The comparative host status of red veld rats (*Aethomys chrysophilus*) and bushveld gerbils (*Tatera leucogaster*) for epifaunal arthropods in the southern Kruger National Park, South Africa

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ABSTRACT

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Red veld rats (*Aethomys chrysophilus*) and bushveld gerbils (*Tatera leucogaster*) were trapped at monthly intervals, when possible, over a 2-year period, in the southern Kruger National Park, Mpumalanga Province. Forty-six specimens of each species were caught, euthenased and microscopically examined for fleas, lice, ticks and mites. Clear differences existed between the two rodent hosts in infestation intensity and also parasite species. The flea, *Xenopsylla brasiliensis*, commonly and exclusively utilized red veld rats, whereas *Xenopsylla frayi* was common and specific to bushveld gerbils. *T. leucogaster* were commonly infested with the lice *Hoplopleura biseriata* and *Polyplax biseriata*, while only a single *A. chrysophilus* hosted the louse, *Hoplopleura patersoni*. Red veld rats harboured small numbers of the immature stages of *Haemaphysalis leachi/spinulosa* and relatively large numbers of *Rhipicephalus simus*. The larvae of *R. simus* were irregularly collected from February to September and the nymphs from March to November. Bushveld gerbils hosted fewer ticks than did the rats, with a single specimen of *H. leachi/spinulosa* and low numbers of immature *Hyalomma truncatum*, the latter erratically present from June to October. Mites were abundant on both rodent hosts, *A. chrysophilus* hosting 13 species in six families, and *T. leucogaster* hosting 12 species representing seven families, with clear differences in mite assemblages between the two rodents. As the rats and gerbils were collected from the same trap lines at the same times, the differences in species composition and infestation intensity of their parasites, suggest that immunological, behavioural or other segregating mechanisms are in operation to maintain discrete parasite assemblages.

Keywords: *Aethomys chrysophilus*, anthropods, bushveld gerbils, epufaunal, host status, Kruger National Park, red veld rats, *Tatera leucogaster*

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INTRODUCTION

Rodents are hosts of numerous zoonoses such as plague (*Yersinia pestis*), several rickettsial infections, encephalomyocarditis, various haemorrhagic fevers as well as helminth infections (Schnurrenberger & Hubbert 1981). Consequently, knowledge of the ectoparasitic and other epifaunal associations of these animals provides insight not only into potential disease transmission, but also into the role of rodents in the population dynamics of ticks or other parasites affecting wildlife or domestic stock.

It has been suggested that rodents may serve as the hosts of more ixodid tick species than do any other mammal taxa (Oliver 1989). In South Africa, a total of 77 ixodid tick species have been recorded from all host species examined thus far, and 29 of these have been collected from rodents, chiefly in the immature stages of development (Walker 1991). Some of these associations may be accidental and merely a reflection of the very large numbers of immature ticks present within the particular environments of specific rodents. Other associations may be more specific, while some rodents harbour not only the immature stages but also the adults of certain tick species (Walker 1991). A number of species, for which rodents serve as hosts of the immature stages, are important parasites of domestic animals in the adult stage. These are *Haemaphysalis leachi*, a parasite of dogs and cats, *Hyalomma truncatum*, a parasite of cattle, sheep and horses, and *Rhipicephalus simus*, a parasite of cattle and dogs.

Several surveys have already been conducted on the parasites infesting rodents in South Africa. Extensive plague-related surveys initiated in 1926 by the South African Institute for Medical Research, in collaboration with the South African Department of Health, culminated in the substantial reference work on fleas by De Meillon, Davis & Hardy (1961), which formed the basis for Zumpt's (1966) publication. Lice were intensively collected and studied from as early as 1918, by persons such as Bedford, Emerson, Ferris, Hopkins & Paterson, their work forming the basis of the volume on systematics by Ledger (1980). Rodents have been examined for ticks in the Eastern Cape Province by Rechav (1982), Howell, Petney & Horak (1989) and Horak, Fourie, Novellie & Williams (1991); in the Western Cape Province by Horak, Sheppey, Knight & Beuthin (1986); in the Free State by Fourie, Horak & Van Heerden (1992); and in North-West Province by Rechav, Zeederberg & Zeller (1987) and Els (1987). Comparatively little is known regarding mite species utilizing wildlife hosts in southern Africa, with only isolated advances since the major publication edited by Zumpt (1961).

The present study was initiated to determine the species composition and infestation intensity of fleas, lice, ixodid ticks and mites infesting *Aethomys chrysophilus* and *Tatera leucogaster*, two of the most common rodent species in the southern Kruger National Park (KNP), Mpumalanga.

