Parasites of domestic and wild animals in South Africa. XXXVII. Ixodid ticks on cattle on Kikuyu grass pastures and in Valley Bushveld in the Eastern Cape Province

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ABSTRACT

HORAK, I.G. 1999. Parasites of domestic and wild animals in South Africa. XXXVII. Ixodid ticks on cattle on Kikuyu grass pastures and in Valley Bushveld in the Eastern Cape Province. *Onderstepoort Journal of Veterinary Research*, 66:175–184

Individual calves, exposed to infestation for 14 d on dry-land Kikuyu grass pastures on the coast near Alexandria, were slaughtered at approximately monthly intervals over a period of 2 years and examined for ticks. Although seven species were recovered total tick burdens were for the most part low. Changing the acaricide with which other cattle on the farm, but not the survey calves, were treated from an organophosphate-based compound to a synthetic pyrethroid resulted in a marked sustained reduction in the number of ticks on the calves.

Successive pairs of yearling cattle exposed to infestation on a farm in Valley Bushveld were slaughtered at monthly intervals over a period of 2 years and examined for ixodid ticks. Eleven species were recovered, of which *Amblyomma hebraeum, Haemaphysalis silacea, Rhipicephalus appendiculatus* and *Rhipicephalus glabroscutatum* were the most abundant and prevalent. Adult *A. hebraeum* were generally most numerous from early to late summer, adult *R. appendiculatus* from mid to late summer, and adult *R. glabroscutatum* from spring to mid-summer.

Keywords: Acaricidal effect, cattle, Eastern Cape Province, ixodid ticks, Kikuyu grass pastures, seasonal abundance, Valley Bushveld

INTRODUCTION

Various surveys on the ixodid ticks parasitizing domestic animals on farms in the Eastern Cape Province have been published. These include studies on both coastal and inland farms. Robertson (1981) and Rechav (1982) have determined the seasonal abundance of ticks on cattle on a coastal farm close to East London. While Rechav (1982), Horak, Williams & Van Schalkwyk (1991a) and Horak, Knight & Williams (1991d) have done so for cattle, sheep and goats on inland farms.

Several studies on the ixodid ticks parasitizing domestic and wild animals on the farm "Bucklands" as well as wildlife in the adjacent Andries Vosloo Kudu Reserve, situated in Valley Bushveld in the Eastern Cape Province, have been published. These studies include cattle (Rechav 1982), Dorper sheep (Horak, Williams & Van Schalkwyk 1991a), Angora goats (Rechav 1982; Horak, Knight & Williams 1991d), greater kudus (Knight & Rechav 1978; Horak, Boomker, Spickett & De Vos 1992), scrub hares (Horak & Fourie 1991), four-striped grass mice (Rechav 1982) and helmeted guineafowls (Horak, Spickett, Braack & Williams 1991c). The seasonal abundance of questing tick larvae on the vegetation of the farm has also been ascertained (Rechav 1982; Petney & Horak 1987).

The present paper describes the abundance of ticks on dairy calves on the farm "Glendye", a coastal farm near Alexandria, and the seasonal abundance of

Accepted for publication 3 June 1999—Editor

ticks on young beef cattle on the farm "Bucklands", north of Grahamstown. This research was conducted a number of years ago, but for various reasons has not been published. The survey on Glendye" clearly demonstrates the "rub-off" effect of synthetic pyrethroid acaricides, while that on "Bucklands" was carried out simultaneously with some of those already published for other domestic and wild animals on this property and thus deserves recording for completeness sake.

GENERAL MATERIALS AND METHODS

TICK RECOVERY

After exposure to infestation on the farms the survey animals from "Glendye" and from "Bucklands" were transported to Grahamstown where they were slaughtered. The skin of the head, body and tail, as well as the lower legs and feet with skin attached, were removed from the carcasses and processed for tick recovery as described by Horak *et al.* (1992) for greater kudus.

TICK IDENTIFICATION AND COUNTS

Ticks were collected from the processed material, identified and counted under a stereoscopic microscope. The numbers of female ticks that were completing engorgement, and were therefore likely to detach within the next 24 h, were determined for each species using some of the idiosomal lengths suggested by Horak, Fourie, Novellie & Williams (1991b). The seasonal abundances of several of the tick species have been graphically illustrated using a square-root transformation of the data.

