RELATIONSHIPS BETWEEN CLIMATE AND VERTICAL POSITION OF *RHIPICEPHALUS SANGUINEUS* AND *R. BURSA* (IXODIDAE) UNDER NATURAL CONDITIONS.

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TICKS
CLIMATE
POSITION IN VEGETATION

SUMMARY : Adult tick climbing responses to climate, under different canopy conditions, are presented for the species *Rhipicephalus sanguineus* and *R. bursa*, under natural conditions in the Ebro mid valley (North-east of Spain), in the time period of their normal activity. The only factors that effectively modulate position are temperature and sun intensity, with relative humidity having a minor effect when canopy conditions allow a low atmospheric saturation deficit.

TIQUES
CLIMAT
POSITION DANS LA VÉGÉTATION

RÉSUMÉ : Cet article présente le résultat de la montée des tiques en réponse au climat sous des vo-tes végétales de conditions différentes, pour les espèces *Rhipicephalus sanguineus* et *R. bursa* dans les conditions naturelles de la vallée moyenne de l'Ebre (Nord Est de l'Espagne), et au cours de leur période d'activité normale. Les seuls facteurs qui modifient effectivement leur position sont la température et l'intensité du soleil, l'humidité relative ayant un effet mineur quand les conditions de la vo-te végétale permettent un déficit de saturation atmosphérique bas.

INTRODUCTION

Some investigations (SONENSHINE, 1963 ; NOSEK, 1977 ; CAMIN & DRENNER, 1978 ; BELOZEROV, 1982) have demonstrated that microclimate is one of the factors responsible for tick vertical movements into vegetation. This pattern of vertical migration is a very important feature to know the month or season at which risk of parasitation already exists. When the active tick stages are located at the top of vegetation, they are in optimal conditions for attaching hosts.

It is known that vegetal canopy modulates the microclimate that exists at the soil level, influencing both tick activity and survival. In such a way, laboratory investigations on tick vertical movements display only approximate data on the physiology of ticks, while field studies allow to an in-depth study of tick responses to climate and vegetation. This paper presents the results of our investigations of tick climbing responses to climate, under different canopy conditions.

MATERIAL AND METHODS

Unfed adults of both *R. sanguineus* and *R. bursa* were used for experiments. The method used for estimating tick activity in vegetation was that of GRAY (1981, 1982), with some modifications. Twenty-five unfed ticks were placed inside rigid plastic tubes, 50 cm long and with an inner diameter of 1.5 cm. Tubes were divided in 10 segments, segment 10 being the topmost. The tubes were placed in the vegetation and sealed at both ends with cotton wool. The experiment was conducted between April and June of 1987. In these months, the number of ticks at each segment was

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observed twice a day, at 0900 and 1500 hours. The percentage of ticks at the 4 topmost segments is here considered as indicative of tick activity, and it means for the percent of population under host active search.

Bearing in mind the modulating effect of vegetation on microclimate, a set of three habitats were evaluated for adult tick activity. All three habitats were located at the Ebro mid valley area (north-east of Spain, continental climate). Site EF has pasture less than 10 cm high, with very low canopy. Site EN has vegetative averaging 40-50 cm high. Finally, site EP displays pastures over 50 cm in height, with a very dense canopy. Climate parameters were measured at the same time as tick activity, and include temperature, relative humidity, and sun intensity. Climate was recorded at both soil level and 1.5 m above the soil.

A multiple regression analysis between climate variables and data for activity was undertaken. Data were converted to their moving average (window amplitude : four observations). Also, simple linear regressions were evaluated for each climate parameter and tick activity.

Results

R. sanguineus adults display high multiple correlation coefficients between the position observed in vegetation and the three climatic variables (table 1). Considering the habitat differences, temperature is the higher activity modulator in the EF site, following by the values for relative humidity and sun intensity. In this habitat, relative humidity has a negative effect in tick position inside the tubes, while temperature and sun intensity show a positive modulation on tick activity. The obtained data reflects such a main tendency. When temperature and light intensity raised and relative humidity falls, the number of ticks in the 4 top segments is highest (figure 1). In April, this parameter slowly elevates, reaching the 40-60 % of tick adults in June.

On the other hand, regression values for the sites EN and EP are very alike. The only factors that effectively modulate the position are temperature

Multiple regression	r	p
EF	0.743	0.0001
EN	0.660	0.0001
EP	0.630	0.0001
Single regression	**r**	**p**
EF (Aver. Temp)	0.721	0.0001
EF (Aver. RH)	-0.534	0.0001
EF (Light Intens)	0.465	0.0001
EN (Aver. Temp)	0.527	0.0001
EN (Aver. RH)	0.029	0.7633
EN (Light Intens)	-0.491	0.0001
EP (Aver. Temp)	0.487	0.0001
EP (Aver. RH)	-0.311	0.0600
EP (Light Intens)	-0.452	0.0001

TABLE 1 : correlation coefficient (r) and level of significance (p) between the position of *Rhipicephalus sanguineus* adults and climate variables in each of the three study sites. Both multiple regression and single linear regression are included.

and sun intensity, in a way positive and negative, respectively. Under the conditions of these two habitats, relative humidity has a minor effect. The position series of data for the EN site (figure 1) show the rise in the number of active ticks, being positively modulated by the temperature : the highest value in April is 50 %, in May 70 %, and in June 62 %. The same figures are observed for the EP site (figure 1), with a gradual increment in the number of active ticks to reach the maximum of 76 %.

