

## TICKS (ACARINA, IXODOIDEA, IXODIDAE) OF SERBIA: FAUNA AND ECOLOGY

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*Faunistic and ecological investigations of ticks were carried out in 67 places in East, South-East and West Serbia between 1984-1990. Of the fourteen species of the Ixodidae family occurring in Serbia, ten species of ticks were found in the investigated region. The investigation involved: the faunistic composition, relative abundance, population dynamics, the sex ratio and the distribution of fed, unfed and gravid females, as well as the effect of temperature, relative humidity and precipitation on the dynamics of tick populations.*

*Key words: fauna, ecology, tick, population*

### INTRODUCTION

Research on the morphology, biology, and ecology of ticks and their distribution is of great importance for human and veterinary medicine considering the place and role of these parasites in epidemiology and epizootology. The biomedical significance and therefore the epidemiological effectiveness of the medically relevant ticks is primarily based on the relative host nonspecificity which not only implies a very extensive exchange of infective agents among different species of animals but also includes man in the passage of these agents.

Initial investigations of ticks in Serbia were started in the years 1937-1940, especially in South Serbia. Following World War II, the first data about these arthropods came from Kosovo (1941-1951) and Vojvodina (1954). Results from inner Serbia have been acquired since the fifties (Mekuli, 1952; Simić and Petrović, 1954; Petrović K., 1955; Petrović and Simić, 1957).

Our investigations were carried out in those parts of East, South-east and West Serbia which have never been examined for tick fauna, but which border directly on the areas known as enzootic foci of domestic ruminant pyroplasmosis. These investigations covered the effects of some ecological factors under which these haematophagous arthropods breed and multiply. Namely, we looked for a correlation between monthly temperature, relative humidity and the precipitations and abundance of the detected tick species.

## MATERIAL AND METHODS

The method of collecting the ticks and further processing them in the laboratory has been previously reported (Milutinović et al. 1989).

Data about the monthly mean temperature, relative humidity and precipitations for the period 1984-1990 were obtained from the Weather Bureau of the Republic of Serbia.

## RESULTS

During the period from 1984 to 1990 the tick fauna was examined on a total of 19,010 various domestic animals in 67 places in East, South-east and West Serbia (Figure 1). The majority of the examined animals were sheep (11,577), followed cattle (4,383) and finally goats (2,527). Ticks were collected from March till the end of November. The collected specimens - a total of 15,921 - were adult males and females, with only a small number of nymphs. All the collected tick specimens belonged to species from the Ixodidae family.

Ten tick species were detected, namely: *Ixodes ricinus*, Linne 1758; *Dermacentor marginatus*, Sulzer 1776; *Dermacentor pictus*, Hermann 1804; *Haemaphysalis punctata*, Canestrini & Fanzago 1877; *Haemaphysalis sulcata*, Canestrini & Fanzago 1877; *Haemaphysalis inermis*, Birula 1895; *Rhipicephalus bursa*, Canestrini & Fanzago 1877; *Rhipicephalus sanguineus*, Latreille 1804; *Boophilus calcaratus*, Birula 1895; *Hyalomma savignyi*, Gervais 1844. Differences among the investigated regions were observed too, namely the macroclimate.

In the region of East and South-east Serbia the species *Dermacentor pictus* was non detected. In the region of West Serbia the species *Hyalomma savignyi* and *Boophilus calcaratus* were not found. Out of the nine detected species in East and South-East Serbia, the most abundant were: *Dermacentor marginatus*, *Rhipicephalus bursa*, *Ixodes ricinus* and *Haemaphysalis punctata*. Also in the investigated places of West Serbia out of the eight detected species the most abundant were: *Haemaphysalis sulcata*, *Ixodes ricinus*, *Haemaphysalis punctata* and *Dermacentor marginatus*.

