

## Parasites of domestic and wild animals in South Africa. XXXIV. Arthropod parasites of nyalas in north-eastern KwaZulu-Natal

I.G. HORAK<sup>1</sup>, J. BOOMKER<sup>2</sup> and J.R.B. FLAMAND<sup>3</sup>

### ABSTRACT

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Seventy-three nyalas (*Tragelaphus angasii*) in the Umfolozi, Mkuzi and Ndumu Game Reserves in north-eastern KwaZulu-Natal were examined for arthropod parasites during 1983 and 1984. In addition, six animals were examined during 1994. Ten ixodid tick species, two louse species and a louse fly species were recovered. The nyalas were good hosts of all stages of development of *Boophilus decoloratus*, *Rhipicephalus appendiculatus* and *Rhipicephalus muehlensi* and the immature stages of *Amblyomma hebraeum* and *Rhipicephalus maculatus*.

Adult male animals harboured more adult ticks, biting lice and louse flies than did adult females.

*B. decoloratus* was generally most abundant from October to May. The larvae of *R. appendiculatus* peaked from April to October, nymphs from July to October and adults, on adult male nyalas, from February to May. Larvae of *R. maculatus* were most abundant from May to July and nymphs from June to October. The immature stages of *A. hebraeum* and all stages of *R. muehlensi* were present throughout the year.

**Keywords:** Arthropod parasites, nyalas, north-eastern KwaZulu-Natal, *Tragelaphus angasii*

### INTRODUCTION

Several surveys of ixodid ticks infesting domestic and wild animals in KwaZulu-Natal, have already been conducted. Baker & Ducasse (1967) and Baker, Du-

casse, Sutherst & Maywald (1989) examined cattle, and Baker & Ducasse (1968), goats. Buffaloes (*Syncerus caffer*), nyalas (*Tragelaphus angasii*), common reedbuck (*Redunca arundinum*), impalas (*Aepyceros melampus*), bushbuck (*Tragelaphus scriptus*), common duikers (*Sylvicapra grimmia*), red duikers (*Cephalophus natalensis*), bushpigs (*Potamochoerus larvatus*) and scrub hares (*Lepus saxatilis*) were examined by Horak, Potgieter, Walker, De Vos & Boomker (1983), Horak, Keep, Flamand & Boomker (1988), Horak, Keep, Spickett & Boomker (1989), Horak, Boomker & Flamand (1991a) and Horak, Spickett, Braack, Penzhorn, Bagnall & Uys (1995). Baker & Keep (1970) published a checklist of ticks infesting the larger wild animals in KwaZulu-Natal game reserves, while Keep (1971) produced such a list specifically for nyalas.

<sup>1</sup> Department of Veterinary Tropical Diseases, Faculty of Veterinary Science, University of Pretoria, Onderstepoort, 0110 South Africa

<sup>2</sup> Faculty of Veterinary Science, Medical University of Southern Africa, Medunsa, 0204 South Africa

<sup>3</sup> Natal Parks Board, Mtubatuba, 3935 South Africa. Present address: King Khalid Research Centre, P.O.Box 61681, Riyadh, 11575 Saudi Arabia

Nyalas in the north-eastern KwaZulu-Natal game reserves had to be culled during the late 1970s and early 1980s because their numbers exceeded the carrying capacity of the land. Culling or relocation has subsequently continued at irregular intervals. In conjunction with this activity, parasites were collected from some of the culled animals and Boomker, Horak & Flamand (1991) reported on the helminths recovered. They also summarized the available data on the morphometrics, feeding and behaviour of nyalas and briefly described the physiography of the Umfolozi, Mkuzi and Ndumu Game Reserves.

According to Smithers (1983), male nyalas are considerably taller and heavier than females. Adult males are horned and slatey-grey to dark brown in colour with a few white, vertical stripes on the body. They have a dorsal crest of long hair from the back of the head to the base of the tail and a heavy fringe of long hair on the under-parts of the neck and along the middle line of the chest and belly. Females are hornless, bright chestnut in colour and have up to 18 white, vertical stripes on their bodies. Nyalas are predominantly browsers and have a restricted habitat in that they are usually found in thickets in dry savanna woodland or riverine woodland (Smithers 1983).

