

Spatial and temporal variations in the commencement of seasonal activity in the Karoo paralysis tick, *Ixodes rubicundus*

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ABSTRACT

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Successful prophylaxis of paralysis, induced in small stock by feeding female *Ixodes rubicundus*, is dependent on the accurate determination of the commencement of seasonal activity by the tick. The commencement of this activity was recorded for 11 consecutive years on a farm in the south-western Free State, South Africa, and for shorter periods on other farms, some of these in regions with markedly colder climates. The colder the mean minimum atmospheric temperatures during the 2 months preceding the start of tick activity, the earlier it commenced. This could differ by 4 weeks from year to year on the same farm. In a region with a low effective temperature activity commenced between 3–8 weeks earlier than in a region with a higher effective temperature.

Keywords: *Ixodes rubicundus*, Karoo paralysis, seasonal activity, spatial and temporal variations, tick

INTRODUCTION

Karoo paralysis, caused by feeding female *Ixodes rubicundus* ticks, is of considerable economic importance in South Africa (Stampa 1959; Spickett & Heyne 1988; Fourie, Petney, Horak & De Jager 1989). Domestic stock and wild ungulates can be paralysed by this tick (Stampa 1959; Fourie & Horak 1987; Fourie *et al.* 1989; Fourie & Vrahimis 1989; Fourie, Horak & Van Zyl 1992). During 1987 small-stock losses attributable to paralysis caused by *I. rubicundus* were estimated at 36 000 animals (Spickett & Heyne 1988).

The chances of an animal becoming paralysed are related to the burden of female *I. rubicundus* it carries (Fourie *et al.* 1989, 1992). Since peak infestation densities on livestock are normally reached 4–6 weeks after the onset of seasonal activity of the tick (Fourie *et al.* 1989; Fourie & Kok 1992; Fourie, Kok, Horak & Van Zyl 1995), information on when activity actually commences is of paramount importance for effective control. Seasonal activity may commence as early as February and as late as April in different areas (Stampa & Du Toit 1958; Spickett & Heyne 1988; Fourie *et al.* 1989, 1995), making decisions on when to initiate prophylactic treatment difficult.

We surmised that marked differences occur in the onset of *I. rubicundus* activity between years with different prevailing temperatures in any particular region, and also between regions with conspicuous climatic differences. The study was conducted mainly in the south-western Free State, South Africa, where climatic influences on the seasonal activity of *I. rubicundus* have been investigated over an 11-year period.

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In addition, short-term observations in other areas, some of them markedly different in climate, were made to determine the extent of differences between regions.

MATERIALS AND METHODS

The study was conducted on the farm "Preezfontein" which is situated 10 km from the town Fauresmith (29°46'S; 25°19'E) in the south-western Free State. A fenced camp on the farm, encompassing 190 ha of vegetation typical of the region, was selected for this study.

Two methods were used to determine the commencement of seasonal activity of adult *I. rubicundus*: ticks were observed on hosts and on the vegetation. Small stock (sheep or Angora goats) were kept in the camp and examined visually for the presence of *I. rubicundus* at approximately weekly intervals during March and April (1985–1995). The numbers of animals examined varied but were usually not less than ten. In addition, grasses in the vicinity were examined for questing adult ticks from 1990 to 1995, as described by Fourie, Kok & Van Zyl (1991). Personal observations have shown that vertical migration by adult *I. rubicundus* coincides with livestock becoming infested. For each year of the study the earliest date on which ticks were observed on livestock or questing on grasses was used for the purpose of analysis. Ticks were also collected weekly from Dorper sheep during February and March of 1991 and 1993 on three farms in the Sutherland area of the Northern Cape Province, and from Merino sheep on a farm near New Bethesda, Eastern Cape Province, during 1990. During 1991 and 1993 observations were also made on Merino sheep and the vegetation on the farm "Langberg", which is situated near the town Jagersfontein, about 30 km north of "Preezfontein".

Weather data for the various regions were obtained from the South African Weather Bureau. The weather station at Fauresmith closed down during 1990, and in order to obtain data for the period 1991 to 1995, temperature data from Fauresmith and Bloemfontein for the period before 1990 were compared by means of a linear regression model. The relationship between mean monthly minimum temperatures at Fauresmith and Bloemfontein is calculated by means of the following equation:

$$y = 2,2194 + 0,885x$$

where

y = mean minimum temperature (°C) for a particular month at Fauresmith

x = mean minimum temperature (°C) for the same month at Bloemfontein ($r^2 = 0,987$)

In order to categorize the climate within each of the observation areas the effective temperatures (ET) for each locality were calculated according to the following formula (Stuckenberg 1969).

$$ET = \frac{8T + 14 AR}{AR + 8}$$

where

ET = effective temperature (°C)

T = mean annual temperature

AR = difference between the means of the warmest and coldest months

The ET values for the various regions were calculated from long-term temperature data published by the South African Weather Bureau (Weather Bureau 1986).

