



Ticks associated with the three largest wild ruminant species in southern Africa

I.G. HORAK^{1*}, H. GOLEZARDY² and A.C. UYS²

ABSTRACT

HORAK, I.G., GOLEZARDY, H. & UYS, A.C. 2007. Ticks associated with the three largest wild ruminant species in southern Africa. *Onderstepoort Journal of Veterinary Research*, 74:231–242

The objective of this study was to assess the host status of the three largest southern African wild ruminants, namely giraffes, *Giraffa camelopardalis*, African buffaloes, *Syncerus caffer*, and eland, *Taurotragus oryx* for ixodid ticks. To this end recently acquired unpublished data are added here to already published findings on the tick burdens of these animals, and the total numbers and species of ticks recorded on 12 giraffes, 18 buffaloes and 36 eland are summarized and discussed. Twenty-eight ixodid tick species were recovered. All stages of development of ten species, namely *Amblyomma hebraeum*, *Rhipicephalus (Boophilus) decoloratus*, *Haemaphysalis silacea*, *Ixodes pilosus* group, *Margaropus winthemi*, *Rhipicephalus appendiculatus*, *Rhipicephalus evertsi evertsi*, *Rhipicephalus glabroscutatum*, *Rhipicephalus maculatus* and *Rhipicephalus muehlensii* were collected. The adults of 13 species, of which the immature stages use small mammals as hosts, namely *Haemaphysalis aciculifer*, *Hyalomma glabrum*, *Hyalomma marginatum rufipes*, *Hyalomma truncatum*, *Ixodes rubicundus*, *Rhipicephalus capensis*, *Rhipicephalus exophthalmos*, *Rhipicephalus follis*, *Rhipicephalus gertrudae*, *Rhipicephalus lounsburyi*, *Rhipicephalus lunulatus*, *Rhipicephalus pravus* group and *Rhipicephalus simus*, were also collected.

Keywords: African buffaloes, eland, *Giraffa camelopardalis*, giraffes, ixodid ticks, *Syncerus caffer*, *Taurotragus oryx*, tick burdens

INTRODUCTION

Although numerous collections of ticks have been made from giraffes, *Giraffa camelopardalis*, African buffaloes, *Syncerus caffer* and eland, *Taurotragus*

oryx (Theiler 1962; Yeoman & Walker 1967; Baker & Keep 1970; Walker 1974; Norval 1983), it would seem that few attempts have been made to determine the total tick burdens of these large animals. This is perhaps not surprising considering the amount of assistance required to collect ticks from dead or immobilized animals of this size, and the time that has to be spent identifying and counting immature ticks in representative samples of these collections and often all the several thousand adult ticks that a single large herbivore may harbour. Amongst those who have attempted to do so are Horak, Potgieter, Walker, De Vos & Boomker (1983), Rechav, Zeederberg & Zeller (1987), Horak, Fourie, Novellie & Williams (1991a), Horak, Anthonissen, Krecek & Boomker (1992a) and Zieger, Horak, Cauldwell & Uys (1998). Prior as well as subsequent to these published studies the opportunity to sam-

* Author to whom correspondence is to be directed. E-mail: ivan.horak@up.ac.za

¹ Department of Veterinary Tropical Diseases, Faculty of Veterinary Science, University of Pretoria, Onderstepoort, 0110 South Africa; Division of Parasitology, Onderstepoort Veterinary Institute, Onderstepoort, 0110 South Africa; and Department of Zoology and Entomology, University of the Free State, P.O. Box 339, Bloemfontein, 9300 South Africa

² Department of Veterinary Tropical Diseases, Faculty of Veterinary Science, University of Pretoria, Onderstepoort, 0110 South Africa. A.C. Uys' present address: P.O. Box 652, Newlands, 0049 South Africa

ple more of these large herbivores has arisen and the present paper reports the results of the latter collections. However, since we thought it unlikely that, in the near future, similar exhaustive tick collections would be made from such large animals in southern Africa, we decided to combine the earlier published data with the more recent findings in order to give a more comprehensive overview of the numbers and species of ticks that may infest giraffes, African buffaloes and eland in a variety of habitats.

Giraffes occur in several associations of dry savanna, varying from scrub to woodland. They do not occur in forest or desert and generally are not found in open plains. They are present in north-eastern Limpopo and Mpumalanga Provinces, South Africa, and in the north-eastern parts of Namibia (Skinner & Smithers 1990), but in recent times have been introduced into a number of regions in South Africa in which they previously did not occur.

African buffaloes prefer savanna-type habitats and need a plentiful supply of grass, shade and water. They occur in herds, which increase in size in the dry season, but become more fragmented during the wet season because of the usual plentiful supply of water and grazing (Skinner & Smithers 1990). The current distribution of African buffaloes in South Africa is mostly patchy. Large numbers are present in the Kruger National Park (KNP) and the Hluhluwe-iMfolozi Park in the north-eastern regions of the Limpopo, Mpumalanga and KwaZulu-Natal Provinces, with smaller populations in national, provincial and privately owned reserves in these and nearly all other provinces of South Africa.

Eland are gregarious animals usually occurring in small herds, and are as at home in arid semi-desert scrub associations as they are in montane grassland (Skinner & Smithers 1990). Historically they were present virtually throughout South Africa, but overexploitation reduced their numbers. However, because they are a sought after species, reintroductions have resulted in their now occupying virtually the same regions in which they originally occurred.

One of the serious shortcomings of the past and current studies is that they are biased towards localities and seasons at which animals were, or have been, made available for survey purposes and are thus not necessarily representative of the entire ixodid tick fauna present within the geographic distribution of the host species being examined. Nevertheless a remarkably large number of tick species were recovered. Moreover, because of the

large size of the hosts, large numbers of adult ticks were collected (Gallivan & Horak 1997), and the greater certainty with which the adult ticks can be identified has augmented the accuracy of our identification of the immature stages, and hence our results.