SURVEY ON "GLENDYE"

MATERIALS AND METHODS

Study site

The farm "Glendye" (33°45'S, 26°29'E; Alt. 137 m) is 232 ha in extent and is situated approximately 3000 m from the coast south of Alexandria, Eastern Cape Province. With the exception of some indigenous coastal forest retained as windbreaks and shelter, virtually the entire farm has been planted to Kikuyu grass, *Pennisetum clandestinum*, and divided into paddocks approximately 1 ha in size. These paddocks are not irrigated and are used mainly as grazing for dairy cattle. Rainfall is non-seasonal and the long-term mean annual total is 830 mm, virtually equally distributed between the first and second halves of the year. Total precipitation is supplemented by heavy coastal mists. At the time of the survey the farm was stocked with approximately 200 Friesland cows, 90 replacement heifers, 30 beef cattle and 40 mutton-breed sheep.

Four ha of the pastures were allocated to the study and were divided into four fenced paddocks, each approximately 1 ha in size. Prior to fencing this particular piece of pasture had been grazed by cattle and horses. Subsequent to the fencing five Friesland calves were rotated through the four paddocks and on occasion also dairy cows. All cattle were removed from the paddocks during November 1982. On 1 December 1982 15, 9-month old Friesland heifer calves were placed in one of the four paddocks and thereafter were rotated through these paddocks as the vegetation was grazed down.

From 29 November 1982 to 7 June 1983 the 15 heifers, as well as other cattle on the farm, were plunge-dipped in the acaricide chlorfenvinphos [Disnis: Agricura Animal Care (Sanvet)] at approximately 14-d intervals. From 21 June 1983 until the conclusion of the survey in November 1984 all the cattle were dipped at approximately 14 to 21-d intervals in the acaricide cyhalothrin [Librekto: Milborrow Animal Health (Sanvet)]. The heifers were artificially inseminated and removed from the paddocks shortly before they were due to calve. The last heifers were removed from the paddocks during September 1984. As the heifers were removed from the paddocks other dairy cattle were rotated through them.

Survey animals

Once every 28 d from December 1982 to January 1984, separate pairs of approximately 4-month old Friesland bull calves, raised under tick and worm-free conditions, were placed with the 15 heifers in the paddocks for a period of 14 d. Once every calendar month from February 1984 onwards, the pairs of calves were placed with the heifers or other cattle in the four paddocks for periods of 14 d. With the exception of one calf, which was accidentally plunge-dipped in chlorfenvinphos 2 d prior to its slaughter during April 1983, none of these calves was treated with an acaricide.

At the conclusion of their 14-d periods of exposure the bull calves were transported to Grahamstown. On the following day one was killed and processed for ecto- and endoparasite recovery. The other calf was killed 21 d later and processed only for the collection of endoparasites. The endoparasite burdens of the calves will be reported separately.

RESULTS AND DISCUSSION

The species and total numbers of ixodid ticks collected from the calves on "Glendye" are summarized in Table 1.

TABLE 1 Ixodid ticks collected from 25 Friesland bull calves on the farm "Glendye", Eastern Cape Province

Tick species	Total numbers recovered					No. of calves infested
	Larvae	Nymphs	Males	Females	Total	
Amblyomma hebraeum	40	0	0	0	40	6
Boophilus decoloratus	16	21	6	0	43	8
Haemaphysalis silacea	36	20	11	4	71	10
Ixodes sp.	2	0	0	0	2	1
Rhipicephalus appendiculatus	4 181	210	105	136 (5)	4 632	15
Rhipicephalus evertsi evertsi	188	158	6	1 (1)	353	9
Rhipicephalus glabroscutatum	17	4	0	0	21	2

( ) = number of engorging female ticks that could detach within the next 24 h

Seven species were recovered, with *Rhipicephalus appendiculatus* being the only species present in substantial numbers. The dominance of this tick on "Glendye" was possibly due to the clumps of indigenous trees retained on the pastures for shelter, which then provided a suitable habitat for its free-living stages. Although not illustrated here, the larvae of *R. appendiculatus* were most abundant from February to May 1983, the nymphs from April to June and in August 1983 and the adults from December 1982 to March 1983.

From the first week of June 1983 onwards, just before the acaricide used on the resident farm cattle on "Glendye" was changed from chlorfenvinphos to cyhalothrin, there was a marked decline in the total number of ticks acquired by the bull calves in the survey. This decrease persisted until the end of the study and is graphically illustrated in Fig. 1.