The analysis of the relative abundance of the species detected in East and South-East Serbia region revealed the following: the species *Dermacentor marginatus* achieved the maximal abundance of 55.21% (1985), and the minimal abundance of 19.18% (1984). This species was absolutely dominant within the 1985-1990 period, but not in 1984, when the species *Rhipicephalus bursa* accounted for 32.53%. The minimal abundance of this species was found in 1988 (8.88%). As for the species *Ixodes ricinus*, it reached its maximal abundance in 1986. (26.62%) and a minimal abundance in 1985 (6.57%). The species *Rhipicephalus sanguineus* and *Haemaphysalis punctata* reached their maxima in 1984 and 1988 (16.19% and 15.79% respectively), and their minima in 1990 and 1984 (5.37% and 7.67% respectively). The minimal abundance of *Haemaphysalis sulcata*, *Haemaphysalis inermis*, *Boophilus calcaratus* and

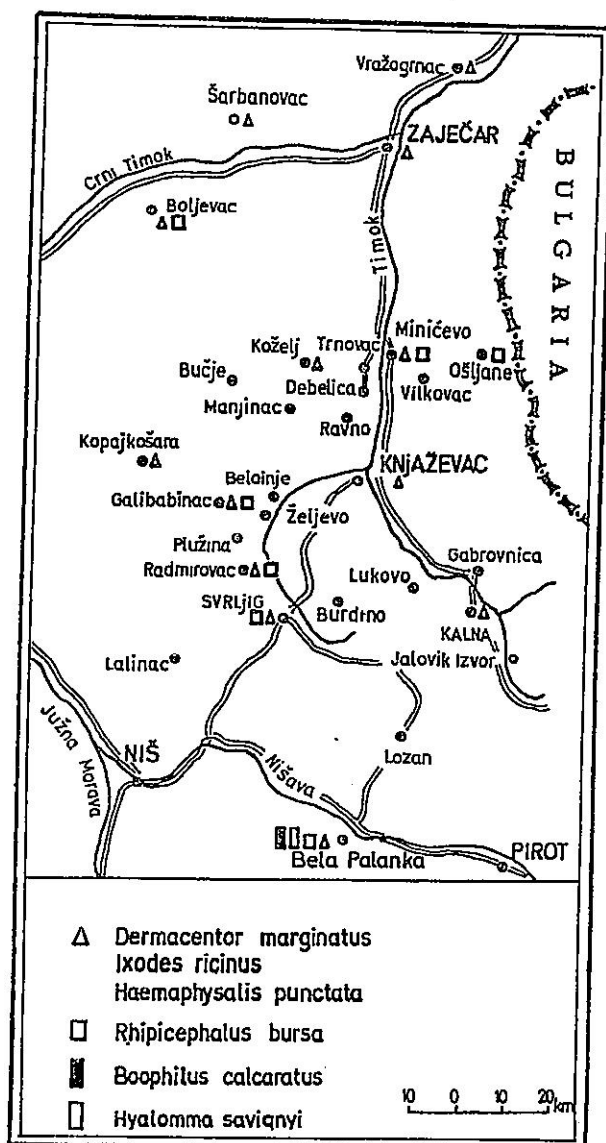


Figure 1. East and South-East Serbia regions in which tick investigations were carried out in the period 1984-1990.

*Hyalomma savignyi* ranged from 0.22% to 1.99%, and the maximal between 0.86% and 5.26% (Table 1).

Table 1. Relative abundance of nine tick species collected in the area of East and South-East Serbia in the period 1984-1990.

Tick species	Years						
	1984 %	1985 %	1986 %	1987 %	1988 %	1989 %	1990 %
<i>I. r.</i>	16.76	6.57	26.62	26.58	7.2	10.8	9.9
<i>D. m.</i>	19.18	55.21	27.77	40.74	5.89	40.71	49.0
<i>Hae. p.</i>	7.67	9.88	12.1	7.96	15.79	12.66	8.67
<i>Hae. s.</i>	1.99	1.68	2.57	1.65	2.1	2.61	.61
<i>Hae. i.</i>	0.64	0.4	0.86	0.22	0.40	0.8	0.41
<i>Rh. b.</i>	1.5	15.06	11.26	14.11	8.88	18.70	20.09
<i>Rh. s.</i>	16.19	7.85	1.6	5.80	8.0	10.71	5.7
<i>Hy. s.</i>	0.78	0.84	1.4	1.21	0.98	0.92	1.67
<i>B. c.</i>	5.26	2.57	.91	1.7	2.1	2.9	1.76

