Vestnik zoologii, **50**(2): 155–162, 2016
DOI 10.1515/vzoo-2016-0018

DE GRUYTER OPEN

UDC 595.421(477)

IXODID TICKS (ACARI, IXODIDAE) IN URBAN LANDSCAPES. A REVIEW

I. A. Akimov, I. V. Nebogatkin

Schmalhausen Institute of Zoology, NAS of Ukraine,
vul. B. Khmelnytskogo, 15, Kyiv, 01030 Ukraine
E-mail: niv_zoo@ua.fm

Ixodid Ticks (Acari, Ixodidae) in Urban Landscapes. A review. Akimov, I. A., Nebogatkin, I. V. — This study presents the results of content analysis of published works on ixodid ticks in urban conditions in order to determine the species diversity, the vectors of research interests at various stages. Information about ticks in the cities up to the 1980s is incidental, to the point of exclusive, after this point there is targeted research in urban landscapes. There are 106 or 15 % of hard ticks of the world fauna registered in the urban territory, 26 species or 3.7 % being the most abundant. Of the urban hard tick species, 23 (88.5 %) can attack humans, and 12 species are the most adapted to the urban landscape: *Ixodes ricinus, I. persulcatus, Dermacentor reticulatus, D. marginatus, I. pavlovskyi, I. scapularis (dammini), Amblyomma cajennense, Haemaphysalis longicornis, I. hexagonus, Hyalomma marginatum, Am. americanum,* and *Rhipicephalus sanguineus*. It was determined that the most likely causes of the growing number of publications on ixodids urban landscapes are: global accelerating urbanization, the development of recreational areas, the development of green tourism, the growth of the prestige of outdoor recreation, the creation of new, especially of the landscape parks and a tendency to preserve the native landscape in the cities, a significant increase in the density of populations of common species of hard ticks adapted to living in urban environment. The vectors of further work in urban landscapes will be directed to exact planning of monitoring studies of ixodids and associated tick-borne infections.

Key words: ticks, city, tick-borne infection, urban landscapes.

Introduction

It is a fact globally acknowledged that anthropogenic and urban landscapes are consuming natural ecosystems compelling plant and animal life to leave their destroyed and transformed habitats or, rarer, to adapt to new conditions. Invasive (introduced) species tend to manifest in such landscapes, often quite far from their previous habitats (Klausnitzer, 1984). Some of these species are dangerous for humans, domesticated and wild animals. Hard ticks of the family Ixodidae are among the most important such species because they are specialized obligate hematophages capable of transmitting pathogens of various etiologies on every developmental stage, causing great losses (Jongejan, Uilenberg, 2004).

We analyzed the history of research of ixodids in urban conditions; identified the species diversity of ixodids in zoogeographic regions and cities; ascertain the possible reasons that inspire the scientists to study these ectoparasites in urban landscapes; determine vectors of the most important and promising directions of research.

More than 800 publications that focus on ixodid ticks in urban environment or mention findings of some species in cities were analyzed. Literature on studies in suburbs was not taken into account. Ixodid systematics follows that of Guglielmone et al. (2014). Argasidae ticks were not considered because they had been already studied, rather exhaustively, by Uspensky (2008, 2014).

Hereafter we use the following abbreviations for terms and tick-borne infections: LD — Lyme disease (as it is often referred to in literature, though the truer name would be ixodid tick borreliosis; also we didn't include *Borrelia miyamotoi* species group in statistical analysis); TE — tick encephalitis; ID — index of dominance; Af — Afrotropical; EP — Eastern Palearctic; NE — Nearctic; NeO — Neotropical; Or — Oriental; WP — Western Palearctic.

Also, we composed an index of references for relative evaluations, which ranges from 0 to 100:

$$IR = d_i/D_i,$$

where *IR* — index of references, D_i — number of publications during the *i* time period, *i* — time period.

For analysis and maintenance of the database we used Microsoft Excel 2010.

