



UNIVERSITI PUTRA MALAYSIA

**TICK RESISTANCE BETWEEN VARIOUS BREEDS OF CATTLE IN
MALAYSIA**

AHMAD AZAM BIN HAMZAH

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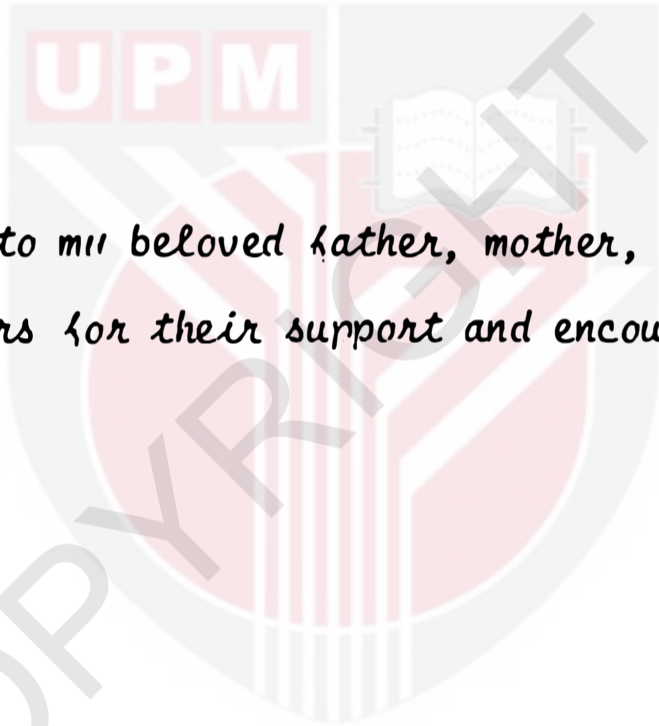
by

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A paper submitted
in partial fulfilment of the requirement
for the of Doctor of Veterinary Medicine,
at Faculty of Veterinary Medicine and Animal Science
Universiti Pertanian Malaysia

January 1986

*Dedicated to my beloved father, mother, brothers and
sisters for their support and encouragement*



ACKNOWLEDGEMENT

The author wishes to express his special appreciation and heartfelt thanks to his supervisor, Dr. Shaik Mohamed Amin Babjee for his invaluable advice and guidance which led to the completion of the study. Profound thanks is conveyed to Dr. Mohd Arief Omar and Dr. Dahlan Ismail of Kluang MARDI who have provided the animals and their facilities for this study. I would also like to thank their staff who were involved directly or indirectly in completing this study. A lot of thanks are also due to En. Bohari Yaacob from the parasitology laboratory, UPM, who was involved directly in this project and to those who had one way and another helped to make this project possible. Special thanks also extended to Cik Jah bte Hussein for her invaluable help.

Last but not least special thanks to Puan Sohaila bte Abdul Karim for typing this manuscript.

ABSTRACT

Five different breeds of cattle namely pure Hereford, Hereford x Kedah-Kelantan, Friesian x Kedah-Kelantan, Brahman x Kedah-Kelantan and pure Kedah-Kelantan were used in the tick resistance study. Each animal was infested with 40,000 larvae Boophilus microplus which were cultured in the laboratory. Tick resistance of the individual animal was assessed by the number of engorged tick produced, by the weight of tick and the weight of eggs produced by the ticks. The naturally detached engorged female ticks were collected daily starting from day 18 up to day 26 after the application of larvae, until there were no more detached ticks present. The results of this study showed a very significant breed differences ($P < 0.01$) in tick resistance. The pure Kedah-Kelantan and their crossbreds appeared to be highly resistant as compared to pure Hereford. The former produced a range of 0.7 to 4.2 percent of applied larvae, whereas the latter produced a range of 17 to 28 percent. Among the crossbreds the Hereford x Kedah-Kelantan produced significantly higher number of ticks as compared to pure Kedah-Kelantan and Brahman x Kedah-Kelantan. The differences between tick resistance among the breeds shown in this study seemed to have no effect on the tick weight and eggs produced by the ticks.

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INTRODUCTION

It is well known that ticks and the disease they transmit can cause great economic loss and has been identified as a global problem. The direct effects of tick feeding are the damage they do to hides, 'tick worry', blood loss and injection of toxic substance which can cause 'tick paralysis' by some species of ticks. Some of the major tick borne diseases are anaplasmosis, babesiosis and theileriosis. These diseases may cause high mortality in introduced temperate breed cattle especially experienced in many parts of the developing world, which are trying to improve the quality of their livestock.