in the region of West Serbia the species *Ixodes ricinus* accounted for 40.48% and 17.80% in 1989 and 1990 respectively. In 1989 the species *Haemaphysalis sulcata* came immediately after the species *Ixodes ricinus* with an abundance of 25.60%, but it was absolutely dominant in 1990 (41.85%). The abundance of *Haemaphysalis punctata* was similar (between 14.22% and 15.89%) throughout the period of investigation. This was followed by *Dermacentor marginatus* with an abundance of 12.65% to 14.28%. The minimal abundance of *Haemaphysalis inermis*, *Dermacentor pictus*, *Rhipicephalus bursa* and *Rhipicephalus sanguineus* was between 0.36% and 3.79% and the maximal between 0.48% and 5.53% (Table 2).

Table 2. Relative abundance of eight tick species collected in West Serbia regions in 1989 and 1990.

	1989	1990
<i>Ixodes ricinus</i>	40.48%	17.80%
<i>Haemaphysalis sulcata</i>	25.60%	41.85%
<i>Haemaphysalis punctata</i>	14.22%	15.89%
<i>Dermacentor marginatus</i>	12.65%	14.28%
<i>Rhipicephalus bursa</i>	.79%	5.5%
<i>Rhipicephalus sanguineus</i>	2.6%	.75%
<i>Dermacentor pictus</i>	0.54%	0.42%
<i>Haemaphysalis inermis</i>	0.6%	0.48%

The population dynamics of all ten species was established and described, revealing the existence of spring, summer and autumn species, as well as of the species which produced two generations within the same year.

In the follow up of the population dynamics of the nine species collected in the territory of East and South-East Serbia within the period 1984-1990 it

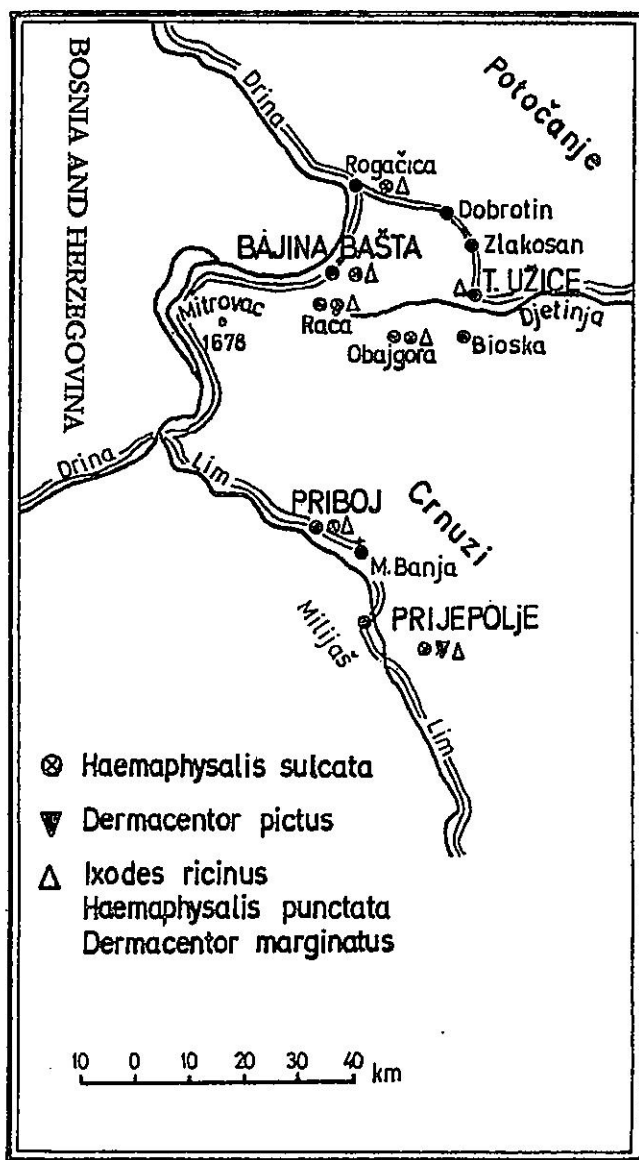


Figure 2. West Serbia regions in which tick investigations were carried out in the period 1989-1990

