A survey of tick species on cattle and African buffaloes in the Tsavo Conservation Area, Kenya

by

Edward Kamau Kariuki

Supervisor: BL Penzhorn

Co-supervisor: IG Horak

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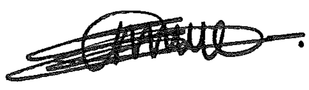
Dedication

This dissertation is dedicated to my wife Juliet and our two sons Allan and Alvin without whose support I would not have completed this work.

Declaration

I declare that this is my own original work and that it has not been presented for any other degree to this or another University.

Signed:



Edward Kamau Kariuki

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ABSTRACT

The objective of this study was to compare the tick species that infest African buffaloes (*Syncerus caffer*) with those that infest domestic cattle in the Tsavo Conservation Area in Kenya. To this end ticks were collected from cattle and African buffaloes within the study locality. Fourteen tick species belonging to the genera *Amblyomma*, *Hyalomma* and *Rhipicephalus* were collected. Eight species, namely *Amblyomma gemma, Amblyomma lepidum, Hyalomma albiparmatum, Hyalomma rufipes, Hyalomma truncatum, Rhipicephalus evertsi evertsi, Rhipicephalus pravus* and *Rhipicephalus pulchellus,* were collected from cattle and from buffaloes sampled during the study period. Three species, namely *Hyalomma impeltatum, Rhipicephalus humeralis* and *Rhipicephalus praetextatus,* were present only on buffaloes, and three, *Rhipicephalus* (*Boophilus*) sp.*, Rhipicephalus kochi,* and *Rhipicephalus muehlensi,* were collected only from cattle. Of all the ticks collected, those of the genus *Amblyomma* are associated with the highest risk of disease and possibly with severe losses in cattle in the area. New locality records for *H. impeltatum* and *H. truncatum* were determined and the first locality records for *R. praetextatus sensu stricto* in Kenya are reported.

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INTRODUCTION

Tsavo Conservation Area comprises the Tsavo National Park complex (Tsavo East, Tsavo West and Chyulu Hills National Parks) and the adjacent interface area (Taita ranches), and represents the largest conservation area in Kenya. The land is utilized solely for conservation and is a great income earner for the country through tourism. Adjacent to and also between the large conservation areas lie the community-owned ranches, which are used mostly for beef production and indigenous dairy production for domestic use. Tsavo East National Park (TENP) and the neighboring Taita ranches are designated as a disease-free zone and hence attract many pastoralist communities in search of grazing. Rearing livestock in this area not only ensures pasture for the beef animals, but also helps the farmers to fetch premium market prices for their beef products. Because of the large number of livestock brought into the area, there are a lot of stock incursions into the park and the adjacent interface. Since the parks are not fenced, most pastoralist cattle utilize the park's pastures during the dry seasons, with the pastoralists finding themselves in the park without intent, or specifically going there for fresh pastures.

Tourism and beef production are the two major income-generating activities at Tsavo Conservation Area. It is important to understand the limiting factors that could reduce or lower the utilization of the area, in order to maximally exploit the large landmasses of the conservation area. Tourism can be adversely affected by a decrease in wildlife populations, while livestock could be severely affected by disease. Parasites are known to regulate host populations in natural environments. Since ticks are vectors of certain parasites to cattle and to African buffaloes (*Syncerus caffer*), a study devoted to ticks and their cattle and buffalo hosts could provide well-founded data towards the management of the area for posterity.

Ticks are of great economic importance as vectors of several diseases of domestic livestock and of commercially farmed wildlife in sub-Saharan Africa (Norval & Horak 2004). The majority of tick species are found on wildlife and several would not complete their life cycles without wildlife hosts (Walker 1991). Wild animals are affected by several diseases that cause serious infections in livestock such as theileriosis, heartwater, babesiosis and anaplasmosis (Kuttler 1984, Grootenhuis 1989, Allsopp, Bezuidenhout & Prozesky 2005). Buffaloes do not show clinical signs of babesiosis, but may act as inapparent carriers of *Babesia bigemina* (Karbe, Grootenhuis, Kelly & Karstad 1979). Though the presence of tick-borne pathogens are normal in wildlife and cause no overt disease, external factors such as drought or translocations can lead to stress and result in clinical symptoms in these animals. Previous studies have associated wildlife mortalities with *Babesia* sp and *B. bicornis* infections in black rhinos in Kenya (Mugera & Wandera 1967) and Tanzania and South Africa (Nijhof, Penzhorn, Lynen, Mollel, Morkel, Bekker & Jongejan 2003).

Disease transmission between wildlife and livestock can be of particular concern when wild ungulates share their habitat and other resources with domestic livestock (Bohm, White, Chambers, Smith & Hutchings 2007). It should be noted that beef cattle in Tsavo share pastures and water points with wildlife and particularly African buffaloes in the parks. Tick-borne infections and an abundance of competent hosts (those host species with the ability to infect a vector with a particular pathogen) can increase the prevalence of diseases, while research also suggests that high densities of incompetent hosts (those hosts which fail to infect a vector) can decrease the prevalence of infectious agents in ticks (Logiudice, Ostfeld, Schmidt & Keesing 2003).

The tick species infesting African buffaloes and cattle that occur independently in Kenya have been meticulously listed from as early as the 1960s by Walker (1974), but no work has been done on ticks infesting both wildlife (buffaloes) and cattle sharing the same habitat. Because of interactions between cattle and wildlife within the park during livestock incursions, and also within the interface at other times, a study of the ticks infesting cattle and buffaloes should give a good indication of the possibility of pathogen transmission and disease emergence between wildlife and livestock.

The objectives of this study were to determine, firstly the species of ticks associated with African buffaloes in Tsavo East National Park and on cattle in the adjacent interface areas, and secondly the aim was to establish the level of infestation and predilection attachment sites of ticks on the two host species as well as identifying tick species shared between buffaloes and livestock. Where possible it was attempted to identify also the immature stages of the ticks on both host species and to determine their predilection attachment sites. Body regions considered as important predilection attachment sites for many tick species include the ears, neck, legs, tail, and upper and lower perineum.

CHAPTER ONE

LITERATURE REVIEW

Ticks are blood-feeding external parasites of mammals, birds and reptiles throughout the world. A total of 896 tick species have been identified and described worldwide. They belong to three families: Argasidae consisting of 193 species, Ixodidae with 702 species and one species of the monotypic Nuttulliellidae (Guglielmone, Robbins, Apanaskevich, Petney, Estrada-Peña, Horak, Shao & Barker 2010). Ticks are important vectors of pathogens such as protozoa, rickettsiae, viruses and bacteria that can cause disease in wildlife and livestock. They are perhaps better suited than any other group of arthropods mainly due to their vectorial capacity and role in transmission of disease agents to many different vertebrates throughout most of the world (Cupp 1991). According to Balashov (1972), ticks rank first as vectors of disease to non-human vertebrates, and second only to mosquitoes as vectors of human and animal diseases (Sonenshine 1991). Ticks are formidable vectors because they are widely distributed, do not have many natural predators or parasites and are able to evade most host-defence mechanisms while feeding (Kocan 1995). Worldwide economic losses from ticks and tick-borne diseases are estimated to be in the billions of dollars annually (Sonenshine 1991), and failure to control ticks and tick-borne diseases is a major factor limiting livestock production worldwide, especially in Africa (Kocan 1995).

Ticks can maintain dense populations in suitable habitats because of their enormous reproductive capacity (Friedhoff 1990). Infected ticks in the environment also serve as reservoirs of disease agents (Kocan 1995). Ticks inhabit wildlife and farming areas, and also interfaces in which wildlife and domestic livestock share pastures and water. Cattle and African buffaloes are the main species found in the wildlife–livestock interface in the Tsavo Conservation Area in Kenya. Both animal species are affected by tick-borne diseases, which include theileriosis and anaplasmosis. Corridor disease, which is caused by buffalo-derived *Theileria parva*, results in large losses of cattle in Kenya (Young & Grootenhuis 1985), and cattle farming in the presence of buffaloes is a hazardous undertaking because of mortalities due to *T. parva* (Neitz 1955).

Although there are no clear-cut data on the magnitude and effects of tick-borne diseases in Kenyan wildlife, many wildlife deaths cannot be attributed to any infectious agent (personal observation). Most of these animals have heavy tick burdens, including some species which could be vectors of various disease agents that may affect wildlife (personal observation).

During the drought of January to September 2009, several wildlife deaths were reported concurrent with many cattle incursions into the TENP. Though infectious diseases like anthrax were incriminated as the cause of the deaths, it could often not be determined due to inadequate diagnostic tools or the lack thereof, and there was no attempt to detect the presence of tick-borne diseases (personal observation). Elephants (*Loxodonta africana*) were most affected by the drought and several hundreds died. Hippopatami (*Hippopotamus amphibius*) were also affected, mostly because of the long distances they had to cover in search of forage. Buffaloes, zebras (*Equus quagga*) and blue wildebeest (*Connochaetes taurinus*) also died in large numbers, but no record was kept of their deaths or of those of the smaller herbivores. Thus there is a large gap in information on the cause of death of herbivores, particularly in relation to “key” species such as elephants, rhinoceroses and buffaloes.

Several instances of wildlife mortality, with no diagnosis of an infectious agent, but with large numbers of ticks evident on many carcasses (personal observation), led to the investigation of the role that ticks might play in these mortalities. Though there haven’t been many clearly diagnosed cases of deaths due to tick-borne infections in Kenyan wildlife, many tick-borne parasites have been identified in routine blood smears at our laboratory (personal observation). Livestock in close proximity to wildlife conservation areas are vulnerable to tick-borne diseases such as heartwater and Corridor disease. There is a need for a well-informed study on ticks infesting both wildlife and livestock in order to gain an understanding of tick-borne diseases that are shared between livestock and wild animals.

The tick species occurring on many species of Kenyan wildlife and their geographic distributions were last reviewed in 1974 (Walker 1974). Since then climate and vegetation cover in Kenya have undergone several changes. Most of these changes have been influenced by the introduction of new farming systems and a change in the lifestyle of pastoral communities. Since the survival of ticks depends on climate, and to a lesser extent vegetation, it is critical to understand the effects of changes in climate, vegetation and farming practices on tick diversity and ecology.

Global climatic changes could affect the ecology of ticks and tick-borne diseases. Climatic conditions influence fluctuations in tick numbers and in wild animal populations that serve as reservoir hosts of tick-borne diseases (Kocan 1995). Other factors such as the movement of birds could influence tick occurrence. Camus & Barre (1992) noted that ticks could be transported between islands by attaching to birds. Replacement of the indigenous *Rhipicephalus (Boophilus) decoloratus* by exotic *Rhipicephalus* (*Boophilus) microplus* is an indicator of changing ecology and is something worth tracking. *Rhipicephalus (B.) microplus* is an introduced species from Asia and its presence on wildlife could result in a change in the ecology of tick-borne diseases as it can transmit both *Babesia bigemina* and *Babesia bovis* to cattle, whereas the indigenous *R*. *(B.) decoloratus* can only transmit *B. bigemina*. Following the introduction of *R. (B.) microplus* into Africa on cattle of Asian origin, it would be interesting to know whether buffaloes sharing a habitat with cattle also share this tick species. However, buffaloes do not appear to be good hosts of the indigenous *R. (B.) decoloratus* (Horak, Golezardy & Uys 2006), and may thus also not be good hosts of the introduced *R. (B.) microplus*. Tracking the presence of alien ticks on wildlife would be a useful disease-monitoring and surveillance tool and helpful in formulating effective tick and disease-control measures.

Failure to control ticks and tick-borne diseases is a major factor limiting livestock production worldwide, especially in Africa (Kocan 1995). Control programmes require information on tick diversity, seasonality and hosts in order to achieve effective mitigating strategies. Information on preferred tick attachment sites also guides the farmer in his choice of the best method of acaricide application.

Cattle are utilized by the Taita community to create income on Taita ranches, and livestock in this area often interacts with buffaloes and other wildlife species (mostly grazers) on common pastures. Consequently, an update of the tick species prevalent in the Tsavo National Park complex (Tsavo East, Tsavo West and Chyulu Hills National Parks) and the adjacent interface area (Taita ranches) and on buffaloes would be most useful, particularly as buffaloes act as reservoir hosts of some important tick-borne protozoa affecting cattle.

A survey of the tick species present on buffaloes and cattle at this locality will assist in determining what diseases could be shared between the two host species. This information could be used in formulating tick or tick-borne disease control strategies. Details on tick diversity would also assist in understanding future changes in wildlife populations and disease ecology in relation to changing factors like climate. Such a survey may also reveal changes in tick distributions and disease relationships in the light of global climate change, human invasion of virgin environments such as wildlife areas, unrestricted movement of wild and domestic animals and associations between wild and domestic animals.

With progressive damage to previously undisturbed habitats as a result of human agricultural activities and natural climatic changes, the distribution of ticks and tick-borne diseases is expected to change. Incidents of disease are also expected to change and even increase. Disease transmission dynamics will also change, with several disease agents crossing from domestic livestock to wild animals and *vice versa*. Increases in the introduction of tick vectors into previously uninfested areas could introduce diseases and hence cause a change in disease ecology.

Currently tick taxonomy in Kenya is a neglected field, with minimal output. The ability to identify ticks is the foundation of a good understanding of tick biology, distribution, hosts and disease epidemiology and the planning of appropriate control strategies. Most of the records on tick occurrence are based on Walker's contribution in the 1960s (Walker 1974). Several new tick species have been described since then and many older species redescribed, of which some occur in Kenya. Work done in 1999 by Okello produced an identification manual, but did not touch on tick prevalence or distribution. The present study adds data to the efforts of Walker (1974) and also serves towards a revival of the dormant field of tick taxonomy in Kenya.

Because of the near absence of vaccines, inefficient diagnostic capabilities and faulty treatment of tick-borne illness, the most expedient method to minimize the problem of tick-borne diseases is to reduce the abundance of ticks (Ostfeld, Price, Hornbostel, Benjamin & Keesing 2006). It is with these facts in mind that it is deemed necessary to identify and study the ticks present in Tsavo East National Park (TENP) and neighbouring Taita ranches, both of which are demarcated as disease-free zones.

CHAPTER TWO

MATERIALS AND METHODS

STUDY AREA

The survey was conducted in the Tsavo Conservation Area and the adjacent Taita ranches. The area lies between, E 037.65º S 04.20º and, E 039.36º S 01.92º, Tsavo is the largest conservation area in Kenya, encompassing approximately 40,000 km^2 (Fig. 2.1). The study area included Tsavo East National Park (TENP) and Tsavo West National Park (TWNP), covering 11,747 km^2 and 9,065 km^2, respectively. Large community and human settlement areas and privately owned ranches covering about 22,000 km^2 lie adjacent to and within the Tsavo Conservation Area. TENP and TWNP comprise 52% of the total area of protected regions in Kenya and about 3.9% of the total Kenyan land area. Taita ranches form part of the ranches in the Taita-Taveta district sandwiched between TENP and TWNP. The ranches, numbering approximately 20, are owned by various local clans of the Taita tribe and are a critical wildlife dispersal area.

TENP lies between 150 and 1200 m above sea level, and is located within the Taita Taveta district. The vegetation of the park comprises open plains alternating from grasslands and bushlands to semi-arid *Acacia* shrub and woodlands (Tolvanen, 2004). Annual rainfall varies between 350 and 450mm, and temperatures range between 23°C and 35°C. Rain falls in two seasons, from March to May and October to December.

TWNP lies on the western side of TENP at 150 to 1800 m above sea level. The park has a vegetation cover ranging from bushland with scattered trees covering the range land and hills in the north, to open plains in the south. The area receives 200 to 700 mm of rain per year and temperatures range from 20°C to 30°C.

