Individual host variations in tick infestations of cattle in a resource-poor community

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ABSTRACT

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Relative resistance levels of cattle against tick infestations in the communal grazing area of Botshabelo in the south-eastern Free State were determined. The objective was to establish whether differences in resistance can be exploited to contribute to tick control methods used by small-scale farmers in resource-poor environments. Ten cows (*Bos taurus* crosses) between the ages of 18 months and four years were used and tick counts were conducted once a month over a period of 12 months to compare their total tick burdens. Tick burdens of the various animals were compared mutually as well as with the mean tick burden of the group as a whole. Tick numbers varied throughout the year on all individuals but some animals consistently tended to have either higher or lower numbers than the mean of the group. Tick burdens on cattle classified as having a relatively low resistance to tick infestations increased eleven-fold from January to June 1996 compared to a six-fold increase on cattle categorized as belonging to the high resistance group. Twenty-eight percent of the cattle in the total study group carried 50% of the ticks collected (60 079). It is recommended that farmers in the region visually assess *B. decoloratus* burdens, the most abundant tick species, and sell or cull the most susceptible animals first in their normal program of utilization of the animals. This should eventually result in the direct improvement of the overall tick resistance of their cattle herds.

Keywords: Cattle, host variation, infestation, resistance, ticks

INTRODUCTION

The detrimental effects of ticks on their hosts have been extensively discussed. Tick feeding can reduce live-mass gain, milk yield and hide quality, transmit certain infectious diseases and provide portals of entry for secondary bacterial infections and for myiasis inducing larvae (Sutherst 1981; Norval, Sutherst, Kurki, Gibson & Kerr 1988). Results from a study on ticks infesting cattle in the small-scale peri-urban farming communities at Botshabelo and Thaba Nchu in the Free State Province, have indicated that high tick burdens, especially of *Boophilus decoloratus,* occur almost throughout the year (Dreyer 1997). Tick control methods employed by the small-scale farmers in the areas include the use of commercial acaricides (pour-on, hand spray and tick grease), the application of used engine-oil as an acaricide, deticking by hand and the use of chickens as predators of cattle ticks (Dreyer 1997).

A control method that can potentially be practised by these livestock farmers is the selection of resistant hosts with either an innate or acquired resistance to tick infestations, or both. Many studies have confirmed the fact that certain cattle, such as the *Bos indicus* breeds, are more resistant to ticks than others due to an innate resistance (Bourne, Sutherst, Sutherland, Maywald & Stegeman 1988; Spickett, De Klerk, Enslin & Scholtz 1989; Fivaz, De Waal & Lander 1992; Fourie, Kok & Heyne 1996). Host resistance can regulate *Boophilus microplus* populations in the field (Su-

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therst, Wharton, Cook, Sutherland & Bourne 1979). When resistant cattle grazed paddocks artificially infested with *Rhipicephalus appendiculatus* for over 12 months, the tick populations were greatly diminished when they were compared to those in similarly infested paddocks grazed by susceptible hosts (Cunningham 1981). It has also been shown that some animals within a herd can consistently carry fewer ticks than others (De Castro 1986) because of a stronger acquired resistance. Ticks are usually overdispersed within a host population, consequently most ticks occur on only a few hosts while the majority of hosts harbour only a small number of ticks (Petney, Van Ark & Spickett 1990). Consistently above or below average tick burdens on hosts can therefore be indicative of a relatively low or high level of resistance to infestation.

The objective of this study was to determine the differences in tick infestation levels on individual cattle maintained under traditional management systems in the Botshabelo-area, and to relate these observations to the relative resistance levels of the host animals.

MATERIALS AND METHODS

The study took place over a 12 month period from September 1995 to August 1996 on the western communal grazing area of Botshabelo, which is situated 55 km east of Bloemfontein in the Free State Province of South Africa. These cattle are kept under small-scale farming conditions in which farmers own an average of 6,96 (± 0,7) head of cattle. During the day the cattle graze in a mixed herd on the communal pastures. In the evenings cattle are collected and the lactating cows milked. At night they are kept in enclosures in the backyards of their owners (Dreyer 1997).

