TICK INFESTATION (ACARI: IXODIDAE) OF APODEMUS FLAVICOLLIS MELCHIOR, 1834 (RODENTIA: MURIDAE) IN VOJVODINA (SERBIA)

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Abstract

The vector potential of rodents as hosts of mainly larval and nymphal stages of ixodid ticks is influenced by a large number of factors. Considering the confirmed role of mice as important reservoirs and vectors of zoonotic diseases, the aim of the study was to determine the qualitative and the quantitative diversity of ectoparasiting ticks. The total number of trapped mice was 238, and the total number of collected ticks was 449. Six species from four genera of ixodid ticks were identified: *Ixodes ricinus*, *I. trianguliceps*, *Dermacentor marginatus*, *Haemaphysalis concinna*, *H. punctata* and *Rhipicephalus sanguineus*. The average number of ticks per mouse was 2.211823±0.157862. The highest values for the selected parameters were: the prevalence for *I. ricinus* larvae (8.241%), the average infestation intensity for *D. marginatus* larvae (4.714), the abundance and the infestation index for *I. ricinus* larvae (0.236; 0.022). Based on the seroprevalence and prevalence of infested rodents, the level of potential risk for human and animal could be predicted.

Introduction

Most rodent species represent a specific type of an "epidemiological bridge" due to their wide ranges of activity, seasonal migrations and population size fluctuations. That is the reason why they are responsible for the maintenance of high population density of ecto- and endoparasites within certain habitats, but more importantly, their spatial transfer beyond present boundaries.

The vector potential of rodents as hosts of mainly larval and nymphal stages of ixodid ticks is influenced by a large number of factors, such as the preference of certain tick species to certain species of rodents or specific characteristics of habitats. These factors also determine the behavior of certain tick species, their population densities and their possibility to survive and maintain their presence in the habitats.

The density of large mammal populations also have a crucial role in maintenance of tick populations as they serve as hosts and vectors of nymphal and adult stages, and thus the role in defining the rate of larvae mortality within the certain habitat. The great influence on the survival rate of larval and nymphal stages of three-host tick species, beside microclimatic characteristics of the habitats, has the density of rodent populations as the transition hosts, because mice have characteristic diurnal and seasonal rhythms and variances in spatial distribution and dispersions.

For the parasites, the host represents a place to live, feed and reproduce, and therefore can be considered as a habitat in the narrow sense. In order to achieve the reproductive maximum ectoparasite selects among the different hosts by choosing its optimal microhabitat, which depends on a large number of factors: age of the individual, reproductive group, sex, body weight, intensity of infestation with the same or other type of ectoparasite [1, 2]. In natural populations, higher number of ectoparasites are found on certain host specimens, which means that their distribution can not be described as a random and indicates the presence of an ectoparasite preference for certain (appropriate) host [3].

During their life cycle, ixodid ticks have frequent contacts with a large number of hosts (amphibians, reptiles, birds and mammals), in which they can overtake, maintain and transmit a large number of infectious agents relevant to human and animal health [4].

Mammals are the main hosts for 511 ticks species, four more species parasite on mammals and birds and two on mammals and reptiles [5]. Of this number, 87 tick species are associated with rodents. Some rodent species, although not synanthropic, can reach high urban populations (especially along the river banks, in the parks, gardens and yards), and therefore based on seroprevalence and prevalence of infested rodents, the potential risk and level of the infestation influence on people and domestic animals could be predicted [6].

In Vojvodina province *Apodemus flavicollis* (Melchior, 1834) demonstrates the preference for the deciduous forests with a high production of seeds and fruits for consumption, although some authors state that it could be present in mixed forest ecosystems and open habitats such as urban or agro ecosystems.

Considering the confirmed role of mice as the important reservoirs and vectors of zoonotic diseases, the aim of the study was to determine the qualitative and the quantitative diversity of ectoparasiting ticks.

Experimental

The study was conducted at three localities in Vojvodina (Northern Province of Serbia): Apatin, Bogojevo and Labudnjača. The localities were selected according to their floristic composition and anthropogenic influence. Each trapped specimen of yellow-necked mouse was weighted, the body and tail length were measured, and the sex was determined. According to obtained measurements, specimens were classified in seven age groups: early and late pre reproductive, early, middle and late reproductive and early and late post reproductive group. Each individual was systematically and thoroughly inspected using palpatory technic. The collected ticks were properly labelled and transported to the laboratory till examination and identification.

Ticks were identified up to species level according to the standard identification keys [7, 8]. The ixodid tick infestation was described using four parameters: the prevalence (P), the average infestation intensity (AII), the abundance (A) and the infestation index (II) [9]. The results were statistically analyzed using ANOVA and Fisher's post-hoc test (Statistica 12, StatSoft, University license).

Results and discussion

The total number of trapped mice was 238, and the total number of collected ticks was 449. Six species from four genera of ixodid ticks were identified: *Ixodes ricinus* Linnaeus, 1758, *I. trianguliceps* Birula, 1895, *Dermacentor marginatus* Sulzer 1776, *Haemaphysalis concinna* Koch 1844, *H. punctata* Canestrini & Fanzago 1878 and *Rhipicephalus sanguineus* (Latreille 1806).

