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PARASITES OF DOMESTIC AND WILD ANIMALS IN SOUTH AFRICA. XV. THE SEASONAL PREVALENCE OF ECTOPARASITES ON IMPALA AND CATTLE IN THE NORTHERN TRANSVAAL*

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ABSTRACT

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The prevalence of ectoparasites on a total of 36 impala *(Aepyceros melampus)* slaughtered monthly from February 1975 to February 1976 and a total of 24 cattle slaughtered monthly from March 1976 to March 1977 in the Nylsvley Provincial Nature Reserve was determined. Six species of ixodid ticks were collected from the impala and these, in order of abundance, were: *Rhipicephalus evertsi evertsi, Rhipicephalus appe..liculatus, Amblyomma hebraeum, Boophilus decoloratus, Ixodes cavipalpus* and *Hyalomma marginatum rufipes*. Only 340 (2,7%) of the 12 757 ticks collected from the impala were adult. The 4 species of lice present on the impala were, in order of abundance: *Damalinia aepycerus, Linognathus aepycerus, Damalinia elongata* and *Linognathus nevilli*. The cattle harboured 8 species of ixodid ticks. In order of abundance, these were: *R. appendiculatus, R. evertsi evertsi, A. hebraeum, Hyalomma truncatum, H. marginatum rufipes, B. decoloratus, Rhipicephalus simus* and *I. cavipalpus*. A total of 14 186 ticks was collected from the cattle and of these 4 660 (32,9%) were adults.

Clear seasonal prevalences could be determined for certain ticks only. Adult *A. hebraeum* reached peak numbers on cattle from November to March, adult *H. marginatum rufipes* from December to February and adult *H. truncatum* during January and February. Larvae of *R. appendiculatus* reached peak numbers on cattle and impala from March or April to July, nymphae from June to October and adults from December to March. Peak numbers of larvae of *R. evertsi evertsi* were recovered from impala from May to July and nymphae during July, while adults were present on cattle throughout the survey period, with peaks being recorded during December and February.

INTRODUCTION

The seasonal prevalence of adult ticks on cattle grazing in the Nylsvley Provincial Nature Reserve in the Naboomspruit area of the northern Transvaal has been determined by Londt, Horak & De Villiers (1979). Although they recovered some immature ticks, their sampling methods were not sufficiently sensitive for the collection of these in large numbers. The present paper describes surveys of ectoparasites conducted on cattle running with the animals that Londt *et al.* (1979) used in their survey, and on impala *(Aepyceros melampus)*. All the ticks were collected at slaughter from these animals, and their viscera were processed for the recovery of helminth parasites (Horak, 1978a, b).

MATERIALS AND METHODS

Survey area

The survey area in the Nylsvley Nature Reserve (24°29′S; 28°42′E; Alt. ± 1 110 m) comprised 750 ha situated in a region classified as Mixed Bushveld (Acocks, 1975). The vegetation in the survey area consisted of trees, among which *Burkea africana* predominated, shrubs, chiefly *Ochna pulchra* and *Grewia flavescens*, and a herbaceous layer consisting mainly of the grasses *Eragrostis pallens* and *Digitaria eranthia* (Hirst, 1975). This area was continuously grazed by approximately 75 impala and annually from January to May by approximately 200–300 cattle.

Survey on impala

Each month, from February 1975 to February 1976, 2–4 impala were shot in the survey area. The carcasses were transported to a central point where they were eviscerated and their bodies skinned, the skins, heads and legs with skin intact and viscera being placed in separate plastic bags. After transportation to the laboratory at Onderstepoort, the heads, the legs below the knees and hocks, and the hides were immersed separately in large buckets containing water judged to be hot enough (± 60–70 °C) to kill the ectoparasites but not hot enough to remove the hair. They were immersed several times in this hot water and then transferred to buckets containing cold water in which they were also immersed several times. The legs and heads were thoroughly scraped with a sharp knife and the ears were cut off, the ear canal opened and carefully washed. After immersion, washing and scraping, the hides, heads and legs were examined for adult ticks and engorged nymphae which were removed and added to the washings. All water used for immersion or washing was sieved through sieves with 38 μm apertures and the sieve contents were collected, preserved with formalin and stored for later identification and counting under a stereoscopic microscope.

All the lice and all the adult ticks were counted and identified. Where fewer than 200 larval or 200 nymphal ticks were recovered from a particular site (head, hide or legs), all of these were counted and identified. If more than 200 larvae or 200 nymphae were recovered from a particular site, all were counted and at least 200 larvae or 200 nymphae were identified and the remainder allocated to species in proportion to their relative abundance as calculated from these identifications.

The *Amblyomma* larvae were not identified specifically; it was assumed that they were *A. hebraeum*. It is possible that some may have been *A. marmoreum* for although most of these prefer to feed on tortoises (which were also present in the study area), they may also be found on antelope (Norval, 1974). No specific identification of the immature stages of *Ixodes* was attempted.

Survey on cattle

Approximately 220 10–12-month-old Afrikaner and Afrikaner-type cattle were brought into the survey area during January 1976. From these 6 Afrikaner oxen were selected for the survey on the prevalence of adult ticks (Londt *et al.*, 1979) and grazed the study area with the Afrikaner cattle used in the present survey.

During the 1st week of May 1976 the approximately 200 cattle not being used in these studies were removed from the study area. During January 1977 about 250 8–10-month-old Afrikaner and Afrikaner-type calves were introduced into the survey area and remained until after the completion of the survey.

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* This survey forms part of the South African Savanna Ecosystem Project

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During their sojourn in the area the cattle not being used in the surveys were plunge-dipped weekly. The survey cattle were hand-sprayed with an acaricide* at 2-week intervals, the last spraying taking place 2 weeks before slaughter on each occasion.

With the exception of August 1976 and March 1977, when only 1 animal was slaughtered on each occasion, the survey animals were slaughtered in pairs at approximately 4 or 6 week intervals. The intervals were so arranged that animals were slaughtered each month from March 1976 to March 1977.

On all but 1 occasion, when heavy rainfall made this impossible, the majority of adult ticks were collected from the hides of the animals before and immediately after they were slaughtered. After slaughter the method of ectoparasite recovery employed was the same as that for the impala except that, to save labour, the hide from only 1 side of the body was processed. Counting and identification of the ectoparasites were done in the same way as for the impala.

RESULTS

The ticks and lice recovered from impala, their total numbers and relative abundance are summarized in Table 1.

Six species of ticks and 4 of lice were recovered. *Rhipicephalus evertsi evertsi* was the most abundant tick, followed by *Rhipicephalus appendiculatus*, while *Damalinia aepycerus* was the most abundant louse, followed by *Linognathus aepycerus*. Few adult ticks were recovered in comparison with the numbers of larvae and nymphae. Males of *A. hebraeum*, *R. appendiculatus* and *R. evertsi evertsi* outnumbered females while the converse was true for *Boophilus decoloratus*, *Ixodes cavipalpus* and *Hyalomma marginatum rufipes*.