RESULTS

The dates on which *I. rubicundus* commenced seasonal activity in the various years or areas, the mean monthly minimum temperatures (January to March) and the ET values are summarized in Table 1. It is evident that there is a large degree of variation (c. 4 weeks) in the onset of seasonal activity of *I. rubicundus* within a specific area. In the Fauresmith area adult ticks commence seasonal activity at the earliest during the last week of March or at the latest during the third week of April. The earliest onset of seasonal activity (25 and 29 March) occurred after the 2 months (February and March of 1989 and of 1994) during which the lowest mean minimum temperatures were recorded compared to the other years in which observations were made (Table 1). The converse is true for those years during which ticks became active late in April (1987 and 1988). The findings for Jagersfontein are similar to those of Fauresmith. In the Sutherland area the ticks became active either in the second half of February or early in March and at New Bethesda in early March (Table 1). The mean minimum temperatures for the 2 months preceding tick activity at Sutherland and at New Bethesda were lower than those at Fauresmith. The lower the ET value, the earlier in the year tick activity commenced (Table 1).

DISCUSSION

Ixodes rubicundus adults are active mainly during the winter, but the onset of seasonal activity may occur either during late summer or in autumn (Stampa 1959; Horak & Fourie 1992; Fourie *et al.* 1995). It is therefore reasonable to assume that temperature changes, and more specifically those affecting the minimum temperatures, which signify the approach of winter, will influence the onset of seasonal tick activity. The results obtained in this study strengthen this contention. From published results (Stampa 1959; Horak & Fourie 1992) and those recorded in this study, it is evident that in regions with an ET of around 14°C, ticks may become active as early as February. The higher the ET, the later the commencement of seasonal activity. The ET measures heat by defining

TABLE 1 Mean monthly minimum temperatures (January-March), effective temperature (ET) and date at which *Ixodes rubicundus* adults became active in various areas within its distribution range

\bar{x} minimum temperature (°C)						
Locality	Year	Jan.	Feb.	Mar.	ET °C	Date active
Fauresmith	1985	17,2	16,3	12,4	14,62	4 April
	1986	16,5	14,6	13,9		11 April
	1987	17,1	17,9	14,5		22 April
	1988	17,8	17,4	14,7		17 April
	1989	16,1	14,4	12,1		25 March
	1990	15,8	14,5	12,4		10 April
	1991	17,4	15,3	13,5		9 April
	1992	15,4	15,3	13,0		3 April
	1993	16,5	15,3	12,8		7 April
	1994	15,1	14,2	11,8		29 March
	1995	15,6	16,1	13,7		30 March
	Average	16,4	15,6	13,2		
New Bethesda	1990	12,8	10,8	9,9	14,19	7 March
Sutherland	1991	9,8	9,2	7,2	13,29	2 March
	1993	9,0	7,6	7,8		26 February
Jagersfontein	1991	17,4	15,3	13,5	14,62	9 April
	1993	16,5	15,3	12,8		7 April

a sliding scale which specifies temperatures at the beginning and the end of the warm season and these delimit the duration of that period. Consequently an increase in ET is associated with an increase in the proportion of a year with temperatures warmer than the ET (Stuckenberg 1969). An ET map for southern Africa has been drawn by Stuckenberg (1969).

When considering variations in the onset of tick activity within a specific region, it is important to note that different host species may be infested at different times (Fourie & Kok 1992). These variations are related to specific behavioural patterns and differences in the spatial distribution of the hosts within tick-infested habitats.

At those localities where ticks were collected only from hosts (New Bethesda and Sutherland), the ticks may actually have commenced seasonal activity earlier. Year to year variations in minimum temperatures will influence the onset of tick activity. Below average mean minimum temperatures in the 1 or 2 months preceding tick activity will result in earlier vertical migration of adult ticks. Variations of up to 3 weeks in the onset of seasonal activity of *I. rubicundus* at the Middelburg Agricultural College, have also been reported (Leonora Jordaan, unpublished research data 1984). According to Stampa & Du Toit (1958) commencement of adult *I. rubicundus* activity is delayed at lower altitudes. Presumably this delay is temperature related and is applicable to farming areas where there is considerable altitudinal variation between pastures (e.g. mountainous areas).

Early commencement in tick activity is usually also related to the early occurrence of tick paralysis, which can occur from February to as late as October (Stampa 1959; Spickett & Heyne 1988). At the study site near Fauresmith Angora goats first went down with paralysis during May and April of 1988 and 1989 respectively (Fourie *et al.* 1992), the same years in which seasonal activity was delayed and commenced early (Table 1). Because of these differences the commencement of chemical control against *I. rubicundus* should vary according to temperature variations between the various regions within the distribution range of the tick. For the cold Sutherland area treatment should take place towards the middle of February and for the warmer Fauresmith and Jagersfontein areas during the second week of April at the latest. Local variations, due to below average temperatures in the 2 months preceding tick activity, may occur and may necessitate earlier prophylactic treatment. There are also indications that periods of prolonged wet conditions during summer and early autumn may hasten nymphal ecdysis (Van

der Lingen 1995), and that this may also lead to earlier adult tick activity, even under average temperature conditions (L.J. Fourie, unpublished observations 1995). This observation requires further investigation.

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