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THE EFFECT OF MACROCLIMATIC FACTORS ON THE DYNAMICS OF TICK (ACARI: IXODIDAE) POPULATIONS IN EAST AND SOUTH-EAST SERBIA

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The paper presents the results of faunistic and ecological investigations concerning ticks in East and Southeast Serbia between 1984 - 1990. 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 population abundance of ticks.

Key words: tick, population, temperature, relative air humidity, precipitation

INTRODUCTION

Ixodid ticks are characterized by life cycles of different duration. During, the one-year cycle sesonal succesive change of parasitism is observed on animals of all mobile phases of ticks with a winter diapause only in one phase, i. e. for *Dermacentor marginatus* as adult ticks, for *Hyalomma detritum* - as nymphs. The two-year cycle differs by coincidence of seasons of mass parasitism with two phases (adults and nymphs) and heir hibernation (*Dermacentor andersoni*). In species with a three-year cycle (*Ixodes persulcatus, Ixodes ricinus*) the periods of mass parasitism of all the mobile phases coincides and all the mobile phases enter the winter diapause, so for the development of each of them one warm season is necessary. The cycle of development of the tick Ixodes ricinus in the north of its area lasts 4 years in connection with the winter diapause which takes place even in the egg phase. Overall, the termination of behavioural diapause by mating can result in the transfer of ticks from the spring to the autumn population and may make an important contribution to the maintenance of autumn populations in the relatively mild climate (Gray, 1982, 1987; Fourie and Horak, 1994).

The climatic factors, such as temperature, humidity and precipitation, usually vary throughout the year. Thus environmental conditions change seasonally and are characterized by differences in temperature or precipitation.

The change of seasons can have an influence on the distribution of diseases and may cause them to appear periodically. The seasonal character is expressed especially by the appearance of arthropod-borne parasitoses, primarily because the population densities of vectors or intermediate hosts vary throughout the year (Schulze et al., 1986; Ouhelli and Schein, 1988; Mehilhorn, 1988; Petri et al., 1988; Genchi et al., 1994; Acici et al., 1994; Duffy and Campbell, 1994; Lord, 1995).

Therefore, the effects of environmental factors (temperature, relative air humidity and precipitations) on tick populations is significant due to the fact that those arthropods spend a part of their life cycle within that environment (Milutinović, 1992; Spickett, 1994; Milutinović et al., 1995 c).

Our investigations covered the effects of the mentioned ecological factors under which these heamatophagous arthropods breed and multiply.

MATERIALS AND METHODS

The procedure for collecting ticks, the method of proccesing them and the determination of tick species have been described in earlier papers (Milutinović et. al., 1987; Miščević et al., 1989).

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

RESULTS

A very important place in the ecological study of tickes is occupied by the dynamics of their populations, as dependent on the temperature, relative air humidity and amount of precipitations. In the present work we have concentrated on the possible correlation of the mentioned factors and the abundance of the detected tick species. Inside the investigated region nine tick species were detected namely: *Ixodes ricinus, Dermacentor marginatus, Haemaphysalis punctata, Haemaphysalis sulcata, Haemaphysalis inermis, Rhipicephalus bursa, Rhipicephalus sanguineus, Boophilus calcaratus, Hyalomma savignyi.*

A systematic investigation of the ticks was carried out at 30 places in East and Southeast Serbia (The areas of Zaječar, Boljevac, Knjaževac, Kalna, Svrljig, Niš, Bela Palanka and Pirot). A map of these regions may be found in a previous paper (Milutinović et al., 1995 a).

In the follow up of the population dynamics of the nine species in relation to temperature, relative air humidity and amount of precipitations, we considered the monthly means of the mentioned macroclimatic factors for a seven - year period (Figure 1 and 2).

