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Role of wildlife small rodents of the city parks and park-forests in helminth epizootology by the example of *Apodemus Uralensis* Pallas, 1811

key words: Ekaterinburg, Russia, *Apodemus uralensis*, abundance, urban ecology, helminth

Small mammals, among which the leading place belongs to rodents, from the ecological point of view, are one of the main components of ecosystem. Rodents influence beneficial on the soil structure and grass-undershrub vegetation and they are the main food of predatory birds and mammals. Analysing a structure, diversity and dynamics of micromammal communities in the city parks and park-forests we can judge about the degree of change in forest under the impact of urbanization (Chernousova 1996, 2012). However from the anthropocentric standpoint micromammals, especially rodents, can play a negative role as intermediate and reservoir hosts of several helminth species, infesting of people and important for man economy mammals. They are responsible for the maintenance of parasitic communities in ecosystem. Rodents and shrews support helminth nidi in nature and they are reserves of pathogens of natural nidal helminthiasis. That is why to study the state of helminthocenoses of small rodents in recreational city areas is important very much.

Researches of small mammal parasitofauna in urbocenosis, in fact, began to be carried out relatively recently, and they are not very numerous. For example, it was found some specifics of rodent helminths in Tyumen (Timoshenko & Zhigileva 2006; Hritanko, Gashev 2007), Yakutsk (Odnokurtsev 2002), Rostov-on-Don (NUTS 2002), Minsk (Bychkova 2004; Bychkova & Shendrik 2006), in urban landscapes of Uzbekistan (Bykova at al. 2005). There are some studies of urban regions of Sudan (Dina et al. 2009), Poland (Jankovska et al. 2005, Hildebrand et al. 2009), England (Richardsa et al. 2006, Lewis 2008), the USA (Nuismer, Kirkpatrick 2003) and some others. Such studies have a great significance firstly because of there are specific of small mammal community compositions in the city green plots (Chernousova 1996, 2010, 2012), what may lead to a change of parasitic communities of animal and influence on host-parasite relationships, adding to theoretical developments in this field. Secondly due to people active contacts with the nature in the recreational areas of the city in the process of herb, berries, mushroom collection, as well as taking pets for a walk. So the likelihood of infestation with the different stages of helminths, circulating in micromammals and constituting a danger to human, increases in these places.

Helminthofauna of small mammals and their epizootological role as a refuge of pathogenic agents of dangerous to people, domestic and game animals diseases in the great industrial centre of Russia, located in the Middle Urals –

the city of Ekaterinburg (southern taiga subzone; Scotch pine forest) – and its surroundings is not almost investigated. Therefore research in the parks and park-forests of Ekaterinburg represents both theoretical and practical interest. So the model object of our studies was recrea-tional forest regions of the city of Ekaterinburg.

The aim of our research was an investigation of quality and quantity composition of small rodents' helminths in the recreational areas of the City on the example of the most mass species – ***A. uralensis***. A goal of the study was also a comparison of the small wood mouse democenoses from different habitats.

Material and methods

The objects of our studies were helminthofauna of wild micromammals which dwell in the green zones of Ekaterinburg. The research was carried out at the forest sites of the city – five outskirts park-forests located in different directions of the wind rose: south-western (**SW)**, north-eastern (**NE**), north-western (**NW**), south-eastern (**SE**), south-southwestern (**SSW**); and as well as at two small coniferous forest plots within the city buildings: the Central Recreation-and-Entertainment Park (**CP**), and a pine plot of the Arboretum (**Ar**) of the Botanical garden, Ural branch of RAS (fig. 1). Recreation is completely absent at this part of Arboretum because it is closed to people visiting. All sites of pine forest, in some or other degree, are transformed by the urban influence. Recreational load is, evidently, the most in the Central Recreation Park.

Wild small mammals were inventoried during the breeding season when population densities were highest (in the middle of the summer). The data presented in this article were collected, for three years (2010–2012).

