TICKS ON DEER

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1. INTRODUCTION

The tick haemaphysalis longicornis has probably always been on deer in tick infested areas of New Zealand. It was recognised as a problem in this species as early as 1982 (Neilson and Mossman, 1982). At present there is no data on the prevalence of tick infestations on deer farms, but anecdotal information and the personal experience of many farmers and veterinarians would suggest that the problem of tick infestations on farmed deer is increasing in prevalence and severity.

The geographic distribution of deer is detailed in Table I.

TABLE 1 NORTH ISLAND DISTRIBUTION OF FARMED DEER
(Source: Meat & Wool Board. Publ No. 1949)

	AREA	**% of National farmed deer population**
*	Northland+	1.0
*	Auckland+	7.8
*	Waikato+	11.3
*	Thames Valley+	1.7
*	Bay of Plenty+	12.2
	Tongariro	5.6
*	East Cape+	2.8
*	Hawkes Bay+	8.0
*	Taranaki	1.9
*	Wanganui	2.8
*	Manawatu	3.3
*	Wairarapa	1.2
*	Horowhenua/Wellington	0.9

* Tick prone (53.7% of national total)
\+ Most severely affected (37.6% of National total)

Approximately 38% of the national farmed deer population resides in areas which are known to be a source of tick infestation for sheep and cattle. By no means all farms in those areas are infested with the tick, but the potential is there for the introduction to deer herds. Recent figures indicate that approximately 15% of the farmed deer population changes farms each year. While this percentage will decrease as industry growth stabilises, there will be a large number of deer changing from farm to farm for many years to come. Thus the likelihood of transfer of ticks on deer from property to property remains very high. There is also a risk of spread of the tick with the transfer of sheep and cattle.

It is clear that if tick control in deer herds is not addressed at this stage, the distribution and prevalence of tick infestations on deer farms will increase.

Control of ticks in deer herds is a complex issue. Techniques including plunge spray or shower dipping, use of pour-ons, "Ivomec", dog tick collars; pyrethroid-impregnated ear tags, pasture control and pasture spraying have all been attempted on deer farms and a wide range of chemicals used. It would appear, however, that farmers' attempts to control ticks have rarely been carefully planned and therefore they appear to have had little influence on tick infestations on affected farms. On such farms ticks are an annually recurring problem.

This paper describes some aspects of tick infestation on deer. It describes the principles of control, and experimental work conducted recently to investigate the efficiency of one control programme.

2. THE SIGNIFICANCE OF TICKS TO DEER PRODUCTION

2.1 Death of newborn calves

Heavy infestations on newborn deer can result in death within 4-5 days of birth. Such deaths are due to anaemia. Ticks tend to accumulate around the ears and the head of newborn deer as they lie in their hides amongst long grass or other forms of cover. Ticks are found less commonly elsewhere on the body. In excess of 100 ticks have been observed on each ear of deer calves on heavily infested properties. With each tick consuming towards 0.5-1 ml of blood at repletion, and as much if not more ingested and excreted as dried haem over the engorgement period of 4-6 days, blood loss can be severe (a newborn red deer calf weighs approximately 8-9 kgs and therefore has approximately 600 ml of blood). Tick infestations on newborn deer probably also result in a general inappetance, depressed appetite, and lethargy which will exacerbate the animal's dehydration, and accelerate death.

2.2 Growth and Production

There is no data available on the effect of ticks on growth of deer. However, it is well known that even a small number of ticks (as few as 28) can depress weight gains in two-tooth ewes (Heath *et al.*, 1977). Thus the presence of only a small number of ticks on newborn deer probably has an influence on their postnatal growth rate.

Ticks inject saliva into the host to assist feeding by stopping coagulation of blood. However, these materials also influence the host by depressing the appetite. This must have an inhibitory effect on growth rate. Therefore it is likely that there is a significant subclinical production loss attributable to ticks in growing deer. In addition, it is likely that heavy infestations on adult hinds may hinder lactation and consequently, neonatal growth.

2.3 Hide damage

Injection of saliva by the attaching tick dissolves tissues at the site of attachment. The tick also causes plysical damage during insertion at its mouthparts. This results in a puncture of the skin, and this is clearly visible when the hide has been tanned. The scars left by a detached tick persist for a considerable length of time. Thus any number of ticks on a deer which is destined for slaughter has the potential of lowering the value of the hide.

Deer hides produce a very strong, high quality suede material of high value (Halligan pers. comm). In 1985/86 deer skins achieved an export value in excess of $0.5 million. A hide is currently worth approximately $25, therefore there is considerable potential for ticks to reduce the nett earnings of the deer industry in the future.