MATERIALS AND METHODS

Thirty-five to 50 hardboard livetraps as described by Willan (1979) were used during the survey. These were baited with a gholfball-sized mixture of rolled oats and peanut butter. Except for August, September and November 1990, traps were placed in Landscape Zone 4 (Thickets of the Sabie and Crocodile Rivers) (Gertenbach 1983), in undisturbed natural environment at least 4 km from the Skukuza restcamp, KNP, for 4 nights each month from January 1989 to December 1990. The traps were set during the late afternoon, 5 m apart, in a line perpendicular to the road, and collected early the following morning. Traps containing rodents were individually placed in plastic bags, after which a wad of cotton wool soaked with ether was added. After some minutes, the response of each animal was tested, and if quiescent, it was removed, bled by cardiac puncture (Grobler, Raath, Braack, Keet, Gerdes, Barnard, Kriek, Jardine & Swanepoel, 1995), and then returned to the bag until dead. Identification of rodents was based on dentition and skull parameters (Smithers 1983) or spermatozoa (Gordon & Watson 1985).

Each animal was carefully examined under a stereoscopic dissecting microscope, and all ectoparasites were removed and preserved in 70% ethyl alcohol. Because it was not possible to distinguish between the immature stages of *Haemaphysalis leachi* and *Haemaphysalis spinulosa*, the immature ticks resembling them were recorded as *H. leachi/spinulosa*.

RESULTS

Low trap numbers and low trap catch-rates, as well as other factors, meant that samples were consistently small, even absent in some months. Trap catch-rates are presented in Fig. 1. Most (> 96%) rodents captured were either *A. chrysophilus* or *T. leucogaster*. A total of 46 *A. chrysophilus* was captured, varying between zero and six per month, as well as 46 *T. leucogaster*, varying between zero and five per month. Host captures for each month are indicated in Fig. 2–11. The fleas, lice and ixodid ticks recovered from each of the host species are listed in Tables 1 and 2, and the mites in Tables 3 and 4.

Fleas

Fleas differentiated strongly between the two hosts, *Xenopsylla brasiliensis* occurring only on *A. chrysophilus* and *Xenopsylla frayi* only on *T. leucogaster*. Two specimens of *Ctenocephalides felis* were also found as mixed infestations with *X. brasiliensis* on *A.*

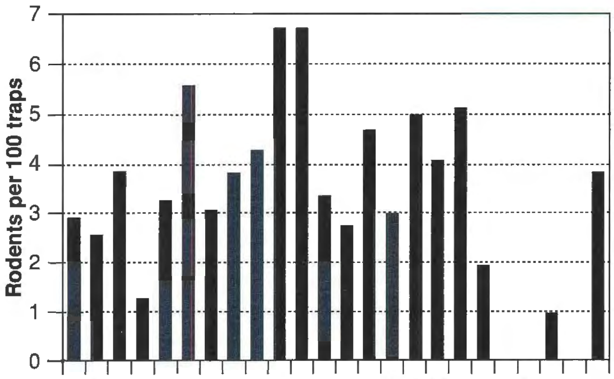

FIG. 1 Rodent-trapping success rate expressed as the total number of all rodent species caught per 100 traps, for each month, January 1989 to December 1990. No trapping was done during August, September or November 1990

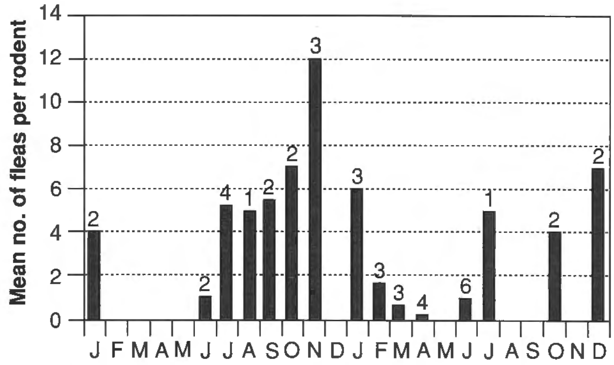

FIG. 2 Mean number of *Xenopsylla brasiliensis* recovered per *Aethomys chrysophilus* for each month, January 1989 to December 1990. No trapping was done during August, September or November 1990. The number of *A. chrysophilus* captured in each month is indicated above each column

TABLE 1 Fleas, lice and ixodid ticks collected from 46 *Aethomys chrysophilus* in the southern Kruger National Park

Arthropod species	Numbers recovered			Total	Number of *Aethomys* infested
	Larvae	Nymphs	Adults		
Fleas					
Xenopsylla brasiliensis	–	–	170	170	31 (67%)
Ctenocephalides felis spp.	–	–	2	2	2 (4%)
Lice					
Hoplopleura patersoni				79	1 (2%)
Ixodid ticks					
Haemaphysalis leachi/ spinulosa	14	30	0	44	16 (35%)
Rhipicephalus simus	537	80	0	617	29 (63%)