The cattle in the area are all of mixed-breed origin comprising predominantly of Friesian-crosses. A total of ten female animals between 18 months and 4 years of age were chosen. Age determination was based on dentition (West 1988). Animals were matched for age and physiological status and only *Bos taurus* crosses were selected. The cattle were ear-tagged for individual identification and had never received any vaccinations or been treated with any anthelmintics or commercial acaricides.

The survey cattle were assembled once a month for half-body tick counts in order to compare the total tick burdens of the various individuals. For this purpose animals were individually restrained in a mobile handling facility consisting of a race, crush and neck clamp and their right sides were carefully examined visually and by palpation of the skin for the presence of ticks. Adult male and female ticks in all stages of engorgement were removed with forceps and placed in labeled plastic containers, filled with 70% alcohol, for later identification and quantification. The data for individual animals were recorded separately. The half-body tick counts were doubled to obtain the total tick burdens of the animals.

The cows were classified according to the number of ticks they carried each month. The tick burdens of the various cows were compared with one another and with the mean tick burden of the group ($n = 10$). Each animal was classified as possessing either high resistance (HR), indicating those that consistently carried few ticks, or low resistance (LR) for those of which the tick counts were consistently high. Subsequently, the mean tick burden of the two most susceptible animals (LR) was compared to the mean burden of the group ($n = 10$) and to the mean burden of the two most resistant animals (HR) to demonstrate their relationship in overall tick population dynamics.

The data sets were statistically analyzed using appropriate analysis of variance techniques. Logarithmic transformations (logarithms of base 10) of the tick numbers were carried out in order to achieve normality and equality of variances. A one-way analysis of variance (ANOVA) (Barnard, Gilbert & Mc Gregor 1993) was used to determine whether there was any significant difference in tick burdens, and thus relative tick resistance, between the different individuals. This was followed by a multiple range procedure, the least significant difference (LSD) test, to identify those individuals with the higher or lower burdens causing the variance (Zar 1974). A significance level of $P \leq 0,05$ was used throughout.

RESULTS

The tick numbers varied throughout the year on all individuals, but some consistently tended to have either higher or lower numbers compared to the mean value for the group (Table 1). Individuals in order of decreasing tick burdens were: numbers 1, 5, 3, 2, 6, 4, 10, 7, 9 and 8. Relative to the mean monthly tick burdens of the group ($n = 10$) the first individual (no. 1) harboured significantly ($P = 0,03$) higher burdens, and thus exhibited a low tick resistance throughout the year. The total tick burden of this animal was 1,86 times higher than the mean total tick burden of the group, and 5,44 times higher than that of the most resistant individual (no. 8). The monthly tick burden of no. 1 was higher than the mean monthly tick burden of the group for the total 12 months of the study. In contrast, individuals 7, 8 and 9 had significantly ($P = 0,03$) lower mean monthly tick burdens than the rest of the group and a lower mean total tick burden than that of the group ($n = 10$), which indicate relatively high resistance levels to ticks. The tick burden on no. 8 was 2,92 times lower than the mean tick burden of the group. The monthly burdens on the

TABLE 1 Monthly tick numbers and mean tick numbers on individual cattle (n = 10) in comparison with one another and with the mean tick count of the group (n = 10)