2.4 Velvet Antler Damage

Heavy tick infestations may be observed on growing velvet antler. Velvet antler growth occurs in the season when the adult tick is becoming most active. The ticks must be removed before the velvet can be sold and when numbers are high, visible scarring occurs. This is likely to result in down-grading as quality control becomes more stringent. It is also probable that heavy infestations reduce velvet antler yields.

3. TICK LIFE CYCLE AND EPIDEMIOLOGY

3.1 Life cycle

The life cycle of H. longicornis has been described in detail elsewhere (Heath, 1985). A schematic representation of the seasonal pattern of H. longicornis numbers on hosts is presented in Figure 1.

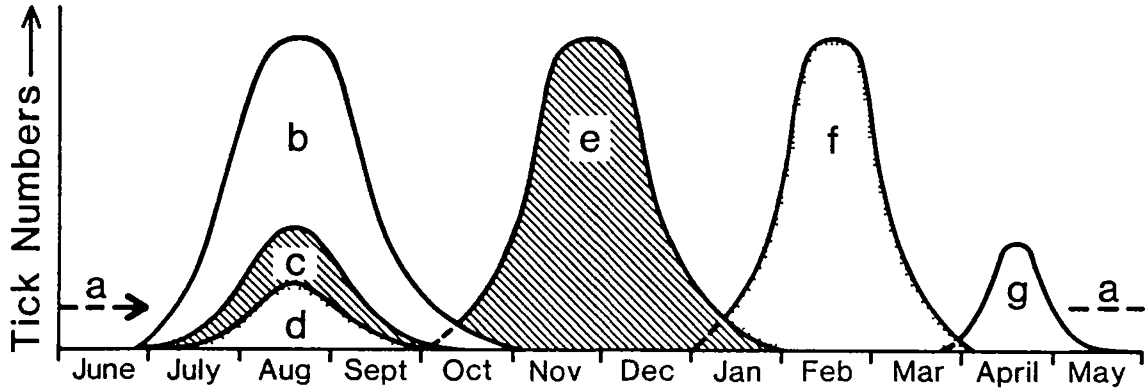


Figure 1. Diagrammatic representation of the seasonal pattern of activity of *Haemaphysalis longicornis* in warmer regions of New Zealand

For simplicity, only major peaks are shown and the diagram should be interpreted using the key below The troughs between peaks do not indicate a total absence of ticks on animals but show when ticks that comprise the main population cohorts for the year are undergoing development on the ground

Key

(a) overwintering eggs, larvae, nymphs and adults.

(b) main nymphal peak derived from overwintered unfed nymphs, gives rise to (e)

(c) early adult peak derived from overwintered engorged nymphs, gives rise to larvae in early to mid-summer and nymphs in mid to late summer (g)

(d) early larval peak derived from overwintered eggs or unfed larvae, gives rise to nymphs active in late spring to early summer and adults in late summer to autumn

(e) main adult peak derived from (b)

(f) main larval peak derived from (e)

(g) subsidiary nymphal peak derived from larvae feeding and moulting mid-late summer, these nymphs give rise to (c)

Adult ticks engorge on the deer for approximately 6 days, and then detach and find a suitable site amongst grass roots, under stones etc., in which to lay eggs. After 1-2 weeks 1000-2000 eggs are produced over a 2-3 week period. H. longicornis is parthenogenic. Adult ticks are found on deer in greatest numbers at a time that coincides with the peak of calving and velvet harvesting, ie: early December.

Eggs hatch in 60-90 days and the emergent larvae climb up vegetation and attach to a suitable host when contact is made. The larva attaches to the skin and becomes engorged after approximately 5 days. The larva sucks only a small quantity of blood. The larva then drops to the ground and finds a dark, moist hiding-place and enters a pre-moult phase of up to 30 days. The larva then moults to the nymphal stage. The peak of larvae infestation on the deer occurs during February and March.

The nymph is the stage most resistant to cold. Nymphs begin to attach to the deer during late winter and right through the spring. They feed for up to 7 days on the host and then detach. They shelter for approximately 40 days under vegetation before moulting to the adult stage. The adult attaches to the host and the cycle is completed.

There is evidence that in certain parts of New Zealand, particularly where the climate is warmer, that the tick may undergo more than one cycle of activity during the year. This is the reason why stages of the tick can be found at times of the year other than their normal peak of infestation for that stage.
It should be remembered that H. longicornis has a large number of potential hosts including deer, sheep, cattle, goats, horses, dogs, cats, hares, rabbits, stoats, hedgehogs and man.

