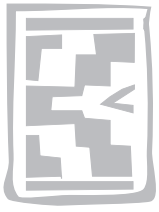

Parasites of domestic and wild animals in South Africa. XLVII. Ticks of tortoises and other reptiles

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ABSTRACT

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A total of 586 reptiles, belonging to 35 species and five subspecies, were examined in surveys aimed at determining the species spectrum and geographic distribution of ticks that infest them. Of these reptiles 509 were tortoises, 28 monitor or other lizards, and 49 snakes. Nine ixodid tick species, of which seven belonged to the genus *Amblyomma*, and one argasid tick, *Ornithodoros compactus* were recovered. Seven of the ten tick species are parasites of reptiles. Amongst these seven species *Amblyomma marmoreum* was most prevalent and numerous on leopard tortoises, *Geochelone pardalis*; *Amblyomma nuttalli* was present only on Bell's hinged tortoises, *Kinixys belliana*; and most *Amblyomma sylvaticum* were collected from angulate tortoises, *Chersina angulata*. *Amblyomma exornatum* (formerly *Aponomma exornatum*) was only recovered from monitor lizards, *Varanus* spp.; most *Amblyomma latum* (formerly *Aponomma latum*) were from snakes; and a single nymph of *Amblyomma transversale* (formerly *Aponomma transversale*) was collected from a southern African python, *Python natalensis*. All 30 Namaqualand speckled padloper tortoises, *Homopus signatus signatus*, examined were infested with *O. compactus*.

The seasonal occurrence of *A. sylvaticum* and the geographic distribution of this tick and of *A. marmoreum*, *A. nuttalli*, *A. exornatum*, *A. latum* and *O. compactus* are illustrated.

Keywords: *Amblyomma* spp., argasid tick, geographic distribution, ixodid ticks, *Ornithodoros compactus*, reptiles, seasonality, snakes, tortoises, varanid lizards

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INTRODUCTION

Reptiles in southern Africa are hosts of several species of ixodid ticks (Theiler 1962). The majority of these ticks belong to the genus *Amblyomma*, of which nine species, including three species that belonged to the former genus *Aponomma* (now *Amblyomma*), occur in South Africa (Walker 1991). Theiler (1943, 1945a, b) has published illustrations of *Amblyomma sylvaticum* and of the ornate and inornate *Aponommas*. The latter ticks have recently been placed in the genus *Amblyomma* and are now designated *Amblyomma exornatum*, *Amblyomma latum* and *Amblyomma transversale* (Klompen, Dobson & Barker 2002). Theiler & Salisbury (1959) have illus-

trated ticks of 'the *Amblyomma marmoreum* group', and colour illustrations of *Amblyomma hebraeum* and *A. marmoreum* have been published by Walker & Olwage (1987). A single argasid species, *Ornithodoros compactus* infests tortoises in southern Africa, and has been illustrated by Walton (1962).

Theiler (1962) has listed the reptile species and the localities in sub-Saharan Africa from which ticks of the genera *Amblyomma* and *Aponomma* (now *Amblyomma*) have been collected. Norval (1983, 1985) has recorded the hosts and mapped the localities at which *Amblyomma nuttalli*, *A. marmoreum*, *A. exornatum*, *A. latum* and *A. transversale* have been collected in Zimbabwe. Walker & Schulz (1984) have recorded the numbers of *A. hebraeum* and *A. marmoreum* collected from tortoises in the Addo Elephant National Park, Eastern Cape Province, and Dower, Petney & Horak (1988) those collected from leopard tortoises in the Andries Vosloo Kudu Reserve and in the Thomas Baines Nature Reserve, Eastern Cape Province. The seasonality of *A. marmoreum* on leopard tortoises in the National Zoological Gardens, Pretoria, Gauteng Province has been determined by Rechav & Fielden (1995), and the hosts, seasonality and geographic distribution of the latter tick in South Africa have been recorded and illustrated by Horak, McKay, Heyne & Spickett (2006). Walton (1962) has listed the tortoise species from which *O. compactus* has been collected.

With the exception of *A. hebraeum* and *O. compactus*, the above-mentioned ticks have all been recorded on reptiles imported into the United States of America (USA) from Africa (Burridge, Simmons & Allan 2000; Burridge 2001; Burridge & Simmons 2003). This illustrates not only the close association between the ticks and their hosts, but their prolonged periods of attachment, which exceed the length of time from the capture of the reptile in Africa, its translocation to a foreign country and its legal or illegal importation into that country. *Amblyomma marmoreum* has in fact adapted to its new habitat and become established at a reptile breeding facility in Florida in the USA (Allan, Simmons & Burridge 1998). According to Walton (1962) the *O. compactus* recorded in European zoological gardens, probably arrived there as first stage nymphs on imported tortoises.

The purpose of this paper is to record the species spectrum of ticks that infest tortoises and various other reptiles in South Africa, and to illustrate the seasonality and geographic distributions of those species for which sufficient data exist.