History of the question

First reports of ticks in cities were incidental, mostly mentioning sporadic findings. Such studies make up the first phase when Korenberg, Černý and Daniel (1984) published their research. Most of these publications deal with ixodid ticks as vectors of human and animal pathogens. For example, one of the first reports on hard ticks in urban conditions is given in the monograph on North American fever (Hunter, Hooker, 1907). It mentions "the adult ticks from the city mains at Dallas Tex.", finding of *Amblyomma tuberculatum* Marx, 1894 on turtles of Crescent City, California. It also referred to the death of the lambs as a result of tick-borne infection in Memphis, Tennessee. The authors have determined livestock losses of 100 million dollars annually at that time.

Czech scientists Černy and Daniel together with their Russian colleague Korenberg analyzed more than 10 papers and confirmed the theoretical possibility of ixodid ticks' persistence in cities, as well as the importance of ticks and perspectives of such studies (Korenberg, Černý, Daniel, 1984). The year 1985 is the beginning of focused studies of hard ticks in urban landscapes, i.e. the second phase.

Regarding the history of hard tick studies in urban landscapes of Ukraine, it may be added that we in fact started it in big cities in 1984 due to a tularemia outbreak that was reported in southern regions (Moiseyeva et al., 1991; Baranovsky, 1992). First results of ixodid ticks studies in Kyiv were presented in 1997 (Akimov, Nebogatkin, 1997) when for the first time in acarological literature the term «urban aspect» was used. Presently, the studies of ticks in Kyiv are most thorough (Nebogatkin, 1996, 1999, 2012 a, 2012 b; Akimov, Nebogatkin, 1999, 2001, 2002, 2011, 2013 a, b, c), as well as in Kharkiv (see for example Naglov et al., 2000; Simonenko (Nikiforova), 2000; Movila et. al., 2009; Maliy et al., 2012 etc.) and in Lviv (Semenyshyn et al., 2010; Biletska et al., 2012 etc.). Research was also conducted in other Ukrainian cities: Berdyansk, Big Yalta, Donetsk, Zaporizhzhya, Kramatorsk, Lugansk, Lutske, Rivne, Mariupol, and Ternopil.

Distribution of ixodids in urban landscapes according to zoogeographic regions

According to reviews by several authors (table 1), there are four ixodid species able to inhabit cities of Europe and Africa: *Rhipicephalus sanguineus* (Latreille, 1806) and three of *Ixodes* genus, two from *ricinus* group (*I. ricinus* (Linnaeus, 1758) and *I. persulcatus* Schulze, 1930) and *I. hexagonus* Leach, 1815.

Analysis shows that majority of the published studies of ixodid ticks in urban landscapes take place in Palearctic region (more than 600), Neotropical and Nearctic regions (table 2).

Altogether in cities of the world, 106 species of 6 ixodid genera were found: 89 in 1 zoogeographic region; 14 in 2; *Rh. (Boophilus) annulatus* (Say, 1821) in 3, *Rh. (Boophilus) microplus* (Canestrini, 1888) in 5 and *Rh. sanguineus* in 6 zoogeographic regions. Thus, the most widely distributed ixodids are the parasites of house pets, aided in their dissemination by human activity.

Table 1. Reviews concerned with ticks inhabiting cities

Korenberg, Cerny, Daniel 1984	Theoretical basis for possibility of ixodid ticks persistence on urban grounds
Dautel, Kahl, 1999	Biology and medical importance of four tick species in Central Europe cities
Gratz, 1999	Infection diseases (such as Lyme disease, ehrlichiosis, hemorrhagic fevers and tick-borne encephalitis) in urban agglomerations
Uspensky, 2008	Conditions of tick populations' adaptation to urban environment
Gray et al., 2013	Biology and world-wide distribution of ixodid tick of *Rh. sanguineus*
Uspensky, 2014	Major groups of bloodsucking ticks that inhabit urban environment Analysis of ways of infection and conditions of persistence of urban ixodid populations

One-host ticks of the genus *Rhipicephalus (Boophilus)* feed on ungulates while the dog is a food source for three-host tick *Rh. sanguineus*. One-host ticks spread easier but are quite vulnerable if livestock is kept in proper sanitation with acaricide treatments, thus the ticks can disappear on vast territories, for example, regions of Ukraine (Nebogatkin, 1993) or USA (Guglielmone et. al., 2014). Species of the group *Rh. sanguineus* also easily spread with hosts, but their instars and adults exit into environment and thus are harder to effect by acaricides. These species are distributed in habitats according to their biological preferences, including urban conditions (Akimov, Nebogatkin, 2013 c).