TABLE 2 Fleas, lice and ixodid ticks collected from 46 *Tatera leucogaster* in the southern Kruger National Park

Arthropod species	Numbers recovered			Total	Number of *Tatera* infested
	Larvae	Nymphs	Adults		
Fleas					
Xenopsylla frayi	–	–	140	140	23 (50%)
Lice					
Polyplax biseriata } *Hoplopleura biseriata* }	–	–	–	568	33 (72%)
Ixodid ticks					
Haemaphysalis leachi/ spinulosa	0	1	0	1	1 (2%)
Hyalomma truncatum	14	25	0	39	9 (20%)

– = not applicable

chrysophilus. A total of 170 *X. brasiliensis* were recovered, fluctuating between zero and 23 per rodent, with the highest numbers occurring between October and December and low numbers between February and June. *T. leucogaster* harboured a total of 140 *X. frayi*, varying between zero and 33 per rodent, but with no clear pattern of seasonality discernible.

TABLE 3 Mites collected from 46 *Aethomys chrysophilus* in the southern Kruger National Park

Taxon	Number collected	Number of *Aethomys* infested
Mesostigmata Laelapidae *Androlaelaps* sp. *Laelaps vansomereni* *Laelaps* sp.	492	36 (78%)
Prostigmata Trombiculidae *Gahrliepia (G.)* sp. *Guntherana (?)* sp. *Odontacarus* sp. *Schoutedenichia (?)* sp.	5053	42 (91%)
Astigmata Myocoptidae *Myocoptes* sp. *Trichoecius* sp.	219	11 (24%)
Listrophoridae *Afrolistrophorus (?)* sp. Atopomelidae *Listrophoroides* (*Olistrophoroides*) *(?)* sp.	3136	33 (72%)
Glycyphagidae	*c.* 3500	33 (72%)

TABLE 4 Mites collected from 46 *Tatera leucogaster* in the southern Kruger National Park

Taxon	Number collected	Number of *Tatera* infested
Mesostigmata Laelapidae *Androlaelaps* sp. *Androlaelaps theseus* Zumpt *Androlaelaps marshalli* Berlese *Laelaps* sp. Prostigmata Cheyletidae *Cheyletes zumpti* Fain	601	36 (78%)
Trombiculidae *Gahrliepia (G.)* sp. Uncertain genus (2 spp.)	602	19 (41%)
Myobiidae *Radfordia (Cryptomyobia) (?)* sp. Astigmata Myocoptidae *Myocoptes* sp.	243	15 (33%)
Listrophoridae *Afrolistrophorus (?)* sp.	1 271	36 (78%)
Glycyphagidae	2 760	20 (43%)

Lice

Only one of the 46 *A. chrysophilus* hosted lice—a male which yielded 79 *Hoplopleura patersoni*, but was otherwise not unusually heavily infested with other arthropod parasites. In contrast, most (71,7%) of the *T. leucogaster* had lice, varying between two and 80 per infested host. These were present as mixed populations of two species, *Polyplax biseriata* and *Hoplopleura biseriata*. Lice were counted collectively, with no separate numbers for the two species. However, *P. biseriata* was more prevalent. High numbers were collected from May to July 1989, but few in the corresponding months of 1990. The seasonal pattern is probably confounded by the small host-sample size.

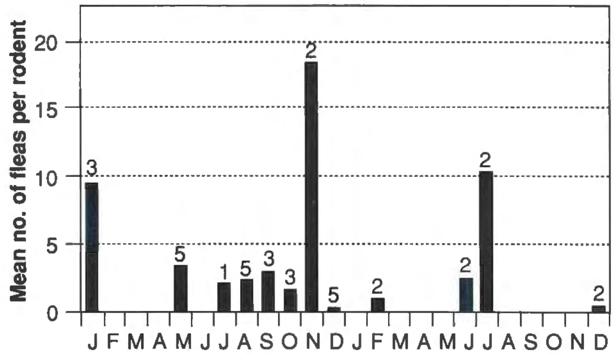

FIG. 3 Mean number of *Xenopsylla frayi* recovered per *Tatera leucogaster* for each month, January 1989 to December 1990. No trapping was done during August, September or November 1990. The number of *T. leucogaster* captured in each month is indicated above each column