Corrier et al (1979) for example reported that heavily infested calves suffered average losses in body weight up to 38 kg., besides decrease in pack cell volume. He also found that 40 percent of the animal died from severe ixodiasis and babesiosis.

Tropical cattle tick, Boophilus microplus which were used in this study is a principle vector for bovine babesiosis, may also cause severe anaemia if the infestation is heavy (O'Kelly and Seifert, 1969), weight loss (Johnston and Haydock, 1969), and death (Little, 1963).

The elimination or reduction of tick infestation by chemotherapy, quarantine and various management methods are the common methods of reducing tick numbers, but the development of resistance towards the acaricides is another major problem created in several major beef producing countries. An alternative method to control ticks therefore needs attention.

It is known that Kedah-Kelantan (KK) cattle and Local Indian Dairy (LID) are highly resistant against the cattle tick. The cross breeding of these tick resistant animals with European breed cattle could be the answer of producing an ideal breed which is productive, suitable and at the same time resistant against the tick and probably other diseases.

This study was undertaken at the government research unit in Kluang, the Malaysian Agricultural Research and Development Institute (M.A.R.D.I) where crossbreeding between pure Hereford and Friesian with the local indigenous cattle (KK) is being done. The main objective of this study is to compare the resistance level of these crossbreds against the susceptible purebred animals.

LITERATURE REVIEW

Tick resistance in various breeds of cattle against the cattle ticks, Boophilus microplus, has been studied by several workers. Generally it is accepted that the zebu (Bos Indicus) is more resistant than the European breeds (Bos taurus). A number of methods have been used to determine the degree of resistance, namely the failure of ticks to develop completely, tendency of light infestation after heavy experimental exposure, failure of engorged female to produce normal number of eggs with normal fertility, delayed completion of female life-cycle and decrease in mean weight of female ticks (Hewetson, 1968, 1971; Cambell, 1976).

Seifert (1971) studied the tick resistance in various breeds of cattle and he found that tick counts in zebu cross breeds were always significantly lower than those of British breeds. The European breeds, were fairly susceptible to tick infestation. The indigenous cattle, Kedah-Kelantan (KK) and Local Indian Dairy (LID) which are well adapted to local condition were observed to be highly resistant to tick infestation as indicated by few engorged ticks on their bodies. Sharif (1982) stated that 83.6 percent of the KK cattle and 46.5 percent of LID cattle carried few or no ticks at all.

Francis and Little (1964) compared the resistance to Boophilus microplus between Droughtmasters and British breed observed that British breeds (Hereford and Friesian) carried significantly higher number of ticks compared to the

Droughtmasters. Dahlan et al (unpublished) found that there was no significant difference in the tick counts between Brahman x KK and pure KK, however the tick counts in Herefore x KK were higher than KK and Brahman x KK.

Tick resistance manifested by cattle is largely an acquired state (Riek, 1962; Hewetson and Nolan, 1968; Wagland, 1975). Riek (1962) however stated that he observed two types of resistance; an acquired state in which resistance was manifested after repeated tick exposures, and an innate resistance which was expressed in some animals on their first exposure to the ticks. He also observed that there were considerable variations in the number of engorged ticks produced, after a known large single infestation, by previously unexposed Sahiwals and Red Sindhis. Wagland (1975, 1978) however found that both native pure Zebus and pure Shorthorns produced about the same number of engorged ticks when experimentally infested. The above findings seem to invalidate the concept of innate resistance as proposed by Riek (1962). Wagland (1978) however found that the zebus acquired resistance faster than the Shorthorn and that they developed a higher level of resistance in subsequent infestations. B. microplus was found to develop more slowly on zebus as compared with European cattle. (Riek, 1962; Hewetson, 1971; Wagland, 1975) and it was found that the larvae grew more slowly within the first 24 hours on the naive Bos indicus (Wagland, 1978). This seemed to indicate that some innate factors, rather than acquired, may be responsible in this cattle species.