Table 2. Number of publications on ixodid ticks in urban landscapes per zoogeographic regions. Reviews are not included

Region	Quantity
Afrotropical (Af)	17
Eastern Palearctic (EP)	109
Nearctic (NE)	66
Neotropical (NeO)	90
Oriental (Or)	8
Western Palearctic (WP)	503

Table 3. Examples of mentions of different ixodid species with ID ranges and most important references on zoogeographic regions. NR — number of references total, including works that name only 1 species (OS), ID — index of dominance

Name	Ticks	NR	OS	ID	Authors, such as
Af	*H. leachi*	4		17–68.4	Dreyer et al., 1997; Kwak et al., 2014
(17)*	*Rh. (Boophilus) decoloratus*	4		68.4–87.2	
	Rh. sanguineus	12	7	1.4–89.5	
EP	*D. silvarum*	8		43.5–58.3	Ohandzhanyan, 1948; Vlasenko, Filippova, 1961; Fedorov, 1968; Ryltseva, 1970; Liu et al., 2013; Kim et al., 2014
(37)	*H. concinna*	9		1.6–84.4	
	H. flava	8		0.05–28.5	
	H. longicornis	19	4	2.7–96.8	
	I. pavlovskyi	44		18.1–84.9	
	I. persulcatus	69	17	1.8–95.4	
	Rh. (Boophilus) microplus	9	2	5.8–28.9	
	Rh. sanguineus	9	3	4.6–72.4	
	Rh. turanicus	5	2	36–79.8	
NE	*Am. americanum*	16	10	11.8–93	Hunter, Hooker, 1907; Cooley, Kohls, 1945; Koch, 1982; Masseti, Bruner, 2009; Willis et. al., 2012
(12)	*D. variabilis*	8	1	8–23.3	
	I. scapularis (dammini)	41	33	15–76.5	
	Rh. sanguineus	10	7	16.8–70.6	
NeO	*Am. cajennense*	25	2	1.6–96.7	Arzua et al., 2003; Reis et al., 2013; Costa-Júnior et al., 2013
(24)	*Am. dubitatum*	6	2	2.8–58.2	
	Am. oblongoguttatum	6		1.5–15.7	
	Am. ovale	10		3.8–46.7	
	Am. tigrinum	6	2	18.2–68.5	
	Rh. (Boophilus) microplus	6		1.4–56.6	
	Rh. sanguineus	70	48	7.2–85.7	
Or	*Hy. marginatum*	2		75.56	Anastos, 1950; Bermúdez et al., 2009; ul-Hasan et al., 2012.
(8)	*Rh. (Boophilus) microplus*	2		5.4	
	Rh. sanguineus	4	3	25–79.4	
WP	*D. marginatus*	43	2	2.0–93.0	Kozuch et. al., 1963; Gothe, 1968; Akimov, Nebogatkin, 1999; Akimov, Nebogatkin, 2001; Akimov, Nebogatkin, 2002; Movila, 2009; Semenyshyn et al., 2010; Nebogatkin, 2012.
(33)	*D. reticulatus*	112	25	0.5–98.6	
	H. concinna	7	1	0.6–54.6	
	H. punctata	9		1.2–6.8	
	Hy. marginatum	17	1	2.4–76.05	
	I. hexagonus	19	1	6.1–72.8	
	I. persulcatus	56	16	15.8–84.9	
	I. ricinus	384	244	0.2–98.6	
	I. trianguliceps	7		0.2–5.7	
	Rh. rossicus	7	1	2.8–36.4	
	Rh. sanguineus	61	29	0.3–89.3	
	Rh. turanicus	12	2	5.5–77.8	

* In parentheses, the total number of ixodid species registered in the region are indicated.