The present paper records the ectoparasite burdens of nyalas culled in the Umfolozi, Mkuzi and Ndumu Game Reserves in north-eastern KwaZulu-Natal.

## MATERIALS AND METHODS

### Study areas and animals

#### *Umfolozi*

The Umfolozi Game Reserve (28°12′–28°21′S; 31°42′–31°59′E) comprises about 47753 ha of hilly country, 130–600 m above sea level. Two vegetation types are recognized, namely Zululand Thornveld along the slopes and crests of the hills and Lowveld in the valleys (Acocks 1988). Both browse and grazing are plentiful. Annual rainfall is 500–750 mm and falls mainly in summer. Summers are hot and winters cool to mild, and frost seldom occurs.

An attempt was made to obtain one adult male, one adult female and one juvenile nyala of either sex at monthly intervals from March 1983 to April 1984, but neither the population sample nor the monthly collection was always possible. Forty nyalas were examined, of which 14 were adult males, 15 adult females, four juvenile males and seven juvenile females. No animals were examined during September or November 1983.

#### *Mkuzi*

The Mkuzi Game Reserve, which is approximately 25091 ha in extent, is situated in the so-called Maputaland (27°33′–27°46′S; 32°07′–32°19′E; altitude

130–300 m), and extends from the eastern foothills of the Lebombo mountain range, eastwards into the Makatini flats. The vegetation of the higher areas is classified as Lowveld, while that at lower altitudes consists of the Zululand Palm Veld subdivision of Coastal Forest and Thornveld (Acocks 1988). Rain falls mostly in summer with a variation of 500–750 mm. Summers are hot and often humid and winters are mild. Frost seldom occurs.

Nineteen nyalas were shot from March 1983 to May 1984. Of these, six were adult males, five adult females, five juvenile males and three juvenile females. In addition to these animals three adult male and three adult female nyalas were examined during March 1994.

#### *Ndumu*

The Ndumu Game Reserve (26°50′–26°56′S; 32°09′–32°21′E; altitude 30–100 m) comprises approximately 11000 ha. It is situated in the extreme north of KwaZulu-Natal and shares a common boundary in the north with southern Mozambique. Ndumu falls within the Lowveld subtype of Tropical Bush and Savannah (Acocks 1988). Rainfall varies from 500 to 750 mm per annum and falls mostly in summer. Summers are hot and humid and winters are mild; frost does not occur.

Fourteen nyalas, five adult males, three adult and one old female, one juvenile male and four juvenile females, were shot in this reserve from April 1983 to May 1984.

### Collection and counting of parasites

The arthropod parasites of the nyalas were collected, identified and counted as described by Horak, Boomker, Spickett & De Vos (1992) for kudus. The numbers of engorging female ticks were determined only on the six animals examined in Mkuzi during March 1994.

## RESULTS

### *Umfolozi*

The ectoparasites collected from animals examined in the Umfolozi Game Reserve are summarized in Table 1.

The nyalas were infested with ten ixodid tick species of which *Rhipicephalus muehlensi*, followed by *Rhipicephalus appendiculatus*, were the most abundant. Every animal was infested with these ticks and with *Boophilus decoloratus*. The nyalas also harboured two louse species and a louse fly.

The seasonal abundances of these ticks and of the immature stages of *Rhipicephalus maculatus* are graphically illustrated in Fig. 1.



The largest numbers of *B. decoloratus* were collected during April and May 1983 and from October 1983 to February 1984. Larvae of *R. appendiculatus* were most abundant from April to October, nymphs from July to October and adults on adult male nyalas during the months of February to May. Larvae of *R. maculatus* were most abundant from May to July and nymphs, from June to October. No clear pattern of seasonal abundance was evident for *R. muehlensi*.

Comment: Observations on the seasonal abundances of all stages of development of *B. decoloratus* and of *R. muehlensi* and the immature stages of *R. appendiculatus* and *R. maculatus* are compromised by the fact that no nyalas were examined during September and November 1983.

**Mkuzi**

The arthropod burdens of animals examined in this reserve during 1983/1984 and during 1994 are summarized in Tables 2 and 3, respectively.

