

FAUNA OF HARD TICKS (ACARI: IXODIDAE) IN DIFFERENT HABITATS IN CROATIAN PART OF BARANJA

FAUNA TVRDIH KRPELJA (ACARI: IXODIDAE) RAZLIČITIH STANIŠTA U HRVATSKOM DIJELU BARANJE

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Summary:

In 5 different habitats in the Croatian part of Baranja in the surroundings of the city Beli Manastir, in the period from March to October 2013, 1254 specimens of hard ticks were collected using the flag dragging method, whereas 240 specimens were collected by hand from pets. Five tick species were identified from collected sample: *Dermacentor marginatus* (Sulzer, 1776), *Dermacentor reticulatus* (Fabricius, 1794), *Haemaphysalis concinna* (Koch, 1844), *Haemaphysalis inermis* (Birula, 1895) and *Ixodes ricinus* (Linnaeus, 1758). In the forest habitats at the locality Haljevo, the highest number (80.45 %) of hard ticks was sampled. The most abundant species was *Ixodes ricinus* with 65.93 %. The highest number (55.49 %) of ticks were sampled in the developmental stage of larvae. In the developmental stage of larvae *Haemaphysalis concinna* was represented with 94.71 %, *Ixodes ricinus* with 38.48 % and *Haemaphysalis inermis* with 6.90 %. The highest number of hard ticks larvae 71.53 % was sampled in July, whereas the highest number of adults 58.50 % was sampled in April. *Haemaphysalis inermis* was found for the first time on the area of continental part of Croatia.

KEY WORDS: hard ticks, Ixodidae, Beli Manastir, Baranja, Croatia

Introduction

Uvod

Hard ticks (Acari: Ixodidae) are of primary importance as blood-feeding ectoparasites (Jaenson and Jensen 2007). In many areas of the world, hard ticks are considered the most common and most important ectoparasites that infest pets (Xhaxhiu et al. 2009, Krčmar et al. 2014). Hard ticks are medically the second most important group of arthropods after mosquitoes (Estrada-Pena and Jongejan 1999, Jaenson and Jensen 2007). Approximately 10% of the currently known 720 species act as vectors of pathogens (Milutinović

and Radulović 2002, Farkaš et al. 2013). In Croatia, the comprehensive studies on the tick fauna were made in second half of twentieth century along the Adriatic coast. In that period Prof. Dr. Davor Mikačić presented the distribution and dynamics of hard ticks along the Adriatic coast (Krčmar 2012). During the 1970s and 1980s prof. dr. Danica Tovornik studied the diversity of tick fauna from the ecological point of view on many islands in the Adriatic Sea (Krčmar 2012). However, there are some regions in inland of Croatia that have not yet been sufficiently studied, one of these regions is eastern part of Croatia (Slavonia and Baranja). On the area of eastern Croatia (Slavonia and Baranja), only

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on four localities ticks were sampled (Krčmar 2012). Therefore, the aim of this study was to investigate the tick fauna diversity and differences in abundance of ticks at five different habitats in the surroundings of the city Beli Manastir in Baranja.

Material and methods

Materijal i metode rada

This study was carried out at five localities in the Croatian part of Baranja in the surroundings of the city Beli Manastir. Croatian part of Baranja extends from the Drava and Danube Rivers to the border with Hungary. The Croatian part of Baranja is a part of a wider Baranja region, the larger part of which is in Hungary (Bognar et al. 1975). Surface of Croatian part of Baranja is 1 147 km² (Bognar et al. 1975). Beli Manastir is the biggest settlement, the single city in the area of Croatian part of Baranja, located in the bottom of Banško Hill, in lowland area (Bognar et al. 1975). The autochthonous forest flora, which in the past were oak forests, is partially maintained in Haljevo Forest, on southern side of Beli Manastir, while from all other sides the city is surrounded with agricultural land. Hard ticks were sampled using the flag dragging method, in the period from mid-March to mid-October 2013. Ticks were sampled once a month in different habitats, on pond edges and melioration channels near to agricultural land, in Haljevo Forest, on meadow near city pools and in park in the center of the city. Length of each transect, on which ticks were sampled, was 20 m. Some tick specimens were hand picked on home pets. All collected ticks were stored in 96 % ETOH solution, and were identified using standard keys for European ticks (Hillyard 1996) via stereomicroscope. Diversity of the tick fauna in these five different habitats was measured by Sørensen index.