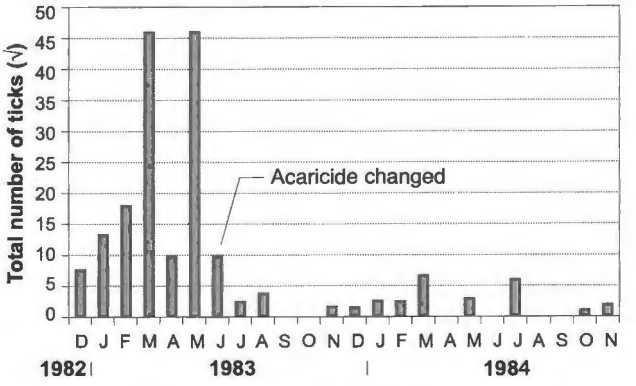

FIG. 1 The combined abundance of all stages and all species of ixodid ticks on individual calves on coastal Kikuyu grass pastures, Eastern Cape Province. One animal was examined at the beginning of August 1983 and another at the end of the same month and their average burden has been plotted

The organophosphate, chlorfenvinphos, initially used on "Glendye", had very little residual acaricidal effect on the cattle and probably no "rub-off" effect between cattle in the same paddock. In contrast the synthetic pyrethroid acaricides usually have a 7–10 d residual effect as well as a "rub-off" effect. Thus, although the survey calves themselves were not treated with either of the acaricides, some of the synthetic pyrethroid may have rubbed off on to them when they came into contact with the treated heifers and later with other cattle in the same paddocks. In addition, the high efficacy of the latter acaricide, combined with its residual effect, would not only have killed the ticks on the treated cattle on the farm, but would ultimately have led to a reduction in the numbers of free-living ticks on the pastures and consequently also on the survey calves.

Two studies with results similar to those recorded on "Glendye" have been published. The first was conducted on "Bucklands" and the adjacent Andries Vosloo Kudu Reserve (Horak & Knight 1986). In that study, with the exception of the various species of domestic animals used for survey purposes, all the cattle on "Bucklands" were treated with a synthetic pyrethroid acaricide at 2 to 4-weekly intervals and the sheep and goats at monthly intervals. This resulted in a significant reduction in the numbers of *A. hebraeum* on the vegetation as well as on greater kudus, scrub hares and helmeted guineafowls on the farm compared to those on the vegetation and the same wild animals on the adjacent reserve (Horak & Knight 1986; Petney & Horak 1987). Not one of the other tick species was similarly affected.

The second study was conducted on "Mubanga", a mixed cattle and wildlife farm, and on "Mtendere Game Ranch", a nearby wildlife farm, in the Central Province, Zambia (Zieger, Horak, Cauldwell, Uys & Bothma 1998). The cattle on "Mubanga" were treated with a synthetic pyrethroid acaricide at weekly intervals during summer and at 2-weekly intervals during winter. This resulted in a significant reduction in the numbers of *Amblyomma variegatum, R. appendiculatus* and *R. evertsi evertsi* on the vegetation as well as on impalas on the farm compared to those on the nearby "Mtendere Game Ranch" (Zieger *et al.* 1998). Those tick species which parasitized mainly wildlife on the farm were not affected by this treatment regime.

The significant reductions in tick numbers on the wild animals on both "Bucklands" and "Mubanga" could not be ascribed to the "rub-off" effect of the acaricides used on the domestic livestock as there would have been no contact between these animals and the wildlife. Rather they were due to the high efficacies of the remedies as well as their residual acaricidal effects on the domesticated hosts. This would have resulted in a disruption of the life cycles of the ticks on these hosts and consequently have led to reduced pasture contamination, ultimately resulting in reduced host infestation.

It thus appears possible to reduce the levels of tick infestation on all animals on a farm by the regular treatment of only some animals with an efficient acaricide with a residual effect. This option could have certain advantages in that the surviving tick population may provide sufficient challenge to maintain endemic stability to the tick-borne diseases prevalent at a particular locality and yet be too small to cause tick damage.

SURVEY ON "BUCKLANDS"

MATERIALS AND METHODS

Study site

The farm "Bucklands" (33°06'S, 26°41'E; Alt. 335–538 m) is 5 480 ha in extent and is situated along the banks of the Great Fish River, Eastern Cape Province. The vegetation is classified as Valley Bushveld (Acocks 1988). Rainfall is non-seasonal and the long-term mean annual total is 484 mm, of which slightly more than 300 mm falls from October to March. At the time of the survey the farm supported approximately 185 cattle, 300 Dorper sheep, 4 000 Angora goats, 300 greater kudus and large numbers of small antelopes, scrub hares and helmeted guineafowls. The domestic stock were regularly treated with the acaricide fenvalarate [Sumitik Cattle Dip: Shell SA (Pty) Ltd].

Survey animals

Four, approximately 12-month-old, beef-type oxen, which ran together, but separately from the other cattle on the farm, were not treated with an acaricide unless they were very heavily infested with ticks. At monthly intervals two yearling oxen were treated with a synthetic pyrethroid acaricide and kept under tick-free conditions for 7 d. They were then placed in the same camp on the farm as that in which the four normally untreated animals were grazing at that particular time.

