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RESISTANCE OF BRAHMAN AND SIMMENTALER CATTLE TO SOUTHERN AFRICAN TICKS

Y. RECHAV[1], J. DAUTH[2] and D. A. ELS[1]

ABSTRACT

RECHAV, Y., DAUTH, J. & ELS, D. A., 1990. Resistance of Brahman and Simmentaler cattle to Southern African ticks. *Onderstepoort Journal of Veterinary Research*, 57, 7–12 (1990)

Field collections of ticks from two breeds of cattle in the North Western Transvaal showed the common tick species to be *Rhipicephalus appendiculatus, Amblyomma hebraeum, Rhipicephalus evertsi evertsi* and *Hyalomma marginatum rufipes*. The number of these ticks was higher on Simmentaler than on Brahman cattle.

Correlation was found between the number of ticks on the cattle and their serum gamma globulin levels indicating an increase in the production of antibodies. Similar correlation was also found between the number of ticks on the cattle and the number of eosinophils in their blood. Resistance was probably acquired by the hosts and, it appears, to a higher degree in Brahman than in Simmentaler.

INTRODUCTION

Resistance of cattle to various species of ticks, a well known and documented phenomenon was recently reviewed by Wikel & Whelen (1986), Brown (1988) and Wikel (1988). The acquired resistance in cattle against the one-host cattle tick *Boophilus microplus* (Canestrini) was studied extensively in Australia and resulted in the development of resistant cattle which were introduced to the ranching community of Queensland (Waters, Round & Bond, 1982). Similar studies aimed at controlling *B. microplus* were also recently conducted in South-America (Oliveira & Alencar, 1987). Investigations directed towards the production of vaccines against *B. microplus* yielded promising results (Johnston, Kemp & Pearson, 1986; Kemp, Agbede, Johnston & Gough, 1986; Opdebeeck, Wong, Jackson & Dobson, 1988; Willadsen, McKenna & Riding, 1988). However, less information has been published on the acquired resistance of cattle to three-host ticks. Some American workers demonstrated that the three-host tick *Amblyomma americanum* was less abundant on Brahman than on Hereford animals (Strother, Burns & Smert, 1974; Garris, Stacey, Hair & McNew, 1979).

In Africa, two and three-host ticks are abundant on cattle. Very little is known about the resistance of Southern African cattle to the common and economically important species of ticks. A few reports from Africa indicate that European breeds of cattle tend to carry more ticks than zebu breeds (Bonsma 1944; Kaiser, Sutherst & Bourne, 1982; Latif, 1984; Rechav & Zeederberg, 1986; Rechav, 1987; Norval, Floyd & Kerr, 1988; Newson & Chiera, 1989). Information on the effect of ticks on South African cattle breeds and its effect on the meat industry, is thus incomplete.

The objectives of this study were: (a) to record the tick species and their seasonal prevalence in the study area; (b) to compare the density of each species on Brahman and Simmentaler cattle; and (c) to study in each of these breeds the relationship between the tick burden and various serum and blood parameters.

MATERIALS AND METHODS

Study area

The selected farm, "Naauwpoort", is situated in the north western part of the Waterberg mountains (24° 10′ S and 28° 20′ E) in the northern Transvaal. The study area consisted of 120 ha of natural grazing in the northern part of the farm.

Climate

The climate in the northern Transvaal consists of two seasons: a hot and wet summer (October to March) and a cool and dry winter (April to September). Weather conditions on the farm were recorded throughout the survey period, using a thermohygrograph[1]. Rainfall was recorded with a standard gauge. The mean maximum and minimum temperatures recorded at "Naauwpoort" during winter (July) were 20 °C and −4,5 °C and 37 and 14 °C respectively during summer (January and February).

Vegetation

Acocks (1975) defines the area in which the study area was situated as a Sour Bushveld type. It is an open savanna, dominated by tall trees of *Faurea saligna* and *Acacia caffra* with grass between the trees. In some parts where the soil is very shallow a mixed Bushveld dominated by *Combretum apiculatum* or a Sourish/mixed Bushveld in which *Acacia caffra* is abundant.