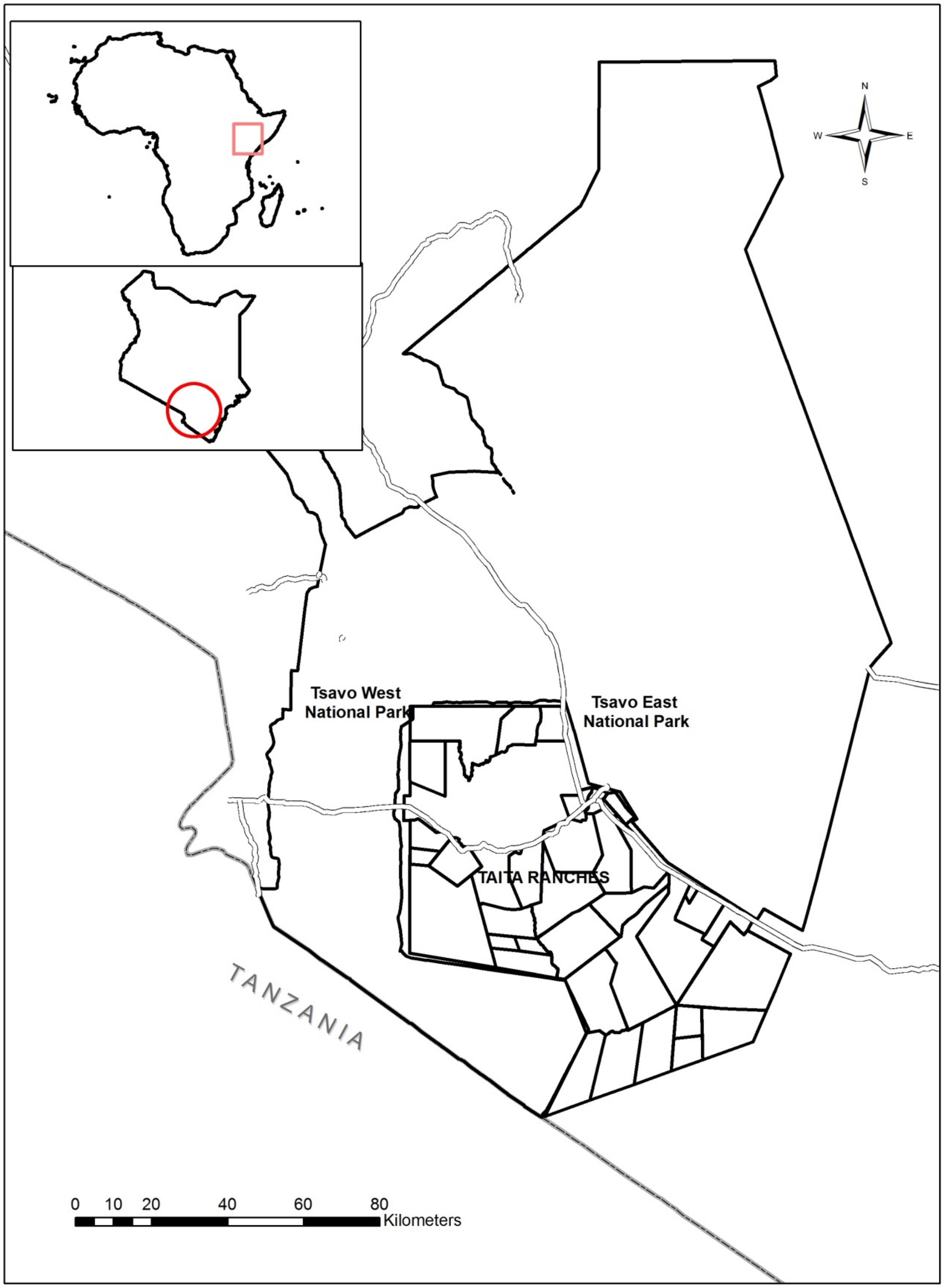


Figure 2.1 Map of the study area where ticks were collected from cattle and buffaloes in Kenya during February 2010

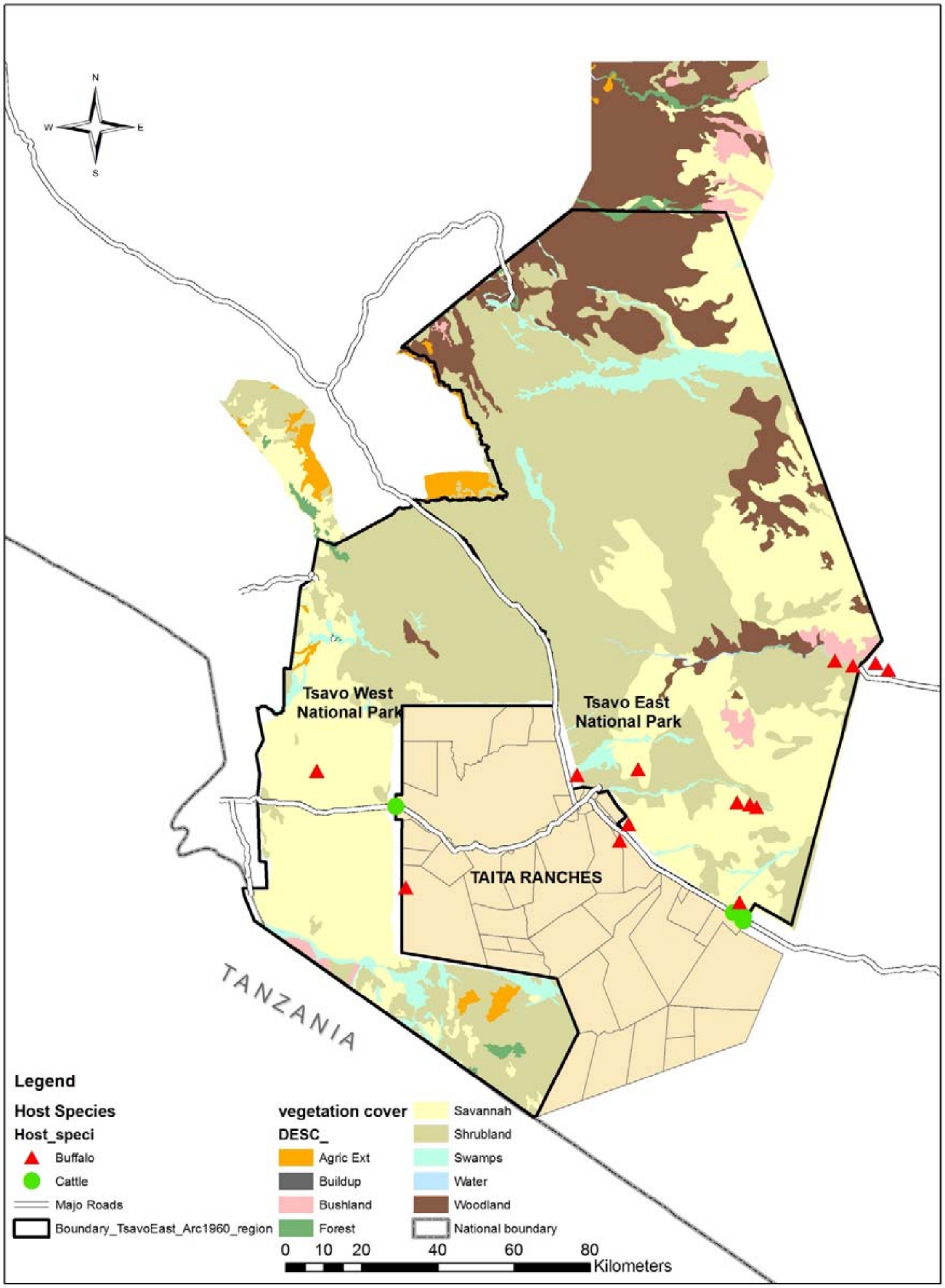


Figure 2.2 Sites at which ticks were collected from African buffaloes and cattle in the Tsavo Conservation Area, Kenya, during February 2010

ANIMALS

Ticks were collected from 62 African buffaloes during a rinderpest sero-surveillance campaign between 1 and 29 February 2010. Cattle in areas adjacent to the TENP and TWNP were sampled at a common cattle dip tank in order to facilitate collection of ticks and the applicable data (Table 2.1). Additional collections were made from a herd of cattle held by Kenya wildlife rangers at Maktau gate in TWNP due to illegal entry into the park, as well as from available cattle in other randomly distributed areas adjacent to the National Park. The tick collection procedure from cattle was hampered by the fact that most animals had to be gathered by their owners over long distances from pastures to which they had been moved in search of grazing. Furthermore, most of the cattle present within the periphery of the park were not accompanied by their owners and hence could not be sampled because of the lack of owner's consent. Nevertheless, 25 cattle were sampled for ticks.

Data on cattle and buffaloes sampled are summarized in Table 2.1. Sampling locations are also depicted in Figure. 2.2.

Table 2.1 African buffaloes and cattle from which ticks were collected in the Tsavo Conservation Area, Kenya, during February 2010

African buffaloes, *Syncerus caffer*							
Herd No.	**Herd Size**	**Location**	**Area Coordinates (ddd°mm.mmm´)**	**Animals Sampled**			**Date**
				Approx. Age	*Sex*	*Sample ID*	
B1	100-120	Irima T/East NP	S 03°19.833´ E 038 °32.896´	2.5 yrs	Male	TEIB1	14th Feb 2010
				1.5 yrs	Female	TEIB2	
				4 yrs	Male	TEIB3	
				2.8 yrs	Male	TEIB4	
				3.8 yrs	Female	TEIB5	
				2.5 yrs	Female	TEIB6	
				1.5 yrs	Female	TEIB7	
B2	250-300	Mark No. 104 T/East NP	S 03°19.050´ E 038°41.580´	1.5 yrs	Female	TEMB8	15th Feb 2010
				2.8 yrs	Male	TEMB9	
				2.8 yrs	Female	TEMB10	
				3 yrs 9 months	Female	TEMB11	
B3	150-200	Satao T/East NP	S 03°23.790´ E 038°55.610´	3. 8 yrs	Female	TESB12	15th Feb 2010
				1.5 yrs	Male	TESB13	
				2 yrs	Male	TESB14	
				4 yrs	Male	TESB15	
				1.5 yrs	Male	TESB16	
B4	100-	Satao T/East NP	S 03°24.037´	2 yrs	Male	TESB17	15th Feb year 2010

	150		E 038º57.455´	4 yrs	Male	TESB18	
B5	400-500	Ngutuni-T/East NP Boundary	S 03º26.820´ E 038º40.210´	1.5 yrs	Female	TENgB19	16th Feb 2010
				4 yrs	Male	TENgB20	
				1.5 yrs	Male	TENgB21	
				>10 yrs	Female	TENgB22	
				2 yrs	Male	TENgB23	
				4 yrs	Male	TENgB24	
				2 yrs	Female	TENgB25	
B6	100-120	Bachuma T/East NP	S 03º37.916´ E 038º55.949´	1.5 yrs	Male	TEBB26	17th Feb 2010
				2.8 yrs	Male	TEBB27	
				4 yrs	Male	TEBB28	
				1.5 yrs	Male	TEBB29	
B7	100	Dika plains/Satao T/East	S 03º24.450´ E 038º58.390´	1.5 yrs	Male	TESB30	17th Feb 2010
B8	50-70	Sala T/East NP	S 03º03.660´ E 039º09.510´	>9 yrs	Female	TESB31	18th Feb 2010
				4 yrs	Male	TESB32	
				2 yrs	Female	TESB33	
				3 yrs	Female	TESB34	
B9	200	Sala T/East NP	S 03º04.400´ E 039º12.070´	1.5 yrs	Female	TESB35	18th Feb 2010
				4 yrs	Female	TESB36	
				1.5 yrs	Female	TESB37	
				2 yrs	Male	TESB38	
B10	150	Kulalu Ranch	S 03º04.952´	3 yrs	Male	KUB39	19th Feb 2010
				4 yrs	Male	KUB40	

		(next to Sala area)	E 039º17.116´	4 yrs	Male	KUB41	
				1.5 yrs	Female	KUB42	
B11	200-250	Galana Ranch (North of Sala)	S 03º03.971´ E 039º15.264´	4.5 yrs	Female	GLB43	19th Feb 2010
				4 yrs	Female	GLB44	
				3.8 yrs	Male	GLB45	
				4 yrs	Female	GLB46	
				1.5 yrs	Female	GLB47	
B12	1	Sagalla Lodge (inhabited)	S 03º29.209´ E 038º38.959´	1.5 yrs	Male	SagB48	23rd Feb 2010
B14	150-200	Luarenyi Ranch-Lake Jipe Cutline	S 03º35.847 ´ E 038º08.637´	3 yrs	Male	LLB50	24th Feb 2010
				2.5 yrs	Female	LLB51	
				1.5 yrs	Male	LLB52	
				1.5 yrs	Male	LLB53	
				3.5 yrs	Male	LLB54	
				1.3 yrs	Female	LLB55	
				7-8 yrs	Male	LLB56	
B15	80-100	Salaita T/West NP	S 03º19.289 ´ E 037º56.010´	9 yrs	Female	TWSB57	25th Feb 2010
				2.5 yrs	Female	TWSB58	
				4 yrs	Male	TWSB59	
				3 yrs	Male	TWSB60	
				2 yrs	Female	TWSB61	
				5 yrs	Male	TWSB62	
B16	150	Ngutuni Sanctuary Voi	S 03º26.778 ´ E 038º38.741´	1.3 yrs	Female	TENgB63	26th Feb 2010

Cattle sampled during February 2010						
Herd No.	**Herd Size**	**Location Name**	**Area Coordinates (GPS)**	**No. of cows sampled**	**Frequency of tick control**	**Acaricide used**
H1	60	Bachuma	37M0490938 UTM9595844	10	Weekly spraying (estimated at two lids per 5 litres of water)	Alphacypermethrin 10 %w/v EC
H2	71	Bachuma (Miaseni cattle dip)	37M0493440 UTM9593701	4	3 times per week spraying	Non-Specific
H3	26	Bachuma (Miaseni cattle dip)	37M0493440 UTM9593701	2	Once per week spraying	Dominex
H4	60	Bachuma (Miaseni cattle dip)	37M0493440 UTM9593701	1	Once per week	Non Specific
H5	56	Bachuma (Miaseni cattle dip)	37M0493440 UTM9593701	3	Once per week	Amitraz.
H6	7	Bachuma gate point	37M0493590 UTM9594773	2	Not available (these were confiscated animals)	No details available
H7	4	Maktau gate (Tsavo West National Park)	37M0402202 UTM9623575	3	Not available (these were confiscated animals)	No details available

TENP =-Tsavo East National Park

TWNP = Tsavo West National Park

TICK COLLECTION AND PRESERVATION

Sampling was done opportunistically on immobilized buffaloes during a Rinderpest surveillance exercise in Tsavo Conservation Area between 14 and 28 February 2010. Ticks were also collected from cattle within the conservation area during February 2010. While collecting ticks the following information was entered on a form: species of animal, sex, approximate age (except for cattle), date, GPS position, owner (cattle), sample identification number, history of tick control (cattle).

Ticks were collected by hand or forceps and placed in bijou bottles containing Boardman's solution (80% water, 3% di-ethyl ether and 17% alcohol) in order to kill them. After 24 hours the ticks were removed and placed in a long-term preservative (80% alcohol to which 1% chloroform was added to preserve their colour + 15% water + 5% glycerol). Identifying labels were written in pencil and placed inside the sample bottles with the preservative in order to ensure correct identification of the samples. The sample bottles were then stoppered and sealed to prevent leakage.

Ticks were collected from six sites on the host animal (one ear, one side of the neck, one leg including the foot, whole tail including the tail brush, whole upper perineum, and one half of lower perineum).

TICK IDENTIFICATION AND COUNTING

The collected ticks were transported to the laboratory for identification and counting using a stereoscopic microscope. Ticks whose identity could not be determined were stored in labeled vials and couriered to Prof Ivan Horak at the Department of Veterinary Tropical Diseases (DVTD), University of Pretoria, for identification. Since the Bijou bottles were heavy and would result in costly courier charges, the samples were sent to the DVTD in 1.8 ml cryo-vials. Morphological characteristics, as well as host and predilection attachment sites, and geographical location and a list of valid tick names were used as aids towards identification. (Walker 1960; Walker, Keirans & Horak 2000; Guglielmone *et al.* 2010; Walker, Bouattour, Camicas, Estrada-Pena, Horak, Latif, Pegram & Preston 2003). Some of the ticks were photographed and these photographs are presented as figures in the text.

DATA ANALYSIS

The data collected were entered on an MS Excel spread sheet and organized using appropriate capacities of MS Excel software. Descriptive statistics were used on the distribution of ticks by GPS locations (Mapping tick distribution), tick species (number of species and their distribution by location), tick species and how they are distributed by location, total population of ticks collected, classification of ticks by life stage categories (immature and adults), classification of ticks by sex, tick species by host preference, tick species and predilection attachment site.

CHAPTER THREE

RESULTS

CATTLE

A total of 11 ixodid tick species belonging to the genera *Amblyomma, Hyalomma and Rhipicephalus* were collected from cattle during February 2010. The tick species were *Amblyomma gemma, Amblyomma lepidum, Hyalomma albiparmatum, Hyalomma rufipes, Hyalomma truncatum, Rhipicephalus* (*Boophilus*) sp.*, Rhipicephalus evertsi evertsi, Rhipicephalus kochi, Rhipicephalus muehlensi, Rhipicephalus pravus,* and *Rhipicephalus pulchellus* (Table 3.1). The sites of attachment of the various tick species and the number collected are summarized in Table 3.1.

At 33.4%, *A. gemma (*Figure 3.2) comprised a third of the ticks collected from cattle. It was collected from the neck, leg, upper perineum, lower perineum and tail, and most were collected from the neck followed by the lower perineum (Table 3.1). More males than females were collected and 56% of the cattle sampled were infested (Table 3.2). *Amblyomma lepidum* comprised 3% of the ticks collected from cattle and most were recovered from the neck, leg and lower perineum. More males than females were collected (Table 3.2).

