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TICKS AND OTHER BLOODSUCKING ARTHROPODS AS URBAN PESTS INSIDE AND OUTSIDE DWELLINGS

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Abstract The first case of hard ticks, *Dermacentor reticulatus* (F.) and Ixodes ricinus (L.), as well as mites, *Ornithonyssus bacoti* (Hirst), and rat lice living in the ground floor office of an apartment building of the city of Minsk, Byelorussia is described. Ectoparasites appeared in the end of November in a house situated 300 m away from the nearest homestead as a result of rat immigration from incompletely destroyed houses nearby, coupled with insufficient disinfestation. Climate warming could have caused I. ricinus ticks appearing in the city parks of Vilnius, Lithuania very early in the season, first collected on April 15, 2005. Ticks collected by flagging totaled 23 nymphs, 39 adults. Among adults, 47.2% specimens showed exoskeleton anomalies; ten of 36 PCR-tested ticks were infected by tick-borne pathogens. *Borrelia afzelii, Borrelia garinii* and *Ehrlichia muris* were revealed, *Borrelia burgdorferi* sensu lato was identified twice while in seven ticks live spirochetes not belonging to the *B. burgdorferi* s.l. group were found. Dually (two species of *Borrelia* simultaneously) and triple infected ticks were detected. Multi-infected ticks prevailed among the specimens with exoskeleton abnormalities. Ticks in dwellings, near suburbs and parks infected ixodids are found, indicate that entry of tick-borne infection inside them can not be completely ruled out.
Key Words Ectoparasites, dwellings, *Ixodes ricinus*, urban parks, tick-borne pathogens

INTRODUCTION

Human settlements, towns, cities and even enormous megalopolises usually occupy territories once (years, centuries or millennia ago) supporting wild nature with their own flora and fauna. Stone, brick and pavement, houses, buildings and skyscrapers, they all smeared but not totally eliminate wildlife. Instead of forests appeared parks decorated by different kind of trees and bushes as well as flowerbeds; instead of clearing in the woods and grassy glades of the forest appeared lawns. As a rule expanding towns include not only parts of old small settlements but also fragments of wild nature. Some representatives of their flora and fauna: birds, rodents and especially arthropods find themselves capable to survive and to develop inside the changing synanthropic conditions. House flies (*Musca domestica*), cockroaches, bed bugs and some fleas (*Pulex irritans*) are tied to with human dwellings. Being obligate synanthropic insects relatively weakly associated with environments other than man-made, they are less important epidemiologically compared to other, especially bloodsucking, arthropods, whose synanthropization is weaker, but their roles as vectors of arthropod-borne diseases is much greater.

Some of specially dangerous urban pests: plague for example, according to not long ago obtained data (Suntsov and Suntsova, 2006) is able to circulate between rats in the humid conditions of South Vietnam only beneath the roofs of dwellings or other man made constructions, where rat fleas as vectors of the disease find sufficiently dry conditions for development of their progeny. In European towns and suburbs, basements and cellars often serve as habitats of black and sewer rats known as hosts not only of fleas and bloodsucking mites, but sometimes also as facultative sources of blood for hard ticks in places of intense urbanization.

Other infections, for example tick-borne ones, originally pure diseases with natural nidality due to bird and rodent migration settled in new and old parks as foci. In the town parks and suburban green zones, mites and ticks can survive, feed on smaller vertebrates (sometimes pets), and develop often becoming infected by different pathogens. In urban conditions, the roles played by *Ixodes* ticks as vectors of diseases appear to be studied the best. In the European town parks especially distributed in the central city or near the city the most favorable conditions exist for *Ixodes ricinus* ticks. In the North-West part of Europe, in some Baltic countries and Russia, *Ixodes persulcatus* Schulze ticks are common and on the large territories coexist with *I. ricinus* (Haglund et al., 2003; Golovljova et al., 2004). Parasitizing on similar hosts, both are capable of exchanging different pathogens. For example, Alekseev and Dubinina (2003), among about 1,500 *I. persulcatus* ticks they had collected in a suburb forested recreation zone at St. Petersburg, Russia, one-third were found to be infected by one or several of seven different tick-borne pathogens of viral (tick-borne encephalitis virus), bacterial (genera *Borrelia, Ehrlichia, Anaplasma*) or protozoan (*Babesia muris*) origin, with the maximum of three agents recorded per female. In a recreational park in southwestern Ireland, *I. ricinus* ticks infected by *Borrelia burgdorferi sensu lato* were numerous at the edges of paths and roads (Gray et al., 1999). According to the opinion of these authors, birds were the main source of blood for these ticks, this allowing now to suggest that the neuroborreliosis agent, *Borrelia garinii*, prevailed among the infected ticks. Bašta et al. (1999) showed similar trends: in the Prague (Czech Republik) urban parks Petřin, Vitkov and Stromovka, where ticks were regularly collected, they revealed mainly *B. garinii*, fed and transported by birds, and less *Borrelia afzelii* connected with rodents. They stated that every tenth tick was infected. Koči et al. (2007), who collected *I. ricinus* in the green suburban area of Chisinau, capital of Moldova in the spring of 2005, revealed not only 5 species of *B. burgdorferi* s.l., mainly *B. garinii* (42%), but also *Anaplasma phagocytophilum*, the agent of human granulocytic anaplasmosis.