Fauna

The following game animals were found on the farm during the study period: kudu (*Tragelaphus strepsiceros*), bushbuck (*Tragelaphus scriptus*), common duiker (*Sylvicapra grimmia*), steenbok (*Raphicerus campestris*), caracal (*Felis caracal*) and bushpigs (*Potamochoerus porcus*). Small numbers of leopard, jackal and baboons were observed at "Naauwpoort" while many small mammals, mainly rodents, were reported to be present in the study area.

Livestock

All animals used during this study (3 Brahman and 3 Simmentaler) were part of a herd kept in the study area which had been exposed to ticks on the farm prior to the commencement of the survey. The same individual animals were used throughout the study. They were not treated with acaricides and were left exposed to natural conditions.

Removal of feeding ticks from hosts

The collections of ticks were carried out by a trained team. For the removal of ticks from the hosts heads, the animals were tethered with ropes to a wooden fence and their legs restrained. The ticks

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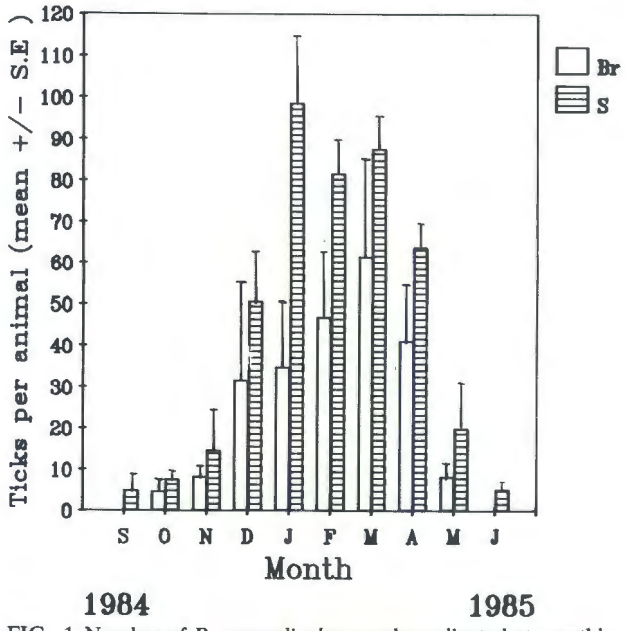

FIG. 1 Number of *R. appendiculatus* males collected at monthly intervals from Simmentaler (S) and Brahman (Br) cattle.

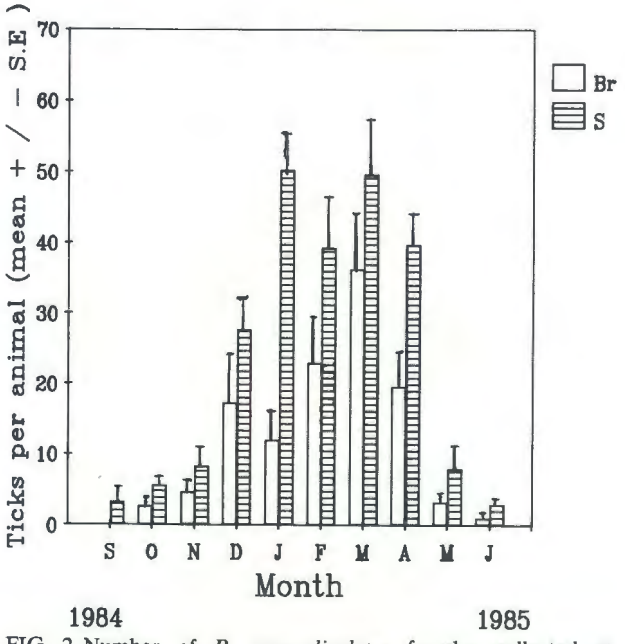

FIG. 2 Number of *R. appendiculatus* females collected at monthly intervals from Simmentaler (S) and Brahman (Br) cattle.