MATERIALS AND METHODS

The data for this communication are derived from four surveys of ticks parasitizing tortoises and other reptiles.

Firstly a study conducted specifically on tortoises, chiefly in the southern provinces of South Africa, between 1975 and 1981, during which all visible ticks were collected, but no record was kept of the number of tortoises that were not infested. Secondly ticks were collected from tortoises in the Western and Northern Cape Provinces between 2000 and 2003 as part of a larger investigation on the biology and conservation of these animals. Again no record was kept of the number of tortoises that were not infested. Thirdly from casual collections between 1981 and 2005 from tortoises and other reptiles, and finally studies on 23 leopard tortoises conducted by Dower *et al*. (1988) and Horak & Boomker (1998) have been included for completeness' sake. The vast majority of collections were made from free-living reptiles, with a few made from captive animals. With the exception of the study by Dower *et al*. (1988), in which ticks were recovered after detaching from caged, naturally infested tortoises, ticks were collected manually, or by means of pincers, and preserved in 70 % ethyl alcohol for subsequent identification and counting. The collections made by Dower *et al*. (1988) were exhaustive, while the others concentrated on collecting only the visible and hence more easily accessible ticks. The parasite host tables that follow list the total number of tortoises and other reptiles of each species that were infested irrespective of the tick species and the numbers of animals that were infested with particular species. The localities at which ticks were collected were recorded and their geographic coordinates determined and plotted.

The results of the collections pertaining to *A. marmoreum* have been reported separately (Horak *et al.* 2006) and, with the exception of the tick-host table and geographic distribution map, to which new data have been added, they are not repeated here. Large numbers of all stages of development of *A. sylvaticum* were collected from angulate tortoises during the course of the surveys, and the mean numbers recovered each month, irrespective of the year, have been used to determine the seasonal occurrence of this tick on these animals. The maps illustrating the geographic distributions of the various tick species have been compiled from the coordinates of localities listed by Theiler (1962), as well as from those at which ticks were collected in the surveys reported here.

We have used Branch (1998) as our primary source of reference for the specific and common names of the tortoise and other reptile species examined. These have been listed in the tables and the scientific names will not be repeated in the text. Whenever we have been uncertain of the sub-specific identity of a particular tortoise we have used the geographic distribution maps plotted by Branch (1998), or the habitat preferences of the various sub-species of tent tortoises (Branch 1989), and the field experience of B.T.H. and M.D.H. to arrive at an acceptable solution. When this has not been possible we have used only the specific name of the tortoise. In some cases the animals were identified only as 'tortoise' or 'monitor lizard' by the collectors and are listed as such in the tables.

RESULTS AND DISCUSSION

Amblyomma hebraeum

The hosts of adult *A. hebraeum* are large herbivorous mammals, whereas the larvae and nymphs can be found on a variety of large and small mammals and on ground-frequenting birds, and the nymphs also on reptiles (Norval 1983; Horak, MacIvor, Petney & De Vos 1987; Dower *et al.* 1988). Consequently, despite the fact that *A. hebraeum* adults were

TABLE 1 Ticks collected from various reptile species

Tick and host species	Number infested with ticks	Number infested with species listed	Number of ticks collected				
			Larvae	Nymphs	Males	Females	Total
Amblyomma hebraeum							
Leopard tortoise, *Geochelone pardalis*	31*	19	0	686	20	13	719
Rock monitor, *Varanus albigularis albigularis*	4*	2	0	33	0	0	33
Amblyomma nuttalli							
Bell's hinged tortoise, *Kinixys belliana*	7	5	0	0	9	0	9
Amblyomma exornatum							
Rock monitor, *V. a. albigularis*	7	7	0	112	191	116	419
Water monitor, *Varanus niloticus*	12	12	0	53	104	75	232
"Monitor", *Varanus* spp.	3	3	0	3	17	2	22
Amblyomma transversale							
Southern African python, *Python natalensis*	3	1	0	1	0	0	1
Hyalomma truncatum							
Leopard tortoise, *G. pardalis*	82	3	0	0	1	3	4
Geometric tortoise, *Psammobates geometricus*	86	1	0	0	1	0	1
Rhipicephalus gertrudae							
Geometric tortoise, *P. geometricus*	86	1	0	0	0	1	1
"Tortoise"	9	1	0	0	2	0	2