Results

Rezultati

In five different habitats in Croatian part of Baranja, in the surroundings of the city Beli Manastir, 1254 ticks were sampled. All ticks were sampled by the flag dragging method. Additionally 240 ticks were collected on home pets, 65 on dogs and 175 on cats. Five species of hard ticks from family Ixodidae were identified in collected tick fauna and most abundant species among these was *Ixodes ricinus* (Linnaeus, 1758) (65.93 % of the sampled ticks) followed by *Haemaphysalis concinna* (Koch, 1844), (31.66 %), *Haemaphysalis inermis* (Birula, 1895) (1.94%), *Dermacentor reticulatus* (Fabricius, 1794) (0.4 %), and *Dermacentor marginatus* (Sulzer, 1776) representing 0.07% of the sampled tick individuals (Table 1). The highest number (55.49 %) of sampled ticks were in larval stage, 24.83 % in nymphal

stage, and 19.68 % were adults (Table 2). The largest number of ticks (80.45 %) was sampled in forest habitat, that is in Haljevo Forest. These were the following species: *D. marginatus*, *H. concinna*, *H. inermis* and *I. ricinus* (Table 3). On the rest of the four sampled habitats and pets, only 19.54 % of ticks were found. On habitats near to the pond edges and meadows, only *I. ricinus* was sampled, while on vegetation near to melioration channels *D. reticulatus* was collected (Table 4). Only in park, located in the city center, no ticks were found (Table 4). Concerning the sampling done on pets, only *I. ricinus* was collected. Analyses of seasonal dynamics of sampled ticks in the forest type of habitat reveals two peaks of abundance, one in March, and other in July (Table 3). On pets, the highest number of ticks (60.83%) was sampled in April, in adult stage (Table 5). Comparison of hard tick fauna on five habitats via the Sørensen index showed that fauna of pond edges and meadow near to city pools were most similar to each other (100 %). However, between Haljevo Forest and pond edges, Haljevo Forest and meadow, Sørensen index values were smallest (40 %). In Haljevo Forest, in the period from March– July 2013, with the flag dragging method, 26 adults, 1 nymph and 2 larvae of *H. inermis* were sampled. The collection of *H. inermis* represents a new record, not only for the area of eastern Croatia, but also for the area of continental part of Croatia (Figure 1).

Table 1. Taxonomic list of hard ticks (Acari: Ixodidae) on five different habitats in the surroundings of the city Beli Manastir.

Tablica 1. Taksonomski popis tvrdih krpelja (Acari: Ixodidae) na pet različitim staništa u okolici grada Belog Manastira.

Family Porodica	Genus Rod	Species Vrsta	Specimens Jedinke	%
Ixodidae	<i>Dermacentor</i>	<i>Dermacentor marginatus</i>	1	0.07
		<i>Dermacentor reticulatus</i>	6	0.40
	<i>Haemaphysalis</i>	<i>Haemaphysalis concinna</i>	473	31.66
		<i>Haemaphysalis inermis</i>	29	1.94
	<i>Ixodes</i>	<i>Ixodes ricinus</i>	985	65.93
Σ1	3	5	1494	

Table 2. Number of developmental stages of hard ticks (Acari: Ixodidae) in the surroundings of the city Beli Manastir.

Tablica 2. Broj razvojnih stadija tvrdih krpelja (Acari: Ixodidae) u okolici grada Belog Manastira.

Species/Stage Vrsta/Stadij	Larvae Larve	Nymph Nimfe	Adult Imago
<i>Dermacentor marginatus</i>	–	–	1♀
<i>Dermacentor reticulatus</i>	–	–	5♀, 1♂
<i>Haemaphysalis concinna</i>	448	19	6♀
<i>Haemaphysalis inermis</i>	2	1	13♀, 13♂
<i>Ixodes ricinus</i>	379	351	188♀, 67♂
Σ5	829	371	294

Table 3. Seasonal dynamics of hard ticks (Acari: Ixodidae) in the Haljevo Forest.