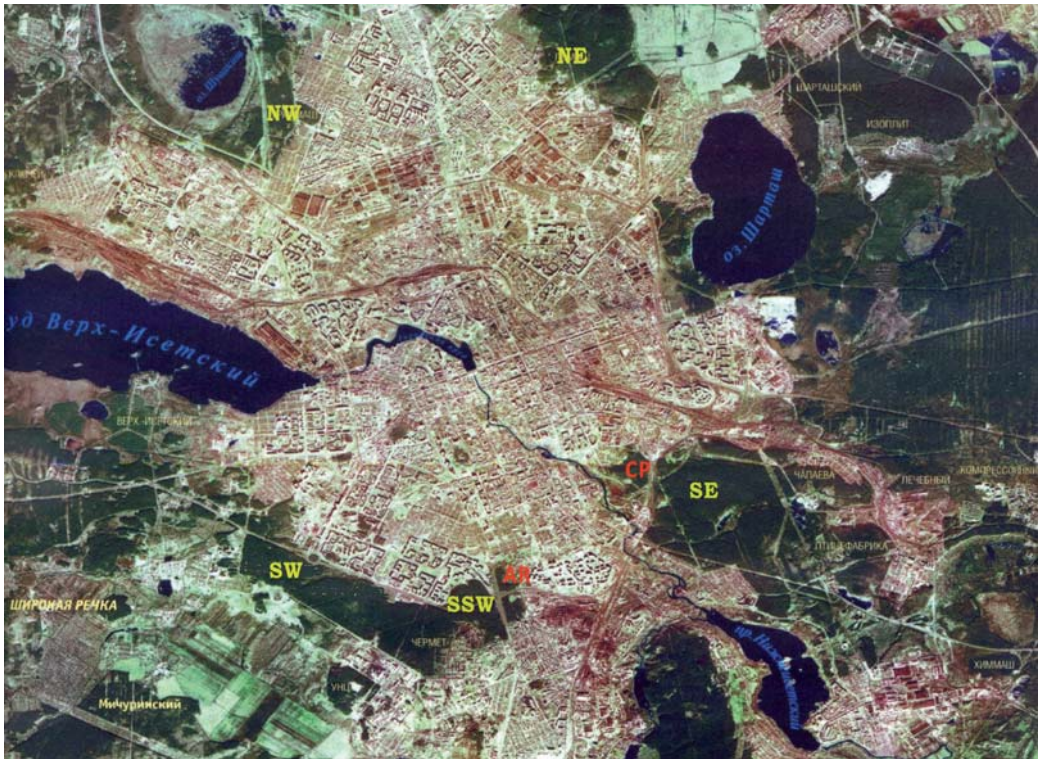

Fig. 1 Sites of animal catching: **SW**, **NE**, **NW**, **SSW** *– park-forests of the city outskirts;* **CP** *– Central Recreation-and-Entertainment Park,* **Ar** *– Arboretum – intracity plots.*

Animals were helminthological autopsy (Anikanova et al. 2007) with analyzing all organs of thoracic and abdominal cavities. The parasitic communities of one of the most numerous rodent species of the surveyed city sites – wood mouse (*Apodemus (Sylvemus) uralensis* Pallas, 1811) collected for last three years were studied.

To analyse separate helminth species was not our goal. We considered the following parameters: prevalence and intensity helminth invasion of the wood mouse 1) with any helminth species, 2) with separately cestodes, 3) with separately nematodes, 4) with helminthes, representing a potential danger for human.

Statistical analysis of the material was done using programs: http://folk.uio.no/ohammer/past) **and** Quantitative Parasitology (**QP 3.0**) (Rozsa et al. 2000), **Past2** (Hammer et al. 2008), φ-Fisher's angular transformation (Ermolaev 2002).

Results and Discussion

Total **609** individuals of *A. uralensis* were analysed and there were found **19** species of helminths of them: **11** nematodes, **7** cestodes and **one** acanthocephalan species. Six helminth species (*Capillaria hepatica* Bancroft 1893, *Syphacia stroma* Linstow 1884, *Trichocephalus muris* Schrank 1788, *Hymenolepis diminuta* Rudolphi, 1819, *Taenia hydatigena* Pallas 1766, *Macracanthorhynchus hirudinaceus* Pallas, 1781 – one case) are pathogenic for human, game mammals and farm livestock.

