# The geographic distribution of ticks in the eastern region of the Eastern Cape Province

by

**NKULULEKO NYANGIWE**

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*This dissertation is dedicated*

*with love and respect*

*to*

*my parents, my wife (Kuhle) and my children*

*for their support during my long absences from home*

*whilst working on the MSc.*

# Declaration

Besides the assistance received that has been reported in the acknowledgements and in the appropriate places in the text,

this dissertation represents the original work of the author

No part of this dissertation has been presented for

any other degree at any other university

**Candidate…**Nkululeko Nyangiwe… **Date …**August 2007**…**

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

# Summary

## The geographic distribution of ticks in the eastern region of the Eastern Cape Province

by

Nkululeko Nyangiwe

Supervisor: Prof. I.G. Horak
Co-supervisor: Dr. N.R. Bryson

The objective of the study was to determine the species composition and geographic distribution of ticks in the eastern region of the Eastern Cape Province. Ninety out of a total of 1 057 communal cattle dip-tanks in the region were selected by means of a table of random numbers, and 72 of these were eventually allocated to the survey. At each of the chosen dip-tanks an attempt was made to collect ticks from five cattle, five goats, five dogs and two hen coops, and free-living ticks from the vegetation by means of flannel strips, and ticks were collected from January 2004 and 2005 to May 2004 and May 2005 respectively. The geographic coordinates of the dip-tanks at which the ticks were collected were recorded, and used for plotting the distributions of the various tick species. The ticks were stored in 70 % ethyl alcohol in internally labelled vials for later identification and counting.

Eleven ixodid tick species were collected from cattle, goats, dogs and the vegetation, namely *Amblyomma hebraeum*, *Haemaphysalis elliptica, Haemaphysalis spinulosa*, *Hyalomma marginatum rufipes*, *Ixodes pilosus* group, *Rhipicephalus* (*Boophilus*) *decoloratus*,

*Rhipicephalus* (*Boophilus*) *microplus*, *Rhipicephalus appendiculatus*, *Rhipicephalus evertsi evertsi*, *Rhipicephalus sanguineus* and *Rhipicephalus simus*. Of these *R. e. evertsi* and *R. appendiculatus* were the most numerous, and constituted 38.8 % and 34.9% of the 13 768 ticks collected respectively. They were followed by *R.* (*B.*) *microplus* (17.4 %) and *A. hebraeum* (5.3%).

Two argasid tick species were collected, namely *Otobius megnini* from the ear canals of two cattle, and *Argas walkerae* from fowl houses. *A. walkerae* was collected from 102 (70.8%) of 144 fowl houses in the vicinity of 57 (79.2%) of the 72 selected dip-tanks, and seemed to be present only when there was wood in the structure of the fowl house.

Adult *A. hebraeum* was present in areas where there are trees and bush as well as grass, particularly along the coast, but also surprisingly far inland beyond the distribution limits previously illustrated for it. *R.* (*B.*) *microplus*, *R. appendiculatus* and *R. e. evertsi* were present throughout the survey area region, and from their distribution maps there are strong indications that the exotic *R.* (*B.*) *microplus* is displacing the indigenous *R.* (*B.*) *decoloratus* in this region.

A large percentage of goats were infested with the adults of ticks normally associated with cattle, namely *A. hebraeum*, *R.* (*B.*) *microplus*, *R. appendiculatus* and *R. e. evertsi*. A more significant finding, however, is the large proportion of *R.* (*B.*) *microplus* females measuring 5 mm or more in length on the goats, a good indication that they were successfully completing their life cycles. In the light of these findings, it is imperative to include goats in any tick control programme aimed at controlling a tick-borne disease outbreak in sympatric cattle.

Eight ixodid tick species were collected from the dogs, and *H. elliptica*, followed by *R. appendiculatus* and *R. simus* were present on these animals at the largest number of dip-tanks. The kennel tick *R. sanguineus*, a parasite of dogs in urban environments, was collected from dogs only at two localities.

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# Chapter 1

## General Introduction and Literature Review

Ticks are the most important external parasites of domestic animals in South Africa and can easily constitute a limiting factor to successful stock farming unless appropriate measures are taken to control them (Howell, Walker & Nevill 1978). They do harm to their hosts both directly and indirectly. Directly ticks cause deterioration in the condition of their hosts resulting from loss of blood, tick worry and tick toxicosis. Their bites can result in damage to hides, and are frequently the site of secondary microbial infections resulting in sloughed teats, missing tail tips, lameness and foot-abscess. Tick bites may also become maggot-infested and the pinnae of the ear may crumple because of this (Howell *et al*. 1978). Their indirect effects are even more serious in that ticks act as vectors of a wide range of pathogenic organisms which not infrequently cause the death of their hosts (Norval & Horak 2004).

Animal farming in the communal areas of the Eastern Cape Province is concerned mainly with the production of cattle, goats and sheep. Locally, ticks and tick-borne diseases are considered a major problem in cattle, but less so in goats and sheep. Cattle are, however, considerably more important in rural communities, and the status of the farmer is often related to the number of cattle he owns. The major tick-borne diseases affecting cattle in the Eastern Cape Province are gallsickness, redwater and heartwater (Masika, Sonandi & Van Averbeke 1997).

Tick infestations and tick-borne diseases are the most widespread of all the major livestock problems in Africa (Dipeolu, Mongi, Punyua, Latif, Amoo & Odhiambo 1992). Several ticks that commonly infest cattle are vectors of disease and can also *per se* cause a decrease in animal productivity. In South Africa *Amblyomma hebraeum*, the South African bont tick is the vector of *Ehrlichia* (*Cowdria*) *ruminantium* the causative organism of heartwater in cattle, sheep and goats; *Rhipicephalus* (*Boophilus*) *decolaratus*, the blue tick, is the vector of *Babesia bigemina* and *Rhipicephalus* (*Boophilus*) *microplus*, the Asiatic blue tick, is the vector of *Babesia bovis* and of *B. bigemina* the causative organisms of redwater in cattle; while *Rhipicephalus appendiculatus*, the brown ear tick transmits several species of *Theileria*, causing theilerioses in cattle (Howell *et al*. 1978; Norval & Horak 2004).

The South African Tick Survey, conducted between 1937 and 1943, has shown that the tick species that occur here have adapted to the various climatic and vegetation conditions prevailing in the country (Theiler 1962; Howell *et al.* 1978). *A. hebraeum* and *R. appendiculatus* need the shelter of trees and bush as well as grass and cannot survive in open grasslands. Their distributions largely overlap and they are found in the bushveld regions of the northern, north-eastern, eastern and south-eastern parts of South Africa (Howell *et al.* 1978). *R.* (*B.*) *decolaratus* is present in bushveld and grasslands in warm as well as in cold regions of the country, its westward distribution is limited by increasing aridity, while *Rhipicephalus evertsi evertsi*, the red-legged tick is widespread in South Africa and is absent only in the arid far west (Howell *et al.* 1978). The geographic distribution of many indigenous ticks is, however, not linked with gross climatic conditions, but rather with factors within the microclimate of the vegetation within their distribution range. Accurate information on tick ecology, such as geographical distribution and seasonal variations in numbers is thus required (Pegram, Perry, Musisi & Mwanaumo, 1986). Such information is important in the planning of tick management programmes and the investigation of alternative means of control (Londt, Horak & De Villiers 1979).

The general geographic distribution of ticks in South Africa is well documented (Theiler 1962; Howell *et al*. 1978; Walker, Keirans & Horak 2000), but their specific distributions in the various provinces or sub-regions of these provinces have not been accurately determined. Research has been done on a number of tick species in regions around or within the borders of the region formerly referred to as the Transkei within the Eastern Cape Province (Rechav 1982; Baker 1982; Horak, Keep, Spickett & Boomker 1989), but much of this data is more than 20 years old and does not cover the inland or coastal areas of this region.

In addition to preferred habitats several tick species also have preferred hosts. For instance the preferred hosts of the bont tick are large domestic and wild herbivores (Horak, MacIvor, Petney & De vos 1987a). Those of the blue tick are cattle (Howell *et al*. 1978), but it will also parasitize several species of wild antelopes (Horak, Boomker, Spickett & De Vos 1992; Walker *et al.* 2000). The preferred hosts of the brown ear tick are African buffaloes and domestic cattle (Walker *et al.* 2000), while the preferred hosts of the adults of the two-host red-legged tick are horses, donkeys, zebras, cattle and sheep (Walker *et al.* 2000). The parasitic life stages of the different species of ticks also often prefer to feed on particular sites on their preferred host animals. One immediately thinks of the red-legged tick whose larvae and nymphs are found in the ear canal of cattle, whilst the adults attach around the anus and under the tail (Baker & Ducasse 1967).

There are two major groupings of ticks, namely the family Argasidae, known as the soft ticks or tampans, and the family Ixodidae, known as the hard or shield ticks. Members of the family Argasidae have a tough, leathery integument that is more or less uniform in appearance all over the body. With the exception of *Ornithodoros savignyi*, the sand tampan, which occurs in some of the drier regions of southern Africa, and *Otobius megnini* that occurs in cattle that are kraaled at night, these ticks are not important cattle ticks (Howell *et al*. 1978). The fowl tampan, *Argas walkerae* is an important parasite of free-ranging poultry that roost in fowl houses or coops.

Hard ticks are subdivided into three groups according to the number of hosts they require to complete their life cycle, and these groupings also largely determine the manner in which they will transmit pathogens. One-host ticks, such as *R.* (*B.*) *decolaratus*) remain on the same animal from the time that they attach to it as larvae until they finally drop off as fully–fed adults. Two-host ticks, like *R. e. evertsi* attach as larvae, feed and then stay on the same animal after moulting into nymphs. The nymphs re-attach, feed and then drop to the ground to moult. When the adults emerge they have to find a second host on which to feed. Three-host ticks require three animals to enable them to complete their life cycle because each of the two immature stages drops from the host after feeding and then moults to the next stage, with the adults feeding on a third host. Most ixodid ticks belong to this group, for example *A. hebraeum* and *R.*

*appendiculatus*. The abovementioned ticks are parasites of cattle, but their immature stages and sometimes also adults will feed on goats and sheep. Nymphs and larvae frequently feed on the same hosts as the adults as well as on smaller animals such as hares (Howell *et al*. 1978; Horak *et al*. 1987a; Horak & Fourie 1991; Walker *et al.* 2000).

Several ixodid tick species infest domestic dogs in South Africa (Horak, Jacot Guillarmod, Moolman & De Vos 1987b; Horak & Matthee 2003). The three species most frequently encountered on these animals in this country are *Haemaphysalis elliptica, Rhipicephalus sanguineus* and *Rhipicephalus simus*. The geographic distribution of *H. elliptica* (previously referred to as *H. leachi*) has been illustrated by Howell *et al.* (1978) and that of *R. simus* by Walker *et al.* (2000), while that of *R. sanguineus* appears to be widespread, but patchy. Dogs belonging to more affluent owners with larger properties or belonging to owners in rural environments tend to have a higher prevalence of infestation with *H. elliptica,* which requires rodents as hosts for its immature stages (Horak *et al.* 1987b), whereas dogs belonging to less affluent owners, who often live in urban or peri-urban townships, have a higher prevalence of *R. sanguineus* (Bryson, Horak, Höhn & Louw 2000), of which all stages virtually exclusively feed on dogs (Walker *et al*. 2000). In South Africa *H. elliptica* (then referred to as *H. leachi*) is the vector of *Babesia canis rossi*, a particularly virulent species of *Babesia* causing canine babesiosis (Lewis, Penzhorn, Lopez-Rebollar & De Waal 1996). *R. sanguineus* on the other hand transmits *Ehrlichia canis* to dogs.

Domestic poultry, and more particular chickens, are plagued by the fowl tampan, *A. walkerae*, which is widespread in South Africa, living in cracks and crevices in poultry houses and transmitting several diseases to poultry (Howell *et al*. 1978).

This dissertation describes a comprehensive survey on the ticks infesting domestic animals in the eastern region of the Eastern Cape Province. This region has a seaboard of approximately 250 km and rises from the Indian Ocean to a height of approximately 2 000 m above sea level. Acocks (1988) has described the vegetation along the coast as Coastal Forest and Thornveld, adjacent to this in the west lies a strip of vegetation described as Eastern Province Thornveld and in the east a strip he described as Ngongoni Veld. With the exception of ribbons of Valley Bushveld along the rivers the remainder of the inland vegetation in the mountainous north of this region is described as Highland Sourveld (Acocks 1988).

The objective of the present study was to determine the geographic distribution of ticks in the eastern region of the Eastern Cape Province. The main focus was on ticks infesting cattle, but by including ticks of goats and dogs and the free-living stages of ticks as well as the free-living stages of ticks of poultry a much larger and more in-depth picture of the geographic distribution of most tick species present in the region could be established. With this information it should be possible to assist in the development of more scientifically based methods for the efficient control of individual species on their preferred hosts in each geographic area of the region.

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# Chapter 2

## General Materials and Methods

A list of all the dip-tanks in the eastern region of the Eastern Cape Province was obtained and 1 057 dip-tanks, at each of which more than 200 cattle were dipped, were identified. These tanks were allocated numbers and by means of a table of random numbers, drawn up by Prof Bruce Gummow of the Section of Epidemiology of the Department of Production Animal Studies, Faculty of Veterinary Science, University of Pretoria, 90 of these tanks were selected for the survey on the geographic distribution of ticks in this region. It was intended that ticks were to be collected at approximately 75 of these dip-tanks, but extra numbers were selected in case some of the tanks were inaccessible even by means of a four-wheel drive vehicle. At each of 72 dip-tanks eventually selected for the geographic distribution survey, an attempt was made to collect ticks from five cattle, five goats, five dogs and two fowl houses, and free-living ticks from the vegetation by means of dragging with flannel strips.

### 2.1 Survey areas

The survey was carried out at dip-tanks within the four municipal districts, namely Alfred Nzo, Amatole, Chris Hani and O.R. Tambo that fall within the eastern region of the Eastern Cape Province. The numbers of cattle and goats in each of these districts are summarized in Table 2.1.

TABLE 2.1: Numbers of cattle and goats in the eastern region of the Eastern Cape Province, South Africa (Eastern Cape Animal Population Census, 2002).

| **District** | **Cattle** | **Goats** |
|---|---|---|
| Alfred Nzo | 239, 749 | 236, 294 |
| Amatole district | 458, 110 | 369, 448 |
| Chris Hani | 318, 196 | 331, 360 |
| O.R. Tambo | 609, 209 | 669, 643 |

The locations of the dip-tanks selected for survey purposes in the eastern region of the Eastern Cape Province are plotted in Figure 2.1.

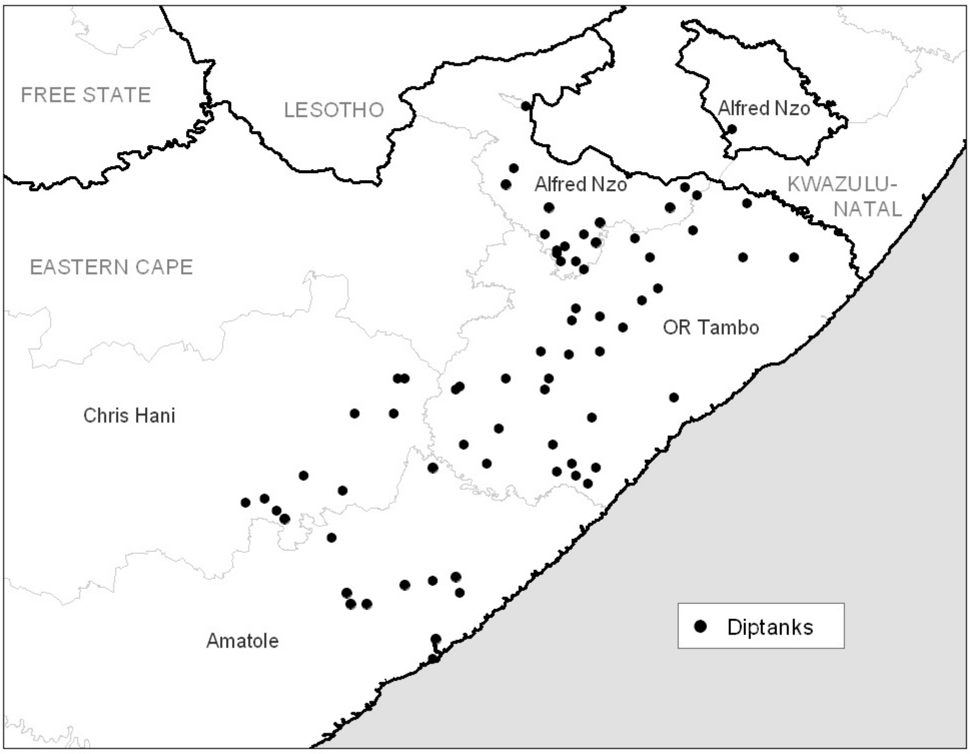


Figure 2.1: The eastern region of the Eastern Cape Province, and the communal dip-tank localities at which ticks were collected during 2004 and 2005

This region is a summer rainfall area with a high adult tick challenge during the warmer months.

### 2.2 Sample size and target animals

a) Five healthy, but visibly tick-infested cattle approximately 1 year old, belonging to five different owners at each dip-tank site.
b) Whenever available five healthy adult goats, preferably with visible tick infestations, and belonging to five different owners at each dip-tank site.
c) Five healthy dogs, preferably with visible tick infestations, at each dip-tank.