In *R. bursa* (table 2), the correlation between temperature and the position of unfed adults was negative. Also, the modulating effect of relative humidity must be noted. In such a way, when temperature increases and relative humidity decreases, the number of active tick specimens is lower. These variations can be observed in figure 2 (EF and EP sites). Average position is lower in EF site in both May and June because of the scarce values of relative humidity observed at these months.

The absence of significant multiple correlation between the number of active ticks and climatic variables in the EN site must also be mentioned. Only a negative simple correlation between temperature and position has been observed. Observations (figure 2) show the decrease of active ticks when temperature and light intensity increase.

1

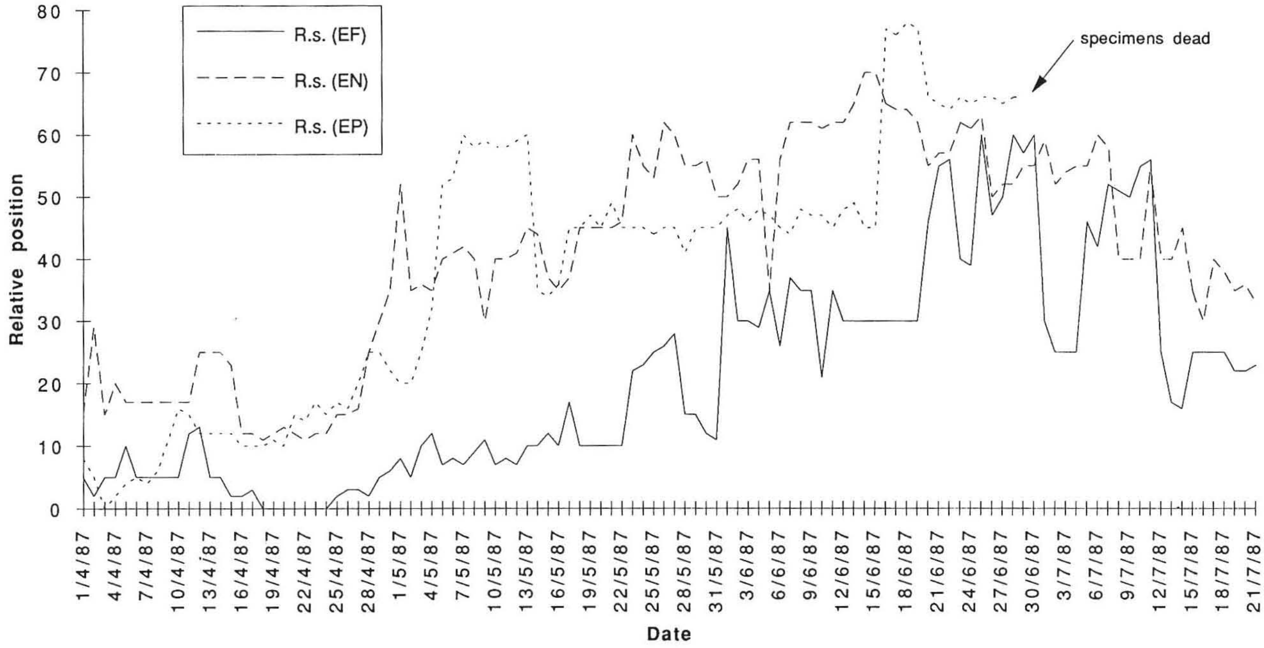

FIG. 1 : Relative position of *Rhipicephalus sanguineus* adults in the three study sites.