Ticks were the only ectoparasites recovered from the cattle and their relative abundance is summarized in Table 2.

R. appendiculatus, followed by *R. evertsi evertsi* and *A. hebraeum*, accounted for the major proportion of the total tick burden. The larvae of *R. appendiculatus* were particularly numerous. Males of all species outnumbered females except in the case of *B. decoloratus* and *I. cavipalpus*, where the converse was true.

The monthly mean tick burdens of the impala and cattle are graphically illustrated in Fig. 1–7.

Except in August, when none were recovered, larvae of *A. hebraeum* were present on impala throughout the survey period, with peak numbers occurring during January and February 1976. With the exception of June, when none were collected, nymphae of this tick were always present, albeit in small numbers. Only 2 adults were recovered.

Larvae of *A. hebraeum* on cattle reached their highest numbers in 1976 during March and December and an even higher peak during March 1977, while nymphae reached their peak during March and April 1976 and March 1977 and adults from November 1976 to March 1977.

TABLE 1 Relative abundance of tick and lice species collected from impala in the Nylsvley Nature Reserve

Species	Numbers of ectoparasites					Percentage
	Larvae	Nymphae	Adults		Total	
			Male	Female		
Ticks						
R. e. evertsi	5 583	2 240	65	34	7 922	62,10
R. appendiculatus	2 937	1 198	138	83	4 356	34,15
A. hebraeum	394	42	2	0	438	3,43
B. decoloratus	3	7	5	11	26	0,20
I. cavipalpus	5	8	0	1	14	0,11
H.m. rufipes	0	0	0	1	1	0,01
Totals	8 922	3 495	210	130	12 757	100,00
Lice						
D. aepycerus	—	1 921	711		2 632	67,92
L. aepycerus	—	298	309		607	15,67
D. elongata	—	298	157		455	11,74
L. nevilli	—	141	40		181	4,67
Totals	—	2 658	1 217		3 875	100,00

TABLE 2 Relative abundance of tick species collected from cattle in the Nylsvley Nature Reserve

Species	Numbers of ticks					Percentage
	Larvae	Nymphae	Adults		Total	
			Male	Female		
R. appendiculatus	5 770	2 355	2 066	1 100	11 291	79,59
R. e. evertsi	848	96	416	273	1 633	11,51
A. hebraeum	290	153	275	149	867	6,11
H. truncatum	0	0	96	77	173	1,22
H.m. rufipes	0	0	111	59	170	1,20
B. decoloratus	1	9	2	10	22	0,16
R. simus	0	0	16	5	21	0,15
I. cavipalpus	2	2	0	5	9	0,06
Totals	6 911	2 615	2 982	1 678	14 186	100,00

* Disnis: Agricura (Pty) Ltd

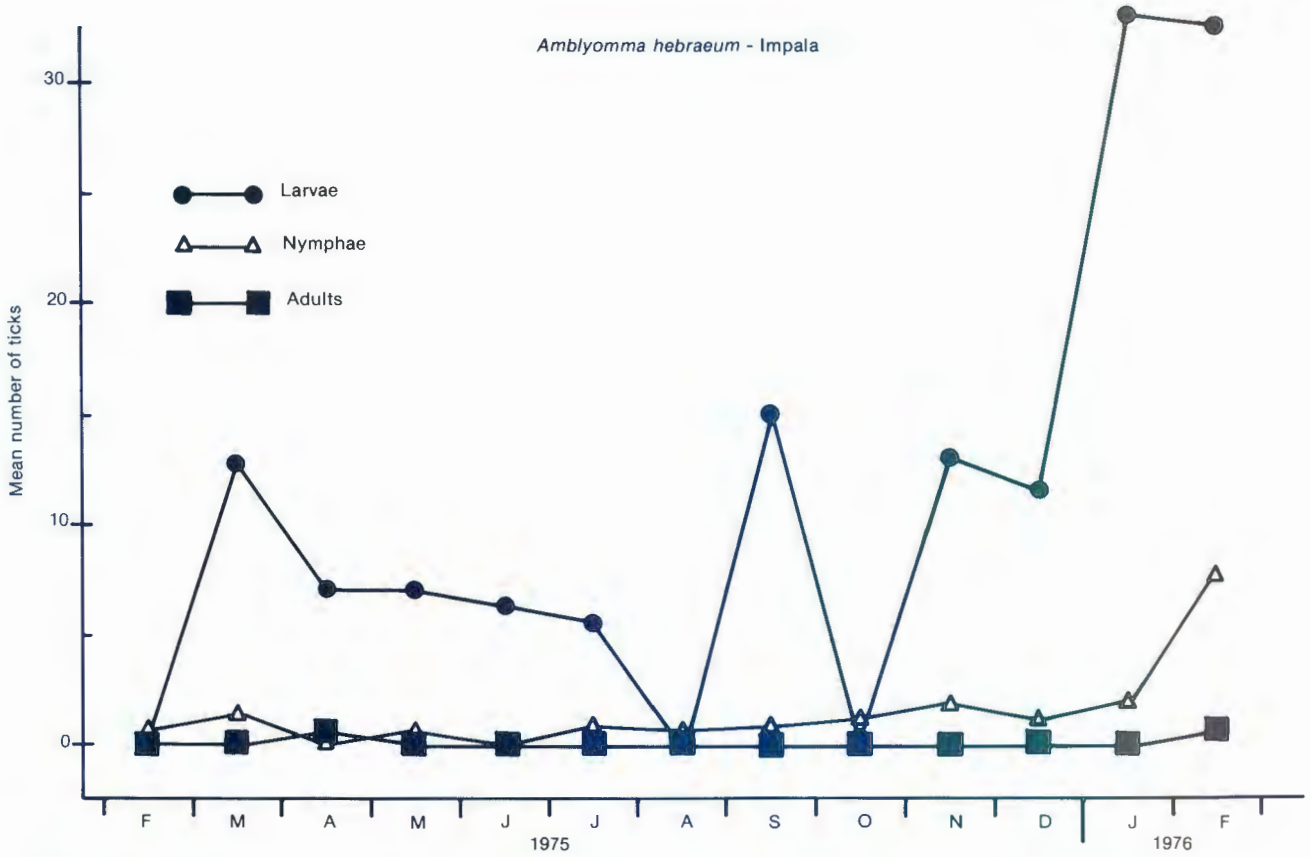

FIG. 1 Monthly fluctuations in the mean numbers of *Amblyomma hebraeum* recovered from impala in the Nylsvley Nature Reserve

