

ECOLOGICAL NOTES ON TICKS (ACARI: IXODIDAE) IN SERBIA (CENTRAL REGIONS)

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A survey of ticks was undertaken in some regions of central Serbia (1998-2000). Out of 10 species of the family Ixodidae occurring in Serbia, seven species were found in the investigated regions, namely: Ixodes ricinus, Dermacentor marginatus, Dermacentor reticulatus syn. pictus, Rhipicephalus sanguineus, Rhipicephalus bursa, Haemaphysalis punctata and Boophilus annulatus. The faunistic composition, relative abundance, population dynamics and the sex ratio of the detected species were investigated. The temperature, relative humidity and rainfall were monitored in terms of their respective effects on the dynamics of tick populations.

Key words: ticks, Ixodidae, diversity, ecology

INTRODUCTION

About 10% of approximately 800 species of ticks are of medical importance because of their indiscriminate host selection and feeding behavior. As a result, a number of diseases have begun to emerge in the temperate zones, including Lyme borreliosis and several others putatively associated with ticks (Cupp, 1991).

In research on fauna and ecology of ticks, which are hematophagous arthropods, it is of great importance to provide elements about the zoogeographic distribution, particularly the possible presence of species which might be indicator species of disease.

The change of seasons may have an influence on disease prevalence and may result in periodical occurrence. This seasonal characteristic is present especially in arthropod-borne parasitoses, primarily because population densities of vectors or intermediate hosts vary throughout the year (Schulze *et al.* 1986; Ouhelli and Schein, 1988; Mehlhorn, 1988; Petri, 1988).

MATERIAL AND METHODS

The method for collecting, processing and determining tick species has been described in earlier papers (Milutinović *et al.* 1987, 1998; Milutinović and Bobić, 1997).

The study included evaluation of the following parameters: faunistic composition, relative abundance, sex ratio and the effects of environmental factors (temperature, relative air humidity and precipitation) on tick populations.

Data on the monthly average temperature, relative air humidity and total precipitation for the period 1998 - 2000. were obtained from the Weather Bureau of the Republic of Serbia.

A systematic investigation of the ticks was carried out at 19 locations within central Serbia (the areas of Belgrade, Smederevo, Mladenovac, Arandelovac, Topola, Gornji Milanovac, Kragujevac, Čačak and Kraljevo).

RESULTS

In the period 1998-2000, the tick fauna was collected on a total of 3734 domestic animals of different species in the central area of Serbia. The majority of examined animals were sheep (n=2602), followed by cattle (n= 800) and dogs (n= 180). The number of hosts infested by ticks was 1997. The collected tick specimens were 4802 adult males and females belonging to the Ixodidae family. Ticks were collected monthly from March until the end of October (Table 1.A,B).

Relative abundance analysis revealed that the species *I. ricinus* was absolutely dominant, followed by *D. marginatus*, *R. sanguineus*, *R. bursa*, *B. annulatus* took the seventh place (Figure 1).

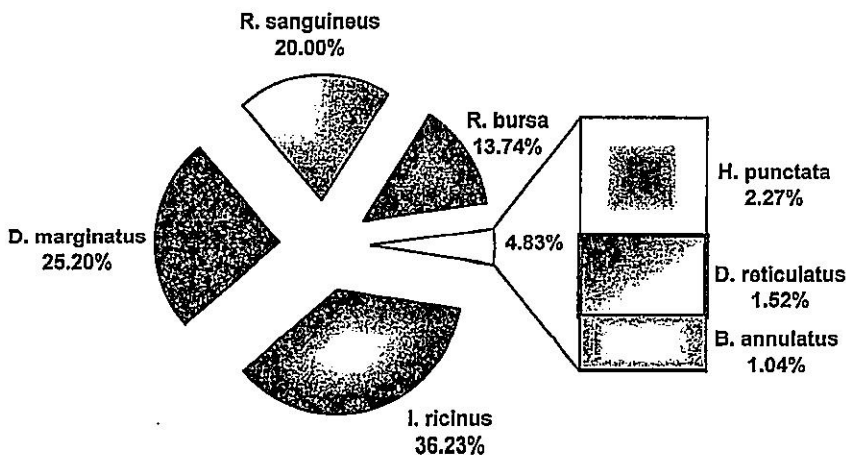


Figure 1. Relative abundance of tick species

In research on the population dynamics of the seven species in relation to temperature, relative air humidity and precipitation, we took into consideration the monthly means of the above-mentioned macroclimatic factors for the three year period (Figure 2)

The population dynamics of ticks was monitored from March to October. It was noted that an increase in abundance commenced in March when the temperature was 6.9°C, relative humidity 70% and precipitation 37 mm. The population maximum for three species: two species of the genus *Dermacentor* -

Table 1. Percentage of ticks collected from domestic animals in central Serbia regions, 1998-2000.