Of the cattle sampled, 8% were infested with *H. albiparmatum* (Figure 3.3), which accounted for 1.7% of the ticks recovered from them. All the ticks were collected from the tail. There were more males collected than females (Table 3.2). *Hyalomma rufipes* (Figure 3.5) were collected from the upper perineum and the tail. These ticks constituted 3.6% of the ticks recovered from the cattle. They were present on 24% of cattle and more females than males were collected (Table 3.2). *Hyalomma truncatum* (Figure 3.6) accounted for 1.1% of the ticks collected. The ticks were recovered from the upper perineum and the tail, and equal numbers of males and females were collected (Table 3.2).

Only one *Rhipicephalus* (*Boophilus*) sp. female was collected; no specific identification could be made, since her mouthparts were damaged.

Rhipicephalus evertsi evertsi was collected only from the upper perineum, and accounted for 2.8% of the ticks recovered from the cattle. A single *Rhipicephalus kochi* was collected from the ear of an animal. *Rhipicephalus muehlensi* (Figure 3.8) constituted 4.7% of the ticks collected from cattle, and most were recovered from the ear (Table 3.1). This tick was present on 32% of the cattle, and more males than females were collected (Table 3.2). *Rhipicephalus pravus* (Figure 3.10) was collected from the ear, leg and the lower perineum of cattle (Table 3.1), and comprised 12.2% of the ticks recovered from 52% of the cattle. More females than males were collected (Table 3.2). At 37% of the total, *R. pulchellus* (Figure 3.11) constituted the greatest proportion of ticks collected from the cattle. It was present on the ear, neck, leg, lower perineum, upper perineum and the tail, with most being present on the ears (Table 3.1), and 92% of the cattle were infested. More males than female ticks were collected (Table 3.2).

Table 3.1 Tick species and their attachment sites on cattle (n=25) in the Tsavo Conservation Area, Kenya, during February 2010

Ticks Species	**Ear**	**Neck**	**Leg**	**Upper perineum**	**Lower perineum**	**Tail**	**Total**	**Percentage of total Tick count**
Amblyomma gemma	0	56	17	3	44	1	121	33.4
Amblyomma lepidum	0	6	2	0	3	0	11	3
Hyalomma albiparmatum	0	0	0	0	0	6	6	1.7
Hyalomma rufipes	0	0	0	10	0	3	13	3.6
Hyalomma truncatum	0	0	0	2	0	2	4	1.1
Rhipicephalus (*Boophilus*) sp.	0	0	1	0	0	0	1	0.3
Rhipicephalus evertsi evertsi	0	0	0	10	0	0	10	2.8
Rhipicephalus kochi	1	0	0	0	0	0	1	0.3
Rhipicephalus muehlensi	14	0	0	0	3	0	17	4.7
Rhipicephalus pravus	41	0	2	0	1	0	44	12.2
Rhipicephalus pulchellus	73	3	1	21	12	24	134	37
Total	**129**	**65**	**23**	**46**	**63**	**36**	**362**	**100**

Table 3.2 Species and prevalence of ticks on cattle in the Tsavo Conservation Area, Kenya, during February 2010

Tick Species	**Male**	**Females**	**Total**	**No. of cattle (infested)**	**Average burden of infested animals**	**Proportion of animals infested %**
Amblyomma gemma	68	53	121	14	8.6	56
Amblyomma lepidum	6	5	11	7	1.6	28
Hyalomma albiparmatum	4	2	6	2	3	8
Hyalomma rufipes	4	9	13	6	2.2	24
Hyalomma truncatum	2	2	4	2	2.0	8
Rhipicephalus (*Boophilus*) sp.	0	1	1	1	1.0	4
Rhipicephalus evertsi evertsi	7	3	10	4	2.5	16
Rhipicephalus kochi	0	1	1	1	1	4
Rhipicephalus muehlensi	13	4	17	8	2.1	32
Rhipicephalus pravus	21	23	44	13	3.4	52
Rhipicephalus pulchellus	85	49	134	23	5.8	92
Total	**210**	**152**	**362**	**25**	**-**	**100**

BUFFALOES

Eleven tick species, namely *A. gemma, A. lepidum, H. albiparmatum, Hyalomma impeltatum, H. rufipes, H. truncatum, R. evertsi evertsi, Rhipicephalus humeralis, Rhipicephalus praetextatus*, *R. pravus* and *R. pulchellus*, *w*ere collected from the buffaloes (Table 3.3).

Amblyomma gemma was the second most commonly collected tick from the buffaloes (Table 3.3). It was collected from the leg, tail, lower perineum and upper perineum, with the greatest numbers collected from the lower perineum, and 46.8% of the buffaloes sampled were infested (Table 3.4). *Amblyomma lepidum* was collected from the leg and lower perineum (Table 3.3), and 25.8% of the animals sampled were infested (Table 3.4).

Hyalomma albiparmatum was collected from the leg, lower perineum and the tail of buffaloes (Table 3.3), and all the ticks collected were males and 9.7% of buffaloes were infested. *Hyalomma impeltatum* (Figure 3.4) was collected only from the lower perineum. All the ticks collected were males and were recovered from a single animal. Even though *H. rufipes* contributed only 9.3% of the ticks collected from the buffaloes (Table 3.3), 48.4% of the animals sampled were infested with this tick (Table 3.4). It was collected from the ear, leg, lower perineum, upper perineum and the tail. More male ticks than females were recovered. *Hyalomma truncatum* was collected from the leg and the tail. This tick was present in low numbers (Table 3.3), and 3.2% of the buffaloes were infested (Table 3.4). More males than females were collected.

Rhipicephalus evertsi evertsi was collected from the upper perineum, lower perineum and the tail. The greatest numbers of ticks were collected from the upper perineum (Table 3.3), and more males than females were recovered. *Rhipicephalus humeralis* (Figure 3.7) was recovered from all collection sites, namely the ear, neck, legs, upper and lower perineum, and the tail, and 22.6% of the buffaloes were infested (Table 3.4). *R. praetextatus* (Figure 3.9) was collected from the ear, neck, lower perineum and the tail (Table 3.3), and 6.5% of the buffaloes were infested. A single specimen of *R. pravus* was collected and it was present on the ear. *Rhipicephalus pulchellus* was recovered in greater numbers than any other tick species (Table 3.3). It was present in all predilection sites, namely the ear, neck, leg, lower perineum, upper perineum and the tail (Table 3.3), and 66.1% of the buffaloes were infested (Table 3.4).

Buffalo Data

Table 3.3 Tick species and their attachment sites on buffaloes (n=62) in the Tsavo Conservation Area, Kenya, during February 2010

Ticks	Ear	Neck	Leg	Upper perineum	Lower perineum	Tail	Total	Percentage of total Tick count
Amblyomma gemma	0	0	23	1	113	2	139	13.0
Amblyomma lepidum	0	0	10	0	23	0	33	3.1
Hyalomma albiparmatum	0	0	6	0	3	6	15	1.4
Hyalomma impeltatum	0	0	0	0	3		3	0.3
Hyalomma rufipes	2	0	1	73	4	20	100	9.3
Hyalomma truncatum	0	0	2	0	0	1	3	0.3
Rhipicephalus evertsi evertsi	0	0	0	30	6	5	41	3.8
Rhipicephalus humeralis	5	3	1	9	6	2	26	2.4
Rhipicephalus praetextatus	1	2	0	0	1	4	8	0.8
Rhipicephalus pravus	1	0	0	0	0	0	1	0.1
Rhipicephalus pulchellus	117	34	43	221	112	175	702	65.6
Total	**126**	**39**	**86**	**334**	**271**	**215**	**1071**	**100.0**

Table 3.4 Ticks sex and prevalence of infestation on buffaloes (n = 62) in the Tsavo Conservation Area, Kenya, during February 2010

Tick Species	**Male**	**Females**	**Total**	**No. of infested buffaloes**	**Average burden of infested buffaloes**	**Proportion of infested buffaloes%**
Amblyomma gemma	121	18	139	29	4.8	46.8
Amblyomma lepidum	24	9	33	16	2.1	25.8
Hyalomma albiparmatum	15	0	15	6	2.5	9.7
Hyalomma impeltatum	3	0	3	1	3	1.6
Hyalomma rufipes	79	21	100	30	3.3	48.4
Hyalomma truncatum	2	1	3	2	1.5	3.2
Rhipicephalus evertsi evertsi	33	8	41	11	3.7	17.7
Rhipicephalus humeralis	17	9	26	14	1.9	22.6
Rhipicephalus praetextatus	7	1	8	4	2	6.5
Rhipicephalus pravus	0	1	1	1	1	1.6
Rhipicephalus pulchellus	165	537	702	41	17.1	66.1
Total	**466**	**605**	**1071**	**62**		**100.00**

Table 3.5 Average tick burdens and prevalence of infestation on cattle and buffaloes in the Tsavo Conservation Area, Kenya, during February 2010

	Cattle		**Buffaloes**	
Tick species	**Mean intensity of infestation**	**% infested**	**Average burden of infested animals**	**% infested**
Amblyomma gemma	8.6	56	4.8	46.8
Amblyomma lepidum	1.6	28	2.1	25.8
Hyalomma albiparmatum	3	8	2.5	9.7
Hyalomma impeltatum	0	0	3	1.6
Hyalomma rufipes	2.2	24	3.3	48.4
Hyalomma truncatum	2	8	1.5	3.2
Rhipicephalus (*Boophilus*) sp.	1	4	0	0
Rhipicephalus evertsi evertsi	2.5	16	3.7	17.7
Rhipicephalus humeralis	0	0	1.9	22.6
Rhipicephalus kochi	1	4	0	0
Rhipicephalus muehlensi	2.1	32	0	0
Rhipicephalus praetextatus	0	0	2	6.5
Rhipicephalus pravus	3.4	52	1	1.6
Rhipicephalus pulchellus	5.8	92	17.1	66.1
All tick species combined	**14.5**	**100**	**17**	**100**

A total of 14 tick species were collected from the cattle and the buffaloes during the project. Eight species, namely *A. gemma, A. lepidum, H. albiparmatum*, *H. rufipes*, *H. truncatum, R. evertsi evertsi, R. pravus and R. pulchellus*, were shared between the cattle and buffaloes (Tables 3.5). Six tick species, namely *H. impeltatum*, *R.* (*Boophilus*) sp*., R. humeralis*, *R. kochi, R. muehlensi* and *R. praetextatus*, were not shared. *R.* (*Boophilus*) sp*., R. kochi, R. muehlensi* were present only on cattle, while *H. impeltatum, R. humeralis,* and *R. praetextatus* were collected only from buffaloes.

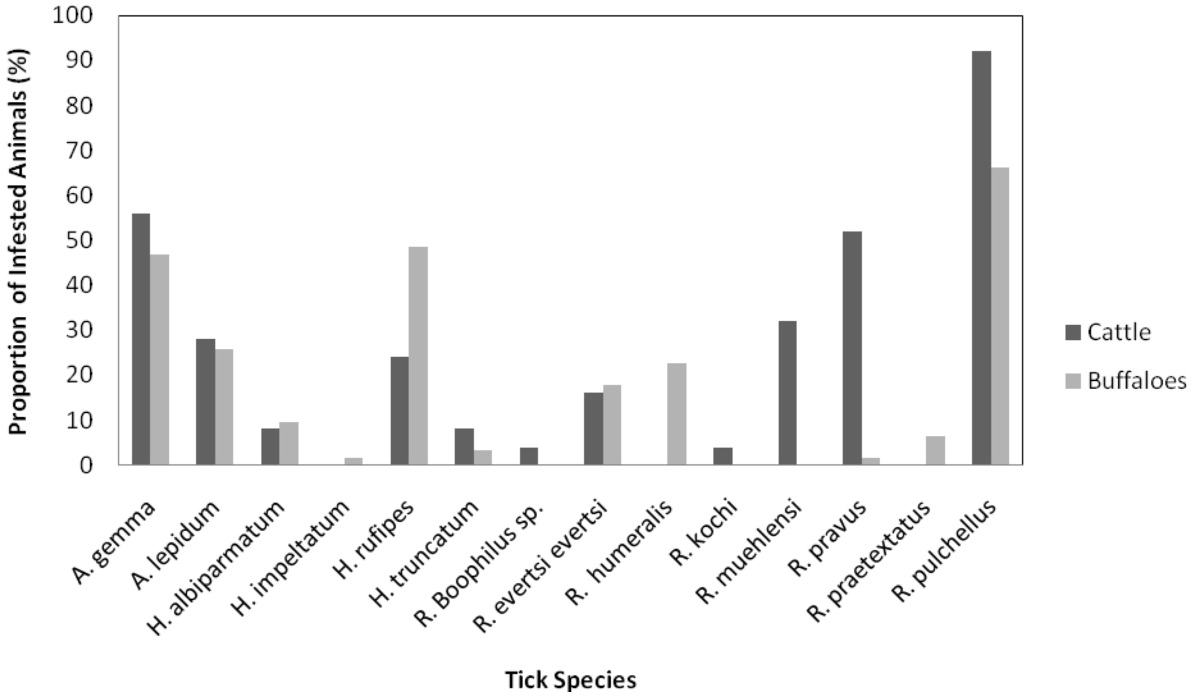


Figure 3.1 Comparison of tick infestation levels on cattle and buffaloes in the Tsavo Conservation Area, Kenya, during February 2010

The localities at which *A. gemma, A. lepidum, H. albiparmatum, H. impeltatum, H. rufipes, H. truncatum*, *R.* (*Boophilus*) sp., *R. evertsi evertsi, R. humeralis, R. muehlensi, R. praetextatus, R. pravus* and *R. pulchellus* were collected are depicted in Figure 3.12 to 3.24.

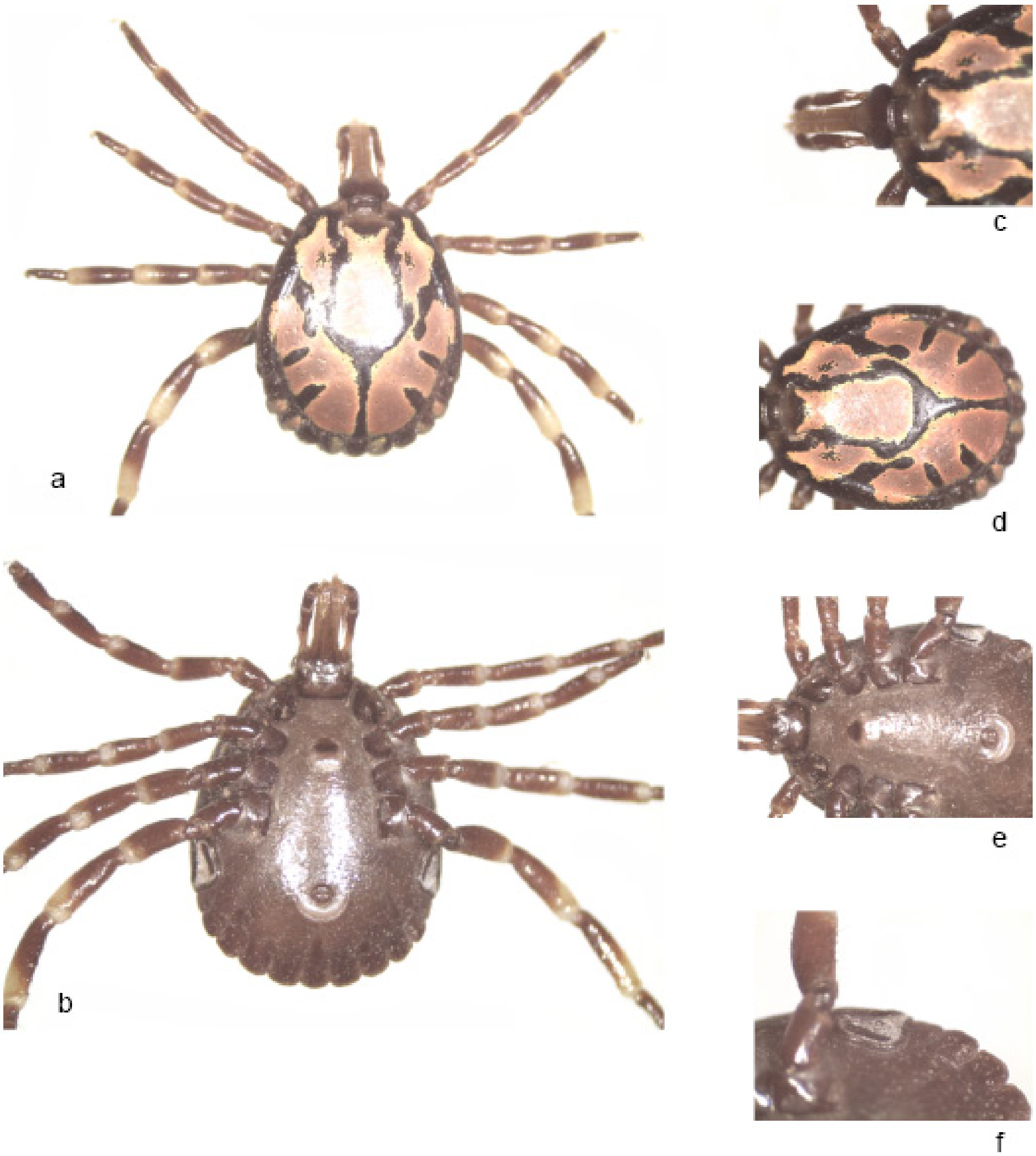
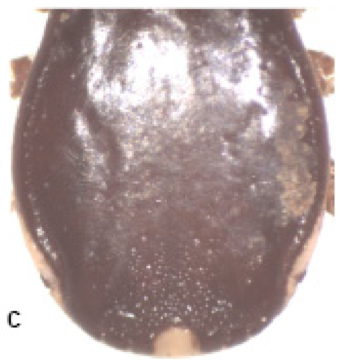


