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Small mammals and their parasites (ixodid ticks) in urban forests and parks of St. Petersburg

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Abstract. The biodiversity and abundances of small mammals and ticks inhabiting parks and forests of St. Petersburg were examined. No more than six species of small mammals were observed in each biotope. In localities with a low anthropogenic pressure, *Myodes glareolus* was dominant whereas in the territories with a serious anthropogenic load *Sorex araneus* or *Apodemus agrarius* dominated. Four tick species were collected from captured hosts: *Ixodes persulcatus* and *I. ricinus* represented by immatures and *I. apronophorus* and *I. trianguliceps* represented by immatures and adults.

Key words: *Myodes glareolus*, *Sorex araneus*, *Apodemus agrarius*, *Ixodes persulcatus*, *Ixodes ricinus*, anthropogenic load.

INTRODUCTION

The 20th century was noted for an extensive growth of cities. It was also true for St. Petersburg. The city included territories that used to be considered distant suburbs. Green belts, which previously were parts of large forestlands, appeared in the city. At present, they border on built-up areas. These are forest parks and other parks that at different times were found within the city boundaries, preserving to some degree features of natural biotopes. Tikhonova et al. (1997) suggested a classification of undeveloped territories of a present-day city for analysis of small mammals distribution. Although their research was conducted in Moscow and the structure of our city is somewhat different from that of Moscow (feebly marked radial pattern, recently constructed ring road), we accepted this classification. Accordingly, the territories where we performed our research can be defined as small suppressed parks, landscape parks, and forest parks. Besides, part of the research was conducted at isolated plots of natural forest that happened to be within the city boundaries.

Research works on small mammals fauna in St. Petersburg have been published since long (Lutov & Vashchenok, 1977). Ixodid ticks have been monitored in St. Petersburg (formerly Leningrad) since 1968 (Vershinsky et al., 1988; Smyslova et al., 1989). Unfortunately, these researches suffer from several methodological

drawbacks. They lack data on immature phases of taiga tick and forest tick and species of nest and burrow type of parasitism, which can be obtained upon capturing small mammals, their main hosts (this is true not only about works on St. Petersburg (Daniel & Černý, 1990)).

In this work we make an attempt to estimate what small mammals inhabit parks and forests in St. Petersburg, what ixodid ticks they house, and how partial isolation from forestlands influences their species composition and numbers.

MATERIALS AND METHODS

Small mammals belonging to nine species, 941 specimens in total (Table 1), were trapped in different areas of St. Petersburg during 7800 trapping days.

During the period of study 1129 individuals of ixodid ticks belonging to four species (*Ixodes persulcatus*, *I. ricinus*, *I. trianguliceps*, and *I. apronophorus*) were collected (Table 2).

Small mammals were trapped in 12 different areas of St. Petersburg (Fig. 1). According to the classification of Tikhonova et al. (1997), the territories where we performed our research can be defined as small suppressed parks, landscape

Table 1. Species list of mammals trapped in St. Petersburg during 2006–2007

Species	Number of animals caught	Proportion of species, %
Common shrew, *Sorex araneus*	338	35.9
Pygmy shrew, *Sorex minutus*	40	4.3
Laxmann's shrew, *Sorex caecutiens*	3	0.3
Ural field mouse, *Apodemus uralensis*	52	5.5
Black-striped field mouse, *Apodemus agrarius*	141	15.0
Yellow-necked mouse, *Apodemus flavicollis*	1	0.1
House mouse, *Mus musculus*	1	0.1
Bank vole, *Myodes glareolus*	328	34.9
Common vole, *Microtus* ex. gr. *arvalis* (*Microtus arvalis*, *Microtus rossiaemeridionalis*)	37	3.9

Table 2. Numbers of ixodid ticks collected from small mammals in St. Petersburg during 2006–2007

Stage	Species			
	I. persulcatus	*I. ricinus*	*I. apronophorus*	*I. trianguliceps*
Larva	242	9	175	485
Nymph	11	0	3	183
Imago	0	0	2	19