A

Hosts	Number of examined hosts	Number of hosts infested by ticks	Number of collected ticks	<i>Ixodes ricinus</i> %	<i>Dermacentor marginatus</i> %	<i>Rhipicephalus sanguineus</i> %	<i>Rhipicephalus bursa</i> %
Cows	800	168	231	32.47	15.58	1.73	30.30
Sheep	2602	1600	3542	39.90	31.42	9.60	16.37
Dogs	180	165	901	17.31	6.77	68.37	0.00
Goats	112	40	90	70	0.00	0.00	11.11
Horses	40	24	38	86.85	0.00	0.00	0.00
	3734	1997	4802				

B

Hosts	Number of examined hosts	Number of hosts infested by ticks	Number of collected ticks	<i>Haemaphysalis punctata</i> %	<i>Dermacentor reticulatus</i> %	<i>Boophilus annulatus</i> %
Cows	800	168	231	3.03	2.17	14.72
Sheep	2602	1600	3542	2.57	0.00	0.14
Dogs	180	165	901	0.00	7.55	0.00
Goats	112	40	90	12.22	0.00	6.67
Horses	40	24	38	0.00	0.00	13.15
	3734	1997	4802			

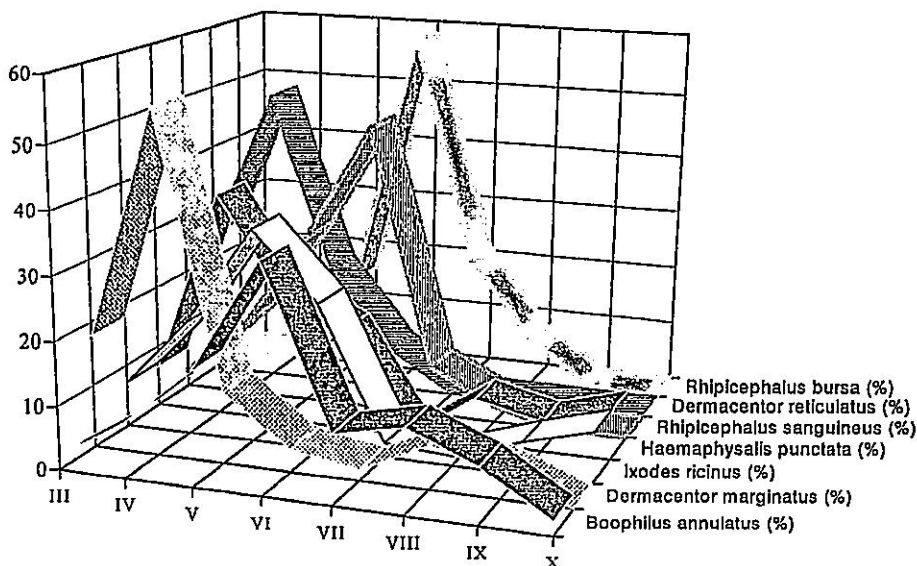


Figure 2. Population dynamics of tick species in central Serbian regions.

D. marginatus and *D. reticulatus* as well as *H. punctata* occurred in April at 9.79 °C mean temperature, 73% relative humidity, i.e. in early spring at the beginning of the rainy season (monthly mean precipitation: 48 mm). The most extensive precipitation was recorded from mid - May to mid - June when a period with little rain followed until the end of summer. Thus, May, with its mean temperature of 18.51 °C, 73% relative humidity and 81 mm precipitation, was the month of the population peak for *I. ricinus* which requires higher relative humidity. It was noted that this species started to decrease in abundance in June at a mean temperature of 20.05 °C, 68% relative humidity and 78 mm precipitation. Two species of the genus *Rhipicephalus*, *R. sanguineus* and *R. bursa*, then reached their maxima, decreasing gradually until August, and disappearing completely in September and October. The autumn population peak in September, at a temperature of 15 °C, 74% relative humidity and 53 mm precipitation, and in October (10.12 °C, 77% relative humidity and 43 mm precipitation) only occurred for the four species *I. ricinus*, *D. marginatus*, *H. punctata* and *B. annulatus*.