Tablica 3. Sezonska dinamika tvrdih krpelja (Acari: Ixodidae) u šumi Haljevo.

Species/ Months Vrsta/Mjeseci	III	IV	V	VI	VII	VIII	IX	X
<i>Dermacentor marginatus</i>	–	1 ♀	–	–	–	–	–	–
<i>Haemaphysalis concinna</i>	–	1 ♀	4n	4n, 16l	9n, 431l	5 ♀	1n, 1l	1n
<i>Haemaphysalis inermis</i>	7 ♂	11 ♀, 6 ♂	1 ♀, 1n	1 ♀	2l	–	–	–
<i>Ixodes ricinus</i>	3 ♀, 1 ♂, 87n	2 ♀, 1 ♂, 46n	1 ♀, 3 ♂, 62n	1 ♀, 2 ♂, 82n, 119l	1 ♀, 50n, 139l	41l	1n, 39l	1n, 17l
Σ4	98	68	72	225	632	46	42	19

Table 4. Abundance of hard ticks (Acari: Ixodidae) in five different habitats in the surroundings of the city Beli Manastir.

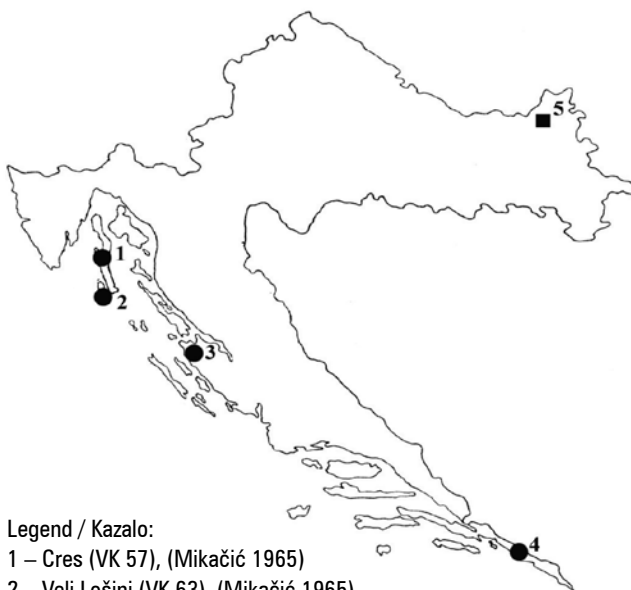
Tablica 4. Brojnost tvrdih krpelja (Acari: Ixodidae) na pet različitim staništa u okolici grada Belog Manastira.

Species/Habitat Vrsta/Stanište	Haljevo Forest Šuma Haljevo	Pond edge Rub ribnjaka	Meadow near to city pools Livada uz gradske bazene	Edge of melioration channels Rub melioracijskog kanala	Park in the center of the city Park u središtu grada
<i>Dermacentor marginatus</i>	1	–	–	–	–
<i>Dermacentor reticulatus</i>	–	–	–	6	–
<i>Haemaphysalis concinna</i>	473	–	–	–	–
<i>Haemaphysalis inermis</i>	29	–	–	–	–
<i>Ixodes ricinus</i>	699	43	3	–	–
Σ5	1202	43	3	6	–

Table 5. Seasonal dynamics of hard ticks (Acari: Ixodidae) on pets in the city Beli Manastir.

Tablica 5. Sezonska dinamika tvrdih krpelja (Acari: Ixodidae) na kućnim ljubimcima u gradu Belom Manastiru.

Species/Months Vrste/Mjeseci	III	IV	V	VI	VII	VIII	IX	X
<i>Ixodes ricinus</i>	24 ♀, 8 ♂	105 ♀, 41 ♂	31 ♀, 6 ♂, 1n	6 ♀, 1 ♂, 3n, 2l	3 ♀, 1l	1n	1 ♀, 1l	3 ♀, 2n
Σ1	32	146	38	12	4	1	2	5



Legend / Kazalo:

- 1 – Cres (VK 57), (Mikačić 1965)
- 2 – Veli Lošinj (VK 63), (Mikačić 1965)
- 3 – Zadar (WJ 18), (Mikačić 1965)
- 4 – Dubrovnik (BN 62), (Mikačić 1965)
- 5 – Haljevo Forest (CR 17) – new records

Figure 1. The distribution area of *Haemaphysalis inermis* in Croatia.Slika 1. Područje rasprostranjenosti vrste *Haemaphysalis inermis* u Hrvatskoj.