was noted that the increase of abundance commenced in March for five species: *Ixodes ricinus*, *Dermacentor marginatus* and two species of the genus *Haemaphysalis*-*punctata* and *sulcata*. May was marked by *Ixodes ricinus*, *Haemaphysalis sulcata* and *Hyalomma savignyi* predominance, June by two species of the genus *Rhipicephalus*-*bursa* and *sanguineus*. In July the maximal abundance was attained by *Boophilus calcaratus*. Six species were encountered in August, but sporadically. September was the month of the early autumn predominance of *Dermacentor marginatus*, accompanied by *Haemaphysalis sulcata*. Throughout the spring population maximum, this species followed the species *Ixodes ricinus* for several years which had its maximum in October, as did *Haemaphysalis punctata*. The species *Haemaphysalis punctata* and *Boophilus calcaratus* were rarely encountered in November (Figure 1).

Parallel population dynamics of the species detected in the area of West Serbia within the 1989-1990 period is represented in Figure 2. March was the

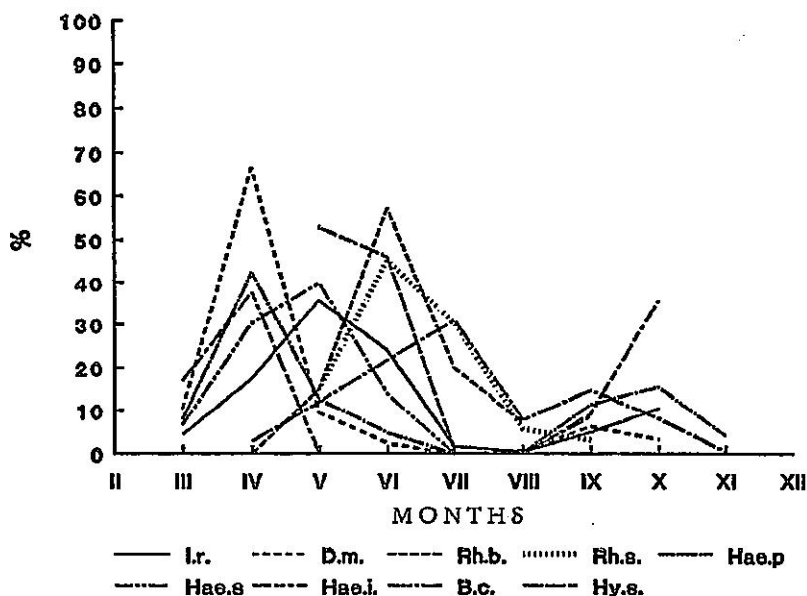


Figure 3. Population dynamics of ticks in the regions of East and South - East Serbia in the period 1984-1990.

period of an increase in abundance for the following five species: *Ixodes ricinus*, three species of the genus *Haemaphysalis*-*sulcata*, *punctata* and *inermis* and *Dermacentor marginatus*. April was the month of the population maximum relating to four species: two species of the genus *Haemaphysalis* - *sulcata* and *punctata* and two species of the genus *Dermacentor* - *marginatus* and *pictus*. The species *Ixodes ricinus* was the only one which had its population maximum in May, while two species of the genus *Rhipicephalus* - *bursa* and *sanguineus*,