* = Number of animals examined within the distribution range of *A. hebraeum*

TABLE 2 *Amblyomma marmoreum* collected from reptiles

Host species	Number infested with ticks	Number infested with *A. marmoreum*	Number of ticks collected				
			Larvae	Nymphs	Males	Females	Total
Leopard tortoise, *G. pardalis*	82	80	336	105	545	217	1 203
Bell's hinged tortoise, *K. belliana*	7	2	0	0	5	3	8
Geometric tortoise, *P. geometricus*	86	68	28	9	64	14	115
Serrated tortoise, *Psammobates oculiferus*	11	11	0	1	9	4	14
Tent tortoise, *Psammobates tentorius tentorius*	23	22	0	8	21	11	40
Namaqualand tent tortoise, *Psammobates tentorius trimeni*	5	1	0	0	1	0	1
Bushmanland tent tortoise, *Psammobates tentorius verroxii*	11	2	0	0	4	0	4
Tent tortoise, *Psammobates tentorius*	5	1	1	0	0	0	1
Angulate tortoise, *Chersina angulata*	138	9	0	6	17	2	25
Common padloper, *Homopus areolatus*	87	75	68	65	33	21	187
Karoo padloper, *Homopus boulengeri*	2	2	2	5	0	0	7
Greater padloper, *Homopus femoralis*	4	4	0	1	4	0	5
Southern speckled padloper, *Homopus signatus cafer*	8	2	81	0	1	0	82
Namaqualand speckled padloper, *Homopus signatus signatus*	30	0	0	0	0	0	0
"Tortoise"	10	8	7	21	23	10	61
Rock monitor, *V. a. albigularis*	7	3	0	7	1	0	8
"Monitor", *Varanus* spp.	3	1	0	2	2	0	4
Southern African python, *P. natalensis*	3	3	0	11	0	0	11
"Python"	1	1	0	0	0	1	1
Puff adder, *Bitis arietans*	3	2	0	2	2	0	4
Gaboon adder, *Bitis gabonica*	1	1	2	0	0	0	2
Common egg eater, *Dasypeltis scabra*	1	1	0	1	0	0	1
Boomslang, *Dispholidus typus*	1	1	0	2	0	0	2
Total	**529**	**300**	**525**	**246**	**732**	**283**	**1 786**

present on a number of leopard tortoises examined within the tick's distribution range (Table 1), these infestations must be considered opportune, possibly triggered by *A. hebraeum* or *A. marmoreum* males already present on the tortoises. Attached, engorging *A. hebraeum* males produce pheromones that, with the carbon dioxide exhaled by their hosts, attract con-specific females, other males and nymphs (Norval, Yunker & Butler 1987). The life stage spectrum of the ticks attached to the 19 infested leopard tortoises seems to indicate that male *A. marmoreum* may also produce pheromones that can be detected by con-specific ticks as well as by *A. hebraeum* nymphs and adults.

Howell, Walker & Nevill (1978) have illustrated the geographic distribution of *A. hebraeum* within the boundaries of South Africa, and the present records from tortoises all fall within this range.

Amblyomma marmoreum

This tick, colloquially known as the South African tortoise tick, is probably the species most frequently encountered on tortoises throughout South Africa (Theiler & Salisbury 1959; Horak *et al.* 2006). It is the largest ixodid tick in South Africa, and engorged females may exceed 25 mm in length. With the exception of angulate and Namaqualand speckled padloper tortoises (the latter the smallest tortoise species in the world), a large percentage of individuals within each tortoise species were infested (Table 2). It would seem that the larger the species the greater the number of adult ticks it is likely to harbour, and leopard tortoises, the largest of the South African species, carried most adult ticks. Amongst the latter was a tortoise infested with 63 male and 105 female ticks. The immature stages, particularly larvae, infest not only reptiles, but also a large variety of mammals and birds (Horak *et al.* 2006).

The comparatively small total number of immature ticks collected from the various tortoise species could not sustain the large number of adult ticks collected from these animals. Because complete collections were not always made, large numbers of immature ticks were probably overlooked. Furthermore, the large number of larvae and fewer nymphs that attach to a variety of warm-blooded hosts, both avian and mammalian (Horak *et al.* 2006), could serve to augment the apparently insufficient numbers of immature ticks collected.

Theiler & Salisbury (1959) mapped the distribution of *A. marmoreum* in South Africa from the geographic coordinates of 49 localities at which collections had been made. Horak *et al.* (2006) added more than 100 localities to that map and we have now added approximately 70 more sites (Fig. 1). Most collections have been made in the south-western