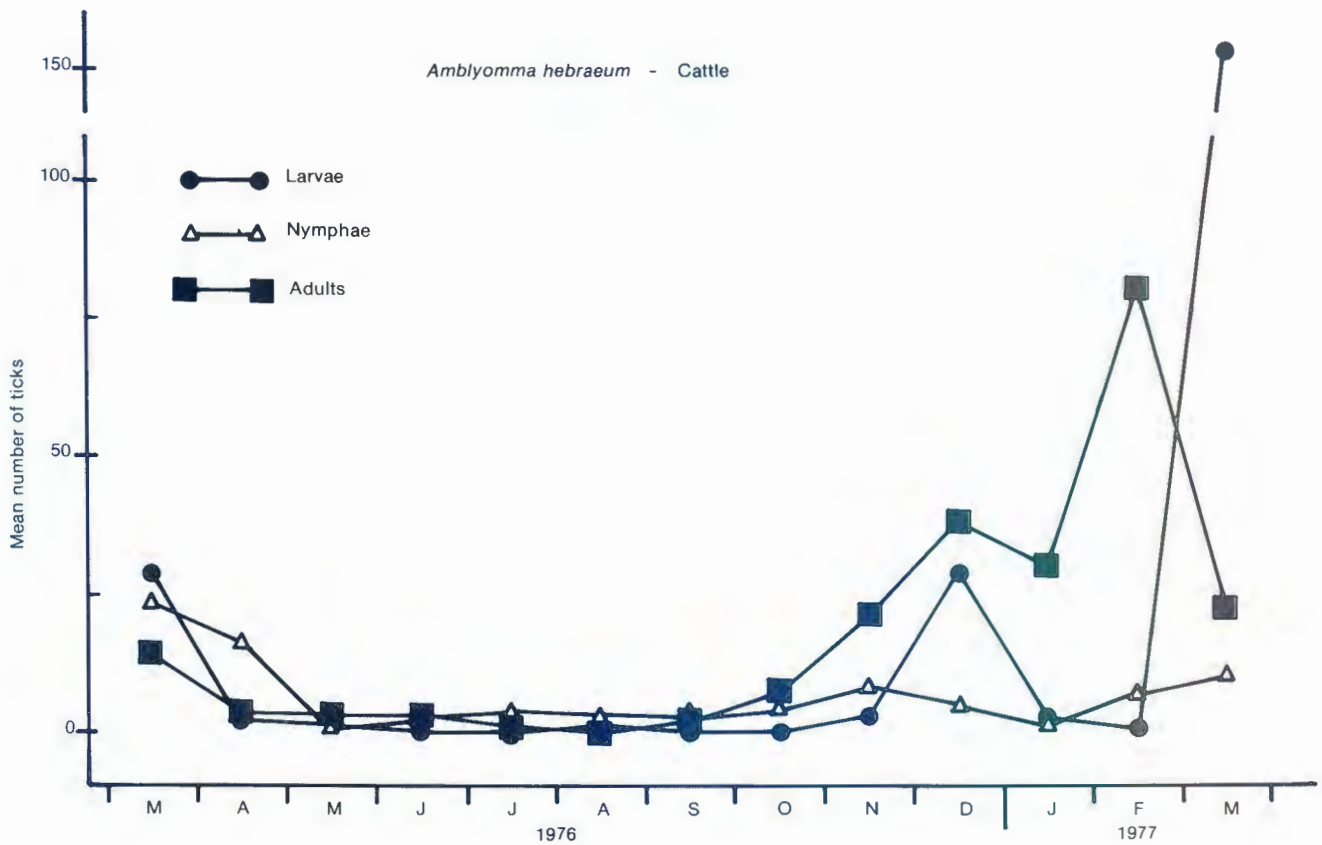

FIG. 2 Monthly fluctuations in the mean numbers of *Amblyomma hebraeum* recovered from cattle in the Nylsvley Nature Reserve

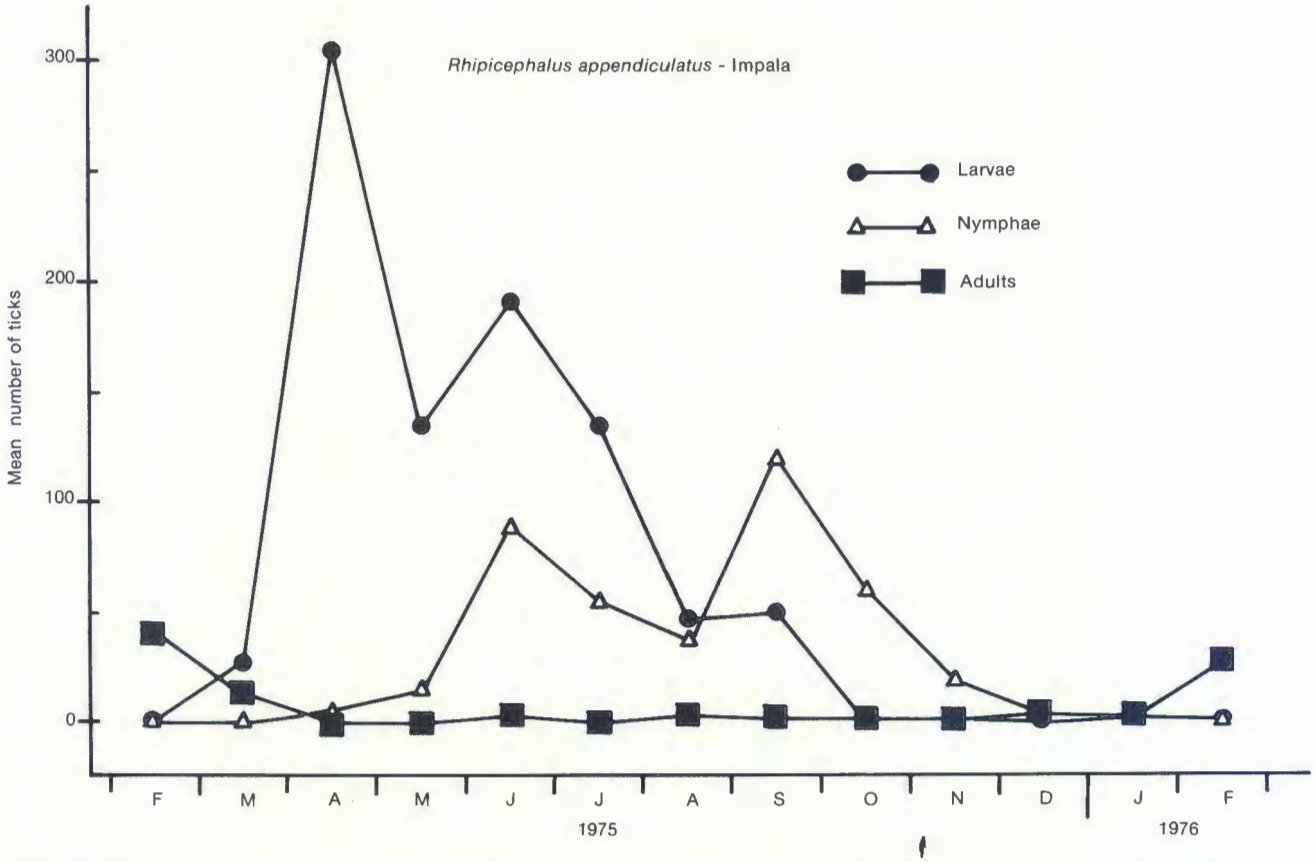

FIG. 3 Monthly fluctuations in the mean numbers of *Rhipicephalus appendiculatus* recovered from impala in the Nylsvley Nature Reserve