MATERIALS AND METHODS

The localities at which animals were examined, including those of the earlier studies of Horak *et al.* (1983, 1991a, 1992a), Rechav *et al.* (1987) and Zieger *et al.* (1998), are summarized in Table 1. With the exception of Free State and Gauteng Provinces at least one of the three large wild ruminant species was sampled in each province of the Republic of South Africa. In addition, six of the giraffes were examined in the Etosha National Park in northern Namibia (Horak *et al.* 1992a), and two of the eland on a game ranch in Central Province, Zambia (Zieger *et al.* 1998).

Ticks were recovered from the animals in the earlier surveys as described by the authors of those studies. The carcasses of giraffes, African buffaloes and eland in the present surveys were processed for tick recovery and the ticks identified and counted as described by Horak, Boomker, Spickett & De Vos (1992b). When animals had been immobilized, and not killed, an attempt was made to collect as many adult ticks as possible, with particular attention being paid to the preferred sites of attachment of the various species.

A total of 12 giraffes, 18 African buffaloes and 36 eland were examined, but in the tables devoted to each host species only the results for those animals sampled within a particular tick species' distribution range are given for that particular tick.

RESULTS AND DISCUSSION

The species and numbers of ticks collected from the giraffes, buffaloes and eland are summarized in Tables 2, 3 and 4, and the total numbers of male and female ticks recovered and, where it was possible to calculate this, the ratio of males to females for each species are summarized in Table 5.

A calculated total of 450 709 ticks, belonging to 28 species and three subspecies, were collected from the 66 animals examined. Of these 57 688 were adults, of which at least half were identified and counted. Although this may seem like a large number of ticks, probably three times as many would

TABLE 1 Localities at which large wild ruminants were examined for ixodid ticks

Country and province	Locality	Co-ordinates	Vegetation type (Van der Merwe 1983; White 1983; Acocks 1988)
South Africa			
Western Cape	West Coast National Park	33°06' S, 17°59' E	Strandveld and patches of Coastal Fynbos
Eastern Cape	Thomas Baines Nature Reserve	33°23' S, 26°28' E	False Macchia, Eastern Province Thornveld and Valley Bushveld
	Andries Vosloo Kudu Reserve	33°07' S, 26°40' E	Valley Bushveld
	Mountain Zebra National Park	32°15' S, 25°27' E	Karroid <i>Merxmeullera</i> Mountain Veld, replaced by Karoo on the higher slopes and Karroid Broken Veld in the north
Northern Cape	Kgalagadi Transfrontier Park	24°45'–26°28' S, 20°00'–20°50' E	Lightly wooded grassland on dune crests and grassland in depressions between dunes
KwaZulu-Natal	Eastern Shores Park	28°08' S, 32°30' E	Zululand Palm Veld, subdivision of Coastal Thornveld and Coastal communities
	iMfolozi Nature Reserve	28°15' S, 31°57' E	Zululand Thornveld and Lowveld
North West	SA Lombaard Reserve	27°35' S, 25°29' E	Dry <i>Cymbopogon-Themeda</i> veld
Mpumalanga	Pretoriuskop (KNP)	25°10' S, 31°16' E	Lowveld Sour Bushveld
	Lower Sabie (KNP)	25°07' S, 31°55' E	Lowveld
	Mtethomusha Nature Reserve	25°29' S, 31°17' E	Lowveld
Namibia			
	Okaukuejo, Etosha National Park	19°11' S, 15°55' E	Mopane savanna
Zambia			
Central	Mtendere Game Ranch	15°05' S, 28°16' E	Miombo Woodland

KNP = Kruger National Park

have been recovered had the digestion technique of Van Dyk & McKenzie (1992) been used. However, the fine structures of tick larvae and nymphs are often damaged during the period of digestion required in the latter technique, and thus, although tick recovery may be more complete, it is achieved at the expense of accurate species determination.

Two of the 28 species recovered are one-host ticks, namely *Margaropus winthemi* and *Rhipicephalus (Boophilus) decoloratus*. Five are two-host ticks, these being *Hyalomma glabrum*, *Hyalomma marginatum rufipes*, *Hyalomma truncatum*, *Rhipicephalus glabroscutatum* and *Rhipicephalus evertsi* of which both subspecies of the latter, namely *evertsi* and *mimeticus* were collected. The remaining 21 species are all three-host ticks. All stages of development of *Amblyomma hebraeum*, *R. (Boophilus) decoloratus*,

Haemaphysalis silacea, *Ixodes pilosus* group, *M. winthemi*, *Rhipicephalus appendiculatus*, *R. evertsi*, *R. glabroscutatum*, *Rhipicephalus maculatus* and *Rhipicephalus muehlensi* were collected. Only the adults of 13 species, namely *Haemaphysalis aciculifer*, *H. glabrum*, *H. marginatum rufipes*, *H. truncatum*, *Ixodes rubicundus*, *Rhipicephalus capensis*, *Rhipicephalus exophthalmos*, *Rhipicephalus follis*, *Rhipicephalus gertrudae*, *Rhipicephalus lounsburyi*, *Rhipicephalus lunulatus*, *Rhipicephalus pravus* group and *Rhipicephalus simus*, of which the immature stages use small mammals as hosts, were recovered. In addition the larvae and nymphs of the South African tortoise tick, *Amblyomma marmoreum*, nymphs and adults of the tropical bont tick, *Amblyomma variegatum*, a single male *Rhipicephalus longiceps*, 30 *Rhipicephalus supertritus* males and 16 *Rhipicephalus zambeziensis* nymphs were re-

TABLE 2 Giraffes examined and the number infested within the distribution range of each tick