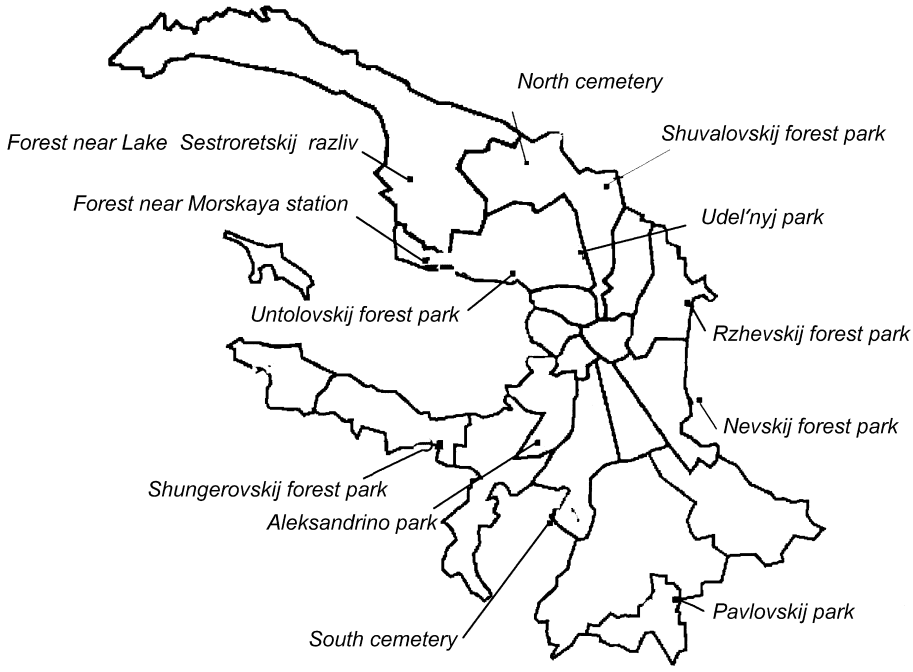

Fig. 1. Plan of St. Petersburg with areas studied.

parks, and forest parks. Small suppressed parks (Aleksandrino, Udel′nyj) are about 10 hectares in area. They are isolated from natural forests and characterized by a heavy anthropogenic load. Plant communities in these parks are very poor. Landscape parks (Pavlovskij) cover about 100 hectares. They have a lower anthropogenic load than small suppressed parks, but are also isolated from natural forests. Plant communities are richer. Forest parks (forest near Morskaya station, Nevskij forest park, forest near the North cemetery, forest near the South cemetery, Rzhevskij forest park, forest near Lake Sestroretskij razliv, Shungerovskij forest park, Shuvalovskij forest park, Untolovskij forest park) are large forests connected with natural forests. They have rich plant communities. Large animals can live only in these parks. Their anthropogenic load is insignificant.

Small mammals were captured in June and September 2006–2007. In the forest near Lake Sestroretskij razliv small mammals were captured in 2006 only in June. In the forest near the South cemetery and in Nevskij forest park they were captured only in June and September 2007. A hundred Gero traps were placed in two lines (50 traps in a line) in each point for two days. The traps were checked in the morning and in the evening. A captured animal was placed into a plastic bag for laboratory examination. Species, sex, and age of each animal were determined. Species and development stage of parasites collected from the animals were also investigated.

RESULTS AND DISCUSSION

Sorex araneus and *Myodes glareolus* were dominant species among small mammals in various areas of St. Petersburg. They accounted for 35.9% and 34.9% of the total number of trapped small mammals, respectively (Table 1).

Apodemus agrarius was present in traps significantly less often than both previous species (15.0%). None of the other species made up over 6%. Some species were represented by a single specimen.