2

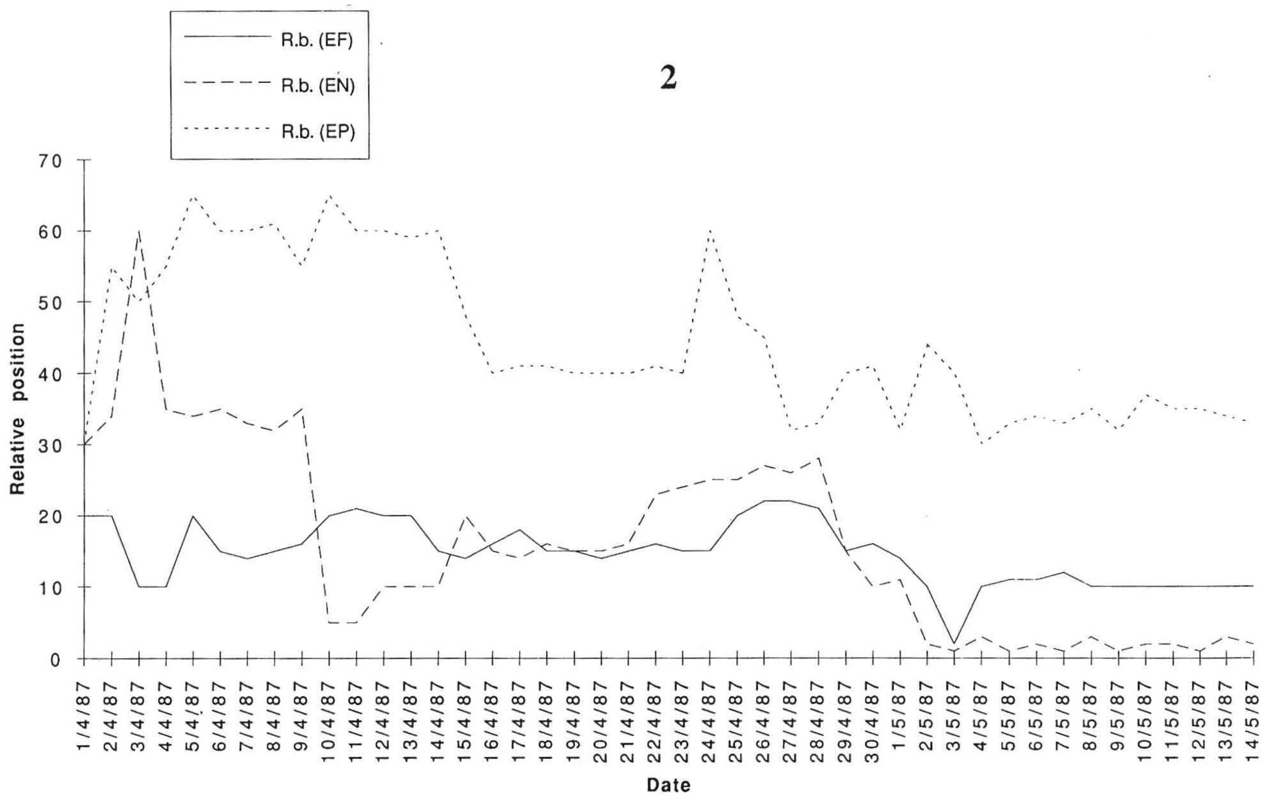

FIG. 2 : Relative position of *Rhipicephalus bursa* adults in the three study sites.

Multiple regression	r	p
EF	0.759	0.0001
EN	0.413	0.5620
EP	0.752	0.0001
Single regression	r	p
EF (Aver. Temp.)	-0.517	0.0006
EF (Aver. RH)	0.318	0.0456
EF (Light Intens.)	0.620	0.0001
EN (Aver. Temp)	-0.335	0.0263
EN (Aver. RH)	0.005	0.9756
EN (Light Intens.)	0.094	0.5442
EP (Aver. Temp)	-0.536	0.0002
EP (Aver. RH)	0.527	0.0002
EP (Light Intens.)	-0.584	0.0001

TABLE 2 : correlation coefficient (r) and level of significance (p) between the position of *Rhipicephalus bursa* adults and climate variables in each of the three study sites. Both multiple regression and single linear regression are included.

DISCUSSION

NORVAL (1977a, b) mentioned that the activity of *Amblyomma hebraeum* larvae did not correlate directly with climatic factors. However, activity in nymphal and adult stages is regulated by seasonal changes in climate. In such a way, activity in *A. hebraeum* adults is significantly dependent over the photoperiod, bearin temperature and relative humidity a lower influence. Moreover, relative humidity had a stronger influence in the summer, while the regulating actions of temperature are important in fall and winter.

On the other hand, SEMTNER & HAIR (1973) recognized that adults of *Amblyomma americanum* display an activity period in the summer onset, as a response to the combined action of increasing values of temperature and light intensity, together with high values for relative humidity. Similarly, GRAY (1982, 1985) mentioned that the combination of both temperature and photoperiod, is responsible for the activity in *Ixodes ricinus* larvae.

Our results suggest a similar type of regulation in activity of both *R. sanguineus* and *R. bursa* adult stages. However, the extremely low values in relative humidity observed in the study areas seems to have a more direct effect on the percentage of active ticks, in detriment of light intensity changes. In the same way, SHORT & NORVAL (1981) indicated that the intrinsic mechanism of tick activity regulation is a very ductile one, with a clear response to the changes in temperature and humidity. The photoperiod has a direct importance only at the end of the activity period, when days are progressively shorter.

Two questions must be reminded. The climatic factors responsible for tick activity regulation can have a different importance if different geographic areas are considered. Some authors (e.g. LANE *et al.*, 1985) demonstrated that the high number of positive correlations between tick activity and climatic variables, make it very difficult to recognize the factor or group of factors with regulation on the activity of ticks.

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