Figure 3.2 *Amblyomma gemma* , (a) Male dorsal view , (b) Male ventral view, (c) long mouthparts, (d) lateral ornate spots attached to the central ornamented spots, about 6 ornate and 5 plain festoons, (e) spurs on the coxae (f) spiracle (g) banded leg

a

b



c

Figure 3.3 *Hyalomma albiparmatum* , (a) Male dorsal view , shiny smooth dorsal part (b) Male ventral view, coxae1-1V, (c) caudal depression with deep punctations and two ridges , central festoon is pale white in colour (e) square end of the adanal plates, subanal plates aligned directly under the adanal plate.

d

a b

Figure 3.4 *Hyalomma impeltatum* , (a) Male dorsal view , long posterior median groove, large paramedian grooves (b) Male ventral view, coxae1-1V, adanal plates with square ends, subanal plate vertically aligned with the adanal plate

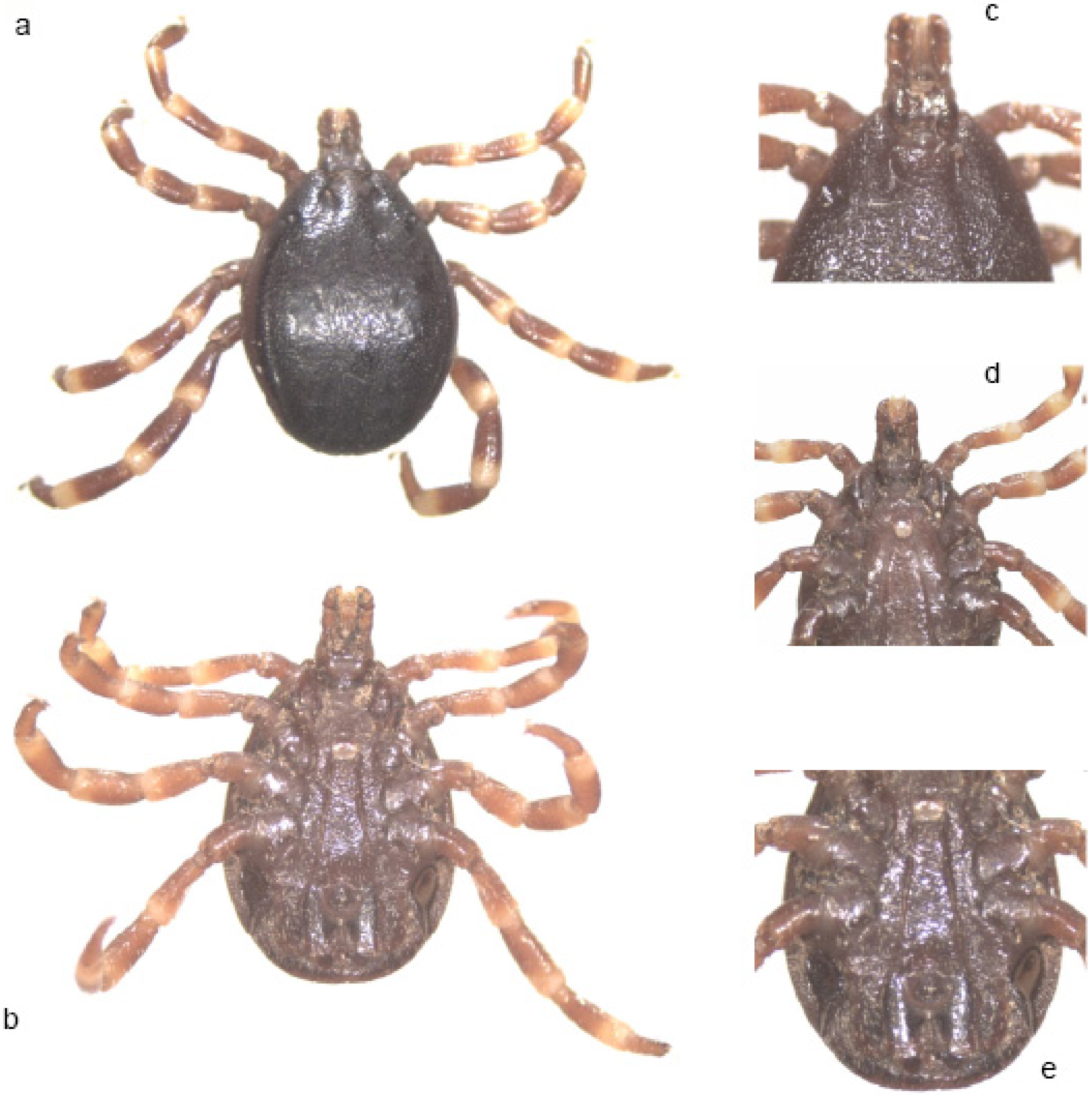


Figure 3.5 *Hyalomma rufipes* , (a) Male dorsal view , (b) Male ventral view, (c) long mouthparts ,heavy punctations (d) coxae I-IV , banded legs (e) square end of the adanal plates, subanal plates aligned directly under the adanal plate. (f) dense setae around the spiracles

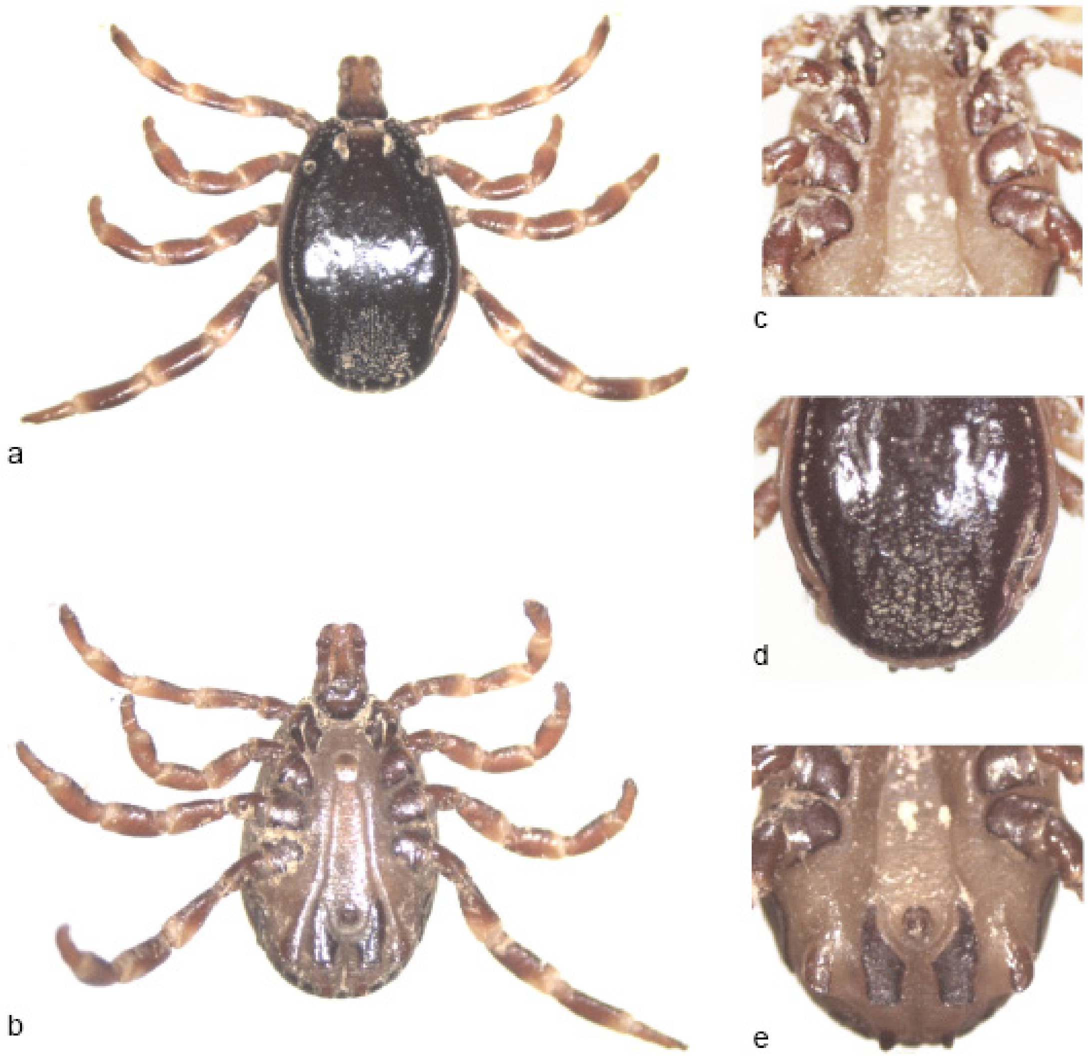


Figure 3.6 *Hyalomma truncatum* , (a) Male dorsal view , (b) Male ventral view, (c) coxae1-1V, (d) caudal depression with deep punctations and two ridges , central festoon is dark in colour and the smooth shiny dorsal surface anterior to the caudal depression (e) square end of the adanal plates, subanal plates aligned directly under the adanal plate.

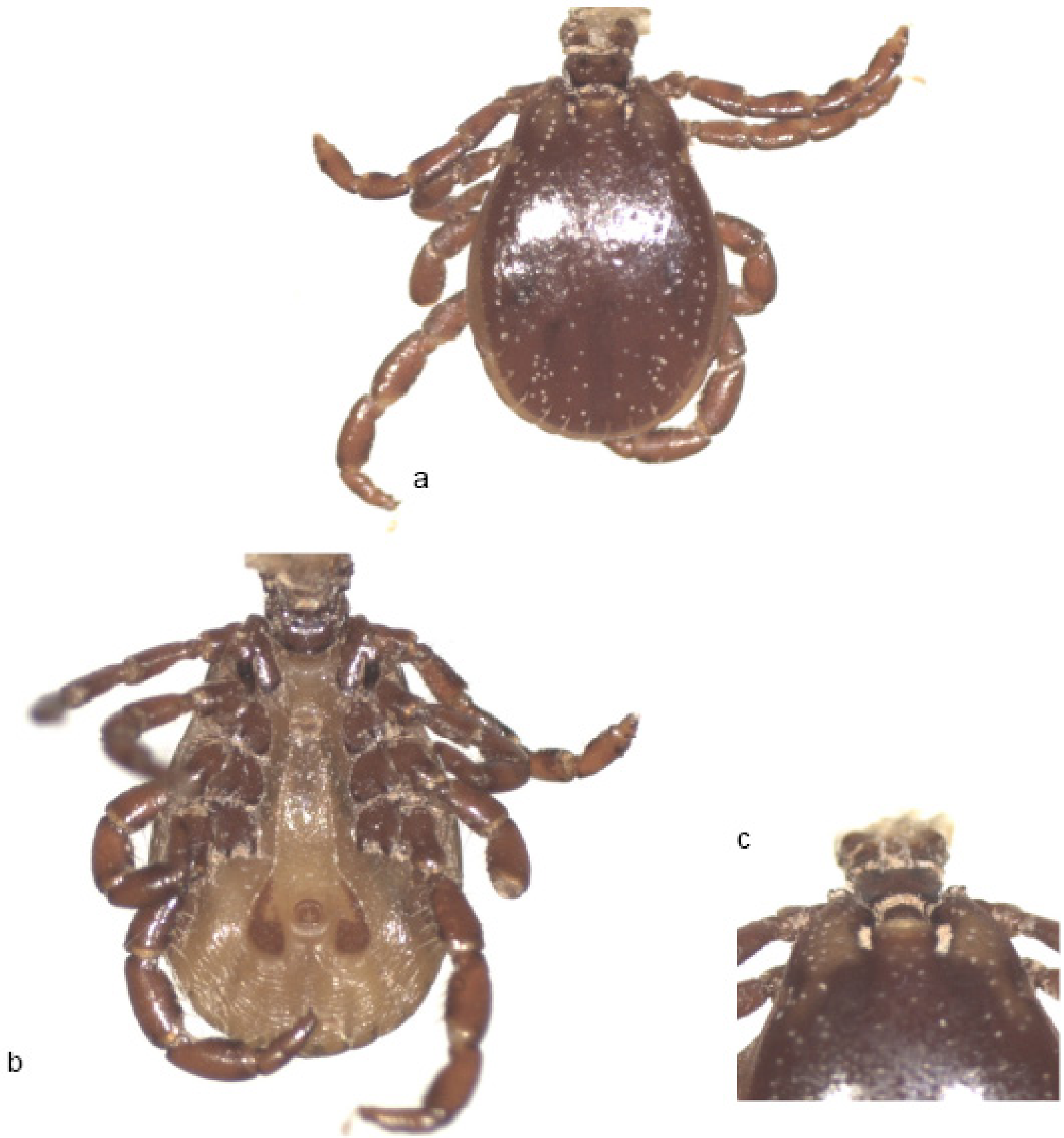


Figure 3.7 *Rhipicephalus humeralis* , (a) Male dorsal view , (b) Male ventral view, (c) the coloured cervical areas

Figure 3.8 *Rhipicephalus muehlensi* , (a) Male dorsal view , (b) Male ventral view, (c) tear shaped adanal plates

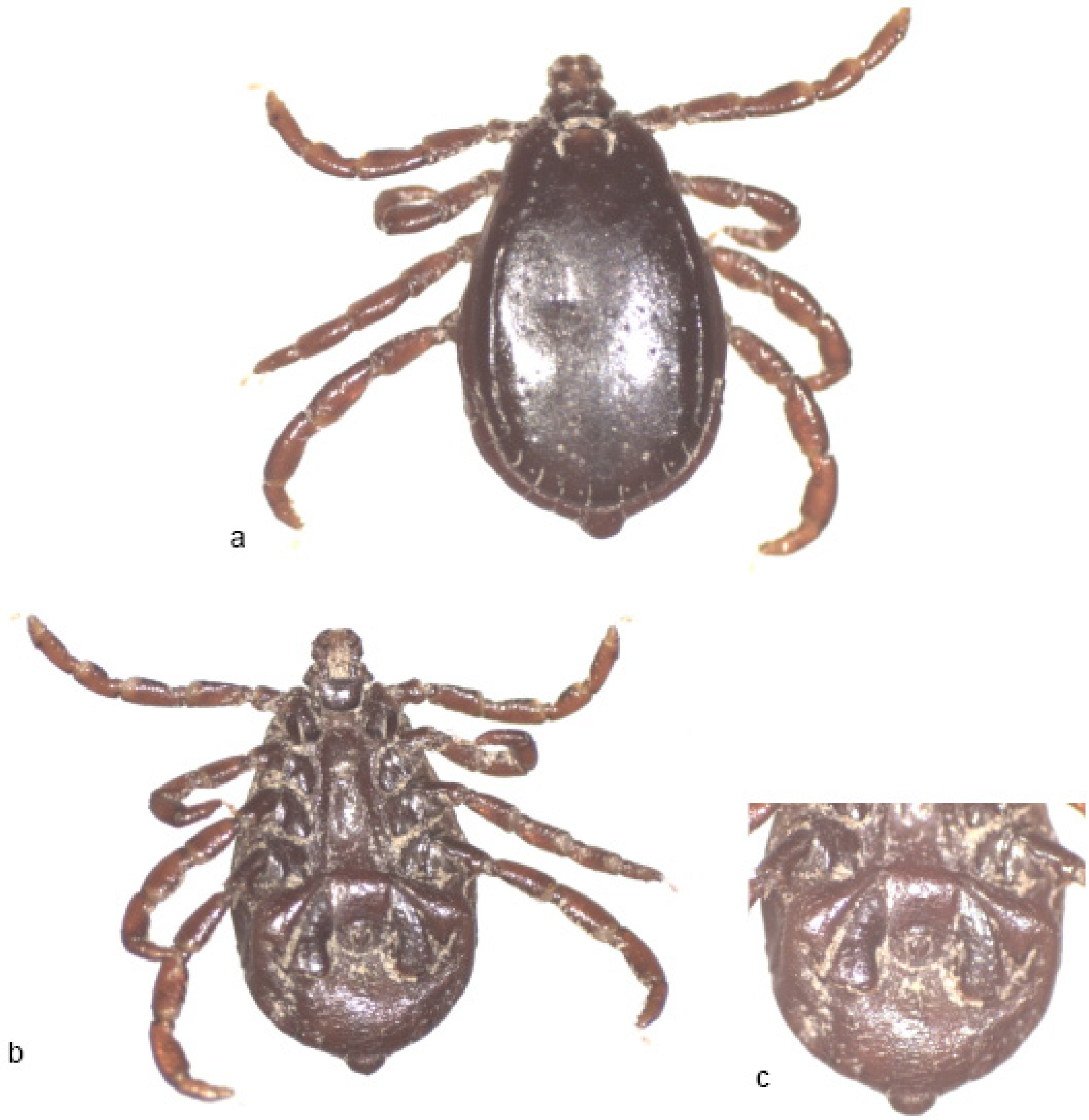


Figure 3.9 *Rhipicephalus praetextatus*, (a) Male dorsal view , (b) Male ventral view, (c) Adanal plates