Table 4. Number of countries and cities in which studies of ixodid ticks in urban landscapes were conducted

Time periods	XXth century			XXIth century	
	1970s	1980s	1990s	2010s	2020s
Countries	11	12	22	39	Approx. 50
Cities	14	24	60	120	>220

The majority of the 106 species are incidental for urban environment. The summarizing table includes ixodid ticks that are mentioned in publications a certain number of times: in Af — 4; in EP and NE — 8; in NeO — 6; in Or — 2; in WP — 7 (the numbers are related to differing amount of research in the zoogeographical regions). Twenty-six ixodid species (3.7 %) are repeatedly listed in the studies (table 3). These are *Am. americanum* (Linnaeus, 1758), *Am. cajennense* (Fabricius, 1787), *Am. dubitatum* Neumann, 1899, *Am. oblongoguttatum* Koch, 1844, *Am. ovale* Koch, 1844, *Am. tigrinum* Koch, 1844, *D. marginatus* (Sulzer, 1776), *D. reticulatus* (Fabricius, 1794), *D. silvarum* Olenev, 1931, *D. variabilis* (Say, 1821), *H. concinna* Koch, 1844, *H. flava* Neumann, 1897, *H. leachi* (Audouin, 1826), *H. longicornis* Neumann, 1901, *H. punctata* Canestrini et Fanzago, 1878, *Hy. marginatum* Koch, 1844, *I. hexagonus*, *I. pavlovskyi* Pomerantzev, 1946, *I. persulcatus*, *I. ricinus*, *I. scapularis* (*dammini*) Say, 1821, *I. trianguliceps* Birula, 1895, *Rh. (Boophilus) decoloratus* Koch, 1844, *Rh. (Boophilus) microplus* (Canestrini, 1888), *Rh. rossicus* Yakimov et Kohl-Yakimova, 1911, *Rh. sanguineus*.

Of them, 88.5 % feed on humans.

Of those mentioned above repeatedly named species, the most frequently mentioned are 12: *I. ricinus* in 384 sources, it is a singular hard tick species in 244 sources; *I. persulcatus* is in 125 sources, singularly in 33; *D. reticulatus* in 115, singularly in 26; *D. marginatus* in 44, singularly in 2; *I. pavlovskyi* in 44; *I. scapularis* (*dammini*) in 41, singularly in 33; *Am. cajennense* in 25, singularly in 2; *H. longicornis* in 19, singularly in 4; *I. hexagonus* in 19, singularly in 1; *Hy. marginatum* in 17, singularly in 1; *Am. americanum* in 16, singularly in 10; at last, *Rh. sanguineus* in 166, singularly in 97, respectively. All these species except *I. hexagonus* feed on humans; regarding the latter, feeding on humans is yet unproved but the tick species is a part of pathogen circulation of natural focal infections in cities.

Thus, apparently there is a trend towards an increased risk of human and animal infections associated with ticks in urban landscapes. For examples we recommend the reviews by Wu et al. (2013) about tick-borne infections distribution in China and Rizzoli et al. (2014) about infections associated with *I. ricinus* in urban and suburban areas.

Current state of ixodid ticks research in world countries and cities

As mentioned above, the history of ixodid ticks research is divided in two phases: before 1984 the studies and registrations of these ectoparasites are incidental, after 1984 there is a research targeting ixodids in urban environment. To ascertain the depth of the research, the regularities and possible reasons of interest in this problem, we used six time periods in our analysis: 1907–1969, 1970–1979, 1980–1989, 1990–1999, 2000–2009, and 2010–2015.

Research of ixodid ticks in cities is inextricably linked with the countries where the studies were conducted. According to our data, there are publications on 68 countries and 793 cities (table 4). There are countries where ixodids have been studied for five time periods or longer: Germany, Russia, USA, and France. A minority of countries is characterized by the number of publications nearing 25, thus urban ixodid populations are most studied in: Brazil (58), Germany (62), Chine (24), Poland (74), Russia (163), USA (63), Ukraine (54) and Czech Republic (42).

Areas of research on ixodid ticks in cities

To find out vectors of interest of research on ixodids in cities, we analyzed the number of publications in each of the time periods (see above), number and severity of most important tick-borne diseases, publications about ticks parasitizing in cities.