First we analysed the possibility of links between abundance of the host species (*A. uralensis*) and prevalence of its helminth invasion (fig. 2). Though in three of seven cases the correlation rate was about 0.7, but it was not significant, that is in fact, such a link is missing. Infection of animals with helminths occurs at any abundance of the host population as a result of the implementation of its basic trophic linkages.

The highest indices of prevalence infestation by all helminths in *A. uralensis* we recorded at the intracity plots: the Central Recreation Park and Arboretum, which differ between each other in the recreational load level very much. However significant differences were only between indicators of the Central Park and SSW park-forest, where it was the lowest of all sites (table 1).

The most number of all helminthes per one infested individual (invasion intensity) was at the smallest forest plot – the Arboretum. Here this indicator was almost two times higher than at all park-forests. But there were not significant differences in one case of comparing between sites.

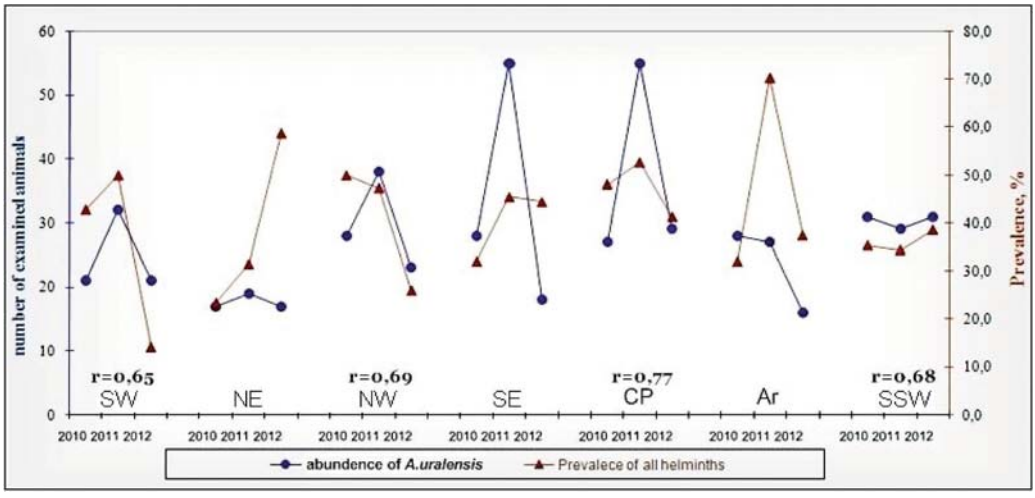

Fig. 2 Dynamics of A. uralensis abundance and its prevalence infestation of all helminths. Legends: the same as on fig. 1.

Table 1 Indicators of A.uralensis helminth invasion in forest sites of the city

Parameter \ Place	park-forests					intracity plots	
	SW	**NE**	**NW**	**SE**	**SSW**	**CP**	**Ar**
Prevalence of all helminths, %	**37.8**	**37.7**	**42.7**	**41.6**	**36.3**	**48.6**	**47.9**
Intensity of all helminths	**6.6**	**6.5**	**10.4**	**9.2**	**5.5**	**10.9**	**15.4**
Prevalence Nematoda, %	**24.3**	**32.1**	**28.1**	**31.7**	**36.3**	**51.4**	**40.8**
Intensity Nematoda	**8.8**	**6.4**	**14.5**	**11.2**	**4.9**	**9.9**	**17.2**
Prevalence Cestoda,%	**17.6**	**13.2**	**18.0**	**13.9**	**8.8**	**12.6**	**16.9**
Intensity Cestoda	**2.2**	**3.0**	**2.1**	**2.0**	**2.5**	**1.5**	**2.2**
Prevalence dangerous for human helminth,%	**23.0**	**17.0**	**11.2**	**18.8**	**18.7**	**18.9**	**38.0**
Intensity dangerous for human helminth	**9.2**	**8.3**	**24.6**	**5.1**	**5.3**	**7.0**	**15.0**
Taxa_*S*_dangerous	**4**	**4**	**4**	**3**	**4**	**4**	**4**
$N_{A.uralensis}$	**74**	**53**	**89**	**101**	**91**	**111**	**71**

Legends: ***N*** – number of ***A. uralensis*** individuals, Taxa_*S* - number of species; **SW**, **NE**, **NW**, **SSW** – park-forests of the city outskirts; **CP** – Central Recreation-and-Entertainment Park, **Ar** – Arboretum.