Resistance of cattle to B. microplus is heritable, more so in the zebu type of cattle. Kelly (cited by Amin, 1984) stated

that the pure zebus, for practical purpose are completely tick resistant and they pass this characteristic to their descendents almost in direct porportion to the percentage of the zebu 'blood'. Hewetson (1968) in his study of inheritance of resistance in six group of 1/4 bred Sahiwal cross Jersey sired by six half-bred Zebu bulls reported no inheritance in the first three repeated infestations. However the heritability was 28 percent on the fourth infestation and increased to 42 percent in the fifth infestation. Seifert (1971) studied the inheritance of tick resistance in both zebu (Africander-Brahman cross) and European cattle (Shorthorn-Hereford 1/2 bred). He found the correlation between the tick count on the calf and her dam in the zebus were comparable and gave a pooled heritability estimate of 82 percent. The dam-calf correlation in the European breed was not significant. Wharton et al (1970) in a field study gave a estimate heritability of tick resistance of 48 percent in the Australian Illawara Shorthorn cattle.

An acquired resistance become evident after animal have been repeatedly exposed to ticks and was associated primarily with the development of hypersensitive state. Several workers (Hewetson, 1971; Wagland, 1978; Amin, 1984) have shown the acquisition of resistance by repeated infestation and they agreed that animals infested for the first time will acquire some degree of resistance in subsequent infestations.

Riek (1962) appeared to be the first to notice that the weight of ticks dropped by pure Bos indicus was less than the weight of those dropped by pure Bos taurus. The differences in

the weight of eggs produced and the number of larvae hatched from ticks dropped by three-quarter bred Zebu x Shorthorn group were not significantly different to the pure *Bos taurus*. Hewetson (1971) observed that pure bred and crossbred Sahiwal cattle dropped ticks of similar size in the first infestation, but as resistance developed the mean weight of ticks became less until at the fourth infestation. Ticks dropped by the purebreds were significantly lighter than those dropped by the crossbreds.

Besides the differences of resistance between breeds, there are a wide range of individual variation. Riek (1962) reported that there is a wide range of individual variation when cattle were intermittently infested with *B. microplus*. A range of 1.5 to 15 percent of the 2000 larvae applied were produced by the zebu and their crosses. Wagland (1978) observed that, there were a wide range of ticks recovered from previously exposed and unexposed animals. About 1352 to 10,193 ticks were recovered from unexposed Brahman, 5387 to 12,322 from unexposed Shorthorn and 109 to 3841 from previously exposed Brahman. In his previous study (1975) he found that about 9.6 to 34.4 percent of ticks recovered from previously unexposed Brahman.

The resistance of animal towards the cattle tick were expressed in several ways. Grooming which was thought to play a major role in the expression of resistance can remove the larvae from the animals' body from 9 to 54 percent during first 24 hours of infestation and more time were spent for grooming by resistant animal (Koudstaal et al, 1978). It has been shown that resistant cattle when prevented from grooming increase their tick yield dramatically (Riek, 1962; Bennett, 1969; Koudstaal et al, 1978).

The duration of the parasitic life cycle on Brahman was slightly longer than those of the European breeds (Riek, 1962; Hewetson, 1971; Wagland, 1975). Kemp et al (1976) studied the behaviour of larvae on resistant animal using phosphorus 32 labelled larvae and they found that the attachment time was shorter and the larvae spent more time wandering on highly resistant animals during the first 16 hours. The attachment were stabilised on second day of infestation but more detachments and wandering were still observed from the highly resistant animals.

As resistance is an acquired phenomena, the mechanism of tick rejection is considered to have a major immunological component. The immunity to tick have been comprehensively written by Willadsen (1980). Robert (1976) showed that plasma from highly resistant animal to the B. microplus conferred some resistance to previously unexposed calves.

Francis and Little (1964) thought that the coat difference may contribute to the breed difference in susceptibility to tick infestation. Riek (1962) stated that the hypersensitive reaction of acquired tick resistance is probably the major factor in rejecting the larvae and it was associated with pruritis.

Pharmacological mediators, such as histamine in the vicinity of tick attachment sites have been implicated in the resistance response. Willadsen et al (cited by Amin, 1984) found that the difference in the skin histamine concentration between the high and low resistance cattle was significant; the highly resistant animals had a two-fold difference in the average total concentration. Schleger et al (1976) found a significantly

greater mast cell breakdown in the skin of resistant animals as compared to low resistance animals. Injection of histamine beneath an attached tick will make it detach (Kemp, 1978). His studies provide some evidence that histamine may play a major effector role in the rejection of ticks.