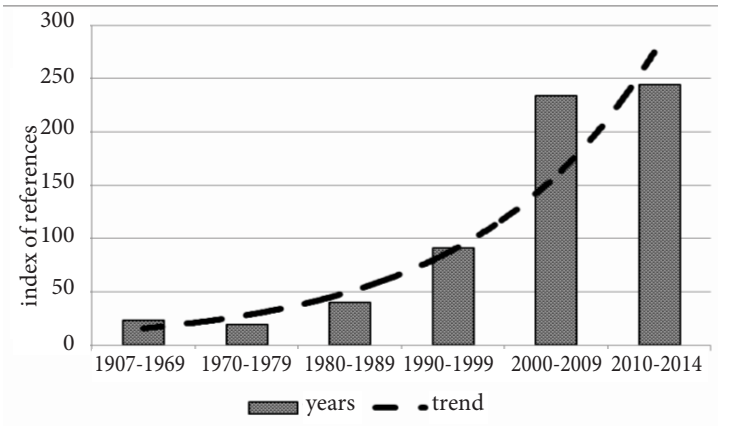

Fig. 1. Numbers of publications on ixodid ticks in urban landscapes per decade and the trend.

Analysis of the number of publications on ixodid ticks revealed that interest in the study of this group of bloodsuckers in the urban environment is growing (fig. 1). Another peculiarity is that this scientific interest in all of the countries is concentrated in time on determining ixodid reactions characterizing the transition to living in urban environments.

Comparative analysis of a diagram of the number of publications on the ten-year periods and the indexes of references of major tick-borne infections in urban areas (fig. 2) indicates their possible connection which may be one of the reasons for the interest in the study of ticks in urban landscapes. First of all, the diagram shows that until 1980s, interest in ixodids is linked solely to the study of natural foci of tick-borne encephalitis. Secondly, it demonstrates the dynamics of improvement of the diagnostic systems, and thirdly, there is the fact that interest in different groups of tick-borne infections is varying in certain decades, and it comes on suddenly, immediately after the appearance of more or less accurate diagnostic methods.

Thus, the interest in Lyme disease piqued in the last thirty years. Simultaneously, it is clear that the recent discovery of *Borrelia miyamotoi* will undoubtedly cause increase of scientific papers on the subject of *Borrelia*.

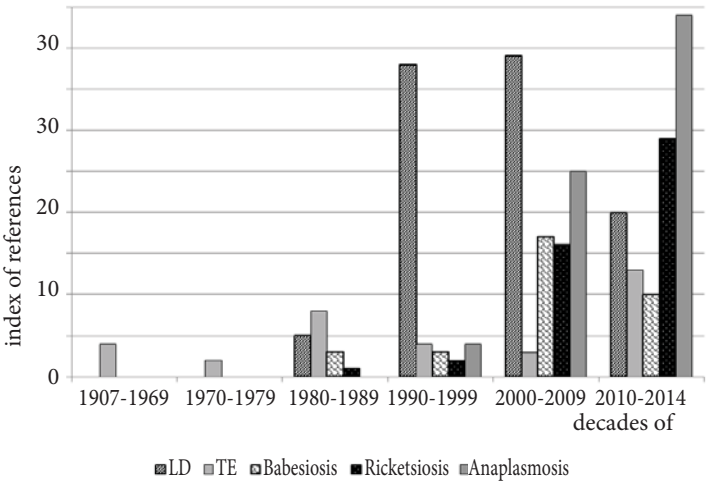

Fig. 2. Diagram of indexes of references of tick-borne diseases in urban landscapes.

Identification of possible areas of motivation of further research

To identify the direction of further research, we analyzed publications on the subject of hard ticks most frequently found in European urban environment (including Russia), as the region is most studied (fig. 3).

It must be noted that the majority of publications are concerned with hard tick species of the group *ricinus* (*I. ricinus* and *I. persulcatus*) which is possibly better adapted to urban landscapes. The genus *Dermacentor* only recently began to be mentioned in this regard but is referenced more frequently for the last few years than the ticks of *Ricinus* species group and of the genus *Rhipicephalus*.

Observations show (Akimov, Nebogatkin, 2011) that in the context of global climate change, seasonal tick activity varies due to changing weather conditions, thus there is a need for correction and accurate planning of monitoring studies, especially in urban landscapes (Akimov, Nebogatkin, 2013 c).