Ticks were collected from 21.67% specimens of the total number of mice and 3.94% specimens did not have any species of ectoparasite. The average number of ticks per mouse was 2.211823±0.157862 (for σ=2.249193 and σ2=5.058869). The highest number of ticks (14) per one mouse was detected on male specimen of late post reproductive group, trapped in Apatin.

The highest prevalence was calculated for *I. ricinus* larvae (8.241%) and the lowest for *D. marginatus* nymphs (2.004%). The highest values of average infestation intensity was obtained for *D. marginatus* larvae (4.714), and the abundance and the infestation index for *I. ricinus* larvae (0.236; 0.022) (Table 1.).

Table 1. Tick infestation of *A. flavicollis*

Tick species	Stage	n	B	P	AII	A	II
I. ricinus	larval	118	37	8.241	3.189	0.263	0.022
	nymphal	36	29	6.459	1.241	0.080	0.005
I. trianguliceps	larval	30	15	3.341	2.000	0.067	0.002
	nymphal	0	0	0.000	0.000	0.000	0.000
D. marginatus	larval	99	21	4.677	4.714	0.220	0.010
	nymphal	10	9	2.004	1.111	0.022	0.000
H.concinna	larval	54	26	5.791	2.077	0.120	0.007
	nymphal	14	14	3.118	1.00	0.031	0.001
H. punctata	larval	36	17	3.789	2.118	0.080	0.003
	nymphal	20	18	4.009	1.111	0.045	0.002
R. sanguineus	larval	19	13	2.895	1.462	0.042	0.001
	nymphal	13	13	2.895	1.000	0.029	0.001
	Total	449	212				
	C	449					

n – the total number of one tick species
B - the number of hosts infested with certain tick species
C – the total number of examined hosts
P – the prevalence
AII - the average infestation intensity
A - the abundance
II - the infestation index

Similar results were published [10] where on 12 rodent species (*A. agrarius*, *A. flavicollis*, *A. sylvaticus*, *A. uralensis*, *M. glareolus*, *Micromys minutus*, *M. arvalis*, *M. subterraneus*, *M. musculus*, *M. spicilegus*, *R. norvegicus* and *Spermophilus citellus*) from six counts in Romania, eight tick species were detected: *I. ricinus*, *I. redikorzevi*, *I. apronophorus*, *I. trianguliceps*, *I. laguri*, *D. marginatus*, *R. sanguineus* and *H. sulcata*. According to these authors the average prevalence for all tick and rodent species was 29.55%, the average infestation intensity was 3.86 and the average abundance was 1.14. The most abundant species was *I. ricinus* with the highest level of infestation on *M. arvalis*, *A. uralensis*, *A. flavicollis* and *M. glareolus*. The high statistical significances in the prevalence and the tick infestation intensity on rodents, especially for *I. ricinus* and *Dermacentor reticulatus* Fabricius 1794 were obtained in forest and meadow ecosystems in northeast Poland [11].

The one-way ANOVA did not emphasize any statistical significance regarding tick infestation paired with age or sex group (p_{ag}=0.320987 and p_s=0.107251 for $p<0.05$). However, it could be noticed that tick infestation was slightly higher in all three reproductive groups and in male specimens of *A. flavicollis*. These results could be explained by the fact that specimens of the reproductive groups have higher activity and wider home range, especially males. A study [12] has statistically proved that the number of tick larvae, nymphs and adults is in a positive correlation with the rodent body mass, that the number of all developmental stages of ticks on hosts decreases with the increase of the rodent population density and that there is no reliable data on the tick preference to the host's sex.

From the total number of collected ticks, only 27 (6.01%) were found on the heads (on 25 specimens of yellow-necked mouse). The grooming as a specific behavior of mice has also a significant role in the level of tick infestation. Furthermore, the grooming has a lot of functions such as body surface cleaning, ectoparasite removal, thermoregulation, auto-stimulation and the transfer of antibacterial agents from the saliva to the hair and skin and also the transmission of secondary signals from one individual to another [13]. This method of grooming is distinctive for rodents comparing to other mammal species. Mice usually clean their heads, ears and necks using their front legs and paws with intensive and fast movements, which could be the reason for small number of ticks in this body region.

The percentage of tick infestation of rodents could be extremely high [14]. Due to the reproductive strategies of tick females who usually lay (depending on species) about 2000-3000 eggs in one place, the microdistribution of the host seeking larvae in the habitats usually depends on their dense distribution and the small area of activity limited to only a few meters.

Conclusion

Six tick species sampled from the 238 individuals of *A. flavicollis* were identified: *I. ricinus*, *I. trianguliceps*, *D. marginatus*, *H. concinna*, *H. punctata* and *R. sanguineus*. The average number of ticks per mouse was 2.2. The highest values for the selected parameters were: prevalence for *I. ricinus* larvae, the average infestation intensity for *D. marginatus* larvae, the abundance and the infestation index for *I. ricinus* larvae. Based on the seroprevalence and prevalence of infested rodents, the level of potential risk for human and animal could be predicted.

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