### 2.3 Sample size free-living ticks

a) Free-living ticks were collected from three by 100 m long drag-samples conducted by dragging a spar with attached flannel strips over the vegetation. The drags were not performed in the close vicinity of the dip-tank.

b) Whenever available fowl tampans were collected from two fowl houses or roosting places in the vicinity of the dip-tank. Free-living ticks were collected with the owners' consent from poultry houses or roosts while the birds were out foraging.

## 2.4 Experimental procedures

Prior arrangements were made with the district veterinary authorities and with community members through the headmen or chiefs in a particular area so that tick collections sometimes coincided with livestock inspection or dipping days. These meetings were organised by Animal Health Technicians through their Animal Health Controllers at each of the selected dip tanks. If ticks were collected on dipping days this was done prior to the animals being dipped.

### Tick collection

Sampling of parasitic ticks

A work-sheet was used to record reference information for the village and the dip-tank that serves the village. Five healthy cattle approximately 1 year of age, with visible tick infestations, were selected when possible from five different owners at each dip-tank. In most cases ticks were collected from the animals while they were confined in a dipping race. If, however, the dipping race was in a bad state of repair and the animals could break out, they were cast with ropes and laid on their sides and properly restrained before collection commenced.

Adult ticks were collected paying attention to the predilection sites of attachment of the various species; six clearly defined sites on each host animal were selected for examination because of their importance as feeding sites for the different stages of the commoner cattle ticks (Baker & Ducasse, 1967). The sites studied were as follows:

1. *Pinna*: (Site 4 of Baker & Ducasse, 1967). Both surface of one ear of each bovine were sampled. This site is important for all stages of *Rhipicephalus appendiculatus.*
2. *Neck*: (Sites 7, 8 and 6 of Baker & Ducasse, 1967). This site included the lateral surfaces of the neck, the dewlap and the mane. Both sides of each bovine were sampled. This is an important site for all the stages of *Rhipicephalus* (*Boophilus*) *decolaratus*, *Rhipicephalus* (*Boophilus*) *microplus* and *R. appendiculatus* larvae.
3. *Leg*: (Sites 9, 16 and 17 of Baker & Ducasse, 1967).This site included the axilla, leg (from elbow to fetlock) and foot (below fetlock). Both forelegs of each survey animal were sampled. This site is important for the feeding of all stages of *R.* (*B.*) *decolaratus,* nymphs and larvae of *Amblyomma hebraeum* and larvae of *R. appendiculatus*.
4. *Tail*: (Sites 14 and 15 of Baker & Ducasse, 1967). This site included the tail and tail brush, and is important for the feeding of *Rhipicephalus simus* and *A. hebraeum* adults.
5. *Upper perineum*: (Site 13 of Baker & Ducasse, 1967). This site, extending from the base of the tail to about 10 cm below the anus, is very important for the feeding of the adults of *Rhipicephalus evertsi evertsi*, *A. hebraeum and Hyalomma marginatum rufipes*.
6. *Lower perineum*: (Site 12 of Baker & Ducasse, 1967). This site, extending from below the upper perineum to the base of the scrotum, is a very important feeding site of *A. hebraeum* adults.

As the survey was aimed at determining the geographic distribution of the various tick species and not their prevalence or intensity of infestation none of the collections were intended to be complete. However, visibly infested animals were chosen to ensure the maximum collection of ticks and a good probability of collecting the more rare species. The ticks from each animal were separately preserved in 70% ethanol in a single internally labelled bottle. The label recorded the animal's identification, the dip-site at which and date on which it was sampled.

Adult ticks were collected from one side of each of five adult goats. All visible ixodid ticks were collected by means of blunt-tipped forceps from the goats after the animals had been restrained on the ground. Special care was taken to collect ticks from the legs, particularly around the claws. When dogs were available ticks were collected from five dogs with the assistance of their respective owners in order to minimise stress to the dogs as well as injuries to the researchers.

Free-living ticks

Ticks questing on the vegetation were collected by drag-sampling as described in detail by Spickett, Horak, Braack & Van Ark (1991). Ten flannel strips, each 1m long by 100mm wide, were attached adjacent to each other with Velcro tape to a 1.2m long wooden spar. A rope was attached to the ends of this spar, allowing the operator to pull it over the vegetation. At each sampling site three replicate drags of 100m approximately 50m apart were performed at every occasion at each dip-tank. The samples were not made in the immediate vicinity of the dip-tank in order to avoid the possible effects of dipping compounds that had drained from cattle that had been dipped, contaminating the vegetation and hence killing the free-living ticks. After each drag all instars of all ticks on the flannel strips were collected by means of fine-point forceps and stored in 70% ethanol in internally labelled glass vials for later identification and counting.

The presence of dew on the grass in the early mornings precluded most drags before 09:00 as the flannel strips became too wet and this would decrease their efficacy in collecting ticks. Most larvae are usually collected between 11:00 and 14:00, and fewest between 16:00 and 17:00 (Spickett & Horak 2006, personal communication). No drags were performed after 17:00.

Free-living fowl tampans were collected from cracks and crevices and from under the bark of poles in two fowl houses or roosts in the vicinity of each dip-tank. The tampans were also placed in 70 % ethanol in two separate internally labelled bottles.

### 2.5 Observations

At each collection site a pre-prepared form was filled out. This form included the name of the nearest village, the name of the farmer, geographic co-ordinates, age and sex of the animals, estimated level of tick infestation, and other relevant details.

### 2.6 Tick Identification

After collection the ticks were transported to the Döhne Agricultural Development Institute, where they were identified and counted using a stereoscope microscope. Those that could not be identified at Döhne were sent to the Department of Veterinary Tropical Diseases, Faculty of Veterinary Science, Onderstepoort, for identification by Prof I. G. Horak.

### 2.7 Sampling period

Tick collections were done during the warmer, summer months because of the greater adult tick population present during this period. Ticks were collected from January 2004 to May 2004 and collections recommenced in January 2005 and ceased during May 2005.

**Worksheets**

1. Pre-prepared descriptive forms for each collection site.

2. Pre-prepared labels for the sample bottle of each animal and animal species sampled at each collection site and for the collections of free-living ticks and tampans at each collection site.
3. Pre-prepared forms for the laboratory identification and counts of ticks collected from the animals and the vegetation at the various pre-selected tick collection sites.

These worksheets are attached as Appendices I, II and III.

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## Appendix I

**Tick Survey. O.R. Tambo; Mbizana; Ntlamvukazi Dip-Tank**

**Coordinates: ……………………………………Altitude: ………….Date: ……………**

| Animal | No. | Sex | Remarks |
|---|---|---|---|
| Calf | 1 | | |
| Calf | 2 | | |
| Calf | 3 | | |
| Calf | 4 | | |
| Calf | 5 | | |
| | | | |
| Goat | 1 | | |
| Goat | 2 | | |
| Goat | 3 | | |
| Goat | 4 | | |
| Goat | 5 | | |
| | | | |
| Dog | 1 | | |
| Dog | 2 | | |
| Dog | 3 | | |
| Dog | 4 | | |
| Dog | 5 | | |
| | | | |
| Hens | 1 | | |
| Hens | 2 | | |
| | | | |
| Drag | 1 | | |
| Drag | 2 | | |
| Drag | 3 | | |

# Appendix II

## Tick Survey. O.R. Tambo; Mbizana; Ntlamvukazi Dip-Tank

### Labels for inclusion with each collection

| | | |
|---|---|---|
| Calf 1, ORT, Mbizana, Tlamvukazi | Calf 2, ORT, Mbizana, Tlamvukazi | Calf 3, ORT, Mbizana, Tlamvukazi |
| Calf 4, ORT, Mbizana, Tlamvukazi | Calf 5, ORT, Mbizana, Tlamvukazi | |
| | | |
| Goat 1, ORT, Mbizana, Tlamvukazi | Goat 2, ORT, Mbizana, Tlamvukazi | Goat 3, ORT, Mbizana, Tlamvukazi |
| Goat 4, ORT, Mbizana, Tlamvukazi | Goat 5, ORT, Mbizana, Tlamvukazi | |
| | | |
| Dog 1, ORT, Mbizana, Tlamvukazi | Dog 2, ORT, Mbizana, Tlamvukazi | Dog 3, ORT, Mbizana, Tlamvukazi |
| Dog 4, ORT, Mbizana, Tlamvukazi | Dog 5, ORT, Mbizana, Tlamvukazi | |
| | | |
| Hens 1, ORT, Mbizana, Tlamvukazi | Hens 2, ORT, Mbizana, Tlamvukazi | |
| | | |
| Drag 1, ORT, Mbizana, Tlamvukazi | Drag 2, ORT, Mbizana, Tlamvukazi | Drag 3, ORT, Mbizana, Tlamvukazi |

# Appendix III

**Tick Survey. O.R. Tambo; Mbizana; Ntlamvukazi Dip-Tank**

**Laboratory Tick Counts, Date: ……………………..**

| Animal | No. | Sex | Tick counts |
|---|---|---|---|
| Calf | 1 | | |
| Calf | 2 | | |
| Calf | 3 | | |
| Calf | 4 | | |
| Calf | 5 | | |
| | | | |
| Goat | 1 | | |
| Goat | 2 | | |
| Goat | 3 | | |
| Goat | 4 | | |
| Goat | 5 | | |
| | | | |
| Dog | 1 | | |
| Dog | 2 | | |
| Dog | 3 | | |
| Dog | 4 | | |
| Dog | 5 | | |
| Hens | 1 | | |
| Hens | 2 | | |
| Drag | 1 | | |
| Drag | 2 | | |
| Drag | 3 | | |

# Chapter 3

## Species composition and geographic distribution of ticks in the eastern region of the Eastern Cape Province

### 3.1 INTRODUCTION

There are many published records of the exact localities at which some of the many species of ticks that occur in South Africa have been found. These records can be converted into maps, which then give an indication of where a particular species is likely to occur. However, the actual distribution of some of the more rarely collected species is probably considerably more extensive than current records or maps may indicate. On the other hand, if a frequently collected tick, with a well-mapped distribution, is found in a seemingly favourable habitat that is a long distance from the geographical area of its usual distribution, it is likely to be a recent introduction (Walker, Bouattour, Camicas, Estrada-Peña, Horak, Latif, Pegram & Preston 2003). It could be most important to verify the presence of such introductions in their new habitats to detetermine whether viable populations have become established. Popular livestock trading routes are often important clues as to where newly introduced ticks may have originated from as they can be transported great distances on infested livestock on ships, trains, trucks, or even on animals driven on foot from one region to another.

One of the criticisms of distribution maps is that they usually only indicate the presence of a species and not its absence. Thus within a map illustrating the overall distribution range of a species there are likely to be several smaller areas in which it is absent because of a locally unsuitable habitat. Furthermore, historical records of the distribution of ticks may also be inaccurate because of mistakes in the identification of species, or because the name of a tick has changed (Walker *et al*. 2003), or because of a change in climate or in land-use practice from crops to livestock.

Studies of the ecology of ticks are the tools with which we are able to analyze the properties of tick populations and to use that knowledge to design more economically efficient tick and tick-borne disease control and eradication programs (Kebede, 2004). Firstly, ecological understanding of the nature of the problem is required, and that knowledge is then used to design control strategies that are technically efficient and economically sound. Climatic favourability is the main factor that determines the geographic distribution of tick species, while a knowledge of the seasonality of a given tick species provides a means of assessing its risk to cattle production in a particular region (Walker, 1974).

Knowledge of the geographic distributions and seasonal dynamics of ticks enables us to design chemical control strategies to suit different types of cattle in different environments; to calculate the losses in productivity caused by ticks and the economic benefits of control programs of different intensity; to design integrated control programs that combine different methods in a manner that is appropriate for a particular situation; and finally, to assess the impact of the effectiveness of novel control methods (de Castro 1994).

Amongst other regions in South Africa the species composition of the ixodid tick populations parasitizing cattle, sheep, goats and wild ruminants have been determined in southern kwaZulu–Natal (Baker & Ducasse 1967, 1968; Baker, Ducasse, Sutherst & Maywald 1989; Horak, Keep, Spickett & Boomker 1989), which is a region that lies to the north-east of the present study area in the eastern region of the Eastern Cape Province. Similar studies have also been conducted to the south-west of this region in the East London and Grahamstown districts of the Eastern Cape Province (Rechav 1982; Horak, Jacot Guillarmod, Moolman & De Vos 1987b; Horak, Williams & Van Schalkwyk 1991a; Horak, Knight & Williams 1991b; Horak, Boomker, Spickett & De Vos 1992), as well as to the north-west of this region in the north-eastern, and eastern central Free State Province (Horak *et al.* 1991a; Dreyer, Fourie & Kok 1998). With the exception of the various surveys published by Theiler in the 1940s and 1950s, culminating in her monograph on the ticks of Africa south of the Sahara (Theiler 1962), and acaricide resistance studies conducted by Baker, Jordaan & Robertson (1979) and Baker (1982) no such data are available for the eastern region of the Eastern Cape Province. Although the species spectrum of ticks that do occur in this region is known (Rechav 1982; Horak *et al.* 1989), the exact geographic distributions of several are largely unknown, while those distributions that are known are based on surveys conducted more than 60 years ago (Theiler 1962). In addition a number of new species have been described since then (Walker *et al.* 2000).

The general geographic distribution of ticks in South Africa is well documented (Theiler, 1962; Howell, Walker & Nevill 1978; Walker *et al.* 2000), and the specific localities at which they have been collected in the various provinces or sub-regions of these provinces have been plotted by Theiler and her co-workers in a series of papers published in the 1940s and 50s and illustrated in map format by Howell *et al.* (1978). As mentioned above, research has been done on a number of tick species in regions surrounding or within the borders of the territory formerly referred to as the Transkei within the Eastern Cape Province (Rechav 1982, Baker 1982; Horak *et al.* 1989), but much of this data is more than 20 years old and does not cover the entire inland or coastal area of this zone.

## 3.2 MATERIALS AND METHODS

At each of the 72 dip-tanks selected for the geographic distribution survey, an attempt was made to collect ticks from five cattle, five goats, five dogs and two fowl houses, and free-living ticks from the vegetation by means of three separate drag-samples with flannel strips (See General Materials and Methods). At the same time the geographic coordinates of each dip-tank were recorded.

## 3.3 RESULTS AND DISCUSSION

### 3.3.1 Tick species and prevalence

The tick species recovered and their total numbers collected from cattle, goats, dogs, fowl houses and the vegetation are summarized in Tables 3.1 to 3.5, while Table 6 combines the results of these five tables.

TABLE 3.1: Ticks collected from 360 cattle (of which 359 were infested) at 72 dip-tanks in the eastern region of the Eastern Cape Province

| Tick species | No. of positive localities | No. of infested cattle | Stage of development | No. of ticks collected |
|---|---|---|---|---|
| *Amblyomma hebraeum* | 39 | 138 | Nymphs<br>Males<br>Females | 4<br>402<br>186 |
| *Hyalomma marginatum rufipes* | 16 | 21 | Males<br>Females | 20<br>10 |
| *Rhipicephalus* (*Boophilus*) *decoloratus* | 4 | 6 | Nymphs<br>Males<br>Females | 1<br>1<br>23 |
| *Rhipicephalus* (*Boophilus*) *microplus* | 69 | 242 | Nymphs<br>Males<br>Females | 8<br>245<br>715 |
| *Rhipicephalus appendiculatus* | 67 | 271 | Nymphs<br>Males<br>Females | 5<br>1 496<br>658 |
| *Rhipicephalus evertsi evertsi* | 72 | 316 | Nymphs<br>Males<br>Females | 31<br>1 286<br>640 |
| *Otobius megnini* | 2 | 2 | Nymphs | 4 |

TABLE 3.2: Ticks collected from 360 goats (of which 358 were infested) at 72 dip-tanks in the eastern region of the Eastern Cape Province

| Tick species | No. of positive localities | No. of infested goats | Stage of development | No. of ticks collected |
|---|---|---|---|---|
| *Amblyomma hebraeum* | 25 | 61 | Nymphs<br>Males<br>Females | 19<br>36<br>13 |
| *Hyalomma marginatum rufipes* | 2 | 2 | Males<br>Females | 2<br>0 |
| *Ixodes pilosus* group | 1 | 1 | Females | 1 |
| *Rhipicephalus* (*Boophilus*) *decoloratus* | 1 | 1 | Males<br>Females | 0<br>2 |
| *Rhipicephalus* (*Boophilus*) *microplus* | 48 | 113 | Nymphs<br>Males<br>Females | 8<br>67<br>161 |
| *Rhipicephalus appendiculatus* | 70 | 296 | Nymphs<br>Males<br>Females | 59<br>1 208<br>657 |
| *Rhipicephalus evertsi evertsi* | 72 | 334 | Nymphs<br>Males<br>Females | 41<br>1 731<br>479 |

TABLE 3.3: Ticks collected from 200 dogs (of which 132 were infested) at 40 dip-tanks in the eastern region of the Eastern Cape Province

| Tick species | No. of positive localities | No. of infested dogs | Stage of development | No. of ticks collected |
|---|---|---|---|---|
| *Amblyomma hebraeum* | 7 | 19 | Larvae<br>Nymphs<br>Males<br>Females | 16<br>34<br>5<br>1 |
| *Haemaphysalis elliptica* | 36 | 93 | Males<br>Females | 25<br>168 |
| *Haemaphysalis spinulosa* | 1 | 1 | Males | 1 |
| *Ixodes pilosus* group | 2 | 2 | Females | 2 |
| *Rhipicephalus appendiculatus* | 15 | 19 | Nymphs<br>Males<br>Females | 4<br>12<br>13 |
| *Rhipicephalus evertsi evertsi* | 2 | 2 | Males | 2 |
| *Rhipicephalus sanguineus* | 2 | 7 | Nymphs<br>Males<br>Females | 3<br>10<br>12 |
| *Rhipicephalus simus* | 14 | 29 | Males<br>Females | 23<br>31 |