Eight ixodid tick species were recovered from the first set of nyalas and seven from the second set. Animals examined during the months of October to March generally harboured substantial numbers of *B. decoloratus*, while those examined during May, June and July had very small burdens. The seasonal abundances of *R. appendiculatus* and *R. maculatus* appeared to be similar to those recorded on the nyalas examined in the Umfolozi Game Reserve. *R. muehlensi*, which comprised more than 75% of the

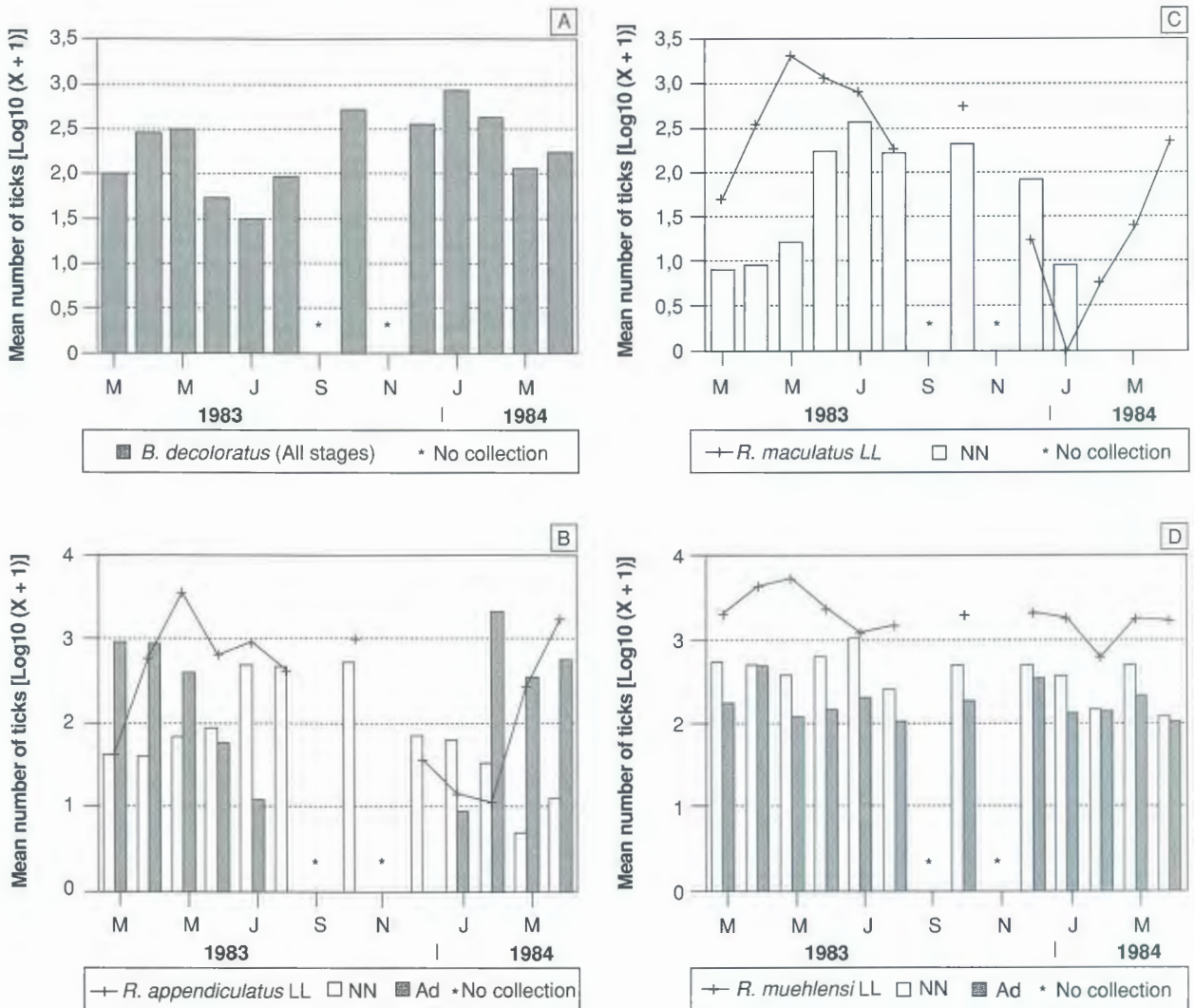


FIG. 1 The seasonal abundance of A. *Boophilus decoloratus*  
 B. *Rhipicephalus appendiculatus*, (adults only on male animals)  
 C. *Rhipicephalus maculatus*  
 D. *Rhipicephalus muehlensi* on nyalas in the Umfolozi Game Reserve

ticks collected from both groups of animals, was present in large numbers throughout the survey.