Tick species	Hosts examined (infested)	Life stage	Total No. of ticks	Locality
<i>Amblyomma hebraeum</i>	6 (6)	Larvae Nymphs Males Females	773 554 2 406 512	KNP
<i>Hyalomma marginatum rufipes</i>	12 (8)	Males Females	374 77	KNP, Etosha
<i>Hyalomma truncatum</i>	12 (12)	Males Females	1 649 619	KNP, Etosha
<i>Rhipicephalus (Boophilus) decoloratus</i>	6 (6)	Larvae Nymphs Males Females	2 472 2 538 1 503 821	KNP
<i>Rhipicephalus appendiculatus</i>	6 (6)	Larvae Nymphs Males Females	168 682 49 4	KNP
<i>Rhipicephalus evertsi evertsi</i>	6 (6)	Larvae Nymphs Males Females	452 190 106 20	KNP
<i>Rhipicephalus evertsi mimeticus</i>	6 (5)	Males Females	14 5	Etosha
<i>Rhipicephalus longiceps</i>	6 (1)	Males	1	Etosha
<i>Rhipicephalus pravus</i> group	6 (3)	Males Females	32 20	KNP
<i>Rhipicephalus simus</i>	6 (4)	Males Females	22 6	KNP

KNP = Kruger National Park

covered. Ten of the 28 tick species recovered occur only in South Africa. They are *H. silacea*, *H. glabrum*, *I. pilosus*, *I. rubicundus*, *M. winthemi*, *R. capensis*, *R. follis*, *R. glabroscutatum* and *R. lounsburyi*.

With the exception of ticks of the *I. pilosus* group and *I. rubicundus*, of which more females than males were recovered, considerably more males than females of all other species, of which both sexes were present, were collected. Mating in *Ixodes* species may occur in the preparasitic phase of the life cycle (Fourie & Horak 1994), and many males thus never attach. This behaviour is probably largely responsible for the female-biased parasitic populations of the two ticks in this genus in the present study. The male-biased populations of the other tick species is due to the propensity of parasitic male ixodid ticks of several species to spend extended periods on

their hosts (Londt 1976; Jordaan & Baker 1981), whereas the females may require only a few days to two weeks to mate and engorge before detaching. Furthermore the larger size of engorging females is likely to make them more susceptible to removal by grooming or predation than the considerably smaller males.

Amblyomma species

The larvae of *Amblyomma hebraeum* infest a wide variety of hosts, including ungulates, carnivores, lagomorphs and birds, and all stages of development, but particularly the adults, infest very large hosts (Horak, Maclvor, Petney & De Vos 1987a). The males may remain attached for several months (Jordaan & Baker 1981), thus augmenting the already male-biased population of adult ticks. *Ambly-*

TABLE 3 African buffaloes examined and the number infested within the distribution range of each tick

Tick species	Hosts examined (infested)	Life stage	Total No. of ticks	Locality
<i>Amblyomma hebraeum</i>	18 (18)	Larvae Nymphs Males Females	47 815 6 437 6 154 1 764	KNP, Eastern Shores, iMfolozi, Thomas Baines, Mtethomusha
<i>Amblyomma marmoreum</i>	18 (4)	Larvae Nymphs	8 26	KNP, Eastern Shores, iMfolozi, Thomas Baines, Mtethomusha
<i>Haemaphysalis silacea</i>	15 (7)	Larvae Nymphs Males Females	81 357 135 78	Eastern Shores, iMfolozi, Thomas Baines
<i>Hyalomma truncatum</i>	17 (2)	Males Females	6 0	KNP, iMfolozi, Mtethomusha
<i>Rhipicepalus (Boophilus) decoloratus</i>	18 (11)	Larvae Nymphs Males Females	1 640 290 248 160	Eastern Shores, iMfolozi, Thomas Baines, Mtethomusha
<i>Rhipicephalus appendiculatus</i>	18 (17)	Larvae Nymphs Males Females	139 389 32 715 1 360 774	KNP, Eastern Shores, iMfolozi, Thomas Baines, Mtethomusha
<i>Rhipicephalus evertsi evertsi</i>	18 (15)	Larvae Nymphs Males Females	721 35 96 45	KNP, Eastern Shores, iMfolozi, Thomas Baines, Mtethomusha
<i>Rhipicephalus follis</i>	1 (1)	Males Females	40 32	Thomas Baines
<i>Rhipicephalus maculatus</i>	14 (14)	Larvae Nymphs Males Females	15 379 16 772 946 398	Eastern Shores, iMfolozi
<i>Rhipicephalus muehlensi</i>	16 (15)	Larvae Nymphs Males Females	11 775 495 193 141	Eastern Shores, iMfolozi, Mtethomusha
<i>Rhipicephalus simus</i>	18 (9)	Males Females	121 64	KNP, Eastern Shores, iMfolozi, Mtethomusha

KNP = Kruger National Park

omma hebraeum is present in the Bushveld and Lowveld regions of northern, eastern and south-eastern South Africa (Walker & Olwage 1987).

Amblyomma marmoreum is known as the South African tortoise tick, and all stages of development may be found on a variety of these reptiles, with leopard tortoises, *Geochelone pardalis*, generally the

most heavily infested (Horak, McKay, Heyne & Spickett 2006). The larvae infest a wide variety of mammals and birds, and are often found on mammals and birds of several species that are present within the tick's distribution range (Horak *et al.* 2006).

Amblyomma variegatum does not occur in South Africa, but is present in most sub-Saharan countries

TABLE 4 Eland examined and the number infested within the distribution range of each tick