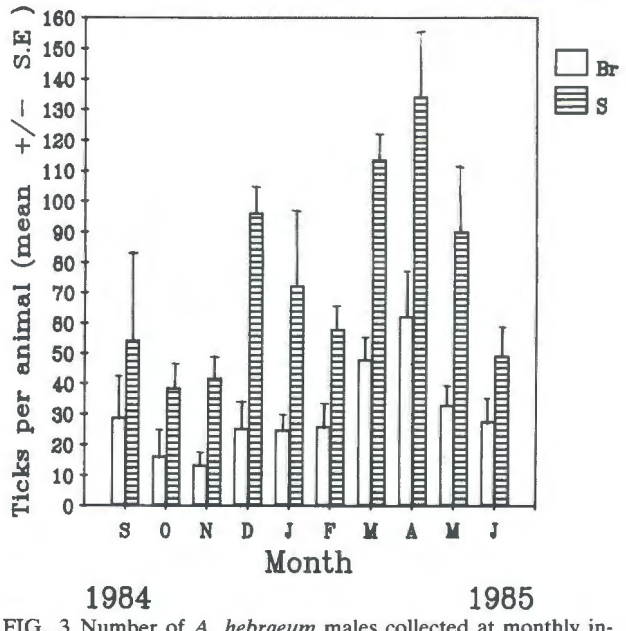

FIG. 3 Number of *A. hebraeum* males collected at monthly intervals from Simmentaler (S) and Brahman (Br) cattle.

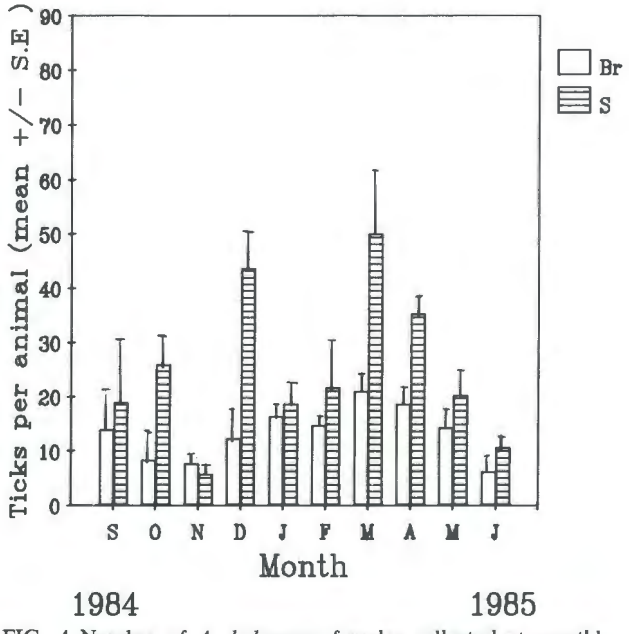

FIG. 4 Number of *A. hebraeum* females collected at monthly intervals from Simmentaler (S) and Brahman (Br) cattle.

removed from each animal were placed in 4 bottles, one each for ticks removed from the head, the back, the abdomen, legs and hooves, and one bottle for ticks removed from the perianal areas.

All adult ticks were removed from the hosts with the exception of *Boophilus decoloratus* Koch and *Rhipicephalus appendiculatus* Neumann, which were found in high numbers and were only sampled. *R. appendiculatus* (males and females) were collected only from a 10 cm^2 area on the ears while collections of *B. decoloratus* females were done from sampling areas, 10 cm^2 each, on the neck, back, shoulders and the belly area of the cattle.

Blood counts

Blood was collected from the jugular vein of each animal into sterile tubes which contained EDTA to prevent coagulation. The blood was kept in cooled containers and analysed in the laboratory. The methods used for counting red blood cells, determining total number of leukocytes, packed cell volume and hemoglobin were described previously by Rechav (1987). The red blood cell count (RCC) was performed with the standard hemocytometer technique by counting the red blood cells in 5 of the 25 center squares. Packed cell volume (PCV) was measured applying the microhematocrit technique, using capillary glass tubes of 75 mm in length and centrifugation for 7 min at 20 000 rpm. Hemoglobin concentration (Hb) was measured according to the cyanomethomoglobin method using a colorimeter. Differential leukocyte counts were made using blood smears which were stained with Wright's stain and examined microscopically under oil immersion (Rechav, Kuhn & Knight, 1980).