Conclusions

1. Information about the hard ticks in the cities up to 1980s is quite scattered and even sporadic; thereafter it is associated with research on ixodids as vectors of pathogens of tick-borne infections in urban landscapes.

2. Of the 707 species that constitute the world ixodid fauna, 106 or 15 % are mentioned in urban landscapes, and 26 species of those (3.7 %) are the most abundant. Among the latter, 23 species can attack humans, and 12 species are most adapted to the urban landscape: *I. ricinus*, *I. persulcatus*, *D. reticulatus*, *D. marginatus, I. pavlovskyi*, *I. scapularis* (*dammini*), *Am. cajennense*, *H. longicornis*, *I. hexagonus*, *Hy. marginatum*, *Am. americanum*, and *Rh. sanguineus*.

3. The most likely causes of the growing number of publications on ixodids in urban landscapes are: accelerating global urbanization, the development of recreational areas, the development of green tourism, the growth of the prestige of outdoor recreation, the creation of new, especially the landscaped parks, and the tendency to preserve the native landscape in the cities, a significant increase in population density of common species of ixodid ticks that adapted to life in the urban environment.

4. Further research in urban landscapes will be directed to exact planning of monitoring studies on ixodids and related tick-borne infections, the development of regional databases

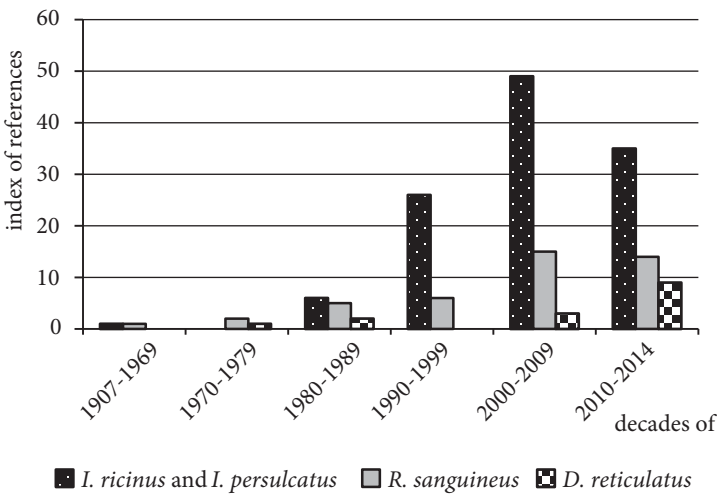

Fig. 3. Diagram of indexes of references of mass hard tick species that adapted to European urban landscapes (including Russia).

of these ectoparasites that would substantiate the introduction of short-term and long-term forecasts of tick numbers in separate sites in the urban environment. Also, among the vectors are likely to be the study of general and specific patterns of distribution and population density of these bloodsuckers in urban conditions, including evaluation of "thermal islands" effects of urban areas as compared to the natural landscape of the metropolitan areas.

5. Further laboratory studies are likely to be directed to etiological transcript from febrile patients with a history of a hard tick bite. Techniques related to biomarkers of infectious diseases apparently, be introduced in practice.

The authors wish to express his sincere acknowledgements to V. Kharchenko (Institute of Zoology, NAS of Ukraine) for the invaluable assistance and numerous helpful advices.

References

Akimov, I. A., Nebogatkin, I. V. 1997. Sertain results of the ixodid ticks study in the borreliosis focuses in Ukraine. *Vestnik zoologii*, **31** (4), 72–77 [In Russian].

Akimov, I. A., Nebogatkin, I. V. 1999. Monitoring of paths of circulation of the activator of Lyme disease in urban natural refuges. *Proceedings, VIII International Conference on Lyme Boreliosis and other Emerging Tick-Borne Diseases*, 20–24 June 1999, Munich., 44.

Akimov, I. A., Nebogatkin, I. V. 2001. Borrelia and Borreliemia on Territory of Kiyv and in its Vicinity. *Vestnik zoologii*, **35** (3), 30.

Akimov, I. A., Nebogatkin, I. V. 2002. Ticks of Kyiv — Urbozoological and Epyzootological Aspects. *Vestnik zoologii*, **36** (1), 91–95 [In Russian].

