



Relations of the imago of *Ixodes persulcatus* (Schulze, 1930) and large mammals in natural biogeocenoses of the Northern Urals of Russia

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Abstract

The active role of ticks *Ixodes persulcatus* in the reservation and transmission of many dangerous diseases for humans and animals requires knowledge of the relationship of adults of this type of parasite with animals that feed tick populations in a specific area. The objective of the research was to study the composition of the hosts of adult *Ixodes persulcatus* living in the Northern Urals of Russia and to determine their significance in the life of these parasites. The study was carried out from April to October throughout 2001 to 2015 in subtaiga and forest-steppe climatic zones of the Northern Urals of Russia. During the observation period, 5416 heads of animals were examined, including 5218 farm animals, 157 domestic animals, and 41 representatives of the wild fauna which had 14,010 adult ticks removed therefrom, 6,708 of which are *Ixodes persulcatus*. It has been established that interspecific relations of ixodid ticks are close with all animals living in their biomes. In the taiga-forest zone, where *I. persulcatus* prevails, all large animals participate in its feeding, and a particularly close interaction is established with wild animals living throughout their habitat: the dominance of the taiga tick in some animals reaches 100%. Farm animals are also involved in the feeding of *I. persulcatus*, but since their grazing sites, for the most part, are confined to natural pastures, these animals actively feed the ticks of the genus *Dermacentor*. In the forest-steppe zone, the species ratio of adult ixodid ticks depends on the ethology and location of the food supply of animals participating in feeding. Thus, cattle, which prevails among the animals examined by us and whose food base is located on dry pastures, feeds a significant amount of ixodids, while *I. persulcatus* (ID - 43.9%) is just subdominant, giving way to ticks of the genus *Dermacentor*. Wild animals in this zone are most closely associated with the taiga tick *I. persulcatus*, which is explained by the coincidence of their preferences in settlement, although such domestic animals as dogs and horses also actively feed the adult taiga tick, which perhaps relates to their behavior.

Keywords: Ixodid ticks, *Ixodes persulcatus*, farm animals, wild mammals, ethological features

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INTRODUCTION

The basis of the emergence and existence of biocenoses are complex interspecific interactions in various animal species that provide for the biological circulation in nature (Glazunov and Glazunova 2018a). Subjects to the peculiarities of the life cycles of ixodid ticks, geographically confined to the Northern Urals, characterized by triple hostness, when the tick at each stage of its development (larva, nymph and imago) needs to be fed to different animals — feeder, the dependence of the development of the parasite on the ecology of feeding animals is determined (Apanaskevich and Oliver 2015, Beati and Klompen 2019, Hoogstraal and Aeschlimann 1982). Considering the biotic relationships in the biocenosis, it is necessary to take

into account both trophic interaction and the phoric relationship, as some species, as potential hosts, are daily able to cover considerable distances, and during migration they move several kilometers, which cannot but affect the geographical range of ixodids (Bolshakov and Bazhenov 1988, Grigorkina and Olenev 2011, Klompen et al. 1996, Korenberg and Lebedeva 1969, Kuznetsov 2009).

Taking into account the epidemiological and epizootic importance of ticks *Ixodes persulcatus*, their active participation in the reservation and transmission

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Table 1. The infestation rate of animals by various species of adult pasture ticks in the forest steppe and taiga-forest zone of the Northern Urals in 2001-2015

Animal species	Examined heads	Total adult ticks found	<i>I. persulcatus</i>		AI, individuals
			individual	DI, %	
Taiga-forest zone					
Cattle	1920	3389	1846	54.5	0.96±0.12
Horses	39	268	142	53.0	3.64±0.36
Dog	27	229	126	55.0	4.67±0.41
Red fox	2	27	27	100	16.50±0.82
Eurasian hedgehog	7	144	127	88.2	18.14±1.04
European hare	4	143	134	93.7	33.50±3.14
TOTAL for zone:	1999	4200	2402	57.2±5.42	1.20±0.20
Forest-steppe zone					
Cattle	3152	7788	3152	40.5	1.00±0.18
Horses	71	462	292	63.2	4.11±0.30
Sheep	36	32	32	100	0.89±0.13
Dogs	114	872	434	49.8	3.81±0.33
Cats	16	46	29	63.0	1.81±0.14
Red fox	2	33	29	87.9	14.50±0.90
Eurasian hedgehog	16	427	242	56.7	15.12±1.68
European hare	3	131	82	62.6	27.33±3.01
Russet souslik	7	19	14	73.7	2.00±0.44
TOTAL for zone:	3417	9810	4306	43.9±6.14	1.26±0.22
TOTAL:	5416	14,010	6708	47.88±5.88	1.24±0.21

of many dangerous diseases for humans and animals, knowledge is needed about the relationship of the images of this parasite with animals feeding tick populations in a specific area (Khasnatinov et al. 2019, Korenberg et al. 2002, Rizzoli et al. 2014, Stolbova et al. 2018).