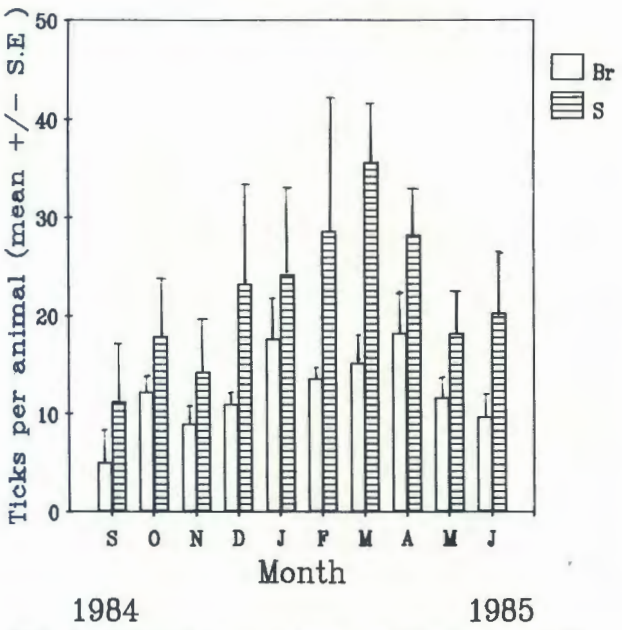

FIG. 5 Number of *R.e. evertsi* males collected at monthly intervals from Simmentaler (S) and Brahman (Br) cattle.

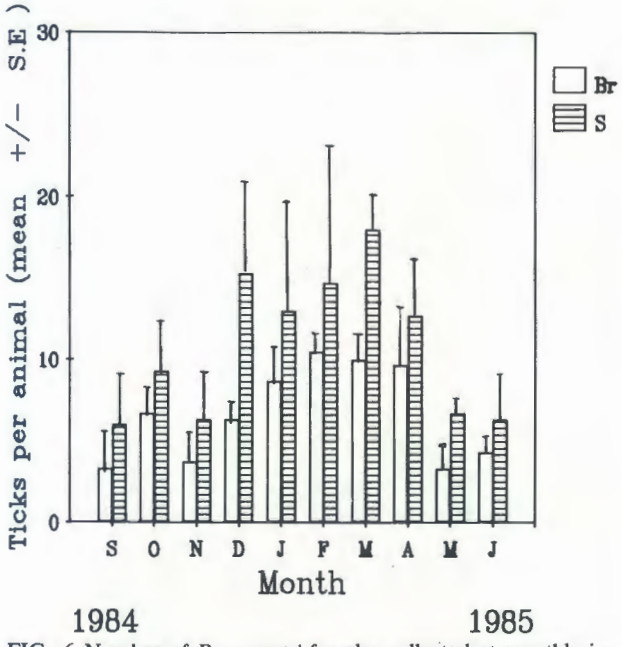

FIG. 6 Number of *R.e. evertsi* females collected at monthly intervals from Simmentaler (S) and Brahman (Br) cattle.

Total protein determination and serum electrophoresis

Serum samples obtained from additional blood which were allowed to clot were batched and used for the determination of total protein by means of the biuret rate method utilizing a discrete automated analyzer (ASTRA-8)[2].

Serum electrophoresis was done on Tital III Cellulose acetate membranes using a buffer with pH 8,6 and stained with Ponceau S[3]. For the quantitation of the different protein fractions the membranes were densitometrically scanned[4].