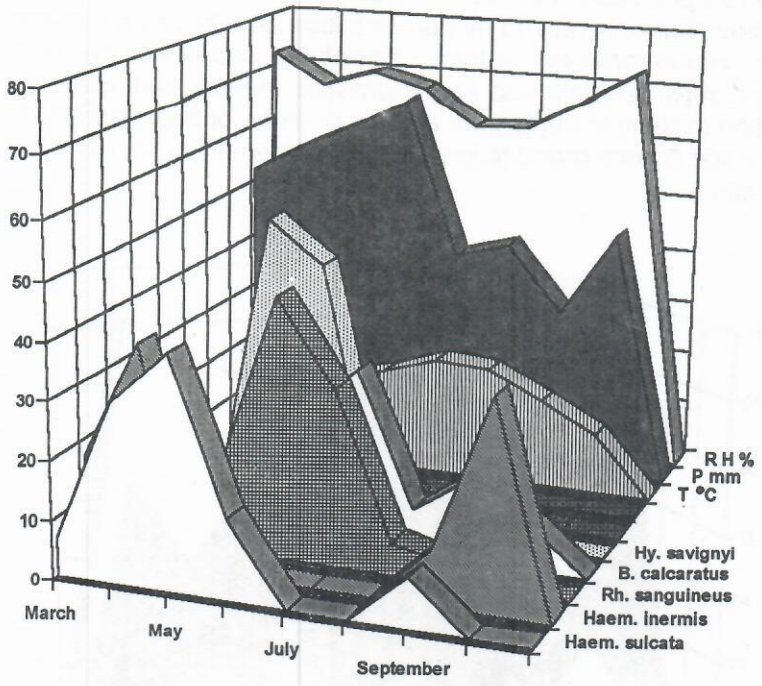

Figure 1. Population dynamics of four tick species in relation to temperature, relative humidity and precipitations in the regions of East and South - East Serbia between 1984 - 1990.

Tick populations were monitored from March to October. It was noted that the increase of abundance commenced in March for five species *Ixodes ricinus, Dermacentor marginatus* and three species of the genus Haemaphysalis - namely, punctata, sulcata and inermis at the temperature of 6.15^0, 73% relative humidity and 52 mm precipitation. Three species *Dermacentor marginatus, Haemaphysalis punctata* and *Haemaphysalis inermis*) expressed their maxima in April (T-12^{0}C, RH -67%), i. e. in early spring at the commencement of the rainy season (monthly mean precipitations - 57 mm). The most extensive precipitations were recorded from mid - May to mid - June when a period with little rain until the end of summer started. Thus May at the temperature of 16^{0}C, 70% relative humidity and 62 mm precipitation, was the month of the population maximum for species which require greater relative humidity - *Ixodes ricinus, Haemaphysalis sulcata* and *Hyalomma savignyi.* June was marked by two species of the genus *Rhipicephalus* namely-*bursa* and *sanguineus* at the temperature about 19^{0}C, 67% relative humidity and about 67 mm precipitation. The species *Boophilus calcaratus* was the only which

exhibited its population maximmum in July at the temperature of about 22^0 C, 62% relative humidity and 40 mm precipitation. Six species (*Dermacentor marginatus, Haemaphysalis sulcata, Boophilus calcaratus, Ixodes ricinus, Haemaphysalis punctata and Haemaphysalis inermis* had their the autumn population maxima in September at a temperature of about 16^{0}C, 67% relative humidity and 30 mm precipitation, and in October (T - 12^{0}C, RH - 73%, 46 mm precipitation).