3.2 Tick habitat

H. longicornis requires environmental conditions that fall within a particular range of temperature and humidity. Each stage has different requirements, eg: the nymphs can survive cooler conditions better than the other stages. Ticks survive best when the temperature range is 18-38°C and relative humidity is 85-95%. Eggs and larvae are very susceptible to desiccation. By comparison engorged adult ticks are highly resistant to desiccation, and the nymphs even more so.

Therefore regional and seasonal climatic variations exert a major influence on tick populations. However, it is clear that the type and density of vegetation and the microclimate on a particular property have the major bearing on tick survival.

Since the tick spends approximately 350 days of the year off the host, the environment is a major factor which influences tick survival. The requirements for shade and humidity are all-important. Ticks survive best where pastures are allowed to grow reasonably long, and where there is sufficient moisture to maintain a high humidity.

3.3 Newborn deer habitat

It can be seen that the life cycle and habitat of H. longicornis provides the newborn deer with the maximum challenge of the most pathogenic stage of the tick. It has been traditional for farmers to calve deer on paddocks with cover for the newborn to cater for the apparent need to hide. Cover such as long grass, scrub, weeds and rushes also provides the optimum conditions for survival of the tick. Thus, management may be a contributing factor to the apparently excellent survival of tick populations on deer farms.

3.4 Sites of attachment

The preferred site of attachment in newborn calves is the ear. However, ticks may be found at all other parts of the body when infestations are very heavy.

The preferred site of attachment on adult deer is the submandibular region. However, while ticks concentrate in that area they are also commonly found on the ears, along the ventral abdomen and on the face, but in lesser numbers elsewhere on the body.

4. PRINCIPLES OF TICK CONTROL

Tick control in deer herds must be compatible with seasonal management requirements; eg: it is not practical to treat hinds during calving or mating and it is undesirable to treat stags during the rut or late velvet antler growth. It is therefore important that a control programme must be designed for an individual farm, given the variety of farming options practised; eg: control on a farm with a breeding herd only will be different from that on a farm which concentrates on rearing young stock.

In essence, a control programme has four practical components:

- animal treatment
- modification of the tick environment
- use of other grazing species
- pasture treatment.

4.1 Animal treatment

The ideal chemical would have the following properties:-

I. Ease of application
II. Effective tickicidal activity
III. Activity of long duration
IV. Safety for deer and operator
V. Absence of side effects (irritation, hair loss)
VI. Absence of damage to the hide
VII. Absence of tissue residues
VIII. Low cost

A number of methods have been used to treat ticks on deer and these include:-

(a) Shower/sprays -

Organophosphates (eg. "Asuntol") or synthetic pyrethroids (eg. "Grenade") have been used. Plunge dipping of deer is practised in Queensland. The usual method of application here has been by hand-held jet sprays. This procedure is laborious and is not without its risks to the operator, particularly when organophosphates are used. It is difficult to get complete cover of the animal with the chemical, and it is a time-consuming exercise. There is no data on the longevity of effect of any of the shower or spray dips on deer. Experience indicates that the period of protection is fairly short. In cattle, protection is for 1-3 days, and with grease-free hair found on deer, protection probably would be even less (Heath *et al*, 1980).

Reservations have been expressed about the suitability of this technique for treatment of deer given the stress that it may cause. However, it is the author's experience that deer cope very well with this method of application. The limiting factors are the time and labour involved and short duration of chemical effectiveness.

(b) Pour-ons -

Pour-ons used have included both the organophosphate and synthetic pyrethroid types. While chemicals such as "Tiguvon" appear to have some effectiveness against ticks, the efficacy of this product and most other pour-ons available have not yet been evaluated for deer. On cattle this product provides protection for 1-3 days but by 3 days, protection is at best 50%.A later section of this paper reports on the efficacy of one synthetic pyrethroid in deer. Research conducted by one of the authors (PRW) indicates wide differences in the effectiveness of different pour-ons against ticks. Therefore care must be taken to choose chemicals with proven efficacy. It is anticipated that at least one such product will shortly be licensed for use on deer.

(c) Synthetic pyrethroid impregnated ear-tags / tick collars

Both of these techniques have been used. Ear-tags appear to have had limited success. However, a number of farmers have used dog tick collars on newborn deer. The technique has involved cutting a dog tick collar in half and applying these to newborn deer. This procedure is both laborious, particularly when deer numbers are high, and costly ($8 per collar). While this technique has afforded protection of the newborn deer, the effect on tick control on the property as a whole is probably minimal, since the ticks will be able to feed on older deer. This technique must therefore be regarded as a treatment rather than a preventive.

A further problem with the tick collars has been the tightening of the collar around the neck as the deer grows. Removal necessitates the mustering and yarding of very young deer, and acceptance of the risks of injury that are encumbent upon this practice.