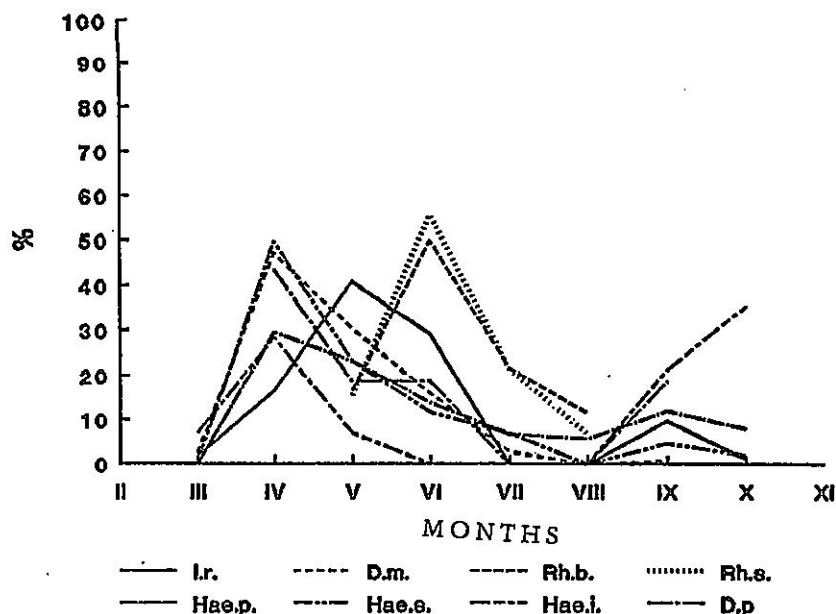


Figure 4. Population dynamics of ticks in the area of West Serbia in the period 1989-1990.

reached their maxima in June. They were not found in the autumn. The autumn population maximum only occurred with four species: *Ixodes ricinus* and three species of the genus *Haemaphysalis* - *Haemaphysalis sulcata*, *Haemaphysalis punctata* and *Haemaphysalis inermis*, while two species of the genus *Dermacentor* - *Dermacentor marginatus* and *Dermacentor pictus* were rarely encountered.

Out of the total number of collected specimens in East and South-East Serbia 58.21% were females and 41.79% males. However, the sex ratio within individual species indicated some differences, because in six species (*Ixodes ricinus*, *Dermacentor marginatus*, *Haemaphysalis punctata*, *Haemaphysalis inermis*, *Rhipicephalus bursa*, *Rhipicephalus sanguineus*) a larger number of females was found, and in three species (*Haemaphysalis sulcata*, *Hyalomma savignyi* and *Boophilus calcaratus*) a larger number of males was detected.

In West Serbia out of the total number of collected ticks 51.95% were females and 48.05% males. The sex ratio within individual species showed a larger number of females for five species (*Ixodes ricinus*, *Haemaphysalis punctata*, *Haemaphysalis inermis*, *Rhipicephalus sanguineus*, *Dermacentor marginatus*); a larger number of males in two species (*Rhipicephalus bursa*, *Haemaphysalis sulcata*), and an even number of both sexes in one species (*Dermacentor pictus*).

The proportion of females, whose digestive organs were filled with blood, to unfed females, varied. In three species fed females were predominant i. e.

*Dermacentor marginatus*, *Ixodes ricinus*, *Rhipicephalus bursa* (80-90%); whereas in the remaining seven species the differences were insignificant.

The results of the study of the effects of temperature, relative air humidity and precipitation were compared with population dynamics for each separate year, and a summary for all the seven years and ten species.

#### DISCUSSION

Out of nine tick species encountered within the territory of East and South-East Serbia the species *Dermacentor marginatus* was the most abundant in the period 1985-1990, while in 1984 it came second after *Rhipicephalus bursa*. The third species, regarding abundance, was *Ixodes ricinus* followed by *Haemaphysalis punctata*, *Rhipicephalus sanguineus*, *Boophilus calcaratus*, *Haemaphysalis sulcata*, *Hyalomma savignyi* and *Haemaphysalis inermis*. Due to the fact that the most abundant species in West Serbia, besides *Haemaphysalis sulcata*, are also *Ixodes ricinus*, *Haemaphysalis punctata* and *Dermacentor marginatus*, we shall discuss these species within the whole investigated area.