Months	Animal numbers and their total tick counts									tick count	Mean monthly
	1	2	3	4	5	6	7	8	9	10	$\bar{x}$ ± S.E.
Sept.	141	57	45	73	103	27	128	46	98	22	74,0 ± 13,2
Oct.	340	109	194	179	164	118	284	128	159	197	187,2 ± 23,3
Nov.	256	109	331	443	200	217	377	51	146	370	250,0 ± 40,6
Dec.	416	120	196	120	423	229	306	143	119	283	235,5 ± 37,3
Jan.	183	222	221	240	262	153	154	110	136	38	179,3 ± 22,1
Feb.	819	624	874	530	637	459	175	154	297	252	473,7 ± 85,7
Mar.	1 243	695	1 023	1 156	2 768	788	408	237	225	1 520	1 006,3 ± 39,2
Apr.	1 908	1 120	572	694	960	272	359	130	268	538	682,1 ± 68,5
May	2 822	1 175	1 560	625	1 038	1 166	387	239	876	614	1 050,2 ± 34,0
Jun.	2 216	862	3661	235	2 919	1 309	631	774	717	510	1 383,4 ± 64,8
Jul.	764	240	546	723	349	284	333	18	452	378	408,7 ± 70,9
Aug.	91	96	177	42	63	89	72	28	65	42	77,5 ± 13,3
$\bar{x}$ ± S.E.	933,3 ± 265,1[a]	452,4 ± 121,6	783,3 ± 291,0	421,7 ± 97,0	823,8 ± 287,3	425,9 ± 124,0	301,2 ± 44,9[b]	171,5 ± 58,7[b]	296,5 ± 74,6[b]	397,0 ± 117,2	500,7 ± 57,3

[a] Value significantly higher than rest of group and mean value for group
[b] Values significantly lower than rest of group and mean value of group

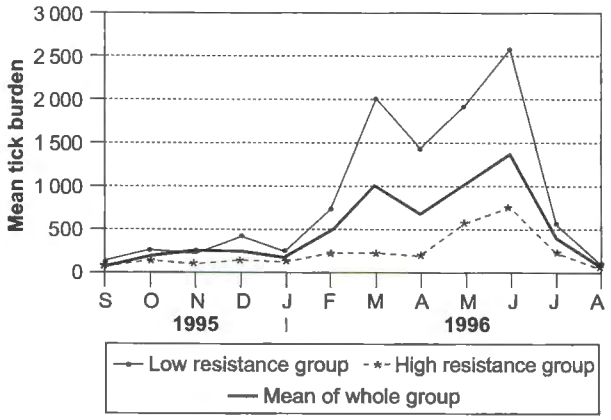

FIG. 1 Mean monthly counts of ticks on ten cattle in Botshabelo, to indicate variations in individual relative resistance [—•— low resistance group (n = 2); —*— high resistance group (n = 2); — mean of whole group (n =10)]

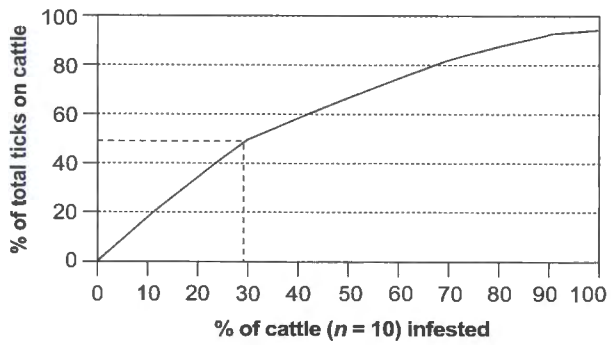

FIG. 2 The percentage of total ticks (——) on different percentages of cattle in the group (n = 10). Animals were arranged in order of decreasing tick numbers. The percentage of the herd carrying 50% of the total number of ticks is indicated by the broken line (– – –)

three individuals (7, 8 and 9) were lower than the mean monthly tick burden for 8, 12 and 10 months of the year, respectively. These HR cattle showed little seasonal variation in tick numbers throughout the year, compared to the LR group consisting of individuals 1 and 5.

The mean monthly tick numbers on individuals 1 and 5 were used to illustrate the tick burdens on LR cattle and the mean monthly tick burdens on nos 8 and 9 to demonstrate the burdens of HR cattle (Fig. 1) in comparison to the mean monthly tick burdens of the whole group (n = 10).

Pronounced seasonal variations in tick numbers on the LR cattle, with a peak in June 1996, were detected. There was an eleven-fold increase in tick burdens of the LR group from January to June 1996. The HR cattle had only a six-fold increase in tick numbers from January to June 1996. Differences in tick burdens among the other individuals were not significant.