The distribution of ticks in central Serbia in the period 1998-2000, (Table2) indicates that females of the species *I. ricinus* were predominant, followed by females of *D. marginatus*. *R. sanguineus* males came immediately after females of the species *D. marginatus*. They were followed by males of *D. marginatus* and *I. ricinus* (occupying the second and the third place). The abundance of *R. bursa* was 10.10% for females and 3.64% for males. Out of the total number of ticks collected, 58.87% were females and 41.13% were males. Moreover, the sex ratio within individual species showed a higher number of females for four species: *I. ricinus*, *D. marginatus*, *R. bursa* and *H. punctata*, but a higher number of males in three species: *R. sanguineus*, *D. reticulatus* and *B. annulatus*.

Table 2. Relative occurrence of male and female ticks of the different species

Tick species	In total (%)		Within species (%)	
	F	M	F	M
<i>Ixodes ricinus</i>	26.03	10.20	68.07	31.93
<i>Dermacentor marginatus</i>	14.00	11.20	57.85	42.15
<i>Rhipicephalus sanguineus</i>	6.40	13.60	36.46	63.54
<i>Rhipicephalus bursa</i>	10.10	3.64	75.76	24.24
<i>Haemaphysalis punctata</i>	1.20	1.07	64.22	35.78
<i>Dermacentor reticulatus</i>	0.70	0.82	47.95	52.05
<i>Boophilus annulatus</i>	0.44	0.60	32.00	68.00
TOTAL:	58.87	41.13		

F: females; M: males

DISCUSSION

Generally hard ticks were more abundant in spring and less abundant in autumn. The considerable interchange between Spring and Autumn tick populations can be attributed mainly to environmental conditions.

The species *I. ricinus* is often predominant in material originating from Serbia. Moreover, this species is one of the most widely distributed in Yugoslavia.

Thus, *I. ricinus* took the first place regarding abundance in 1986 and 1987 (26.62% and 26.58%, respectively) and the third place in the period 1984 to 1990 (14.21%) in East and Southeast Serbia (Milutinović et al. 1995b). For Northeast Serbia, Milutinović et al. (1987) presented data on the absolute predominance of the *I. ricinus* (98.99%), while in West Serbia that species took the first place in 1989 (40.48%) and the second place in the years 1989 and 1990 (Milutinović et al. 1996 - 1997).

The dynamics of *I. ricinus* shows two phases of seasonal fluctuation: spring and autumn, because two generations mature every year. When ticks were first observed in the spring (in March), the daytime temperature was around 6 - 7 °C, so these conditions represent the starting point for their activity. Thus, the species *I. ricinus* which favours high humidity attained its maximal abundance in the May - June interval then dropped suddenly at the beginning of summer. By the beginning of autumn, however, and with a rainy season in October, there was another peak of this species. Such dynamics are thus associated with the amount of precipitation. Cvjetanović (1956) has already pointed out for Dalmatia that air humidity might play an important role in tick biology, especially for species appearing in the cooler months. Moreover, Muftić (1965) provided data on *Ixodidae* appearance in Northwest Bosnia which were dependent on the combined effects of average temperature, relative humidity and amount of precipitation. The effects of these climatic factors on *I. ricinus* have also been revealed by other authors (Ayidin and Tinar 1994; Richi et al. 1995; Milutinović et al. 1995a,b 1996).

The male : female ratio was 26.03% vs. 10.20%. Female prevalence has also been reported by Petrović and Bordjoški (1955a), Milutinović and Bobić (1997), Milutinović et al. (1987) and Milutinović (1992).

H. punctata reached peak abundance twice a year, in April and the September - October interval. Furthermore, this species had a spring peak in April and an autumn peak in September (1985, 1986, 1989, 1990) or October (1984, 1987, 1988) in East and Southeast Serbia (Milutinović, 1992). Moreover, the appearance of spring and autumn populations of this tick species was discussed by Muftić (1965) for Northeast Bosnia. He reported that with the fall of temperature from 10 to 2 °C and a sudden drop of relative humidity below 86%, only a few ticks could be collected or they were not found at all. Additionally, our results were similar to those obtained by Tovornik (1980) for the eastern part of the island of Brač and by Milutinović et al. (1987) for Northeast Serbia.

The total and within species prevalence of *H. punctata* females was 1.20% and 64.22%, respectively. A higher number of females was also reported by Milutinović (1992) for the region of East and Southeast Serbia and by Milutinović et al. (1987, 1996-1997) for Northeast and West Serbia, respectively.

