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HARD TICK (ACARI: IXODIDAE) CO-INFESTATION OF ROE DEER (*CAPREOLUS CAPREOLUS* LINNAEUS, 1758) IN VOJVODINA HUNTING RESORTS (SERBIA)

Ivana IVANOVIĆ[1], Aleksandra PETROVIĆ[1], Aleksandar JURIŠIĆ[1], Aleksandra POPOVIĆ[1], Miloš PETROVIĆ[1], Vojislava BURSIĆ[1], Nikola PUVAČA[2]

[1]University of Novi Sad, Faculty of Agriculture. Trg Dositeja Obradovića 8, 21000 Novi Sad, Serbia
[2]Patent co. doo, Vlade Ćetkovića 1a, 24211 Mišićevo, Serbia

Corresponding author email: petra@polj.uns.ac.rs

Abstract

Roe deer are important hosts for ticks, providing them constant and reliable source of food, as well as the mode for habitat distribution. The aim of this study was to determine the species diversity of ixodid ticks parasitizing on the roe deer and the level of co-infestation. Eight tick species sampled from the 72 carcasses of roe deer were identified: I. ricinus, D. marginatus, D. reticulatus, H. punctata, H. concinna, H. sulcata, R. sanguineus and R. bursa. The most abundant were the females of I. ricinus and the highest prevalence was obtained for I. ricinus and D. marginatus. The single-species infestation was not detected. The co-infestation of all identified tick species was found on 15 carcasses and equally high percentage was obtained for co-infestation of six tick species. Roe deer as the habitat generalist and polyphagous herbivore are exposed to a greater tick species diversity present at the same habitats. The roe deer co-infestation with ixodid ticks in Vojvodina region could be explained by both sets of factors that promote multiparasitism: the spatial distribution of the hosts and the host life quality.

Key words*: ticks, roe deer, co-infestation, Ixodes, Dermacentor.*

INTRODUCTION

The ecological niche is one of the most important and the hardest to define concepts in ecology. According to the competitive exclusion principle (Gause's principle), there are no means that two species that compete for the same resource could coexist at constant population values in the same niche of the same habitat for a long period of time if other ecological factors remain constant. According to Amarasekare (2000), there are theories that suggest that spatial dynamics may play a key role in maintaining both competitive and consumer resource interactions. Still, how to explain multiparasitism or other multi-species systems?

The multiparasitism is a condition in which different species of parasites parasitize a single host using it as a same ecological niche. According to Vaumourin et al. (2015) some parasites could occur more frequently than expected because the same factors promote their presence, not because they interacting synergistically. The most important factors are: environmental and climatic conditions, host density, host behaviours and host physiological conditions. All factors that promote multiparasitism could be grouped in two sets: 1) factors that influence host exposure – the spatial distribution of host, and 2) factors that influence host susceptibility are intrinsic to hosts – host life history traits (Vaumourin et al., 2015).

European roe deer (*Capreolus capreolus* Linnaeus 1758) are very common species all over Europe (Vor et al., 2010). This ungulate species is a habitat generalist and polyphagous herbivore. Therefore, it is able to feed on a variety of plants and thus live in the different habitats. In Vojvodina region, roe deer are usually found in the fragmented habitats: agroecosystems bordered by deciduous forest belts and shrubby vegetation. These habitats are also suitable for ixodid tick populations (Jurišić et al., 2011; Jurišić et al., 2012). All ixodid tick species are obligatory hematophagous parasites and their occurrence is strictly limited to the host presence. Consequently, roe deer are important hosts for ticks, providing them

constant and reliable source of food, as well as the mode for habitat distribution (Vazquez et al., 2011; Vor et al., 2010).
The aim of this study was to determine the species diversity of ixodid ticks parasitizing on the roe deer and the level of co-infestation.