TABLE 3.4: Ticks collected from 216 drag-samples taken at 72 dip-tanks in the eastern region of the Eastern Cape Province

| Tick species | No. of positive localities | No. of positive drags | Stage of development | No. of ticks collected |
|---|---|---|---|---|
| *Amblyomma hebraeum* | 2 | 5 | Larvae | 18 |
| *Haemaphysalis elliptica* | 5 | 5 | Larvae<br>Nymphs | 7<br>1 |
| *Rhipicephalus (Boophilus) decoloratus* | 25 | 48 | Larvae | 138 |
| *Rhipicephalus (Boophilus) microplus* | 63 | 158 | Larvae | 1 085 |
| *Rhipicephalus appendiculatus* | 43 | 88 | Larvae<br>Nymphs<br>Males<br>Females | 697<br>4<br>3<br>1 |
| *Rhipicephalus evertsi evertsi* | 66 | 161 | Larvae<br>Females | 1 132<br>1 |

TABLE 3.5: *Argas walkerae* collected from fowl houses and roosts in the eastern region of the Eastern Cape Province

| Tick species | No. of localities (No. positive) | No. of fowl houses (No. infested) | Stage of development | No. of ticks collected |
|---|---|---|---|---|
| *Argas walkerae* | 72 (59) | 144 (102) | Larvae<br>Nymphs<br>Males<br>Females | 14<br>170<br>266<br>149 |

Six ixodid tick species and one argasid tick were collected from the cattle (Table 3.1). Seven ixodid tick species were collected from goats (Table 3.2) and eight from dogs (Table 3.3), while six species were collected from the vegetation (Table 3.4). A single argasid tick species was collected from the fowl houses (Table 3.5). In total 11 ixodid tick species were collected from cattle, goats, dogs and the vegetation, namely *Amblyomma hebraeum*, *Haemaphysalis elliptica, Haemaphysalis spinulosa*, *Hyalomma marginatum rufipes*, *Ixodes pilosus* group, *Rhipicephalus* (*Boophilus*) *decoloratus*, *Rhipicephalus* (*Boophilus*) *microplus*, *Rhipicephalus appendiculatus*, *Rhipicephalus* *evertsi evertsi*, *Rhipicephalus sanguineus* and *Rhipicephalus simus* (Table 3.6). Four of these ticks, namely *H. elliptica*, *H. spinulosa*, *R. sanguineus,* and *R. simus* were collected only from dogs (Table 3.3). Two argasid tick species were also collected, namely *Otobius megnini* from cattle and *Argas walkerae* from fowl houses that contained wood in their structures (Tables 3.1 and 3.5).

Although total collections of ticks were not made (see General Materials and Methods), certain trends can nevertheless be discerned from the numbers of ticks collected. Of the 11 ixodid tick species recovered *R. e. evertsi* and *R. appendiculatus* were the most numerous , and constituted 38.8 % and 34.9% of the 13 768 ticks collected respectively (Table 3.6). They were followed by *R.* (*B.*) *microplus* (17.4 %) and *A. hebraeum* (5.3%). The other tick species were collected in small numbers only. The larvae of *R.* (*B.*) *microplus*, *R. e. evertsi* and *R. appendiculatus* were the most frequently recovered, mostly from the vegetation as well as a few from animals. This is probably due to the high prevalence of adult ticks of these species (Table 3.6), and the fact that the months of March to May, during which the larvae of *R. appendiculatus* are present on the vegetation (Rechav 1982), fell within the survey months of both years of the survey.

Table 3.6: The species and total number (excluding *Argas walkerae*) of ticks collected from all sources in the eastern region of the Eastern Cape Province, between January and May 2004 and 2005

| **Tick species** | **Total number of ticks collected** | | | | |
|---|---|---|---|---|---|
| | **Larvae** | **Nymphs** | **Males** | **Females** | **Total** |
| *Amblyomma hebraeum* | 34 | 57 | 443 | 200 | 734 |
| *Haemaphysalis elliptica* | 7 | 1 | 25 | 168 | 201 |
| *Haemaphysalis spinulosa* | 0 | 0 | 0 | 1 | 1 |
| *Hyalomma marginatum rufipes* | 0 | 0 | 22 | 10 | 32 |
| *Ixodes pilosus* group | 0 | 0 | 0 | 3 | 3 |
| *R. (Boophilus) decoloratus* | 138 | 1 | 1 | 25 | 165 |
| *R. (Boophilus) microplus* | 1 085 | 16 | 412 | 876 | 2 389 |
| *Rhipicephalus appendiculatus* | 697 | 72 | 2 719 | 1 329 | 4 817 |
| *Rhipicephalus evertsi evertsi* | 1 132 | 72 | 3 019 | 1 120 | 5 343 |
| *Rhipicephalus sanguineus* | 0 | 3 | 10 | 12 | 25 |
| *Rhipicephalus simus* | 0 | 0 | 23 | 31 | 54 |
| *Otobius megnini* | 0 | 4 | 0 | 0 | 4 |
| **Total** | **3 093** | **226** | **6 675** | **3 774** | **13 768** |

*Argas walkerae* was collected from 102 (70.8%) of 144 fowl houses in the vicinity of 57 (79.2%) of the 72 selected dip-tanks (Table 3.5). The tampans were found under the bark of poles, or rafters, in cracks in walls, and under nest boxes, bricks, logs and other floor debris. None of the larvae that were collected had fed, whereas several of the nymphs and adults were partially or fully engorged. Tampans seemed to be present only when there was wood in the structure of the fowl house, and few were collected from coops constructed only from stone or bricks.

## 3.4 Ixodid Ticks

### 3.4.1 Hosts and distribution

*Amblyomma hebraeum*

This tick is commonly known as the South African bont tick because of the brightly coloured conscutum of the male. The adult ticks prefer large domestic hosts such as cattle and large wild ruminants, particularly giraffes, buffaloes, elands and rhinoceroses (Horak, MacIvor, Petney & De Vos 1987a). They do, however, also infest sheep and goats (Walker *et al*. 2003). The adults and nymphs are hunters, scuttling along the ground when a suitable host is in the vicinity. The larvae quest for hosts from the vegetation and can thus be collected by drag-sampling (Petney & Horak 1987; Spickett, Horak, Braack & Van Ark 1991; Spickett, Horak, Van Niekerk & Braack 1992). In the Eastern Cape Province the larvae are most numerous on hosts in late summer and autumn, the nymphs during winter and early spring and the adults during summer (Rechav 1982; Horak *et al*. 1992). In the coastal areas of the Eastern Cape Province *A hebraeum* adults are present on cattle throughout the year, but the highest numbers are recorded during summer (Rechav 1982).

According to Howell *et al*. (1978) *A. hebraeum* is present in the bushveld and wooded savanna regions of South Africa provided there is some grass cover, from north-western North West Province, Limpopo Province and Mpumalanga Province in the north, through north-eastern and eastern KwaZulu-Natal Province in the east to Eastern Cape Province in the south-east and south. In the present study, adults of this tick were most numerous in the woodland areas in which there are trees and bush as well as grass. The tick was present at all the dip- tanks surveyed along the coast, but was also collected surprisingly far inland beyond the distribution limits illustrated for it by Howell *et al.* (1978) (Fig. 3.1). No larvae were found in habitats where shrubs or trees were either uncommon or absent. The largest numbers of the small number of larvae recovered were collected in savanna-type habitat with tall grass among trees. It would appear as if *A. hebraeum* cannot survive in open grasslands.

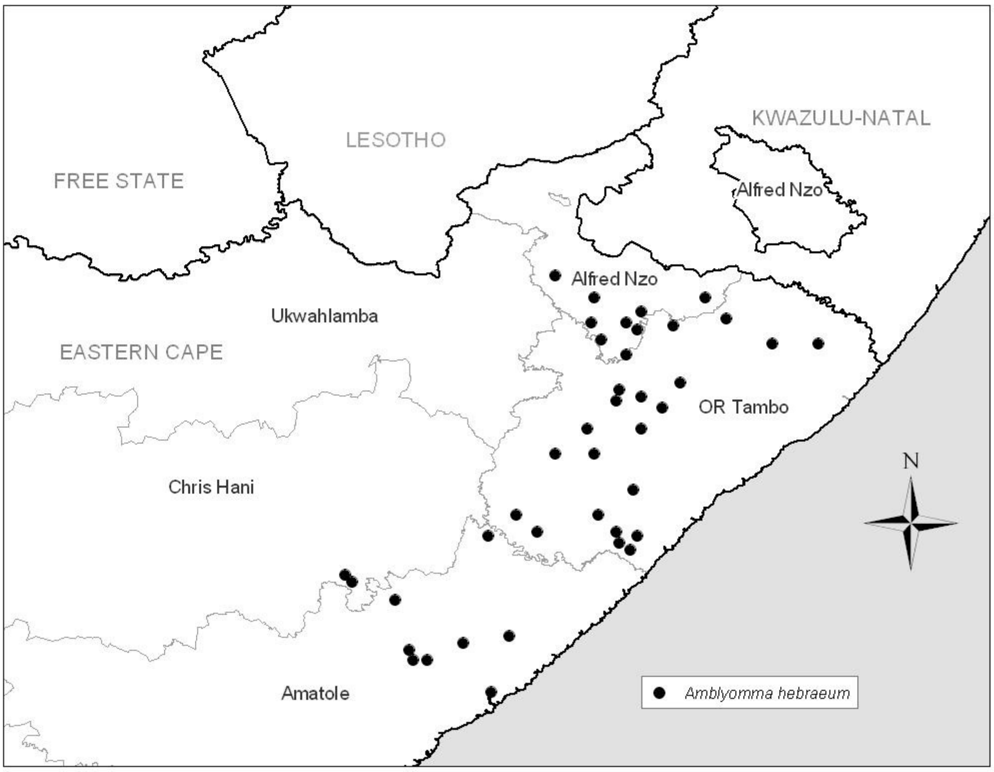


Fig 3.1: Dip-tanks at which *Amblyomma hebraeum* was collected in the eastern region of the Eastern Cape Province

*Haemaphysalis elliptica*

The common name of this tick is the yellow dog tick. Subsequent to the completion of the current survey, one of the most commonly collected ticks from dogs in southern Africa, including this survey, namely *Haemaphysalis leachi*, has been reinstated as *Haemaphysalis elliptica*, an old taxon from the Cape of Good Hope (Apanaskevich, Horak & Camicas 2007), and it this tick that was collected in the present survey.

It is a common tick on rural, free-running domestic dogs and on the larger wild felids (Horak *et al*. 1978b; Horak, Braack, Fourie & Walker 2000; Horak, Emslie & Spickett 2001). In the present survey *H. elliptica* was present on dogs at 90% of the 40 dip-tanks at which ticks were collected from dogs, and was collected from 70.4% of tick-infested dogs (Nyangiwe, Horak & Bryson 2006). Among wild animals its adults occur on the big cats and on jackals and hunting dogs, but rarely on smaller wild carnivores such as mongooses and genets (Horak *et al.* 2000). Its immature stages infest murid rodents (Norval 1984), and have been collected from these animals at several localities in South Africa (Fourie, Horak & Van Den Heever 1992; Braack, Horak, Jordaan, Segerman & Louw 1996; Petney, Horak, Howell & Meyer 2004).

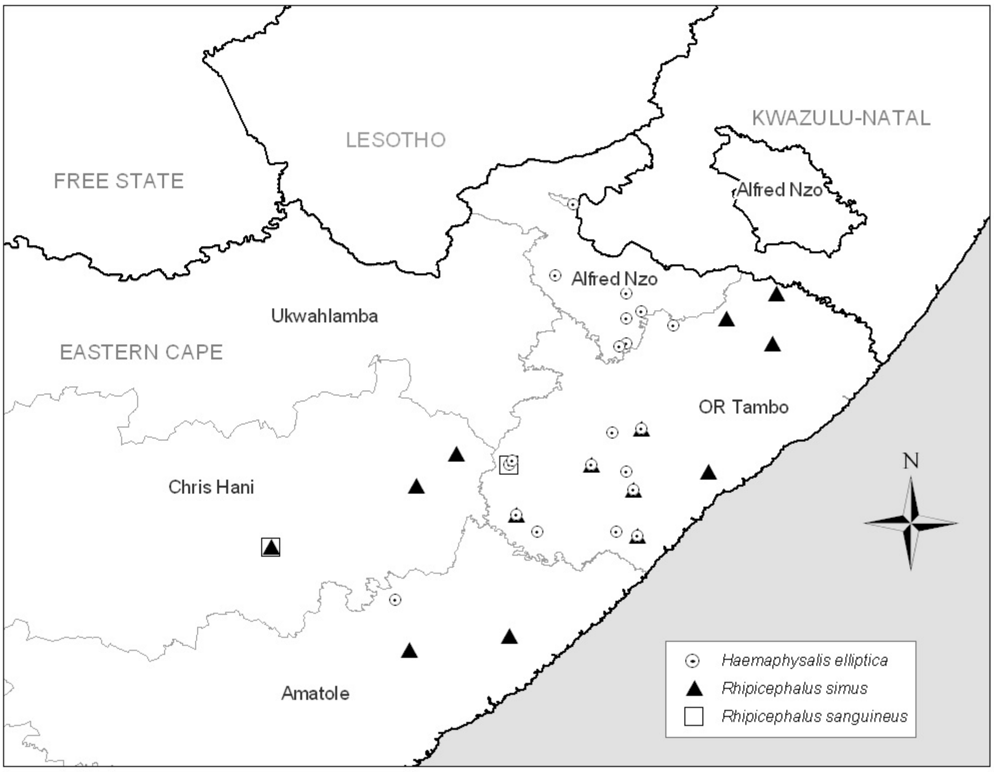


Fig 3.2: Dip-tanks at which *Haemaphysalis elliptica*, *Rhipicephalus sanguineus* and *Rhipicephalus simus* were collected in the eastern region of the Eastern Cape Province

The geographic distribution of *H. elliptica* in South Africa has been mapped by Howell *et al.* (1978), and appears to be patchy and discontinuous particularly in the western regions of the country. Norval (1984), however, believed that this tick was likely to be present at localities wherever the tick-rodent-carnivore relationship was satisfactory. The sites at which it was collected in the present survey (Fig. 3.2), all fall within its distribution range as mapped by Howell *et al.* (1978). With the exception of the southern coastal regions of the Western Cape Province, *H. elliptica* would appear to be the most numerous adult tick on dogs in coastal and adjacent inland regions from southern Mozambique in the north-east to the western regions of the Western Cape

Province in the south-west (Horak *et al.* 1987b; 2001; Horak & Matthee 2003; Neves, Afonso & Horak 2004; Fig. 3.2).

*Hyalomma marginatum rufipes*

This tick has been given the common name of the large, coarse bont-legged tick, because of the white bands surrounding each segment of its otherwise red-brown legs. The preferred hosts of the adults of this two-host tick species are large domestic animals, namely, cattle, horses, sheep and goats, and large wild animals (Horak, Swanepoel & Gummow 2002). The larvae and nymphs have been collected from hares and from several species of birds (Horak & Fourie 1991; Van Niekerk, Fourie & Horak 2006).

In general the adults of this tick are most active in summer. *H. marginatum rufipes* is the most widely distributed bont-legged tick in South Africa, occurring in the greater part of the Republic. Its distributtion in the eastern regions of the Eastern Cape Province is, however, patchy (Howell *et al.* 1978), a fact confirmed by the few ticks collected in the present survey and the patchiness of their distribution (Table 3.1; Fig. 3.3).