MATERIALS AND METHODS

Larvae Production

Replete female ticks were collected from naturally infested beef cattle of MARDI, Serdang. The ticks were incubated at 25°C and several trays of water were placed in the incubator to give sufficient moisture. The eggs were separated from the ticks one week after oviposition commenced and weighed in one gram lots. Each gram of eggs produced about 20,000 larvae. They were placed in glass vials and covered with nylon cloth which were incubated further in the same incubator. Larvae hatched about 3 weeks later and they were infested on the animals when they were 3 weeks old.

Animals

Five different breeds of cattle which comprise of 4 animals in each group were used. The breeds were pure Hereford, Hereford x Kedah-Kelantan, Fresian x Kedah-Kelantan, Brahman x Kedah-Kelantan and pure Kedah-Kelantan. Three of the pure Hereford were 3 years old (identified as 2001, 2005 and 2033) and the other was 7 years old (8017). The age of other group of animals were about 8 months to one and half years. All the crossbreds animals have 50 percent indigenous blood (KK).

Before the experiment, all the animals have had previous exposure to the cattle ticks. Except for the crossbreds, the Hereford had been regularly treated for worms. The cattle were placed in individual pen, provided with clean grass and supplemented with palm kernel cake.

Infestation

To facilitate the infestation process, the animals were tethered. Each animal receives 40,000 larvae of Boophilus microplus which were applied along the animal's back using a brush, from the forehead down to rump area. The body was covered with gunny sack and was secured by strings. They were tethered at least for 24 hours to minimise grooming activities and ensuring proper attachment of larvae.

Counting of engorged female ticks

For this purpose once again the animals were tethered 3 days before the engorged female started to drop to facilitate the counting process. Replete ticks that dropped from the animals including the crushed ones were counted daily starting from day 18 after larval application up to day 26 where there were no more replete ticks present. After counting, the ticks and faeces were removed manually to facilitate the next counting. Counting of ticks was done at the fixed time daily from 8 am up to 1.30 pm.

Measurement of weight of replete ticks

As far as possible, ticks that dropped on day 19 and 20 were used for this purpose. Those animals which produced large number of ticks, 200 of normal size ticks were weighed, but for those animals which produced small numbers, all the apparently normal ones were used. Before weighing, the ticks were washed and dried gently with tissue paper. A Sartorius scientific balance (accurate up to 0.0001 g) was used to determine the weight of the ticks.

Measurement of average egg production

The same batch of ticks from individual animal mentioned above were kept in glass containers and kept in incubator. The containers were covered with tissue paper and holes were made with 18 gauge needle to ensure enough air and moisture were available to the ticks. They were kept for 10 days to ensure maximum number of eggs produced. The shrunken ticks were removed using 22 gauge hypodermic needle, at the same time brushing away the adhering eggs into the container. The same scientific balance was used to weigh the eggs. Dead ticks which were still bloated and black in colour were recorded.

RESULTS

The mean tick counts for the different breeds of animals and their standard deviation is presented in Table 1. The purebred Hereford obviously produced the largest number of ticks as compared to other crossbreds, and this difference is highly significant ($P < 0.01$). There were also significant differences between the other breeds. The Hereford x KK produced the second highest number of ticks, however these differences were only highly significant when they are compared to Brahman x KK and pure KK ($P < 0.01$). There is no significant difference between Hereford x KK and Fresian x KK, between Fresian x KK and pure KK and between Fresian x KK and Brahman x KK. The pure KK group apparently showed the highest level of resistance as indicated by the lowest tick counts.

There seemed to be a wide range of resistance within each breed of animals (Table 1). One of the Hereford, that is the oldest animal, showed a very high tick count as compared to the others (range of 3391 - 7100).

The parasitic life-cycle seemed to be a day shorter in the pure Hereford than in the Zebu crosses. The pure Hereford started to drop engorged female ticks on day 18, whereas in other crossbreds and pure KK the life-cycle seems to be longer, where the ticks started to drop on day 19 after the application of larvae.

All animals showed signs of pruritis soon after infestation. They spent considerable time licking and rubbing their body and head against the wall and this activity was observed to be more

obvious in the pure KK and their crosses.

The mean tick weight and the weight of eggs produced by each group of animals are presented in Table 2 and 3 respectively. The mean tick weight was highest in pure Hereford (149.1566 mg), followed by Fresian x KK (134.7332 mg), Brahman x KK (126.5619 mg), pure KK (121.832 mg) and Hereford x KK (120.9898 mg). However this difference was not significant among the groups. Similarly the differences in the mean weight of egg produced between the various breeds was not statistically significant.

