

Ticks of four-toed elephant shrews and Southern African hedgehogs

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Several studies on ticks infesting small mammals, including elephant shrews, have been conducted in South Africa; however, these studies have included only a single four-toed elephant shrew and no hedgehogs. This study thus aimed to identify and quantify the ixodid ticks infesting four-toed elephant shrews and Southern African hedgehogs. Four-toed elephant shrews (*Petrodromus tetradactylus*) were trapped in dense shrub undergrowth in a nature reserve in north-eastern KwaZulu-Natal. They were separately housed, first in cages and later in glass terraria fitted with wire-mesh bases to allow detached ticks to fall through for collection. Southern African hedgehogs (*Atelerix frontalis*) were hand caught on a farm in the eastern region of the Northern Cape Province and all visible ticks were collected by means of tweezers while the animals were anaesthetised. The ticks from each animal were preserved separately in 70% ethanol for later identification and counting. The immature stages of five ixodid tick species were collected from the elephant shrews, of which *Rhipicephalus muelhensi* was the most common. It has not been recorded previously on any species of elephant shrew. Three ixodid tick species were collected from the hedgehogs. Large numbers of adult *Haemaphysalis colesbergensis*, which has not been encountered previously on hedgehogs, were collected from these animals. Four-toed elephant shrews are good hosts of the larvae and nymphs of *R. muelhensi*, and Southern African hedgehogs are good hosts of adult *H. colesbergensis*.

Introduction

Several papers regarding the role of small mammals as hosts of immature ixodid ticks have been published in South Africa during the past two decades (Braack *et al.* 1996; Horak & Cohen 2001; Matthee *et al.* 2007; Petney *et al.* 2004). Rock elephant shrews (*Elephantulus myurus*), and to a lesser extent Cape elephant shrews (*Elephantulus edwardii*), dominate the tick-associated literature for elephant shrews (Fourie, Horak & Van den Heever 1992; Fourie *et al.* 2002; Fourie, Horak & Woodall 2005). This is primarily because they are the preferred hosts of the immature stages of tick species that affect commercially important livestock (Fourie *et al.* 2005). However, with the exception of a single four-toed elephant shrew (*Petrodromus tetradactylus*) examined in north-eastern Mpumalanga Province (Fourie *et al.* 2005), no tick collections have been made from these animals or from Southern African hedgehogs (*Atelerix frontalis*), another small insectivorous species, during the past 20 years.

To date, the immature stages of only two ixodid tick species have been recorded on four-toed elephant shrews in South Africa (Theiler 1962); however, the immature stages of a further nine species have been collected from them in Zambia (MacLeod 1970) and one in Tanzania (Clifford, Walker & Keirans 1973). Small numbers of several tick species have been collected from Southern African hedgehogs (Theiler 1962; Walker, Keirans & Horak 2000), but, with the exception of a small number of species, all of these should be considered accidental infestations and simply a reflection of the abundance of the free-living stages of ticks in a particular region.

The opportunity arose to collect ticks from these two small mammal species during a study on the metabolic rate of four-toed elephant shrews in north-eastern KwaZulu-Natal and a similar study on Southern African hedgehogs in the eastern region of the Northern Cape Province, South Africa. Here we report on the ixodid tick species collected from these animals.

Materials and methods

Several four-toed elephant shrews were caught at Bonamanzi Game Park (28°03'47.17"S, 32°18'06.79"E) in walk-in wire-mesh traps (60 cm x 25 cm x 25 cm) during April 2009. Trapping occurred in dense shrub undergrowth where the animals' characteristic runways could be identified. The nine captured animals were subsequently housed separately in cages (56 cm x 34 cm x 20 cm) each fitted with a tray to collect any detached ticks, and later in glass terraria (60 cm x 30 cm x 30 cm) fitted with wire-mesh bases to allow detached ticks to fall through. Detached ticks were collected on a daily basis and each animal's were preserved separately in 70% ethanol in internally labelled bottles. The ticks were identified to species level and counted using a stereoscopic microscope.

The hedgehogs were caught by hand on and around the farm Plaafontein (31°01.693'S, 23°45.993'E). All visible ticks were collected with tweezers from the 12 anaesthetised animals (immediately after implantation of body temperature data loggers). The same collection procedures as for ticks on the elephant shrews were then followed.