After 1 month the two introduced cattle were removed from the camp, killed and processed for tick recovery. On the same day two more oxen of approximately the same age, and prepared in the same way as the previous two, were placed in the camp where they remained for a month before being killed for tick recovery. With the exception of December 1985 and January 1986, when only one animal was slaughtered on each occasion, this procedure was repeated for 24 consecutive months. Although the cattle were confined to the camps by fences these did not prevent greater kudus or smaller antelopes as well as other wildlife from entering the camps.

RESULTS AND DISCUSSION

The species and numbers of ixodid ticks collected from the cattle on "Bucklands" are summarized in Table 2.

Eleven tick species were recovered. Of these *Amblyomma hebraeum, Haemaphysalis silacea, Rhipicephalus appendiculatus* and *Rhipicephalus glabroscutatum* were the most abundant and all animals were infested with the latter three species. Adult ticks

TABLE 2 Ixodid ticks collected from 46 cattle on the farm "Bucklands", Eastern Cape Province

Tick species	Total numbers recovered					No. of cattle infested
	Larvae	Nymphs	Males	Females	Total	
Amblyomma hebraeum	6 769	366	778	314 (78)	8 227	45
Amblyomma marmoreum	1 796	13	0	0	1 809	29
Boophilus decoloratus	179	197	95	83 (38)	554	19
Haemaphysalis silacea	18 674	2 512	630	441 (224)	22 257	46
Hyalomma marginatum rufipes	0	0	21	16 (1)	37	10
Rhipicephalus appendiculatus	10 223	1 456	932	312 (95)	12 933	46
Rhipicephalus evertsi evertsi	1 354	916	55	19 (2)	2 344	33
Rhipicephalus exophthalmos	0	0	223	75 (22)	298	19
Rhipicephalus glabroscutatum	16 889	3 975	1 076	649 (66)	22 589	46
Rhipicephalus simus	0	0	28	20 (4)	48	15
Rhipicephalus sp.	2	5	0	0	7	4

( ) = number of engorging female ticks that could detach within the next 24 h

accounted for a substantial proportion of the total tick population and large numbers of females were completing engorgement on the cattle.

Fifteen tick species have already been collected from cattle, Dorper sheep, Angora goats, greater kudus, four-striped grass mice, scrub hares and helmeted guineafowls examined on "Bucklands" (Knight & Rechav 1978; Rechav 1982; Horak & Fourie 1991; Horak *et al.* 1991a, c, d; 1992).

Four of these 15 species were not recovered in the present survey. One of these four was *Rhipicephalus oculatus,* which parasitizes hares almost exclusively (Keirans, Walker, Horak & Heyne 1993) and occurs in large numbers on scrub hares on "Bucklands" (Horak & Fourie 1991). The other three missing species were *Haemaphysalis leachi, Hyalomma truncatum* and *Ixodes pilosus. H. leachi* is a carnivore tick, but feeds on certain murid rodents and also on carnivores during its immature stages (Hoogstraal 1956; Norval 1984). Hence its absence on the cattle is not surprising. On the other hand cattle are one of the preferred hosts of adult *H. truncatum* (Hoogstraal 1956; Norval 1982). It was absent on the survey animals, despite the fact that a few of its immature stages were collected from scrub hares examined at the same time (Horak & Fourie 1991). This suggests that "Bucklands" lies at the limits of this tick's distribution in this region of the Eastern Cape Province. The same probably applies to both *I. pilosus* and *Hyalomma marginatum rufipes.* The latter tick was, however, collected from the survey cattle in small numbers.

The seasonal abundances of *A. hebraeum, Amblyomma marmoreum, H. silacea, R. appendiculatus* and *R. glabroscutatum* are graphically illustrated in Fig. 2–6.

Amblyomma hebraeum

The parasitic and free-living populations of *A. hebraeum* on "Bucklands" were considerably reduced by the regular acaricidal treatment of the resident domestic stock (Horak & Knight 1986; Petney & Horak 1987). The 8 227 and 199 ticks collected from the 46 cattle and from the nine greater kudus respectively examined on "Bucklands" compared with the 36 293 *A. hebraeum* collected from the 16 kudus examined on the adjacent Andries Vosloo Kudu Reserve during the same time period confirm this (Table 2; Horak *et al.* 1992). The tick burdens on the survey cattle would undoubtedly have been lower had they grazed with the other cattle on the farm and not been kept separately in camps with the four untreated cattle on which only emergency acaricidal treatment was permitted. The fairly large adult burdens recorded on the cattle during the summer months substantiates the preference of this life stage for cattle and for other large hosts (Theiler 1962; Norval 1983; Horak, MacIvor, Petney & De Vos 1987a).