Table 1: Mean tick counts in each breed of cattle

Breeds	n	range	mean+s.d
Pure Hereford	4	3391-7100	5539.7500+1347.1261
Hereford x KK	4	458-1315	843.5000+313.2415
Fresian x KK	4	219-1653	804.5000+525.5447
Brahman x KK	4	78-333	231.7500+100.8424
Pure KK	4	8-186	131.2500+72.7096

- N.B. 1. The analysis of variance (ANOVA) revealed a highly significant difference among the breeds ($p < 0.01$)
2. t-test showed a highly significant difference between the pure Hereford and the other groups

Significant differences are also observed between Hereford x KK and pure x KK and between Hereford x KK and Brahman x KK

Table 2: Mean Weight of Individual Tick in Each Breed of Animal

Breeds	Range no. of ticks weighed	Range tick weight (mg)	mean+s.d.
Pure Hereford	200	128.5595-170.4655	149.1566+19.1854
Hereford x KK	50-100	112.2040-133.2400	120.9898+8.2807
Fresian x KK	74-100	113.6620-159.1275	134.7332+17.2577
Brahman x KK	10-50	117.8340-136.8937	126.5619+7.0632
Pure KK	5-35	80.2400-153.4000	121.8320+27.2042

N.B. The ANOVA revealed no significant difference among the breeds.

Table 3: Mean Egg Production Per Tick in Each Breed of Cattle

Breeds	Range no of ticks used	Range egg production per tick (mg)	mean egg production+s.d
Pure Hereford	200	57.0958-89.9505	72.8688+14.2973
Hereford x KK	50-100	56.9484-67.4310	60.6586+4.0359
Fresian x KK	74-200	61.3400-78.7833	71.1073+6.8026
Brahman x KK	20-100	59.6050-76.1350	67.7485+5.8649
Pure KK	5-75	60.1000-84.4333	69.5890+9.0633

N.B The ANOVA revealed no significant difference among the breeds in term of egg production

DISCUSSION

The assesment of tick resistance in cattle based on counting replete ticks that dropped naturally seems to be the most reliable and consistant method which have been agreed by most of the workers in this field.

Differences in tick resistance among the various breeds of cattle have been demonstrated in present study. It was obvious that pure zebu (Kedah-Kelantan) and their crossbreds are highly resistant to tick infestation while European breeds (Hereford) were shown to be fairly susceptible. All KK animal produced less than 200 ticks and one of them produced only 8 engorged female although 40,000 larvae were applied on their body. This is in agreement with previous workers, who compared the zebu with other European breeds of cattle. Wharton et al (1969) had studied the effect of artificial infestation on Hereford, Shorthorn, Brahman x Hereford and Africander x Hereford and they observed that the mean counts on British steers were five times higher than those on the zebu crosses. Riek (1962) in another study reported that the pure Shorthorn yielded six times more ticks than the pure Brahman. Francis and Little (1964) found that tick counts on mixed British breeds was observed to be ten times higher as compared with the Droughtmasters.

There was a wide individual variation with tick numbers produced within each breed of animals used in this study. One of the pure Hereford had high burden of ticks up to more than seven thousand while the rest of animals in the same group produced abviously lesser numbers (less than 3500 ticks). This was

similarly seen in the other breeds used. The wide range of individual variation have been demonstrated by other workers. Riek (1962) found a range of 1.5 to 15 percent produced by the zebus and their crosses following intermittent infestations with 20000 larvae. He also found that individual animal among the Bos taurus may even express complete resistance to B. microplus. One of his Australian Illawara Shorthorn cattle produced no ticks at all after receiving 20000 larvae and after a massive application of 100000 larvae, only 12 engorged female recovered. Wharton et al (1978) in their experimental infestation study found that a range of 251 to 2539 ticks were recovered from susceptible Australian Illawara Shorthorn cattle whereas a range of 60 to 1446 ticks were recovered from animals which he considered resistant.

The present study showed that the Brahman x KK cattle produced more ticks than the KK (Table 1) and it has been documented that Brahman cattle were less resistant as compared to KK (Sharif 1982). However, the results showed that there was no significant difference between KK and Brahman x KK because both were of the pure zebu type.