(d) "Ivomec"(Avermectin)

"Ivomec" does not carry a label claim for use gainst ticks in this country. Research elsewhere has indicated some efficacy against various species of ticks, and the injectible form appears more effective than the oral form. Nolan and Schnitzerling (1983) concluded that "Ivomec" would need to be given at intervals not exceeding 7 days in cattle against *Boophilus microplus*. This would be an expensive exercise and for most farmers, weekly treatment would not be acceptable.

To the authors' knowledge, this drug is not commonly used for tick control in New Zealand.

4.2 Modification of the tick environment

A major feature of tick control must be to minimise the optimum habitat for the tick. Given that the tick resides for approximately 350 days of the year on the pasture, modification of the pasture environment should have a major impact on tick control.

Grass should be kept as short as possible while maintaining optimum feed availability for satisfying the nutritional requirements of stock. Shorter pastures allow for greater desiccation of immobile stages of the tick, and it is considered that the increase in penetration of solar radiation to soil level may also be harmful. Further, it is probable that intensive grazing results in a decline in tick numbers, because they are either consumed or trampled into the ground ("hoof and tooth").

However, on a deer farm where lush summer pasture is desirable for calving and lactation the requirements to reduce pasture cover to reduce tick numbers is incompatible with management requirements. The management requirements of deer farms tend to favour survival of the tick. Therefore, where ticks are a major problem some changes in management policies may be necessary.

Paddocks with rank pasture, reeds or rushes, or scrub should be avoided for calving. Calving paddocks should be prepared well in advance and they should have an even pasture cover and have been eaten out fairly low early in spring, ie: the 'hoof and tooth' effect. It is probably an advantage to graze heavily infested pastures very hard during winter to achieve a similar effect. Another advantageous procedure is to use silage paddocks for calving by taking silage off as close to calving as possible.

It would be managerially desirable to have hinds calving in alternate paddocks and to graze the unoccupied paddocks very low, perhaps using other classes of stock, in the early summer period, ie: during the early stage of calving, and allow these to recover to provide quality pasture for mid-summer and after (this practice also helps lactation and calf growth, since feed quality will be higher and is a procedure used successfully on the property described in Section 6 below).

4.3 Use of other stock

Ticks numbers on pasture may be reduced in preparation for calving by using some other class of stock, eg: yearling stags, or sheep or cattle, to graze those areas very heavily to provide a "vacuum

cleaner effect." Once the animals have grazed the pasture for no more than 3 days they can be removed and treated for ticks. Preferably this procedure should be repeated immediately. In this manner a substantial number of ticks can be removed from that pasture. This technique also assists the requirement of 4.2 above.

4.4 Treatment of pastures

A popular procedure on many tick-infested farms has been to spray pastures with chemicals that are presumed to be tickicidal. These are agricultural chemicals used as insecticides for various pasture pests. Such chemicals have included "Ripcord" (a synthetic pyrethroid), and Diaznon.

Until recently there has been no objective assessment of the effectiveness of pasture spraying. Reports and the experience of one of the authors (PRW) suggest that pasture spraying results in a transient reduction in tick activity, and therefore may be useful if it becomes apparent that other control measures (see Section 5) have been unsuccessful. It appears the chemical may be short-lived and kills only the ticks that it penetrates to. Chemical is usually applied by helicopter and is therefore expensive ($80-$100/ha). This procedure is risky since it has usually been done when hinds are calving, often even on paddocks with hinds and calves in. Ground spraying carries the risk of running over newborn deer as they hide in the pasture. The effects on non-target organisms on pasture, soil and water also are of considerable concern.

Because of the widespread practice of spraying pastures for ticks a research programme has been conducted by Ruakura scientists, Peter Pottinger and Ross Wren, in conjunction with our own studies (Section 6), to determine the effectiveness of chemical treatment of pastures as a method of tick control. This research is on-going and no results are yet available.

5. AN HYPOTHESIS FOR TICK CONTROL

Having considered all the above factors, it was considered that the most suitable approach to tick control on deer farms would be to initiate a programme as follows:

5.1 Hinds

Treat all hinds during the nymph phase of the tick, ie: mid-August until immediately prior to calving. This should reduce the need to treat newborn deer since a reduction in the survival of the nymph stage would result in a subsequent reduction in adult tick numbers. The alternative of treating during the larval phase would not be the most practical because it coincides with weaning and mating.

5.2 Stags

Treat all stags during the nymph phase of the tick, ie: mid-August onwards until velvet growth increased to a point where the risk of damage outweighed the benefit of treatment. Treatment for stags would be resumed at velvetting and through until late January, ie: towards the end of the adult tick phase.