Tick species	Hosts examined (infested)	Life stage	Total No. of ticks	Locality
<i>Amblyomma hebraeum</i>	4 (4)	Larvae Nymphs Males Females	32 394 2 405 3 488 530	KNP, Andries Vosloo Kudu Reserve, Thomas Baines NR
<i>Amblyomma marmoreum</i>	15 (8)	Larvae	167	KNP, Mountain Zebra NP, AV Kudu Reserve, Thomas Baines NR
<i>Amblyomma variegatum</i>	2 (2)	Nymphs Males Females	4 60 26	Mtendere Game Ranch
<i>Haemaphysalis aciculifer</i>	2 (1)	Males	2	KNP
<i>Haemaphysalis silacea</i>	4 (4)	Larvae Nymphs Males Females	7 686 933 1 409 386	Andries Vosloo Kudu Reserve, Thomas Baines NR
<i>Hyalomma glabrum</i>	11 (11)	Males Females	955 191	Mountain Zebra NP
<i>Hyalomma marginatum rufipes</i>	16 (16)	Males Females	907 470	Kgalagadi Transfrontier Park, Thomas Baines NR, SA Lombaard NR
<i>Hyalomma truncatum</i>	32 (27)	Males Females	1 702 650	Mountain Zebra NP, Kgalagadi Transfrontier Park, West Coast NP, SA Lombaard NR
<i>Ixodes pilosus</i> group	4 (4)	Larvae Nymphs Males Females	2 817 177 22 64	Andries Vosloo Kudu Reserve, Thomas Baines NR
<i>Ixodes rubicundus</i>	11 (7)	Males Females	34 81	Mountain Zebra NP
<i>Margaropus winthemi</i>	11 (9)	Larvae Nymphs Males Females	12 792 6 874 1 915 893	Mountain Zebra NP
<i>Rhipicephalus (Boophilus) decoloratus</i>	8 (5)	Larvae Nymphs Males Females	3 106 3 988 3 581 848	KNP, AV Kudu Reserve, Thomas Baines NR, Mtendere Game Ranch
<i>Rhipicephalus appendiculatus</i>	8 (8)	Larvae Nymphs Males Females	18 025 1 489 8 106 3 345	KNP, AV Kudu Reserve, Thomas Baines NR, Mtendere Game Ranch
<i>Rhipicephalus capensis</i>	2 (2)	Males Females	1 506 408	West Coast NP
<i>Rhipicephalus evertsi evertsi</i>	34 (31)	Larvae Nymphs Males Females	6 900 2 128 1 574 392	KNP, Mountain Zebra NP, AV Kudu Reserve, Thomas Baines NR, West Coast NP, SA Lombaard NR, Mtendere Game Ranch

TABLE 4 *Cont.*

Tick species	Hosts examined (infested)	Life stage	Total No. of ticks	Locality
<i>Rhipicephalus exophthalmos</i>	11 (1)	Males Females	0 2	Mountain Zebra NP
<i>Rhipicephalus follis</i>	11 (11)	Males Females	983 447	Mountain Zebra NP, Thomas Baines NR
<i>Rhipicephalus gertrudae</i>	2 (1)	Males Females	4 2	West Coast NP
<i>Rhipicephalus glabroscutatum</i>	14 (13)	Larvae Nymphs Males Females	6 510 2 846 868 499	Mountain Zebra NP, Andries Vosloo Kudu Reserve, West Coast NP
<i>Rhipicephalus lounsburyi</i>	11 (2)	Males	3	Mountain Zebra NP
<i>Rhipicephalus lunulatus</i>	2 (2)	Males Females	218 48	Mtendere Game Ranch
<i>Rhipicephalus simus</i>	6 (4)	Males Females	39 5	KNP, AV Kudu Reserve, Thomas Baines NR
<i>Rhipicephalus supertritus</i>	2 (2)	Males	30	Mtendere Game Ranch
<i>Rhipicephalus zambeziensis</i>	2 (1)	Nymphs	16	KNP

KNP = Kruger National Park

NP = National Park

NR = Nature Reserve

to the north (Walker & Olwage 1987). Its host spectrum is similar to that of *A. hebraeum* and its presence on the two eland examined in Zambia is thus to be expected.

***Haemaphysalis* species**

The two male *Haemaphysalis aciculifer* recovered from an eland in the KNP during September 1979 (Horak *et al.* 1983; Table 4), were the only specimens of this species reported in the park until 2000, when Horak, Braack, Fourie & Walker (2000) recorded 13 males and two females from a honey badger, *Mellivora capensis*. This tick is seldom recovered in large numbers but appears to be present in north-eastern Mpumalanga Province and thence along the eastern and southern coastal and adjacent inland regions to the south-western region of the Cape Province (Theiler 1962; Horak, Keep, Spickett & Boomker 1989; Horak & Boomker 1998).

Haemaphysalis silacea is present in north-eastern KwaZulu-Natal and in the Eastern Cape Provinces (Walker 1991), and is associated with vegetation classified as Valley Bushveld (Acocks 1988) and with greater kudus, *Tragelaphus strepsiceros*, common duikers, *Sylvicapra grimmia*, Cape grysbok,

Rhaphicerus melanotis, and helmeted guineafowls, *Numida meleagris* (Horak & Knight 1986; MacIvor & Horak 2003). Seven of the 18 buffaloes and all four eland examined in Valley Bushveld-type vegetation in the north-eastern KwaZulu-Natal and the Eastern Cape Provinces were infested.

***Hyalomma* species**

Delpy (1949) described the tick now known as *Hyalomma glabrum* as *Hyalomma rufipes glabrum*, and the latter name persisted until Theiler (1956) raised it to species level as *Hyalomma glabrum*. In the same year Hoogstraal (1956) synonymized it with Asian *Hyalomma marginatum turanicum*, and since then it has been considered identical to the latter tick. Recent studies have, however, revealed that it is a separate taxon, and Apanaskevich & Horak (2006) have subsequently reinstated it as *Hyalomma glabrum*. Howell, Walker & Nevill (1978) have illustrated its distribution (as *H. m. turanicum*) in the central and western regions of South Africa. The adults prefer large animals such as eland and Cape mountain zebras, *Equus zebra zebra*, and its immature stages infest scrub hares, *Lepus saxatilis*, and ground-frequenting birds (Apanaskevich & Horak 2006).