Analysis of infestation with different helminth classes

On the average for all studied sites, prevalence of infestation with nematodes was more than two times higher than with cestodes ($t = 5.7$, $p < 0.01$). But despite the rodents were infested more with cestodes than nematodes everywhere, significant differences in the infestation inside plots were only at three places: at the Arboretum, the Central Recreation Park and the South-south-western park-forest. Especially (more than three times) indices of mouse infestation with nematodes and cestodes differed in the Central Park.

Cestodes

Both prevalence and intensity of the cestode infestation of mice in the different urban sites were about equal; only in the South-western park-forest the prevalence was a little lower than in others. However, in any case differences even did not approximate to significant.

Nematodes

But in regard to Nematode prevalence invasion, there were some differences between populations. At the Central Recreation Park and the Arboretum *A. uralensis* were infested with nematodes much higher than in the other forest areas of the city. The differences **in nematode prevalence** between mouse populations of the Central Recreation Park and all park-forests were highly significant ($p < 0,01$) what together with the high mouse abundance in the Park can **contribute to the unfavorable situation** of helminthic zoonosis maintenance in it. Rodents from the Arboretum differed in this indicator only from animals of the south-western and the north-western park-forests. All park-forests did not differ in this index between each other.

Intensity mouse invasion with Nematodes at the Arboretum was significantly higher, than at NE, SW and SSW park-forests.

Analysis of infestation with dangerous to human helminth

The special interest from a practical standpoint represents the analysis of invasion with dangerous to human helminths. The most infested with them was the population of *A. uralensis* at the Arboretum which is located inside the urban building. The prevalence was significantly higher here than at the other city forest plots. The intensity of dangerous helminth invasion was also a relatively high here. Although this part of the Arboretum is closed for population visiting, but the mice from this plot can move freely to other parts of the Botanical Garden and the adjacent to it green plots of the city, so they can be the food of stray dogs and cats to long distance inside the city and are included actively in the maintenance of zoonoses of nearest places.

Favourable from an epidemiological point of view was the fact that in the most frequently visited by people park-forests (SE and the SSW) the percentage of mice with dangerous worms was not high and the intensity of dangerous helminths was the least (table 1). In all other park-forests and the Central Park the percentage of mice infested with dangerous for human helminthes was almost equal, about 20 %.

Community analysis

To characterize helminthocenoses of *A. uralensis* we used standard indices: dominance, Shannon-Wiener diversity and Pielou's evenness (table 2). The lowest diversity (Shannon-Wiener index) was in the small limited area – the Arboretum. The most diversity of helminth communities were at the city forest sites with the highest recreation load (SSW and CP), and ibidem communities were the most evenness. The presence of large amounts of food residues at these places attracts a lot of stray dogs that, apparently, contributes not only to maintaining zoocenoses, but also increasing their diversity.

For a total comparative assessment of *A. uralensis* democenoses (term of Savinov 2011) in all observed sites we have built a dendrogram (fig. 3) with all indices of helminth infestation and diversity indices (table 1, 2).

The dendrogram (fig. 3) shows that on the basis of *A. uralensis* democenosis characteristics the intracity populations (the Arboretum, the Central Park) form a separate cluster isolated from the park-forests ones. All park-forests form one group more or less interconnected clusters. While this is pretty amazing, but similar grouping of clusters we have got earlier for population indices of small mammal communities from these sites (Chernousova et al. 2012). This testifies to the profound differences environmentally formed under the influence of different degree of urbanization of intraurban and suburban democenoses.

Table 2 Diversity and domination indices of helminthocenoses of A. uralensis. Legends: the same as in the table 1.