Figure 3.10 *Rhipicephalus pravus* , (a) Male dorsal view , (b) Male ventral view, (c) adanal plates

a

b

c

d

e

Figure 3.11 *Rhipicephalus pulchellus* (a) Male dorsal side (b) Male vental side (c) female dorsal side (c) male adanal plate (e) male ventral side , spiracles

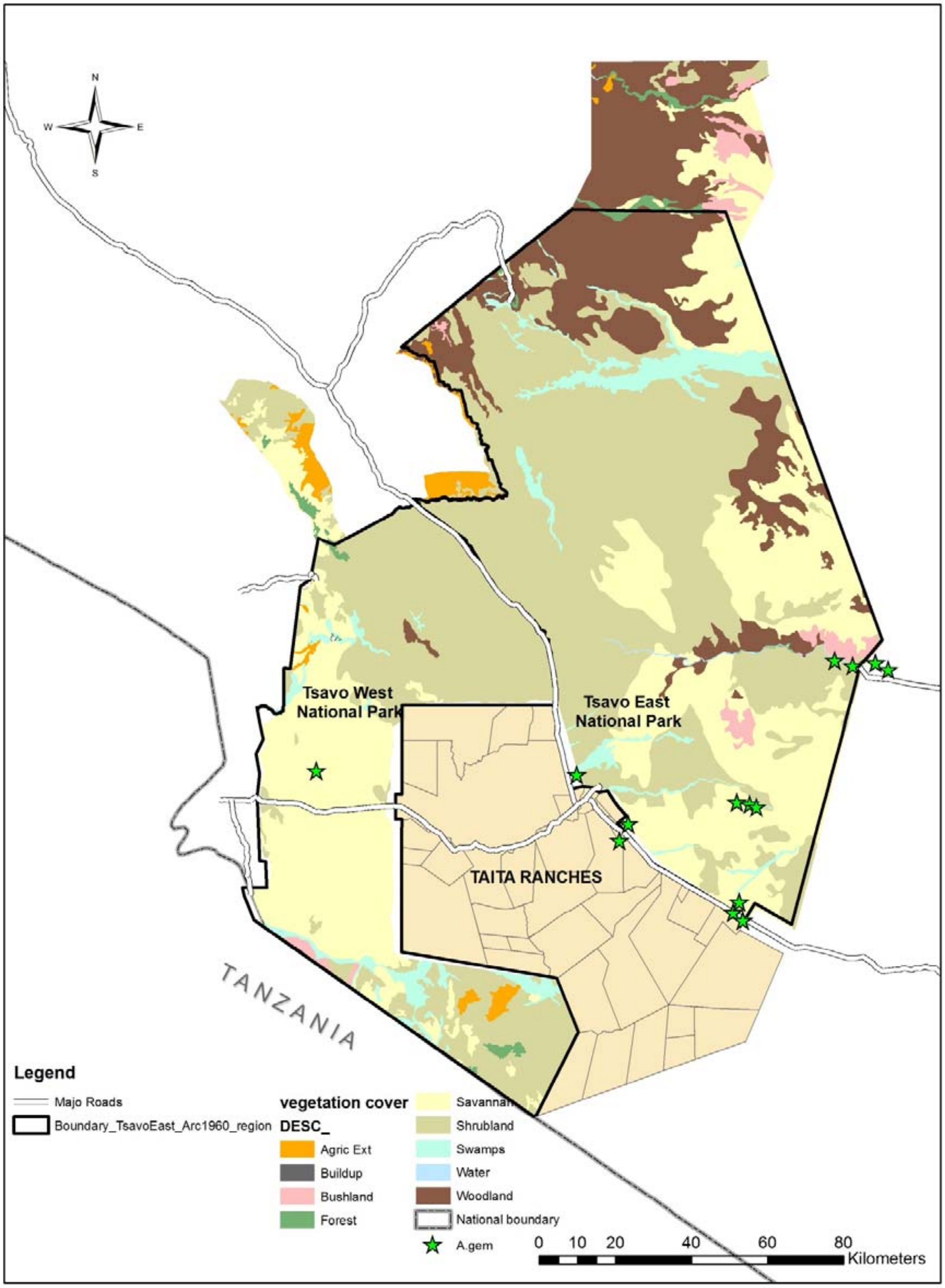


Figure 3.12 Localities at which *Amblyomma gemma* was present on cattle and buffaloes in the Tsavo Conservation Area, Kenya, during February 2010

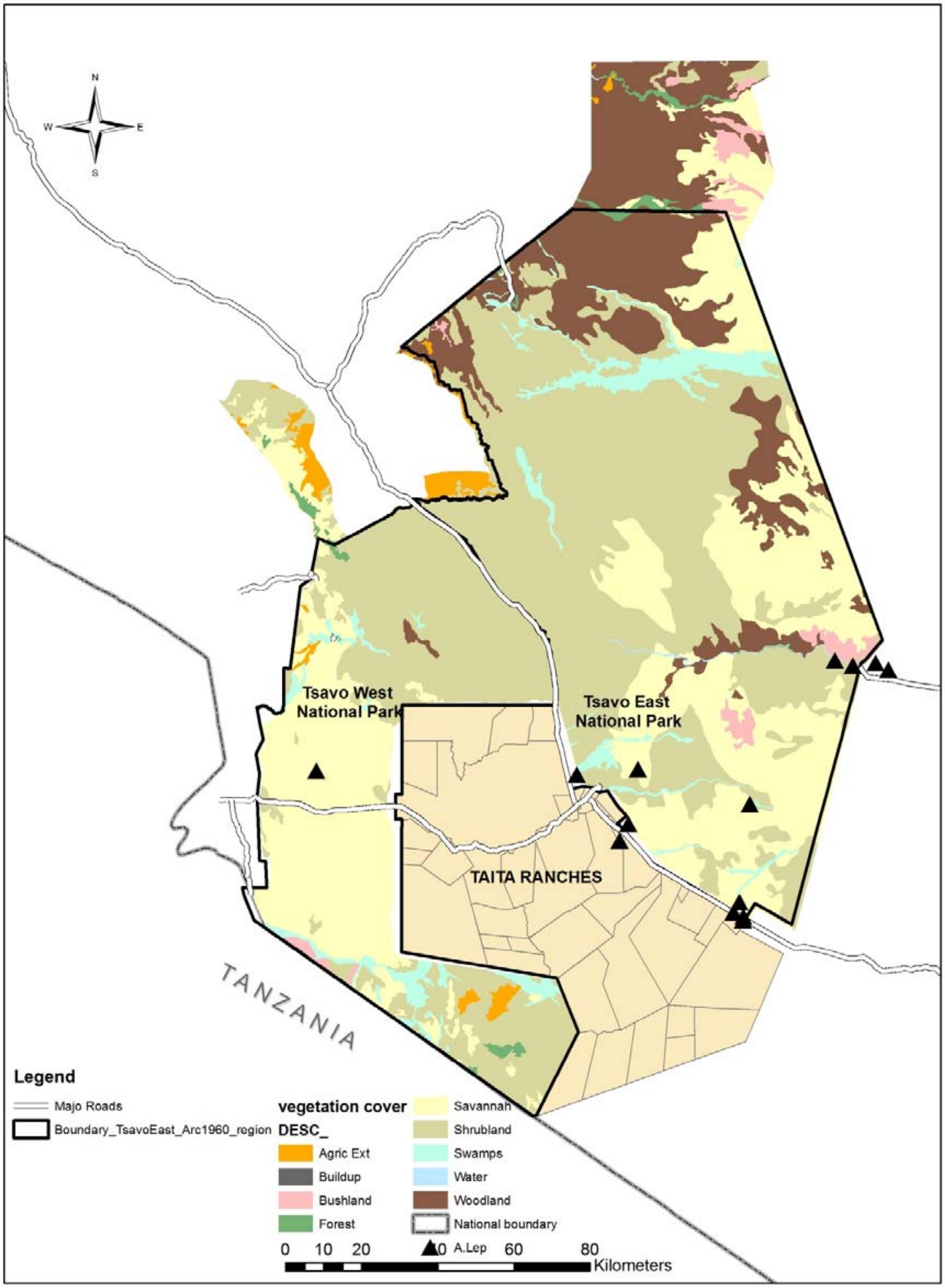


Figure 3.13 Localities at which *Amblyomma lepidum* was present on cattle and buffaloes in the Tsavo Conservation Area, Kenya, during February 2010

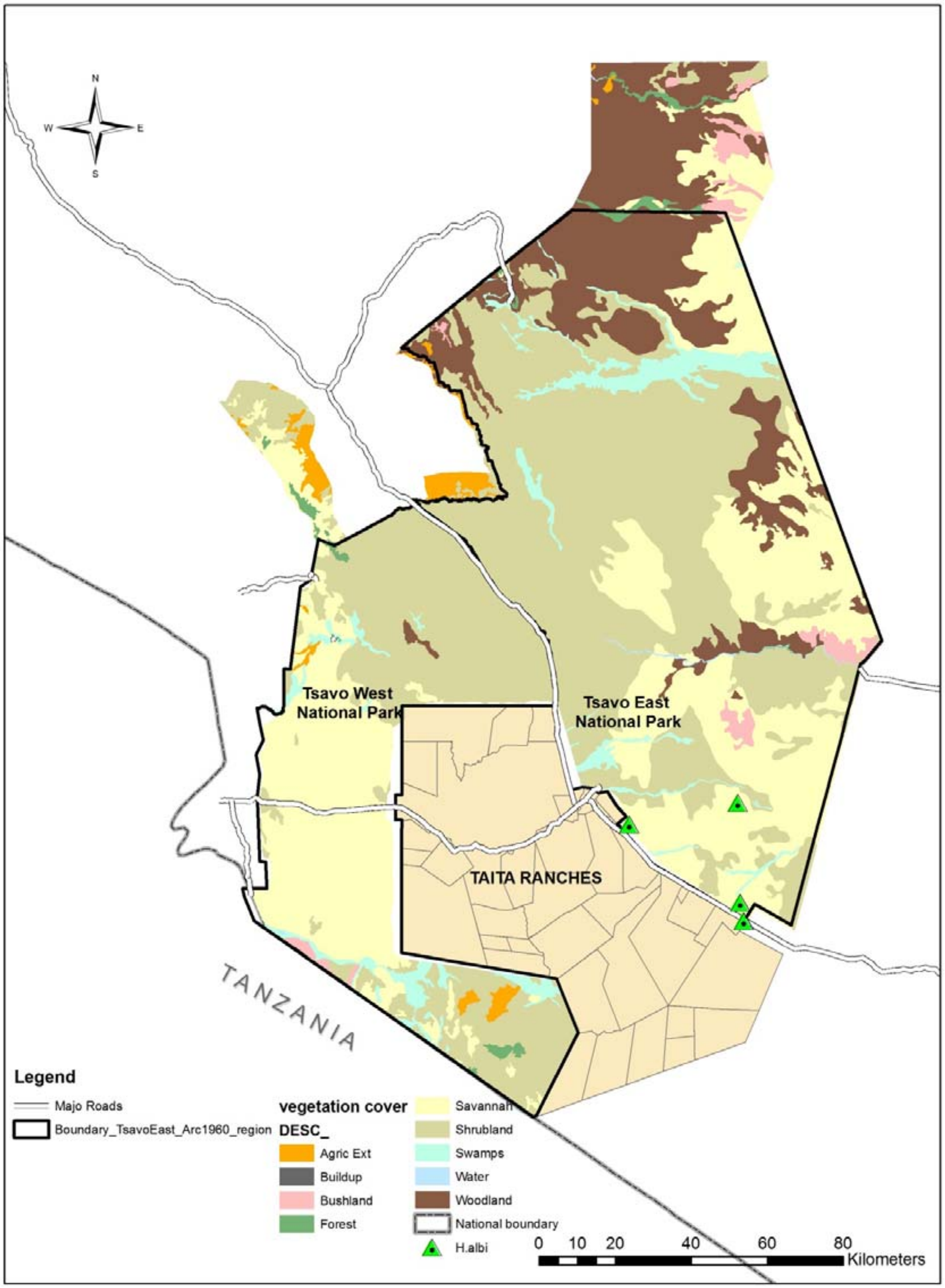


Figure 3.14 Localities at which *Hyalomma albiparmatum* was present on cattle and buffaloes in the Tsavo Conservation Area, Kenya, during February 2010

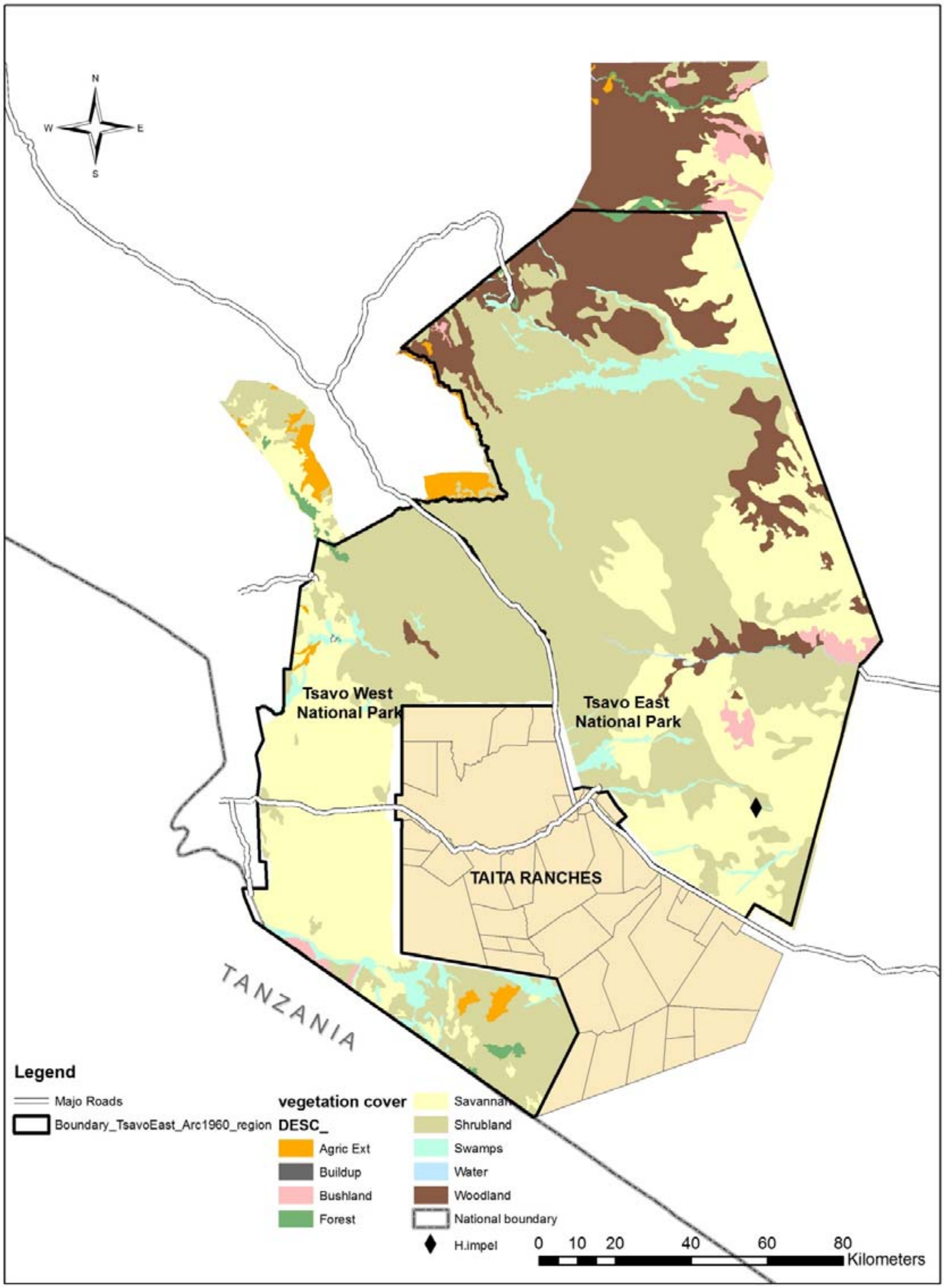


Figure 3.15 Localities at which *Hyalomma impeltatum* was present on buffaloes in the Tsavo Conservation Area, Kenya, during February 2010