Most of the nyalas were infested with *Linognathus angasi* and all, with *Lipoptena paradoxa*.

### Ndumu

The numbers of arthropods collected from nyalas in this reserve are summarized in Table 4.

The animals were infested with eight ixodid tick species, two species of louse and a louse fly species. *R. muehlensi* was the most abundant and prevalent tick, while considerably fewer *R. appendiculatus* than *R. maculatus* were recovered. The approximately 4-month intervals at which animals were examined, precluded determination of seasonal abundance.

### Host sex preference

Twenty-one adult male and 21 adult female nyalas were shot in pairs at the same times and at the same localities during the 1983/1984 survey period. In addition, three adult male and three adult female animals were shot in the Mkuzi Game Reserve on 9–10 March 1994. The parasite burdens of the male and female nyalas were compared by means of the Mann-Whitney *U*-test for non-parametrically distributed data. The mean burdens of the major parasites on these 48 animals are summarized in Table 5.

Adult male nyalas harboured significantly more ( $P < 0.05$ ) nymphs of *Amblyomma hebraeum*, males and females of *B. decoloratus*, *R. appendiculatus* and

*R. muehlensi*, males of *R. maculatus*, nymphs and adults of the *Damalinia* sp. and adults of *L. paradoxa* than did adult female nyalas.

### Locality preferences

The mean parasite burdens of nyalas examined in each of the reserves during 1983 and 1984 are summarized in Table 6.

Umfoloji was a good habitat for *A. hebraeum*, the only habitat in which *Haemaphysalis silacea* was present, and the only habitat of the three which was more suitable for *R. appendiculatus* than for *R. maculatus*. Mkuzi was a good habitat for *A. hebraeum*, *B. decoloratus*, *R. maculatus* and *R. muehlensi*. With the exceptions of *R. muehlensi*, for which it appeared to be the best of the three habitats, and of *R. maculatus*, Ndumu was the least favourable habitat for nearly all tick species. It must, however, be remembered that the animals were not examined in each of the reserves at the same times.

### DISCUSSION

Hunters in KwaZulu-Natal often comment on the large numbers of ticks encountered on nyalas. The present findings confirm this observation, particularly as trophy hunters invariably shoot adult male animals and the head and cape (skin of the neck) of the animal are regarded as the trophy. *R. appendiculatus* and *R. muehlensi* prefer the ears, heads and upper necks of male nyalas as attachment sites and are

TABLE 1 Arthropod parasites of 40 nyalas examined in the Umfolozi Game Reserve during 1983/1984

Arthropod species	Total numbers recovered					No. of nyalas infested
	Larvae	Nymphs	Males	Females	Total	
<i>Amblyomma hebraeum</i>	16 296	3 030	66	22	19 414	39
<i>Amblyomma</i> spp.	56	0	0	0	56	1
<i>Boophilus decoloratus</i>	4 611	3 225	1 526	1 063	10 425	40
<i>Haemaphysalis aciculifer</i>	0	0	0	2	2	1
<i>Haemaphysalis silacea</i>	571	152	47	60	830	16
<i>Ixodes</i> sp. (near <i>I. pilosus</i> )	598	8	14	16	636	11
<i>Rhipicephalus appendiculatus</i>	32 343	7 352	3 160	2 580	45 435	40
<i>Rhipicephalus evertsi evertsi</i>	644	0	10	4	658	15
<i>Rhipicephalus maculatus</i>	20 674	4 183	6	64	24 927	35
<i>Rhipicephalus muehlensi</i>	92 024	19 724	4 662	2 940	119 350	40
Lice	Nymphs		Adults		Total	13 36
<i>Damalinia</i> sp.	2 134		1 269		3 403	
<i>Linognathus angasi</i>	5 132		2 792		7 924	
Louse flies	Males		Females		Total	38
<i>Lipoptena paradoxa</i>	1 032		1 304		2 360 <sup>a</sup>	

<sup>a</sup> Including pieces of flies whose sex could not be determined



consequently present on those parts of the animal which will ultimately become the trophy. In addition, adults of the latter tick are present throughout the year so that large numbers of ticks are always present on and around the heads of nyalas.