Knowledge of the biotic relationships of adult ticks in a particular region will allow the development of a system of measures able to prevent not only the growth of the parasite population, but the spread of vector-borne infections and invasions (Glazunov and Glazunova 2018b, Glazunov and Glazunova 2018c).

Having studied and analyzed the literature data, taking into account the regional location of the region of research, we found it necessary to study the composition of the hosts of adults *Ixodes persulcatus* living in the Northern Urals of Russia and determine their importance in the life of these parasites.

MATERIALS AND METHODS

We studied the participation of mammals in the feeding of the pasture-fed imago ticks *Ixodes persulcatus* from April to October throughout 2001 to 2015 in the subtaiga and forest-steppe climatic zones of the Northern Urals.

The species composition of ixodid-feeding mammals was found out by examining domestic animals, including farm ones. Mature ticks were removed from the large mammals by hands, with a thorough examination of all parts of the animal's body, paying special attention to the concentration of parasites – neck, dewdrops, auricles, groin, udder, etc. The processing of data obtained with the registration of ticks was performed according to the method by V.N. Beklemishev (Beklemishev 1961). The main indicators of the number of parasitic arthropods were the abundance index (AI) and domination index (DI).

To determine the type of adult ticks, a binocular magnifying glass and a MBS-1 microscope were used. The species affiliation was established using the determinants by Pomerantsev B.I. (1950), Serdiukova G.V. (1956), and Filippova N.A. (1966). After determining the species, live ticks were placed in special tubes with sawdust.

During the observation period, 5416 heads of animals were examined, including 5218 farm animals, 157 domestic animals, and 41 representatives of the wild fauna which had 14,010 adult ticks removed therefrom, 6,708 of which are *Ixodes persulcatus*.

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RESULTS

The results of the infestation of animals by ticks *I. persulcatus* are presented in **Table 1**.

The most widely represented were domestic agricultural animals, among which were representatives of the order of artiodactyls, the suborder of ruminants – 5072 heads of cattle (*Bos taurus taurus* L. 1758) and 36 sheep (*Ovis aries* Linnaeus 1758), the order of solidungulates was represented by 110 heads of horses (*Equus ferus caballus* Linnaeus 1758). Among domestic animals, representatives of the order of predators, canids – 41 domestic dogs (*Canis lupus familiaris* Linnaeus 1758) and felids – 16 domestic cats (*Felis silvestris catus* Linnaeus 1758) were examined. Over the entire observation period, 41 representatives of the wild fauna were caught and examined, including animals from the family Erinaceidae – 23 hedgehogs (*Erinaceus europaeus* Linnaeus 1758), rodents – 7 russet sousliks

(*Citellus major* Pallas 1779) and 7 hares (*Lepus európaëus* Pallas 1778), as well as representatives of the canid group – 4 red foxes (*Vulpes vulpes* Linnaeus 1758).

DISCUSSION

Despite the small number of wild animals surveyed, we can definitely say that these animals play a significant role in maintaining the *I. persulcatus* population in the region. Thus, the highest abundance indices of *I. persulcatus* were found in the European hare and the European hedgehog. Indicators of the abundance of adult ixodid ticks varied depending on the climatic zone: in the taiga-forest zone, the abundance of ticks on the hare was 33.50 ± 3.14 individuals, while in the forest-steppe zone this indicator was higher and amounted to 27.33 ± 3.01 individuals per examined animal. The abundance of ticks on the hedgehog was 18.14 ± 1.04 individuals in the taiga-forest zone and 15.12 ± 1.68 individuals in the forest-steppe zone. Slightly lower abundance of adult ixodid ticks was recorded in the red fox; in the taiga-forest zone, AI was 16.50 ± 0.82 individuals, and in the forest-steppe zone - 14.50 ± 0.90 individuals. Among wild animals, the smallest share in the feeding of adult ixodid ticks belongs to the russet souslik, who feeds 2.00 ± 0.44 individuals in the forest-steppe zone.

