GENETIC AND ENVIRONMENTAL ASPECTS OF THE RESISTANCE OF ZEBU CATTLE TO THE TICK *Boophilus microplus*

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SUMMARY
There were analysed 1,465 data on tick counts made in naturally infested 421 Gyr Zebu cattle sired by 38 bulls. Eight counts were performed in one side of each animal from May 1994 through February 1996. Traits analysed were counts of engorged females ≥4.5 mm (x_1), larvae (x_2), nymphs (x_3), males (x_4), and total females (x_5). After transformed to $y_i=\log_e[x_i+1]$, data were analysed by the method of least squares, the effects of month, sex, age of the animal, coat density, coat colour and forage type in the pasture being considered as fixed, while sires, animals within sires, and error were considered as random. Average $\log_e$ of the number of engorged females (y_1) was 1.24±.04 or 3.5 ticks per animal. All the effects but sex were statistically significant ($P<.01$). Highest average tick counts were observed in the fall 1994 and winter 1995, while the lowest figures were observed in summer. Older (>11 years), dark haired animals were the most susceptible. Heritability of the tick count (y_1) was estimated as $h^2=.266\pm.029$.
Keywords: Zebu cattle, *Boophilus microplus*, resistance, heritability.

INTRODUCTION
In recent years there has been increased interest in an approach to tick control based on the use of animals which are resistant to the infestation with *Boophilus microplus.*The most references to tick resistance in the literature are associated with European cattle breeds since the pioneering works of Villares (1941), Wilkinson (1955, 1962), Hewetson (1968) and Wharton *et al.* (1970). With respect to the natural resistance of Zebu cattle to tick infestation (and to its consequences), it has been assumed as being almost a dogma, and little information has been published about this matter (Francis 1966, Oliveira *et al.* 1989, Gomes 1992). Brazilian breeders have long observed that in herds of Zebu cattle and in particular those of the Gyr breed there are many animals with varied levels of tick infestation. Although the infestations in Zebu animals were not as intense as those in European cattle, chemical control is often needed. The present paper deals with the evaluation of some genetic and environmental factors affecting the ability of Gyr dairy cattle to limit the infestation by the tick *Boophilus microplus.*

MATERIALS AND METHODS
There were observed purebred Zebu cattle of the Gyr breed, raised at the EPAMIG Experiment Station, Uberaba, MG, Brazil (19°47'27" South, 47°55" West, 785 m altitude).

This herd has been selected for milk since 1948, but no attempt was made to select for tick resistance. The animals were not given any chemical control for tick during the observations we made. Tick counts were recorded from April 1994 through February 1996, using first the method of Villares (1941) as modified by Wilkinson (1995), in which each animal was counted in one side for all engorged female ticks 4.5 mm or more in length. Later there was used the method of Oba and Rocha (1971), counting all instars present in a 10 cm diameter area in the perineal region. A total of 1,465 counts were obtained from 421 cattle sired by 38 bulls. The main analysis was performed by the method of least squares, using the model:

$$y_{ijklmnopq} = \mu + M_i + C_j + D_k + S_l + I_m + F_n + T_o + A_p + e_{ijklmnopq}$$

where $y_{ijklmnopq}$ is the natural log of the tick count+1; μ is the overall mean; M_i is the effect of the month (i=1,...,9); C_j is the effect of the coat colour (j=1,...,8); D_k is the effect of the coat mass density (k=1,...,5); S_l is the effect of the sex (l=1,2); I_m is the effect of the age (m=1,...,6); F_n is the effect of the forage type in the pen (n=1,...,10); T_o is the random effect of sire (o=1,...,38); A_p is the random effect of animals within sires, and $e_{ijklmnopq}$ is the random error.

The following traits were considered: counts of engorged females ≥4.5 mm (x_1), number of larvae (x_2), number of nymphs (x_3), number of males (x_4), and total female count (x_5). Owing to the fact that these counts were distributed as Poisson, they were transformed to $y_i=\log_e[x_i+1]$. Using the above model a system of 500 simultaneous equations was built and then solved by the iterative method of Gauss-Seidel.

RESULTS AND DISCUSSION

All the effects of the model but sex were statistically significant for y_1(transformed counts engorged females ≥4.5 mm), the mean of this trait being 1.24±.04 or 3.45 engorged females per animal (Table 1). This low figure agrees to that obtained by Gomes (1992) for Gyr cows (1.94±.10) and to the result of Oliveira *et al.* (1989) in Nelore cattle (.607).