Horak *et al.* (1992) noted that adult male kudu carried significantly more nymphal and adult *A. hebraeum* and adult *B. decoloratus* than did adult females. A similar finding for *L. paradoxa* on kudu was reported by Visagie, Horak & Boomker (1992). These

authors postulated that body size, grooming or hormonal influences could be responsible for these differences. If it is assumed that adult male and female nyalas utilize the same habitat, the reasons for the lower tick, louse and louse fly burdens on the females justify further investigation.

#### *Amblyomma* spp.

Horak, MacIvor, Petney & De Vos (1987) observed that the larger the host species the greater the likeli-

TABLE 2 Arthropod parasites of 19 nyalas examined in the Mkuzi Game Reserve during 1983/1984

Arthropod species	Total numbers recovered					No. of nyalas infested
	Larvae	Nymphs	Males	Females	Total	
<i>Amblyomma hebraeum</i>	7 169	916	28	4	8 117	19
<i>Amblyomma</i> spp.	1 271	0	0	0	1 271	7
<i>Boophilus decoloratus</i>	6 882	1 966	492	214	9 554	18
<i>Ixodes</i> sp. (near <i>I. pilosus</i> )	32	0	0	0	32	1
<i>Rhipicephalus appendiculatus</i>	4 650	348	775	645	6 418	18
<i>Rhipicephalus evertsi evertsi</i>	112	8	2	0	122	4
<i>Rhipicephalus maculatus</i>	12 499	1 488	56	58	14 101	19
<i>Rhipicephalus muehlensi</i>	105 491	17 856	7 409	5 238	135 994	19
Lice	Nymphs		Adults		Total	
<i>Damalinea</i> sp.	112		104		216	4
<i>Linognathus angasi</i>	1 492		562		2 054	17
Louse flies	Males		Females		Total	
<i>Lipoptena paradoxa</i>	354		414		798 <sup>a</sup>	19

<sup>a</sup> Including pieces of flies whose sex could not be determined

TABLE 3 Arthropod parasites of six nyalas examined in the Mkuzi Game Reserve during March 1994

Arthropod species	Total numbers recovered					No. of nyalas infested
	Larvae	Nymphs	Males	Females	Total	
<i>Amblyomma hebraeum</i>	2 620	274	24	4	2 922	6
<i>Amblyomma</i> spp.	81	0	0	0	81	2
<i>Boophilus decoloratus</i>	1 785	375	160	146 (16)	2 466	6
<i>Rhipicephalus appendiculatus</i>	8	0	975	535 (22)	1 518	6
<i>Rhipicephalus evertsi evertsi</i>	48	0	11	2	61	5
<i>Rhipicephalus maculatus</i>	220	19	14	14	267	6
<i>Rhipicephalus muehlensi</i>	30 880	4 351	3 235	2 092 (190)	40 558	6
Lice	Nymphs		Adults		Total	
<i>Damalinea</i> sp.	222		55		277	3
<i>Linognathus angasi</i>	639		232		871	6
Louse flies	Males		Females		Total	
<i>Lipoptena paradoxa</i>	295		403		704 <sup>a</sup>	6

( ) = Number of engorging female ticks, i.e. idiosoma of *B. decoloratus* and *R. muehlensi* > 4,0 mm and *R. appendiculatus* > 5,0 mm in length

<sup>a</sup> = Including pieces of six flies whose sex could not be determined

TABLE 4 Arthropod parasites of 14 nyalas examined in the Ndumu Game Reserve during 1983/1984