Among the domestic animals, the highest indices of adult ixodid ticks were recorded in dogs and horses (Tkacheva 2019c). For examination, hunting and shepherd dogs were selected, as well as service dogs kept un leashed. For example, AI in dogs in the taiga-forest zone was 4.67 ± 0.41 individuals, and in the forest-steppe zone - 3.81 ± 0.33 individuals. Examination of the horses revealed almost equal infestation by ixodid ticks, AI made up 3.64 ± 0.36 and 4.11 ± 0.30 individuals in the taiga-forest and forest-steppe zones, respectively.

The most shares examined for the infestation by adult ixodid ticks was cattle. It was established that this species of animals uniformly fed ixodid ticks in the examined territories. In the taiga-forest zone, AI was 0.96 ± 0.12 individuals, and in the forest-steppe zone - 1.00 ± 0.18 individuals. Despite the fact that the abundance of ticks on these animals was not large, the volume of feedings is significant, since mostly cattle visit the habitats of ixodid ticks in herds and graze alone extremely rarely.

Also, low AI of adult ixodid ticks were recorded in cats, which were examined only in the forest-steppe zone, and amounted to 1.81 ± 0.14 individuals, which seems to be due to the behavior of these animals and the preference of the home territory.

The lowest AI of ixodid ticks was recorded in sheep, which were also examined only in the forest-steppe zone, where AI was 0.89 ± 0.13 individuals. Probably, the

sheep because of the thick coat of wool are not the most comfortable hosts for ixodid ticks.

It was noted that, depending on the ethological features and abiotic factors, various types of ixodid ticks attacked animals, and the dominance of *I. persulcatus* varied depending on the natural climatic zone. In the taiga-forest zone *I. persulcatus* (DI – $57.2 \pm 5.42\%$) dominated, and in the forest-steppe zone *I. persulcatus* competed with *Dermacentor reticulatus*, which dominance indices, taking into account the standard deviation, were on the same level – $43.9 \pm 6.14\%$ and $45.6 \pm 3.98\%$, respectively.

We also noted that wild animals living in the taiga-forest natural-climatic zone were to a greater extent infested by ticks *I. persulcatus*. Thus, among the wild inhabitants, the dominance of the taiga tick ranged from 88.2% to 100%, whereas the steppe tick was absent at all. Domestic animals in this zone were also more attacked by the tick *I. persulcatus*, but its dominance indices were much lower than those in wild animals (DI ranged from 53.0% to 100%), moreover, the steppe tick was recorded in domestic animals, albeit in small amounts.

Wild animals living in the forest-steppe climatic zone were also the most exposed to the taiga tick, although dominance indices differed from those in the taiga-forest zone. Thus, the prevalence of *I. persulcatus* in wild animals varied in the range of 56.7% in the European hedgehog, and 87.9% in the red fox. The only species of ticks *I. persulcatus* was found in sheep, albeit in small quantities. Also high rates of dominance of *I. persulcatus* were revealed in cats (DI – 63.0%) and horses (DI – 63.2%). At the same time, cattle were the most infested by ticks of the genus *Dermacentor*.

CONCLUSION

It has been established that interspecific relations of ixodid ticks are close with all animals living in their biomes. In the taiga-forest zone, where *I. persulcatus* prevails, all large animals participate in its feeding, and a particularly close interaction is established with wild animals living throughout their habitat: the dominance of the taiga tick in some animals reaches 100%. Farm animals are also involved in the feeding of *I. persulcatus*, but since their grazing sites, for the most part, are confined to natural pastures, these animals actively feed meadow and steppe ticks.

In the forest-steppe zone, the species ratio of adult ixodid ticks depends on the ethology and location of the food supply of animals participating in feeding. Thus, cattle, which prevails among the animals examined by us and whose food base is located on dry pastures, feeds a significant amount of ixodids, while *I. persulcatus* (ID – 43.9%) is just subdominant, giving way to ticks of the genus *Dermacentor*.

Wild animals in this zone are most closely associated with the taiga tick *I. persulcatus*, which is explained by the coincidence of their preferences in settlement, although such domestic animals as dogs and horses

also actively feed the adult taiga tick, which perhaps relates to their behavior, since hunting and shepherd dogs as well as shepherds' horses were examined.

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