Parameter \ Locality	park-forests					intracity plots	
	SW	**NE**	**NW**	**SE**	**SSW**	**CP**	**Ar**
***N** A. uralensis*	**74**	**53**	**89**	**101**	**91**	**111**	**71**
Dominance_D	0.53	0.32	0.42	0.45	0.23	0.26	0.54
Shannon_*H*	1.11	**1.66**	1.26	1.22	**1.81**	**1.59**	1.03
Pielou_*E*	**0.48**	**0.67**	**0.51**	**0.51**	**0.71**	**0.62**	**0.47**
Taxa_S	**10**	**12**	**12**	**11**	**13**	**13**	**9**

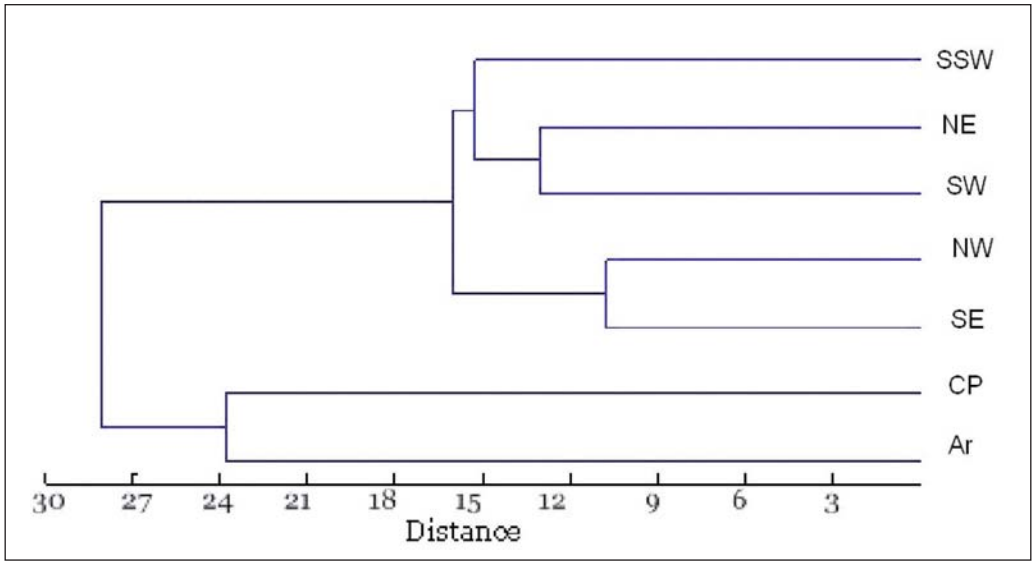

Fig. 3 Dendrogram of grouping of A. uralensis populations of the forest city sites on the basis of their democenosis characteristics. Legends are the same as on fig 1.

Conclusions

There were not correlation between abundance of the host species (*A. uralensis*) and prevalence of its helminth invasion.

The intensity of *A. uralensis* invasion both all helminths and the different worm classes did not differ at all surveyed sites.

The highest indices of prevalence infestation of A.uralensis with all helminths were recorded at the intracity plots: the Central Recreation-and-Entertainment Park and the Arboretum, having completely opposite recreational loads, thus this indicator does not depend on recreation load. But at the both, the diversity indices of micromammal communities (as we found Earlier-Chernousova et al. 2012) were the lowest in comparison with all other sites.

The presence of a large quantity of stray dogs can not only promote increasing helminthocenosis diversity, but also create an unfavorable situation of helminth zoonosis maintaining.

The most abundant rodent species inside the city boundaries – the small wood mouse – can be a source of supporting zoonoses both in the park-forests and the intracity sites. Especially it matters in the most frequented by people the Central Recreation Park. Certainly more epidemiological importance has the percentage of infested animals in the population of *A. uralensis*, but not invasion intensity.

The high abundance of the small wood mouse in Central Recreation Park, in view of that about 20 % of the animals contain dangerous to human helminths, may cause an unfavorable epizootic situation in the most attended by population recreational site.

The clear distance between the intraurban and the suburban democenoses is the result of evolutionary processes occurring in forest communities under the influence of different degree of urbanization.

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