Discussion

Rasprava

Fauna of hard ticks (Acari: Ixodidae) in eastern Croatia is insufficiently known. First study of fauna of hard ticks in eastern Croatia was conducted during 1955 (Mikačić 1968). During that study in Baranja, only *D. marginatus* was found (Mikačić 1968). After twelve years, during 1967, on locality Kapelački Lug using the flag dragging method, *D. reticulatus* was collected (Vesenjak-Hirjan and Šooš 1976). More recent samplings of hard ticks on the area of eastern Croatia were carried out in 2011 on localities Đakovo, Mikleuš and Zmajevac. During these screenings *H. concinna*, *Ixodes hexagonus* Leach, 1815 and *I. ricinus* were recorded for the first time on the area of eastern Croatia (Krčmar 2012, Teni 2012). Present study of the fauna of hard ticks in the surroundings of the city Beli Manastir resulted in five identified species, four of them already confirmed in previous studies in eastern Croatia. *Ixodes ricinus* is the most abundant species of hard ticks sampled in the surroundings of the city of Beli Manastir. Majority of specimens of this species were sampled in the forest of pedun-

culate oak and hornbeam (as. *Carpino betuli* – *Quercetum roboris* Ht. 1938) on locality Haljevo. All ticks collected on home pets belonged to same species, that is *Ixodes ricinus*. *Ixodes ricinus* was also the only tick species recorded on roe deers (Pintur et al. 2012) and on birds (Trilar 2004). *Ixodes ricinus* has been sampled on many bird species during field studies all over Europe, and it has been found that bird species are very important in the spatial spread of this species (Tovornik 1990). Results of this study are in agreement with results of many similar field studies conducted in Europe where the species *I. ricinus* was found to be the most abundant member of local tick fauna. Habitat suitability for *Ixodes ricinus* is relatively stable in Europe (Estrada-Pena and Venzal 2006), and that is the reason for their wide geographic distribution within the latitudes 65° and 39° N, inhabiting the area from Ireland and Portugal eastward to the Volga River in Russia and southward to North Africa (Jaenson and Jensen 2007). In adult stage, *I. ricinus* was the most abundant in April, whereas in larval stage it dominated in July. From March to mid-May, nymphs and adults of *I. ricinus* has been sampled, whereas in July mostly larvae and nymphs. These results are in line with seasonal dynamics of certain developmental stages of *I. ricinus*, because in midsummer in July, diapause often affects the adults (Hillyard 1996). However, the activity periods are affected by dry conditions and host availability (Mikačić 1965, Hillyard 1996). Availability of roe deer as host is very significant, because they are the most important wild hosts for adult stage of *I. ricinus* on the area of central Europe (Tovornik 1988a, Pintur et al. 2012). That is probably the reason of large number of sampled ticks in Haljevo Forest, where the population of roe deer is also high. Roe deer are animals with an extremely small circulation radius, therefore they constantly live in the same part of the forest, and as a consequence, fragmented forests and their edges with roe deer have very abundant tick populations (Tovornik 1988a). Among all European tick species, *I. ricinus* is the most widely distributed (Milutinović et al. 2006). Wide ecological plasticity makes it one of the main vectors of infectious diseases within humans, consequently causing highest human health threat in Europe (Pundapolić et al. 2002, Lindström and Jaenson 2003, Jongejan and Uilenberg 2004, Estrada-Pena and Venzal, 2006). *Ixodes ricinus* is one of the most widely distributed tick species in continental and Mediterranean part of Croatia (Krčmar 2012). In the area of northern and northwestern Croatia, nine species of hard ticks have been identified (Mikačić 1968, 1969, Tovornik 1976, 1988b, 1991), within these, four of them within this study in the area of eastern Croatia. *Haemaphysalis concinna* takes second place in the abundancy list, and all specimens belonging to this species were sampled in Haljevo Forest. Recently, three years ago, this species was sampled for the first time on the area of