Despite the reduced numbers of *A. hebraeum* it was still possible to determine a pattern of seasonal abundance on the cattle (Fig. 2). The larvae were most abundant during the period March to May (autumn) and the adults during the period October to May (summer to autumn). No clear pattern of seasonality was evident for the nymphs. The larval and adult abundance corresponds to that observed on greater kudus in the same vicinity by Knight & Rechav (1978) and by Horak *et al.* (1992) and on cattle in the same region (Rechav 1982), as well as on cattle in thornveld in southern KwaZulu-Natal (Baker & Ducasse 1967). The abundance of adults from early to late summer also corresponds to that observed on cattle in the Northern Province of South Africa and in southern Zimbabwe (Horak 1982; Norval 1983).

This pattern of abundance, which is probably controlled by climate, strongly suggests that at least the majority of the population completes a single life cycle annually at these localities. In regions where the winters are warmer, such as the north-eastern lowveld of the KwaZulu-Natal and Mpumalanga Provinces, there is little indication of a pattern of seasonal abundance with all stages of development being present simultaneously (Horak *et al.* 1992; Horak, Boomker & Flamand 1995). In these regions it seems possible that the life cycle may even be shorter than 1 year. In Norval's (1977) initial research on *A. hebraeum* in the Eastern Cape Province he stated that the life cycle is normally of 3 years duration. Rechav (1982), however, disagreed and suggested that his own research in this province indicated that many ticks completed a 1-year life cycle, with a few cohorts having a life cycle of 15–18 months. The present results tend to confirm Rechav's findings.

Amblyomma marmoreum

All parasitic stages of this tick prefer tortoises, and probably more particularly leopard tortoises as hosts (Theiler 1962; Norval 1975b; Dower, Petney & Horak 1988). However, the larvae and sometimes the nymphs commonly also infest carnivores, equids, ruminants, lagomorphs and the larger ground-frequenting birds (Norval 1975b; Horak *et al.* 1987a; Horak, Jacot Guillarmod, Moolman & De Vos 1987b). During the period of the present study cattle, sheep, goats, greater kudus, scrub hares and helmeted guineafowls were concurrently examined on "Bucklands" (Horak & Fourie 1991; Horak *et al.* 1991a, b, c; 1992). The prevalence of infestation on the ruminants varied between a low of 47,9% on sheep and a high of 63,0% on cattle, while 25,5% of scrub hares and 78,4% of guineafowls were infested.

The peak period of larval abundance from January to April or May on the above-mentioned animals

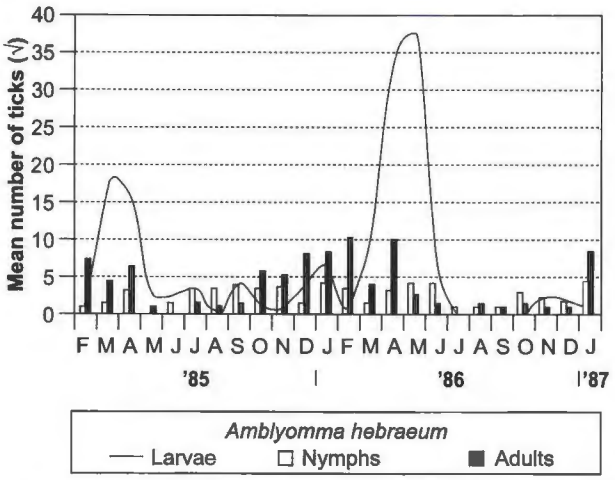

FIG. 2 The seasonal abundance of *Amblyomma hebraeum* on yearling cattle in Valley Bushveld, Eastern Cape Province

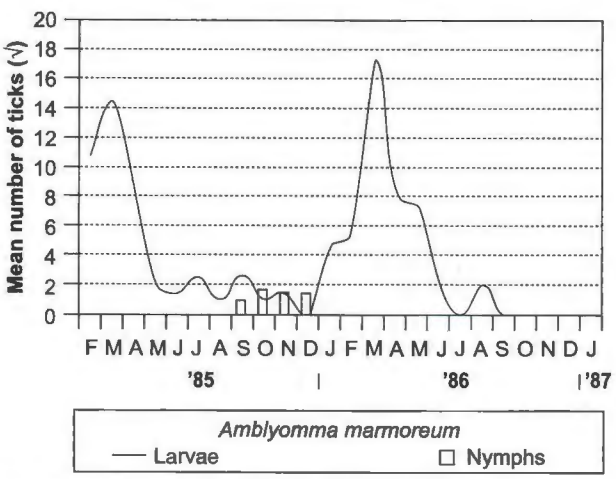

FIG. 3 The seasonal abundance of *Amblyomma marmoreum* on yearling cattle in Valley Bushveld, Eastern Cape Province