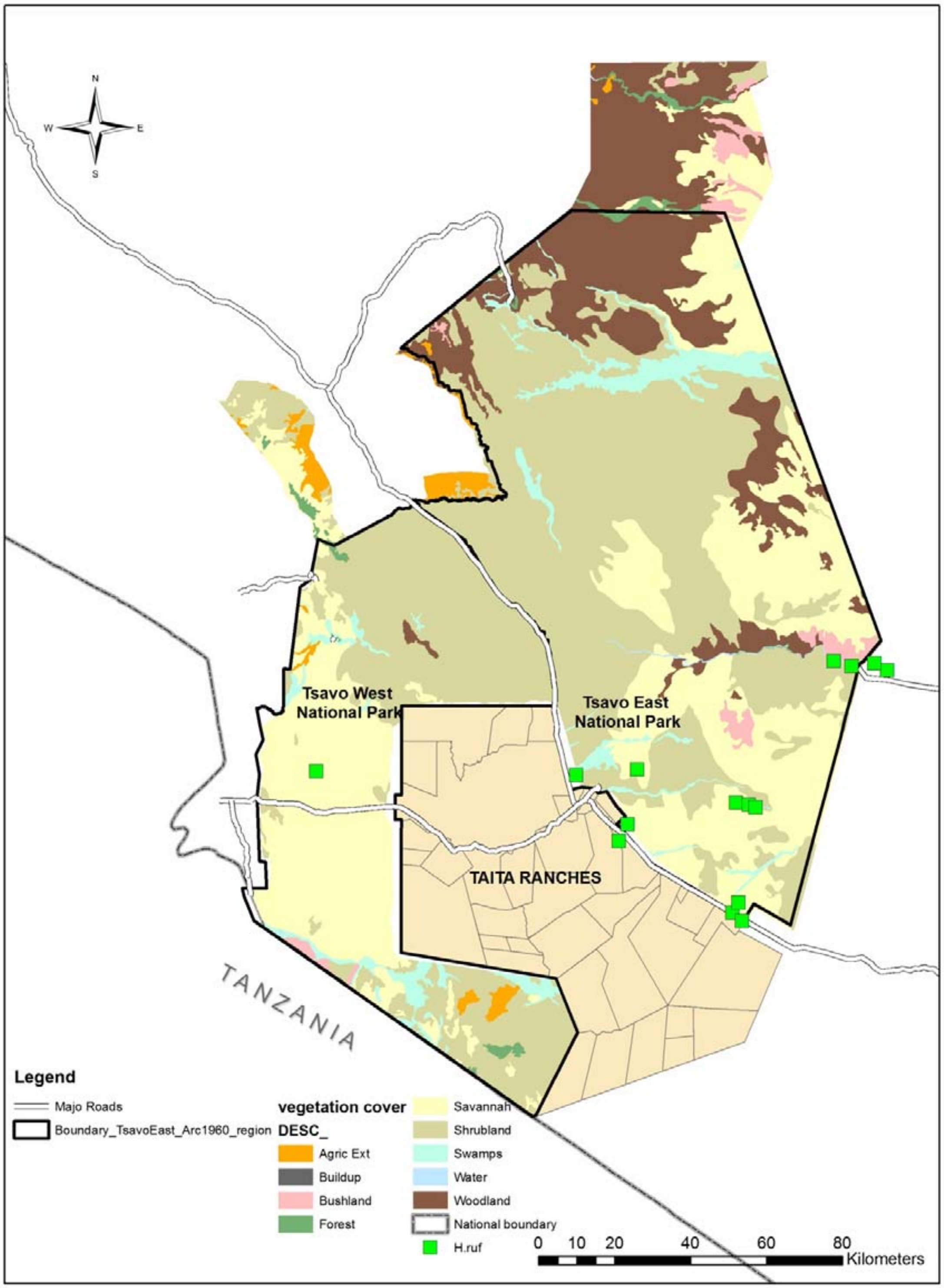


Figure 3.16 Localities at which *Hyalomma rufipes* was present on cattle and buffaloes in the Tsavo Conservation Area, Kenya, during February 2010

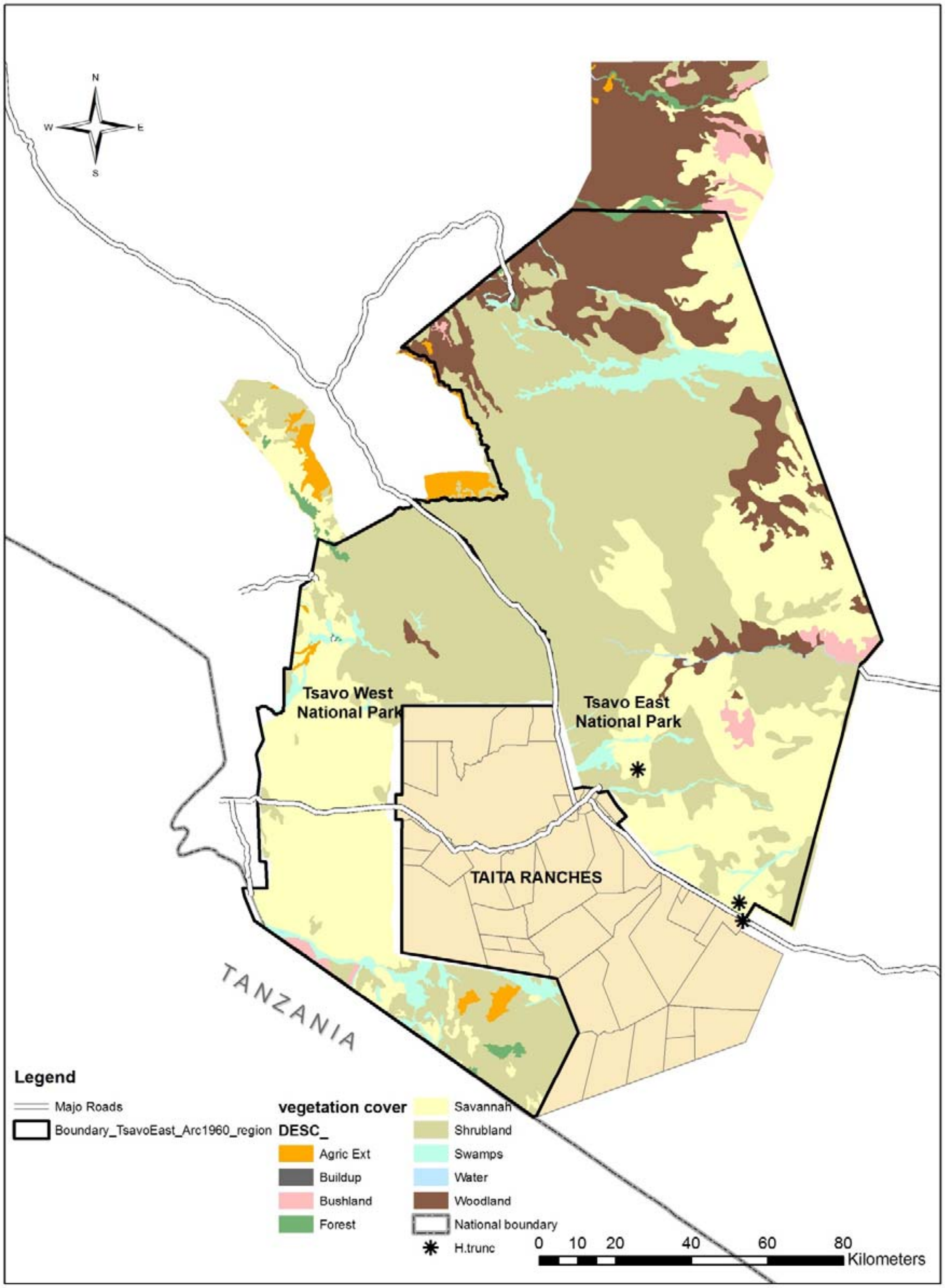


Figure 3.17 Localities at which *Hyalomma truncatum* was present on cattle and buffaloes in the Tsavo Conservation Area, Kenya, during February 2010

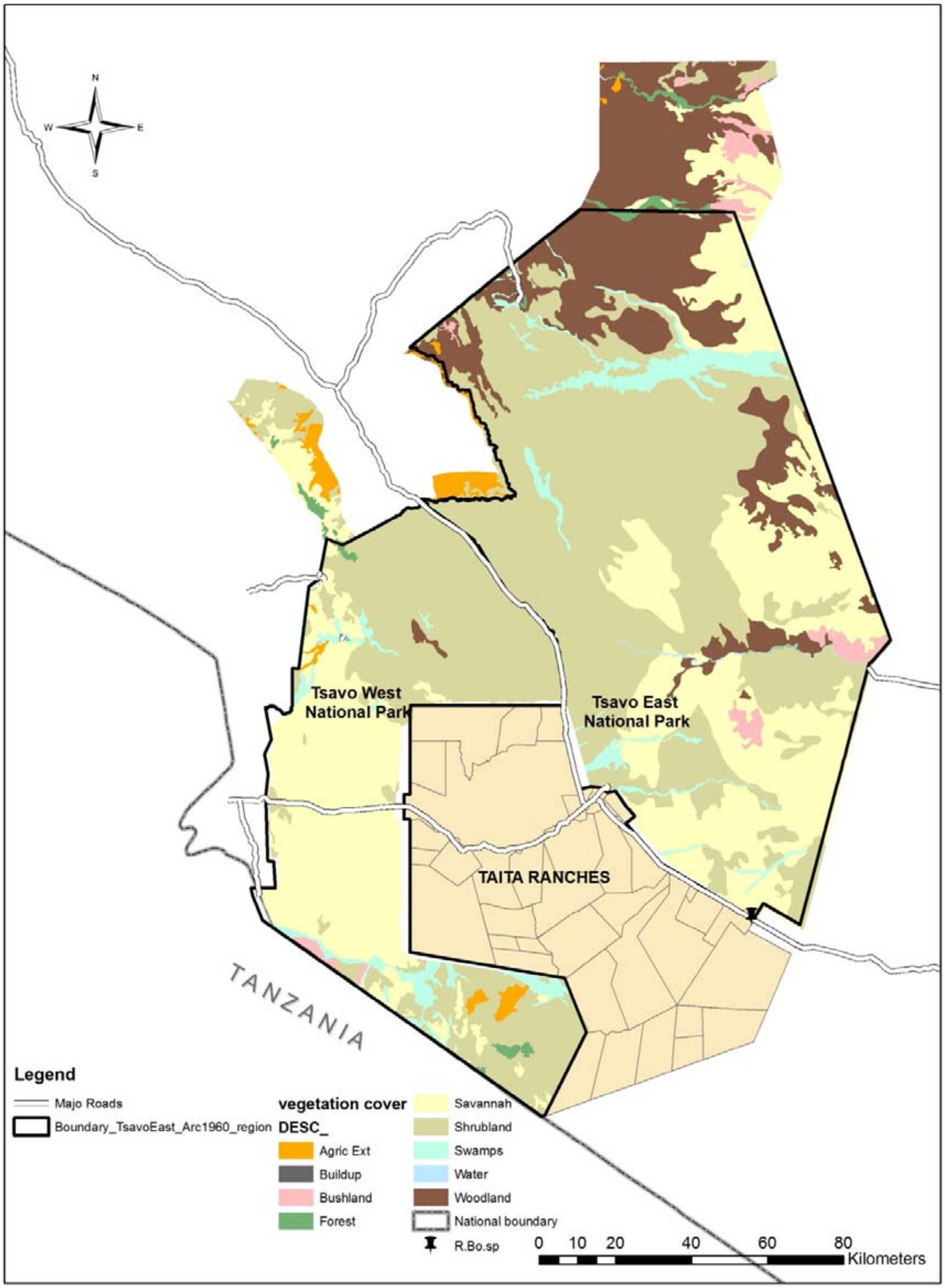


Figure 3.18 Locality at which *Rhipicephalus* sp*. (Boophilus)* was present on cattle in the Tsavo Conservation Area, Kenya, during February 2010

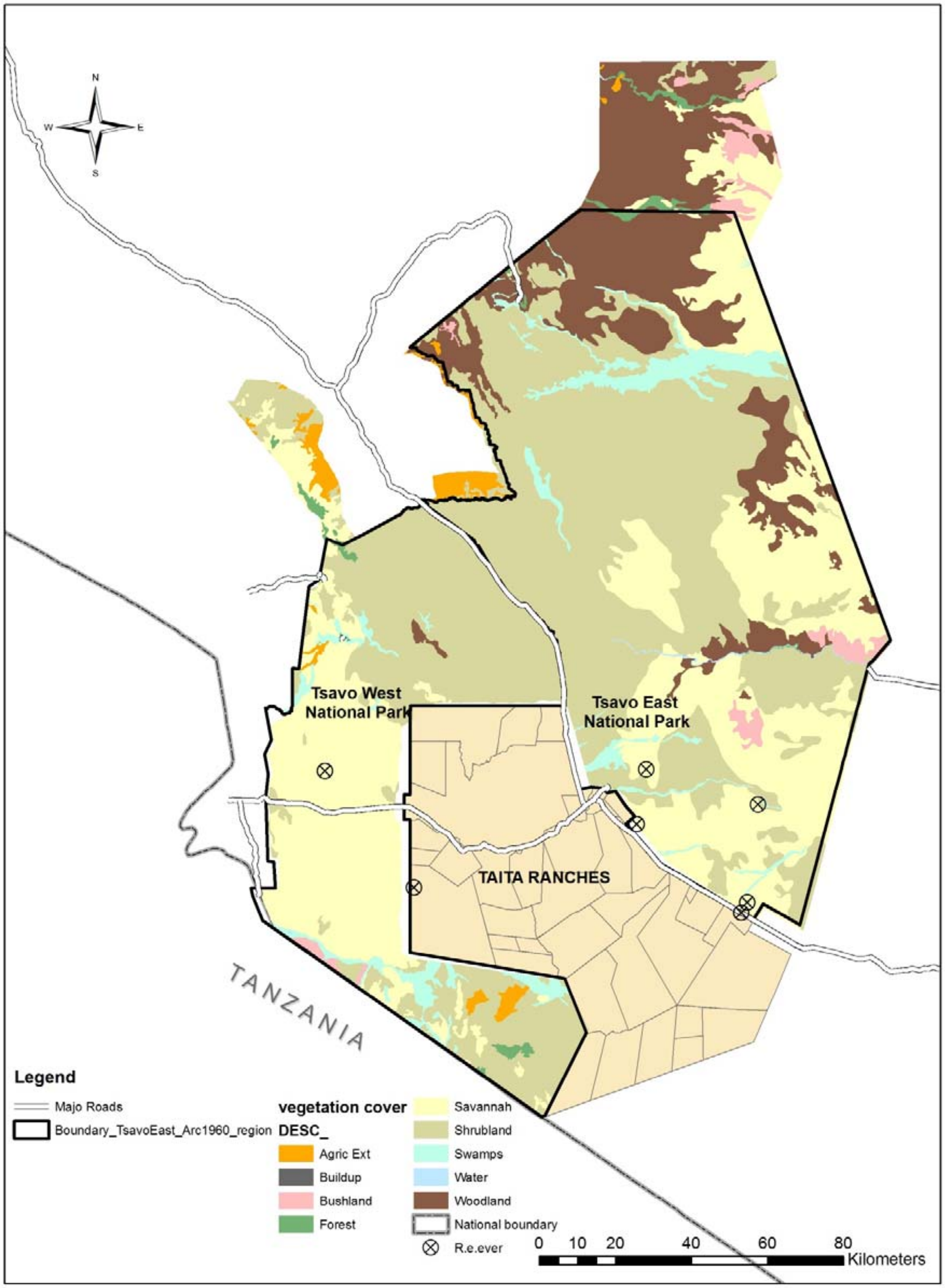


Figure3.19 Localities at which *Rhipicephalus evertsi evertsi* was present on cattle and buffaloes in the Tsavo Conservation Area, Kenya, during February 2010