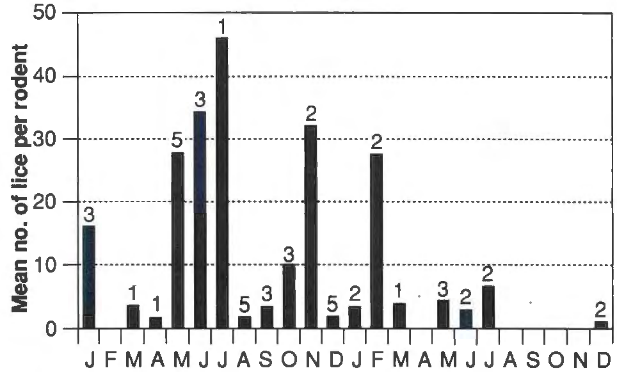

FIG. 4 Mean number of *Hoplopleura patersoni* lice recovered per *Tatera leucogaster* for each month, January 1989 to December 1990. No trapping was done during August, September or November 1990. The number of *T. leucogaster* captured in each month is indicated above each column

Ticks

Forty-four *H. leachi/spinulosa* (zero to eight per host) and 617 *R. simus* (zero to 114 per host) were recovered from *A. chrysophilus*. The small sample size for *H. leachi/spinulosa* prevented the detection of any seasonality. *R. simus* larvae were most abundant between June and September in 1989 and from February to June in 1990. Nymphs were erratically present from March to November.

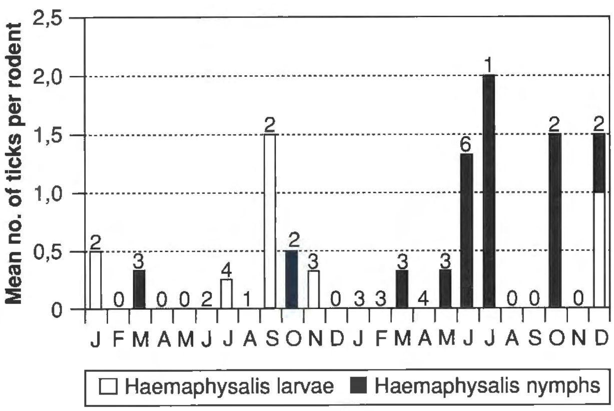

FIG. 5 Mean number of *Haemaphysalis leachi/spinulosa* larvae and nymphs recovered per *Aethomys chrysophilus* for each month, January 1989 to December 1990. No trapping was done during August, September or November 1990. The number of *A. chrysophilus* captured in each month is indicated above each column

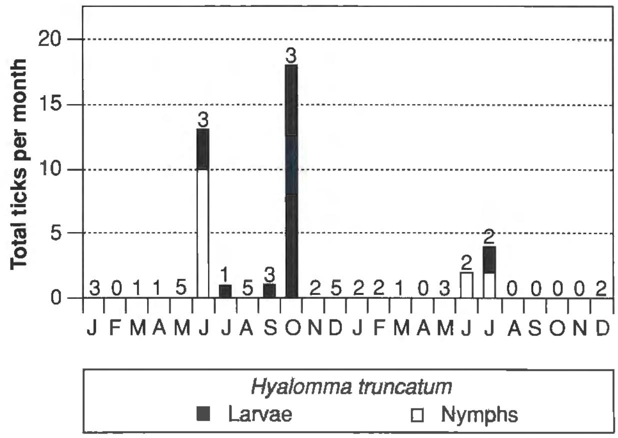

FIG. 7 Total number of *Hyalomma truncatum* recovered from all *Tatera leucogaster* captured in each month, January 1989 to December 1990. No trapping was done during August, September or November 1990. The number of *T. leucogaster* captured in each month is indicated above each column

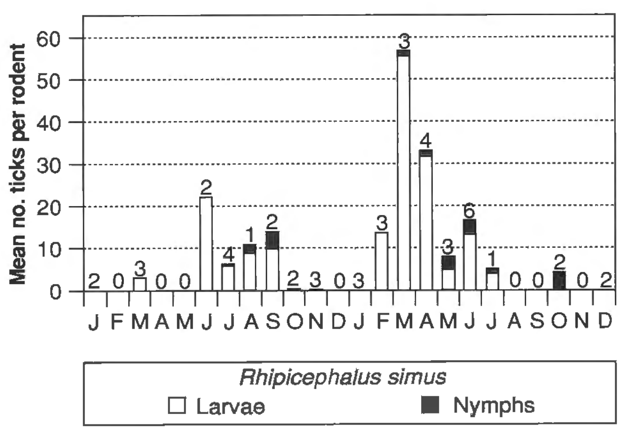

FIG. 6 Mean number of *Rhipicephalus simus* larvae and nymphs recovered per *Aethomys chrysophilus* for each month, January 1989 to December 1990. No trapping was done during August, September or November 1990. The number of *Aethomys chrysophilus* captured in each month is indicated above each column

Few ticks were recovered from *T. leucogaster*, with a total of only one *H. leachi/spinulosa* nymph and 39 immature *H. truncatum*. Larvae of *H. truncatum* were present in June and July, and nymphs from June to October. Despite *R. simus* being commonly recovered from *A. chrysophilus*, not a single individual was found on *T. leucogaster* trapped at the same site.