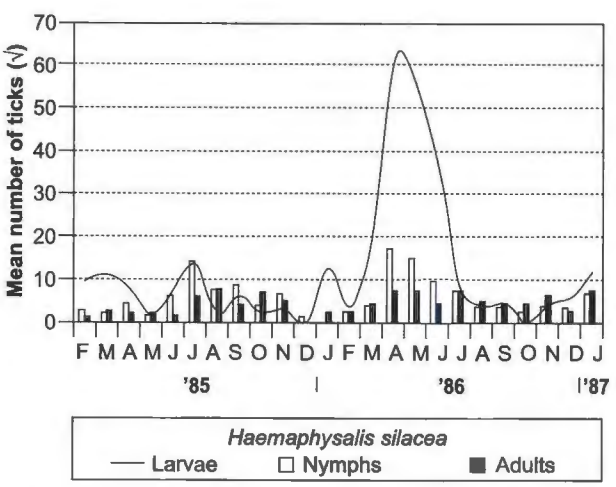

FIG. 4 The seasonal abundance of *Haemaphysalis silacea* on yearling cattle in Valley Bushveld, Eastern Cape Province

would seem to indicate a 1-year life cycle for this tick (Fig. 3). On the preferred tortoise hosts a cycle as short as this seems unlikely as larvae may remain attached for as long as 30–104 d, nymphs 47–51 d and females 60–73 d (Norval 1975b; Dower *et al.* 1988). The parasitic portion of the life cycle on tortoises could thus theoretically last 228 d, making it improbable that the total life cycle could be completed within 1 year. Norval (1975b) has suggested that the life cycle of *A. marmoreum* in the Eastern Cape Province can be 1 or 2 years long depending on whether the nymphs feed on tortoises during spring or during mid-summer. However, should the immature stages feed on sheep, and probably other warm-blooded animals, this may only take between 6 and 12 d for the larvae and between 8 and 20 d for the nymphs (Norval 1975b). This eventuality would reduce the parasitic phase of the life cycle, and possibly the length of the whole life cycle, considerably.

Boophilus decoloratus

Cattle and greater kudus are excellent hosts of this tick (Hoogstraal 1956; Baker & Ducasse 1967; Mason & Norval 1980; Horak *et al.* 1992). The small numbers collected from the cattle in the present survey, and from greater kudus on "Bucklands" and in the adjacent Andries Vosloo Kudu Reserve during the concurrent surveys on the latter animals (Horak *et al.* 1992), indicate that this farm and its environs are not a suitable habitat for *B. decoloratus*. This is confirmed by the fact that Rechav (1982) collected large numbers of this tick from cattle on the farm "Beaconsfield", scarcely 45 km to the south of "Bucklands", whereas he found none on cattle examined on "Bucklands" at the same time. Whether these differences were due to climatic, vegetational or other dissimilarities between the two farms could not be determined within the scope of this survey.

Haemaphysalis silacea

This tick was the second most numerous on the cattle and many of the females were completing engorgement. On greater kudus examined concurrently in the adjacent Andries Vosloo Kudu Reserve 27,8% of males, 59,5% of females and 84,8% of females completing engorgement were attached to the tails of the animals (Horak *et al.* 1992). In the present study 18,6% of the males, 31,5% of the females and 22,3% of engorging females were attached to the tails of the cattle. These differences could be due to the vastly different structures and pilosities of the tails of these two hosts, with the short bushy tails of the kudus affording greater protection to the adult ticks. Besides cattle, all stages of development may be found on sheep and goats as well as on various antelope species and also, rarely, on dogs. The immature stages have been found on small wild carnivores, scrub hares and helmeted guineafowls (Norval 1975a; Horak *et al.* 1987b; Walker 1991).

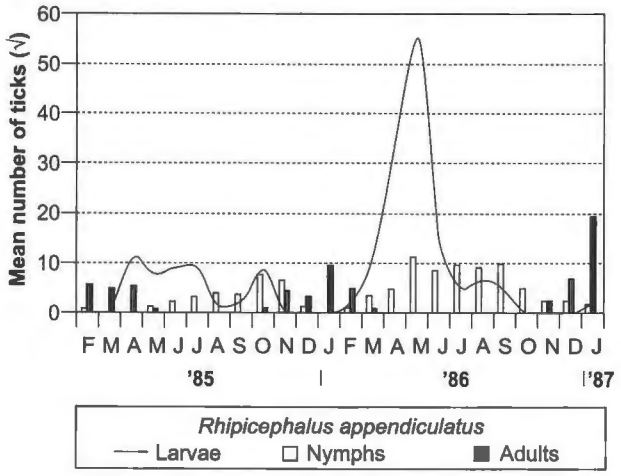

FIG. 5 The seasonal abundance of *Rhipicephalus appendiculatus* on yearling cattle in Valley Bushveld, Eastern Cape Province