Akimov, I. A., Nebogatkin, I. V. 2011. Dynamics of numbers and some ecological peculiarities of ticks (Acari, Ixodidae) in urbanized landscapes of Kyiv since the beginning XXI century. *Science magazine National Pedagogical University M. P. Dragomanova. Series 20 "Biology"*, 3, 98–109 [In Ukrainian].

Akimov, I. A., Nebogatkin, I. V. 2013 a. Street line as a way of movement of ticks (Acari, Ixodidae) in the city. *VIII Congress of the PA «Ukrainian Entomological Society»* 26–30 August 2013. Kyiv, 8–9 [In Russian].

Akimov, I. A., Nebogatkin, I. V. 2013 b. Ticks (Acari: Ixodidae) on the banks of lakes in the metropolitan area (for example, Kyiv) and determine the feasibility of measures against ticks. *Veterinary Medicine: Interdepartmental subject scientific collection*, 97, 372–373 [In Russian].

Akimov, I. A., Nebogatkin, I. V. 2013 c. Species diversity of ticks (Acari: Ixodidae) in the megalopolis Kyiv. "*Fundamental and Applied Aspects of the Study of Parasitic Arthropods in the XXI Century*". Russia, St. Petersburg, 21–25 October, St. Petersburg, 21–24 [In Russian].

Baranovsky, P. M. 1992. All-USSR Conference on tularemia. *Med. parazitol. and parasitic. disease,* (5–6), 61–62 [In Russian].

Biletska, G. V., Semenyshyn, O. B., Ben, I. I., Shulgan, A. M., Drul, A. S., Fedoruk, V. I., Lozinsky, I. 2012. Modern parasitic ticks system infections in Lviv region. *Annals of Mechnikov Institute*, 4, 126–132 [In Ukrainian].

Dautel, H., Kahl, O. 1999. Ticks (Acari: Ixodoidea) and their medical importance in the urban environment. *In*: Robinson, W. H., Rettich, F., Rambo, G.W., eds., *Proceedings of the 3rd International Conference on Urban Pests*. Czech University of Agriculture, Prague, 73–82.

Gratz, N. G. 1999. Urbanization, arthropod and rodent pests, and human health. *In*: Robinson, W. H., Rettich, F., Rambo, G. W. eds. *Proceedings of the 3rd International Conference on Urban Pests*. Czech University of Agriculture, Prague, 51–58.

Gray, J., Dantas-Torres, F., Estrada-Peña, A., Levin, M. 2013. Systematics and ecology of the brown dog tick, *Rh. sanguineus*. *Ticks and Tick-borne Diseases*, **4** (3) 171–180.

Guglielmone, A. A., Robbins, R. G., Apanaskevich, D. A., Petney, T. N., Estrada-Peña, A., Horak, I.G. 2014. *The Hard Ticks of the World (Acari: Ixodida: Ixodidae*. Springer Dordrecht Heidelberg, N. Y., London, 1–730.

Hunter, W. D., Hooker, W. A. 1907. Information concerning the North American fever tick, with notes on other species. *U.S. Dept. Agric., Bur. Entom. Bull*, **2** (72), 87.

Jongejan, F., Uilenberg, G. 2004. The global importance of ticks. *Parasitology*, **129**, 3–14.

Klausnitzer, B. 1984. *Käfer im und am Wasser*. A. Ziemsen Verlag ,Wittenberg Lutherstadt, 1–148.

Korenberg, E. I., Černý, V., Daniel M. 1984. Occurrence of Ixodid ticks-the main vectors of tick-borne encephalitis virus in urbanized territory. *Folia Parasitologia*, **31**, 365–370.

Maliy, V. P., Shepileva, N. V., Tkachenko, L. V. 2012. Tick-borne infections in the Kharkiv region. *Intern. Med. J.*, **3**, 99–102 [In Russian].

Moiseyeva, A. V., Kompantsev, N. F., Litus, Z. V., Tretyakova, L. V., Nebogatkin, I. V., Laugen, E. A. 1991. Epidemic and epizootic situation of tularemia in Ukraine at present and immediate tasks. *Abstracts of the All-Union Scientific-practical conference "Actual problems of prevention of tularemia," and a plenum of the problem commission "natural focal infections."* Simferopol, 16–17 [In Russian].