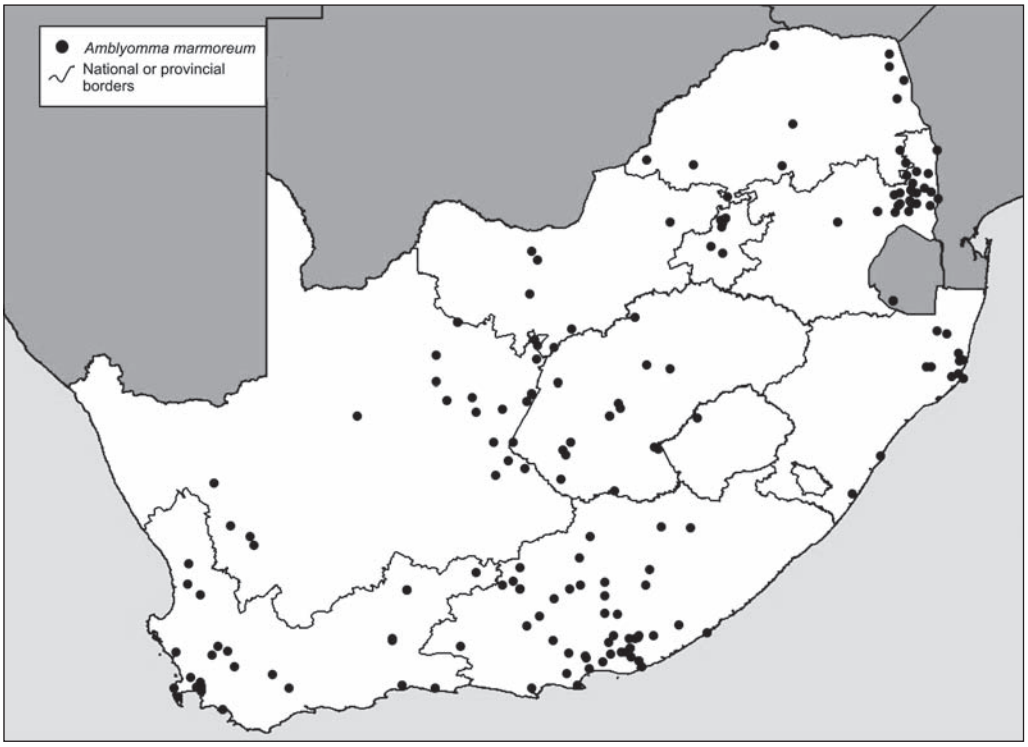

FIG. 1 Geographic distribution of *Amblyomma marmoreum* in South Africa

Western Cape Province, the western half of the Eastern Cape and Free State Provinces, the eastern regions of the Northern Cape Province, and the north-eastern regions of KwaZulu-Natal and Mpumulanga Provinces. This distribution closely corresponds to that of several of the tick's most favoured host species, namely common padloper tortoises in south-western Western and Eastern Cape Provinces, geometric tortoises in south-western Western Cape Province, tent tortoises in western Western and Northern Cape Provinces, serrated tortoises in eastern Northern Cape Province, and leopard tortoises in the central, northern and north-eastern regions of South Africa (Branch 1998).

Amblyomma nuttalli

The difficulty in distinguishing between *A. nuttalli* and other ticks of the *A. marmoreum* group has been discussed by Theiler & Salisbury (1959). One of the hosts frequently infested by adult *A. nuttalli* is Bell's hinged tortoise, *Kinixys belliana* (Hoogstraal 1956; Table 1), but other tortoises, monitor lizards and snakes may also be infested (Theiler & Salisbury 1959; Burridge *et al.* 2000). The immature stages infest the same hosts as the adults, but are also found on birds and mammals (Theiler 1962). The tick is widespread in the Afrotropical region, but in South Africa almost all collections have been made in north-eastern KwaZulu-Natal (Theiler 1962; Walker 1991; Fig. 2).

Amblyomma sylvaticum

Theiler (1962) describes *A. sylvaticum* as "this somewhat rare Cape tortoise tick", an observation refuted by the present surveys, during which, after *A. marmoreum*, *A. sylvaticum* was the tick most frequently collected. Theiler lists adult ticks on the angulate tortoise, tent tortoise and common padloper as well as on a mole snake, *Pseudaspis cana*. In contrast to *A. marmoreum*, which infests a wide spectrum of tortoise species, all stages of development of *A. sylvaticum* would seem to infest angulate tortoises by preference (Table 3). The number of immature ticks collected from these tortoises could clearly not sustain their adult burdens, and incomplete collections can in part be responsible for this. Although we have examined numerous birds and mammals, we have not collected larvae or nymphs of *A. sylvaticum* from any of them, and it would thus appear as if infestations on other tortoise species and reptiles augment the population of immature ticks (Table 3).

The considerable differences in the numbers of angulate tortoises examined in the different months of