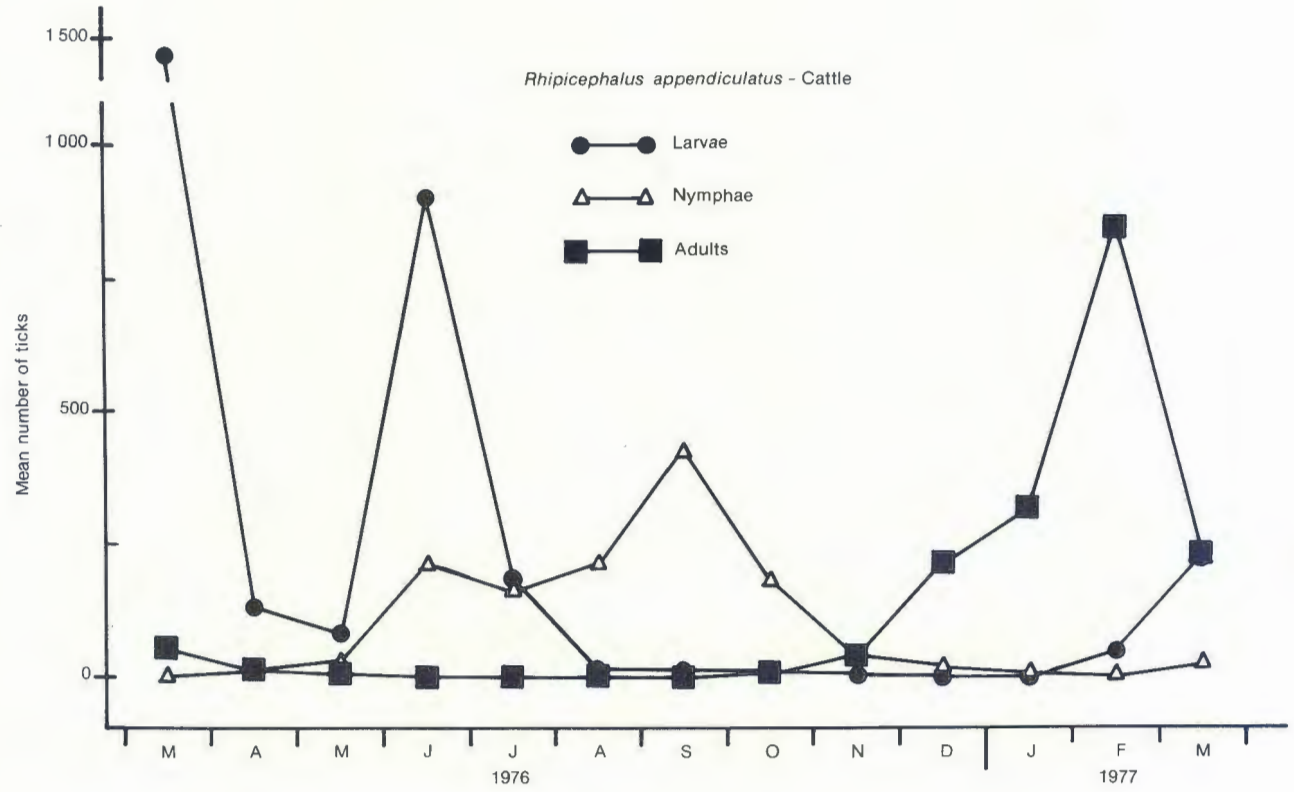

FIG. 4 Monthly fluctuations in the mean numbers of *Rhipicephalus appendiculatus* recovered from cattle in the Nylsvley Nature Reserve