Ethical considerations

All procedures adhered to the Code of Animal Experimentation adopted by the Nelson Mandela Metropolitan University. Ezemvelo KZN Wildlife issued a permit for the capture and transport of elephant shrews (permit number 1462/2009) and the Northern Cape Department of Tourism, Environment and Conservation issued a permit for the capture of hedgehogs (permit number FLORA 036/2009).

Results and discussion

Four-toed elephant shrews

A total of 4007 immature ticks, belonging to five species, were collected from the nine animals, which were all infested (Table 1). The majority of these were larvae and nymphs of *Rhipicephalus muehlensi*, of which a large proportion were engorged. A few engorged nymphs that had escaped immersion in alcohol moulted into adults, thus confirming the species identification. Despite the region in which the study was conducted encompassing part of the geographic distributions of *Rhipicephalus appendiculatus* and *Rhipicephalus maculatus*, only a single larva of each of these species was recovered. In view of these findings, as well as for comparative purposes, the results of previous surveys on ticks infesting nyalas (*Tragelaphus angasii*) and scrub hares (*Lepus saxatilis*) in north-eastern KwaZulu-Natal (Horak *et al.* 1995a; Horak, Boomker & Flamand 1995b) have been summarised in Table 2.

TABLE 1: Species and number of ticks collected from nine four-toed elephant shrews in north-eastern KwaZulu-Natal.

Tick species	Number of ticks collected		Number of animals infested
	Larvae	Nymphs	
<i>Haemaphysalis elliptica</i>	18	0	2
<i>Haemaphysalis silacea</i>	1	11	5
<i>Rhipicephalus appendiculatus</i>	1	0	1
<i>Rhipicephalus maculatus</i>	1	0	1
<i>Rhipicephalus muehlensi</i>	2904	1071 ^a	9

^a, of these, 19 had moulted to adults.

TABLE 2: Host status of four-toed elephant shrews for three sympatric *Rhipicephalus* species in north-eastern KwaZulu-Natal.

Tick and host species	Number examined	Number infested	Total number of ticks collected			
			Larvae	Nymphs	Males	Females
<i>Rhipicephalus appendiculatus</i> Nyalas	79	76	39 889	7896	5144	3936
Scrub hares	34	16	92	281	0	0
Four-toed elephant shrews ^a	9	1	1	0	0	0
<i>Rhipicephalus maculatus</i> Nyalas	79	73	43 393	6424	162	192
Scrub hares	34	5	0	26	0	0
Four-toed elephant shrews ^a	9	1	1	0	0	0
<i>Rhipicephalus muehlensi</i> Nyalas	79	79	322 159	59 655	21 676	14 446
Scrub hares	34	29	841	213	0	0
Four-toed elephant shrews ^a	9	9	2906	1037	0	0

^a, present study.

Large numbers of *R. appendiculatus*, *R. maculatus* and *R. muehlensi* have previously been collected from nyalas, indicating not only that they are good hosts but also that the geographic distributions of the three tick species overlap in the study region (Table 2). Similarly, scrub hares have been found to be infested with fair numbers of the immature stages of these ticks, but the four-toed elephant shrews harboured only a single larva of each of *R. appendiculatus* and *R. maculatus*, and large numbers of larvae and nymphs of *R. muehlensi*.

Walker *et al.* (2000) have placed *R. muehlensi* and *R. maculatus* within the *R. appendiculatus* group of ticks based on the morphology of their immature stages. This group consists of 11 species. The immature stages of each of these 11 species may infest scrub hares, but only those of *R. appendiculatus* have been collected, and then only in very small numbers, from elephant shrews (MacLeod 1970; Theiler 1962). The present collection of a single larva of each of *R. appendiculatus* and *R. maculatus*, in an environment in which these ticks abound, confirms that elephant shrews are not favoured hosts of the immature stages of ticks in this group. The collection of large numbers of *R. muehlensi* larvae and nymphs from four-toed elephant shrews is thus remarkable. Furthermore, the large numbers of engorged larvae and nymphs which were recovered, together with the fact that some of the nymphs had moulted to adults, imply that four-toed elephant shrews are excellent hosts of the immature stages of *R. muehlensi*. This host preference resembles that of the immature stages of the six species comprising the *Rhipicephalus pravus* group of ticks, all of which use elephant shrews as hosts (Clifford *et al.* 1973; Fourie *et al.* 2005; MacLeod 1970; Theiler 1962; Walker *et al.* 2000).