5.3 Young stock

Young stock would be treated from mid-August through until late January, ie: through the peak of both the nymph and the adult phases, and if necessary, until immediately prior to the rut.

5.4 Annual programme

It must be expected that tick control will not be achieved in one season alone. To get a substantial reduction in the tick count on a heavily infested property the process may need to be repeated for a number of seasons. This is because the lifecycle of the tick can continue outside the times mentioned here (see Fig 1). In addition, a significant number of nymph ticks may delay attachment to a host until late in the season and these may attach to the hinds and calves, and thereby perpetuate the cycle. It is unlikely that any chemical treatment will be 100% effective. There are generally a number of feral hosts (particularly hares) available to perpetuate the cycle. As the tick numbers on the property decrease, the period and frequency of treatment may be able to be reduced. It is difficult to see how the tick could be eradicated from a property, therefore annual surveillance will be necessary. It has been advocated that a hare shooting campaign should be conducted.

5.5 Pasture control

As above (See section 4.2).

5.6 Pasture spray

This can be undertaken as an emergency procedure if other control measures have not been successful enough.

5.7 Treatment frequency

For the above programme to be effective it is imperative that deer are treated at such frequency as to provide continuous protection against tick infestations, thereby preventing a whole stage of the tick's life-cycle from being completed, ie: if nymphs are prevented from attaching and engorging, they will not develop to the adult stage.

For management reasons a chemical with a long residual effect is desirable. The chemical must also be easily applied.

6. EVALUATION OF FLUMETHRIN 1% POUR-ON ("BAYTICOL" BAYER AG)

Perusal of the literature indicated that flumethrin had a long period of persistence against ticks on cattle in a number of countries, (Hamel and van Amelstoort 1985). This chemical, in a 1% pour-on formulation, suggested some promise for use on deer. A study funded by Bayer New Zealand Ltd was undertaken to evaluate the use of this product in the suggested control programme as outlined above. This involved intensive trial work at the Massey University Deer Research Unit and this was followed up by an extensive field trial.

6.1 Intensive trials

These trials were undertaken to investigate various aspects of the use of "Bayticol".

6.1.1 Safety

20 mls of "Bayticol" Pour-on were applied to a number of deer and no signs of toxicity were observed.

6.1.2 Side effects

Observations of deer at intervals after application of "Bayticol" indicated that the formulation was somewhat irritant to deer. Behavioural responses included:-

- rubbing of the backline using the head
- attempts to scratch the dorsum with hind legs, particularly around the withers and neck area
- whole body shaking
- increased agitation manifest by changes in posture, ie: increased alternation of sitting and standing
- increased pacing
- less grazing
- occasional rolling on the ground
- occasional sternal recumbency with head stretched forward and with the jaw on the ground.

Many of these signs were observed 24 hours after application. No behavioural changes were observed after 48 hours.

However, it is interesting to note that behavioural changes of deer in the field trial work (see section 6.2) were not as marked as those on the Massey University deer herd. This was probably due to the conditioning of the deer at Massey to the presence of observers, and therefore such presence did little to alter their behavioural responses. However, in a large commercial herd attempts at observation of the deer resulted in a greater display of alert behaviour bordering on the flight response rather than behavioural responses suggesting irritation. Thus in a large commercial herd it is unlikely that behavioural changes observed would be particularly notable.

On the other hand, the increased grooming behaviour by the deer would assist in the spread of the chemical over the animal, particularly about the head, and this would indeed have some advantage since the primary site for tick attachment is the head.

It became apparent within 2-3 weeks of "Bayticol" application that there was hair loss in some animals along the line of application. It was not surprising that even untreated control deer had considerable hair loss at the time of observation (late winter/early spring). This coincided with the natural loss of the winter coat. However, it was clear that in a number of deer (approximately 17%) there was significant hair loss along the line of chemical application.

It must be stressed, however, that the hair loss was observed only when the animals were in their winter coat: "Bayticol" application to deer with summer coat resulted in no hair loss whatsoever. The summer coat grew normally on all treated deer.

6.1.3 Efficacy

To test the efficacy of "Bayticol" as a preliminary trial, three groups each of three deer were treated with 20 ml of flumethrin 1% pour-on ("Bayticol") applied along the mid-line from the base of the neck to the tail at intervals such that at the time of challenge with ticks 2, 4 and 6 weeks had elapsed since application of the acaricide. Four other animals remained untreated to serve as controls. These deer were kept in separate groups on pasture and were housed one day before tick infestation. A velcro rectangle was glued to the skin of each deer across the mid-line and over the thoracic cage. A terylene patch was fixed to the opposite portions of the velcro to form a tick-proof patch on the back of the deer. On the day of infestation 50 unengorged adult and 30 unengorged nymphs were applied to the area under the covers. 5-7 days later the ticks were recovered and examined for live/dead and engorged status.