eastern Croatia, in the forest of sessile oak and hornbeam (as. *Epimedio-Carpinetum betuli* /Horvat 1938/Borhidi 1963) at the locality of Mikleuš (Teni 2012). Together with these findings from eastern Croatia, there are only two more records of this species in Croatia, one in the northern Croatia (Dekanovec), and the other on Krk island (Tovornik 1988, Hassl 2003). Species from the genus *Derma-centor* are represented with only 0.47 % in collected sample (Table 1). In Great Britain and Ireland *D. reticulatus* occurs at low densities (Ogden et al. 2000) which complies with our results. However, in Hungary this species is very abundant, as well as in the area of Tuzla canton in Bosnia and Herzegovina (Földvári and Farkas 2005, Krčmar et al. 2014). In three habitats, pond edges, melioration channels near to agricultural land and meadow near to city pools, only 3.48 % of ticks have been sampled. The most likely reason for that is the fact that forest habitats provides a buffering effect against climatic extremes, with less variation in temperature and humidity compared with more open habitats (Lindström and Jaenson 2003). In park in the center of the Beli Manastir, during the whole research period, no ticks were sampled. There may be more reasons for that, one of the seemingly important one is that pet owners are taking good care of their pets using different repellents against ticks, and they rarely bring out their pets in city park. In the city of Beli Manastir typical housing by 90 % are low or high single-storey houses with smaller or bigger courtyards and that is a logical reason why owners have no need to bring their pets into parks, or they do it on rare occasions. In this study, *H. inermis* is recorded for the first time in continental Croatia. Until this research this species was sampled only in the Mediterranean part of Croatia (Mikačić 1965, Krčmar 2012). *Haemaphysalis inermis* mainly inhabits deciduous and mixed forests (Hillyard 1996), and that is probably the main reason why it was sampled only in the forest of common oak and hornbeam on locality Haljevo. Another possible reason for first finding this tick species in continental Croatia is lack of more similar studies throughout the country. Additionally, global warming, as climate related changes, may affect the geographical distribution of ticks (Hornok and Farkas 2009) and may also play role in the changes of tick species distribution in the country diverse as Croatia. The largest amount of tick fauna similarity existing among five different habitats turned out to be within pond edges and meadow near to city pools, since these habitats contain only one species, *I. ricinus*. Large percentage of *I. ricinus* on certain types of habitats indicates little diversity of tick fauna. The reason is probably in the fact that *I. ricinus* is least sensitive on temperature changes, while other species are sensitive to various extent (Ploj 2007). On the other hand, in the areas where temperature is not a limiting factor, the rainfall becomes the primary factor, defining the tick fauna diversity (Estrada-Pena and Venzal 2006).

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Sažetak

U Hrvatskoj, intenzivna istraživanja faune tvrdih krpelja (Acari: Ixodidae) počinju u drugoj polovici 20 stoljeća. U tom razdoblju prof. dr. sc. Davor Mikačić prikazuje rasprostranjenost i sezonsku dinamiku tvrdih krpelja na otocima i lokalitetima uz obalu Jadranskog mora. Tijekom sedamdesetih i osamdesetih godina prošloga stoljeća prof. dr. sc. Danica Tovornik istražuje raznolikost faune krpelja te ekološke značajke tvrdih krpelja na otocima hrvatskoga Jadrana. Međutim, mnoga područja u unutrašnjosti Hrvatske ostala su nedovoljno istražena. Jedno od takvih područja je i područje Slavonije i Baranje u istočnoj Hrvatskoj, gdje su tvrdi krpelji