Mites

All individuals of both host species harboured mites, usually in large numbers. At least 13 species of mites in six families (three suborders) were recovered from *A. chrysophilus*, while *T. leucogaster* yielded 12 species representing seven families (three suborders). These taxa are listed in Tables 4 and 5. In most cases, mites could be identified only to genus level, but there is little doubt that a number of new species are represented in the material collected.

Comment: Because of initial unfamiliarity with the mites, the person (L.E.O.B.) processing the rodents for parasite recovery compiled a rough key to keep track of mite numbers by appearance and habits, thus obaining in collective totals for several species as indicated in Tables 4 and 5. This system of recording unfortunately resulted in species of different families sometimes being counted together, such as members of the Listrophoridae and Atopomelidae being lumped together, as well as Myobiidae and Myocoptidae, based on similarities in appearance and microhabitat.

The most numerous mites on *A. chrysophilus* were Trombiculid larvae, found on 91 % of hosts. These mites were typically present in clusters, mouthparts embedded within the skin of the host, usually within the ear or posteriorly near the tail. One species occurred as individual mites partially enclosed in small oedomatous pits on the body. These were usually evenly spaced as a narrow band mid-dorsally, a broadening area laterally, and extending ventrally as a somewhat narrowed band with up to 400 individuals per infested host.

Trombiculids were far less numerous and also less prevalent on *T. leucogaster*. On this host, hypopi (inactive phoretic immatures) of the family glycyphagidae were the most numerous, despite these mites not having as high a general prevalance as some of the other families. This implied that, while fewer rodents hosted glycyphagids, those hosts which did have hypopi carried them in large numbers (50–250 per infested animal). All the glycyphagid mites were recovered from positions buried in the tail skin, and

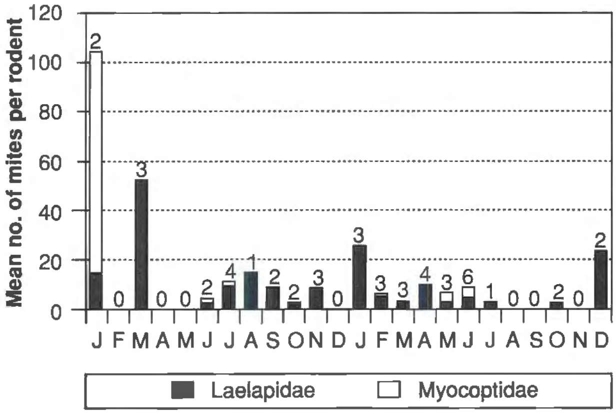

FIG. 8 Mean number of mites (Laelapidae and Myocoptidae) recovered per *Aethomys chrysophilus* for each month, January 1989 to December 1990. No trapping was done during August, September or November 1990. The number of *A. chrysophilus* captured in each month is indicated above each column

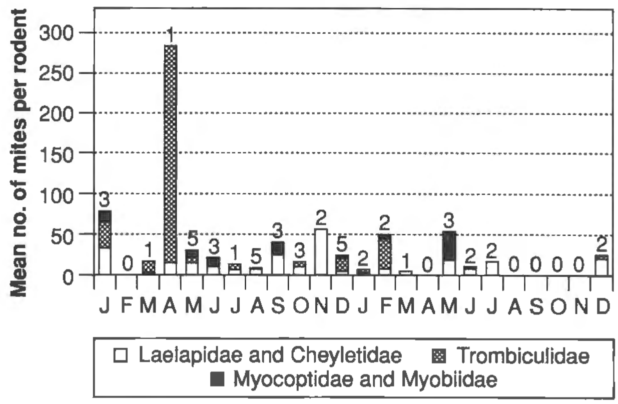

FIG.10 Mean number of mites (Laelapidae and Cheyletidae; Trombiculidae; Myocoptidae and Myobiidae) recovered per *Tatera leucogaster* for each month, January 1989 to December 1990. No trapping was done during August, September or November 1990. The number of *T. leucogaster* captured in each month is indicated above each column