Movila, A., Rolain, J. M., Podavalenko, A., Toderas, I., Tkachenco L., Naglov, V., Raoult, D. 2009. Detection of spotted fever group rickettsiae and family *Anaplasmataceae* in *Ixodes ricinus* ticks from Republic of Moldova and Eastern Ukraine. *Clin Microbiol Infect*., **15** (2), 32–33.

Naglov, V. A., Tkach, G. E., Simonenko, O. V. 2000. Features of ecology of the tick *Ixodes ricinus* L. (Ixodidae) in a forested area of Kharkiv. *Kharkov Entomological Society gazette*, **8** (1), 127–131 [In Russian].

Nebogatkin, I. V. 1993. On the absenceof Ixodes persulcatus and disappearance of Boophilus annulatus in the Ukraine. *Vestnik zoologii*, 2, 76–78 [In Russian].

Nebogatkin, I. V. 1996. A spontane reproduction focus of the ticks *Rhipicephalus rossicus* (Acari, Ixodidae) in the vicinity of Kiev. *Vestnik zoologii*, **30** (3), 65–67 [In Russian].

Nebogatkin, I. V. 1999. Problems dissemination of ticks and tick-borne borreliosis in Kiev.*The health of your pets*, 5, 53–57 [In Russian].

Nebogatkin, I. V. 2012 a. Intraurban near-water areas and their role in distribution of ticks (Acari, Ixodidae) in negalopolis the example of Kyiv. *Vestnik zoologii*, **46** (2), 29–34.

Nebogatkin, I. V. 2012 b. Cats as feeders for ticks (Acari: Ixodida) in Kyiv megalopolis. *Arthropods. The medical and economic importance.* AKAPIT, Lublin, 81–85.

Rizzoli, A., Silaghi, C., Obiegala, A., Rudolf, I., Hubálek, Z., Földvári, G., Plantard, O., Vayssier-Taussat, M., Bonnet, S., Spitalská, E., Kazimírová, M. 2014. Ixodes ricinus and Its Transmitted Pathogens in Urban and Peri-Urban Areas in Europe: New Hazards and Relevance for Public Health. *Front Public Health.* 2014 Dec 1;2:251. DOI: 10.3389/fpubh.2014.00251. eCollection 2014 [Epub ahead of print].

Semenyshyn, O. B., Biletska, G., Drul, A. S., Fedoruk, V., Shulgan, A., Lozinski, I. M., Kostyuk, L., Velichko, A., Hacyy, L., Vasyunek, L. 2010. Monitoring natural foci of tick-borne transmissible infections in Lviv region. *Compilation of scientific-practical conference* "*Modern problems of epidemiology, microbiology and hygiene*." Lviv, 462–467 [In Ukrainian].

Simonenko (Nikiforova), O. V. 2000. Fauna and ecology of ticks (Parasitiformes: Ixodidae) Kharkov region. *Veterinary Medicine: Interdepartmental subject scientific collection*, 77, 293–298 [In Russian].

Uspensky, I. 2008. Ticks as urban pests and vectors with special emphasis on ticks outside their geographical range. *In*: Robinson, W. H., Bajomi, D., eds. *Proceedings of the 6th International Conference on Urban Pests*. OOK-Press Kft, Veszprém, Hungary, 333–347.

Uspensky, I. 2014. Conditions of tick (Acari: Ixodoidea) population persistence in the urban environment. *In*: Müller, G., Pospischil, R., Robinson, W. H., eds. *Proceedings of the Eighth International Conference on Urban Pests.* OOK-Press Kft, Veszprém, Hungary, 203–210.

Wu, X. B., Na, R. H., Wei, S. S., Zhu, J. S., Peng, H. J. 2013. Distribution of tick-borne diseases in China. *Parasit Vectors*. 6(1):119. [Epub ahead of print], http://www.parasitesandvectors.com/content/6/1/119

Full literature is presented in entomological online peer-reviewed journal "Ukrainska Entomofaunistyka", 2016, 7 (2), 1–34.

Received 22 December 2015
Accepted 23 February 2016