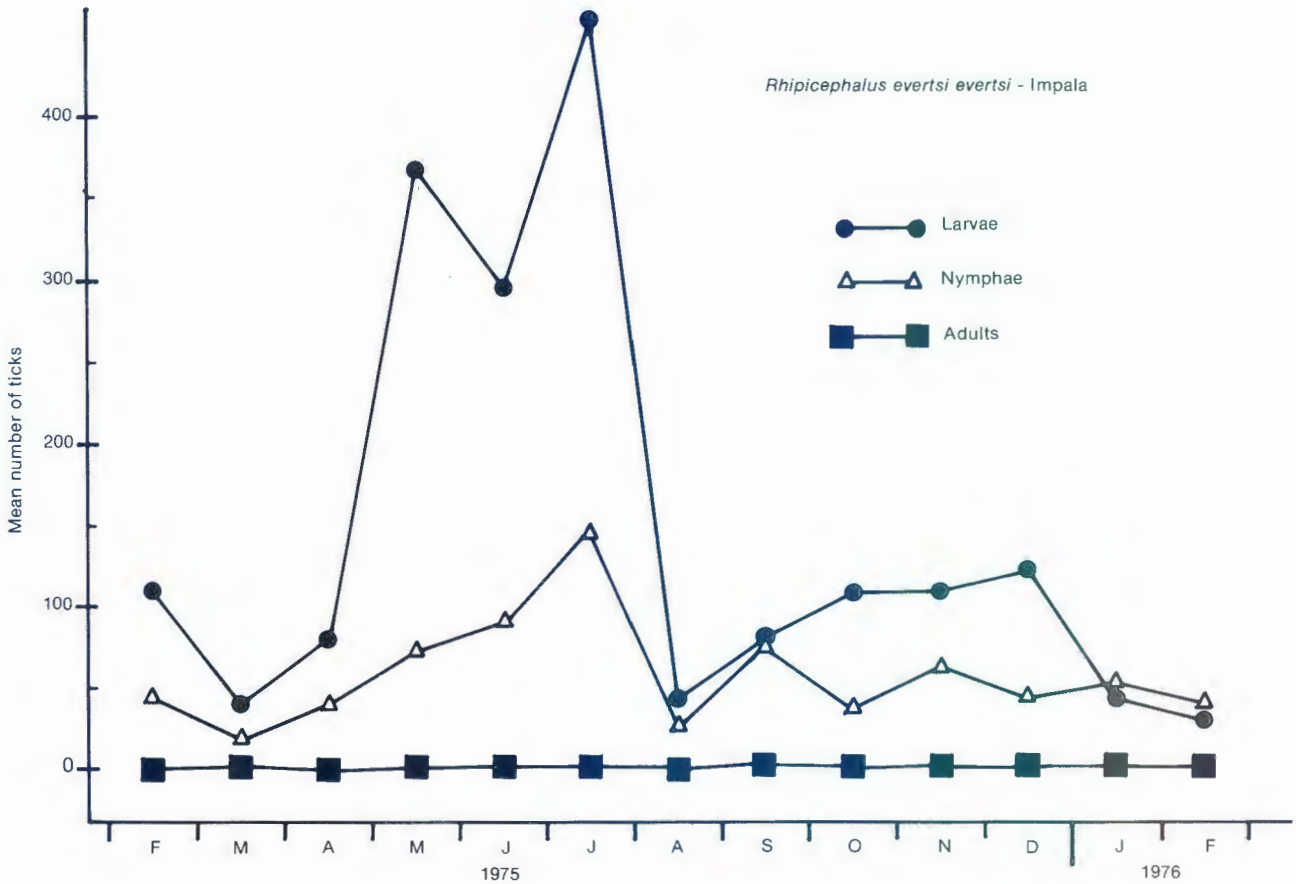

FIG. 5 Monthly fluctuations in the mean numbers of *Rhipicephalus evertsi evertsi* recovered from impala in the Nylsvley Nature Reserve

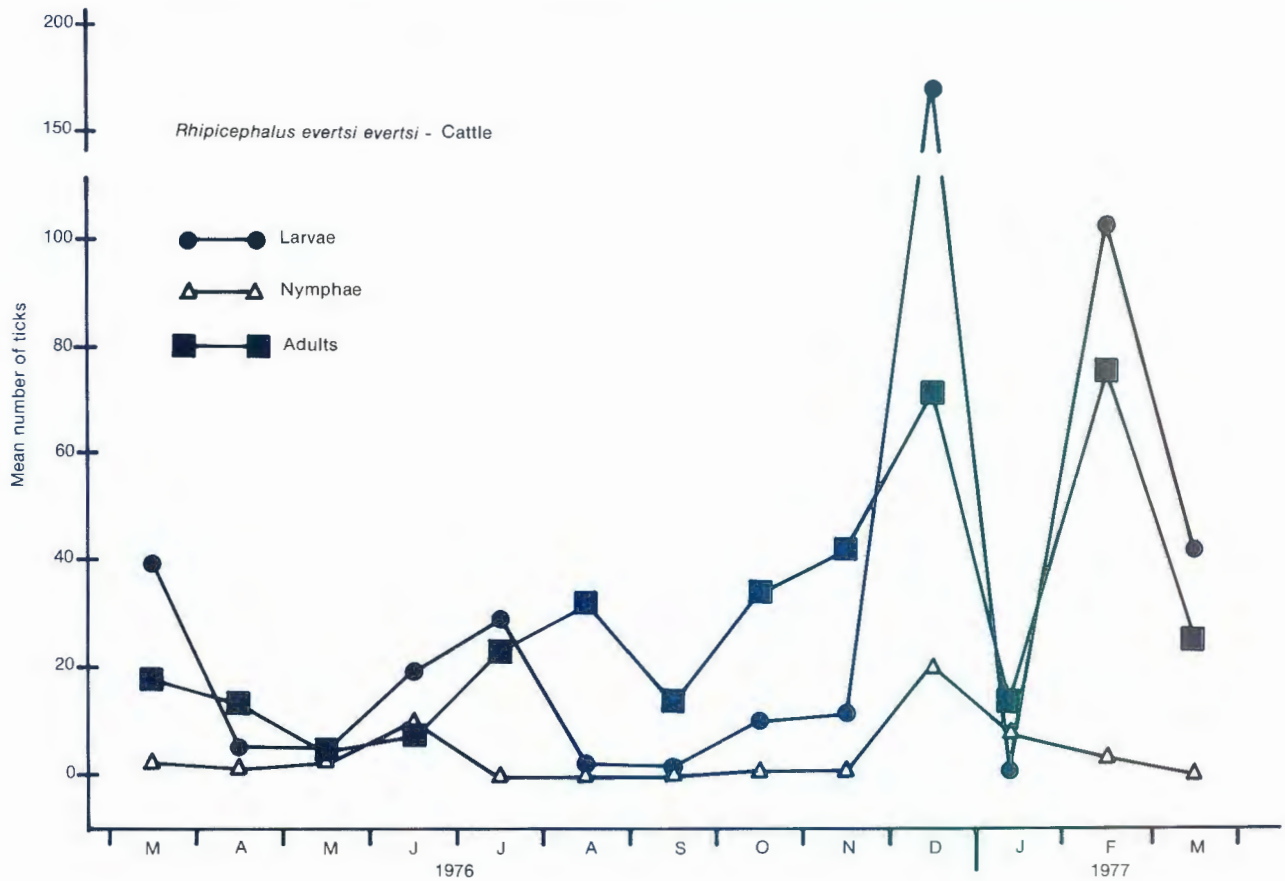

FIG. 6 Monthly fluctuations in the mean numbers of *Rhipicephalus evertsi evertsi* recovered from cattle in the Nylsvley Nature Reserve

