The effect of locality, breed and previous tick experience on seasonal changes in the resistance of cattle to *Boophilus microplus* (Ixodoidea: Ixodidae)

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Summary. A seasonal cycle in the expression of resistance to the tick *Boophilus microplus* occurs in cattle in central and southeastern Queensland, Australia. This is due to a seasonal fluctuation in the capacity of cattle to mount an effective immune response against the parasitic tick and is manifest as a waning of the expression of resistance in autumn and early winter which occurs irrespective of breed or the nutritional state of the cattle.

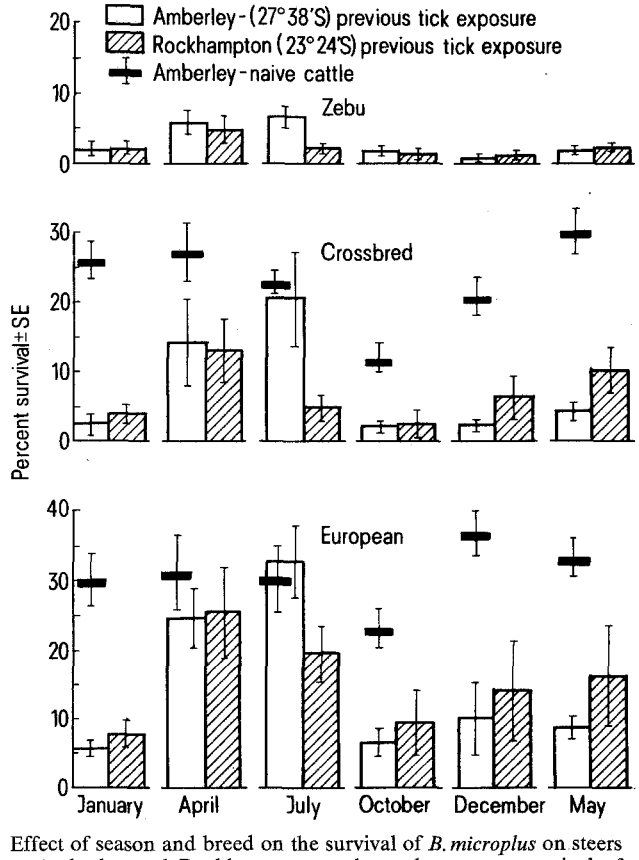
The expression in mammals of acquired resistance to parasites is known to vary with antigenic stimulation[1,2], with hormone levels in the host[3,4], with season[5,6], with levels of host nutrition[7–9], with pregnancy and lactation[5,10,11], with ambient temperature[12], and with social stress[4]. Bovine resistance to the cattle tick, *Boophilus microplus,* is associated more with zebu *(Bos indicus)* cattle than with European *(B. taurus)* cattle[10,11,13]; it is acquired[14,15], it has an immunological basis[16,17], and the capacity to become resistant is heritable[5,10,11,18]. Seasonal variation in the expression of tick resistance in cattle has been the subject of a number of studies. The difference between European cattle of high and low resistance was reduced during the winter[10,11,18], as was the difference between zebu and European cattle[10,20,21]. Density dependent mortality of ticks, and hence resistance, European and crossbred cattle which had previous tick experience, was less in winter than in summer in southeastern Queensland[6]. Here we document the way in which the expression of resistance of cattle to *B. microplus* changes with season in relation to locality, breed and previous tick experience.

Resistance of cattle to ticks is defined as the mortality of female ticks during parasitic development and is estimated by measuring the proportion of females surviving from larvae to maturity. Preliminary observations at Rockhampton (central Queensland) 23°24′S and at Amberley (southeastern Queensland) 27°28′S showed that in both localities the resistance of cattle to the tick *B. microplus* fluctuated over the year, waning in autumn and increasing again in late winter and early spring.

An experiment was carried out to examine the effect of locality, breed and previous tick resistance on the seasonal change in resistance. Resistance in steers, with a lifetime of tick experience (exposed), of 3 breeds (zebu, zebu × European (crossbred) and European) was compared at the National Cattle Breeding Station, Rockhampton and at Amberley. Crossbred and European steers without previous tick experience (naive) were examined at Amberley. All cattle were 12–15 months of age at the beginning of the experiment in January, 1974. The cattle grazed native pastures at Amberley or improved pastures at Rockhampton. Each treatment comprised a group of 5 animals. Within each breed, animals with previous tick exposure were selected so that each group had approximately equal resistance. At intervals of about 3 months from January to December, 1974, and again in May, 1975, the exposed cattle were infested with about 20,000 larvae, and naive cattle with about 5000 larvae of *B. microplus* via a neck collar[5]. All cattle were tick free immediately before infestation. During the period from 17 to 28 days after infestation the numbers of female ticks 4.5–8.0 mm in length on the right hand side of each animal were counted: ticks of this size mature and drop off on the following day[19]. A fresh group of naive cattle of equivalent age was used at each infestation.