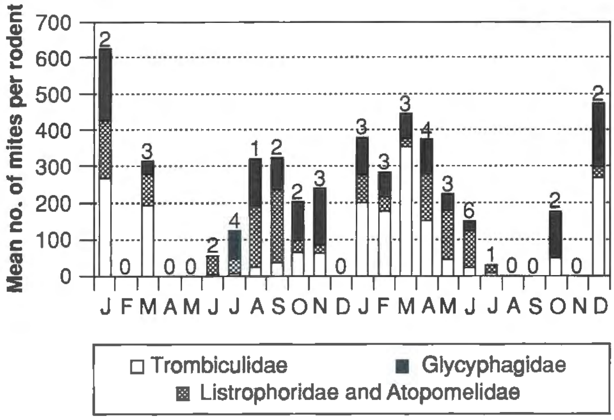

FIG. 9 Mean number of mites (Trombiculidae, Glycyphagidae, Listrophoridae & Atopomelidae) recovered per *Aethomys chrysophilus* for each month, January 1989 to December 1990. No trapping was done during August, September or November 1990. The number of *A. chrysophilus* captured in each month is indicated above each column

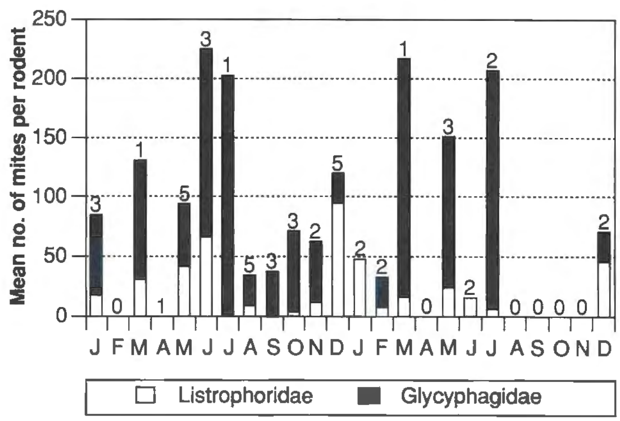

FIG. 11 Mean number of mites (Listrophoridae and Glycyphagidae) recovered per *Tatera leucogaster* for each month, January 1989 to December 1990. No trapping was done during August, September or November 1990. The number of *T. leucogaster* captured in each month is indicated above each column

they were collected by squeezing a section of skin with forceps.

Listrophoridae (*Afrolistrophorus ?*) were abundant on both hosts, and were always found clinging to the hair shafts. The vast majority were concentrated anterodorsally, mainly on the neck. Atopomelid mites were common on *A. chrysophilus*, also attached to hair shafts, but concentrated posterodorsally and sometimes ventrally on the abdomen.

Laelapid mites had a prevalence rate of 78% on both rodent hosts, although the rodents appeared to host different species of these mites. The mites were large and walked around readily, unlike all the other mite groups which tended to be fairly sessile. Up to 65 of these mites were found on each infested host, mostly posterodorsally on the body near the base of the tail.

Myocoptid and myobiid mites were the least numerous and occurred on the skin as isolated individuals, often with mouthparts embedded.

DISCUSSION

Probably the most striking feature of this survey was the marked difference in the species composition of the parasites recovered from *A. chrysophilus* and from *T. leucogaster* captured at the same time and in the same trap lines. This was reflected in specific differences in the fleas and lice and also in clear differentiation between hosts by three species of ticks. These differences may be due to host-specificity, behavioural differences of the parasites, differences in host behaviour, particular scents exuded by the hosts, a combination of these factors or a number of other reasons.

Fleas

A. chrysophilus was exclusively parasitized by *X. brasiliensis*, whereas *X. frayi* were found only on *T. leucogaster*. *X. brasiliensis* is widely distributed in the Afrotropical Region and has been transported to other parts of the world. It is considered to be an important transmitter of plague in rural environments, and its principal hosts include *Aethomys, Mastomys, Rattus* and *Thallomys* (De Meillon *et al.* 1961; Zumpt 1966). Despite the abundance of *X. brasiliensis* and its hosts within the KNP, plague has never been recorded from this area, and no antibodies against the causative organism could be detected from a sample from several hundred rodents taken in the study area and elsewhere in the KNP between 1982 and 1994 (P.A. Leman, National Institute for Virology, Johannesburg, personal communication 1996).

X. frayi is distributed throughout the savanna bushveld areas from northern Transvaal through Swaziland to Natal, and has never been incriminated in plague transmission. Its principal host is *T. leucogaster*, with only isolated individuals occasionally recovered from other hosts (De Meillon *et al.* 1961).

Regarding host separation, the following statement by De Meillon *et al.* (1961) provides some insight: "A striking feature about the host-association of *brasiliensis* is its rare occurrence in the underground nests and burrows of gerbils (*Tatera* spp.). This is in contrast to its abundance in the nests and lairs of house rats and the above-mentioned group of wild rodents." *A. chrysophilus* and *T. leucogaster* are both nocturnal and terrestrial, often with overlapping habitat, but whereas *T. leucogaster* lives in underground burrows, *A. chrysophilus* appears to prefer to find refuge in piles of vegetation, rocks or other types of cover above ground, although it will also burrow (De Graaff 1981; Smithers 1983). This may contribute to the strong separation in host utilization between the two species of fleas.