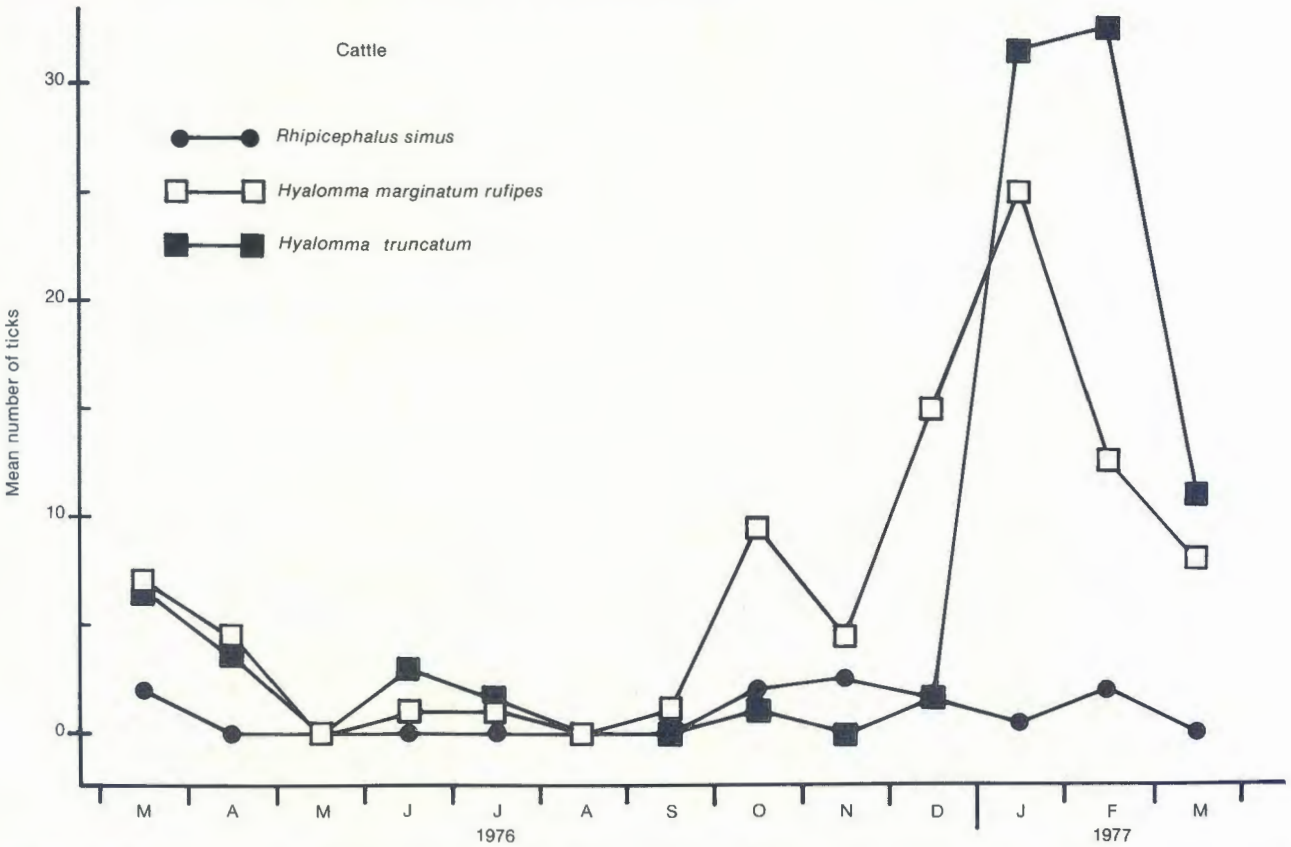

FIG. 7 Monthly fluctuations in the mean numbers of adult *Hyalomma marginatum rufipes*, *Hyalomma truncatum* and *Rhipicephalus simus* recovered from cattle in the Nylsvley Nature Reserve

Peak numbers of *R. appendiculatus* larvae were recovered from impala from April to July, nymphae from June to October, and adults during February 1975 and 1976.

R. appendiculatus larvae were active on cattle during March to July 1976 and March 1977, with major peaks occurring during March and June 1976. The nymphal burdens reached their peak during June to October 1976 and the adults during December 1976 to March 1977.

Substantial numbers of larvae and nymphae of *R. evertsi evertsi* were present on impala throughout the survey period, peak numbers of larvae being recovered from May to July and nymphae during July. With the exception of February and April 1975, when no adult ticks were recovered, very small numbers of adults were collected throughout the survey period.

The mean numbers of larvae of *R. evertsi evertsi* recovered from cattle fluctuated considerably, the largest burdens being recorded during December 1976 and February 1977. Few nymphae were recovered, and while adults were present throughout the survey period, peak numbers were collected during December 1976 and February 1977.

Peak burdens of adult *H. marginatum rufipes* were present on the cattle from December 1976 to February 1977 and adult *H. truncatum* during January and February 1977.

Only adult *Rhipicephalus simus* were recovered from the cattle and were present in small numbers during March 1976 and from October 1976 to February 1977.

The impala harboured only 1 adult *H. marginatum rufipes* and no adult *H. truncatum* or *R. simus*.

Ixodes sp. larvae were recovered from the impala during March 1975 and February 1976, nymphae during March, June and July and an adult *I. cavipalpus* during November 1975. On cattle *Ixodes* sp. larvae were present during April and May 1976, nymphae during June and adult *I. cavipalpus* during October and December.

The mean burdens of lice and total louse-fly burdens of the impala are summarized in Table 3.

No clear pattern of seasonal abundance for the 4 louse species recovered is apparent. Few lice, however, were recovered during March, August and October 1975. An old ewe shot during July had a large burden of *D. aepycerus*, while 3 lambs, approximately 6 weeks old, shot during January 1976, each had fairly large burdens of *L. aepycerus*.

The monthly mean minimum and maximum atmospheric temperatures and rainfall at Nylsvley from May 1975 to March 1977 are graphically reproduced in Fig. 8.

The mean monthly minimum atmospheric temperatures exceeded 15 °C from November 1975 to March 1976 and October 1976 to March 1977. Maximum temperatures exceeded 30 °C only during December 1976. No rain fell during July 1975 or from June to August 1976, and the monthly rainfall only exceeded 10 mm from October 1975 to May 1976 and from October 1976 to March 1977.

DISCUSSION

The method used for ectoparasite recovery yielded large numbers of immature ticks, but it is possible that equally large numbers remained on the skins and were not counted. The ensuing discussion must be viewed in the light of this possibility.

Although the surveys in impala and cattle were conducted in consecutive years and thus are not directly comparable, the following factors do allow certain comparisons to be made: (1) both surveys were conducted

TABLE 3 The monthly mean burdens of lice and total louse-fly burdens of impala in the Nylsvley Nature Reserve

No. of impala examined	Month examined	Mean numbers of lice recovered								Total No. of *Lipoptena paradoxa* recovered
		Damalinia aepycerus		*Damalinia elongata*		*Linognathus nevilli*		*Linognathus aepycerus*		
		Nymphae	Adults	Nymphae	Adults	Nymphae	Adults	Nymphae	Adults	
	1975									
2	February	0	0	57,0	33,0	0	0	0	0	0
3	March	0,3	0,3	2,0	1,3	0	0	0	0	0
4	April	4,0	5,3	1,5	2,3	0	0	1,0	1,5	0
2	May	7,5	2,5	44,0	13,0	7,0	1,5	2,5	2,0	0
3	June	8,3	2,0	7,3	1,7	0,3	0	29,3	17,0	1
4	July	428,8*	152,3*	0,3	0,5	0	0	3,8	3,8	0
2	August	0	0	0	0	0	0	1,0	2,5	0
3	September	36,7	12,0	0,3	0,3	26,3	5,7	2,3	1,0	0
3	October	0,3	0	0	0	0	0	0,7	0,3	0
3	November	2,3	2,0	0	0,7	7,7	1,7	1,0	1,3	1
2	December	4,0	2,5	4,0	2,5	0,5	0	7,5	1,0	1
	1976									
3**	January	4,3	5,0	2,7	0,3	7,7	4,7	51,7	70,3	1
2	February	5,0	3,5	22,0	18,0	0	0,5	1,0	3,5	0