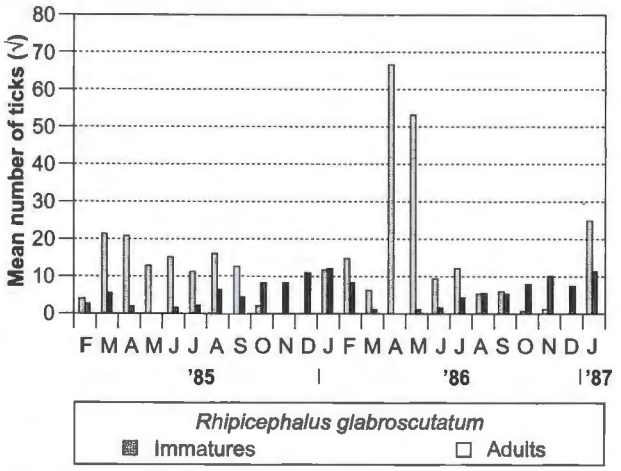

FIG. 6 The seasonal abundance of *Rhipicephalus glabroscutatum* on yearling cattle in Valley Bushveld, Eastern Cape Province

Apparently the life cycle continues throughout the year but with peaks of larval abundance occurring from late summer to winter, nymphs from autumn to spring and adults in spring and in late summer (Norval 1975a; Rechav 1982; Horak *et al.* 1991d; 1992; Fig. 4).

Haemaphysalis silacea is found only in parts of South Africa. Even here it is confined to localized areas of Fish River Bush along the hot and dry river valleys in the Eastern Cape Province as well as to the subtropical and deciduous bush complex along the coast (Theiler 1945; Norval 1975a; Rechav 1982). It is also present in KwaZulu-Natal, especially in the Hluhluwe, Umfolozi and St Lucia regions (Baker & Keep 1970; Horak, Keep, Flamand & Boomker 1988; Horak *et al.* 1995), in vegetation types classified as Valley Bushveld, Lowveld and Coastal Forest and Thornveld (Acocks 1988).

Rhipicephalus appendiculatus

All stages of development prefer cattle and the larger wild bovids as hosts (Yeoman & Walker 1967; Walker 1974; Norval, Walker & Colborne 1982). The immature stages are also found on the smaller antelopes as well as on carnivores and on hares (Clifford, Flux & Hoogstraal 1976; Norval *et al.* 1982; Horak & Fourie 1991).

Although the seasonal abundance of *R. appendiculatus* in the present survey was typical for this species in the Eastern Cape Province adult numbers were nevertheless relatively low in the late summer of 1985 and during the subsequent summer of 1985/1986 (Fig. 5). The larval and nymphal numbers were also low during the autumn to spring months of 1985. However, larval numbers increased considerably during 1986, commencing in February and peaking at several thousand during May and continuing until September. The numbers of nymphs collected during 1986 also considerably exceeded those collected during 1985. These were followed by the greatest numbers of adults collected during the entire survey from the cattle examined during January 1987.

Short & Norval (1981) state that the seasonal occurrence of the larvae and the nymphs of *R. appendiculatus* is determined by the pattern set by the adults. According to them the activity of the latter life stage is influenced by rainfall, temperature and daylength. Randolph (1993), on the other hand, believes that it is the timing of the questing activity of the dessication-vulnerable larvae that determines the pattern of the tick's seasonal activity. She suggests that the timing of nymphal and adult activity is determined by temperature-dependent development rates as well as the delaying phenomenon of photo-period sensitive diapause. She also thinks that the timing and duration of this diapause have evolved to achieve maximum tick survival by ensuring the presence of eggs and larvae during optimal climatic conditions.

The proposals by Short & Norval (1981) and Randolph (1993) are not necessarily mutually exclusive. They probably complement one another. In the current survey both larval and nymphal activity commenced approximately 2 months earlier during 1986 than during 1985 and greater numbers of both stages were collected. The increase in numbers during 1986 may, however, not have been due to more favourable climatic conditions, but rather to the fact that by that time hardly any acaricide had been used on the four cattle kept permanently in the survey camps. The absence of control could have resulted in an overall increase in tick numbers.

"Bucklands" is situated fairly close to the western extremity of the distribution of *R. appendiculatus* in the Eastern Cape Province. At Grahamstown, 30 km to the south-west, it occurs in mixed infestations with *Rhipicephalus nitens* (Horak *et al.* 1987b). On the

farm "Sidbury", situated in Eastern Province Thornveld interspersed with macchia (fynbos), 60 km to the south-west of "Bucklands", it is virtually entirely replaced by *R. nitens* (Horak *et al.* 1991a), while in the Addo Elephant National Park, in Valley Bushveld 100 km to the south-west, both ticks are absent (Horak *et al.* 1992).