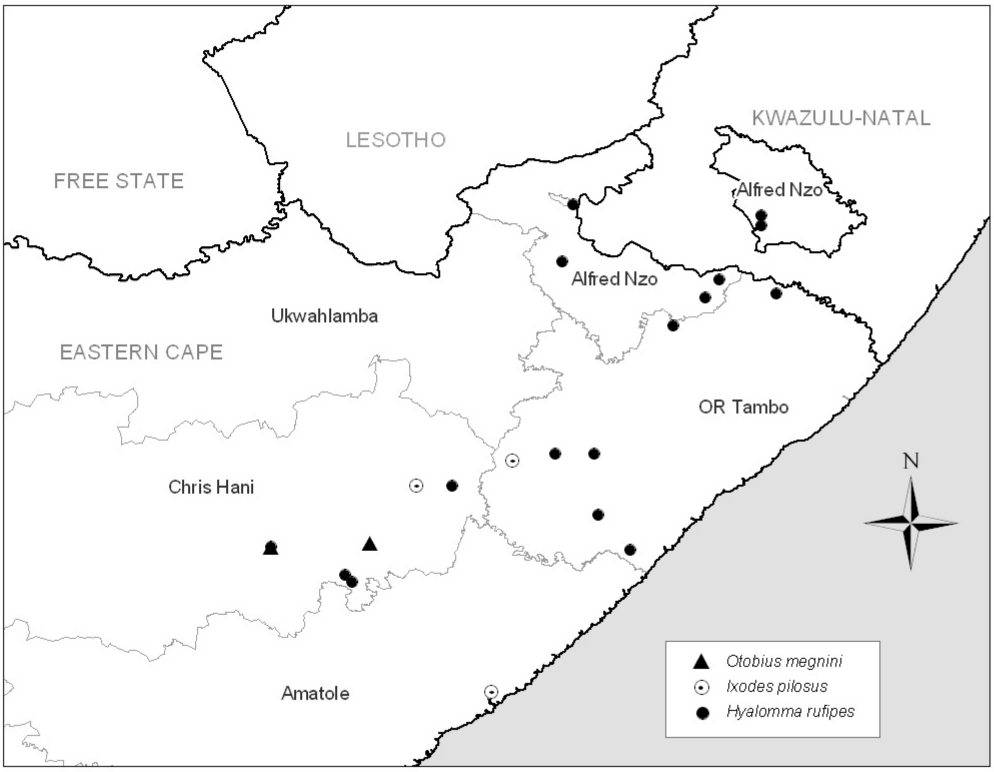


Fig 3.3: Dip-tanks at which *Hyalomma marginatum rufipes*, ticks of the *Ixodes pilosus* group, and *Otobius megnini* were collected in the eastern region of the Eastern Cape Province

Ticks of the *Ixodes pilosus group*

The preferred hosts of the adults of this three-host species are the larger domestic animals especially cattle (Walker 1991). Dogs and caracals are also subject to infestation (Horak *et al*. 1987b). The larvae and nymphs feed on the same hosts as the adults (Horak *et al*. 1987b). In the south-eastern coastal regions of the country peak adult infestation occurs in spring and early summer (Horak *et al.* 1987b). This tick is most widely distributed in the southern sourveld areas of South Africa, continuing along the coastal belt and somewhat inland in the eastern region of the Eastern Cape Province

(Howell *et al*. 1978). Two of the three collections made in the present survey are further inland than the recorded distribution of the tick in this region, while the third lies within its known coastal distribution (Howell *et al.* 1978) (Fig. 3.3).

*Rhipicephalus (Boophilus) decoloratus* and *Rhipicephalus (Boophilus) microplus*

The common names of these ticks are the African blue tick and the Asiatic blue tick because of the slaty-blue colour of the engorged females.

*Rhipicephalus (Boophilus) decoloratus*

Cattle are the main domestic hosts of *R. (B.) decoloratus*, but it also feeds on horses, donkeys, sheep, and goats and the medium-sized to large wild antelope species and zebras (Mason & Norval 1980; Walker 1991; Horak 1998). *R.* (*B.*) *decoloratus* is strictly an African tick.

*Rhipicephalus (Boophilus) microplus*

Cattle are probably the only effective hosts of this tick. Provided cattle are present, other livestock and wildlife may also be parasitized. It only feeds on other host species when infested cattle are present in the habitat (Horak, Sheppey, Knight & Beuthin 1986), but Nyangiwe & Horak (2007) have found that indigenous goats are also effective hosts and could possibly sustain infestation even in the absence of cattle.

Both species of *R. (Boophilus)* are one-host ticks, and both can complete more than one life cycle annually. In southern Africa the hatching of larvae from eggs that have overwintered is synchronised with the rise in temperature in spring, and large numbers of larvae are present on the vegetation in this season (Robertson 1981). After the spring rise the largest numbers of ticks are present on cattle in southern Africa during the summer and autumn to early winter months (Dreyer *et al.* 1998).

*Rhipicephalus (B.) decoloratus* is present in most of the moister areas of southern Africa, and it occurs in both warm lowveld and cold highveld regions of South Africa (Howell *et al.* 1978). In the generally arid territory of Namibia it is present only in localized areas in the north, and in Botswana it is restricted to the higher rainfall eastern border areas and a few scattered localities in the north. It is present in the eastern half of Zimbabwe, in Angola, much of Zambia, Malawi, south–western and northern Tanzania, Burundi, Uganda, western Kenya and in the wetter highlands and sub-highlands of Ethiopia (Norval & Horak 2004; Estrada-Peña, Bouattour, Camicas, Guglielmone, Horak, Jongejan, Latif, Pegram & Walker 2006). In much of its habitat in the hot, moist regions of several countries it would seem to have been replaced by *R.* (*B.*) *microplus*. This is supported by the present findings where even though only partial collections of ticks were made, *R.* (*B.*) *microplus* accounted for a larger proportion of the total numbers of ticks collected (17.4 %) than the 1.2% for *R* (*B.*) *decoloratus* (Table 3.6.) These findings agree with those of Tonnesen, Penzhorn, Bryson, Stoltsz & Masibigiri (2004), who recorded a seeming increase in the distribution of *R. (B.) microplus* in Limpopo Province, South Africa, at the expense of that of *R. (B.) decoloratus*.It has been postulated that *R.* (*B.*) *microplus* was introduced into East and South Africa from Madagascar, where it had originally arrived with cattle from southern Asia (Hoogstraal 1956). It is now present in probably all warm moist regions of South Africa both along the coast and inland (Howell *et al.* 1978; Tonnesen *et al.* 2004). It spread into

Zimbabwe in the 1970´s, when dipping was disrupted during the pre- independence war, and replaced *R.* (*B.*) *decoloratus* in several areas. By 1988 it had disappeared from that country, possibly because of drought and the reintroduction of dipping (Norval & Horak 2004). It is also present in the Eastern and Central Provinces of Zambia, and throughout Malawi. In Tanzania it has displaced *R.* (*B.*) *decoloratus* in several coastal and inland regions. Although *R.* (*B.*) *microplus* has been recorded in Mozambique (Dias 1991) its precise distribution is not known and recent unpublished findings indicate that it may have displaced *R.* (*B.*) *decolaratus* in extensive areas of the latter tick's probable erstwhile distribution in that country.The present study confirmed that *R.* (*B.*) *microplus* was widespread in the study area (Fig 3.4 and Fig 3.5) and that it was more common than *R.* (*B.*) *decolaratus* (Table 3.6). The findings in this survey strongly support other surveys in which the rapid spread of *R.* (*B.*) *microplus* and the displacement of *R.* (*B.*) *decolaratus* have been reported (Berkvens, Geysen, Chaka, Madder & Brandt, 1998; Tonnesen *et al.* 2004).

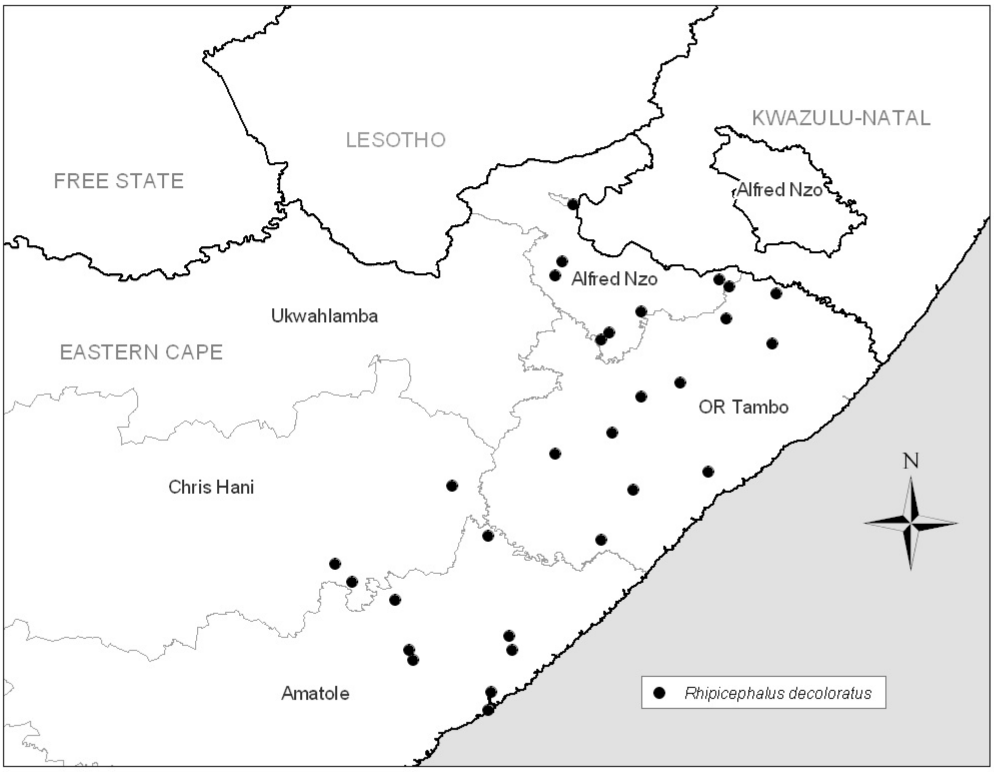


Fig 3.4: Dip-tanks at which *Rhipicephalus (Boophilus) decolaratus* was collected in the eastern region of the Eastern Cape Province

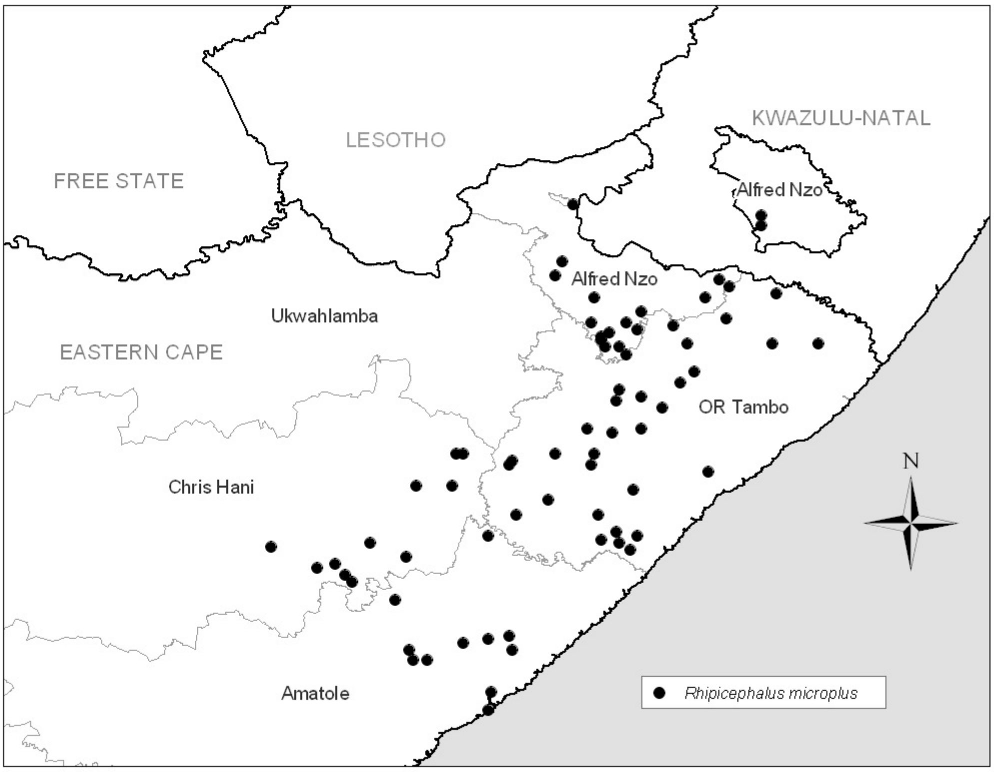


Fig 3.5: Dip-tanks at which *Rhipicephalus (Boophilus) microplus* was collected in the eastern region of the Eastern Cape Province

*Rhipicephalus appendiculatus*

The common name of this tick is the brown ear tick, because of its brown colour and the fact that the adults attach to the ears of cattle and other host species. Adult *R. appendiculatus* infest mainly cattle, but can also be found on other species including sheep, goats, and several species of wild antelope (Walker 1991; Walker *et al.* 2000). Immature ticks infest the same hosts as the adults and also scrub hares (Horak & Fourie 1991; Walker *et al.* 2000). In South Africa this three-host tick completes one life cycle per year. In the Eastern Cape Province the adults are present in summer to late summer, the larvae in autumn and winter and the nymphs in winter and spring (Rechav 1982; Horak *et al.* 1992).

*Rhipicephalus appendiculatus* is restricted to the higher rainfall eastern regions of South Africa (Howell *et al.* 1978). According to Theiler (1962), it does not occur in open grasslands without bush, but requires tall grass interspersed with trees or bush. In the present study, adults of this tick were most numerous in the woodland areas with trees and bush as vegetation cover (Figure 3.6). A significant finding, however, is that *R. appendiculatus* was present on goats at 70 and on cattle at 67 dip-tanks, and a total of 296 goats and 271 cattle were infested (Nyangiwe & Horak, 2007). Their greater prevalence on goats than on cattle has implications for the control of this tick during outbreaks of disease and more particularly theileriosis in cattle.

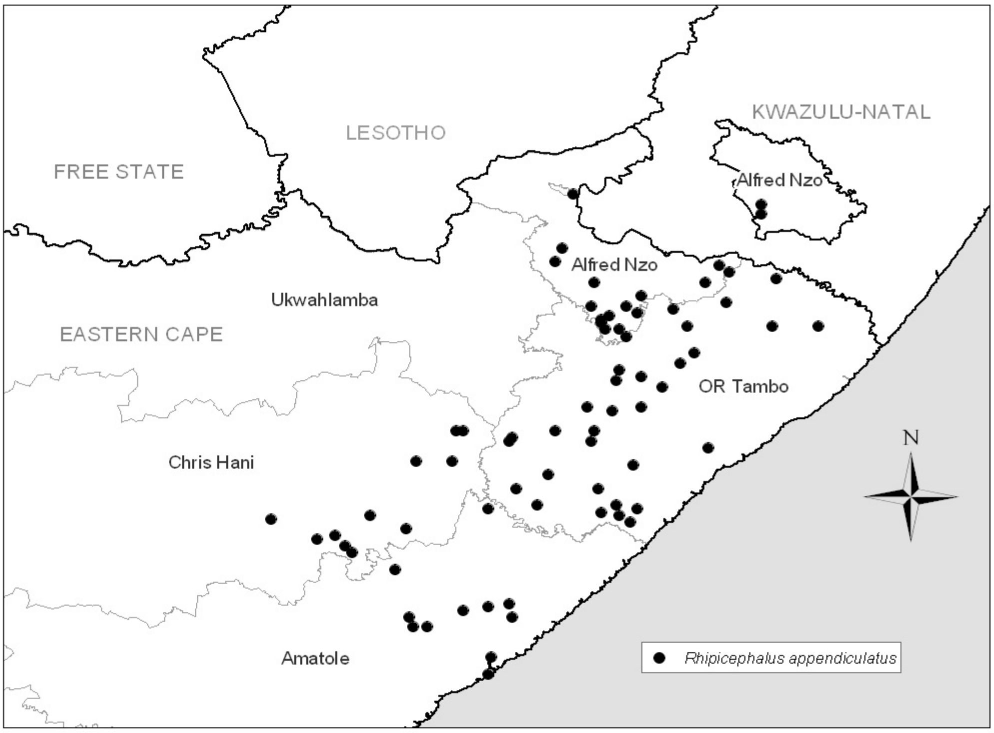


Fig 3.6: Dip-tanks at which *Rhipicephalus appendiculatus* was collected in the eastern region of the Eastern Cape Province

*Rhipicephalus evertsi evertsi*

Commonly known as the red-legged tick, because of the orange to red colour of its legs. The preferred hosts of all its parasitic life stages are domestic and wild equids, but large numbers may infest cattle, goats and sheep (Norval 1981; Walker *et al*. 2000). Baker & Ducasse (1968) collected more adult ticks from untreated cattle than from goats at five localities in KwaZulu-Natal Province, but the converse was true for goats in Mpumalanga Province (Bryson, Tice, Horak, Stewart & Du Plessis 2002a, b). Nyangiwe & Horak (2007) collected *R evertsi evertsi* from both goats and cattle at all 72 survey localities in the present survey, and a total of 334 goats compared to 316 cattle were infested with adult ticks.

This species is a two-host tick. Both immature and adult ticks are present on host animals throughout the year. Adult *R evertsi evertsi* are most active in summer, though some can be found throughout the year. This is supported by the high prevalence of this species during the collection periods of both 2004 and 2005 in the present survey (Table 3.6).

*Rhipicephalus evertsi evertsi* has the most widespread distribution of all ticks belonging to the genus *Rhipicephalus* in Africa, and also has one of the largest host ranges (Walker *et al*. 2000). It is thus not surprising that it was collected at every sampling locality from the coastal regions in the south, to the mountainous inland regions in the north and north-east (Fig. 3.7).