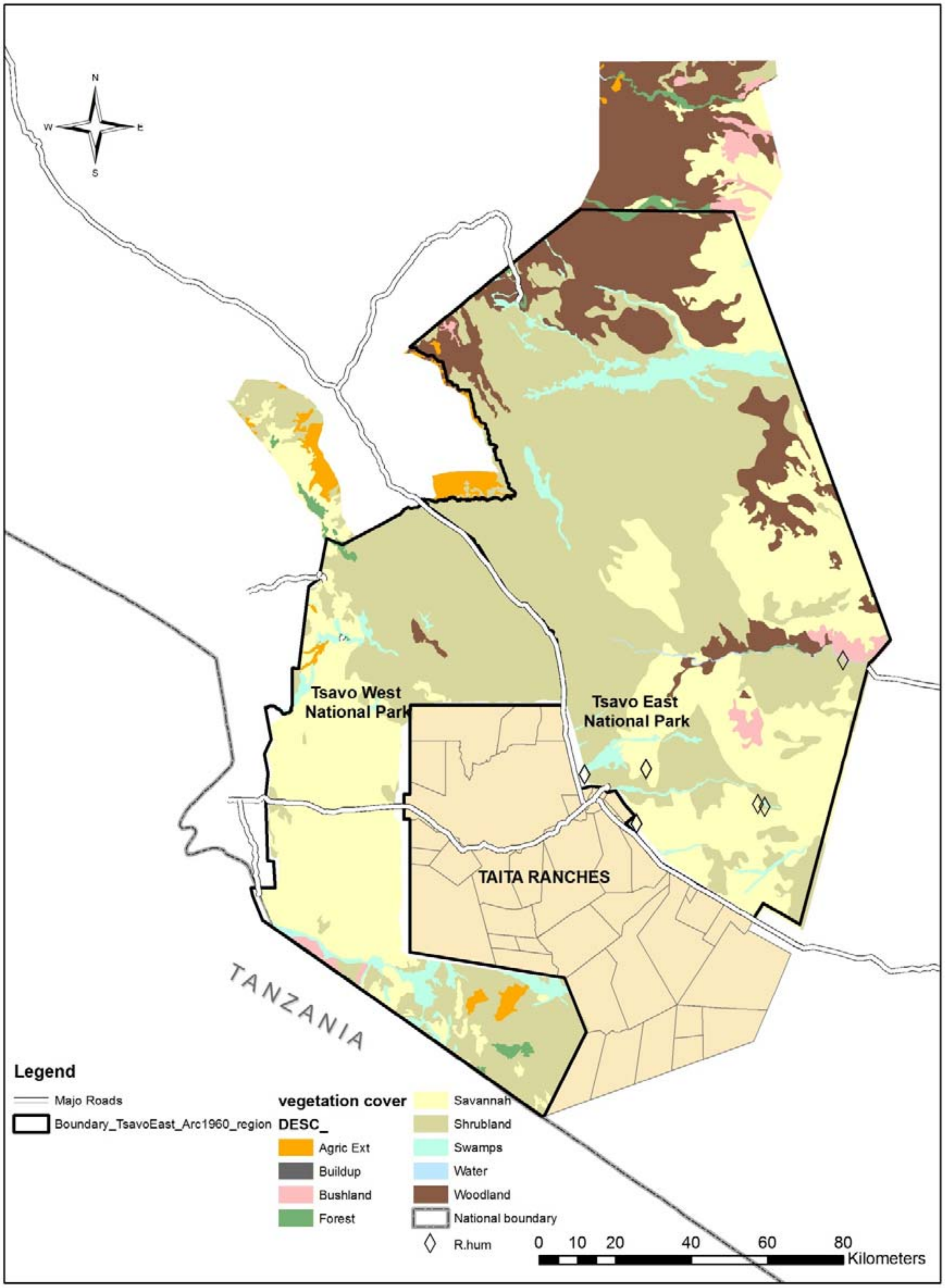


Figure 3.20 Localities at which *Rhipicephalus humeralis* was present on buffaloes in the Tsavo Conservation Area, Kenya, during February 2010

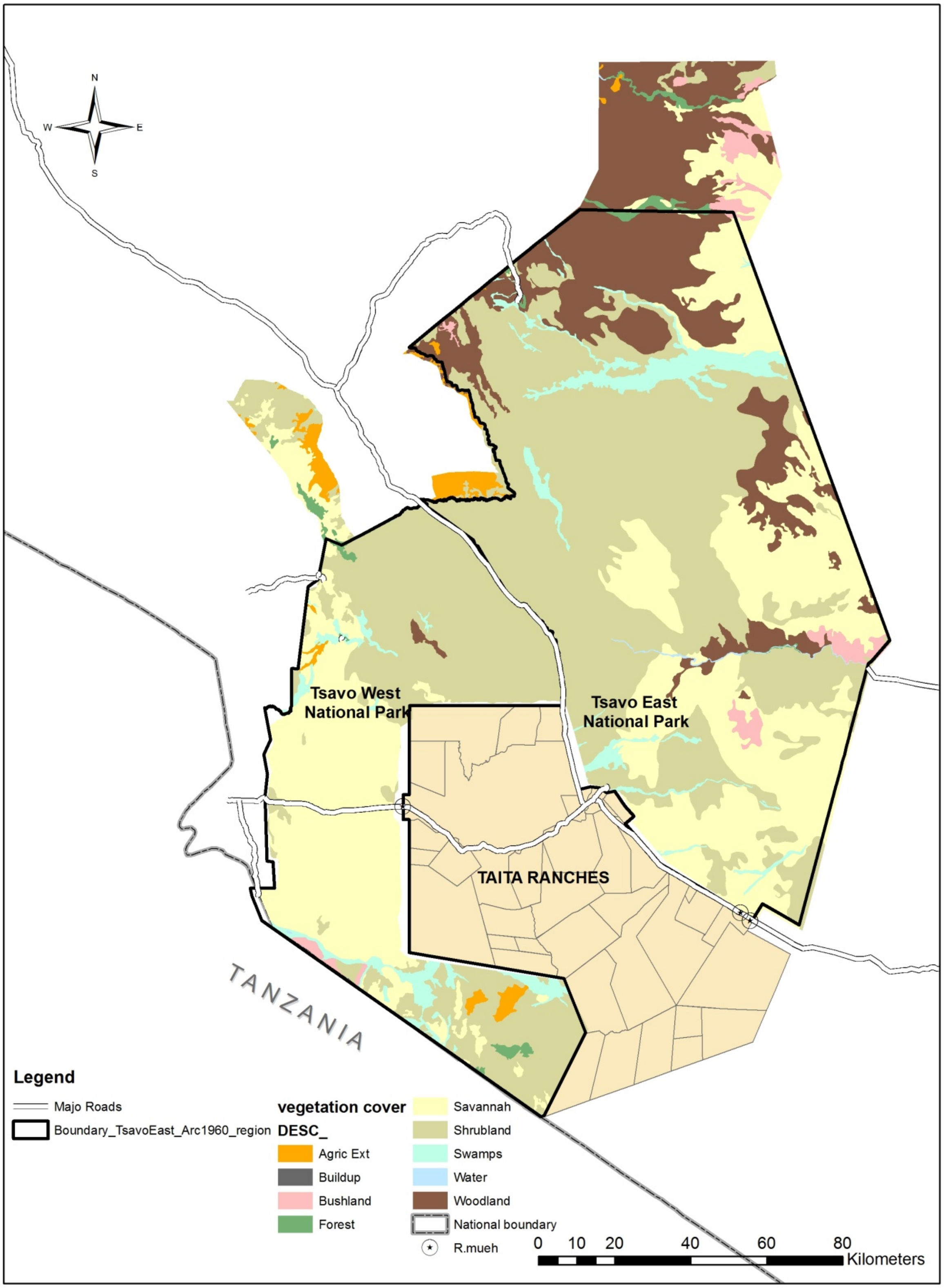


Figure 3.21 Localities at which *Rhipicephalus muehlensi* was present on cattle

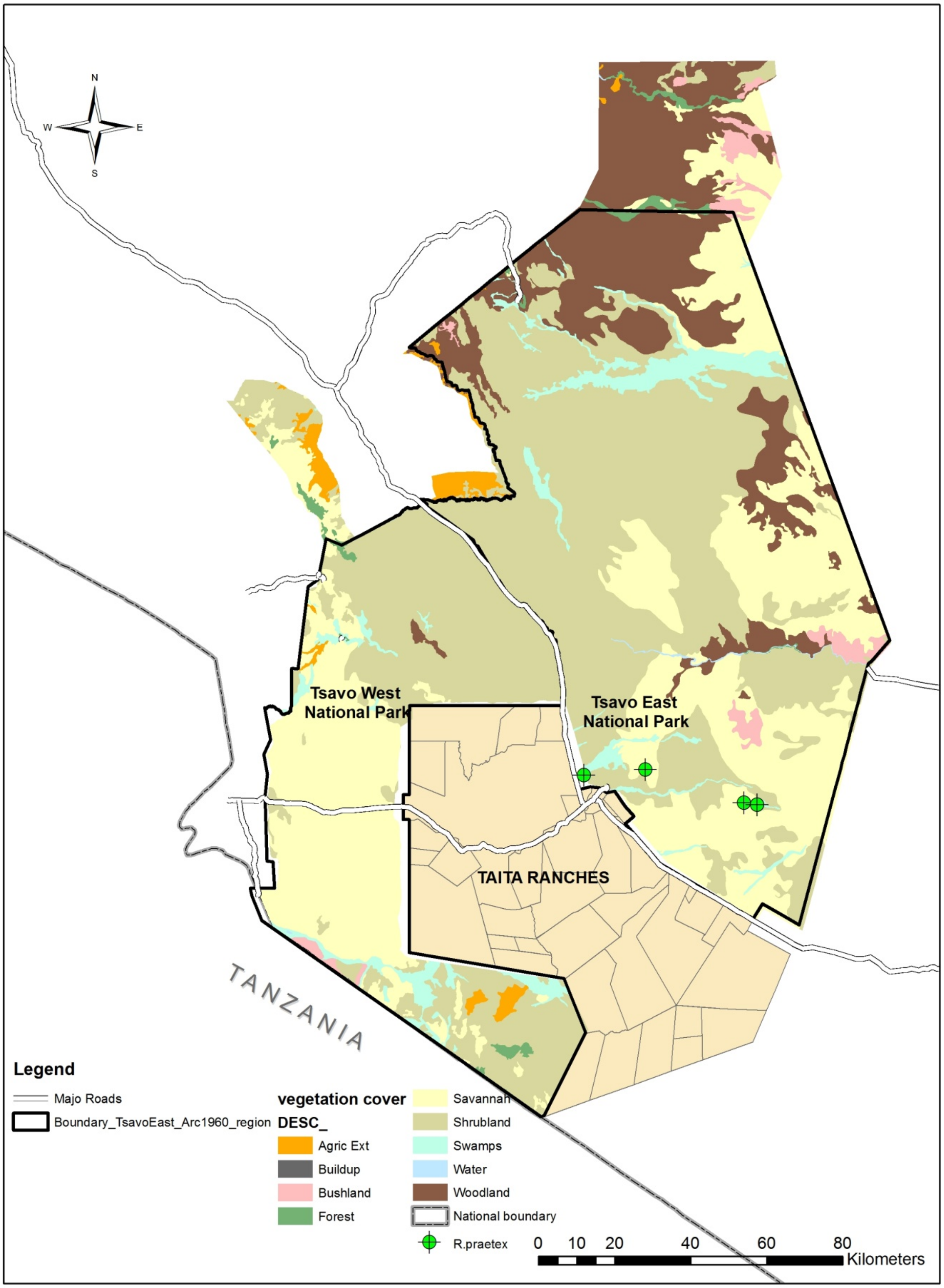


Figure 3.22 Localities at which *Rhipicephalus praetextatus* was present on buffaloes

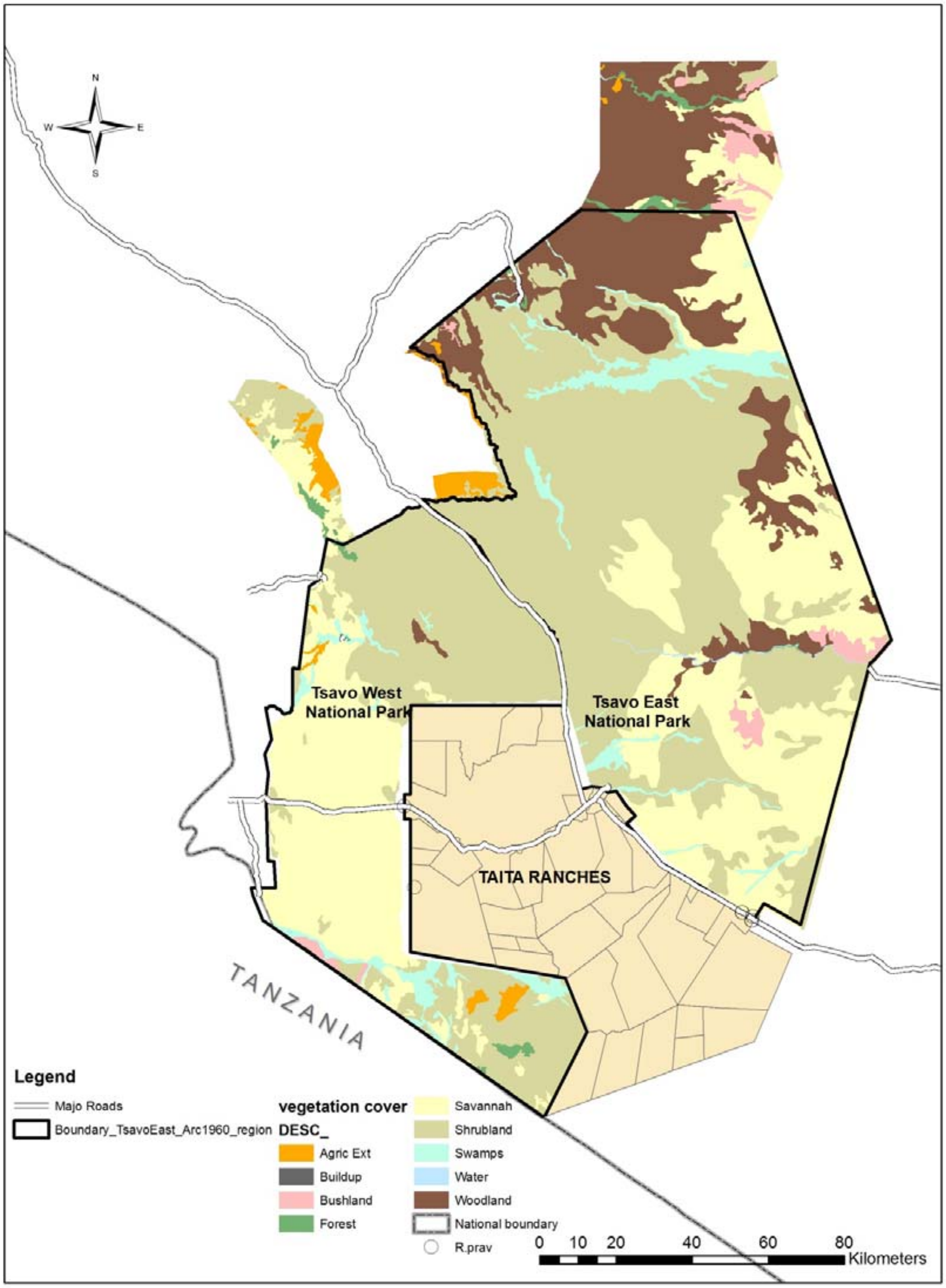


Figure 3.23 Localities at which *Rhipicephalus pravus* was present on cattle and buffaloes in the Tsavo Conservation Area, Kenya, during February 2010

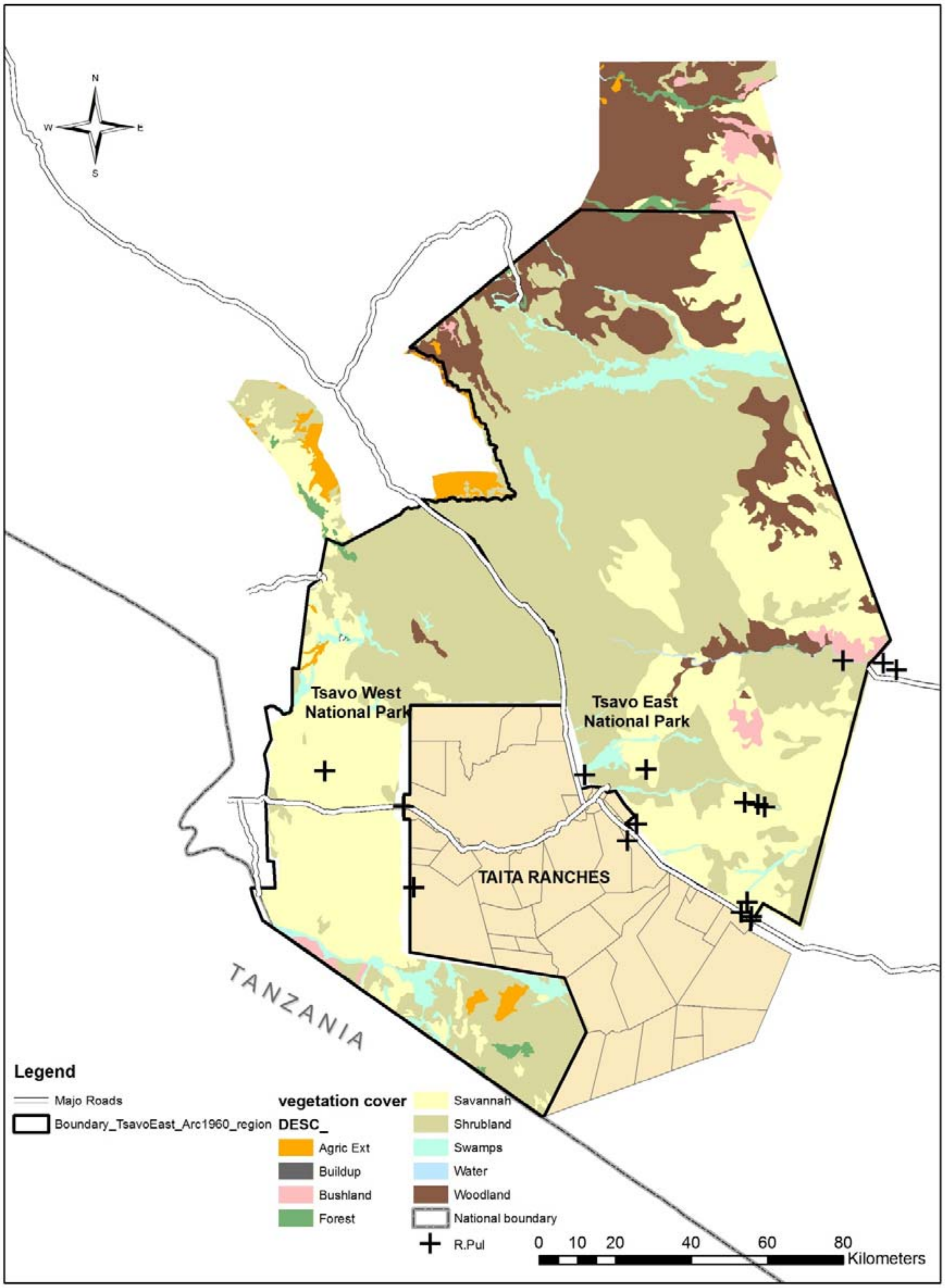


Figure 3.24 Localities at which *Rhipicephalus pulchellus* was present on cattle and buffaloes in the Tsavo Conservation Area, Kenya, during February 2010

CHAPTER FOUR

DISCUSSION

Fourteen ixodid tick species, namely *A. gemma, A. lepidum, H. albiparmatum, H. rufipes, H. truncatum, R. (Boophilus)* sp*, R. evertsi evertsi, R. kochi, R. muehlensi, R. pravus* and *R. pulchellus*, were collected from cattle and buffaloes sampled during the project. *Amblyomma gemma, A. lepidum, H. albiparmatum, H. rufipes, H. truncatum, R. evertsi evertsi, R. pravus and R. pulchellus* were common to both cattle and buffaloes. *Hyalomma impeltatum, R. humeralis, R. praetextatus* were present only on buffaloes, while *R.* (*Boophilus*) sp.*, R. kochi* and *R. muehlensi* were present only on cattle.