TABLE 5 Male to female ratios of tick species collected from giraffes, African buffaloes and eland in southern Africa

Tick species	Total No. of adult ticks		Male:female ratio	
	Male	Female	Male	Female
<i>Amblyomma hebraeum</i>	12 048	2 806	4.29	1.0
<i>Amblyomma variegatum</i>	60	26	2.31	1.0
<i>Haemaphysalis aciculifer</i>	2	0	–	–
<i>Haemaphysalis silacea</i>	1 544	464	3.33	1.0
<i>Hyalomma glabrum</i>	955	191	5.00	1.0
<i>Hyalomma marginatum rufipes</i>	1 281	547	2.34	1.0
<i>Hyalomma truncatum</i>	3 357	1 269	2.65	1.0
<i>Ixodes pilosus</i> group	22	64	0.34	1.0
<i>Ixodes rubicundus</i>	34	81	0.42	1.0
<i>Margaropus winthemi</i>	1 915	893	2.14	1.0
<i>Rhipicephalus (Boophilus) decoloratus</i>	5 332	1 829	2.92	1.0
<i>Rhipicephalus appendiculatus</i>	9 515	4 123	2.31	1.0
<i>Rhipicephalus capensis</i>	1 506	408	3.69	1.0
<i>Rhipicephalus evertsi evertsi</i>	1 776	457	3.89	1.0
<i>Rhipicephalus evertsi mimeticus</i>	14	5	2.80	1.0
<i>Rhipicephalus exophthalmos</i>	0	2	–	–
<i>Rhipicephalus follis</i>	1 023	479	2.14	1.0
<i>Rhipicephalus gertrudae</i>	4	2	2.00	1.0
<i>Rhipicephalus glabroscutatum</i>	868	499	1.74	1.0
<i>Rhipicephalus longiceps</i>	1	0	–	–
<i>Rhipicephalus lounsburyi</i>	3	0	–	–
<i>Rhipicephalus lunulatus</i>	218	48	4.54	1.0
<i>Rhipicephalus maculatus</i>	946	398	2.38	1.0
<i>Rhipicephalus muehlensi</i>	193	141	1.37	1.0
<i>Rhipicephalus pravus</i> group	32	20	1.60	1.0
<i>Rhipicephalus simus</i>	182	75	2.43	1.0
<i>Rhipicephalus supertritus</i>	30	0	–	–
Total (excluding <i>Ixodes</i> spp.)	42 805	14 682	2.92	1.0

The distribution of *Hyalomma marginatum rufipes* is more extensive than that of *H. glabrum*, which it almost entirely overlaps (Howell *et al.* 1978). Its host preferences are the same as those of the latter tick (Walker 1991), but include giraffes and buffaloes, which are generally not present within the distribution range of *H. glabrum* (Tables 2 and 3).

With the exception of the eastern coastal regions and some adjacent inland areas and the southern coastal regions, *Hyalomma truncatum* is present virtually throughout the country (Howell *et al.* 1978). The adults are found on the same large hosts as the former two ticks, and its immature stages infest scrub hares and rodents (Walker 1991).

***Ixodes* species**

Ticks of the *Ixodes pilosus* group are present in the southern coastal and adjacent regions of the Western and Eastern Cape Provinces and in south-eastern KwaZulu-Natal Province, where all stages of development may be encountered on antelopes,

caracals, *Caracal caracal* and domestic dogs (Horak, Jacot Guillarmod, Moolman & De Vos 1987b; Horak *et al.* 1989; Horak & Boomker 1998; Horak & Matthee 2003).

The colloquial name given to *Ixodes rubicundus* is Karoo paralysis tick, because of the paralysis associated with infestation of small domestic livestock in the Karoo regions of the country (Howell *et al.* 1978; Fourie & Horak 1994). The hosts of the adults are wild and domestic ruminants, caracals and domestic dogs (Horak *et al.* 1987b, 1991a; Fourie & Horak 1993; Horak & Matthee 2003). The immature stages infest Smith's red rock rabbits, *Pronolagus rupestris*, caracals and rock elephant shrews, *Elephantulus myurus* (Horak *et al.* 1991a; Fourie, Horak & Woodall 2005).

Margaropus winthemi

This tick is commonly known as the winter horse tick, and its distribution in the cooler higher-lying regions of the country suggests that its original hosts

were Cape mountain zebras, on which it still occurs in very large numbers during the winter months (Horak *et al.* 1991a). The burdens of the eland (Table 4), examined at the same time as zebras in the Mountain Zebra National Park, although large, did not nearly approach those of the latter animals.

***Rhipicephalus* species**

Rhipicephalus (Boophilus) decoloratus. Using molecular analyses supported by an analysis of morphological characters Murrell, Campbell & Barker (2000) and Beati & Keirans (2001) decided that the genus *Rhipicephalus* is paraphyletic with respect to the genus *Boophilus* and consequently Murrell & Barker (2003) proposed the use of the above nomenclature. We have chosen to follow their proposal, although many people prefer to retain *Boophilus* as a generic name. Giraffes and eland can generally be considered as good hosts of this tick, whereas African buffaloes appear to be resistant to infestation, with more than half of the adult ticks reported here coming from a single, approximately 6-month-old calf. Norval (1984) and Horak, Golezardy & Uys (2006) have discussed the apparent resistance of African buffaloes to artificial and natural infestations with this tick, and it would seem that this resistance is acquired, rather than innate.

Adult *Rhipicephalus appendiculatus* are common parasites of African buffaloes, eland, greater kudu, male nyalas, *Tragelaphus angasii*, and domestic cattle in wooded savannas from south-eastern South Africa in the south to Kenya and Uganda in the north (Walker, Keirans & Horak 2000). The immature stages are found on the same hosts as the adults, but also infest smaller antelopes and scrub hares (Walker *et al.* 2000). The eland included in the present study and more particularly those from Zambia, were heavily infested with adult ticks (Table 4). The buffaloes, which were examined mainly during the early winter months, harboured very large numbers of larvae (Table 3).

Rhipicephalus capensis, *Rhipicephalus follis*, *Rhipicephalus gertrudae* and *Rhipicephalus simus* have several morphological characteristics in common and also have similar life cycles during which the immature stages infest murid rodents and the adults the larger species of antelopes (Walker *et al.* 2000). Adult *R. gertrudae* also infest domestic dogs and primates, including humans (Brain & Bohrmann 1992; Horak, Fourie, Heyne, Walker & Needham 2002; Horak & Matthee 2003), while those of *R. simus* infest domestic and wild equids, suids and carnivores (Horak *et al.* 1987b, 2000; Walker *et al.*

2000). *Rhipicephalus capensis* occurs almost exclusively in the western coastal regions of the Western Cape Province, South Africa; *R. gertrudae* is present in the same western regions, but its distribution extends east to the southern and southern-central regions of the country and north into Namibia; *R. follis* is only found in South Africa and is present to the east and north-east of *R. gertrudae*'s distribution range and generally in mountainous terrain; while, with the exception of the more arid regions of central and western South Africa and southern Namibia, the distribution range of *R. simus* effectively overlays those of the other three species and extends north into Africa to a latitude of approximately 9° south.