MATERIALS AND METHODS

Ticks were collected during the five year study (2011-2015) from the hunted carcasses of roe deer (*Capreolus capreolus*) immediately after the hunt. Each carcass was systematically and thoroughly inspected using palpatory technic by three observers. The collected specimens were properly labelled and transported to the laboratory till examination and identification. Tick species were identified up to species level according to identification keys: Nosek & Sixl (1972) and Estrada-Pena et al. (2004).
The study was performed at 8 localities on the territory of Autonomous Province of Vojvodina: Bač (30.149 ha, N45°20`447`` E19°13`108``), Bačka Palanka (52.204 ha, N45°14`198`` E19°20`239``), Bačko Petrovo Selo (11.304 ha, N45°41`144`` E20°05`283``), Turija (5.343 ha, N45°32`509`` E19°51`239``); Novi Bečej (60.745 ha, N45°35`509`` E20°07`219``), Pančevo (69.565 ha, N44°51`530`` E20°37`453``), Novi Kneževac (30.539 ha, N46°01`456`` E20°04`598``) and Ruma (50.560 ha, N45°01`570`` E19°49`189``). All studied localities were described as agroecosystems with sporadic shrub and bush vegetation and wide belts of mixed deciduous forests.
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) (Petrović, 2015).

RESULTS AND DISCUSSIONS

The total number of 2623 ticks specimens were sampled from the 72 carcasses of roe deer (56 males and 16 females). Eight tick species from four genera were identified: *Ixodes ricinus* (Linnaeus, 1758) (63.44%), *Dermacentor marginatus* (Sulzer, 1776) (13.46%), *D. reticulatus* (Fabricius, 1794) (3.70%), *Haemaphysalis punctata* (Canestrini and Fanzago, 1878) (3.55%), *H. Concinna* (Koch, 1844) (2.71%), *H. sulcata* (Canestrini & Fanzago, 1878) (4.69%), *Rhipicephalus sanguineus* (Latreille, 1806) (6.21%) and *R. bursa* (Canestrini & Fanzago, 1878) (2.25%). The most abundant were the females of *I. ricinus* (10.98%). The larval stages of all identified species, as well as the nymphs of *D. marginatus*, *D. reticulatus*, *H. punctata*, *H. sulcata* and *R. bursa* have not been found on the hosts. The highest number of sampled ticks was at hunting resort Novi Kneževac (20.21%) and the lowest at locality Ruma (3.55%).
The highest prevalence was obtained for *I. ricinus* and *D. marginatus*, as they were found on all prospected roe deer carcasses. The lowest values of all four parameters were detected for *R. bursa*, as it was found in small number on only 34 prospected carcasses. Additionally, the high prevalence was obtained for *R. sanguineus*, as this species was found on 69 roe deer carcasses (Table 1).

Table 1. The prevalence (P), average infestation intensity (AII), abundance (A) and the infestation index (II) of identified tick species

Tick species	P (%)	AII	A	II
Ixodes ricinus	100.00	23.11	23.11	23.11
Dermacentor marginatus	100.00	4.90	4.90	4.90
Dermacentor reticulatus	66.67	2.02	1.35	0.90
Haemaphysalis punctata	52.78	2.45	1.29	0.68
Haemaphysalis concinna	54.17	1.82	0.99	0.53
Haemaphysalis sulcata	59.72	2.86	1.71	1.02
Rhipicephalus sanguineus	95.83	2.36	2.26	2.17
Rhipicephalus bursa	47.22	1.73	0.82	0.39

The most abundant tick species of roe deer in Vojvodina was *I. ricinus* (23.11%) which is similar to the results of Carpi et al. (2008), Skotarczak et al. (2008) and Vor et al. (2010). Although *I. ricinus* is the predominant tick species in Europe (Barandika et al., 2008; Mihalca et al., 2012), the high number of adults found on the studied hosts could be explained by the fact that the immature stages of *I. Ricinus* are capable of feeding on almost any vertebrate, but adults require the blood meals of more than 1 ml, especially from the animals that could provide it better, such as ungulates (Donzé et al., 2004).
In Vojvodina, *D. marginatus* follows the distribution pattern of *I. ricinus* as the second most abundant tick species (Jurišić et al. 2011; Jurišić et al., 2012, Petrović et al., 2015). This species prefers deciduous forests, pastures, meadows and all kinds of shrub vegetation along the river banks. Its presence is registered

at all prospected localities and on every carcass as well. *D. reticulatus*, was found at all prospected localities, but only on 48 carcasses. This species prefers river basins, wet/flooded forests, grassland and meadows, rich in bush and shrub vegetation, which is confirmed by similar conclusions of Mihalca et al. (2012).