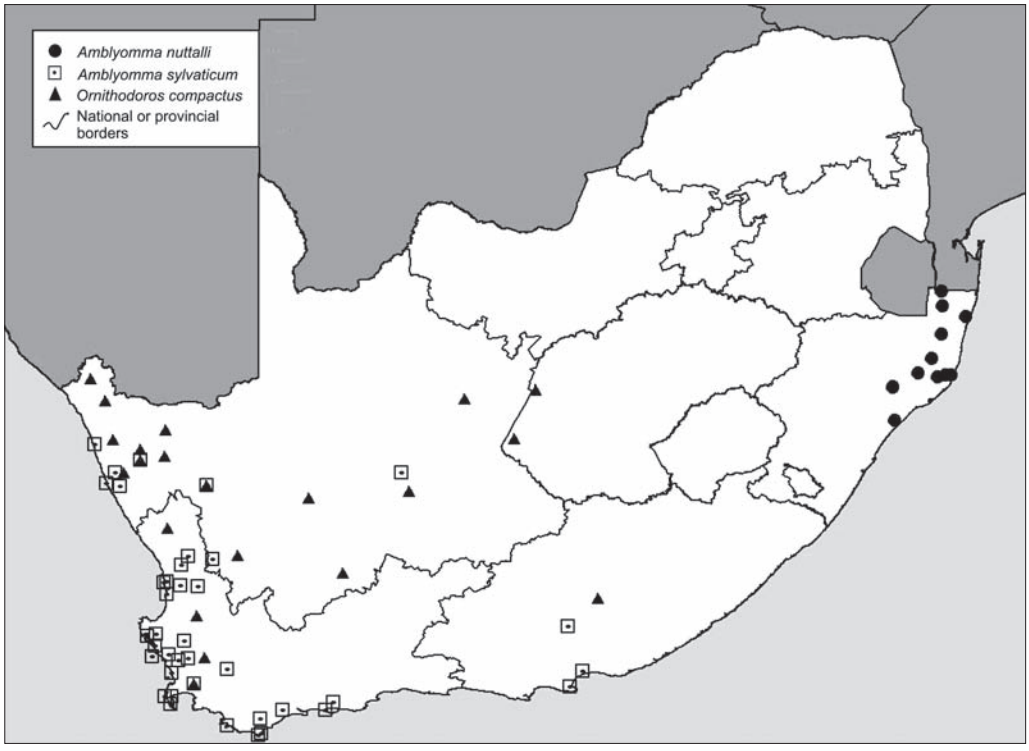

FIG. 2 Geographic distributions of *Amblyomma nuttalli*, *Amblyomma sylvaticum* and *Ornithodoros compactus* in South Africa

TABLE 3 *Amblyomma sylvaticum* collected from various reptile hosts

Host species	Number infested with ticks	Number infested with *A. sylvaticum*	Number of ticks collected				
			Larvae	Nymphs	Males	Females	Total
Geometric tortoise, *P. geometricus*	86	14	2	3	0	14	19
Tent tortoise, *P. t. tentorius*	23	1	0	0	1	0	1
Namaqualand tent tortoise, *P. t. trimeni*	5	0	0	0	0	0	0
Bushmanland tent tortoise, *P. t. verroxii*	11	1	0	0	2	0	2
Tent tortoise, *P. tentorius*	5	1	3	0	0	0	3
Angulate tortoise, *C. angulata*	138	124	736	249	277	159	1 421
Common padloper, *H. areolatus*	87	4	0	14	2	3	19
Southern speckled padloper, *H. s. cafer*	8	5	0	0	4	1	5
Namaqualand speckled padloper, *H. s. signatus*	30	0	0	0	0	0	0
Knox's desert lizard, *Meroles knoxi*	3	3	62	0	0	0	62
Southern spiny agama, *Agama hispida*	1	1	5	0	0	0	5
Total	**397**	**154**	**808**	**266**	**286**	**177**	**1 537**

the year as well as in the tick burdens of individual animals make it difficult to obtain a clear pattern of seasonality for *A. sylvaticum*. Five or fewer tortoises were examined per month in January, March (none examined), June, August and November, and six or more in the other months, with 36 examined during May. To compensate for these inequalities, 3-month running means have been used to illustrate seasonality. With this in mind, most larvae were present from May to November, most nymphs during the period August to January, and most adults from August to February (Fig. 3). This pattern of seasonality agrees with the sizes of ticks observed on angulate tortoises during January, May, July and September by B.T.H. and M.D.H. If this indeed were the pattern of seasonality, it would imply that female ticks deposit eggs in summer and that most larvae hatch from early winter to early summer. These larvae would feed and moult to nymphs from midwinter to midsummer, and once the latter had fed and moulted they would

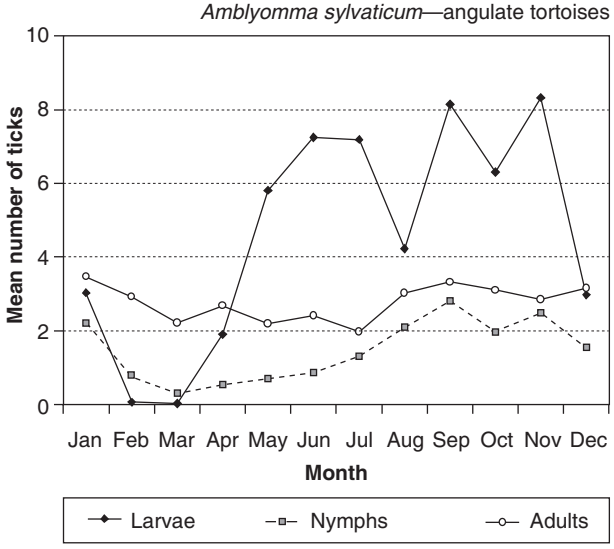

FIG. 3 Seasonal occurrence of *Amblyomma sylvaticum* on angulate tortoises in South Africa (3-month running means)

maintain the numbers of adult ticks during summer. From the available data we are, however, unable to determine whether the life cycle requires 1 or 2 years to complete, or whether diapause occurs during any particular stage of development.