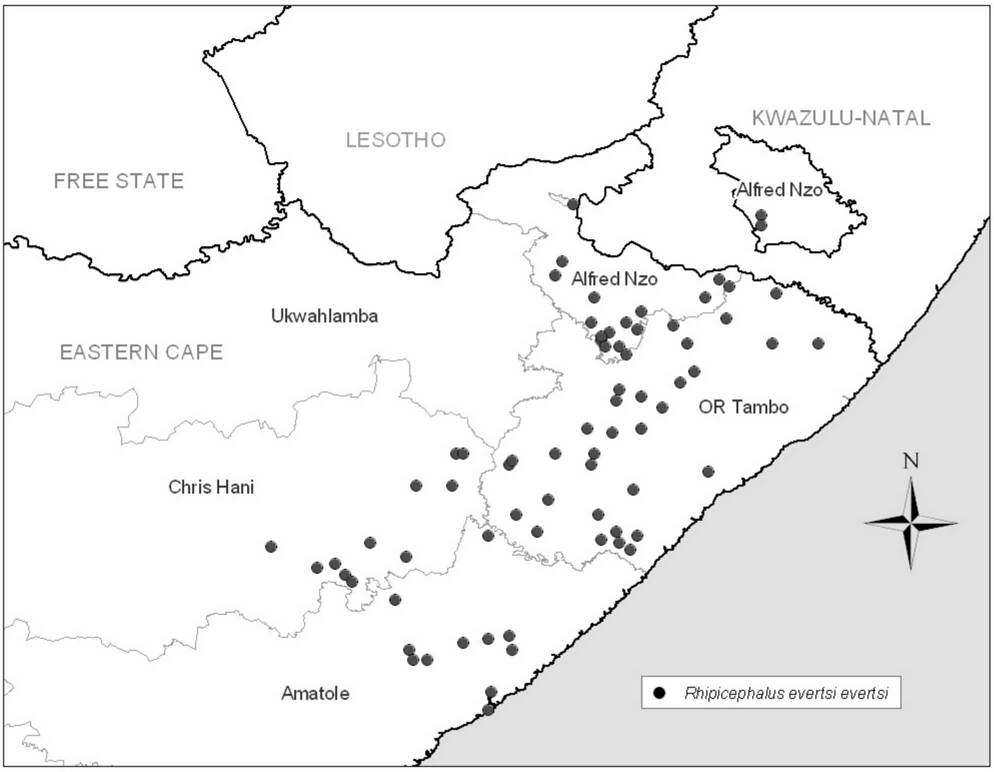


Fig 3.7: Dip-tanks at which *Rhipicephalus evertsi evertsi* was collected in the eastern region of the Eastern Cape Province

*Rhipicephalus sanguineus*

This tick is commonly known in South Africa as the kennel tick. Dogs are the preferred hosts of all stages of development of *R sanguineus* and sometimes become very heavily infested (Horak 1982). It is particularly prevalent on dogs in township or cities where the animals are confined to the properties of their owners (Bryson, Horak, Höhn & Louw 2000; Neves, Afonso & Horak 2004). The surveys indicate that caged or chained dogs or dogs owned by urban householders are more likely to be infested with *R sanguineus* than those on larger properties. No *R sanguineus* were collected from wild carnivores during country-wide surveys of these animals (Horak *et al*. 1987b, 2000).

The precise distribution of *R. sanguineus* has not been determined in South Africa, it is, however, particularly prevalent in cities or townships. Because of its association with domestic dogs and man-made structures this tick occurs in all climatic regions of Africa (Walker 1991). Its presence on dogs at two of the dip-tanks (Fig. 3.2) implies that these animals were probably chained, kennelled or caged at the homesteads of their owners at night (Nyangiwe & Horak, 2006).

*Rhipicephalus simus*

This tick is commonly known as the shiny brown tick, because of the bright shiny appearance of the conscutum of the male. Among domestic animals adult *R simus* prefer to parasitize cattle and dogs (Horak *et al.* 1987b; Walker *et al.* 2000). They also infest monogastric wild animals such as zebras, warthogs and wild carnivores (Walker *et al*. 2000). Because its immature stages infest murid rodents (Norval & Mason 1981; Braack *et al.* 1996; Walker *et al.* 2000), it is more common on free-running dogs in rural environments or on large suburban properties, where rodents are likely to be plentiful, than on city dogs (Horak *et al.* 1987b; 2001). Its preference for dogs rather than for cattle in the present study is evident in that it was collected from 29 dogs at 14 of the 53 dip-tanks at which dogs were examined, compared to none from cattle at the 72 dip-tanks at which the latter animals were examined (Nyangiwe & Horak, 2006).

*Rhipicephalus simus* is a tick of regions with a savanna type climate (Walker *et al.* 2000). It is present on dogs from southern Mozambique in the north-east to at least as far south as Grahamstown, in the Eastern Cape Province in the south-east (Horak *et al.* 1987b; 2001; Neves *et al.* 2004). Although it appears to be more common on dogs at lower altitudes (Fig. 3.2), the localities at which it was collected from dogs in the present study fall within its distribution range as mapped by Walker *et al.* (2000). In south-western Western Cape Province and in central Free State Province it is replaced on dogs and other animals by the closely-related *Rhipicephalus gertrudae* (Jacobs, Fourie, Kok & Horak 2001; Horak & Matthee 2003).

## 3.5 Argasid Ticks

### 3.5.1 Hosts and distribution

*Otobius megnini*

This tick is commonly known as the spinose ear tick because of the spiny integument of the nymph stages. Cattle, sheep, goats, horses, donkeys and mules, and sometimes cats and dogs are infested and the larvae and nymphs feed deep in their external ear canals (Howell *et al.* 1978). The adults are non-parasitic, and are not found on animals. It is most widely distributed in the arid and semi-arid areas of South Africa, and is always associated with animals that are kraaled, stabled or kennelled (Howell *et al.* 1978). Its distribution in the eastern regions of the Eastern Cape Province appears to be patchy (Howell *et al.* 1978). Only four nymphs of this species were recovered and these from two calves at two dip-tanks (Fig. 3.3).

*Argas walkerae*

The common name of this tick is the southern African fowl tampan. It infests domestic poultry, especially fowls and chickens (Howell *et al.* 1978; Norval, Short & Chisholm 1985). The larvae attach to their chicken hosts for a few days before detaching and moulting to nymphs, of which there are several stages, before moulting to adults (Howell *et al.* 1978). The nymphs and adult feed only for short periods of time during the night and spend the rest of the time hidden under bark on wooden poles in the fowl house or in other convenient cracks and crevices (Norval *et al.* 1985). Adults are most active during the summer months (Norval *et al.* 1985).

The dip-tank localities at which *A. walkerae* was collected are plotted in Fig. 3.8. To my knowledge the distribution of *A. walkerae* has not been mapped in South Africa before, but has been mapped in Zimbabwe (Norval *et al.* 1985). *A. walkerae* were collected throughout the eastern region of the Eastern Cape Province, and were present in fowl houses and roosts from the coast of the warm Indian Ocean to the high mountainous regions close to the Lesotho border where winter snow is a frequent occurrence.

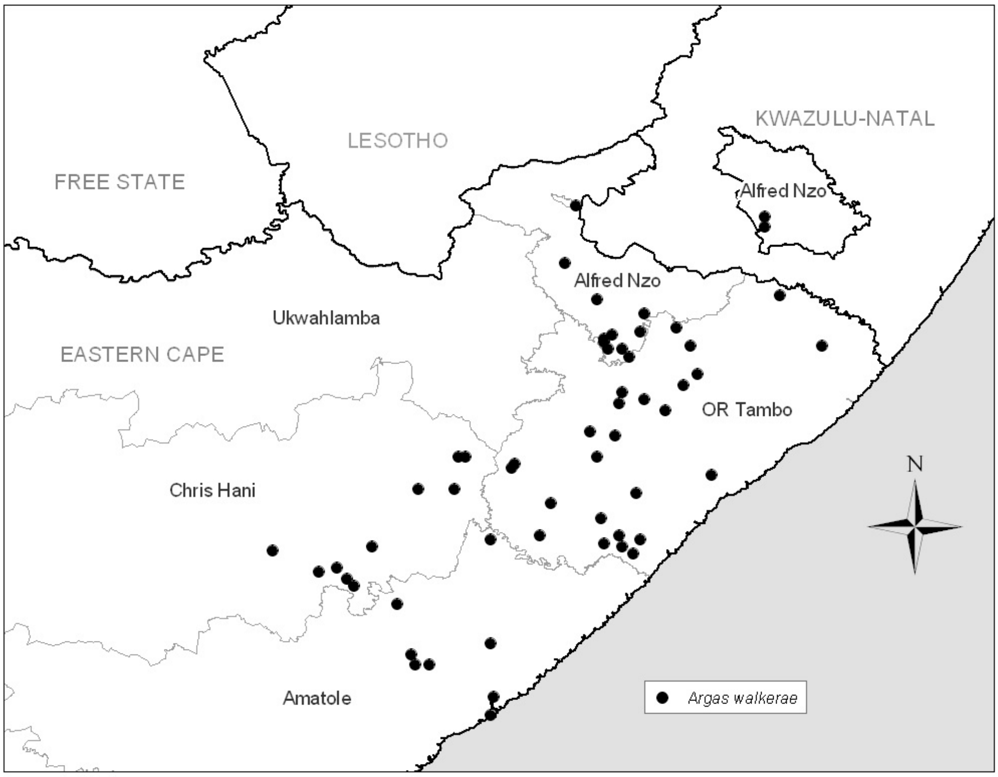


Fig 3.8: Dip-tanks close to which *Argas walkerae* was collected from fowl houses in the eastern region of the Eastern Cape Province

These findings taken in conjunction with those of Norval *et al.* (1985) imply that climate does not play an important role in determining the geographic distribution of *A. walkerae*, but rather meso-environment. Thus *A. walkerae* may be present at any locality in South Africa, in which there are domestic fowls in a rural or 'back yard' setting containing a fowl house or a roost, of which unprocessed or partially processed wood constitutes a major component, and where there is little or no chemical control.

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# Chapter 4

## Goats as alternative hosts of cattle ticks

**Comment:** This chapter has been published in its entirety in the *Ondersteppoort Journal of Veterinary Research*, and is presented here in the format required by the journal.

N. NYANGIWE[1] and I.G. HORAK[2]

**ABSTRACT**

NYANGIWE, N. & HORAK, I.G. 2007. Goats as alternative hosts of cattle ticks. *Onderstepoort Journal of Veterinary Research*, 74: 1-7.

The objective of this study was to compare the presence on goats and cattle of adult ticks that usually infest cattle. To this end ticks collected from sets of five goats were compared with those collected from sets of five cattle at 72 communal dip-tanks in the eastern region of the Eastern Cape Province. *Amblyomma hebraeum* was present on goats at 25 and on cattle at 39 dip-tanks, and a total of 61 goats and 138 cattle were infested. Adult *Rhipicephalus* (*Boophilus*) *microplus* was present on goats at 48 and on cattle at 69 dip-tanks, and a total of 113 goats and 242 cattle were infested. The lengths of 84 of 148 female *R.* (*Boophilus*) *microplus* collected from the goats exceeded 5 mm or more, indicating that they could successfully engorge on these animals. The differences between the proportions of dip-tanks at which *A. hebraeum* or *R.* (*Boophilus*) *microplus* was present on goats and cattle and also between the proportions of goats and cattle that were infested were significant (Chi-square test, P<0.01). Adult

*Rhipicephalus appendiculatus* was present on goats at 70 and on cattle at 67 dip-tanks, and a total of 296 goats and 271 cattle were infested. The proportion of dip-tanks at which cattle were infested did not differ significantly from the proportion of tanks at which goats were infested (Fischer's exact probability test, P= 0.44), but the proportion of infested cattle was significantly lower than the proportion of infested goats (Chi-square test, P<0.05). Adult *Rhipicephalus evertsi evertsi* was present on goats and cattle at all 72 sampling localities, and a total of 334 goats and 316 cattle were infested. The proportion of infested cattle was significantly lower than the proportion of infested goats (Chi-square test, P<0.05). These results underscore the necessity of including goats in any tick control programme designed for cattle at the same locality.

**Keywords:** Adult ixodid ticks, alternative hosts, *Amblyomma hebraeum*, cattle, Eastern Cape Province, goats, *Rhipicephalus* (*Boophilus*) *microplus*, *Rhipicephalus appendiculatus*, *Rhipicephalus evertsi evertsi*

[1] Döhne Agricultural Development Institute, Private Bag X15, Stutterheim, 4930 South Africa, and Department of Veterinary Tropical Diseases, Faculty of Veterinary Science, University of Pretoria, Onderstepoort, 0110 South Africa. E-mail: nkululeko.nyangiwe@agr.ecprov.gov.za

[2] Department of Veterinary Tropical Diseases, Faculty of Veterinary Science, University of Pretoria, Onderstepoort, 0110 South Africa; and Division of Parasitology, ARC-Onderstepoort Veterinary Institute, Onderstepoort, 0110 South Africa

## 4.1 INTRODUCTION

Four tick species are of major economic importance as vectors of diseases that affect domestic cattle in southern Africa. These are *Amblyomma hebraeum*, the vector of *Ehrlichia* (*Cowdria*) *ruminantium*, the cause of heartwater in cattle, sheep, goats and certain wild ruminant species (Allsopp, Bezuidenhout & Prozesky 2004), *Rhipicephalus* (*Boophilus*) *decoloratus*, the vector of *Babesia bigemina*, the cause of babesiosis or African redwater in cattle (De Vos, De Waal & Jackson 2004), *Rhipicephalus* (*Boophilus*) *microplus*, an introduced tick, which is responsible for the transmission of both *B. bigemina* and *Babesia bovis*, the latter the cause of Asiatic redwater in cattle (De Vos *et al*. 2004), and *Rhipicephalus appendiculatus*, the vector of *Theileria parva*, the cause of theileriosis in cattle (Lawrence, Perry & Williamson 2004a, b). A fifth tick, *Rhipicephalus evertsi evertsi*, which is a vector of *Babesia caballi* and *Theileria equi*, the cause of piroplasmosis in horses (De Waal & Van Heerden 2004), has a preference for horses in all its stages of development, but is also a common parasite of cattle, goats and sheep (Norval 1981; Walker, Keirans & Horak 2000).

Several surveys have been conducted on the ticks that infest cattle and goats in South Africa. Some of these have focused only on cattle (Baker & Ducasse 1967; Londt, Horak & De Villiers 1978; Schröder 1980), and others only on goats (Rechav & De Jager 1991; Boomker, Horak & Ramsay 1994; MacIvor & Horak 2003), while a third group have included both cattle and goats at the same locality and same time (Baker & Ducasse 1968; Rechav 1982; Horak, Knight & Williams 1991; Horak 1999; Bryson, Tice, Horak, Stewart & Du Plessis 2002a, b), or in tandem (Fourie & Horak 1990, 1991; Fourie, Kok & Heyne 1996).

There are no tick species that infest either of these hosts to the exclusion of the other, but whereas goats are often the hosts of large numbers of immature ticks and fewer adults (Baker & Ducasse 1968; Bryson *et al*. 2002a; MacIvor & Horak 2003), cattle may harbour large numbers of both adult and immature ticks (Baker & Ducasse 1967; Horak 1982, 1999; Rechav 1982; Bryson *et al*. 2002b). There may, however, also be considerable proportional differences in the species composition of adult ticks on goats and cattle on the same farm (Fourie *et al*. 1996). After examining goats at five localities at which cattle were also present, Baker & Ducasse (1968) came to the conclusion that goats played an important role in maintaining tick infestations on stock farms in KwaZulu-Natal Province, and that they should be included in tick control programmes applied to cattle.

The opportunity to compare the species composition of ticks on goats and cattle examined in numerically equal small groups at the same time at several localities arose during a survey on the geographic distribution of ticks in the eastern region of the Eastern Cape Province, South Africa. The objective of the present communication is to highlight the role of goats as hosts of adult ticks of species that usually infest and transmit diseases to cattle.

## 4.2 MATERIALS AND METHODS

Within the five Municipal Districts that constitute the eastern region of the Eastern Cape Province, there are 1 057 communal dip-tanks at each of which there are 200 or more cattle registered, and 75 of these dip-tanks were selected for survey purposes. At each dip-tank five healthy adult goats, preferably with visible tick infestations, and five healthy, but preferably visibly tick-infested, year-old cattle were examined. Adult ticks were collected from the ears, bodies, bellies, feet, tails and peri-anal regions of these animals on the single occasion that each dip-tank was visited. The ticks were stored in 70% ethyl alcohol in labelled vials for later identification and quantification under a stereoscopic microscope.

The length of the idiosoma of engorging female *R.* (*Boophilus*) *microplus* collected from the goats was measured and the number of maturing (also referred to as standard) females determined. The idiosomal length of a standard *R.* (*Boophilus*) *microplus* female is 4.5-8.0 mm in length and is an indication that she will fully engorge and detach within the next 24 h (Wharton & Utech 1970). The same procedure was not followed with the ticks collected from cattle because living engorging and engorged female *R.* (*Boophilus*) *microplus* were required for acaricide resistance tests. We have chosen to use the name *R.* (*Boophilus*) *microplus* as proposed by Murrell & Barker (2003) after Murrell, Campbell & Barker (2000) and Beati & Keirans (2001) had shown that the genus *Rhipicephalus* is paraphyletic with respect to the genus *Boophilus*. Many people, however, prefer to retain *Boophilus* as a generic name.

The collections of ticks from each goat or bovine were not intended to be exhaustive and consequently the numbers of ticks recovered from these animals cannot be compared. However, the presence or absence of particular tick species on the two host species as well as at the various dip-tanks can be compared. A Chi-square test was used to compare the proportion of dip-tanks at which goats were positive for each of the four tick species with the proportion of dip tanks at which cattle were positive for the same species. It was possible to sample five goats and five cattle at 72 of the 75 selected dip-tanks and consequently the presence or absence of ticks on 360 goats could be compared with that on the same number of cattle. A Chi-square test was used to compare the proportion of positive goats to the proportion of positive cattle for each of the tick species, and Wilcoxon's signed rank test for matched pairs was used to compare the difference between the number of infested goats and the number of infested cattle at each dip-tank.