[2] Beckman Instruments, Brea, Ca, USA

[3] Helena Laboratories, Beaumont, TX, USA

[4] Beckman CDS-200, Beckman Instruments

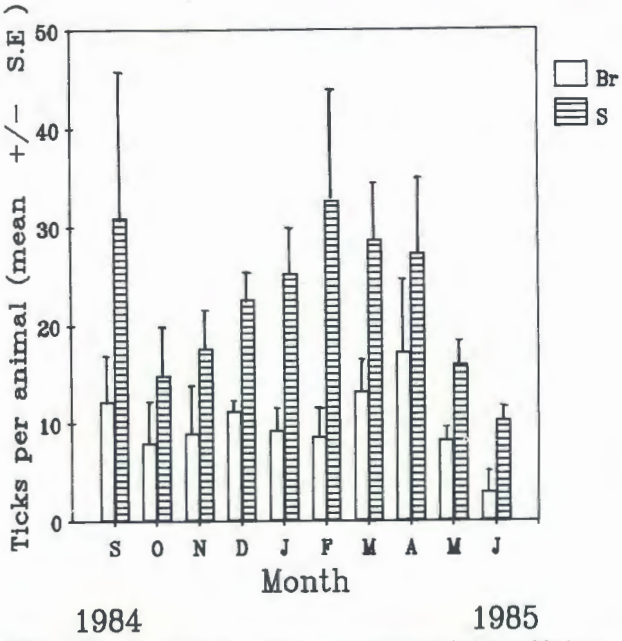

FIG. 7 Number of *H.m. rufipes* males collected at monthly intervals from Simmentaler (S) and Brahman (Br) cattle.

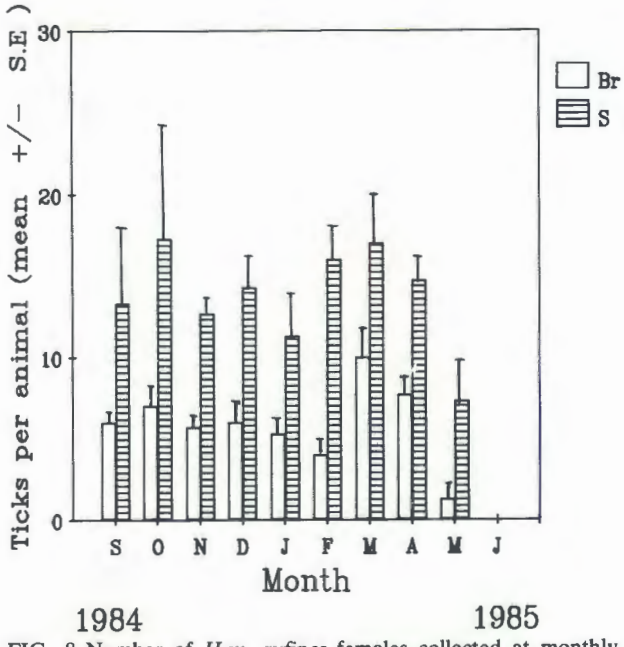

FIG. 8 Number of *H.m. rufipes* females collected at monthly intervals from Simmentaler (S) and Brahman (Br) cattle.

RESULTS

The results are presented as mean ± S.E. and discussed separately for each tick species. The student t-test was applied for analysing the data. *B. decolaratus* was more abundant on Simmentaler than on Brahman cattle (the data will be presented in a separate manuscript).

Brown-ear tick Rhipicephalus appendiculatus

Adults of *R. appendiculatus* demonstrated a clear pattern of seasonal prevalence on their hosts. The numbers of ticks of both sexes increased sharply on the two breeds during December, reached a peak in January and declined after April (Fig. 1 & 2).

From the time of their appearance in November and throughout the summer months the adults of

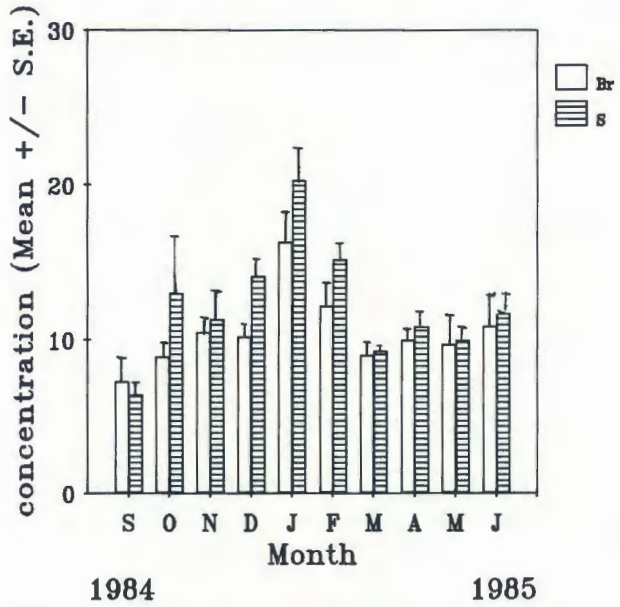

FIG. 9 Number of white blood cells in the blood of Simmentaler (S) and Brahman (Br) cattle exposed to tick infestation under field conditions.