uzorkovani samo na četiri lokaliteta, te je to bio glavni razlog za istraživanje raznolikosti faune tvrdih krpelja u Hrvatskom dijelu Baranje u okolici grada Belog Manastira. Na pet različitih staništa u okolici grada, u razdoblju od ožujka do listopada 2013. godine tvrdi krpelji su uzorkovani krpeljnog zategom. Uzorkovanje je obavljeno jednom mjesečno na sljedećim staništima: na rubovima ribnjaka i melioracijskih kanala uz oranice, u šumi hrasta lužnjaka i običnog graba (as. *Carpino betuli* – *Quercetum roboris* Ht. 1938), na livadi uz gradske bazene i u parku u središtu grada. Dužina transekta na kojemu je obavljeno uzorkovanje iznosila je 20 metara. Nekoliko tvrdih krpelja tijekom istraživanog razdoblja uzorkovano je i rukom na kućnim ljubimcima. Krpeljnog zategom uzorkovano je 1 254 jedinki tvrdih krpelja, a na kućnim ljubimcima uzorkovano ih je 240. U skupljenom uzorku utvrđeno je pet vrsta tvrdih krpelja: *Dermacentor marginatus* (Sulzer, 1776), *Dermacentor reticulatus* (Fabricius, 1794), *Haemaphysalis concinna* (Koch, 1844), *Haemaphysalis inermis* (Birula, 1895) i *Ixodes ricinus* (Linnaeus, 1758). Najbrojnija vrsta tvrdih krpelja je *Ixodes ricinus* sa 65,93 %, slijede vrste *Haemaphysalis concinna* s 31,66 %, *Haemaphysalis inermis* s 1,94 %, *Dermacentor reticulatus* s 0,4 % i *Dermacentor marginatus* s 0,07 %. U šumskom tipu staništa na lokalitetu Haljevo uzorkovan je najveći broj jedinki tvrdih krpelja (80,45 %), svrstanih u vrste: *Dermacentor marginatus*, *Haemaphysalis concinna*, *Haemaphysalis inermis* i *Ixodes ricinus*. Vrsta *Ixodes ricinus* je na lokalitetu u šumi Haljevo najbrojnija, što je u suglasnosti s rezultatima mnogih terenskih istraživanja diljem Europe u kojima je također vrsta *Ixodes ricinus* u šumskim tipovima staništa najbrojnija. U stadiju imaga vrsta *Ixodes ricinus* bila je najbrojnija u travnju, dok je u stadiju ličinke najbrojnija u mjesecu srpnju. Od ožujka pa sve do sredine svibnja, vrsta *Ixodes ricinus* uzorkovana je u razvojnim stadijima nimfe i imaga, dok je u mjesecu srpnju uglavnom uzorkovana u stadiju ličinke i nimfe. To je u skladu sa sezonskom dinamikom pojedinih razvojnih stadija, jer tijekom srpnja dijapauza često zahvaća samo stadij imaga. Dostupnost velikog broja visoke divljači, jelena i srna najvjerojatniji je razlog velikog broja uzorkovanih tvrdih krpelja u šumi Haljevo. Na otvorenim tipovima staništa (livada uz rub ribnjaka, melioracijskih kanala, uz gradske bazene, park u središtu grada) uzorkovano je samo 3,48 % tvrdih krpelja, jer su otvorena staništa više podložna promjenama temperature i vlažnosti od šumskih staništa. Najviše tvrdih krpelja na istraživanom području (55,49 %) uzorkovano je u stadiju ličinke. Vrsta *Haemaphysalis concinna* u stadiju ličinke zastupljena je s 94,71 %, slijedi *Ixodes ricinus* s 38,48 %, te *Haemaphysalis inermis* s 6,90 %. U mjesecu srpnju uzorkovano je najviše ličinki tvrdih krpelja (71,53 %), dok je najviše imaga uzorkovano u mjesecu travnju (58,50 %). Sørensenov indeks faunističke sličnosti pokazuje najveću sličnost u fauni krpelja između staništa uz rub ribnjaka i livade uz gradske bazene, te iznosi 100 %, dok je sličnost između šume i ruba ribnjaka, te šume i livade iznosila svega 40 %. Ulov vrste *Haemaphysalis inermis* prvi je nalaz za područje kontinentalnog dijela Hrvatske, s obzirom da je dosada zabilježena samo na četiri lokaliteta u mediteranskom dijelu Hrvatske.

KLJUČNE RIJEČI: tvrdi krpelji, Ixodidae, Beli Manastir, Baranja, Hrvatska