Rhipicephalus evertsi evertsi and *Rhipicephalus evertsi mimeticus* are two-host ticks and all stages of development may infest the same host species. Excluding the deserts and regions of high rainfall, the former tick is found throughout sub-Saharan Africa, whereas the latter is confined to the arid and semi-arid regions of Namibia, western Botswana and parts of Angola (Walker *et al.* 2000).

The adults of *Rhipicephalus exophthalmos* parasitize antelopes, domestic ruminants and scrub hares in the south-eastern and north-western regions of South Africa and in a broad, central band from the south to the north of Namibia (Walker *et al.* 2000). Its immature stages prefer elephant shrews, *Elephantulus* spp., as hosts (Fourie *et al.* 2005).

The two-host tick, *Rhipicephalus glabroscutatum*, is present in the fynbos and Karoo regions of the Western Cape Province, and also in the Karoo and the Valley Bushveld regions of the Eastern Cape Province (Walker *et al.* 2000). It is a common parasite of the feet and lower legs of small and large antelope in these regions (Horak & Boomker 1998; MacIvor & Horak 2003). Infestation with its adults is a contributory cause of foot abscess in domestic goats in the Valley Bushveld regions of the Eastern Cape Province (MacIvor & Horak 1987).

The distribution in South Africa of *Rhipicephalus maculatus* and *Rhipicephalus muehlensi* is confined to the coastal bush and adjacent inland regions of north-eastern KwaZulu-Natal (Walker *et al.* 2000). The recovery of an *R. maculatus* nymph from the vegetation and adults from an elephant, *Loxodonta africana*, in the southern regions of the KNP (Braack, Maggs, Zeller & Horak 1995), and of *R. muehlensi* adults from one of the buffaloes examined in the Mtethomusha Nature reserve, just south of the KNP, suggest that they have been introduced into these

reserves on animals translocated from north-eastern KwaZulu-Natal. All stages of development of both ticks may infest the same host species, but the adults of *R. maculatus* prefer thick-skinned animals such as buffaloes and bush pigs, *Potamochoerus larvatus*, and those of *R. muehlensi* nyalas (Horak, Boomker & Flamand 1991b; 1995).

Rhipicephalus longiceps is a rarely encountered tick and apparently is present only in certain regions of Namibia and Angola (Walker *et al.* 2000).

Rhipicephalus lounsburyi prefers the higher mountainous regions of the Eastern Cape Province (Walker *et al.* 2000) and two eland in the Mountain Zebra National Park were infested. The adults attach around the feet of their antelope and sheep hosts, while the only known hosts of its immature stages are four-striped grass mice, *Rhabdomys pumilio*, from which a larva and two nymphs have been collected (Walker *et al.* 2000; Horak, Fourie & Braack 2005).

Although *Rhipicephalus lunulatus* is fairly widespread in sub-Saharan Africa its distribution in South Africa is limited to the eastern regions (Walker *et al.* 2000). The adults have a wide host range and would seem to attach around the feet and lower legs of their hosts (Walker *et al.* 2000). The eland examined in Zambia had fairly large burdens of adult ticks (Table 4), while a multimammate mouse, *Mastomys* sp., and a scrub hare examined on the same ranch as the eland were infested with nymphs (Zieger *et al.* 1998).

Ticks belonging to the *Rhipicephalus pravus* group have been collected from scrub hares in the KNP (Horak, Spickett, Braack & Penzhorn 1993), and were assigned to *Rhipicephalus* sp. near *pravus* by Walker *et al.* (2000). However, the ticks collected in the same park from three of the giraffes, appear to us to be very similar, if not identical to the true *R. pravus* of East Africa.

The immature stages of *Rhipicephalus supertritus* are unknown, but are assumed to be similar in appearance to those of *R. appendiculatus*. It is apparently commonest in Central Africa, including northern Zimbabwe and Mozambique, parts of Zambia and southern Tanzania (Walker *et al.* 2000), and both eland examined in Zambia were infested.

ACKNOWLEDGEMENTS

We are most grateful to Ezemvelo KZN Wildlife, SANParks, and the Provincial Division of Nature

Conservation of the Eastern Cape Province for placing the animals included in the recent surveys at our disposal, and for providing assistance and facilities to process them for tick recovery. We are particularly indebted to Messrs Johan Sithole and Eddie Williams for their assistance in the latter respect. The University of Pretoria and the National Research Foundation provided funds for the conduct of this project. The publication of this work has been facilitated through the Integrated Consortium on Ticks and Tick-borne Diseases (ICTTD-3), financed by the International Cooperation Program of the European Union through Coordination Action Project No. 510561.