The number of small mammal species in one biotope was six or less (Table 3). In some areas of Aleksandrino park *Apodemus agrarius* was the only species. This park was established 50 years ago and has a high anthropogenic load. The number of species was not influenced in any biotope by its anthropogenic load. For instance, in Nevskij forest park the anthropogenic load was low. Still, only four species were present. The largest number of species was collected in the forest close to the North and South cemeteries. These areas have high

Table 3. Density of small mammals in different areas of St. Petersburg (number of individuals per 100 trapping days)

Area	Species									
	Sorex araneus	*Sorex minutus*	*Sorex caecutiens*	*Apodemus uralensis*	*Apodemus agrarius*	*Apodemus flavicollis*	*Mus musculus*	*Myodes glareolus*	*Microtus arvalis*	Average number of small mammals
Aleksandrino park*	2.8	0	0	0	9	0	0	0	1	4.3
Udel′nyj park	10.4	0	0	0	6.3	0	0	0	0	8.4
Pavlovskij park	2.8	0	0	2	0	0	0	5	0	3.3
Forest near Morskaya station	6.5	1	0	1	0	0	0	12.7	0	5.3
Nevskij forest park	0.5	1.3	0	0.3	0	0	0	17.8	0	5.0
Forest near North cemetery	5.7	0.3	0	0.8	1.2	0.2	0	8.3	0	2.8
Forest near South cemetery	3.5	1.3	0.3	4.8	0	0	0	8	0.3	3.0
Rzhevskij forest park	5.9	1	0.2	0	0	0	0	1.9	0.2	1.8
Forest near L. Sestroretskij razliv	1.5	0	0.3	0.5	0.3	0	0	5.3	0	1.6
Shungerovskij forest park	0.3	0	0	0.8	0	0	0.3	3.5	0	1.2
Shuvalovskij forest park	0.5	0	0	0	0.5	0	0	0	0	0.5
Untolovskij forest park	11.2	1.6	0	0.3	1.3	0	0	2.1	1.7	3.0

* In some parts of Aleksandrino park *Apodemus agrarius* was the only species of small mammals (22.5 individuals per 100 trapping days).

anthropogenic loads, but they are connected with forests without considerable anthropogenic load. One or two species of small mammals were represented in parks that are not connected with natural forest (some areas of Aleksandrino and Udel′nyj parks).

Myodes glareolus was dominant in the areas with a low anthropogenic load (forest near the North and South cemeteries, Rzhevskij and Nevskij forest parks). Other species were dominant in the territories with a high anthropogenic load. *Apodemus agrarius* was dominant in Aleksandrino park. *Sorex araneus* was numerous in Udel′nyj park and Untolovskij forest park.

A high density of small mammals was recorded in some parts of Aleksandrino park: 22.5 individuals per 100 trapping days. The lowest density of these animals was found in Rzhevskij forest park: 0.2–5.3 individuals per 100 trapping days.

The density of more abundant species of mammals can be independent of anthropogenic load. So, high densities of small mammals were registered both in a territory of low anthropogenic load (Nevskij forest park) and in a territory of high anthropogenic load (Aleksandrino park). Cluster analysis of the percentage of small mammals did not reveal any significant difference between the investigated areas.

Larvae and nymphs of *I. persulcatus* and *I. ricinus* and all stages of *I. apronophorus* and *I. trianguliceps* were collected from the captured small animals. We found pre-imago stages of the two first species in the same places as imagos.

The greatest number of *I. persulcatus* larvae and nymphs were found in Nevskij forest park, in the South cemetery, and the forest near Lake Sestroretskij razliv (Table 4). On the whole, it can be noted that in places with a large number

Table 4. Density of tick species in green areas of St. Petersburg (number of ticks per small mammal individual). L – larva, N – nymph, I – imago