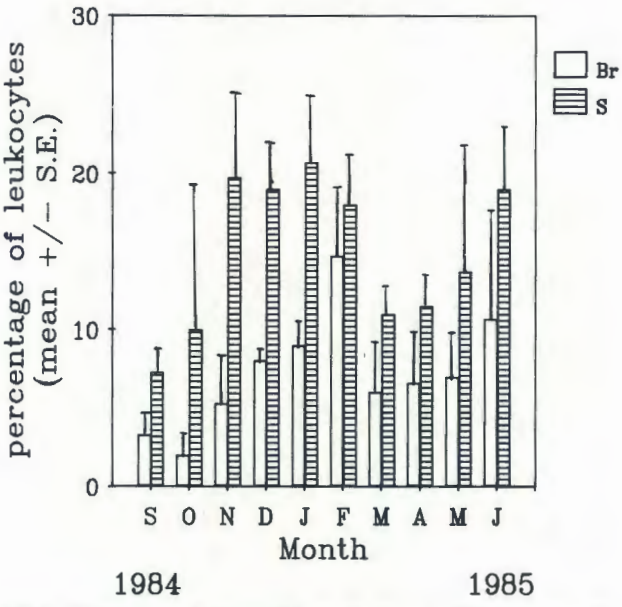

FIG. 10 Number of eosinophils in the blood of Simmentaler (S) and Brahman (Br) cattle exposed to tick infestation under field conditions.

R. appendiculatus were significantly (P<0,01) more abundant on Simmentaler than on Brahman.

Bont tick Amblyomma hebraeum

Field collections of *A. hebraeum* showed that although the adult ticks were found on cattle throughout the year, they were most abundant during summer (Fig. 3 & 4). The numbers of males and females of *A. hebraeum* were significantly (P<0,005) higher on Simmentaler than on Brahman cattle (Fig. 3 & 4).

Red-legged tick Rhipicephalus evertsi evertsi

Adults of *R.e. evertsi* were found on Simmentaler and Brahman cattle throughout the year but were more common during summer. More ticks were removed from Simmentaler than from Brahman. The difference was significant (P<0,01) for males (Fig. 5) and for females (Fig. 6).

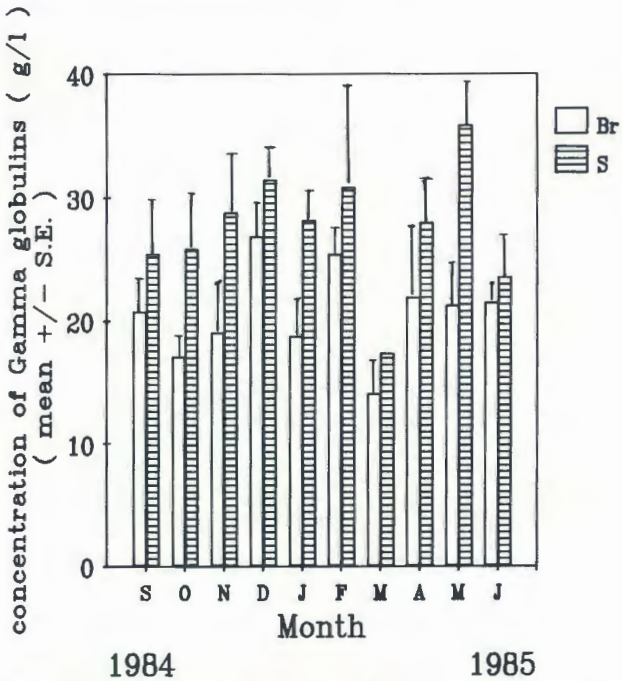

FIG. 11 Concentration of gamma globulins in the serum of Simmentaler (S) and Brahman (Br) cattle exposed to tick infestation under field conditions.