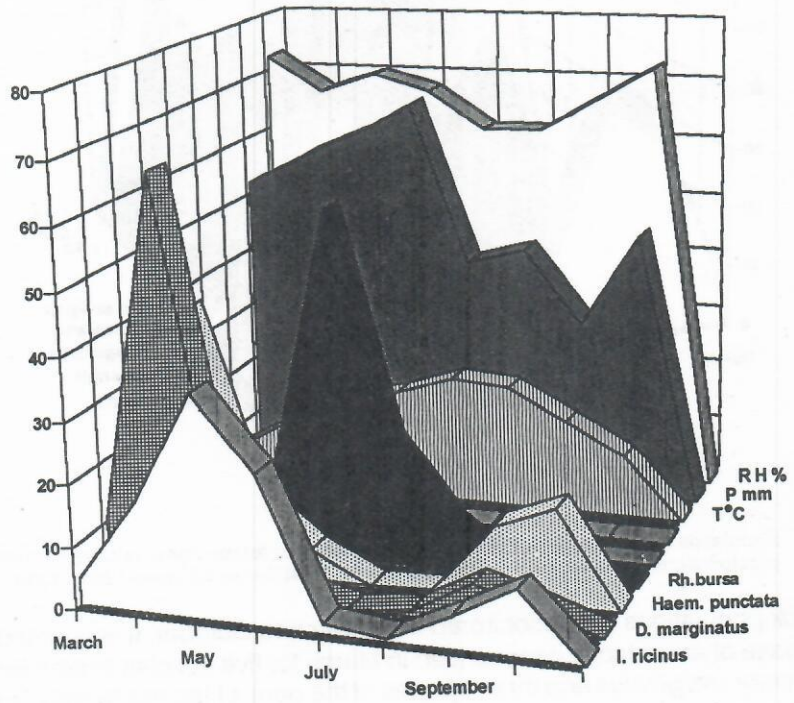

Figure 2. Population dynamics of five tick species in relation to temperature, relative humidity and precipitations in the regions of East and South - East Serbia between 1984-1990.

DISCUSSION

The study of environmental factors (temperature, relative humidity and precipitations) in terms of their respective effect on dynamics of tick populations indicated the existence of spring, summer and autumn species, as well as those species with two generations within a year. Generally hard ticks were more abundant in spring and least in October. Thus Rahbari (1994) claimed that the considerable interchange between spring and autumn tick populations was attributed mainly to favourable for the conditions. A cold winter helps the rise of

tick numbers during spring whereas a hot summer favours the peak in October. These findings were similar to those described by Osman et al. (1982) and Guglielmonf et al. (1990).

Ixodes ricinus population dynamics is known for its two maxima a year - in spring and in autumn, i. e. that it exhibits two generations maturing yearly. It was observed that it first appears in March at 6.15^{0}C and 70% relative humidity. Following the rise of temperature and decrease of relative humidity the population dropped sudden suddenly by the beginning of summer. This species reached the autumn maximum in October at 12^{0}C temperature and 73% relative humidity. Throughout the period of investigation precipitations were most extensive from mid - June, which was the starting point of a period with not much rain until the end of summer. Thus the species Ixodes ricinus which favoured high humidity attained its maximal abundance in the May - June interval to drop suddenly by the beginning of summer. By the beginning of autumn, however, and with a rainy season in October there was another maximum of this species.

Our results for *Ixodes ricinus,* i. e. the dependence of its dynamics on temperature, relative humidity and precipitations, confirm those of other authors. Thus, Cvjetanović (1956) claimed that the limiting temperature for activity of this species falls between 7 and 10^{0}C. To a degree such a claim coincides with our results. Moreover, Muftić (1965) provided data for Norhwest Bosnia that covered the activity and intensity of *Ixodidae* appearance, in relation to the combined effects of mean temperature, relative air humidity and amount of precipitations. He reported that more abundant populations with the most powerful activity appeared at temperatures ranging from 7 to 16^0 C and 79-98% relative humidity. Babenko (1974) maintained that extreme temperatures represent a limitation to the activity of *Ixodes ricinus* and *Ixodes persulcatus,* while Vansulin et al., (1981) established that the seasonal dynamics of tick population density is only slightly dependent on the temperature but much more so on the amount of precipitations and number of rainy days. Effects of the mentioned macroclimatic factors on the species Ixodes ricinus were revealed also by other authors (Milutinović et al., 1987; Miščević et al., 1989; Rich et al., 1995; Aydin and Tinar, 1994; Milutinović, 1995 a; Milutinović et al., 1995 b; Kulišić et al., 1995). However, as opposed to these results, based on winter flagging experiments on Long Island, Duffy and Campbell (1944) pointed out that adult *Ixodes species* have an apparent threshold of questing activity at 4^0 C. This threshold should be inocorporated into public education efforts because the public may be at risk of contracting Lyme diseasy any time during the winter when temperatures exceed 4^{0}C.