According to our previously accumulated data, ticks, which developed in the heavy metal ions polluted suburban and urbanized conditions, have some anomalies of their exoskeleton structure (Alekseev and Dubinina, 1996; Alekseev, 1996). Such anomalies being a marker of some kind of pathology are accompanied by the greatest susceptibility of *I. persulcatus* and *I. ricinus* to tick-borne pathogens. It is tick specimens with anomalies are more often multi infected (Alekseev et al., 2007). This short overview clearly shows that bloodsucking arthropods in urbanized areas can play important roles as human pests, being potential vectors of various diseases. To obtain a broader picture of the epidemiological situation in the urban environments in Eastern Europe, two cities were chosen. Thus, the parks of Vilnius, the capital of Lithuania, were investigated for ticks and tick-borne pathogens. In Minsk, the capital of Byelorussia, not only ticks, but also the other bloodsucking arthropods that appeared in the first floor apartment of a pre-engineered building situated near a suburban half-condemned homestead settlement were studied.

MATERIALS AND METHODS

Bloodsucking Ectoparasites Collected in an Apartment

Live mites (2) and one hard tick were found by accident because this apartment, serving as an office, was not constantly habitable, and collected from the walls of the apartment's water closet using entomological eye pincette. At the next days (November 28, 2001) 75 mites, fleas and lice were collected from walls and floor by the entomological lifting jet. On the third and fourth days, traps were laid inside the flat, with two black rats captured and 29 parasites collected. In the cellar from 4 caught rats 67 ectoparasites were gathered. All of them (total n = 174) were fixed in 70% ethanol and later investigated and identified in the Laboratory of Parasitology at the Institute of Zoology in Minsk.

Ticks Collected In Parks

Adults and nymphs of *I. ricinus* were collected between April 15 and May 2, 2005 by flagging in the downtown Vingio and Bukčių parks of Vilnius. The fortnightly yield was not great, totaling only 62 specimens (23 nymphs and 39 adults), 36 of which were investigated for the presence of pathogens.

Pathogen Detection

The hind part of live adult specimens was dissected and live spirochetes were revealed and calculated in 200 microscope dark fields in a drop of saline in the laboratory of the Vilnius Centre for Communicable

Diseases Prevention and Control. Then the adult ticks fixed in 70% ethanol were transferred to the Zoological Institute in St. Petersburg, Russia to study further under the stereomicroscope for the presence or absence of exoskeleton anomalies, according to the techniques described by Alekseev and Dubinina (1996). To reveal such pathogens as *Borrelia afzelii*, *B. garinii*, *Ehrlichia muris, Anaplasma phagocytophilum* and *Babesia microti*, the techniques described in Alekseev et al. (2007) was applied using PCR with species-specific primers. Tick-borne encephalitis infection was not investigated in this case.

RESULTS

Inside the apartment in Minsk, five different species of ectoparasites (Table 1) belonging to five families and three orders were yielded.

Rats. From the four rats trapped in the cellar 67 ectoparisites belonging to the same five species were obtained. One of the rats bore a hungry female of *I. ricinus* which, unlike a *D. reticulatus* female, obviously had had not enough time to climb up into the first floor room in search of a source of blood bigger than a rat. On rats from the cellar, thee *I. ricinus* nymphs were collected. In the Vilnius parks, tick nymphs and adults were flagged in the open from lawns (Table 2). As can be seen from Table 2, nearly one-third of the ticks (27.8%) taken from the Vilnius parks were infected by agents pathogenic for people. Total number of ticks infected by *B. afzelii* was seven whereas *Borrelia garinii* was detected nearly two times less. *Ehrlichia muris* was met with only twice, but once as triple infection. It is of interest that most often (in 19.4% cases) some spirochetes were revealed of unknown pathogenicity and not identified closer to species, but not belonging to the *B. burgdorferi* s.l. group. Two specimens were infected by *B. burgdorferi* s.l. group. Neither *Anaplasma phagocytophilum* nor *Babesia microti* were found at all.

Ticks. Total proportion of infected ticks was 27.8% (10 of 36), of which 20% (2 of 10) were multiply infected. Exoskeleton anomalies had 47.2% of ticks, and such specimens had multiple infections more often (35% versus 21%) Only among anomalous tick the triply infected specimen was revealed. Live spirochetes absolutely prevailed among anomalous ticks: 35.3 (6 of 17) vs. 5.3% (1 of 19). The difference was statistically significant: $\chi^2 = 5.166$, $p < 0.05$. Thus several important tick-borne pathogens were revealed in the newly detected focus in the Vilnius parks.