H. punctata and *H. concinna* were found at six prospected localities with low abundance on the roe deer. According to Nosek (1971, loc. cit. Mihalca et al. 2012), these species prefer pastures, forest margins and forest-steppes which have been in decline over the past decade in Vojvodina. *H. sulcata* was the most abundant species of *Haemaphysalis* genus, but found only at five localities. Similarly to findings of Mihalca et al. (2012), this species prefers warm and humid areas in Vojvodina.

The high value of *R. sanguineus* prevalence and its presence at all prospected localities indicate that, although it is an endophilic, monotropic and three-host tick species, it is also able to survive and maintain its population in the outdoor environments (Dantas-Torres, 2010) and therefore parasite on cattle or wild ungulates (Estrada-Pena et al., 2004). *R. bursa*, on the other hand is a typical representative of tick fauna commonly found on ungulates, with preferences to areas well covered with bush and steppe vegetation (Fuente et al., 2004). This species was found at 6 prospected localities with low values of prevalence and abundance.

The single-species infestation was not detected. The co-infestation of all identified tick species was found on 15 carcasses (20.83%). Equally high percentage was obtained for co-infestation of six tick species. Oppositely the results of Vazquez et al. (2011), where 99.7% of examined roe deer had single-species infestation by *I. ricinus* and only one specimen of roe deer double-species infestation (*I. ricinus* and *D. marginatus*), this research indicates that the co-infestation of six and more tick species is characteristic for roe deer in Vojvodina (59.72% carcasses) (Figure 1). The average burden of parasitizing ticks of all developmental stages and at all prospected localities was 36.43 per a roe deer.

The results from other European researches state that on red deer (*Cervus elaphus* Linnaeus 1758) could be found up to 15 different ixodid tick species (Vazquez et al., 2011).

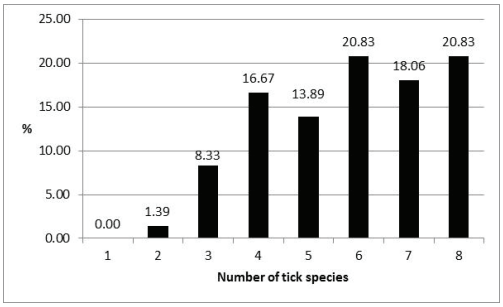

Figure 1. The co-infestation of tick species

Ruiz-Fons et al. (2006) found 10 different ixodid tick species parasitizing Iberian red deer (*Cervus elaphus hispanicus* Linnaeus, 1758), mainly *Hyalomma marginatum marginatum* (63.7%), *R.* (*Boophilus) annulatus* (7.9%) and *R. bursa* (7.5%). According to Vor et al. (2010), roe deer havea preference for dense vegetation and their diurnal rhythm of feeding and resting make them easily accessible hosts for questing ticks. Furthermore, roe deer have large home ranges (10 to more than 200 ha) (Vor et al., 2010). According to Vaumourin et al. (2015) hosts with larger distributions are more likely to become co-infested, as are the hosts that occupy ecological niches in which several parasites are present. Therefore, roe deer as the habitat generalist, which are adapted to a wide range of environmental conditions (including anthropogenic factors) and polyphagous herbivore that could exploit a large number of food resources are, consequently, exposed to greater tick species diversity present at the same habitats. The roe deer co-infestation with ixodid ticks in Vojvodina region could be explained by both sets of factors that promote multiparasitism: the spatial distribution of the hosts and the host life quality.

CONCLUSIONS

Eight tick species sampled from the 72 carcasses of roe deer were identified: *I. ricinus*, *D. marginatus*, *D. reticulatus*, *H. punctata*, *H. concinna*, *H. sulcata*, *R. sanguineus* and *R. bursa*. The most abundant were the females of *I. ricinus* and the highest prevalence was obtained for *I. ricinus* and *D. marginatus*. The single-species infestation was not detected. The co-infestation of all identified tick species was

found on 15 carcasses. Roe deer as the habitat generalist and polyphagous herbivore are exposed to a greater tick species diversity present at the same habitats. The roe deer co-infestation with ixodid ticks in Vojvodina region could be explained by both sets of factors that promote multiparasitism: the spatial distribution of the hosts and the host life quality. Due to consistent population densities, wide home ranges and seasonal migrations, most of the vertebrate species found at hunting resorts are responsible for the maintenance of the high tick density populations in certain habitats and therefore seasonal, spatial, transstadial and transovarial transmission of pathogens important for human and animal health.

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