For comparative purposes the numbers of ticks collected from goats and cattle during previous surveys conducted at various localities in South Africa have been summarized and presented in tabular format.

## 4.3 RESULTS

*Amblyomma hebraeum* was present on goats at 25 and on cattle at 39 dip-tanks, and a total of 61 goats and 138 cattle were infested (Fig. 4.1). The proportion of dip-tanks at which goats were infested differed from the proportion of tanks at which infested cattle were present (Chi-square test, $P<0.05$). The proportion of cattle infested with *A. hebraeum* was higher than the proportion of goats (Chi-square test, $P<0.01$), and the median of the difference between the number of infested cattle and infested goats was greater than zero ($P<0.01$).

*Rhipicephalus* (*Boophilus*) *microplus* was present on goats at 48 and on cattle at 69 dip-tanks, and a total of 113 goats and 242 cattle were infested (Fig. 4.1). The proportion of dip-tanks at which goats were infested differed from the proportion of tanks at which infested cattle were present (Chi-square test, $P<0.01$). The proportion of infested cattle was higher than the proportion of infested goats (Chi-square test, $P<0.01$), and the median of the difference between the number of infested cattle and infested goats was greater than zero (P<0.01). One hundred and forty-eight female *R.* (*Boophilus*) *microplus* that had been collected from the goats were measured and 84 of these were 5 mm or more in length, implying that they would probably engorge and detach within the next 24 h.

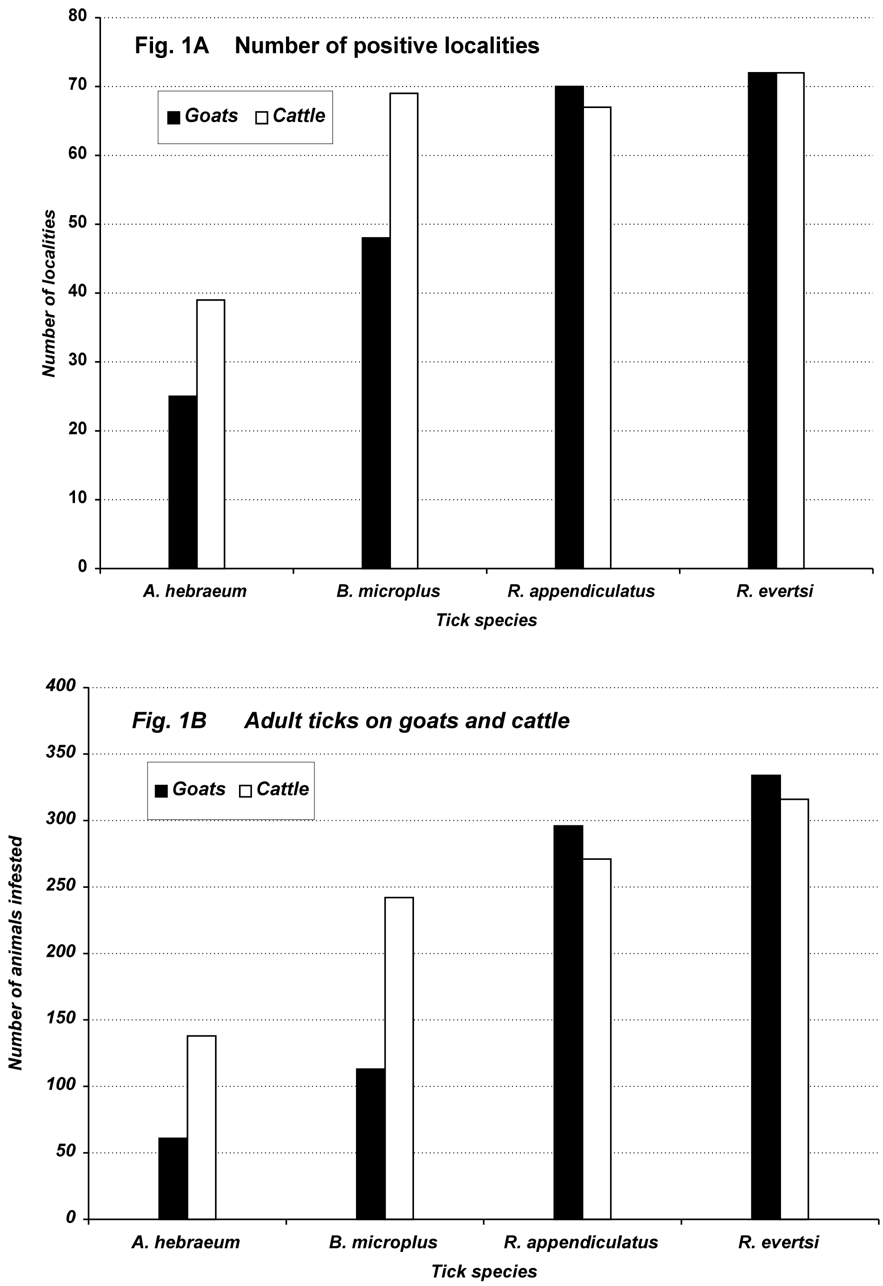


Fig. 4.1: The numbers of (A) dip-tanks at which *Amblyomma hebraeum*, *Rhipicephalus* (*Boophilus*) *microplus*, *Rhipicephalus appendiculatus* and *Rhipicephalus evertsi evertsi* were present on goats and cattle, and the total numbers of (B) goats and cattle on which these ticks were present at 72 dip-tanks in the eastern region of the Eastern Cape Province, South Africa

*Rhipicephalus appendiculatus* was present on goats at 70 and on cattle at 67 dip-tanks, and a total of 296 goats and 271 cattle were infested. The proportion of dip-tanks at which goats were infested did not differ from the proportion of tanks at which cattle were infested (Fischer's exact probability test, P= 0.44). However, the proportion of cattle infested was lower than the proportion of goats (Chi-square test, $P<0.05$), and the median of the difference between the number of infested cattle and infested goats was equal to zero (P=0.1).

*Rhipicephalus evertsi evertsi* was present on goats and cattle at all 72 dip-tanks, and a total of 334 goats and 316 cattle were infested (Fig. 4.1). The proportion of infested cattle was lower than the proportion of infested goats (Chi-square test, $P<0.05$), and the median of the difference between the number of infested cattle and of infested goats was less than zero ($P<0.05$).

TABLE 4.1: Numbers of ticks collected in previous surveys from goats and cattle examined at the same localities in various provinces of South Africa

| Province and Tick species | Total No. of adult ticks (total No. of collections) | |
|---|---|---|
| | **Goats** | **Cattle** |
| **KwaZulu-Natal Province[1]** | **Untreated** | **Untreated** |
| *Amblyomma hebraeum* | 26 (10) | 312 (20) |
| *Rhipicephalus (Boophilus) microplus* | 266 (all stages) (9) | 32 692 (all stages) (18) |
| *Rhipicephalus appendiculatus* | 179 (39) | 782 (70) |
| *Rhipicephalus evertsi evertsi* | 184 (48) | 662 (88) |
| **Eastern Cape Province[2]** | **Untreated, but ran with a treated herd** | **Untreated in previous 5 weeks** |
| *Amblyomma hebraeum* | 16 (48) | 1 092 (46) |
| *Rhipicephalus appendiculatus* | 60 (48) | 1 244 (46) |
| *Rhipicephalus evertsi evertsi* | 3 (48) | 74 (46) |
| **North West Province[3]** | **Untreated** | **Untreated in previous 7 days** |
| *Amblyomma hebraeum* | 90 (123) | 3 461 (141) |
| *Rhipicephalus appendiculatus* | 38 (123) | 1 387 (141) |
| *Rhipicephalus evertsi evertsi* | 226 (123) | 836 (141) |
| **Mpumalanga Province[3]** | **Untreated** | **Untreated in previous 7 days** |
| *Amblyomma hebraeum* | 6 (30) | 72 (36) |
| *Rhipicephalus appendiculatus* | 32 (30) | 38 (36) |
| *Rhipicephalus evertsi evertsi* | 404 (30) | 37 (36) |
| **Free State Province[4]** | **Untreated** | **Untreated** |
| *Hyalomma marginatum rufipes* | 41 (750) | 2 598 (397) |
| *Hyalomma truncatum* | 72 (750) | 270 (397) |
| *Ixodes rubicundus* | 2 052 (750) | 4 565 (397) |
| *Rhipicephalus evertsi evertsi* | 3 (750) | 197 (397) |
| *Rhipicephalus warburtoni* | 3 782 (750) | 562 (397) |

[1] Baker & Ducasse (1968);

[2] Horak *et al*. (1991) and Horak (1999);

[3] Bryson *et al*. (2002a, b);

[4] Fourie & Horak (1990, 1991) and Fourie *et al*. (1996)

With the exception of Free State Province, in which certain species of ticks collected from goats and cattle differed considerably from those on goats and cattle examined in other provinces, the same three or four major species were collected at most localities (Table 4.1). Apart from *R. evertsi evertsi* on goats in Mpumalanga Province, and *Rhipicephalus warburtoni* on goats in Free State Province, cattle examined at the same localities as goats invariably harboured more adult ticks than did goats that were infested with the same species.

## 4.4 DISCUSSION

Horak, MacIvor, Petney & De Vos (1987) concluded that the larger the host species the greater the likelihood that it would harbour large numbers of adult *A. hebraeum*, and this was confirmed by the present findings. In ten collections made over a period of 1 year from a goat in Thornveld in KwaZulu-Natal, Baker & Ducasse (1967) recovered a total of 26 adult *A. hebraeum*. The total number collected from two calves sampled at the same times as the goat at the same locality, where no stock had been dipped in an acaricide for the previous 6 years, was 312 adult ticks (Table 4.1). Horak, Knight & Williams (1991) collected a total of 16 adult ticks from 48 adult Angora goats that were slaughtered in pairs at monthly intervals on a farm in Valley Bushveld in the Eastern Cape Province. Forty-six young cattle that were also slaughtered in pairs at monthly intervals at the same locality as the goats, were infested with a total of 1 092 adult *A. hebraeum*. Goats can, however, harbour larger numbers of adult ticks of this species and Rechav & De Jager (1991) recovered approximately 1 160 adult ticks in 220 collections made from goats over a period of 22 months in Limpopo Province. MacIvor & Horak

(2003) collected totals of 387 and 214 adult ticks from 24 Angora and 24 of Boer goats respectively that were each slaughtered in pairs at monthly intervals on a farm in Valley Bushveld in the Eastern Cape Province.

*Rhipicephalus* (*Boophilus*) *microplus* uses cattle as hosts and is usually only found on other animals provided infested cattle are present at the same locality. Baker & Ducasse (1967) recovered a total of 266 ticks in all stages of development in nine consecutive collections from a goat, while the total yield of nine collections from two calves at the same locality was 32 692 ticks (Table 4.1). Mason & Norval (1980) recorded 81 collections of *R.* (*Boophilus*) *microplus* from cattle and a single collection each from a goat and a horse during the National Tick Survey conducted in Zimbabwe. Horak, Sheppey, Knight & Beuthin (1986) recovered *R.* (*Boophilus*) *microplus* from a grey rhebok, *Pelea capreolus*, grazing with cattle outside the Bontebok National Park near Swellendam in the Western Cape Province, South Africa, but not one of 59 of these antelopes examined inside the park, where no cattle are permitted, was infested (Horak *et al*. 1986; Horak & Boomker 1998).

The recovery of *R.* (*Boophilus*) *microplus* from goats at so many localities in the present study can be ascribed to the high prevalence of infestation on cattle at the same dip-tanks (Fig. 4.1), and to the fact that questing *R.* (*Boophilus*) *microplus* larvae were collected from the vegetation at 62 of the 72 survey sites (Nyangiwe & Horak, unpublished data 2006). A more significant finding, however, is the large proportion of female ticks 5 mm or more in length collected from the goats. This is a good indication that the ticks were successfully completing their life cycles on the goats and could perhaps even do so in the absence of infested cattle to replenish their infestations. If this is so, a further adaptation to several wildlife species, particularly bushbuck, *Tragelaphus scriptus* and greater kudus, *Tragelaphus strepsiceros*, that share much of their habitat with goats in the Eastern Cape Province, and are excellent hosts of the closely related *R.* (*Boophilus*) *decoloratus* (Horak, Potgieter, Walker, De Vos & Boomker 1983; Horak, Boomker, Spickett & De Vos 1992), may be imminent.

Minimum temperature requirements for *R.* (*Boophilus*) *microplus* in Africa are approximately 4°C lower than those required by the same species in South America, and in contrast to ticks in the latter region, African *R.* (*Boophilus*) *microplus* can withstand periods of low rainfall during the winter months (Estrada-Peña, Bouattour, Camicas, Guglielmone, Horak, Jongejan, Latif, Pegram & Walker 2006). Moreover, crossbreeding experiments between South African and Australian *R.* (*Boophilus*) *microplus* resulted in hybrid sterility (Spickett & Malan 1978), indicating additional mutations in South African *R.* (*Boophilus*) *microplus*. An adaptation by this tick to a new host species may thus not be an unrealistic expectation.

Domestic cattle and large herbivores such as greater kudus and male nyalas, *Tragelaphus angasii*, are hosts favoured by *R. appendiculatus* (Baker & Ducasse 1967; Horak 1982; Horak *et al.* 1992; Horak, Boomker & Flamand 1995). Horak *et al.* (1991) collected a total of only 60 adult ticks from 48 adult Angora goats, while 46 young cattle on the same farm harboured a total of 1 244 adult *R. appendiculatus* (Table 4.1). Twenty-five greater kudus examined on the farm and on an adjacent nature reserve harboured a total of 604 adult ticks (Horak *et al.* 1992). Although the actual numbers of ticks collected from goats and from cattle in the present study cannot be compared, 25 more goats at three more localities than cattle were infested with adult ticks.

*Rhipicephalus evertsi evertsi* has the most widespread distribution of all ticks belonging to the genus *Rhipicephalus* in Africa, and also has one of the largest host ranges (Walker *et al*. 2000). The preferred hosts of all its parasitic life stages are domestic and wild equids, but large numbers may infest cattle, goats and sheep (Norval 1981; Walker *et al*. 2000). Baker & Ducasse (1968) collected more adult ticks from untreated cattle than from goats at five localities in KwaZulu-Natal Province, but the converse was true for goats in Mpumalanga Province (Bryson *et al.* 2002a; Table 4.1). In the present study ticks were collected from both goats and cattle at all 72 survey localities, but a total of 334 goats compared to 316 cattle were infested with adult ticks (Fig. 4.1).

## 4.5 CONCLUSIONS

The results of this study indicate that goats are good hosts of most of the economically important ticks that infest cattle, and that *R.* (*Boophilus*) *microplus*, which has previously been considered a cattle tick, may be in the process of adapting to goats. In the light of these findings it is imperative to include goats in any tick control programme applied to sympatric cattle.

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# Chapter 5

## Ixodid ticks on dogs in the eastern region of the Eastern Cape Province, South Africa

**Comment:** This chapter has been published in its entirety in the *Onderstepoort Journal of Veterinary Research* as a Research Communication, and is presented here in the format required by the journal. Since its publication, however, it has been established that the tick referred to as *Haemaphysalis leachi* in South Africa is in fact *Haemaphysalis elliptica* as originally described from the Cape of Good Hope by Koch in 1844.

N. Nyangiwe[1]*, I.G. Horak[2] and N.R. Bryson[3]

**ABSTRACT**

NYANGIWE, N., HORAK, I.G. & BRYSON, N.R. 2006. Ixodid ticks on dogs in the eastern region of the Eastern Cape Province, South Africa. *Onderstepoort Journal of Veterinary Research*, 73:305-309.

The objective of this study was to determine the species composition and geographic distribution of ixodid ticks infesting domestic dogs in the eastern region of the Eastern Cape Province. Seventy-two communal cattle dip-tanks within this region were randomly selected as survey localities and their geographic coordinates recorded. In addition to ticks that were collected from five cattle and five goats at each of the dip-tanks, ticks were also collected from five dogs whenever possible. No dogs were available at 19 dip-tanks and no ticks were collected from dogs at 13 dip-tanks, while ticks were collected from 132 of 200 dogs at 40 dip-tanks. Eight ixodid tick species were collected from these dogs, and *Haemaphysalis elliptica* followed by *Rhipicephalus appendiculatus* and *Rhipicephalus simus* were present on dogs at the largest number of dip-tanks. Seven dogs were simultaneously infested with three tick species and one with four species. The geographic distributions of *Amblyomma hebraeum*, *H. elliptica*, *R. appendiculatus* and *R. simus* recovered from the dogs lay within the ranges previously reported for these ticks.

**Keywords:** *Amblyomma hebraeum,* dogs, Eastern Cape Province, geographic distribution *Haemaphysalis elliptica,* ixodid ticks, *Rhipicephalus appendiculatus, Rhipicephalus simus*,

species composition.