No living ticks were recovered from any of the treated animals. Thus, when ticks are applied to the area upon which the chemical had been applied Bayticol appeared to give a period of protection of at least 6 weeks.

Results are to be reported in more detail elsewhere (Heath et al 1987).

6.1.4 Tissue residues

Two groups each of three deer were treated with Bayticol at intervals such that at the time of slaughter 1 and 3 days had elapsed since application of the acaricide. One untreated animal acted as a control. Deer were slaughtered and samples of kidney, muscle, liver and fat were taken for flumethrin analyses. There were no detectable residues in kidney or muscle.

Two of the deer treated one day previously had traces (0.01ppm) of flumethrin in the liver. One deer treated at each of 1 day and 3 days before slaughter contained 0.02ppm flumethrin in fat samples.

6.1.5 Hide quality

Hides from the deer slaughtered in 6.1.4 above were analysed by the Leather & Shoe Research Association for signs of damage associated with application of the pour-on. There was no indication of cytological or gross changes in hide quality or dye uptake following fluemthrin application.

Results of 6.1.4 and 5 are to be reported in more detail elsewhere (Wilson et al [b]).

6.2 Field trials

A field trial which involved 2,200 deer was conducted on a property in the South Kaipara Head area. The bulk of the herd was treated according to the programme outlined in 5 above. Tick counts were assessed subjectively by the manager, and it was observed that there had been a significant reduction in tick counts on newborn deer when compared with those observed in previous seasons. It must be stressed that no controls were available for this study as it was considered undesirable to place newborn deer at risk in a commercial enterprise.

6.2.1 Controlled trial

A second part of the field trial work involved a group of 66 eight-month old female deer. They were weighed and allocated to 2 groups of 33 on a paired bodyweight basis at the commencement of the trial (20.8.86). Each group was allocated to one paddock of approximately 4 ha. adjacent to one another. At the commencement of the study the pasture quantity and composition was matched as far as possible.

The two groups of deer were treated and sampled according to the Schedule in Table 2.

TABLE 2 Treatment, sampling and weighing dates for experimental groups.

DATE	(WEEK)	GROUP T=treated (n=33) C=control (n=33)	TREATMENT	SAMPLED (n = 10)	WEIGHED (n = 33)
20.8.86	(0)	T	T	S	W
		C	-	S	W
3.9.86	(2)	T	-	S	-
		C	-	S	-
17.9.86	(4)	T	T	S	-
		C	-	S	-
8.10.86	(7)	T	T	S	-
		C	-	S	-
15.10.86	(8)	T	-	S	W
		C	-	S	W
22.10.86	(9)	T		S	-
		C	-	S	-
30.10.86	(10)	T		S	-
		C	-	S	-
6.11.86	(11)	T		S	-
		C	-	S	-
12.11.86	(12)	T	T	S	-
		C	-	S	-
2.12.86	(14)	T	-	S	W
		C	-	S	W
10.12.86	(16)	T	T	S	-
		C	-	S	-
22.12.86	(18)	T	-	S	-
		C	-	S	-
21.1.87	(22)	T	-	S	W
		C	-	S	W
19.2.87	(26)	T	T	S	
		C	-	S	
17.3.87	(30)	T	-	S	W
		C	-	S	W

6.2.2 Sampling techniques

A preliminary investigation determined that to simplify tick collection it would be necessary to clip the hair from sample sites. The sites chosen were a strip along the area of the scapula, a strip along the mid-cervical region, the submandibular area from the ramus of the mandible to the lower lip, one ear, and a site along the bridge of the nose from between the eyes to the nostril.

This technique was subsequently validated by a comparison of tick counts from such clipped areas with those same sites on unclipped deer. It was noted that tick numbers were higher on the sites on unclipped deer. While this finding is of interest, it does not alter the relevance of the result since sampling was carried out in the same manner on each occasion.

6.2.3 Results

(a) Nymphs

Nymph counts are presented in Figure 2. Counts on control deer followed the expected seasonal pattern with a peak around 22.10.86. After each treatment there was a reduction in the tick count from each animal. Overall, the mean reduction in nymph count on treated deer was 29.2%.