Arthropod species	Total numbers recovered					No. of nyalas infested
	Larvae	Nymphs	Males	Females	Total	
<i>Amblyomma hebraeum</i>	224	190	0	0	414	9
<i>Amblyomma</i> spp.	48	0	0	0	48	2
<i>Boophilus decoloratus</i>	388	164	66	36	654	10
<i>Ixodes</i> sp. (near <i>I. pilosus</i> )	48	32	2	0	82	3
<i>Rhipicephalus appendiculatus</i>	2 888	196	234	176	3 494	12
<i>Rhipicephalus evertsi evertsi</i>	32	0	0	0	32	1
<i>Rhipicephalus maculatus</i>	10 000	734	86	56	10 876	13
<i>Rhipicephalus muehlensii</i>	93 764	17 724	6 370	4 176	122 034	14
Lice	Nymphs		Adults		Total	
<i>Damalinia</i> sp.	24		48		72	2
<i>Linognathus angasi</i>	1 968		616		2 584	12
Louse flies	Males		Females		Total	
<i>Lipoptena paradoxa</i>	368		452		822 <sup>a</sup>	12

<sup>a</sup> Including pieces of two flies whose sex could not be determined

hood that it would harbour large numbers of adult *A. hebraeum*. From a subsequent study it would appear as if kudus lie on the border between the really large and the smaller wild-host species (Horak *et al.* 1992). Male kudus may harbour fairly substantial numbers of adult *A. hebraeum*, while females seldom carry more than two or three ticks. Although both the Umfolozi and Mkuzi Game Reserves are located in habitats favourable for *A. hebraeum*, not all animals were infested with adults, and the largest burden of adult *A. hebraeum* comprised only 22 ticks, which incidentally were recovered from an adult female nyala. This indicates that nyalas fall within the group of smaller host species, i.e. they are good hosts of the immature stages but not of adult *A. hebraeum*.

The absence of a pattern of seasonal abundance can be ascribed to the year-round warm climate of the reserves, similar to that encountered in the Kruger National Park, where all stages of *A. hebraeum* were present on kudus throughout the year (Horak *et al.* 1992).

Both *Amblyomma marmoreum* and *Amblyomma nuttalli*, whose adults prefer to feed on tortoises, are present in KwaZulu-Natal (Walker 1991). We are unable to differentiate between the immature stages of these ticks and have therefore allocated specimens resembling them, merely to *Amblyomma* spp. Most of these ticks were collected from nyalas in the Mkuzi Game Reserve and were present mainly during March.

#### ***Boophilus decoloratus***

Substantial numbers of this tick have been recorded on cattle at lower altitudes in southern KwaZulu-Natal

(Baker & Ducasse 1967; Baker *et al.* 1989). Although Baker & Keep (1970) list it as occurring on numerous wild animals, including nyalas, in this province, quantitative studies by Horak *et al.* (1983, 1988, 1989, 1991a) indicate that it is present only in small numbers on wild animals in those regions where the latter authors conducted their studies. In the present survey, however, nyalas in the Mkuzi Game Reserve harboured fairly large numbers of *B. decoloratus*. The overall ratio of larvae to nymphs to adults of 3,7:1,5:1,0, calculated from all the nyalas examined, is not unlike that found on kudus in the Eastern Transvaal (3,0:2,0:1,0) and implies a good translation of larvae and nymphs to adulthood (Horak *et al.* 1992). With the exception of two localities at which tick numbers increased in spring, Baker *et al.* (1989) recorded the largest burdens of *B. decoloratus* on cattle from mid to late summer or autumn. In this survey, the largest burdens were present on nyalas examined in months falling within the period October to May (spring to autumn).

#### ***Haemaphysalis* spp.**

Baker & Keep (1970) recorded *H. aciculifer* on common duikers, common reedbuck and bushbuck in the Umfolozi/Hluhluwe Game Reserve complex, and Horak *et al.* (1989) collected this tick from common duikers and bushbuck in the Weza State Forest, southern KwaZulu-Natal. Although *H. aciculifer* is widely distributed, it is never encountered in very large numbers (Walker 1991). It was collected from only one nyala in this study.