Of the 79 nyalas examined in north-eastern KwaZulu-Natal, 16 harboured all stages of development of *Haemaphysalis silacea* (Horak *et al.* 1995b). This tick has never been recorded on an elephant shrew. Its presence in this study, albeit in small numbers, on five of the nine animals examined, suggests that four-toed elephant shrews can serve as hosts of the tick's immature stages. Larvae and nymphs of the *Haemaphysalis elliptica* group of ticks have been collected in small numbers from rock elephant shrews (Fourie *et al.* 1992), and now also from four-toed elephant shrews. Their preferred hosts are, however, murid rodents (Braack *et al.* 1996; Fourie *et al.* 1992; Matthee *et al.* 2007).

Southern African hedgehogs

A total of 204 ticks belonging to three species were collected from the 12 examined animals, of which 11 were infested (Table 3). The majority of the ticks were adult *Haemaphysalis colesbergensis*, of which a large proportion of the females were engorged. An old male that harboured 55 male and 43 female *H. colesbergensis* was among the 11 infested animals. *H. colesbergensis* has been described only recently (Apanaskevich & Horak 2008) and is named after the town Colesberg (in the eastern region of the Northern Cape Province) where adult ticks have been collected from a dog, domestic cats, caracals (*Caracal caracal*) and an African wildcat (*Felis silvestris*). Their tick burdens are summarised in Table 4 for comparative purposes.

The numbers now recovered from the hedgehogs and the fact that several females were engorged indicate that these small mammals should also be considered preferred hosts of *H. colesbergensis*. Its presence on Southern African hedgehogs is not entirely unexpected, as hedgehogs seem to be one of the preferred hosts of ticks belonging to this genus. In fact, *Haemaphysalis norvali*, a species that appears to be specific to hedgehogs, has been described in Zimbabwe (Hoogstraal & Wassef 1983). To our knowledge *H. norvali* is not present in South Africa.

A larva and five nymphs of the South African tortoise tick, *Amblyomma marmoreum*, were collected from four of the hedgehogs. The immature stages of *A. marmoreum* infest an extremely wide range of domestic and wild mammals and birds in South Africa (Horak *et al.* 2006) and hedgehogs are no exception (Theiler 1962). Although none were recovered now, the adults of *Rhipicentor nuttalli* also infest hedgehogs (Fourie *et al.* 2002; Norval & Colborne 1985; Theiler 1962) and several wild carnivores, of which the larger felids appear to be the hosts of choice (Horak, Heyne & Donkin 2010; Norval & Colborne 1985). The immature stages of *R. nuttalli* infest elephant shrews, of which the rock elephant shrew and the Cape elephant shrew are the most favoured (Fourie *et al.* 2002, 2005).

Conclusion

Four-toed elephant shrews are a new host record for the larvae and nymphs of *R. muehlensii*, a tick of which all stages of development infest nyalas in north-eastern KwaZulu-Natal.

TABLE 3: Species and number of ticks collected from 12 Southern African hedgehogs in the eastern region of the Northern Cape Province.

Tick species	Total number of ticks collected				Number of animals infested
	Larvae	Nymphs	Males	Females	
<i>Amblyomma marmoreum</i>	1	5	0	0	4
<i>Haemaphysalis colesbergensis</i>	0	1	117	79	11
<i>Haemaphysalis</i> sp.	0	0	1	0	1

TABLE 4: Hosts and number of *Haemaphysalis colesbergensis* collected from carnivores near Colesberg in the eastern region of the Northern Cape Province.

Host species	Total number of ticks collected		Number of animals infested
	Males	Females	
Domestic dogs	23	5	1
Domestic cats	112	131	5
Caracals (<i>Caracal caracal</i>)	7	2	2
African wildcats (<i>Felis silvestris</i>)	55	31	1

Large numbers of adult *H. colesbergensis* may infest Southern African hedgehogs and several species of carnivores in the eastern region of the Northern Cape Province. The hedgehogs constitute a new host record for this tick species.

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