There was, however, a variation in reduction after each treatment. It should be emphasised that the treatment interval ranged from three to five weeks, and that while a reduction of 29% does not look particularly striking, it is clear that a shorter treatment interval would result in a disproportionately greater decrease in tick count overall. The finding of the need to treat at intervals as short as 3 weeks is somewhat different to the finding of studies in 6.1 above. However, this trial examined the efficacy of the treatment in the face of a natural challenge. Tick counts in this situation are variable and the whole process of infestation, attachment and detachment is a dynamic process which is influenced by many factors during the time of study. It is clear that "Bayticol" provides considerably longer protection than that offered by other chemicals used to date.

(b) Adults

Infestation patterns with adults is presented in Figure 3. Few adults were present on the deer prior to 12.11.86. Adult tick counts peaked on control deer around 22.12.86. To that date there had been a 60% reduction in adult tick count on the treated deer.

While adult tick counts on treated deer on 21.1.87 exceeded those on untreated deer, it must be remembered that the treatment interval on that occasion was six weeks, ie: no chemical protection remained.

6.2.5 Conclusions

At treatment intervals of 3 weeks this trial has shown that "Bayticol" is effective in reducing tick counts on deer to a substantial degree. It must be remembered that this trial aimed to determine the optimum treatment frequency, and therefore it is expected that if the treatment frequency was reduced to a consistent 3-week interval that mean tick infestations on deer would be reduced considerably further than observed in this trial, which often used a greater treatment interval. Additional trial work is planned to investigate further a number of aspects of tick control.