* 1 old ewe harboured 1 708 nymphae and 600 adult *D. aepycerus*

** Approximately 6-week-old animals

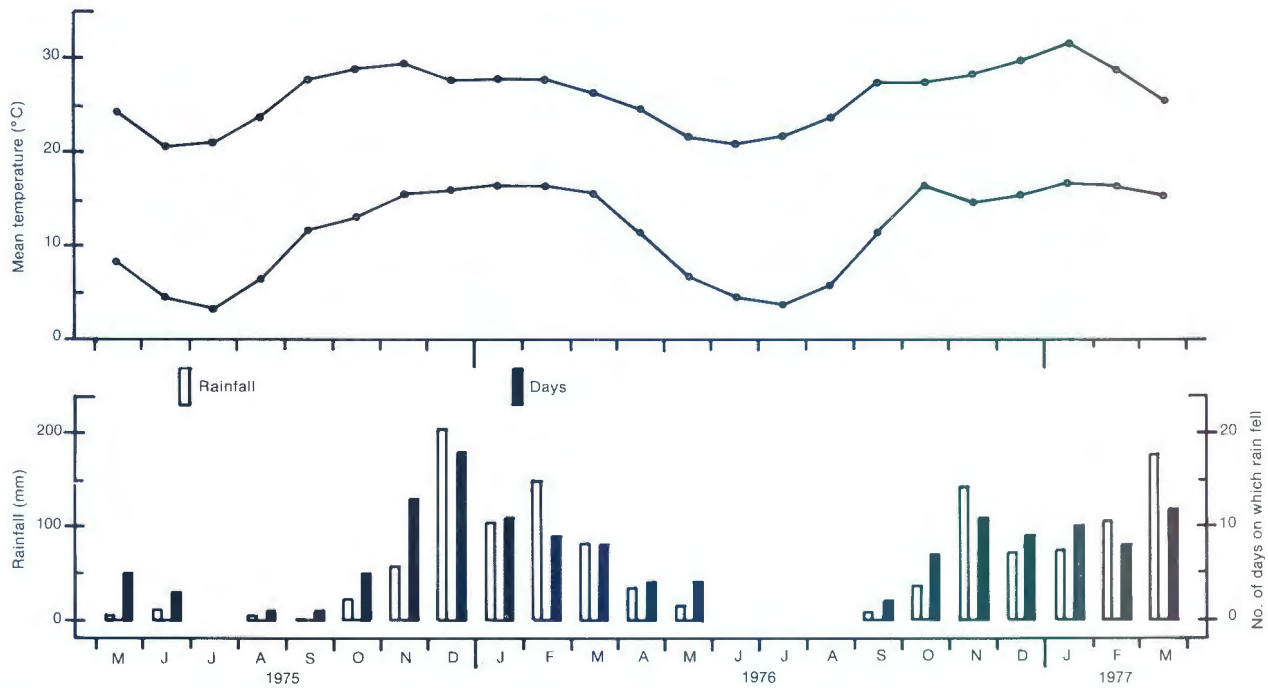

FIG. 8 The monthly mean minimum and maximum atmospheric temperatures and rainfall in the survey area at Nylsvley from May 1975 to March 1977. (No data are available for February to April 1975)

within the same 750 ha area in the Nylsvley Nature Reserve; (2) a large number of cattle were present from January to May each year, including 1975 while the impala survey was in progress (Horak, 1978a); and (3) impala were present during the entire period of the cattle survey.

The most striking difference in these surveys is that between the numbers of immature and adult ticks on the 2 host species. Of the 12 757 ticks recovered from the impala only 340 (2,7%) were adults, while the cattle harboured 14 186 ticks of which 4 660 (32,9%) were adults. MacLeod, Colbo, Madbouly & Mwanaumo (1977), working in Zambia, found also that impala harboured considerably fewer adult ticks than did cattle. The animals they sampled, however, were not necessarily sympatric.

The impala were good hosts of the larvae and nymphae of *R. evertsi evertsi* and *R. appendiculatus*, and reasonably good hosts of the larvae of *A. hebraeum*, but poor hosts of the nymphae of the last-named tick. Cattle were good hosts of the larvae and nymphae of *R. appendiculatus* and the larvae of *R. evertsi evertsi*, reasonably good hosts of the larvae and nymphae of *A. hebraeum*, but poor hosts of the nymphae of *R. evertsi evertsi*. The only adult ticks recovered in fair numbers from the impala were *R. appendiculatus* and *R. evertsi evertsi*, while the cattle harboured substantial numbers of adult *A. hebraeum*, *R. appendiculatus* and *R. evertsi evertsi* and fair numbers of *H. truncatum* and *H. marginatum rufipes*.

From this it would appear that impala are not capable of maintaining substantial tick populations in the absence of cattle because they are inefficient hosts for adult ticks. When cattle and impala are present in the same habitat, however, the impala will make an important contribution to the number of adult ticks on the cattle as they are efficient hosts of the immature stages of a number of

species. Baker & Ducasse (1968) found that domestic goats are also efficient hosts of the immature stages of *A. hebraeum, R. appendiculatus* and *R. evertsi evertsi* but, unlike impala, they are also relatively efficient hosts of adult ticks of these species.

A direct comparison can be made between the results obtained for cattle in the present survey and those reported by Londt *et al.* (1979), as the cattle in the 2 surveys ran together, although the tick collection techniques differed somewhat. Londt *et al.* (1979) collected mainly adult ticks from 6 living cattle at 2-week intervals, while in the present survey the majority of adult ticks were collected from the animals while they were still alive, and the remainder immediately after slaughter, but the immature ticks were collected by heating, washing and scraping once the animals had been slaughtered at approximately 4–6 week intervals.

The present results indicate that both *A. hebraeum* and *R. appendiculatus* were proportionally more abundant than Londt *et al.* (1979) had found and that, contrary to their findings, *A. hebraeum* was in fact more abundant than either *H. marginatum rufipes* or *H. truncatum*. These differences are due to the recovery of large numbers of immature ticks in the present survey.

The prevalence of the more abundant tick species warrants further discussion.

Amblyomma hebraeum

The total number of larvae and nymphae recovered from both impala and cattle compared with the total number of adults collected indicates that numerous larvae, and even more nymphae, must have utilized other hosts than impala or cattle to produce the number of adults present. The immature stages of *A. hebraeum* are known to utilize birds, tortoises, antelope and carnivores as hosts (Theiler, 1962; Norval, 1974; Knight & Rechav, 1978). As all of these were present in the survey area, their tick burdens possibly accounted for the disproportion in numbers between the immature and adult ticks recovered from the impala and cattle.