According to Theiler (1962), who based her findings on collections made at 12 localities, the distribution of *A. sylvaticum* is confined to the Eastern and Western Cape Provinces and to parts of Little Namaqualand. We were unable to trace two of Theiler's 12 collection sites, but have now plotted a further 33 localities. From these it is apparent that *A. sylvaticum* is a strictly South African species, predominantly present in the western regions of the Northern and Western Cape Provinces as well as in the southwestern regions of the latter province and of the Eastern Cape Province, with a single outlying record from a tent tortoise in the centre of the Northern Cape Province (Fig. 2).

Infestation was most prevalent on angulate tortoises, southern speckled padloper tortoises and on Knox's desert lizards. Angulate tortoises and the desert lizards have a strong association with sandy soils. Although southern speckled padloper tortoises occur in rocky terrain, they can be sympatric with angulate tortoises (M.D.H. and B.T.H.) and have sandy soil in their habitat. It is possible that these soils and the micro-environment associated with them provide essential elements for the survival of the free-living stages of *A. sylvaticum*.

This tick and its angulate tortoise hosts are both common in the West Coast National Park and nearly all tortoises examined by two of us (B.T.H. and M.D.H.) were infested. However, despite examining large numbers of angulate tortoises on Dassen island, an island about 10 km southwest of the park, only one tick has been collected from these reptiles. The absence of ticks on this small island might be due to its very salty environment and ephemeral and mostly exotic vegetation. *Amblyomma sylvaticum* has been recorded in the United States on a tortoise imported from South Africa (Burridge & Simmons 2003).

Amblyomma exornatum

No *A. exornatum* larvae were recovered, but 168 nymphs and 505 adult ticks were collected from 22 monitor lizards (Table 1). According to Theiler (1945a), Hoogstraal (1956) and Norval (1985) these large lizards are its preferred hosts. A single rock monitor examined during the present surveys in the National Zoological Gardens, Pretoria, harboured 79 nymphs, 150 males and 94 female ticks. Although no adult ticks were collected during October, 14 of

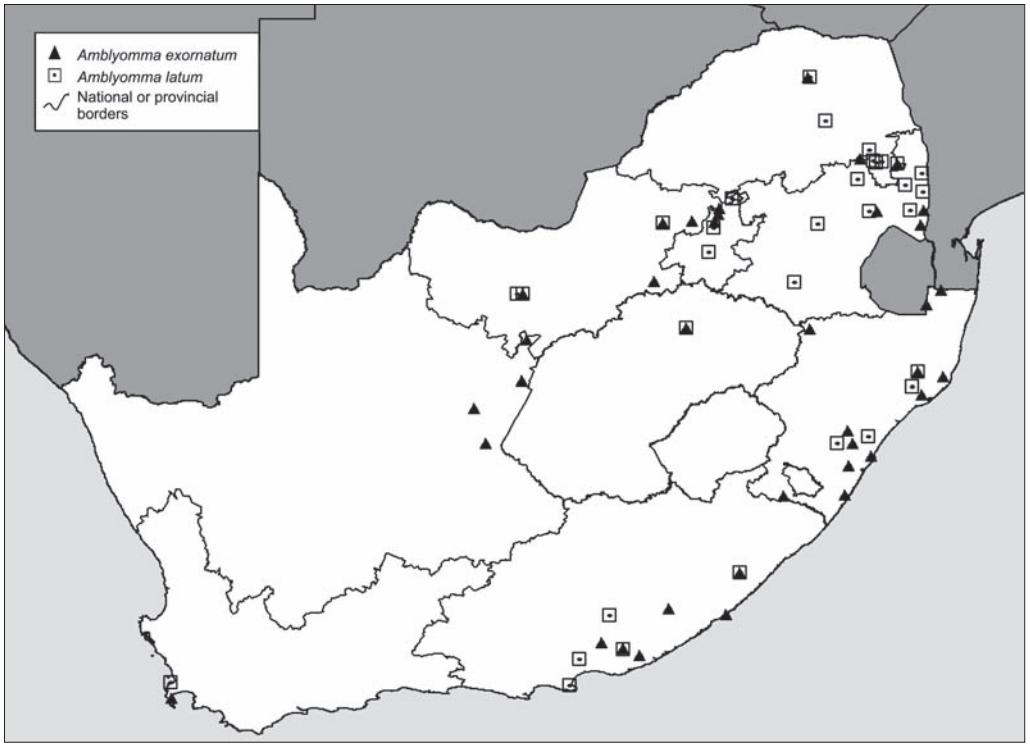

FIG. 4 Geographic distributions of *Amblyomma exornatum* and *Amblyomma latum* in South Africa

the 21 collections of adult ticks were made during the period September to December (spring to midsummer).