* Author to whom correspondence is to be directed: E-mail:

nkululeko.nyangiwe@agr.ecprov.gov.za

1 Döhne Agricultural Development Institute, Private Bag X15, Stutterheim, 4930 South Africa, and Department of Veterinary Tropical Diseases, Faculty of Veterinary Science, University of Pretoria, Onderstepoort, 0110 South Africa

2 Department of Veterinary Tropical Diseases, Faculty of Veterinary Science, University of Pretoria, Onderstepoort, 0110 South Africa, and Division of Parasitology, ARC-Onderstepoort Veterinary Institute, Onderstepoort, 0110 South Africa

3 Department of Veterinary Tropical Diseases, Faculty of Veterinary Science, University of Pretoria, Onderstepoort, 0110 South Africa

## 5.1 INTRODUCTION

Six surveys on the ticks that infest dogs have been conducted in South Africa and a total of 23 ixodid and one argasid tick species have been recovered from these animals (Horak, Jacot Guillarmod, Moolman & De Vos 1987b; Horak 1995; Bryson, Horak, Höhn & Louw 2000; Horak, Emslie & Spickett 2001; Jacobs, Fourie, Kok & Horak 2001; Horak & Matthee 2003). Furthermore the seasonal occurrence of five species, namely *Haemaphysalis elliptica*, ticks of the *Ixodes pilosus* group, *Rhipicephalus gertrudae, Rhipicephalus sanguineus* and *Rhipicephalus simus* has been determined on dogs or wild carnivores (Horak 1982; Horak *et al*. 1987b; 2001; Jacobs *et al.* 2001; Horak & Matthee 2003). With the exception of *R. sanguineus*, the geographic distributions of the above-mentioned ticks have been mapped (Howell, Walker & Nevill 1978; Walker, Keirans & Horak 2000). These five tick species, plus *Ixodes rubicundus*, all regularly use dogs as hosts. All developmental stages of ticks of the *I. pilosus* group and *R. sanguineus* use dogs, whereas the immature stages of the remaining four species infest rodents or elephant shrews, and the adults' dogs or other animals (Norval & Mason 1981; Norval 1984; Horak *et al*. 1987b; Jacobs *et al*. 2001; Fourie, Horak & van den Heever 1992).

During a more comprehensive survey on the ticks infesting domestic animals in the eastern region of the Eastern Cape Province dogs were also examined. This region has a seaboard of approximately 250 km and rises from the Indian Ocean to a height of approximately 2 000 m above sea level. The vegetation along the coast is described as Coastal Forest and Thornveld, adjacent to this in the west lies a strip of vegetation described as Eastern Province Thornveld and in the east a strip described as Ngongoni Veld. With the exception of ribbons of Valley Bushveld along the rivers, the inland vegetation, including that in the mountainous north, is described as Highland Sourveld (Acocks 1988).

## 5.2 MATERIALS AND METHODS

Ninety out of a total of 1 057 communal cattle dip-tanks in this region were selected by means of a table of random numbers, and 72 of these were eventually allocated to the survey. In addition to the ticks that were collected from five cattle and five goats at each of the dip-tanks, ticks were collected from five dogs whenever possible. To minimize stress to the dogs as well as injuries to the researchers the ticks were collected from the dogs by their owners. The ticks were stored in 70 % ethyl alcohol in labelled vials for later identification and counting and, together with the geographic coordinates of the dip-tanks at which they were collected, constitute the principal components of this communication.

## 5.3 RESULTS AND DISCUSSION

No dogs were available at 19 of the dip-tanks and no ticks were collected from 65 dogs examined at 13 dip-tanks. Two hundred dogs were examined at the remaining 40 dip-tanks and 132 of these animals were infested. A total of eight ixodid tick species was collected and *H. elliptica*, followed by *Rhipicephalus appendiculatus* and *R. simus* were present on dogs at the largest number of dip-tanks (Table 5.1). Three of the eight tick species, namely *Amblyomma hebraeum, R. appendiculatus and Rhipicephalus evertsi*

*evertsi* are ticks of cattle and their presence on dogs reflects the abundance of the former animals as well as the ticks that infest them in the region. The remaining five species are ticks that usually or frequently infest dogs or wild carnivores (Norval & Mason 1981; Norval 1984; Horak *et al.* 1987b; Jacobs *et al*. 2001). Two of these, namely ticks of the *I. pilosus* group and *R. simus,* also infest cattle (Howell *et al*. 1978; Walker *et al.* 2000). Twenty-eight of the dogs were simultaneously infested with two species of ticks, seven with three and one with four species.

The small number of ticks collected and the low percentage of dogs infested is rather surprising as it is unlikely that any of them had been treated with an acaricide. The difficulty in controlling a suspicious, frightened rural dog while trying to collect ticks from it might have contributed to this result.

Although adult *A. hebraeum* prefer large herbivorous animals (Norval 1983; Horak, MacIvor, Petney & De Vos 1987a), its immature stages, and more particularly larvae, infest a large variety of hosts including large and small herbivores, carnivores and birds (Norval 1983; Horak *et al*. 1987a; Horak, Braack, Fourie & Walker 2000). In all surveys conducted on domestic dogs in those regions of South Africa in which *A. hebraeum* is present it has always been collected from these animals (Horak *et al*. 1987b; 2001; Horak 1995; Bryson *et al*. 2000) (Fig. 5.1a).

*H. elliptica* was not only present on dogs at 90 % of the 40 dip-tanks at which ticks were collected, but was collected from 70.4 % of tick-infested dogs (Table 5.1). It is a common tick on rural, free-running domestic dogs and on the larger wild felids (Horak *et al*. 1987b; 2000; 2001). Its immature stages infest murid rodents (Norval 1984), and have been collected from these animals in the north-east, south-east, south-west and central regions of South Africa (Horak, Sheppey, Knight & Beuthin 1986; Fourie *et al*. 1992; Braack, Horak, Jordaan, Segerman & Louw 1996; Petney, Horak, Howell & Meyer 2004; Horak, Fourie & Braack 2005).

The geographic distribution of *H. elliptica* in South Africa has been mapped by Howell *et al*. (1978), and appears to be patchy and discontinuous particularly in the western regions. Norval (1984), however, believed that this tick was likely to be present at localities wherever the tick-rodent-carnivore relationship was satisfactory. The sites at which it was collected in the present survey (Fig. 5.1b), all fall within its distribution range as mapped by Howell *et al.* (1978). With the exception of the southern coastal regions of the Western Cape Province, *H. elliptica* would appear to be the most numerous adult tick on dogs in coastal and adjacent inland regions from southern Mozambique in the north-east to the western regions of the Western Cape Province in the south-west (Horak *et al.* 1987b; 2001; Horak & Matthee 2003; Neves, Afonso & Horak 2004) (Fig. 5.1b).

TABLE 5.1: Ticks collected from 200 dogs (of which 132 were infested) at 40 localities in the eastern region of the Eastern Cape Province, South Africa

| Tick species | No. of localities | No. of dogs infested | Stage of development | No. of ticks |
|---|---|---|---|---|
| *Amblyomma hebraeum* | 7 | 19 | Larvae | 16 |
| | | | Nymphs | 34 |
| | | | Males | 5 |
| | | | Females | 1 |
| *Haemaphysalis elliptica* | 36 | 93 | Males | 25 |
| | | | Females | 168 |
| *Haemaphysalis spinulosa* | 1 | 1 | Males | 1 |
| *Ixodes pilosus* group | 2 | 2 | Females | 2 |
| *Rhipicephalus appendiculatus* | 14 | 19 | Nymphs | 4 |
| | | | Males | 12 |
| | | | Females | 13 |
| *Rhipicephalus evertsi evertsi* | 2 | 2 | Males | 2 |
| *Rhipicephalus sanguineus* | 2 | 7 | Nymphs | 3 |
| | | | Males | 10 |
| | | | Females | 12 |
| *Rhipicephalus simus* | 14 | 29 | Males | 23 |
| | | | Females | 31 |

All stages of development of *I. pilosus* group ticks have been collected from dogs and caracals, *Caracal caracal*, in the central coastal and adjacent inland regions of the Eastern Cape Province (Horak *et al*. 1987b). Its presence on two dogs in the more eastern regions of this province is thus not unexpected.

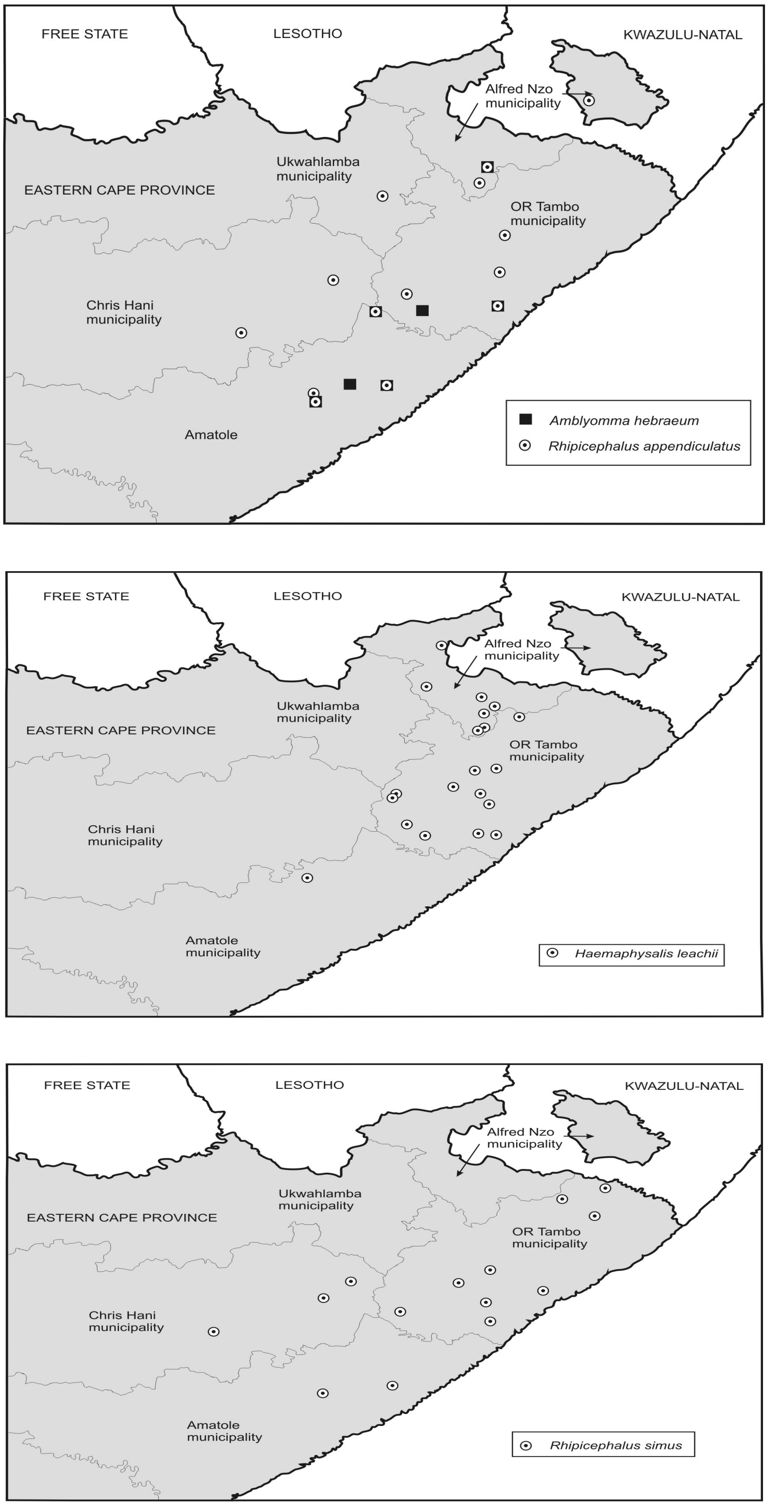


Fig.5.1: Localities at which (A) *Ambylomma hebreaum* and *Rhipicephalus appendiculatus*, (B) *Haemaphysalis elliptica,* and (C) *Rhipicephalus simus* were present on dogs in the eastern region of the Eastern Cape Province, South Africa

Although *R. appendiculatus* is essentially a tick of cattle and large wild bovids (Walker *et al.* 2000), it is not infrequently encountered in all its developmental stages on dogs and on wild carnivores (Horak *et al.* 1987b; 2000; 2001, Bryson *et al.* 2000). Its recovery from cattle or from the vegetation at all 72 dip-tanks at which cattle were examined is proof of the tick's abundance in this region and it is consequently not unusual that several dogs were infested. The dip-tanks at which *R. appendiculatus* was recovered from dogs all lie within the previously plotted distribution range of this tick (Howell *et al*. 1978; Walker *et al*. 2000) (Fig 5.1a).

All stages of development of *R. sanguineus* infest dogs (Walker *et al.* 2000), and its life cycle is adapted to man-made structures such as human dwellings, dog kennels or cages (Howell *et al.* 1978; Horak 1982). It is particularly prevalent on dogs in townships or cities where the animals are confined to the properties of their owners (Bryson *et al.* 2000; Neves *et al.* 2004). Its presence on dogs at two of the dip-tanks implies that these animals were probably chained, kennelled or caged at the homesteads of their owners at night.

Adult *R. simus* infests monogastric animals such as zebras, *Equus* spp., warthogs *Phacochoerus africanus*, and domestic and wild carnivores and also cattle (Walker *et al*. 2000). Because its immature stages infest murid rodents (Norval & Mason 1981; Braack *et al.* 1996; Walker *et al.* 2000), it is more common on free-running dogs in rural environments or on large suburban properties, where rodents are likely to be plentiful, than on city dogs (Horak *et al.* 1987b; 2001). Its preference for dogs rather than for cattle in the present study is evident in that it was collected from 29 dogs at 14 of the 53 dip-tanks at which dogs were examined, compared to none from cattle at the 72 dip-tanks at which the latter animals were examined.

*R. simus* is present on dogs from southern Mozambique in the north-east to at least as far as Grahamstown, Eastern Cape Province in the south-east (Horak *et al.* 1987b; 2001; Neves *et al.* 2004). Although it appeared to be more common on dogs at lower altitudes (Fig. 5.1c), the localities at which it was collected from dogs in the present study fall within its distribution range as mapped by Walker *et al.* (2000). In south-western Western Cape Province and in central Free State Province it is replaced on dogs and other animals by the closely-related *Rhipicephalus gertrudae* (Jacobs *et al.* 2001; Horak & Matthee 2003).

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# Chapter 6

## The prevalence and distribution of *Argas walkerae* (Acari: Argasidae)

### 6.1 INTRODUCTION

There are two well-defined families, the Argasidae (soft ticks or tampans) and the Ixodidae (hard ticks) within the order Acari. Many members of both families are present in South Africa and many of them are parasites of domestic livestock. Argasid species that parasitize domestic animals in this country are the sand tampan, *Ornithodoros savignyi;* the eyeless tampan, *Ornithodoros moubata;* the spinose ear tick, *Otobius megnini*, and the southern African fowl tampan, *Argas walkerae* (Howell, Walker & Nevill 1978). As implied by its colloquial name the latter tick infests domestic fowls. According to Norval, Short & Chisholm (1985) *A. walkerae* is the most important ectoparasite of fowls in Zimbabwe and causes considerable losses to peasant farmers and others. They state that the species is common in resource-poor and 'backyard' situations, where fowl runs are constructed from poles, planks, grass, loose bricks or stones and any other materials at hand.

Lounsbury (1895) originally identified the southern African fowl tampan as *Argas reflexus*, but later changed this to *Argas persicus* (Lounsbury 1903). However, after examining numerous specimens from several localities in southern Africa Kaiser & Hoogstraal (1969) came to the conclusion that these belonged to a new species, which they named *Argas walkerae*. Furthermore they expressed their doubts as to whether *A.*

*persicus* did indeed occur in southern Africa, because all collections they examined from this region proved to be *A. walkerae*. They reported collections from Fort Beaufort and Queenstown in the Eastern Cape Province, Onderstepoort and Pretoria North in Gauteng Province and Christiana, North West Province, all in South Africa, as well as from a farm close to Omaruru in Namibia and from Maseru in Lesotho. Eastwood (1971) reports *A. walkerae* from Windhoek in Namibia and Beit Bridge in Zimbabwe, and Huchzermeyer (1972) records it also from Chinhoyi and Bulawayo in Zimbabwe. Norval *et al*. (1985) report its widespread distribution in Zimbabwe and have mapped the localities at which it has been collected. Its presence in Zambia has been reported by Gothe (1999). Norval *et al.* (1985) also record the preference of the non-feeding stages of *A. walkerae* for certain structures in an experimental fowl run, as well as the seasonal occurrence of its various developmental stages on fowls and the various structures in the run.

Gothe & Koop (1974) report that larvae of *A. walkerae* feed on their fowl hosts for 4 to 9 days. After detaching and moulting the larvae are followed by four nymphal stages and finally adults, all of which are free-living and only feed for relatively short periods while the fowls are roosting at night. During the non-parasitic phases of the life cycle the various developmental stages shelter under loose bark on wooden perches, or on wall and rafter poles or in cracks and crevices in these structures (Norval *et al*. 1985). Adults feed and mate several times and females deposit relatively small egg batches, one after each blood meal. The number of gonotrophic cycles, however, varies between individuals (Gothe & Koop, 1974). Even in the mild climate of Zimbabwe it appears as if only one generation is completed annually, with most larvae and first stage nymphs in early summer, second to fourth instar nymphs in midsummer, and most adults in late summer and winter (Norval *et al.* 1985).

Gothe & Schrecke (1972) have shown that fowl tampans in South Africa can be infected with *Aegyptiannella pullorum*, the cause of fowl aegyptiannellosis, and *Borrelia anserina*, the cause of fowl spirochaetosis. In Zimbabwe Huchzermeyer (1972) suggested that *A. walkerae* may transmit *Pasteurella avicida*, the cause of fowl cholera. Gothe (1999) has induced paralysis in domestic chickens by feeding the larvae of a laboratory strain of *A. walkerae* on them, and has also done so with the larvae of various wild strains of *A. walkerae* collected in the northern provinces of South Africa. In addition the tampans, and particularly the adults, can imbibe a considerable volume of blood.