The species of the genus *Dermacentor* - *D. marginatus* and *D. reticulatus* - had a spring peak in April at a mean temperature of 9.79 °C, 73% relative humidity and 48 mm precipitation which were the same conditions as for *H. punctata*. The autumn peak only occurred for *D. marginatus* and *H. punctata*. By comparing the results of abundance analysis for these species with the values of the above mentioned environmental factors for East, Southeast and West Serbia (Milutinović 1998; Milutinović et al. 1996-1997), it was ascertained that macro-climatic factors may have significant effects on the dynamics of tick populations. In a study of *H. punctata*, data about *D. marginatus* was collected, because of their related biology and seasonal dynamics.

We should stress that this is the first determination of *D. reticulatus* on dogs in the extended area of Belgrade. Petrović (1979) found this species on cattle and horses in the west parts of Serbia, which was confirmed by Milutinović (1992); while Sosnina (1969) found this species on small rodents in mountain woods of Krim, Ropac, Stojanović (1986) in Croatia and Olsufiev (1987) emphasised the frequent finding of *D. reticulatus* in the south part of the Moscow area. Furthermore, *D. reticulatus* is not a rare species in Poland, since in certain parts of the country the numbers of these ticks greatly exceed those of other representatives of *Ixodidae* and become the dominant form there. Summing up the seasonal activity of the tick *D. reticulatus* in all active stages (larva, nymph and adult) it can be said that, similarly to other broadly distributed *Ixodidae* representatives (e.g. *I. ricinus*), it shows geographical variability. In Poland the activity of ticks lasts 8 months (Szymanski 1986, 1987a,b).

As for the sex ratio in *D. marginatus* and *D. reticulatus*, females were more numerous in *D. marginatus*, accounting for 14.00% of the total number of collected ticks, in contrast to *D. reticulatus* which exhibited male prevalence (0.82%).

Concerning *R. sanguineus* and *R. bursa*, we should stress their third and fourth place in terms of abundance (20.00% and 13.74%, respectively) within the period 1998 through 2000. These species were found in the surveyed area from March-April interval to August and reached their maximum in June throughout the surveyed area. Therefore, we conclude that they are summer tick species, as has been suggested by other authors (Tovornik, 1980; Milutinović, 1996). Moreover, Yeruham et al. (1998) pointed out that the most important factor limiting the

distribution of these species was a decrease in humidity. Inokuma *et al.* (1996) described the seasonal occurrence of *R. sanguineus* and the effect of temperature on development of this tick. This species was in the fifth place (8.91%) regarding abundance in East and Southeast Serbia (Milutinović *et al.* 1995b) and in the sixth place (3.06%) in West Serbia (Milutinović *et al.* 1996-1997).

The greatest number of specimens of the species *R. sanguineus* was taken from hunting and stray dogs. This was also reported by Rivoscecchi *et al.* (1980) for the outskirts of Rome and Kulišić *et al.* (1995) in the extended area of Belgrade.

R. bursa was found mostly on sheep. Otherwise, in Serbia, the mentioned species may be encountered at the end of April and in May in southern parts of the republic and in June in the rest of Serbia (Petrović, 1979; Milutinović, 1992, 1995a,b).

As for the sex ratio in *R. sanguineus* and *R. bursa*, males were more numerous in *R. sanguineus*, accounting for 13.60% of the total number of collected ticks, in contrast to *R. bursa* which exhibited female prevalence (10.10%).

Adult forms of *B. annulatus* were encountered in the March-October interval with a maximum in June. The species was found by Petrović and Bordjoški (1955a) in the coastal parts of Montenegro during May and September, Petrović *et al.* (1955b) in the region of Ključ in spring, summer and autumn and by Petrović and Simić (1957) in the Danube basin from August till November with an increase in abundance in May and maximal abundance in the April-September interval. Milutinović *et al.* (1995a,b, 1996) also pointed out the seasonal dynamics of this species in the territory of Serbia.

In this species a higher number of males was detected (Milutinović *et al.* 1995b, 1996).

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EKOLOŠKI ASPEKT KRPELJA (ACARI: IXODIDAE) U SRBIJI (CENTRALNI DELOVI)

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SADRŽAJ

Ekološki aspekt istraživanja krpelja u Srbiji (centralni delovi) je bio u funkciji pojašnjavanja njihove uloge rezervoara i vektora uzročnika zoonoza. Praćen je uticaj temperature, relativne vlažnosti i padavina na dinamiku populacija sedam vrsta krpelja: *Ixodes ricinus*, *Dermacentor marginatus*, *Dermacentor reticulatus* syn. *pictus*, *Rhipicephalus sanguineus*, *Rhipicephalus bursa*, *Haemaphysalis punctata* i *Boophilus annulatus*.