The dynamics of the species *Dermacentor marginatus* shows two-phase seasonal fluctuation: in spring and in autumn. The species was found in the investigated area from March till October. The spring peak was in April at 12^0 C, 67 mm precipitation and the autumn one in September at about 16^{0}C and 67% relative humidity which correspond to the dynamics of this species at Valtice (Černy et al., 1982), some biocenoses in Croatia and Slovenia (Ropac and Stojanović, 1986), in Poland (Szymanski, 1987) and in Northeast Serbia (Miščević et al., 1990). Moreover, by comparing the abundance analysis results of this

species with the values of the mentioned environmental factors recorded in West Serbia (Milutinović, 1992) it has been ascertained that macroclimatic factors have significant effects on the dynamics of the tick populations. Thus, summingug the seasonal activity of this species, it can be said that, similarly to other broadly distributed *Ixodidae* representatives (e.g. *Ixodes ricinus*), it shows geographical variability (Szymanski, 1987).

Haemaphysalis punctata reached its maximum in April and in the September - October interval under the same temperature, relative humidity and precipitation as *Dermacentor marginatus*. Our results confirmed those of Muftić (1965) for Northwest Bosnia, Tovornik (1980) for the eastem part of the island of Brač, Milutinović et al. (1987) for Northeast Serbia, Milutinović et al. (1989) for East and Southeast Serbia and Miščević et. al. (1989) for Northeast Serbia.

Concerning the species *Rhipicephalus bursa,* it should be pointed out that it was found in the investigated area from May till August with maximal abundance in June and thus it is a summer tick species, as was also claimed by other authors (Petrović et al., 1955 b; Petrović, 1979; Tovornik, 1980; Rivosecchi et al., 1980; Milutinović et al., 1989; Aydin and Tinar, 1994; Kulišić, 1995).

Adults forms of *Boophilus calcaratus* were encountered in the April - October interval with a maximum in July. The species was found by Petrović et al.(1955 a) in the coastal parts of Montenegro during May and September, Petrović et al. (1955 b) in the region of Ključ in spring, summer and autumn and Petrović et al. (1957) in the region of the Danube from April till November with an increase in abundance in May and maximal abundance in the April-Septembar interval. Milutinović (1955 d) also pointed out the seasonal dynamics of this species in the territory of Serbia.

The species *Haemaphysalis inermis* was found in March, April, September and October, while *Hyalomma savignyi* occurred during May and June with maximal abundance in May at the same temperature, relative humidity and precipitation as *Ixodes ricinus* in the investigated period. *Haemaphysalis inermis* was also recorded by Petrović et al. (1955 a) in the continental parts of Montenegro during May and *Hyalomma savignyi* in the coastal parts of this Montenegro republic during May and September. Furthemore, in the region of Ključ Petrović et al. (1955 b) marked *Haemaphysalis inermis* as an autumn - winter species and *Hyalomma savignyi* as a predominantly winter species, but with considerable abundance during May and June. Otherwise, Delić et al. (1958) suggested that the difference in tick fauna between Bosnia and Herzegovina was the result of effects of temperature and precipitations. The spring, summer and early autumn tick fauna in Bosnia (the species of genera *Ixodes, Haemaphysalis, Dermacentor*) correspond to tick fauna of late autumn and winter in Herzegovina (the species *Rhipicephalus bursa* and *Hyalomma savignyi*).

The results obtained in the investigated area suggest a correlation between monthly mean temperatures, relative air humidity and precipitations and the abundance of nine tick species.

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UTICAJ MAKROKLIMATSKIH FAKTORA NA DINAMIKU POPULACIJE KRPELJA (ACARI: IXODIDAE) U ISTOČNOJ I JUGOISTOČNOJ SRBIJI

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SADRŽAJ

Rezultati naših istraživanja na područjima istočne i jugoistočne Srbije u periodu 1984 - 1990. godina ukazuju na korelaciju između dinamike populacije devet vrsta krpelja i temperature, relativne vlažnosti vazduha i količine padavina. Niska temperatura, visoka vlažnost i količina padavina su najsnažniji makroklimatski faktori u životnom ciklusu krpelja, posebno vrste Ixodes rixinus.