Table 1. Variance analysis of log natural of counts of engorged females greater 4.5 mm (y_1), number of larvae (y_2), number of nymphs (y_3), number of males (y_4) and total female count (y_5)

Sources	DF	Mean Squares				
		y_1	y_2	y_3	y_4	y_5
Month	8	26.1467**	6.7238**	4.5573**	1.8607**	1.1964**
Coat color	7	4.0899**	1.7756**	0.4075**	0.8241**	0.7266**
Mass density	4	4.2048**	4.0773**	1.5650**	1.1704**	1.0587**
Sex	1	0.6389ns	2.6959*	1.0050ns	2.1287**	1.7812**
Age	5	19.4310**	2.8438**	1.1361**	2.7572**	1.5317**
Pen	9	23.5719**	9.4059**	2.5226**	1.3235**	1.4708**
Sire	37	3.5959**	0.8662ns	0.5850**	0.5637**	0.3753**
Animals	383	1.5299**	0.6591**	0.4134**	0.3545**	0.3194**
Error	1010	0.6610	0.4888	0.2920	0.2291	0.2416

The main effect on y_1 was that of the month, which contributed with 31.2% of the total trait variance. Several authors observed also significant effects of the season upon tick counts (Wharton *et al.* 1970, Sutherst *et al.* 1983, Guaragna *et al.* 1988, Veríssimo 1991). The highest mean counts were observed in the fall and the spring of 1994 (6.13 and 4.19 ticks/animal respectively), and in the fall and the winter of 1995 (4.25 and 5.2 ticks/animal respectively). Summer months presented the least infestation levels in both years (Figure 1).

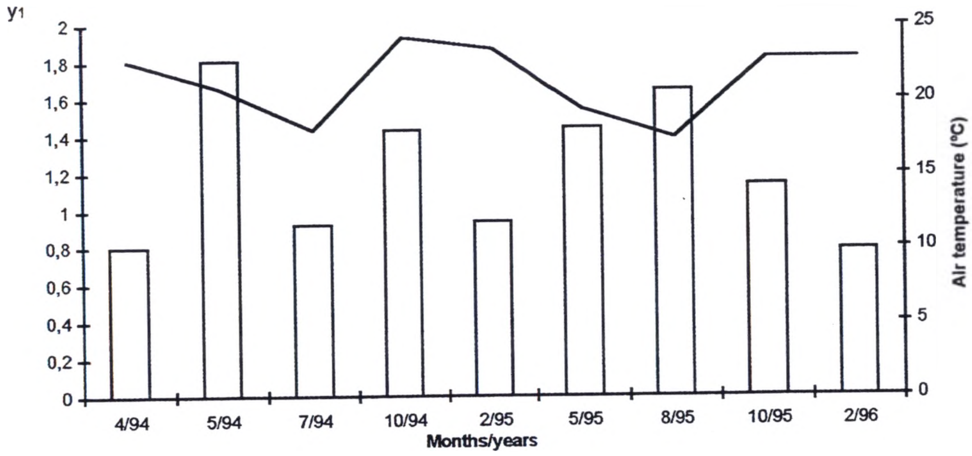

Figure 1. Average infestation (□) y_1=ln(count +1), according to the month of the year and to air temperature (–).

Infestation peaks in the fall were also found by Wharton *et al.* (1970) and Guaragna *et al.* (1988). Several authors had suggested that those increased tick counts in the fall could be attributed to the nutritional stress the animals got during this period. However, high infestation levels have been observed also in animals which were given food supplement during the fall months (Sutherst *et al.* 1983). In the herd we observed in Uberaba the most of the animals (especially calves and lactating cows) received supplemental forage during the fall (dry season), thus minimizing the nutritional stress. It would be possible that the shortening of the photoperiod contributed to the lowering of the resistance of the animals, but there has no direct evidence of the relationship between the photoperiod and the immune response relative to tick infestation.

Althoug sex was not a statistically significant effect upon y_1, males presented more ticks (4.1 per animal) than females (3.2). Oliveira and Alencar (1987) observed that females carry significantly less ticks than the males.

The age of the animals was a significant effect for all the five traits. With respect to y_1, older individuals (>11 years) were more susceptible, presenting 5.5 ticks per animal on the average.

Animals between 3 and 5 years showed the lowest y_1 values (average 3.1 ticks per animal). Similar results were obtained by Utech *et al.* (1978), who observed that cows aged 3 to 4 years were more resistant than the older ones (5 to 6 years). Veríssimo (1991) observed the lowest tick counts in 2 to 4-year-old animals, while Gomes (1992) did so in younger animals (30-39 months of age).

Coat colour affected significantly all traits. Lighter colours were more favourable as for y_1: white, "chita", and light "chita" (3.0, 3.0 and 3.5 ticks/animal respectively), while darked animals presented higher infestations (4 to 5 ticks/animal). Similar results were given by Oliveira and Alencar (1987) and Veríssimo (1991).

Heritability coefficient was estimated for y_1 by the half-sib method, the value being h^2=.266±.029. Hewetson (1968) and Wharton *et al.* (1970) determined similar values for other breeds. Despite the low average infestation levels of Gyr cattle by *Boophilus microplus*, there has a variation in the resistance of the animals. The observed h^2 value must be an indication that their resistance can be improved by means of selection, using tick counts performed in the individual animals and in their ascendent and colateral relatives.

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