The present investigation records the prevalence and distribution of *A. walkerae* in the eastern region of the Eastern Cape Province, South Africa.

## 6.2 MATERIALS AND METHODS

### 6.2.1 Survey localities

The survey was conducted within four municipal districts, namely; Alfred Nzo, Amatole, Chris Hani and O.R. Tambo that completely or partially lie within the eastern region of the Eastern Cape Province. The sampling sites were fowl-coops or runs in the vicinity of 72 communal dip-tanks, which had been selected by means of tables of random numbers for the project on the geographic distribution of ticks parasitising domestic livestock in this region. The geographic coordinates of the dip-tanks at which ticks were to be collected were recorded and are plotted in Fig 6.1.

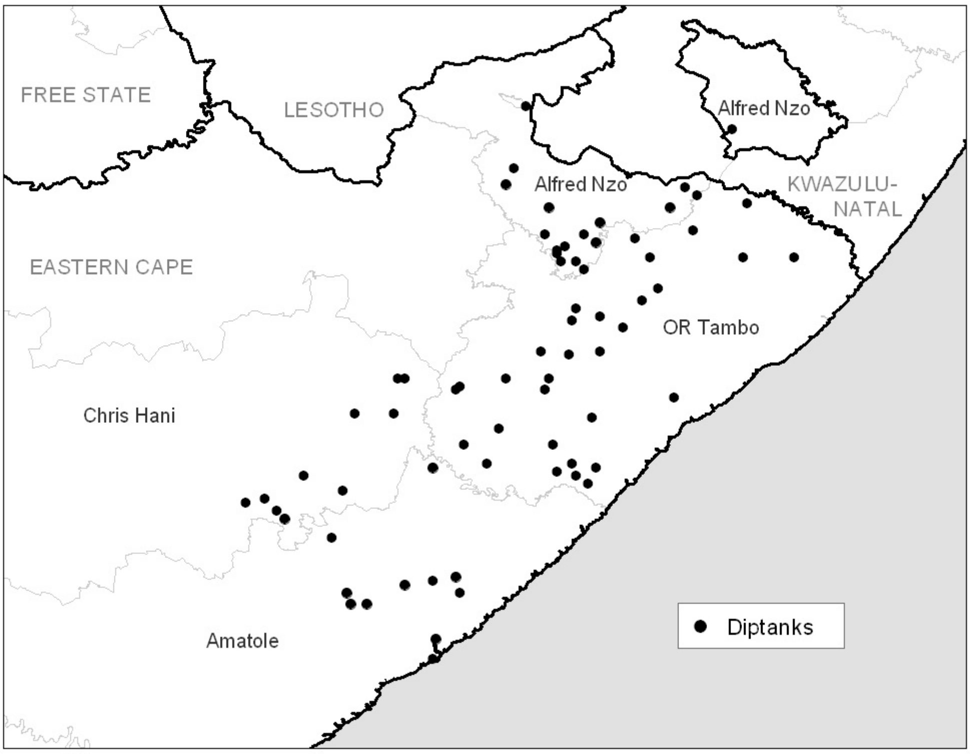


Fig. 6.1: Communal dip-tank localities in the vicinity of which *Argas walkerae* was to be collected from fowl houses in the eastern region of the Eastern Cape Province during 2004 and 2005

### 6.2.2 Sampling

In addition to the ticks that were collected from cattle and goats at each of the 72 dip-tanks, whenever possible *A. walkerae* were collected from two fowl houses or roosting places in the vicinity of each dip-tanks. No attempt was made to collect all the tampans present, and once approximately five had been collected sampling at that fowl house ceased. The ticks were collected while the birds were out foraging, and sampling was carried out from midsummer to autumn (January to May) in 2004 and 2005.

## 6.3 RESULTS AND DISCUSSION

*Argas walkerae* was collected from 102 (70.8%) of 144 fowl-coops in the vicinity of 57 (79.2%) of the 72 selected dip-tanks (Table 6.1). A total of 599 tampans in all stages of development were collected. Males constituted 44.4% of the total, and females 24.8% (Table 6.2). The tampans were found under the bark of poles, or rafters, in cracks in walls, and under nest boxes, bricks, logs and other floor debris. None of the larvae that were collected had fed, whereas several of the nymphs and adults were partially or fully engorged. Tampans seemed to be present mainly when there was wood in the structure of the fowl-coop, and few were collected from coops constructed only from stone or bricks.

TABLE 6.1: *Argas walkerae* collected from fowl houses and roosts in the eastern region of the Eastern Cape Province

| **No. of localities sampled (No. infested)** | **No. of fowl houses sampled (No. infested)** | **Stage of development** | **No. of tampans collected** |
|---|---|---|---|
| 72 (59) | 144 (102) | Larvae | 14 |
| | | Nymphs | 170 |
| | | Males | 266 |
| | | Females | 149 |

The number of localities at which *A. walkerae* was present in each of the four municipal districts in the eastern region of the Eastern Cape Province is summarized in Table 6.2. Fowl tampans were present at 75% or more dip-tank localities and 58% or more fowl-coops were infested in each of the four municipal districts in which sampling was carried out.

TABLE 6.2: Number of localities and fowl houses in four municipal districts of the eastern region of the Eastern Cape Province at which *Argas walkerae* was collected

| **Municipal district** | **No. of localities:** | | **No. of fowl houses:** | |
|---|---|---|---|---|
| | **sampled** | **with tampans** | **sampled** | **with tampans** |
| Amatole | 12 | 9 (75%) | 24 | 14 (58%) |
| Alfred Nzo | 16 | 12 (75%) | 32 | 24 (75%) |
| Chris Hani | 10 | 10 (100%) | 20 | 19 (95%) |
| O.R. Tambo | 34 | 26 (76%) | 68 | 45 (66%) |
| **Totals** | **72** | **57 (79.2%)** | **144** | **102 (70.8%)** |

The dip-tank localities at which *A. walkerae* was collected are plotted in Fig. 2. Tampans were collected throughout the eastern region of the Eastern Cape Province. They were present in fowl houses from the coast of the warm Indian Ocean to the high mountainous regions close to the Lesotho border where winter snow is a frequent occurrence.

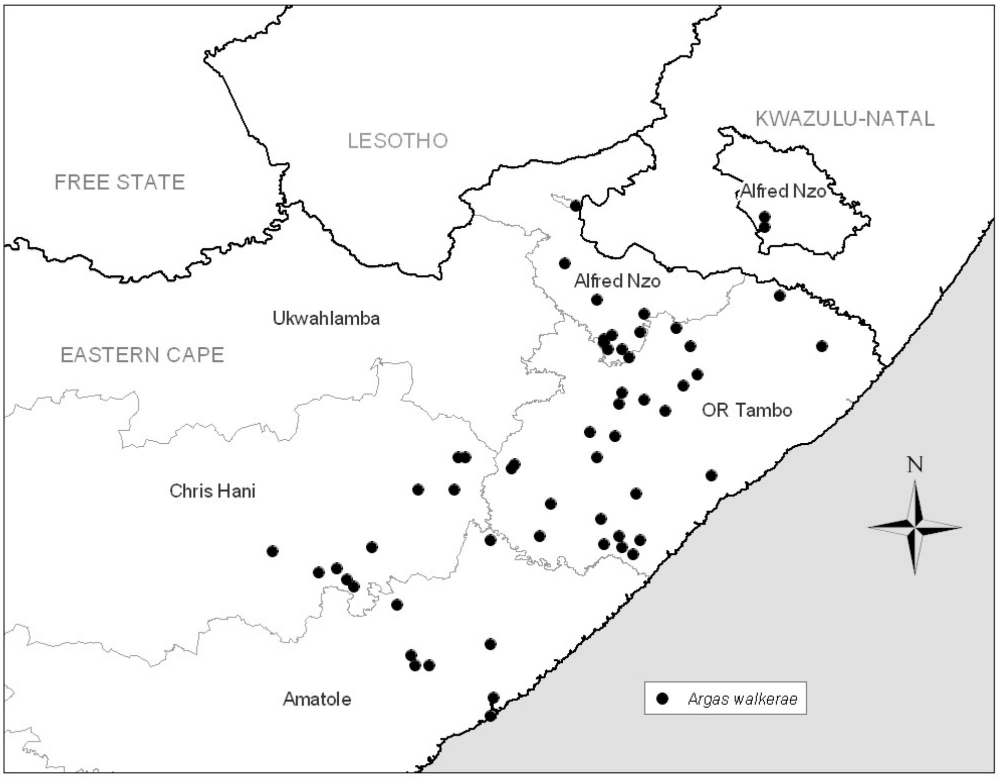


Fig 6.2: Dip-tanks close to which *Argas walkerae* was collected from fowl houses in the eastern region of the Eastern Cape Province

These findings taken in conjunction with those of Kaiser & Hoogstraal (1969), Eastwood (1971), Huchzermeyer (1972) and Norval *et al.* (1985) imply that climate does not play an important role in determining the geographic distribution of *A. walkerae*, but rather meso-environment. Thus *A. walkerae* may be present at any locality in South Africa, in which there are domestic fowls in a rural or 'back yard' environment containing a coop or a roost, of which unprocessed or partially processed wood constitutes a major component, and where there is little or no chemical control.

As an aid to control Norval *et al*. (1985) suggested that fowls should be dusted with an acaricide to kill attached larvae before they are transferred to new runs. They also suggest that the fowl houses should be sprayed with acaricide in winter before the larvae emerge, and that permanent plastered brick houses, which provide no shelter for the non-feeding stages, should be constructed.

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# Chapter 7

## General Discussion

Just before and just after the conduct of this survey the names of three well-known ticks of domestic livestock were changed. These are the cattle ticks *Boophilus decoloratus* and *Boophilus microplus*, which were renamed *Rhipicephalus* (*Boophilus*) *decoloratus* and *Rhipicephalus* (*Boophilus*) *microplus* respectively (Horak, Camicas & Keirans 2002; Murrell & Barker 2003). Although many people disagree with these name changes I have decided to adopt them until further proof of their validity or invalidity is published. The other tick is the carnivore tick *Haemaphysalis leachi*, of which the South African variety has been found to be a valid old taxon described in 1844 by Koch as *Rhipistoma ellipticum*. Koch's tick, a single male specimen, was collected in the Western Cape Province, South Africa, and the name *Haemapysalis elliptica* has now been proposed for it (Apanaskevich & Horak 2007).

It would appear from the number of tick species collected in the present survey that the sampling strategy of examining five cattle, five goats and when possible five dogs, two fowl houses and three vegetation drag-samples at each locality was successful. This strategy also meant that if all the animals as well as the fowl houses and vegetation were sampled at a particular locality a total of 20 separate tick collections were made. In a previous survey of ixodid ticks on livestock and on the vegetation also conducted in the Eastern Cape Province, located at sites between 70 and 150 km to the west of the present one, five ixodid tick species, namely *Amblyomma hebraeum, Rhipicephalus appendiculatus, R.* (*B.*) *decoloratus*, *Rhipicephalus evertsi evertsi* and *Haemaphysalis* *silacea,* were relatively abundant and three other species, *Rhipicephalus simus, Rhipicephalus glabroscutatum,* and *Ixodes pilosus,* were far less frequently encountered (Rechav 1982). In the present survey 11 ixodid tick species were collected, but four of these came from dogs, and dogs were not included in the survey conducted by Rechav (1982).

In Rechav's survey, conducted between 1975 and 1979, *R.* (*B.*) *decoloratus* was recovered from cattle, but apparently no *R.* (*B.*) *microplus*. Similarly the authors of an acaricide resistance survey conducted between February 2000 and August 2001, in which some of the regions sampled overlapped some of those in the present study, also made no mention of the presence of *R.* (*B.*) *microplus* (Mekonnen, Bryson, Fourie, Peter, Spickett Taylor, Strydom & Horak 2002). Instead they made use of the larvae obtained from engorged female *R.* (*B.*) *decoloratus* collected from cattle at their various target localities. However, an earlier publication by Howell, Walker & Nevill (1978) leaves no doubt that *R.* (*B.*) *microplus* was already present in the eastern region of the Eastern Cape Province at the time of the present study.

While the distribution of *R.* (*B.*) *decoloratus* in the eastern regions of the Eastern Cape Province appears to have remained unaltered since its mapping by Howell *et al.* (1978) that of *R.* (*B.*) *microplus* has expanded. Its predominance over the indigenous *R.* (*B.*) *decoloratus* in the region is a new phenomenon, as is its apparent ability to complete its parasitic life cycle on goats. The management of *R.* (*B.*) *microplus* and the control of the two *Babesia* spp. that it transmits, namely the indigenous *Babesia bigemina* and the imported *Babesi bovis* (Norval & Horak 2004), will require careful future planning.

This survey showed that the bont-tick, *A. hebraeum* is present in the woodland areas where there are trees and bush as well as grass. This is in agreement with the findings of Howell *et al.* (1978). The tick was present at all the dip-tanks surveyed along the coast, but was also collected surprisingly far inland, beyond the distribution limits illustrated for it by Howell *et al.* (1978). Horak, MacIvor, Petney & De Vos (1987) concluded that the larger the host species the greater the likelihood that it would harbour large numbers of adult *A. hebraeum,* and this was confirmed by the present findings where *A. hebraeum* was present on goats at 25 and on cattle at 39 dip-tanks, and a total of 61 goats and 138 cattle were infested (Nyangiwe & Horak, 2007). Not only is *A. hebraeum* the only really effective vector of *Rickettsia* (*Cowdria*) *ruminantium* in South Africa (Norval & Horak 2004), the causative organism of heartwater in domestic and wild ruminants, but its long mouthparts and its tendency to form clusters can cause serious damage to hides, udders and scrota (Howell *et al.* 1978).

The geographic distribution of *H. elliptica* (then known as *H. leachi*) in South Africa has been mapped by Howell *et al.* (1978), and appears to be patchy and discontinuous particularly in the western regions. The sites at which it was collected in the present survey, all fall within its distribution range as mapped by Howell *et al.* (1978). *H. elliptica* was not only present on dogs at 90 % of the 40 dip-tanks at which ticks were collected, but was collected from 70.4 % of tick-infested dogs (Nyangiwe, Horak & Bryson 2006). Norval (1984) believed that this tick was likely to be present at localities wherever the tick-rodent-carnivore relationship was satisfactory. The life cycle is sustained by the rodent/carnivore host complex (Norval 1984), and this could account for the high prevalence of *H. elliptica* on dogs in rural areas and its scarcity in cities. This tick (then referred to as *H. leachi*) is the vector of the virulent *Babesia canis rossi*

(Lewis, Penzhorn, Lopez-Rebollar & De Waal 1996), causing babesiosis in domestic dogs, whereas true *H. leachi* apparently does not transmit this disease (Uilenberg 2006, personal communication).

The distribution of *H. marginatum rufipes* in the eastern regions of the Eastern Cape Province is patchy (Howell *et al.* 1978), a fact confirmed by the few ticks collected in the present survey and the patchiness of their distribution. It has been suggested that when farmers observe burdens of more than 15 *Hyalomma spp*. ticks in the perineal and inguinal regions of cattle, the infestations should be treated with a local application of e.g. tick-grease (Dreyer 1997), because of the damage caused by their long mouthparts. *H. marginatum rufipes* is probably also the principal vector in South Africa of the virus causing Crimean Congo haemorrhagic fever (Horak, Swanepoel & Gummow 2002; Swanepoel & Burt 2004). However, because of the seemingly few ticks present and the patchiness of its distribution this disease of humans, has to my knowledge, not been recorded within the region of the current survey.

The distribution of *R. appendiculatus* determined in the current survey stretches further inland than that mapped for it by Howell *et al.* (1978) and is more in line with that mapped for it by Walker, Keirans & Horak (2000). It is the vector of *Theileria parva* the cause of East Coast fever and Corridor disease in domestic cattle (Norval & Horak 2004). East Coast fever has been eradicated in South Africa, whereas Corridor disease is only a danger when infected buffaloes are in the vicinity. The latter possibility should be kept in mind considering the widespread trade in African buffaloes in South Africa to stock newly established game reserves. Domestic cattle and large herbivores such as greater kudus and male nyalas, *Tragelaphus angasii*, are hosts favoured by adult *R.*

*appendiculatus* (Baker & Ducasse 1967; Horak, Boomker, Spickett & De Vos 1992; Horak, Boomker & Flamand 1995). The current survey has revealed that domestic goats are also efficient hosts of the adults.

*Rhipicephalus evertsi evertsi* has the most widespread distribution of all ticks belonging to the genus *Rhipicephalus* in Africa, and also has one of the largest host ranges (Walker *et al.* 2000). In the present study its distribution lay within that plotted for it by Howell *et al.* (1978) and Walker *et al.* (2000). Adult ticks were collected from both goats and cattle at all 72 survey localities, and a total of 334 goats compared to 316 cattle were infested with adult ticks (Nyangiwe & Horak 2007).

The distribution plotted for *Argas walkerae* in the present survey is the first time that this has been done for this tick for any region in South Africa, although it has been done in Zimbabwe (Norval, Short & Chisholm 1985). The distribution of the tick seems to be more strongly associated with the presence of fowls and fowl houses containing raw or processed wood in their structure than with climate.

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