Thirty-one of the 37 localities at which we have recovered *A. exornatum* are in the eastern and southeastern half of the country (Fig. 4). According to Theiler (1962) and Norval (1985) it is widespread in South Africa and Zimbabwe, and Theiler suggests that it is probably present across the range of its varanid hosts in these countries. The single record from Simonstown in south-west Western Cape Province originates from a monitor lizard that had probably been translocated, as this region lies outside the geographic distribution of these lizards (Branch 1998).

Amblyomma latum

This tick, aptly named the snake tick by Hoogstraal, infests snakes, and more particularly the larger species (Theiler 1945b, 1962; Hoogstraal 1956; Norval 1985). According to Walker (1991) the occasional records from lizards and even from some mammals, represent incidental infestations. The single female collected from a leopard tortoise in the present study would thus seem to be unusual (Table 4). *Amblyomma latum* has, however, been collected from two captive yellow-footed tortoises, *Geochelone denticulata*, in the USA. The latter tortoise is native to South America, where this tick does not occur, and the tortoises probably acquired infestation while in captivity (Burridge 2001; Burridge & Simmons 2003).

The 32 males, two females, eight nymphs and 76 larvae collected from a black mamba near Hectorspruit, in the Lowveld of Mpumalanga Province, appear to be one of the largest recorded collections of *A. latum* taken from a single snake. Many of the adult ticks in this collection were attached under scales in and adjacent to a large superficial dorsal wound just posterior to the snake's head. Whether the ticks had caused the lesion, or had attached there because of it, could not be ascertained. According to Burridge (2001), adult ticks attach under dorsal and lateral scales on all parts of the body of snakes, with the head being the most common site.

In Zimbabwe, Norval (1985) recovered all developmental stages of *A. latum* throughout the year, but collected most samples in the warm months when snakes are most active. During the present surveys 28 collections of adult ticks were made during the period October to February (summer) and only 11 from March to September (late summer to spring).

The distribution of *A. latum* in South Africa, based on Theiler's (1962) records, to which we have added several localities, is illustrated in Fig. 4. Most records of this tick emanate from the eastern half of the country, with a single collection in the far south-west from a reptile in a snake park in Cape Town.

Amblyomma transversale

A single nymph of this tick was collected from a southern African python (Table 1), which incidentally was also infested with nymphs of *A. marmoreum* and an adult *A. latum.* Pythons are apparently the only host species recorded for *A. transversale* in southern Africa (Norval 1985; Walker 1991).

Hyalomma truncatum

Despite our examination of large numbers of tortoises in regions in which *H. truncatum* is present (Howell *et al*. 1978), only three leopard tortoises and one geometric tortoise were infested with this tick (Table 1). These ticks should be considered 'stragglers' from a heavily infested environment. The hosts of adult *H. truncatum* are large herbivorous mammals (Norval 1982; Horak, Swanepoel & Gummow 2002), to which they attach in the axillary and perianal regions and in the tail brush.

Rhipicephalus gertrudae

This tick is particularly prevalent in the Western Cape Province, and its adults infest herbivores and carnivores (Walker, Keirans & Horak 2000; Horak & Matthee 2003). The ticks on two tortoises examined during June and August respectively (Table 1), must be considered 'stragglers' reflecting the tick's abundance in the Western Cape Province at this time of the year (Horak & Fourie 1992).

Ornithodoros compactus

This tick has been recorded on the tortoises, *Testudo oculifera* (*Psammobates oculiferus*), *Testudo verreauxi* (*Psammobates tentorius verroxii*), *Testudo shonlandi* (*Psammobates tentorius verroxii*) and *Homopus femoralis* in southern Africa (Walton 1962), and tortoises would appear to be its only hosts. In the current surveys ticks were collected from six tortoise species, and infestation was most prevalent on Namaqualand speckled padloper tortoises. The larvae of *O. compactus* are not parasitic, but 450 nymphs and 57 adults (70 adults if the 13 unsexed adult ticks are included) were collected from 58 tortoises (Table 5).