DISCUSSION

To demonstrate how ectoparasites can migrate from suburban houses and homestead land using the black rat, Figure is presented. Such migration as well as the contact between Ixodid ticks, pasturable bloodsuckers with people inside the apartment was facilitated because multistoried panel buildings of the uptown still being situated amongst or near some not fully destroyed one-storey wooden houses. The nearest homestead land was only 300m from the building where ectoparisites were revealed on the first floor. Dogs, cats, rodents from the now uninhabited houses migrated in the new blocks and tried to survive there. Judged from the preserved old trees and small green patches overgrown by ruderal weed there were places quite available for Ixodid ticks surviving. Stated by us findings of the larvae and nymphs of *I. ricinus* on rats are rather usual. Their presence even in the small quantity as well as black rat migration from dwellings of suburban settlement in the late autumn (very end of November) can be easy explained by the climate warming. For example the mean ten-day long temperature in Minsk during the period 1911-1920 was 5.5°C whereas within 2000-2003 it was 2 degrees warmer — 7.2°C.

Table 1. Ectoparasites collected on the walls and floor and taken from rats

Collection	Ectoparasites	Species	No of stages
Walls and floor of the room	Mites	*Ornithonyssus bacoti*	64F, 5M, 3Ny
	Ticks	*Dermacentor reticulatus*	1F
		Ixodes ricinus	1M, 1Ny
	Lice	*Polyplax spinulosa*	1F
Rats trapped inside the room (n=2)	Mites	*Ornithonyssus bacoti*	12F, 4Ny
	Ticks	*Ixodes ricinus*	1Ny, 1L
	Lice	*Polyplax spinulosa*	5F, 3M
	Fleas	*Ceratophyllus fasciatus*	4F, 2M

F – females, M – males, Ny – nymphs, L – larvae.

Table 2. Prevalence of live spirochetes and other tick-borne diseases agents in *Ixodes ricinus* ticks collected in the town parks of Vilnius.

Type of infection	Microorganisms revealed in 36 investigated specimens		
	Prevalence	**abs.**	**%**
Mono	Live spirochetes[1]	7	19.4
	Borrelia afzelii	5	13.9
	Borrelia garinii	2	5.6
	Ehrlichia muris	1	2.8
Dual	*B. afzelii* and *B. garinii*	1	2.8
Triple	*B. afzelii*, *B. garinii* and *E. muris*	1	2.8
	Total	17 (10)[2]	47.2 (27.8)[2]

[1]Spirochetes not belonging to the group of *Borrelia burgdorferi sensu lato*;
[2] In brackets number and ratio of ticks infected by agent pathogenic for man.

Thus it was not striking that in the beginning of the season of tick activity *I. ricinus* nymphs and adults were revealed in the parks of Vilnius. Climate warming seems likewise to be the cause why ixodids were collected so early in spring in Lithuania, where the climate is very similar to that in Minsk. Even the small number of ticks (36 specimens only) tested by PCR analyses allowed to reveal that nearly one-third of them contained tick-borne agents of diseases pathogenic for man.

The prevalence of *B. afzelii* suggests that, in contrast to the data of Gray et al. (1999), Bašta et al. (1999) and Koči et al. (2007), not birds but rodents serve as the main source of blood and infection for *I. ricinus* in the Vilnius downtown. Most probably, neither *A. phagocytophilum* nor *Bab. microti* was revealed simply because of the small amount of sampling. In a study made in 2000 (Alekseev et al., 2003), *Bab. microti* occurred in 0.9% cases (seven of a total of 738 investigated *I. persulcatus* ticks) while *A. phagocytophilum* was found only in 12 specimens from a total of 1,177 studied (1%). Koči et al. (2007), in a green suburban area of Chisinau, found *A. phagocytophilum* to live in *I. ricinus* more frequent: in 18 of 198 of investigated ticks (9%). In seems plausible that in the warmer climate of Chisinau, more rodents might be infected by this pathogen to become a focus of this agent for ticks and man.

The ratio of *I. ricinus* ticks infected by *E. muris*, 5.6% (2/36) in Vilnius parks was quite comparable with the values obtained for *I. persulcatus* in the St. Petersburg suburban green zone — 5.3% (62 of 1,177). It is necessary to emphasize that, among the ticks from the Vilnius parks, *B. afzelii*, the agent of cutaneous acrodermatitis and *B. garinii*, the causative agent of a still heavier disease (neuroborreliosis), were revealed together, and in one case both species of *Borrelia* were found together with *E. muris*. Such a combination of borreliosis with ehrlichiosis is known to lead to the severe clinic of mixed infection (Shetekauri et al., 2006). In addition, our study of the ticks from the parks in Lithuania, where the rate of anthropogenic pressure on the biota is high enough, confirms the previous information, for example on the ticks from the Kokkola Archipelago, Finland (Alekseev et al., 2007), that ticks with exoskeleton anomalies are not only common in this Baltic country, but appear to be more often infected by tick-borne pathogens.

Ticks revealed inside dwellings in towns or cities, in which suburbs and parks infected ixodids are found, indicate that entry of tick-borne infection in them can not be completely ruled out and show their potential danger for man. Insufficient disinfestations without subsequent disinsection can well allow for ectoparasite migrations from cellars into apartments.

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