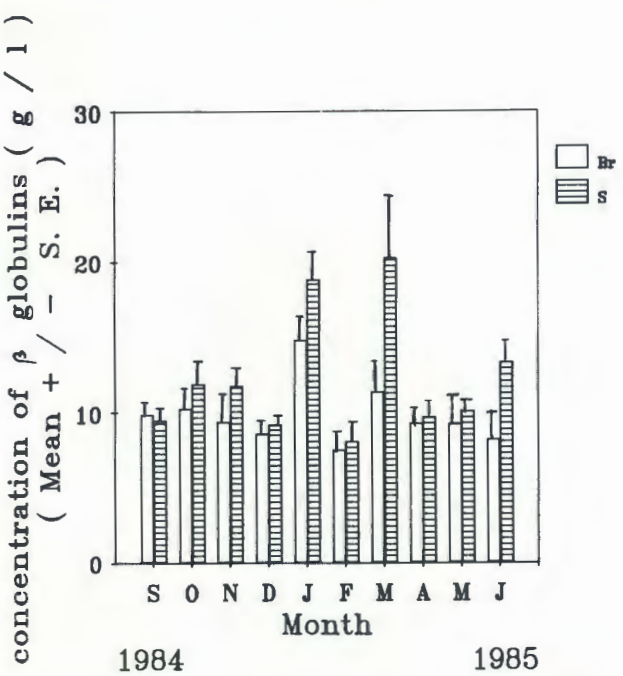

FIG. 12 Concentration of beta globulins in the serum of Simmentaler (S) and Brahman (Br) cattle exposed to tick infestation under field conditions.

Bont-legged tick Hyalomma marginatum rufipes

Simmentaler cattle hosted more than twice the number of males of the tick *H.m. rufipes* than Brahman (Fig. 7). Female ticks showed a similar pattern (Fig. 8) and were present in higher numbers on Simmentaler. The difference in tick numbers between the two breeds was highly significant (P<0,005).

Tick populations and host blood

During summer, when more ticks were found on cattle, the number of white blood cells increased from 7 500/mm^3 in September to 14 000/mm^3 in December and displayed a peak of 20 000/mm^3 in

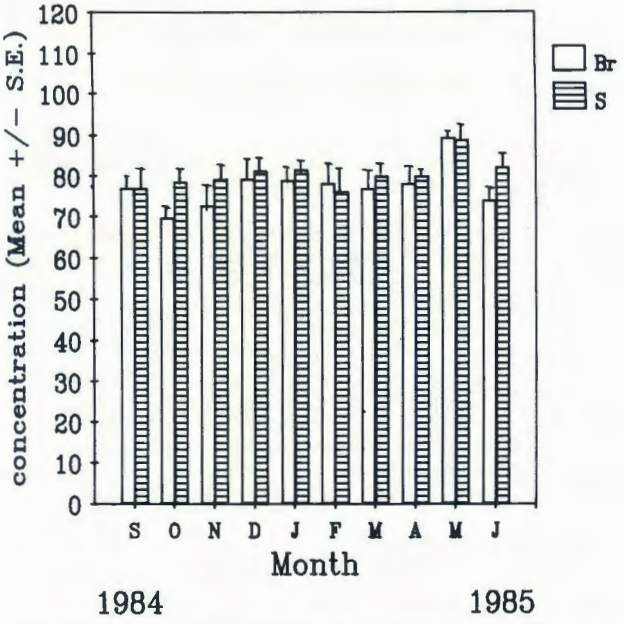

FIG. 13 Concentration of total proteins in the serum of Simmentaler (S) and Brahman (Br) cattle exposed to tick infestation under field conditions.

January. Furthermore, the increase in the number of white blood cells in Simmentaler (which carried far more ticks than Brahman) was significantly higher ($P<0,05$) than observed in Brahman (Fig. 9).

Differential counts revealed that the only component which could be correlated ($r=0,81$) with the number of ticks on the host was the number of eosinophils (Fig. 10). Eosinophil numbers were also significantly higher ($P<0,01$) in blood of Simmentaler cattle than in Brahman blood. Furthermore, the increase in the number of eosinophils was related to an increase in the total number of white blood cells.