Rhipicephalus evertsi evertsi

All stages of development of this two-host tick prefer equids and eland as hosts, on which they may occur in large numbers (Hoogstraal 1956; Norval 1981; Horak *et al.* 1991b). Cattle are frequently infested but seldom harbour the same large numbers of any stage of development as do the former animals (Rechav 1982; Baker, Ducasse, Sutherst & Maywald 1989). Few ticks were collected at "Bucklands", and all stages of development generally preferred the warmer months from November to April. This pattern of abundance agrees with the findings of Rechav (1982) on the farms "Beaconsfield" and "Luembe" in the Eastern Cape Province and those of Baker & Ducasse (1967) in southern KwaZulu-Natal. In localities with warmer winters, such as in Zimbabwe and Zambia, *R. evertsi evertsi* can apparently complete more than one generation annually and successive "waves" of adult activity can be detected (MacLeod, Colbo, Madbouly & Mwanaumo 1977; Matson & Norval 1977).

Rhipicephalus exophthalmos

This tick, which has frequently been confused with *Rhipicephalus oculatus,* with which it often occurs sympatrically on scrub hares, has only recently been described (Keirans *et al.* 1993). Unlike *R. oculatus,* however, which virtually exclusively parasitizes hares, *R. exophthalmos* is encountered on domestic and wild ungulates as well as on hares (Keirans *et al.* 1993). The largest collections to date are those from the two calves examined on "Bucklands" during January 1987. They harboured 85 males, 12 females and 76 males, 24 females respectively. Until recently the only known hosts of the immature stages were scrub hares [Horak & Fourie 1991, as *Rhipicephalus* sp. (near *R. oculatus*)], but they have now also been collected from various species of elephant shrews (Fourie & Horak, unpublished data). Ticks were present on the cattle from February to April 1985, December 1985 to February 1986, and from August 1986 until the termination of the survey in January 1987.

R. exophthalmos is widely distributed in Namibia and in the southern regions of the Eastern and Western Cape Provinces, South Africa (Keirans *et al.* 1993).

Rhipicephalus glabroscutatum

Although this was the most prevalent and abundant tick on cattle on "Bucklands", these animals are not necessarily its preferred hosts. Greater kudus examined at the same time as the cattle on the farm harboured considerably larger numbers of ticks (Horak *et al.* 1992). Other antelopes such as eland and mountain reedbuck are also good hosts (Horak *et al.* 1991b). Large numbers of adult ticks have also been collected from Angora and Boer goats in flocks on which no acaricide was used (MacIvor & Horak 1987). *R. glabroscutatum* is of considerable economic importance on goats in that it has been associated with the occurrence of foot abscesses in these animals (MacIvor & Horak 1987).

This is a two-host tick (Du Toit 1941) and the seasonality of its immature stages, from late summer to spring and its adults from spring to late summer throughout its distribution range, indicate that a single life cycle is completed annually (Horak, Sheppey, Knight & Beuthin 1986; MacIvor & Horak 1987; Horak *et al.* 1991b, d; Fig. 6). *R. glabroscutatum* is found only in South Africa and then only in the Eastern and Western Cape Provinces (MacIvor 1985; Walker 1991).

Rhipicephalus simus

Adults prefer large bovids, such as cattle and African buffaloes, as well as equids, suids and the larger wild carnivores as hosts (Norval & Mason 1981; Walker 1991). The immature stages parasitize various species of murid rodents (Norval & Mason 1981), of which the four-striped grass mouse appears to be particularly favoured (Rechav 1982). Adult *R. simus* are never very numerous and are generally most abundant during the spring and summer months (Baker & Ducasse 1967; Norval & Mason 1981; Horak *et al.* 1987b). The larvae are most numerous on four-striped grass mice in autumn and early winter and the nymphs from early winter to spring (Rechav 1982). The very small numbers of adults collected in the present survey probably indicate that the prevailing climate on "Bucklands" is too arid for this tick, which generally prefers the moister regions of the country (Walker 1991).

ACKNOWLEDGEMENTS

My sincere thanks are due to Messrs H.J.D Matthews and W.A. Phillips for the use of their farms and facilities for the duration of the surveys. Dr Ursula Evans was responsible for rearing the calves used during the survey on "Glendye", and Dr Evans and Messrs John White and Simon Matthews were responsible for their management on the farm. The assistance of Messrs M.M. Knight and E.J. Williams with processing the necropsies for the recovery of ticks, and Messrs E.J. Williams and D.C. Willemse with collecting the ticks from the processed material is greatly appreciated. I am most grateful to Dr J.E. Crafford for preparing the figures.

This research was funded by the South African Meat Board, Rhodes University, Pfizer Animal Health and the Foundation for Research Development.

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