REFERENCES

- ACOCKS, J.P.H. 1988. *Veld types of South Africa with accompanying veld type map*, 3rd ed. (Memoirs of the Botanical Survey of South Africa, No. 57).
- APANASKEVICH, D.A. & HORAK, I.G. 2006. The genus *Hyalomma* Koch, 1844. I. Reinstatement of *Hyalomma* (*Euhyalomma*) *glabrum* Delpy, 1949 (Acari, Ixodidae) as a valid species with a re-description of the adults, the first description of the immature stages and notes on its biology. *Onderstepoort Journal of Veterinary Research*, 73:1–12.
- BAKER, MAUREEN K. & KEEP, M.E. 1970. Checklist of the ticks found on the larger game animals in the Natal game reserves. *Lammergeyer*, 12:41–47.
- BEATI, L. & KEIRANS, J.E. 2001. Analysis of the systematic relationships among ticks of the genera *Rhipicephalus* and *Boophilus* (Acari: Ixodidae) based on mitochondrial 12S ribosomal DNA gene sequences and morphological characters. *Journal of Parasitology*, 87:32–48.
- BRAACK, L.E.O., MAGGS, K.A.R., ZELLER, D.A. & HORAK, I.G. 1995. Exotic arthropods in the Kruger National Park, South Africa: modes of entry and population status. *African Entomology*, 3:39–48.
- BRAIN, C. & BOHRMANN, R. 1992. Tick infestation of baboons (*Papio ursinus*) in the Namib desert. *Journal of Wildlife Diseases*, 28:188–191.
- DELPY, L.P. 1949. Révision par des voies expérimentales du genre *Hyalomma* C.L. Koch 1844 (2^e partie). *Annales de Parasitologie humaine et comparée*, 24 (1–2):97–109.
- FOURIE, L.J. & HORAK, I.G. 1993. Sites of attachment of Karoo paralysis ticks (*Ixodes rubicundus*) on three cattle breeds. *Journal of the South African Veterinary Association*, 64:90–91.
- FOURIE, L.J. & HORAK, I.G. 1994. The life cycle of *Ixodes rubicundus* (Acari: Ixodidae) and its adaptation to a hot, dry environment. *Experimental and Applied Acarology*, 18:23–35.
- FOURIE, L.J., HORAK, I.G. & WOODALL, P.F. 2005. Elephant shrews as hosts of immature ixodid ticks. *Onderstepoort Journal of Veterinary Research*, 72:293–301.
- GALLIVAN, G.J. & HORAK, I.G. 1997. Body size and habitat as determinants of tick infestations of wild ungulates in South Africa. *South African Journal of Wildlife Research*, 27:63–70.
- HOOGSTRAAL, H. 1956. *African Ixodoidea. I. Ticks of the Sudan (with special reference to Equatoria Province and with preliminary reviews of the genera Boophilus, Margaropus and Hyalomma)*. Washington DC: US Navy.

- HORAK, I.G., POTGIETER, F.T., WALKER, JANE B., DE VOS, V. & BOOMKER, J. 1983. The ixodid tick burdens of various large ruminant species in South African nature reserves. *Onderstepoort Journal of Veterinary Research*, 50:221–228.
- HORAK, I.G. & KNIGHT, M.M. 1986. A comparison of the tick burdens of wild animals in a nature reserve and on an adjacent farm where tick control is practised. *Journal of the South African Veterinary Association*, 57:199–203.
- HORAK, I.G., MACIVOR, K.M. DE F., PETNEY, T.N. & DE VOS, V. 1987a. Some avian and mammalian hosts of *Amblyomma hebraeum* and *Amblyomma marmoreum* (Acari: Ixodidae). *Onderstepoort Journal of Veterinary Research*, 54:397–403.
- HORAK, I.G., JACOT GUILLARMOD, AMY, MOOLMAN, L.C. & DE VOS, V. 1987b. Parasites of domestic and wild animals in South Africa. XXII. Ixodid ticks on domestic dogs and on wild carnivores. *Onderstepoort Journal of Veterinary Research*, 54:573–580.
- HORAK, I.G., KEEP, M.E., SPICKETT, A.M. & BOOMKER, J. 1989. Parasites of domestic and wild animals in South Africa. XXIV. Arthropod parasites of bushbuck and common duiker in the Weza State Forest, Natal. *Onderstepoort Journal of Veterinary Research*, 56:63–66.
- HORAK, I.G., FOURIE, L.J., NOVELLIE, P.A. & WILLIAMS, E.J. 1991a. Parasites of domestic and wild animals in South Africa. XXVI. The mosaic of ixodid tick infestations on birds and mammals in the Mountain Zebra National Park. *Onderstepoort Journal of Veterinary Research*, 58:125–136.
- HORAK, I.G., BOOMKER, J. & FLAMAND, J.R.B. 1991b. Ixodid ticks and lice infesting red duikers and bushpigs in north-eastern Natal. *Onderstepoort Journal of Veterinary Research*, 58:281–284.
- HORAK, I.G., ANTHONISSEN, M., KRECEK, R.C. & BOOMKER, J. 1992a. Arthropod parasites of springbok, gemsbok, kudus, giraffes and Burchell's and Hartmann's zebras in the Etosha and Hardap Nature Reserves, Namibia. *Onderstepoort Journal of Veterinary Research*, 59:253–257.
- HORAK, I.G., BOOMKER, J., SPICKETT, A.M. & DE VOS, V. 1992b. Parasites of domestic and wild animals in South Africa. XXX. Ectoparasites of kudus in the eastern Transvaal Lowveld and the eastern Cape Province. *Onderstepoort Journal of Veterinary Research*, 59:259–273.
- HORAK, I.G., SPICKETT, A.M., BRAACK, L.E.O. & PENZHORN, B.L. 1993. Parasites of domestic and wild animals in South Africa. XXXII. Ixodid ticks on scrub hares in the Transvaal. *Onderstepoort Journal of Veterinary Research*, 60:163–174.
- HORAK, I.G., BOOMKER, J. & FLAMAND, J.R.B. 1995. Parasites of domestic and wild animals in South Africa. XXXIV. Arthropod parasites of nyalas in north-eastern KwaZulu-Natal. *Onderstepoort Journal of Veterinary Research*, 62:171–179.
- HORAK, I.G. & BOOMKER, J. 1998. Parasites of domestic and wild animals in South Africa. XXXV. Ixodid ticks and bot fly larvae in the Bontebok National Park. *Onderstepoort Journal of Veterinary Research*, 65:205–211.
- HORAK, I.G., BRAACK, L.E.O., FOURIE, L.J. & WALKER, JANE B. 2000. Parasites of domestic and wild animals in South Africa. XXXVIII. Ixodid ticks collected from 23 wild carnivore species. *Onderstepoort Journal of Veterinary Research*, 67:239–250.
- HORAK, I.G., FOURIE, L.J., HEYNE, HELOISE, WALKER, JANE B. & NEEDHAM, G.R. 2002. Ixodid ticks feeding on humans in South Africa: with notes on preferred hosts, geographic distribution, seasonal occurrence and transmission of pathogens. *Experimental and Applied Acarology*, 27:113–136.
- HORAK, I.G. & MATTHEE, SONJA 2003. Parasites of domestic and wild animals in South Africa. XLIII. Ixodid ticks of domestic dogs and cats in the Western Cape Province. *Onderstepoort Journal of Veterinary Research*, 70:187–195.
- HORAK, I.G., FOURIE, L.J. & BRAACK, L.E.O. 2005. Small mammal hosts of immature ixodid ticks. *Onderstepoort Journal of Veterinary Research*, 72:255–261.
- HORAK, I.G., MCKAY, I.J., HEYNE, HELOISE & SPICKETT, A.M. 2006. Hosts, seasonality and geographic distribution of the South African tortoise tick, *Amblyomma marmoreum*. *Onderstepoort Journal of Veterinary Research*, 73:13–25.
- HORAK, I.G., GOLEZARDY, H. & UYS, A.C. 2006. The host status of African buffaloes, *Syncerus caffer*, for *Rhipicephalus (Boophilus) decoloratus*. *Onderstepoort Journal of Veterinary Research*, 73:193–198.
- HOWELL, C.J., WALKER, JANE B. & NEVILL, E.M. 1978. *Ticks, mites and insects infesting domestic animals in South Africa. Part 1. Descriptions and biology*. Pretoria: Department of Agricultural Technical Services, Republic of South Africa (Science Bulletin no. 393).
- JORDAAN, J.O. & BAKER, J.A.F. 1981. Survival rate on the host and mating capacity of *Amblyomma hebraeum* (Koch) male ticks, in *Tick biology and control*, edited by G.B. Whitehead & J.D. Gibson. Tick Research Unit, Rhodes University, Grahamstown: 115–117.
- LONDT, J.G.H. 1976. Fertilization capacity of *Boophilus decoloratus* (Koch, 1844) (Acarina: Ixodidae). *Onderstepoort Journal of Veterinary Research*, 43:143–145.
- MACIVOR, K.M. DE F. & HORAK, I.G. 1987. Foot abscess in goats in relation to the seasonal abundance of adult *Amblyomma hebraeum* and adult *Rhipicephalus glabroscutatum* (Acari: Ixodidae). *Journal of the South African Veterinary Association*, 58:113–118.
- MACIVOR, K.M. DE F. & HORAK, I.G. 2003. Ixodid ticks of Angora and Boer goats, grysbok, common duikers, kudus and scrub hares in Valley Bushveld in the Eastern Cape Province. *Onderstepoort Journal of Veterinary Research*, 70:113–120.
- MURRELL, A., CAMPBELL, N.J.H. & BARKER, S.C. 2000. Phylogenetic analysis of the rhipicephaline ticks indicates that the genus *Rhipicephalus* is paraphyletic. *Molecular Phylogenetics and Evolution*, 16:1–7.
- MURRELL, A. & BARKER, S.C. 2003. Synonymy of *Boophilus* Curtice, 1981 with *Rhipicephalus* Koch, 1844 (Acari: Ixodidae). *Systematic Parasitology*, 56:169–172.
- NORVAL, R.A.I. 1983. The ticks of Zimbabwe. VII. The genus *Amblyomma*. *Zimbabwe Veterinary Journal*, 14:292–305.
- NORVAL, R.A.I. 1984. Resistance to *Boophilus decoloratus* in the African Buffalo (*Syncerus caffer*). *Zimbabwe Veterinary Journal*, 15:34–35.
- RECHAV, Y., ZEEDERBERG, M.E. & ZELLER, D.A. 1987. Dynamics of African tick (Acari: Ixodoidea) populations in a natural Crimean-Congo hemorrhagic fever focus. *Journal of Medical Entomology*, 24:575–583.
- SKINNER, J.D. & SMITHERS, R.H.N. 1990. *The mammals of the Southern African Subregion*. Pretoria: University of Pretoria.
- THEILER, GERTRUD 1956. Zoological Survey of the Union of South Africa. Tick Survey. Part IX. The distribution of the three South African *Hyalommas* or bontpoots. *Onderstepoort Journal of Veterinary Research*, 27:239–269.
- THEILER, GERTRUD 1962. The Ixodoidea parasites of vertebrates in Africa south of the Sahara (Ethiopian region).