Out of all the species of the Ixodidae family, the species *Ixodes ricinus* is one of the most widely distributed in Serbia.

On the basis of the relative abundance analysis it was found to be the most abundant species in 1986 (26.62%) and in 1987 (26.58%) in the area of East and South-East Serbia, i.e. it attained only 2.77% less than *Rhipicephalus bursa* which was in the second place, regarding abundance. Additionally, this species was predominant in West Serbia in 1989 (40.4%). The mass appearance of this species in our country was recorded by other authors (Mekuli, 1952; Petrović and Bordoški, 1955; Bojanin, 1964). As for the area of North-East Serbia Milutinović et al. (1987) presented data on the absolute predominance of the species *Ixodes ricinus* (98.99%).

It is known that the dynamics of this tick population exhibits two generations maturing yearly. Our investigations showed that the spring maximum of this species predominated incomparably with the autumn in 1984, 1986 and 1990. The appearance of two generations was confirmed by other authors (Oswald, 1938, 1939, 1940; Petrović and Simić, 1957; Rosicky et al. 1961; Tovor-nikov, 1970, 1976; Milutinović et al. 1987).

The species *Ixodes ricinus* had its spring maximum within the period May-June in the area of East and South-East Serbia and in May (1989-1990) in West Serbia. It was rarely encountered during summer, except in July 1987, when it attained a greater abundance than in September the same year. The autumn maximum was reached in September 1984 in the area of East and South-East Serbia. However, it was less noted in September 1989 and 1990 in the territory of West Serbia. Within the 1985-1990 period this species attained the autumn maximum in October.

The sex ratio in *Ixodes ricinus* species showed female prevalence in the region of East and South-East Serbia (61.24%) and in the area of West Serbia (58.39%). A greater number of females was also reported by Petrović and



Bordoški (1955) and Milutinović and co-workers (1987). Our investigations revealed that the greatest percentage of females in comparison with males was in East Serbia in 1990 (71.63% and 28.37%) and in West Serbia in 1989 (65.64% and 34.63%).

As for the results concerning unfed, fed and gravid females, it should be pointed out that mass livestock infestation with this arthropod occurs in the second half of spring, the beginning of summer and in mid-autumn; this was also reported by Tovornik (1976) for the area of Stara Ves. Our findings, concerning this Seven-year, showed that with the species *Ixodes ricinus*, *Dermacentor marginatus* and *Rhipicephalus bursa* 80-90% specimens were fed females whereas an irrelevant percentage referred to unfed forms and gravid females. Within the period 1978-1980 females i. e. fed forms were dominant in the area of North-East Serbia.

Also, the temperature, relative air humidity and precipitations were monitored in terms of their respective effects on the dynamics of tick populations. The results obtained indicate a considerable impact on the greater or smaller population abundance of ticks, because this species i.e. these arthropods spend a part of their life cycle in the environment.

As for East and South-East Serbia, *Dermacentor marginatus* was the most abundant species, though the research by a number of authors suggested the species *Dermacentor marginatus* to be typical of Mediterranean karst regions (Mačička et al., 1955; Tovornik, 1970). This species was the most abundant in 1985 (55.21%) and the least abundant in 1984 (19.18%). In West Serbia this acarina was in the fourth place (13.47%). The dynamics of this species show two maxima a year: in spring and in autumn. We were encountering this species in the investigated area from March till October. The spring peak was in April and the autumn one in September, except that in 1987 it was in October. This tick is most often encountered in the southern warmer and dryer parts of forests that probably provide the most favourable microclimatic conditions for tick survival. We assume that there are variations of biotopes for this species due to the fact that our investigations were carried out in humid oak forests and our findings compared with the results obtained by other authors (Šatas, 1951, cit. Mačička et al., 1955; Georgiev et al., 1971. Černý et al., 1982).

The sex ratio in *Dermacentor marginatus* species showed female prevalence (59.30%) in East and South-East Serbia and also in West Serbia (65.78%). A greater number of females was also reported by Milutinović et al. (1987) in the region of North-East Serbia. As for the ratio of fed to unfed and gravid females, the most abundant were fed forms with few gravid females.