Lice

Pronounced differences were evident in lice utilization of the two rodent species. Ledger (1980) records *H. patersoni* as having been collected from *A. chrysophilus* and *A. namaquensis*, and *H. biseriata* from two species of *Tatera*, including *T. leucogaster*, and *P. biseriata* from several species of *Tatera*, again including *T. leucogaster*. Findings in this study support the strict host differentiation displayed by these lice, even in closely sympatric conditions.

Ticks

Clear separation between the two hosts was also found in ixodid ticks, *A. chrysophilus* being the preferred host of the immature stages of *R. simus*, and *T. leucogaster* of the immature stages of *H. truncatum*. The majority (> 80%) of ticks collected off both hosts were attached laterally and dorsally on the head, most of the remainder dorsally on the neck and shoulders, with a few elsewhere on the body. Virtually all the *H. truncatum* were deeply embedded in dermal pits, which would have made removal by host grooming very difficult. *R. simus*, by contrast, did not burrow into the skin.

Fourie *et al.* (1992) collected the immature stages of 11 tick species from Namaqua rock mice, *Aethomys namaquensis*, and rock-elephant shrews, *Elephantulus myurus*, trapped in the same trap lines in the south-western Free State. The mean burdens of immature stages of the dominant species on the 321 rock mice and 132 rock-elephant shrews comprised 3,3 and 0,4 *H. leachi/spinulosa*; 0,1 and 32,8 *Ixodes rubicundus*; and 0,8 and 87,9 *Rhipicephalus punctatus*, respectively. These small mammals thus also differed markedly in their status as hosts for three tick species.

The free-living immature stages of the three tick species collected from the veld rats and bushveld gerbils in the present study, namely *H. leachi/spinulosa, H. truncatum* and *R. simus*, are rarely collected from vegetation in the KNP by drag-sampling with flannel cloth-tails. During 1989, a total of 13 831 immature ticks were collected from the vegetation by monthly drag-sampling in the same landscape zone as that in which the rats and gerbils were trapped, and during 1990, 14 783 immature ticks were collected. Of these, 27 were *H. leachi/spinulosa*, none *H. truncatum* and 44 *R. simus*. Rechav (1982) has also commented on the absence of the immature stages of *R. simus* on grass, while striped mice, *Rhabdomys pumilio*, which he examined in the same region, were infested with this tick. It would thus appear that the immature stages of these ticks seldom migrate onto the vegetation, but rather infest their rodent hosts from the ground.

The combined total number of immature ticks collected from the vegetation by drag-sampling in 1989 and 1990 comprised 28 614 individuals. The larvae of *Amblyomma hebraeum* accounted for 6 221 of these, those of *Boophilus decoloratus* for 8 648 and those of *Rhipicephalus zambeziensis* for 11 962, yet not one of these ticks was recovered from a red veld rat or bushveld gerbil. Howell *et al.* (1989) trapped *R. pumilio* at monthly intervals for 17 months in the Thomas Baines Nature Reserve, Eastern Cape Province, a habitat in which the vegetation is heavily infested with the immature stages of *A. hebraeum* and *Rhipicephalus appendiculatus*. They recovered only five larvae and one nymph of *A. hebraeum* from the animals examined. Three of the larvae and the nymph did not engorge on the mice and were dead on recovery. The remaining two larvae engorged only partially and did not moult to nymphs. No *R. appendiculatus* were recovered from the mice. Thus there appear to be certain factors militating against rodents becoming infested with immature ticks of species for which they do not serve as natural hosts.

In contrast to the findings on rodents, scrub hares (*Lepus saxàtilis*) examined in the Thomas Baines Nature Reserve carried fairly large burdens of immature *A. hebraeum* and very large burdens of immature *R. appendiculatus* (Horak & Fourie 1991). In the KNP, scrub hares examined in the same region and at the same time as the rodents in the present study, carried fairly large burdens of immature *A. hebraeum* and very large burdens of immature *H. truncatum* and of *R. zambeziensis* (Horak, Spickett, Braack & Penzhorn 1993).

Haemaphysalis leachi/spinulosa

The preferred hosts of adult *H. leachi* are large, wild carnivores and domestic dogs, while those of *H. spinulosa* prefer the smaller carnivores (Norval 1984; Hussein & Mustafa 1985). The immature stages of both these ticks prefer rodents (Norval 1984; Hussein & Mustafa 1985; Fourie *et al.* 1992). The small numbers of immature *H. leachi/spinulosa* collected from red veld rats indicate either that they are not very good hosts or that the trap lines were set in a habitat unsuitable for this tick. The single *H. leachispinulosa* nymph collected from a bushveld gerbil probably represents an accidental infestation.