Area	Tick species									
	I. persulcatus		*I. ricinus*		*I. trianguliceps*			*I. apronophorus*		
	L	N	L	N	L	N	I	L	N	I
Aleksandrino park	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Udel′nyj park	0.00	0.00	0.00	0.00	1.86	0.29	0.03	0.00	0.00	0.00
Pavlovskij park	0.05	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Forest near Morskaya station	0.05	0.04	0.00	0.00	0.02	0.14	0.02	0.00	0.00	0.00
Nevskij forest park	0.53	0.00	0.00	0.00	0.45	0.05	0.00	0.01	0.00	0.00
Forest near North cemetery	0.00	0.00	0.00	0.00	0.22	0.06	0.00	0.02	0.01	0.00
Forest near South cemetery	0.58	0.01	0.01	0.00	0.01	0.04	0.01	0.01	0.00	0.00
Rzhevskij forest park	0.10	0.02	0.00	0.00	2.21	0.34	0.00	0.00	0.00	0.00
Forest near L. Sestroretskij razliv	1.15	0.02	0.20	0.00	0.08	0.17	0.00	0.00	0.00	0.00
Shungerovskij forest park	0.00	0.04	0.00	0.00	0.02	0.15	0.02	0.00	0.00	0.00
Shuvalovskij forest park	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Untolovskij forest park	0.00	0.00	0.00	0.00	0.25	0.17	0.05	0.62	0.07	0.02

of imagos also a considerable number pre-imago stages of development of *I. persulcatus* were registered. *Ixodes ricinus* was very rare, it was found only in three places (Pavlovskij park, forest near Lake Sestroretskij razliv, and the South cemetery). Larvae and nymphs of *I. trianguliceps* parasitize mostly on small mammals. The greatest number of this species was observed in Udel′nyj park. In our collections this species was absent only in Aleksandrino park. *Ixodes apronophorus* was found in Untolovskij and Nevskij forest parks and in the area of the North cemetery. The greatest number of this species was registered in Untolovskij forest park close to the river. This species is met in biotopes with a high level of humidification and near water reservoirs (Filippova, 1977). Obviously, this explains the small number of samples where it existed.

In small suppressed parks (Aleksandrino, Udel′nyj) one to three species of small mammals were caught (common shrew, field mouse, and common vole). In Udel′nyj park we collected only *I. trianguliceps* (species that can live in small mammals only) from these mammals. No ticks were found in Aleksandrino park. As it has already been noted, this park is surrounded by residential blocks. It was created in a barren area, and its ecosystem is disturbed. It must be the reason for the absence of ixodid ticks. Pavlovskij park (landscape park) has a lower anthropogenic load than small suppressed parks and here we trapped bank vole and Ural field mouse. In this park we found larvae of *I. persulcatus* and *I. ricinus*. In forest parks we found the greatest diversity and numbers of small mammals and ticks.

Using the cluster analysis methods, differences between these territories were determined (Fig. 2). As imagos were collected using different methods and the number of nymphs was rather low, for cluster analysis the number of larvae per small mammal individual in each plot was applied.

In the diagram Udel′nyj park, which is inhabited only by *I. trianguliceps*, and Untolovskij forest park, where *I. apronophorus* predominates, stand out. The next

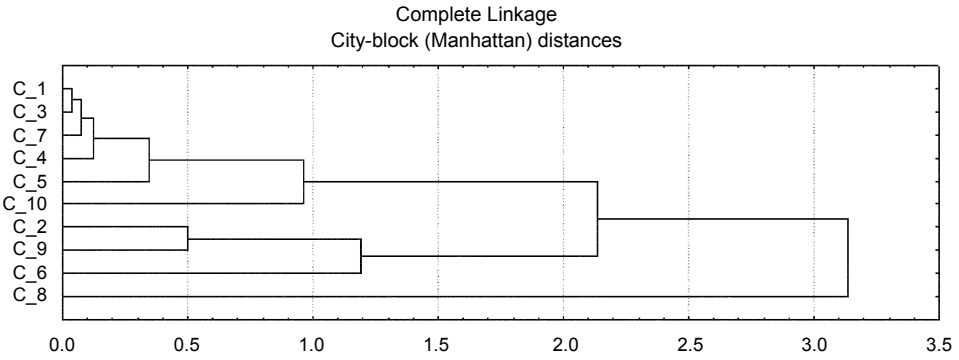

Fig. 2. Tree diagram for similarity of different areas in St. Petersburg with regard to presence of ixodid ticks. 1 – forest near Morskaya station; 2 – Nevskij forest park; 3 – Pavlovskij park; 4 – Rzhevskij forest park; 5 – North cemetery; 6 – forest near L. Sestroretskij razliv; 7 – Shungerovskij forest park; 8 – Udel′nyj park; 9 – South cemetery; 10 – Untolovskij forest park.