AMBLYOMMA GEMMA

Amblyomma gemma was one of the most prevalent ticks in the present study. According to Walker (1974), *A. gemma* is widely distributed in the more arid regions of Kenya and it has been identified in several collections made in the region of the Tsavo Conservation Area. The climate of Tsavo Conservation Area is semi-arid and the tick's presence here confirms Walker's earlier accounts of its widespread distribution in semi-arid areas of Kenya. Furthermore, the vegetation at Tsavo is bushy-grassland with extensive grasslands which also favour the tick (Walker 1974). According to Yeoman & Walker (1967), adult *A. gemma* are primarily parasites of large herbivores. Walker (1974) recorded this species in 368 collections out of 892 (41.3%) made from cattle and in 26 of 119 (21.8%) collections made from buffaloes. The proportion of buffaloes and cattle infested in the present study were similar (buffaloes 46.8% and cattle 56%) (Table 3.5)

Amblyomma gemma was collected from the neck, leg, upper perineum, lower perineum and the tail of cattle. Walker (1974) recorded the ventral parts of the body, including the axilla and perineum as attachment sites for this tick. The ticks were easily seen and collected from the animals. Most of the infested cattle had abscesses at the point of tick attachment, especially on the dewlap and the teats. At other sites at which ticks were collected, small, deep, open wounds were present. These ticks are important in cattle farming because of the damage caused by their mouthparts, while secondary abscessation of wounds on the udder could lead to mastitis in affected cows.

AMBLYOMMA LEPIDUM

This tick, also referred to as the East African bont tick, is reported to be widespread in eastern Sudan, Ethiopia, southern Somalia, eastern Uganda, and Kenya and the northern region of central Tanzania (Walker & Olwage 1987). The present study demonstrates its presence in the Tsavo Conservation Area of Kenya. No ticks were collected from animals in the region at the same latitude as Lake Jipe, thus confirming Walker's (1974) observation that *A. lepidum* could be absent along the Tanzanian/Kenya border. In the current study the tick was common on both cattle (28% infested) and African buffaloes (25.8% infested). It preferred the neck, leg and the lower perineum as attachment sites. This agrees with an earlier study in which it was reported to attach to the ventral surface of the host from the dewlap and axilla to the escutcheon (Yeoman & Walker 1967). *Amblyomma lepidum* is an important parasite of cattle. Not only do its long mouthparts cause damage, but it is also an important vector of *Ehrlichia* *ruminantium*, the causative organism of heartwater in domestic and some species of wild ruminants (Norval & Horak 2004).

HYALOMMA ALBIPARMATUM

Walker (1974) recorded two collections of *H. albiparmatum* from the vicinity of the Tsavo Conservartion Area, with only a few collections made from cattle throughout Kenya and none from buffaloes. In the present study six of the 62 buffaloes examined and two of the 25 cattle were infested, but only small numbers of ticks were collected from the animals that were infested. The ticks were collected from the tail and tailbrush of cattle, and from the tail and lower perineum of buffaloes. The localities at which the tick was collected correspond to those reported by Walker (1974).

HYALOMMA IMPELTATUM

Few collections of *H. impeltatum* have been reported from Kenya and none from the region in which the Tsavo Conservation Area lies (Walker 1974). Its collection in this region has thus added to the limited knowledge of its distribution in Kenya as a whole. A single buffalo was infested and the three ticks it harboured were collected from the lower perineum. No ticks of this species were collected from the cattle, but other reports indicate very high infestations on these animals (Walker *et al*. 2003).

HYALOMMA RUFIPES

Because of concerns on the earlier identification of ticks as *H. rufipes* Walker (1974) lists several records in Kenya as unconfirmed. Walker's records indicate that *H. rufipes* is widespread in the southern half of Kenya, with three confirmed and two unconfirmed records from the Tsavo Conservation Area (Walker 1974). A further 15 distribution records for *H. rufipes* in this region can now be added. Walker (1974) reported 25 confirmed records of collections from cattle and five from buffaloes. In the current survey, *H. rufipes* was collected from both cattle and buffaloes. Ticks were recovered from the upper perineum and the tail of cattle and from the ear, legs, lower perineum and the tail of buffaloes. The greatest number of ticks was collected from the upper perineum, while Yeoman & Walker (1967) reported most records from the peri-anal region.

HYALOMMA TRUNCATUM

Most of Walker's 1974 records for *H. truncatum* originate from the south-west of Kenya with none from the region of the Tsavo Conservation Area or from the whole south-eastern region. The current records of *H. truncatum* are the first in the south-east of the country, far removed from those in the south-west and central regions of Kenya. Walker (1974) records 31 confirmed identifications of *H. truncatum* from 892 collections from cattle and 10 from 119 collections from buffaloes. In the present study, two of 25 cattle and two of 62 buffaloes were infested with this tick. *Hyalomma truncatum* was present on the legs and tail of buffaloes, and on the upper perineum and tail of cattle. The attachment sites of the tick are in agreement with earlier findings on the tick's predilection sites by Hoogstraal (1956), who in addition recorded it from the hooves and the scrotum and udder.

RHIPICEPHALUS (BOOPHILUS) SP.

The single tick of this genus was collected from a cow. Due to damage to its mouthparts, it could not be identified specifically.

RHIPICEPHALUS APPENDICULATUS

Although *R. appendiculatus* was not recovered in this project, its absence is worth mentioning. Walker (1974) records a cluster of seven collections in the region of the Tsavo Conservation Area, but we recoverd no ticks of this species from cattle or buffaloes in this region. A project to determine the distribution of *R. appendiculatus* in this region should yield interesting and important results.

RHIPICEPHALUS EVERTSI EVERTSI

Collections of *R. evertsi evertsi* were common from cattle and buffaloes. The results support previous data, which indicate that the preferred hosts of the tick are large animals such as cattle, horses, elands (*Taurotragus oryx*) and zebras (Walker 1974; Norval 1981; Horak, Fourie, Novellie, & Williams 1991). It has also been collected from African buffaloes in Botswana (Carmichael 1976). Walker (1974) records the tick's presence in the Coastal Province of Kenya at Malindi, Taita, Maktau, Taveta and Kilifi, but by far the majority of her collections originate from the south-west of Kenya. In this study infestation rates were slightly higher on buffaloes than on cattle (Table 3.5). Ticks collected from the cattle were attached in the upper perineum, while those from buffaloes were present on the upper and lower perineum, and the tail (Table 3.1 & Table 3.3). The presence of the ticks on the upper perineum of cattle and buffaloes confirms earlier findings that the peri-anal region is the preferred attachment site for this species (Hoogstraal 1956; Baker & Ducasse 1967). It is also known to occur at other sites such as the neck, genitalia, fetlocks and heels (Yeoman & Walker 1967).

RHIPICEPHALUS HUMERALIS

Collections of *R. humeralis* were made only from buffaloes and no ticks were recovered from cattle. This differs from the records of Walker (1974), who found 16 of 892 collections from cattle to be positive. However, the chance is high that the tick is well controlled on cattle because of the use of acaricides. Although only one of 119 collections of ticks from buffaloes was previously found to be positive for this tick (Walker 1974), we recovered ticks from 14 of 62 buffaloes sampled. *Rhipicephalus humeralis* was collected from the ear, neck, legs, upper and lower perineum, and tail of buffaloes. In the single collection from buffaloes recorded by Walker (1974), the ticks were present on the rump of the animal. The ticks collected during the present study were recovered from buffaloes in bushed grassland vegetation of Tsavo, similar to the grasslands recorded by Walker (1974). Judging from Walker's results and the present findings, the tick seems to be sparsely distributed in Kenya.

RHIPICEPHALUS KOCHI

A single tick of this species was collected and that from cattle. The presence of this tick in the region of the Tsavo Conservation Area agrees with the single record of its occurrence at Taveta in south-eastern Kenya (Walker 1974). Though not found on buffaloes during the study, records on African buffaloes have been made in other studies (Walker, Keirans & Horak 2000).

RHIPICEPHALUS MUEHLENSI

Ticks of this species were collected from cattle and none were found on buffaloes. The ears were their preferred site of attachment, confirming records from nyalas (*Tragelaphus angasii*) (Horak, Boomker & Flamand 1995). Although no *R. muehlensi* was collected from buffaloes in this survey, it has been collected from these animals in other studies (Horak, Potgieter, Walker, De Vos & Boomker 1983; Walker *et al.* 2000). Most collections of *R. muehlensi* have been taken from cattle and nyalas, and by comparison there are relatively few records from buffaloes (Walker *et al.* 2000). Walker (1974) records no collections from buffaloes in Kenya. The present findings indicate that buffaloes may not be very good hosts, confirming earlier results in South Africa (Horak *et al*. 1983). The presence of this tick on cattle in Taita district has previously been reported by Walker (1974). In the present study all ticks were collected from cattle in bushed grassland within the Tsavo Conservation Area. The present collection of *R. muehlensi* in Taita district is in line with the records that it is present in all African countries with an eastern seaboard from Somalia to South Africa (Walker *et al*. 2000). Annual rainfall in the major portion of this tick's distribution zone varies from 500–1000 mm, but it is also present in regions in Somalia where rainfall is possibly less than 200 mm per annum (Walker *et al*. 2000). The sites at which *R. muehlensi* was collected in the Tsavo Conservation Area receive 350–450 mm of rainfall annually. No ticks were collected from the area of Tsavo receiving 200-700 mm of rainfall, but this may have been due to the small number of cattle sampled. Chances are high that we would have needed 10 animals or more to be able to conclude the tick's absence in this area.

RHIPICEPHALUS PRAETEXTATUS

Rhipicaphalus praetextatus was collected primarily from buffaloes and none was found on cattle during the study period. Where the tick does occur on cattle, it is reported to occur as moderate to light infestations (Walker *et al.* 2000). As previously reported (Walker *et al*. 2000), buffaloes are good hosts of this tick. *R. praetextatus* collected from buffaloes during this study preferred the ear, neck, lower perineum and tail for attachment, with the highest number of ticks collected from the tail. Because of confusion over the identification of this tick and *R. simus*, the locality records for *R. praetextatus* in Kenya are all presumed records (Walker *et al*. 2000). The present records now confirm the presence of *R. praetextatus sensu stricto* within the Tsavo Conservation Area.

RHIPICEPHALUS PRAVUS

Rhipicephalus pravus is a common tick on buffaloes and cattle, and prefers the ears as an attachment site (Walker 1974; Yeoman & Walker 1967; present study). The single female tick collected from a buffalo in this study was attached to the ear, while on cattle they were attached to the ear, leg and lower perineum. Attachment of *R. pravus* to the leg and lower perineum confirms earlier findings that they may attach at various sites on the animal's body, namely the outside of the ear and its base, the horn base, eyelids, commisures of the lips, the neck, dewlap, brisket, abdomen, udder, escutcheon, perineum, groin and heels (Yeoman & Walker 1967).

The presence of *R. pravus* in the Kenyan coastal area was suspected, but not proven (Walker 1974). Collections of the tick made at the Bachuma-Miaseni cattle dip (Formally

Taita Taveta district) in Coastal province in this study prove its presence in this region. Since all the cattle sampled were reared in a pastoral system of farming, chances of the tick spreading towards the shore line of Kwale, Kiliffi and Malindi district, which were previously reported as suspect districts for the tick (Walker 1974) are very high. Walker (1974) recorded three unconfirmed collections of *R. pravus* from the 119 buffaloes from which collections were made. In this study a single female tick was collected from the buffaloes sampled at Luarenyi ranch at the level of Lake Jipe. Luarenyi area is adjacent to Maktau where the presence of the tick has been confirmed (Walker 1974). Based on the results of this study, it is clear that *R. pravus* within the area of study prefers cattle as hosts when compared to buffaloes. Furthermore, no collections were made from buffaloes within the immediate vicinity of cattle from which collections were made. Bachuma (TENP) is semi-arid and receives 350–400 mm of rainfall annually. This climatic condition is conducive for the presence of *R. pravus*, which has been recorded in areas with a mean annual rainfall of 250 mm to over 1000 mm (Walker *et al.* 2000).

RHIPICEPHALUS PULCHELLUS

This tick was the most numerous of the tick species collected from both cattle and buffaloes; the proportion of animals infested was also the highest with, cattle at 92% and buffaloes at 66.1% (Figure 3.5). The high proportion of infested cattle agrees with records for some regions of eastern Ethiopia and northern Somalia, where *R. pulchellus* is the most common tick on domestic livestock (Pegram 1976; Pegram, Hoogstraal & Wassef 1981). *Rhipicephalus pulchellus* comprised the highest proportion of all the ticks collected from both the cattle at 37% and buffaloes at 65.6% (Table 3.1 and Table 3.3). These results are lower than those in Harar province in Ethiopia where *R. pulchellus* accounted for 90% all ticks collected from cattle (Walker *et al.* 2000). *Rhipicephalus pulchellus* was present in all six collection sites on the body of cattle, namely ear, neck, legs, upper and lower perineum and the tail. The highest proportion of ticks collected from cattle was from the ears, followed by the upper perineum and the tail (Table 3.2). Similarly, ticks were collected from all six collection sites on buffaloes, but the proportions of the ticks collected differed, with the upper perineum having the highest proportion followed by the tail, ear and the lower perineum (Table 3.3). Similar records of *R. pulchellus* attaching in the six predilection sites have been noted for cattle, sheep and camels, with ticks primarily attaching on the ears, underparts of the body, the chest, belly, and legs, genital and anal areas (Walker *et al.* 2000). With the possible exception of the western regions, *R. pulchellus* is widespread throughout Kenya

CHAPTER FIVE

CONCLUSIONS

The aim of the study was to determine the tick species shared by cattle and buffaloes utilizing the same habitat in the Tsavo Conservation Area. Ticks were collected opportunistically from both host species during rinderpest sero-surveillance activities in the Tsavo Conservation Area. In total, 87 animals were examined for ticks and 14 species of ixodid ticks were collected. Eight of these species namely *A. gemma, A. lepidum, H. albiparmatum, H. rufipes, H. truncatum, R. evertsi evertsi, R. pravus* and *R. pulchellus* were present on cattle and buffaloes. This finding indicates that not only ticks but that tick-borne diseases could be shared by these hosts, with their associated morbidity and mortality and that there is a need to establish the disease status of cattle and buffaloes in the area.

New locality records for *H. impeltatum* and *H. truncatum* were determined and the first locality records for *R. praetextatus sensu stricto* in Kenya are reported.

The findings of this study, based on data from a fairly small number of animals in the south-eastern region of Kenya, support the initiation of a much larger project including more host species and sampling across a much larger region of Kenya. Such a project will have the advantage of the sound base provided by Walker (1974) and will thus be able to make comparisons between its findings and those of Walker and suggest reasons for changes in tick distributions and host preferences. It will also have the advantage that several of the tick species, whose identity was classified as “unconfirmed” by Walker (1974), have now had their taxonomic status verified and their specific names validated.

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