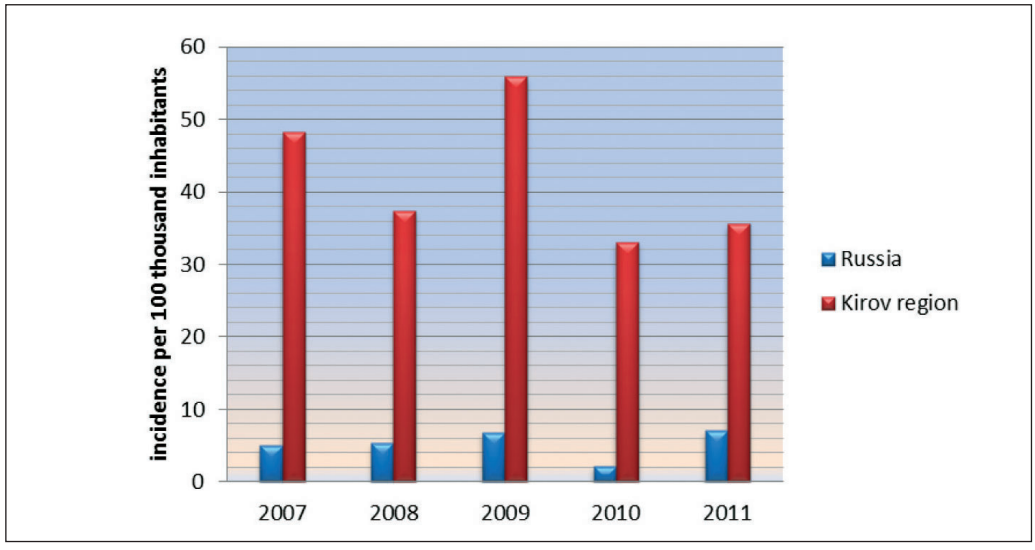

Figure 3 Lyme borreliosis incidence in Kirov region and Russia over time (2007–2011)

Borreliosis hotspots were formerly linked for the most part to forested and rural areas, but now they pose a real threat to the urban population.

As reported by Balashov (2010), *I. persulcatus* males and females in various types of taiga forests traveled no farther than 10 m away from the place of release during the period ranging from several days to 1 month, whereas the majority of ticks remained within a radius of 1 to 2 m. Under the same conditions larvae remained within a radius of 0.5 m, with only a few individual specimens traveling to 1.5 m away from the place of release (Levin 1987). Horizontal travel of *I. ricinus* are just as limited (Gigon 1985). Therefore, ticks use their hosts and reservoirs to expand their habitat to urban areas.

We have found that at the moment the usual residents of suburban areas such as mountain hare, red fox, moose, raccoon dog, black grouse, capercaillie, Eurasian badger and wild boar are hosts of *Ixodes* ticks and reservoirs/spreaders of the *Borrelia* infection.

A certain importance of domestic dogs for the Lyme borreliosis epizootological chain was noted by many Russian and foreign authors (Potekaev et al. 2006, Khristianovsky et al. 2004, Bushmich 1994).

We have established that 8.3 % of dogs have antibodies to the borreliosis agent in their blood. These results make it possible to classify domestic dogs among *Ixodes* ticks hosts and *Borrelia* reservoirs. Furthermore, when dogs are taken to the suburban area, it may result in bringing ticks along from the wildlife to urban parks and homes. This is how dogs can have a real effect on emergence and sustenance of the Lyme disease hotspots in urban areas and affect the local borreliosis incidence rates.

The distinguishing feature of a focal infectious disease is, without debate, the fact that the infection hotspot is present in the wildlife independently from any human action, however, the disease-causing agents have recently been finding their way from natural ecosystems to urbanized and suburbanized areas in increasing numbers. In this respect, there is a permanent danger of introduction of infections to humans, agricultural or domestic animals.

Conclusion

Kirov region is an area with high risk of Lyme borreliosis infection. The incidence of this disease in humans is reported virtually by all administrative districts. *Borrelia* infection rate in ticks is 37.8 %.

Ixodes ticks expand their habitat to urbanized and suburbanized areas with their hosts and reservoirs.

The results of serological and bacteriological testing show that the following species act as reservoirs for the infection in urbanized and suburbanized areas: mountain hare, moose, red fox, raccoon dog, Eurasian badger, wild boar, grouse birds, and dog.

Abstract

Our research resulted in new data on Lyme disease epizootology in urbanized and suburbanized areas in Kirov region, NE part of European Russia. The *Borrelia* infection rate in *Ixodes* ticks in the Kirov suburban area was studied. The evidence of involvement of several species of game animals and dogs in formation and sustenance of the disease hotspots in urbanized areas were obtained.

Zusammenfassung

Die Lyme-Krankheit in den suburbanen Landschaften

Forschungen im Feld und Labor erbrachten neue Daten zur Epizootologie der Lyme-Borreliose in den urbanisierten und suburbanisierten Territorien im Gebiet Kirov. Die Durchseuchung der Zecken (*Ixodes* sp.) mit Borrelien in der grünen Zone der Stadt Kirov beträgt 37,8 %. Jagdbaren Tierarten und Hunden kommt in der Bildung und der Aufrechterhaltung des Krankheitsherdes auf den urbanisierten Territorien große Bedeutung zu.

Резюме

Болезнь Лайма на пригородных территориях

В результате полевых и лабораторных исследований были получены новые данные по эпизоотологии болезни Лайма на урбани-

зированных и субурбанизированных территориях в Кировской области. Изучена зараженность иксодовых клещей боррелиями в зеленой зоне города Киров. Получены доказательства участия охотничьих видов животных и собак в формировании и циркуляции болезни на урбанизированных территориях.

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