By comparing the abundance analysis results of this species with the values of macroclimatic measurements taken in the area of North-East, South-East, East and West Serbia, it has been ascertained that macroclimatic factors have a significant effect on the dynamics of the tick populations.

Besides the most widespread *Ixodes ricinus* species, two species of the genera *Haemaphysalis* - *sulcata* and *punctata*, appeared as its permanent companions in the investigated regions of East, South-East and West Serbia. The

species *Haemaphysalis sulcata* was predominant in the area of West Serbia in 1989 (25.60%) and in 1990. (64.85%) while in East and South-East Serbia is was most abundant in 1990 (3.61%) whereas it reached its minimum in 1987 (1.65%). This species reached the spring maximum in May, except in 1987 when it reached the maximal abundance in April and in September within the period 1984-1990. In the area of West Serbia it had a maximum in April and in the autumn a peak in September. This species was found by Petrović and Bordoški (1955) in the continental parts of Montenegro during May and September which correspond to the dynamics of this species in East and South-East Serbia and only to the autumn population in West Serbia (Petrović et al, 1955; Petrović K., 1955).

In contrast to the other detected species which were female dominant, *Haemaphysalis sulcata* showed male prevalence. Among the *Haemaphysalis sulcata* females, most were unfed, while gravid specimens were not found at all.

Adult forms of *Haemaphysalis punctata* were encountered in the period March-October in the investigated area. Only in 1988 was this species detected in November in the territory of East Serbia. This species was predominant in 1988 (16.79%) and showed the least abundance in 1984 (7.67%) in this area, while in West Serbia it was more abundant in 1990 (15.89%) in comparison with 1989 (14.22%). This species had the spring maximum in April and the autumn maximum in September (1985, 1986, 1989, 1990) and in October (1984, 1987, 1988) in the area of East and South-East Serbia, therefore this species reached the maximum abundance twice: in April and October in the period 1984-1990. Furthermore, this species was predominant in April and September in the area of West Serbia.

The sex ratio in *Haemaphysalis punctata* showed female prevalence (60.61%) in the area of East and South-East Serbia and also in West Serbia (71.57%). A greater number of females in comparison with males was also reported by Mišević et al.(1990) in North-East Serbia.

Concerning *Rhipicephalus bursa* we should stress its vectorial role as a causative agent of pyroplasmosis and hereditary infection with pyroplasmata. This species took the first place in 1984 (31.53%) regarding abundance and the second place within the period 1984-1990 (16.98) in East and South-East Serbia, while in West Serbia it took the fifth place within the period 1989-1990 (4.67%). The species was found in the investigated area from May to August except for two findings of this species in April 1986 and 1987. It reached a maximum in June throughout the investigated area, therefore we consider it is a summer tick species, as was also confirmed by other authors (Petrović Z. and Bordoški, 1955; Petrović Z. et al., 1955; Tovornikov, 1976; Petrović Z., 1979).

As for the sex ratio in *Rhipicephalus bursa*, females dominated in East and South-East Serbia (55.48%) while males were more numerous in West Serbia (67.95%).

The results of our investigation in the regions of East, South-East and West Serbia suggest a correlation between the population dynamics of ten tick species and temperature, relative humidity and precipitation. Low temperature, high humidity and the amount of precipitation are the most important macro-climatic factors in the life cycle of ticks, especially the species *Ixodes ricinus*.

Among the detected tick species there were many which had been shown by investigators to transmit various diseases of viral, bacterial and protozoan origin both to man and to domestic animals.

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#### KRPELJI (ACARINA, IXODOIDEA, IXODIDAE) SRBIJE: FAUNA I EKOLOGIJA

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#### SADRŽAJ

U radu su prikazani rezultati faunističko-ekoloških istraživanja krpelja na područjima istočne i jugoistočne Srbije u periodu 1984-1990 i na područjima zapadne Srbije u periodu 1989-1990.