In Zambia, MacLeod & Colbo (1976) concluded that cattle themselves feed sufficient larvae of *Amblyomma variegatum* to maintain their own levels of nymphal infestation. The ratio of larvae to nymphae on cattle in their experiments varied between 5:1 and 14:1. In the present survey a ratio of approximately 10:1 in respect of *A. hebraeum* larvae to nymphae was noted on the impala. On the cattle, however, this ratio decreased to approximately 2:1, indicating that the larval burdens of other hosts such as impala, kudu and birds present in the habitat probably contributed considerably towards the nymphal burdens on the cattle.

In general, the periods September and November to March appeared to be the most favourable for the larval stage of *A. hebraeum*, November to March for the adults and February to April for the nymphal stage. These differ from the periods February to May, May to September and September to January recorded for the larval, nymphal and adult stages respectively on cattle in Natal by Baker & Ducasse (1967). At Nylsvley all stages of development of *A. hebraeum* apparently prefer the summer months. In the eastern Cape Province, Norval (1977) noted that the larvae and adults preferred the summer and the nymphae the spring.

Hyalomma spp.

The immature stages of these ticks feed on birds and hares (Hoogstraal, 1956). With the exception of a single adult *H. marginatum rufipes* recovered from an impala, adult *Hyalomma* spp. were recovered only from cattle.

The presence of peak burdens of *H. marginatum rufipes* from December to February agrees with the findings of Baker & Ducasse (1967) in Natal (November to February), Matson & Norval (1977) in Zimbabwe (October to February) and MacLeod *et al.* (1977) in Zambia (December to February) and Schröder (1980) in the northern Transvaal (October to February) for this tick. *H. truncatum* reached peak numbers during January and February. This is a considerably shorter time than the January to May period recorded by Jooste (1966) in Zimbabwe and MacLeod *et al.* (1977) in Zambia.

Rhipicephalus appendiculatus

In the present survey impala played an important role as alternate hosts for the immature stages of this tick. In fact, the total number of adult ticks recovered from the cattle would probably not have been as great had the impala not been present.

Considerable confusion seems to exist concerning the role of wild or domesticated hosts in maintaining the immature stages of *R. appendiculatus* (MacLeod & Colbo, 1976). Hoogstraal (1956), summarizing the available information on the immature stages, states "nymphs attack large or medium size hosts, and larvae appear to prefer small to medium size animals above the size of usual rodents." Yeoman (1966) comments that cattle and other domestic animals may be less important hosts of the nymphal and possibly larval stages than are small wild animals such as hare, mongoose and duiker. MacLeod & Colbo (1976) suggest that in Zimbabwe (formerly Rhodesia) the immature stages prefer reedbuck and impala to the smaller grysbok/steenbok-sized animals. The conclusions of Yeoman & Walker (1967) that all stages thrive on cattle and that medium small wild animals seem to carry *R. appendiculatus* nymphae only when there are cattle infested with this tick in the area largely agree with the findings in the present survey. The preferred hosts of the immature stages can probably only be determined by doing a thorough survey of the tick fauna of all the vertebrate hosts in an enzootic region.

Peak burdens of larvae were recovered from March or April to July. This is slightly later than the period February to June recorded on cattle in Natal by Baker & Ducasse (1967), and is more prolonged than the May to June peak found by Knight & Rechav (1978) on kudu in the eastern Cape Province. Nymphae reached a peak in June to October on both impala and cattle, compared with April to September on cattle in Natal (Baker & Ducasse, 1967), April to June and during August on a number of hosts in Zambia (MacLeod, 1970) and May to June and August to October on kudu in the eastern Cape Province (Knight & Rechav, 1978). The adult peak from December to March is in reasonable agreement with that found in surveys in Zimbabwe (Jooste, 1966; Matson & Norval, 1977), Natal (Baker & Ducasse, 1967), Zambia (MacLeod *et al.*, 1977), the eastern Cape Province (Knight & Rechav, 1978) and the northern Transvaal (Londt *et al.*, 1979; Schröder, 1980).

Short & Norval (1981) consider certain climatic factors necessary for adult activity, and these are the following: (1) rainfall $>$ 10 mm per month; (2) mean monthly minimum temperature $>$ 15 °C; (3) mean monthly maximum temperature $<$ 30 °C or $>$ 30 °C only if rainfall exceeds 20 mm per month; (4) daylength exceeding 11 h of light. Using these facts they have constructed a model to predict the seasonal occurrence of adults in a given climatic region. This model indicates that adult activity at Nylsvley should occur between October or November and March. This is indeed so in the cattle survey for which climatic data for the entire period are available (Fig. 4, 8).

Rhipicephalus evertsi evertsi

In the present survey impala appeared to be much more efficient hosts of the immature stages of this tick than cattle. It must be remembered, however, that the cattle were sprayed with an acaricidal compound at fortnightly intervals and that the toxaphene component of this compound probably had a residual effect after mixing with the wax in the ears of the cattle. Larvae may thus have become established only after the effect of the compound had worn off and a few may have moulted to nymphae when the cattle were slaughtered 2 weeks after the last application of the acaricide. Even in the absence of acaricidal treatment a marked loss in numbers between the larval and nymphal stages does occur, as the findings in impala would indicate. The waxy nature of the secretions in the ear canal and the limited space available possibly account for this loss.

Baker & Ducasse (1967) recorded peak numbers of immature ticks on calves in Natal from January to April. In the present survey the larval numbers on impala reached a peak from May to July and nymphae during July. In cattle larval peaks were recorded in December and February. Adults were present on the cattle throughout the year, with peaks occurring during December and February. These "waves" of adult activity on cattle have been described by Matson & Norval (1977) in Zimbabwe and are also apparent on cattle in Zambia (MacLeod *et al.*, 1977). They are probably manifestations of separate generations, these occurring at shorter intervals after each other during the summer months and at longer intervals during the winter (Matson & Norval, 1977).

Control

Control measures based on the tick burdens of cattle at Nylsvley were discussed by Londt *et al.* (1979). It has now become necessary, however, to take into consideration the role as tick hosts played by the impala that were grazing with the cattle and the known seasonal incidence of ticks on these animals. Short interval (every 4–5 days) applications of acaricides to cattle grazing with impala during the autumn to spring period will not completely reduce adult tick numbers of *R. appendiculatus* and *R. evertsi evertsi* during the ensuing summer because of the role played by impala as alternate hosts of the immature stages. Short interval acaricidal applications to cattle, particularly during the period December to February when nearly all adult ticks of all species are on cattle, should have a marked effect on the total population.

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