Although most of the workers found that Zebu breeds tend to be more resistant than British breeds, Riek (1956) has shown that certain individual animals of the European breeds (Bos taurus) cattle can be more resistant to tick infestation than some of the zebu (Bos Indicus) cattle. This is similarly observed in this study in which one of Fresian x KK (European crossbred) had lower tick counts than Brahman x KK (zebu).

It was interesting to observe that ticks took a longer period to mature on the zebus and their crossbreeds as compared to pure British breed. This is in agreement with the study by Riek (1956) where he observed that the average period for ticks to reach maturity on the Shorthorn was 19 to 31 days and for the zebus from 20 to 35 days.

The result of this study indicated that the animals whether zebus or British breeds previously exposed, acquired some degree of resistance to B. microplus because only 28 percent of the applied larvae were produced by the pure Hereford and only 0.7 to 4.2 percent were produced by pure zebus and their crossbreeds. This suggests that previously exposed animals develop resistance and this indicated an immune response. Several workers have shown that this is so. Roberts (1968) documented that when cattle were infested with B. microplus for the first time, most of them were highly susceptible initially, however after 8 days of daily infestation with 1000 larvae, a degree of resistance was acquired and this was reflective of an immunological response. In contrast, animal with previous tick experience were already resistant and immediately expressed their individual level of resistance after an experimental exposure. Over a one year study he observed that the animals with no previous tick experience gradually become more resistant after repeated experimental exposures. The role of immunity was proved by Robert and Kerr (1976) where they found that plasma from cattle highly resistant to B. microplus conferred some resistance to previously unexposed calves. Hewetson and Nolan (1968) showed that infestation with 180,000 larvae in half-bred naive Zebu bulls produced 12000 to

20,000 replete adult ticks. The mean number of replete female ticks were 16,689. However in the second infestation using the same number of larvae, the mean number of ticks dropped to 892. Hewetson (1971) in his study revealed that all animals appear to be relatively susceptible to the tick infestation at the first challenge and subsequently developed individual degree of resistance. He found that purebred Sahiwal were as susceptible as Sahiwal x Jersey at their first infestation, but subsequently the purebreeds became more resistant during the next three infestations. Amin (1984) in his study on tick resistance in Bos taurus cattle found that in primary infestation using 20,000 larvae, 40 percent of the larvae became repleted and detached and this number dropped to 8-12 percent in the subsequent infestations.

The mean tick weight produced by the various groups of animals in this study seemed to differ and this is especially so between the pure Bos taurus and Bos indicus and their crosses. Although there was no significant difference in average tick weights among the breeds, the pure Hereford seemed to produce heavier ticks (149.1566 mg) as compared to Hereford x KK, Fresian x KK and pure KK, where the average tick weight were 120.9898 mg, 134.7332 mg, 126.5619 mg and 121.8320 mg respectively. This result seems to agree with the report that the average tick weight of zebu were less compared to the Bos taurus (Riek, 1962). It is important to mention that the host resistance on the average tick weight would be best demonstrated by repeated infestation. Wagland (1975) reported that in primary infestation

with 20000 larvae of B.microplus the average tick weight in Brahman was 203 mg, while in second, third and fourth infestation, the mean tick weight were 180 mg, 161 mg and 174 mg respectively. Similar patterns were observed in Shorthorn cattle. Amin (1984) in his study found that the tick weight declined dramatically after repeated infestations. He suggested that smaller ticks were produced when cattle required resistance. It has been documented in other studies that zebus produce lighter tick than European breeds (Hewetson, 1971; Wagland 1975).

There was no significant difference in term of weight of eggs produced among the breeds in the present study, however it is obvious that ticks from pure Hereford produce slightly heavier eggs (72.8688 mg) as compared to others (71.1073 mg in Fresian x KK; 69.5890 mg in pure KK, 67.7484 mg in Brahman KK and 60.6586 in Hereford x KK). This is in agreement with Amin (1984) that resistance did not significantly effect the egg weight production.

Although tick resistance manifested by cattle is largely an acquired state, Riek (1962) observed another type of resistance termed as innate resistance in which some animals produce few ticks even when infested for the first time.