At both localities percentage survival on the exposed steers of all breeds of cattle increased in autumn and winter and decreased again in early spring and summer (figure). Thus resistance decreased in autumn and winter and increased again in early spring. In exposed steers at Amberley there was a greater and more prolonged loss of resistance than occurred at Rockhampton. Differences between the resistance levels of zebu, zebu × European and European cattle were maintened throughout; the zebus being the most resistant and the European cattle the least resistant.

The component of resistance that is due to an acquired immunological response may be estimated from the difference between the percent survival of naive and exposed cattle. During spring and summer, exposed steers were significantly more resistant ($p < 0.001$) than naive steers of the same breed (figure). In contrast, for the April and July infestations, there were no significant differences between the survival of ticks on the naive and exposed steers, indicating that the exposed cattle temporarily lost their acquired capacity to prevent ticks from feeding. In other words, there is a seasonal waxing and waning of the



Effect of season and breed on the survival of *B. microplus* on steers at Amberley and Rockhampton as shown by percent survival of ticks to maturity following artificial infestation of exposed cattle with about 20,000 larvae and naive cattle with about 5000 larvae during 1974 and 1975.

Effect of season and breed on the survival of *B. microplus* on bulls (5 animals per treatment) at Amberley was shown by percent survival of ticks to maturity following artificial infestations with about 20,000 larvae during 1974 and 1975. Bulls were held in open yards and were fed lucerne hay ad libitum (means ± SE)

Amberley	1974					1975
	January	April	July	October	December	May
Zebu × European	3.1 ± 0.7	8.7 ± 1.6	2.2 ± 0.5	1.6 ± 0.5	2.3 ± 0.9	4.6 ± 1.1
European beef breed	8.7 ± 2.0	17.9 ± 1.6	6.1 ± 0.8	4.2 ± 0.6	3.4 ± 0.6	9.0 ± 1.5
European dairy breed	17.2 ± 3.3	28.3 ± 3.0	11.2 ± 2.6	9.3 ± 2.1	8.1 ± 1.7	13.9 ± 2.3

capacity of cattle to mount an effective immune response against the parasitic tick.

Tick resistance began to wane well before the winter coat was fully developed and resistance increased again prior to the shedding of the winter coat, and so the characteristics of the coat per se did not control the changes in resistance.

Nutrition can affect the expression of resistance to ticks[8,9] but in our experiment tick resistance began to wane in early autumn when the protein content and digestibility of native and improved pastures are usually high[22], and more significantly, resistance increased again in winter or early spring when nutritional value of pasture is lower than at other times of the year[23]. This suggests that the seasonal change in tick resistance in the steers cannot be explained by seasonal changes in nutrition. This is in accord with the results of a concurrent experiment in which crossbred and European bulls were maintained in tick free yards and allowed to feed ad libitum on lucerne hay. This demonstrated that the seasonal changes in resistance occurred in bulls maintained on a constant diet of high nutritional value (table).

In conclusion, our results confirm those[5,6] which demonstrate a seasonal cycle in the expression of acquired resistance to *B. microplus* in cattle with previous tick experience. The cycle occurs irrespective of breed and the nutritional state of the cattle. There were differences in the magnitude and timing of the seasonal cycle of resistance between bulls and steers at Amberley and between the steers at the 2 localities. These may have been due to differences in nutrition and/or latitude. The seasonal cycle in resistance is of obvious importance in understanding the population dynamics of the cattle tick, and is relevant to control strategies, particularly in regions where tick populations build up to a maximum in winter months[20].

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The effects of histamine dihydrochloride on blastocyst implantation in the laboratory rat

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Summary. This investigation studied the effects of intrauterine injections of histamine dihydrochloride on blastocyst implantation in the laboratory rat. Results of this study lend support to the idea that histamine is the initiator of implantation through the induction of decidualization in this species.

Shelesnyak[1] and Shelesnyak and Kracier[2] were the first to suggest a role for histamine in implantation and proposed that a surge of estrogen produced by the ovaries on the 5th day of pregnancy was responsible for histamine release. Histamine, in turn, sensitized the uterine cornua to respond to the implanting blastocyst by acting as an inducer of decidualization. Additional evidence in support of this hypothesis was that uterine histamine content was found to increase in deciduomata[3] and that the induction of decidualization was inhibited by antihistamine[4]. Also, Riley[5] concluded that a reduction in endometrial mast cells could be correlated with the release of histamine and these observations taken together suggested a role of estrogen via histamine release in the uterus. In our study, we were interested in establishing a dose-response relationship between histamine dihydrochloride levels and viable implan-