Table 5. Density of tick species on different small mammals (number of ticks per small mammal individual). L – larva, N – nymph, I – imago

Small mammal species	Tick species									
	I. persulcatus		*I. ricinus*		*I. trianguliceps*			*I. apronophorus*		
	L	N	L	N	L	N	I	L	N	I
Sorex araneus	0.03	0.00	0.00	0.00	0.58	0.28	0.00	0.23	0.07	0.00
Sorex minutus	0.07	0.00	0.00	0.00	0.41	0.12	0.00	0.12	0.05	0.00
Sorex caecutiens	0.00	0.00	0.00	0.00	2.33	0.00	0.00	0.00	0.00	0.00
Apodemus uralensis	1.42	0.04	0.08	0.00	0.06	0.04	0.00	0.00	0.00	0.00
Apodemus agrarius	0.00	0.00	0.00	0.00	1.43	0.11	0.06	0.02	0.00	0.00
Apodemus flavicolis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mus musculus	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Myodes glareolus	0.49	0.02	0.02	0.00	0.22	0.15	0.04	0.10	0.01	0.00
Microtus arvalis	0.00	0.00	0.00	0.00	0.00	0.25	0.00	0.69	0.00	0.06

group includes Pavlovskij park, Rzhevskij forest park, and areas of forest in the district of Morskaya station and the North cemetery. These areas are characterized by a low number of *I. persulcatus*. Nevskij forest park and forests in the district of Lake Sestroretskij razliv and the South cemetery form a third group, characterized by abundance of this species. Aleksandrino park was not used for analysis because no ticks were found there.

Mostly all these tick species were collected from *M. glareolus*, *A. uralensis*, *A. agrarius*, and *S. araneus* (Table 5). These small mammals play the most important role in the feeding of the ticks. *Ixodes trianguliceps* was most often collected from different species of shrews. The greatest number of *I. persulcatus* was found on Ural field mice and bank voles. Black-striped field mice played an important role in the feeding of ticks too. No ticks were found on rare species, such as house mouse and yellow-necked mouse. The distribution and number of various species of small mammals in the studied areas are significant for tick occurrence on hosts. For instance, the great number of *I. trianguliceps* on *A. agrarius* correlated with the high density of this host in Udel′nyj park.

CONCLUSIONS

As it was stated in the Introduction, all the studied territories can be referred to different park groups (Tikhonova et al., 1997). At the territories adjecent to large forestlands (Nevskij forest park, districts near Lake Sestroretskij razliv, Morskaya railway station, North and South cemeteries) a cenosis structure close to the natural one has preserved. In these areas small mammals are parasitized by *I. ricinus* and *I. persulcatus* ticks, because medium-sized and large mammals, feeding imagos, are present there. In the parks bordering on built-up areas the habitation conditions have been altered, resulting in a decreased number of mammal species. There are virtually no large wild mammals, therefore no *I. ricinus* and

I. persulcatus ticks are found. Thus, it can be concluded that the presence and species composition of ixodid ticks in some territory within the city boundaries depends on the natural conditions of the place rather than on the species composition of small mammals. If hosts typical for certain tick species vanish from some area, their transition to other available hosts is possible. This fact explains the persistence of tick populations within the city boundaries.

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Pisiimetajad ja nende parasiidid (puugid) Sankt-Peterburgi metsades ning parkides

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Uuriti pisiimetajate ja puukide mitmekesisust ning arvukust Sankt-Peterburgi metsades ja parkides. Pisiimetajaid oli ühe biotoobi kohta maksimaalselt kuus liiki. Madala inimmõjuga elupaikades domineeris *Myodes glareolus*, tugeva antropogeense surve aladel aga *Sorex araneus* või *Apodemus agrarius*. Püütud imetajatelt leiti neli liiki puuke. Kaks liiki – *Ixodes persulcatus* ja *I. ricinus* – olid esindatud ainult larvide ning nümfidega ja kaks liiki – *I. apronophorus* ning *I. trianguliceps* – kõigi arenguastmetega.