*H. silacea* has been recorded on animals in the Umfolozi/Hluhluwe Game Reserve complex and in the



TABLE 5 A comparison of the parasite burdens of 24 male and 24 female nyalas examined at the same localities in north-eastern Kwa-Zulu-Natal at the same times

Developmental stage	Male nyalas			Female nyalas			Significance $P \leq 0,05$
	Mean burden (range)	No. of nyalas infested		Mean burden (range)	No. of nyalas infested		
Ixodid ticks							
<i>Amblyomma hebraeum</i>							
Larvae	503,5 (0-1 866)	21		282,3 (0-1 135)	21		-
Nymphs	114,0 (0-368)	21		41,5 (0-160)	20		0,020
Males	2,7 (0-10)	14		1,9 (0-20)	7		-
Females	0,8 (0-4)	8		0,5 (0-10)	2		-
<i>Boophilus decoloratus</i>							
Larvae	186,6 (0-1 157)	19		124,2 (0-464)	21		-
Nymphs	106,3 (0-596)	17		57,1 (0-256)	18		-
Males	61,4 (0-504)	20		18,9 (0-128)	14		0,030
Females	43,3 (0-344)	22		9,7 (0-76)	15		0,005
<i>Rhipicephalus appendiculatus</i>							
Larvae	517,3 (0-3 746)	18		605,5 (0-5 421)	17		-
Nymphs	144,1 (0-912)	14		88,3 (0-560)	15		-
Males	194,2 (0-1 232)	17		4,9 (0-30)	10		0,002
Females	150,4 (0-1 030)	16		2,5 (0-20)	10		0,005
<i>Rhipicephalus maculatus</i>							
Larvae	419,3 (0-3 276)	20		480,2 (0-1 929)	18		-
Nymphs	92,5 (0-448)	17		82,7 (0-448)	18		-
Males	3,8 (0-42)	10		0,0 (0)	0		0,010
Females	6,4 (0-44)	8		0,7 (0-16)	1		-
<i>Rhipicephalus muelhensi</i>							
Larvae	3 561,8 (448-12 564)	24		3 833,2 (762-8 875)	24		-
Nymphs	625,9 (28-3 712)	24		662,2 (0-2 046)	23		-
Males	389,3 (78-1 239)	24		174,2 (14-555)	24		0,002
Females	256,4 (36-1 152)	24		117,5 (10-351)	24		0,010
Lice							
<i>Damalinea</i> sp.							
Total	159,8 (0-2 044)	17		2,0 (0-32)	2		0,001
<i>Linognathus angasi</i>							
Total	156,2 (0-1 056)	22		248,7 (0-3 504)	20		-
Louse flies							
<i>Lipoptena paradoxa</i>							
Adults	114,0 (28-340)	24		37,6 (0-220)	23		0,001

TABLE 6 The mean total arthropod parasite burdens of nyalas examined in the Umfolozi, Mkuzi and Ndumu Game Reserves during 1983/1984

Arthropod species	Mean total burdens per species		
	Umfolozi (40)	Mkuzi (19)	Ndumu (14)
Ixodid ticks			
<i>Amblyomma hebraeum</i>	485	427	30
<i>Amblyomma</i> spp.	1	67	3
<i>Boophilus decoloratus</i>	261	503	47
<i>Haemaphysalis silacea</i>	21	0	0
<i>Ixodes</i> sp. (near <i>I. pilosus</i> )	16	2	6
<i>Rhipicephalus appendiculatus</i>	1 136	338	250
<i>Rhipicephalus evertsi evertsi</i>	16	6	2
<i>Rhipicephalus maculatus</i>	623	742	777
<i>Rhipicephalus muehlensi</i>	2 984	7 158	8 717
Lice			
<i>Damalinea</i> sp.	85	11	5
<i>Linognathus angasi</i>	198	108	185
Louse flies			
<i>Lipoptena paradoxa</i>	59	42	59

( ) = Number of animals examined in each reserve

Mkuzi Game Reserve by Baker & Keep (1970), but we collected it only in the Umfolozi Game Reserve. The preferred habitat of this tick is localized areas of Valley Bushveld in the Eastern Cape Province (Walker 1991), where large numbers have been recorded on kudus (Horak *et al.* 1992).

### *Ixodes pilosus* complex

McKay (1994) believes that there are three separate species in this complex. Although *I. pilosus* sensu stricto does occur in KwaZulu-Natal (McKay 1994), the nyalas in the present study harboured adult ticks which he describes as "thick haired *pilosus*".