These results indicate that certain animals consistently carried higher tick burdens than others. A plot of the percentage of cattle infected against the percentage of the total ticks counted, has shown that 28% of the cattle in the group (n = 10) carried 50% of the total burden of 60 079 ticks counted during the year (Fig. 2).

DISCUSSION

Certain individuals amongst the ten animals studied, carried consistently higher or lower tick burdens than the mean of the group. The HR cattle showed relatively small seasonal fluctuations in tick numbers, even during the months of high tick challenge, namely, May and June 1996. Seasonal variations in tick burdens are normal for all tick species. The variations observed in the tick burdens on the study group of cattle were possibly as a result of increased tick challenge resulting from an accumulation of free living stages associated with more favourable climate for their development. Another factor giving rise to seasonal variations in tick burdens could have been the changes in resistance levels of all the cows, caused by stress and poor nutrition during winter with a concurrent loss in resistance (De Castro 1986; Rechav & Hay 1992; Ørskov 1993).

Throughout the study period the animals in the HR group showed only a single small peak in abundance in June 1996, whereas there were more striking fluctuations in the tick counts of the two LR cattle which had a substantial peak in June 1996. This demonstrates that the LR group made a major contribution to the propagation of the field population of ticks. In contrast, the HR cattle would tend to limit tick multiplication (Bourne *et al.* 1988; Latif & Pegram 1992). The results from the present study compare well to those of a study on individual host resistance conducted in Kenya (Latif, Punyua, Nokoe & Capstick 1991) in which the seasonal increase in tick numbers on LR cattle showed an almost sevenfold increase in magnitude when tick challenge was high, whereas numbers on HR cattle showed little or no seasonal fluctuation and a twofold increase only.

The distribution of ticks within the group was such that 28% of the cattle (n = 10) carried 50% of the total tick population infesting the group. These findings are in accordance with results obtained in studies done by Kaiser, Sutherst & Bourne (1982) in southern Uganda, and Latif *et al.* (1991) in western Kenya. In both these studies about 30% of the cattle herd carried 50% of the total parasitic tick population. Individuals with relatively low resistance are responsible for much of the tick multiplication in the field (Latif *et al.* 1991). The culling of about 9–20% of the most susceptible animals in a herd would lead to an almost 50% reduction in the overall tick population on the animals in the herd (Latif 1984).

Tick resistance is better developed and more evident in certain cattle such as those belonging to *Bos indicus* breeds (Doube & Wharton 1980; Rechav & Kostrzewski 1991; Mattioli, Bah, Faye, Kora & Cassama 1993; Fourie *et al.* 1996). In Botshabelo, however, all cattle are of mixed-breed origin with predominantly *Bos taurus* bloodlines. The main function of these animals is milk production, and the cattle are kept in a specific traditional management system. Age, nutrition, hormone levels of the host, pregnancy and lactation can also influence natural or acquired immunity to ticks (Doube & Wharton 1980; Rechav 1992).

Boophilus decoloratus comprised 86,3% of the total of the 60 079 ticks collected during the present study (Dreyer 1997). Farmers in the Botshabelo area can be informed on tick species in their area, predilection sites and overdispersal. This will enable them to make visual assessments of tick burdens in order to identify animals with relatively low tick resistance, which carried notably larger tick numbers. Should such animals be sold or killed selectively, as part of the management programme of individual farmers, this would lead to a direct improvement of the overall resistance of their herds. Indirectly, this would also positively influence the tick resistance of the progeny, especially if bulls with resistant genes are introduced, since resistance has been shown to be heritable (Hewetson 1981; Dolan 1986). Less acaricide would then also be necessary to control ticks because the mean tick burdens will be lowered. A further important factor to be highlighted to the farmers, is that the selection for tick resistance and for milk production within a certain breed are not mutually exclusive (Hewetson 1981).

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