Changes in the concentration of other components such as lymhocytes, basophils, neutrophils and monocytes were not significant and no correlation between the tick burden and these components was found during this study. Similarly, parameters such as hemoglobin, the number of red blood cells and consequently also the hematocrit were apparently not affected by the number of ticks prevalent on the animals.

Tick populations and globulin levels

A positive correlation ($r=0,76$) existed between the number of ticks removed from cattle and the level of their serum gamma globulins. The sensitive breed, Simmentaler, which always carried more ticks, had a higher level of serum gamma globulins when compared with the more resistant Brahman breed (Fig. 11). The level of beta globulins in Simmentaler was also slightly higher than in Brahman, mainly during January and March when more ticks were found on the cattle (Fig. 12). The increased concentration of beta globulins could be related to the development of anaemia[5] probably due to very high numbers of *R. appendiculatus* adults which fed on the animals between January and March (Fig. 1 & 2) and also to the high numbers of *A. hebraeum* found on the cattle during December and March (Fig. 3 & 4).

[5] Iron deficiency anaemia increases levels of transferrin, which has a vital function in transporting iron. This protein is found in the beta fraction

The concentration of total protein was also higher in Simmentaler than in Brahman (Fig. 13).

DISCUSSION

Collections of ticks from two breeds of cattle showed that the common species of ticks were *R. appendiculatus, R. evertsi evertsi, A. hebraeum* and *H. marginatum rufipes*. The density of these species was higher on Simmentaler than on Brahman cows during periods of peak activity. Our results confirm previous observations of Kaiser *et al.* (1982); Rechav & Zeederberg (1986) and Rechav (1987), who noted that cattle resistant to one species of tick also tend to be resistant to the other tick species present.

Our results showed that there is a positive correlation between the number of ticks on the cattle and the number of white blood cells. During summer, when more ticks were present on cattle, the number of white blood cells increased. Furthermore, this increase was higher in Simmentaler than in Brahman, an indication that the activity of the immune system of the host had increased.

Differences in the number of eosinophils were also observed. Simmentaler cows which carried more ticks had a higher number of eosinophils in their blood. This indicates not only the involvement of a humoral immune response by the host but also a hypersensitivity response. It appears that the high number of ticks found feeding on the animals stimulated an increase in the number of eosinophils in the host's blood. Similar situations were described in *Bos taurus* and *Bos indicus* which had been infested with *B. microplus* by Tatchell & Moorhouse (1968) and by Schleger, Lincoln, McKenna, Kemp & Roberts (1976). In *B. taurus* previously exposed to *Ixodes holocyclus* (Allen, Doube & Kemp, 1977) a similar effect was shown and these authors also concluded that "it is possible that other components of basophils, eosinophils and mast cells are involved in resistance expression" (Matsuda & Kiso, 1988).

The concentration of gamma globulins in the serum of the various breeds was positively correlated with the number of ticks found on the animals. The higher the number of ticks the higher the level of gamma globulins in the serum. This indicates that the amount of antigens inserted into the host during feeding, probably depends on the number of the ticks present on the host. This high rate of feeding would stimulate the production of antibodies which are then detected in the serum. We might thus use the concentration of gamma globulins as a parameter to estimate the sensitivity of cattle to ticks. However, it should be emphasized that an increase in the level of antibodies does not necessarily mean that all the antibodies are protective.

The findings of this study show that resistance to ticks was probably acquired by the host. Furthermore, cattle resistant to one species of tick also tended to be resistant to other tick species to which they had been previously exposed. Although it is unknown if the increase in levels of gamma globulin during summer was caused by one or more than one species of tick, there are indications that each tick species acquired its "own resistance" and that "cross-resistance" between species, or even stages of the same species, is uncommon (Rechav & Dauth, 1987; Rechav, Heller-Haupt & Varma, 1989; Decastro, Newson & Herbert, 1989). These findings show that Brahman cattle have the ability to acquire resistance sooner and probably to a higher degree than Simmentaler cattle. The ability to acquire

resistance to ticks is probably genetically controlled in Brahman animals (Bourne, Sutherst, Sutherland, Maywald & Stegeman, 1988) and should be considered when selection procedures for tick resistant breeds are done.

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