Figure 2. MEAN NYMPH TICK COUNTS FROM TREATED AND CONTROL DEER

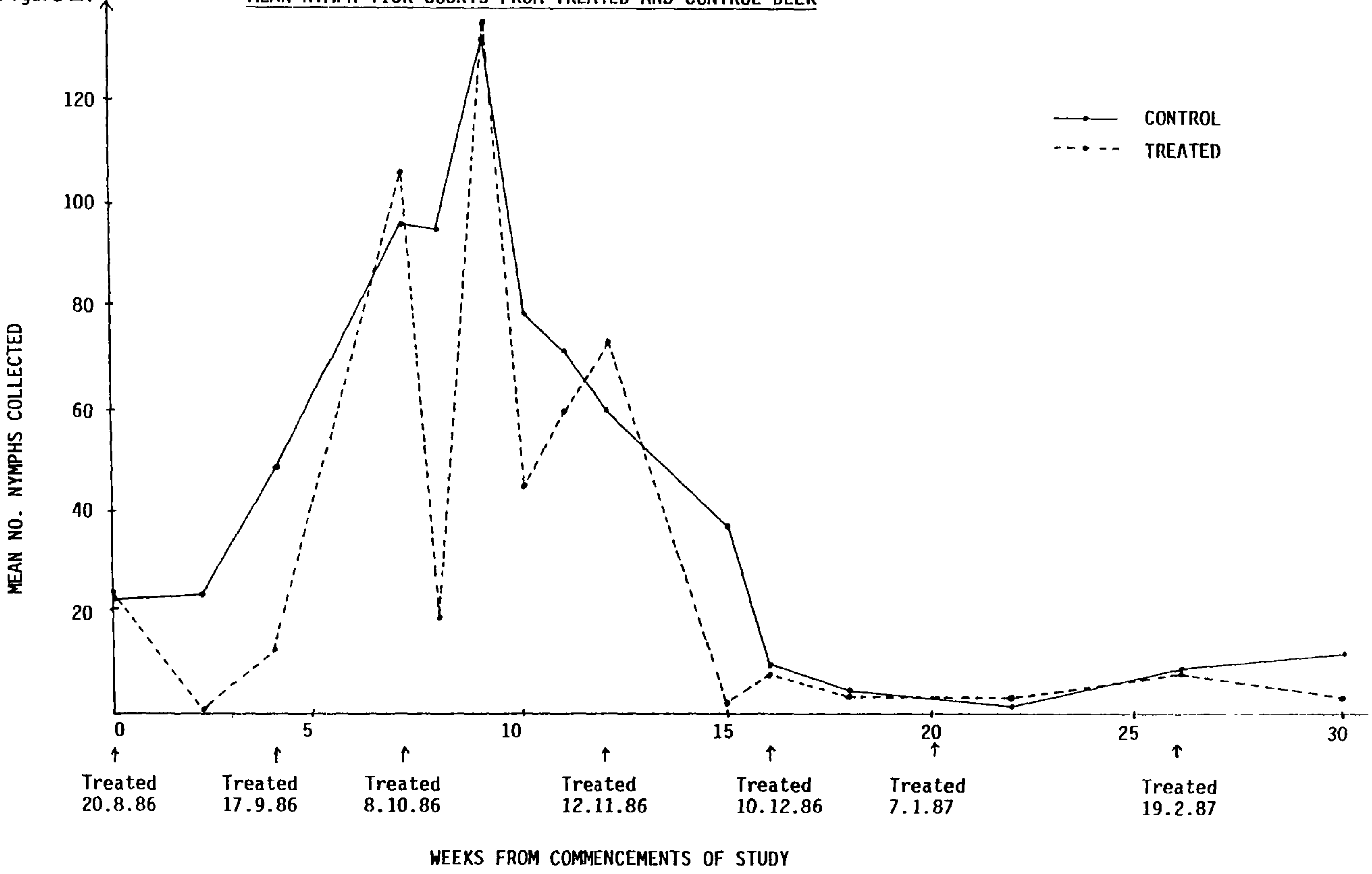
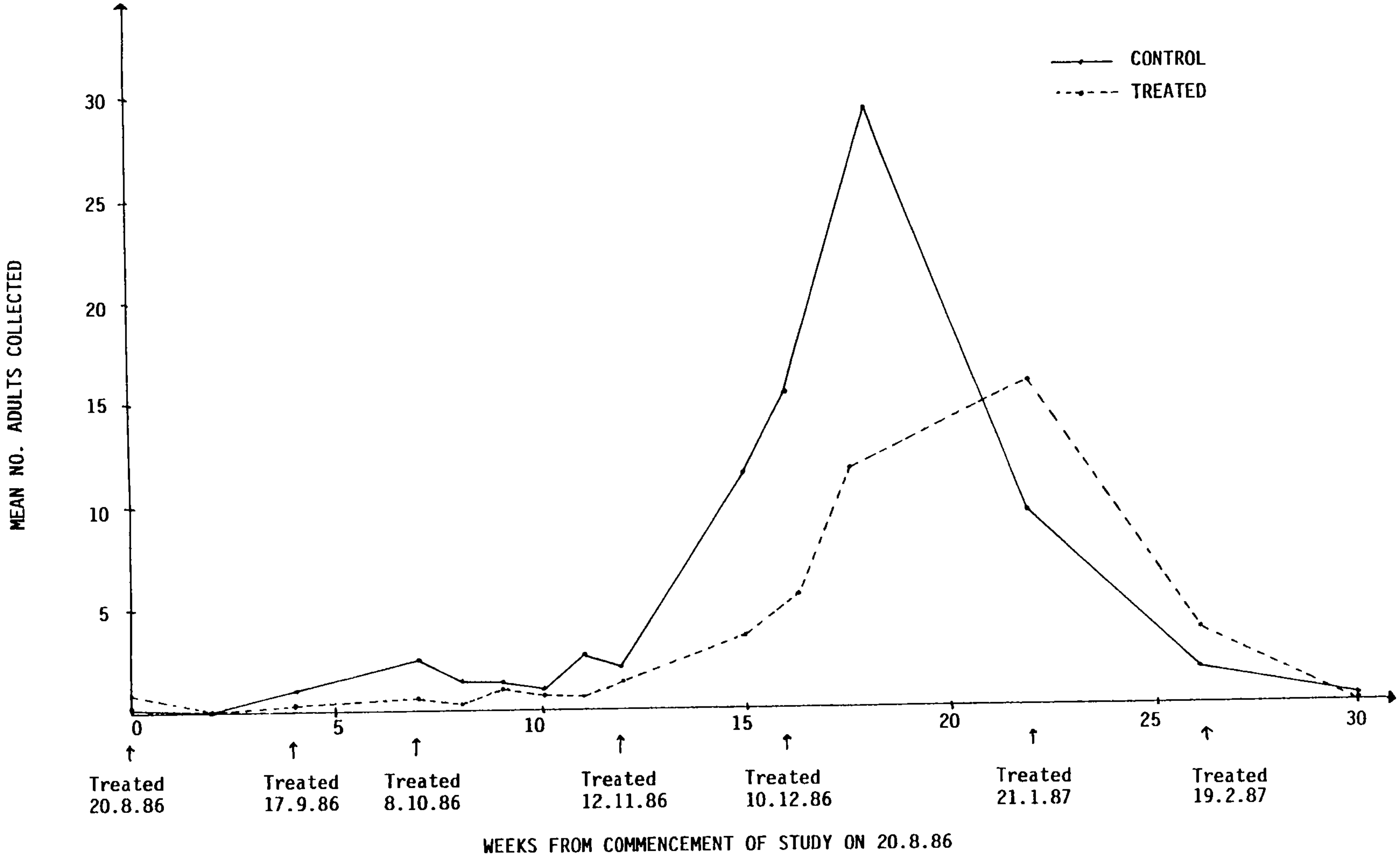


Figure 3

MEAN ADULT TICK COUNTS FROM TREATED AND CONTROL DEER



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