During six years of monthly drag-sampling of the vegetation in two landscape zones in the KNP, a total of 98 adult *H. leachi* and no adult *H. spinulosa* were collected. During the same period, 54 immature *H.leachi/spinulosa* were collected from the vegetation. Forty-seven of the adult *H. leachi* and 30 of the immature *H. leachi/spinulosa* were collected from gully sub-zones, as opposed to open grassland or woodland sub-zones, within each of the landscape zones. As both the adults giving rise to the immatures and the nymphs giving rise to the adults must have detached from carnivores and rodents in the gullies, it would appear as if gullies are important sites of infestation with this tick for both host groups.

Hyalomma truncatum

The preferred hosts of the adults of this tick are large ungulates, particularly giraffes, buffaloes and eland (Norval 1982; Rechav *et al.* 1987; Horak, Anthonissen, Krecek & Boomker 1992). The immature stages prefer Cape and scrub hares (Rechav *et al.* 1987; Horak & Fourie 1991; Horak *et al.* 1993), but may also be found on rodents (Rechav *et al.* 1987; Els 1987). Amongst the rodents, gerbils (*Tatera* spp.) appear to be particularly favoured as hosts (Rechav *et al.* 1987; Els 1987).

The adults of *H. truncatum* are most abundant during the summer months (Horak 1982; Rechav *et al.* 1987). In the southern KNP, large numbers of immature *H. truncatum* are present on scrub hares from May to October, with very few being collected from November to February (Horak *et al.* 1993). The presence of immature ticks on the gerbils during the period June to October in the present study falls within the time of maximum abundance on scrub hares. Although the numbers of immature *H. truncatum* on bushveld gerbils may be small compared with those on scrub hares, the overall abundance of the gerbils themselves may ensure that these small mammals are important hosts of this tick.

Rhipicephalus simus

The preferred hosts of the adults are generally large, monogastric, domestic and wild mammals including dogs, horses, large carnivores, zebras and warthogs, but cattle and buffaloes can also be infested (Norval & Mason 1981; Horak, Jacot-Guillarmod, Moolman & De Vos 1987; Horak, De Vos & De Klerk 1984; Horak, Boomker, De Vos & Potgieter 1988). The immature stages prefer certain rodents (Norval & Mason 1981; Rechav 1982).

In the KNP, adults are present in peak numbers from January to March (Horak *et al.* 1984, 1988), and in the present study, larvae were erratically present from February to September and nymphs from March until November or later.

Eighty-seven of the 136 adult, and 47 of the immature *R. simus* collected by drag-sampling the vegetation in two landscape zones in the KNP at monthly intervals from August 1988 to July 1994, were collected from gully sub-zones as opposed to open grassland and woodland sub-zones. This implies that the hosts of both the adults and the immatures are likely to become infested in this type of habitat.

Mites

In the title of this paper, the term "epifaunal arthropods" was used rather than "ectoparasitic", specifically because many of the mites recovered from their rodent hosts are not parasitic but free-living. As with the other groups of arthropods, clear differences were noticeable in the prevalence rates and infestation intensities of mites on the two host species. Although few groups could be identified to species level, clear differences also existed between the mite taxa associated with the rodents. This reinforces the conclusion that the arthropod assemblages associated with *A. chrysophilus* and *T. leucogaster* are well separated, either in response to host immunological challenges, host behaviour, or other factors, which would either consistently impact differently upon arthropods to which they are exposed, or consistently tend to expose the hosts to different sets of arthropods.

Although some taxonomic studies have been done on mites associated with southern African rodents (Zumpt 1961), very little appears to have been published on the prevalence rates, infestation intensities, interaction and effects of mites on these hosts. The role of rodent-associated mites in the epidemiology of large mammal diseases appears to be minimal, but some laelapine and other mites have been linked with a variety of viral, bacterial and protozoan pathogens of humans and domestic animals (Domrow 1987).

Many mites of the families Laelapidae and Cheyletidae are predatory on other mites or ectoparasites frequenting the same hosts (Durden 1987), and often show their adaptation to this role by their mouthparts and rapid walking abilities.

Myobiid mites may cause dermatitis in affected rodents, but the numbers of *Radfordia* recovered from *T. leucogaster* in this study were very low, with the exception of one individual which hosted 70 of these mites. Trombiculid larvae, too, are known to occasionally cause itching and dermatitis (Georgi 1985).

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