- Project S 9958. Report to the Director of Veterinary Services, Onderstepoort. Mimeographed.
- VAN DER MERWE, J.H. 1983. National atlas of South West Africa (Namibia). Goodwood Cape: National Book Printers.
- VAN DYK, P.J. & MCKENZIE, A.A. 1992. An evaluation of the effectivity of the scrub technique in quantitative ectoparasite ecology. *Journal of Experimental and Applied Acarology*, 15:271–283.
- WALKER, JANE B. 1974. The ixodid ticks of Kenya. A review of present knowledge of their hosts and distribution. London and Reading: Commonwealth Institute of Entomology.
- WALKER, JANE B. & OLWAGE, A. 1987. The tick vectors of *Cowdria ruminantium* (Ixodoidea, Ixodidae, genus *Amblyomma*) and their distribution. *Onderstepoort Journal of Veterinary Research*, 54:353–379.
- WALKER, JANE B. 1991. A review of the ixodid ticks (Acari, Ixodidae) occurring in southern Africa. *Onderstepoort Journal of Veterinary Research*, 58:81–105.
- WALKER, JANE B., KEIRANS, J.E. & HORAK, I.G. 2000. *The genus Rhipicephalus (Acari, Ixodidae): a guide to the brown ticks of the world*. Cambridge: Academic Press.
- WHITE, F. 1983. The vegetation of Africa. A descriptive memoir to accompany the UNESCO/AETFAT/UNSO vegetation map of Africa. Paris: UNESCO.
- YEOMAN, G.H. & WALKER, JANE B. 1967. The ixodid ticks of Tanzania. A study of the zoogeography of the Ixodidae of an east African country. London and Reading: Commonwealth Institute of Entomology.
- ZIEGER, U., HORAK, I.G., CAULDWELL, A.E. & UYS, A.C. 1998. Ixodid tick infestations of wild birds and mammals on a game ranch in Central Province, Zambia. *Onderstepoort Journal of Veterinary Research*, 65:113–124.