Resistance of cattle to B. microplus has also found to be heritable especially so in the zebu type cattle. Kelly (1943) (cited by Amin, 1984) stated that the pure zebus are completely tick resistant and they pass their characteristic to their decendants almost in direct proportion to the percentage of the zebu 'blood'. Hewetson (1968) in his study of inheritance of resistance in six group of 1/4 breed Sahiwal cross Jersey, sired

by six half-Zebu bulls reported that no inheritance of resistance in the first three infestations, however the heritability was 28 percent on the fourth infestation and increased to 42 percent in the fifth infestation. Seifert (1971) found that there is a strong correlation between the tick counts on calves and their dams in the zebus (Africander x Brahman) and gave a pooled heritability estimate of 82 percent. However the dam-calf correlation in the European breeds was not significant. Utech et al (1978) studied the resistance level of European and zebu cattle in natural and artificial infestations and reported that the parent cows selected for the tick resistance consistently carried fewer ticks than those selected for low resistance and the progeny of resistant cows were significantly more resistant than those progeny from low resistant dams

Grooming probably plays an important role in the mechanism in rejecting ticks. It was observed in this study that the zebus and their crossbreds spent considerable time licking and rubbing their body against the wall of their sheds. However, the same behaviour was also observed in Hereford breeds but it was of a lesser intensity.

Riek (1962) reported that the susceptible cattle showed no signs of irritation after application of larvae but resistant animals showed a marked and prolonged irritation, especially during the early feeding period. Riek in an earlier study (1956) observed that excessive serum exudate was only shown by some highly resistant animals which yielded few or no engorged ticks after large experimental infestations. Riek (1962) considered

that hypersensitive reactions may be the most important factor which determine the tick burden on the animals and this may be associated with the formation of papules and edematous swelling at the attachment sites. Kemp and Bourne (1980) suggested that Histamine, which produced from highly resistant animals cause the detachment of B. microplus larvae. The hypersensitivity reaction which is associated with the release of histamine is suggestive an immunologically mediated reaction because such reaction was not expressed by naive cattle. The means by which an immune response may control the level of parasitic burden is not clear. Animals have different level of immune response which influence the chance of survival of larvae on the host, resulting in only a proportion of successful ticks on the body.

The mechanism of tick resistance in cattle against B. microplus may be influenced by other factors such as physiological and environmental conditions. O`Kelly (1968) reported, animals with high cholesterol level significantly harboured lesser number of ticks. Utech et al (1978) and Wharton et al (1970) found that pregnancy depressed resistance significantly. However Johnston and Haydock (1969) and Seifert (1971) could not find any effect of pregnancy on resistance. Seifert (1971) thought that sex may effect tick resistance and suggested that changes in the hormonal balance may play an important role in tick resistance. He found that tick counts in male calves were always higher than in the female animals. He also found that young cows were more resistant than the older cows.

The breakdown of tick resistance in cattle due to malnutrition and loss of body weight have been observed by O'Kelly and Seifert (1969). They found that animal fed with low energy diet harboured heavy burden of ticks and they suggested that malnutrition can affect the growing activities.

Riek (1962), O'Kelly and Seifert (1969) and Turner and Short (1972) found that environmental and seasonal conditions may also affect tick resistance in cattle.



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NO. OF TICKS COLLECTED DAILY IN INDIVIDUAL ANIMAL

ANIMAL IDENTIFICATION	NUMBER OF TICKS COLLECTED PER DAY								Total
	D1	D2	D3	D4	D5	D6	D7	D7	
HEREFORD (PURE)									
2001	1053	1303	573	676	767	711	575	45	5703
8017	474	731	1285	1842	1673	790	287	18	7100
2005	284	450	554	402	828	646	222	5	3391
2033	323	756	1780	1499	1171	381	55	10	5965
HER x KK									
5202	11	173	319	466	202	120	17	7	1315
5206	0	65	40	341	295	143	11	0	895
5210	1	61	198	240	178	14	14	0	706
5212	0	4	80	97	159	109	9	0	458
FR. x KK									
4554	0	11	68	254	220	146	35	0	734
4541	0	71	144	215	120	53	9	0	612
4540	0	31	68	55	42	18	5	0	219
5507	0	119	513	786	206	24	5	0	1653
BR x KK									
4146	0	13	69	71	79	52	26	0	310
4128	0	2	15	18	24	10	7	2	78
4153	0	4	27	78	48	43	3	3	206
4140	0	16	76	104	116	20	1	0	333
KK (PURE)									
4355	0	10	45	65	34	21	8	0	183
4034	0	0	20	77	22	60	7	0	186
4336	0	1	2	3	0	1	0	1	
4354	0	36	23	33	29	21	6	0	148