TABLE 4 *Amblyomma latum* collected from various reptile hosts

Host species	Number infested with ticks	Number infested with *A. latum*	Number of ticks collected				
			Larvae	Nymphs	Males	Females	Total
Leopard tortoise, *G. pardalis*	82	1	0	0	0	1	1
Aurora house snake, *Lamprophis aurora*	1	1	0	0	1	0	1
Brown house snake, *Lamprophis fuliginosus*	4	4	0	1	3	2	6
Black mamba, *Dendroaspis polylepis*	5	5	76	8	81	28	193
Snouted cobra, *Naja annulifera annulifera*	5	5	2	1	30	3	36
Mozambique spitting cobra, *Naja mossambica*	5	5	0	1	15	0	16
Cape (Yellow) cobra, *Naja nivea*	1	1	0	0	2	3	5
Rinkhals, *Hemachatus haemachatus*	1	1	0	0	7	0	7
Puff adder, *B. arietans*	3	2	0	0	1	1	2
Snouted night adder, *Causus defilippii*	2	2	4	2	0	2	8
Common night adder, *Causus rhombeatus*	1	1	0	0	0	2	2
Cape file snake, *Mehelya capensis*	6	6	1	16	49	9	75
Black file snake, *Mehelya nyassae*	1	1	0	3	0	0	3
Herald snake, *Crotaphopeltis hotamboeia*	1	1	0	2	0	0	2
Shield-nose snake, *Aspidelaps scutatus*	3	3	0	0	7	0	7
Southern African python, *P. natalensis*	3	2	0	0	5	14	19
Olive grass snake, *Psammophis mossambicus*	3	3	8	2	4	0	14
Striped skink, *Mabuya striata*	1	1	6	0	0	0	6
Variable skink, *Mabuya varia*	1	1	3	0	0	0	3
Total	**129**	**46**	**100**	**36**	**205**	**65**	**406**

Unlike other *Ornithodoros* species, of which the nymphs and adults spend most of their time in the dwellings or burrows of their hosts, or under the surface of the soil, it would seem as if those of *O. compactus* live on their tortoise hosts. Namaqualand speckled padloper tortoises, all of which were infested, prefer rocky terrain, but also have sand in their habitat. These tortoises often rest among the debris and soil under shrubs or between boulders and it is possibly here that they acquire infestation

TABLE 5 *Ornithodoros compactus* collected from various reptile hosts

Host species	Number infested with ticks	Number infested with *O. compactus*	Number of ticks collected				
			Larvae	Nymphs	Males	Females	Total
Leopard tortoise, *G. pardalis*	51*	2	0	3	0	0	3
Geometric tortoise, *P. geometricus*	86	2	0	26	2	0	28
Tent tortoise, *P. t. tentorius*	23	0	0	0	0	0	0
Namaqualand tent tortoise, *P. t. trimeni*	5	5	0	30	0	0	30
Bushmanland tent tortoise, *P. t. verroxii*	11	8	0	79	2	0	81
Tent tortoise, *P. tentorius*	5	3	0	27	0	0	27
Angulate tortoise, *C. angulata*	138	3	0	9	0	0	9
Common padloper, *H. areolatus*	87	5	0	18	0	0	18
Southern speckled padloper, *H. s. cafer*	8	0	0	0	0	0	0
Namaqualand speckled padloper, *H. s. signatus*	30	30	0	258	12	41	311**
Total	**444**	**58**	**0**	**450**	**16**	**41**	**507****

* Number of tortoises examined within the apparent distribution range of *O. compactus*
** Plus 13 unsexed adults

via newly moulted first stage nymphs. These nymphs would have moulted from non-parasitic larvae that had hatched from eggs that had dropped off or were deposited in these protected localities. Walton (1962) has suggested that the axillary and perineal skin folds are probably the most suitable sites for the ticks to survive on tortoises. Loehr, Henen & Hofmeyr (2006) found that the ticks tend to use the hind limbs of Namaqualand speckled padloper tortoises more frequently than the fore limbs and cervical region, and many move when the tortoises are handled. Like other *Ornithodoros* spp. feeding appears to be occasional, and only one male and two female ticks of the 57 adults that we collected appeared to have recently engorged.

The distribution of *O. compactus* is apparently restricted to southern Africa south of the Zambezi River (Walton 1962). In the present surveys most collections were made from tortoises in the semi-arid Northern Cape Province (Fig. 2).

General

Only 26 of the 591 reptiles examined harboured mixed infestations of two tick species, and only two hosted three species. One of the latter was a rock monitor, which was infested with nymphs of *A. hebraeum* and of *A. marmoreum* and nymphs and adults of *A. exornatum*, and the other a southern African python that harboured nymphs of *A. marmoreum*, a single *A. transversale* nymph, and a male *A. latum*. Eighteen leopard tortoises were infested with both *A. hebraeum* and *A. marmoreum*, three with *A. marmoreum* and *H. truncatum*, and one with *A. marmoreum* and a nymph of *O. compactus*. A geometric tortoise harboured *A. marmoreum* and a female *R. gertrudae*, and a Namaqualand tent tortoise was infested with one male *A. marmoreum* and 20 *O. compactus* nymphs. Two rock monitors were infested with *A. marmoreum* and *A. exornatum*. It would thus seem that, with the exception of *A. hebraeum* and *A. marmoreum*, the ticks infesting reptiles have

evolved fairly distinct preferences for individual host species or for hosts belonging to the same genus or grouping.

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