### *Rhipicephalus* spp.

The adults of *R. appendiculatus* prefer large bovids such as cattle, eland and buffaloes, but kudus, sable antelope and impalas are also good hosts (Norval, Walker & Colborne 1982; Horak *et al.* 1983, 1992). Adult male, but not female, nyalas can now be added to this list. Six male animals each harboured more than 600 adult ticks and one of them, 2262 ticks.

Baker & Ducasse (1967) recovered 69,3% of adult *R. appendiculatus* from the ear pinnae of cattle and 80,0% from the pinnae and the remainder of the cattle's heads. The three male nyalas examined in the Mkuzi Game Reserve during 1994 harboured a to-

tal of 1461 adult *R. appendiculatus* of which 520 (35,6%) attached on their heads and ears. This distribution pattern could be the result of competition with the numerous adult *R. muehlensi* which were also present. The male nyalas harboured a total of 3428 of these, of which 2316 (67,6%) were attached to their heads and ears. The three female nyalas examined at the same time, harboured a total of 49 adult *R. appendiculatus* and 1899 adult *R. muehlensi*, of which 57,1% and 91,0%, respectively, were attached to their heads and ears.

The period of peak abundance of *R. appendiculatus* on the male nyalas (February to May) is the same as that recorded on kudus in north-eastern Eastern Transvaal (Horak *et al.* 1992).

*R. evertsi evertsi* has a very widespread distribution in South Africa (Howell, Walker & Nevill 1978) but, except on zebras and eland, the adults never occur in very large numbers (Horak, Fourie, Novellie & Williams 1991b). Nyalas, like kudus, appear to be poor hosts of this tick (Horak *et al.* 1992). Not only were few adults collected, but very few larvae of this two-host tick developed into nymphs.

Within the South African borders, *R. maculatus* is present in the coastal regions of KwaZulu-Natal (Walker 1991). The adults prefer large animals with thick skins, such as elephants, black and white rhinoceroses, buffaloes, bushpigs and warhogs (Baker & Keep 1970; Horak *et al.* 1983, 1991a). Excluding elephants, the immature stages are also found on these hosts as well as on various duiker species, reedbuck, impalas, and particularly on nyalas, also on scrub hares (Baker & Keep 1970; Horak *et al.* 1983, 1988, 1991a, 1995). The seasonal abundances of the immature stages are similar to those of *R. appendiculatus*.

Nyalas, and probably also bushbuck, must be regarded as the preferred hosts of all developmental stages of *R. muehlensi* (Horak *et al.* 1983, 1988; this study). This tick, like *R. maculatus*, is present in South Africa only in the coastal regions of northern KwaZulu-Natal (Walker 1991). Large numbers of nymphs, and probably also larvae (which at the time were lumped with other larvae and identified as *Rhipicephalus* spp.), have been recovered from red duikers and numerous larvae from scrub hares (Horak *et al.* 1991a, 1995). Nyalas, bushbuck and red duikers are all browsers and are found in habitats containing thickets, various types of woodland or forests, while scrub hares prefer savanna woodland and scrub (Smithers 1983). This implies that *R. muehlensi* also prefers these habitat types.

The large totals of these ticks recovered from nyalas, reflect the year-round abundance of all developmental stages of *R. muehlensi*. As discussed earlier, competition with adult *R. appendiculatus* may affect the proportion of adult *R. muehlensi* attaching to the heads and ears of nyalas.



## Lice

With few exceptions, louse burdens were low, and adult male animals harboured significantly more *Damalinia* sp. than did adult females. No pattern of seasonal abundance was evident for either of the louse species.

## Louse flies

The biology of *L. paradoxa*, with particular reference to kudu, was discussed by Visagie *et al.* (1992). The preferred hosts of this fly are all browsing antelopes, namely common duikers, bushbuck, nyalas and kudus. Adult male kudus and nyalas harbour significantly more of these flies than do adult female animals (Visagie *et al.* 1992; Table 5). Visagie *et al.* (1992) collected 3594 flies whose sex could be determined, from common duikers, bushbuck and kudu. Of these flies 2243 (62.4%) were females. In the present study 4622 *L. paradoxa* whose sex could be determined were collected, and 2573 (55.7%) of these were females.

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