Shifts in the distribution of ixodid ticks parasitising cattle in Zimbabwe

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Abstract

In an attempt to update information on the ecological distribution of ixodid ticks (Ixodida: Ixodidae) in Zimbabwe, a cross sectional survey was carried out between September 2013 and May 2015 at 322 dip tanks. A total of 15 tick species were collected, namely: *Amblyomma hebraeum* Koch (65.2%, n=210/322), *Amblyomma variegatum* Fabricius (14.9%, n=48/322), *Hyalomma rufipes* Koch (62.4%, n=201/322), *Hyalomma truncatum* Koch (37.9%, n=122/322), *Rhipicephalus appendiculatus* Neumann (60.6%, n=195/322), *Rhipicephalus compositus* Neumann (0.3%, n=1/322,), *Rhipicephalus decoloratus* Koch (61.8%, n=199/322), *Rhipicephalus evertsi evertsi* Neumann (65.2%, n=210/322), *Rhipicephalus lunulatus* Neumann (4%, n=13/322), *Rhipicephalus microplus* Canestrini (32%, n=103/322), *Rhipicephalus* near *punctatus* Walker and Horak (7.1%, n=23/322), *Rhipicephalus simus* Koch (5.6%, n=18/322) and *Rhipicephalus* cf. *turanicus* Pomerantsev (3.4%, n=11/322). Compared with previous surveys, changes in the distribution of *A. hebraeum*, *A. variegatum* and *R. microplus* were recorded. The distributions of other tick species have largely remained unchanged. Factors which might have influenced these changes and the possible impacts on the epidemiology of tick-borne diseases are discussed.

Key words: ecology, geography, ixodid, ticks, cattle, Zimbabwe.

Introduction

The distribution of ixodid ticks is not static, it is rather influenced by a number of factors such as animal movements, tick control strategies, resistance to acaricides and variations in rainfall (Tønnesen *et al*., 2004). Ixodid ticks parasitise a number of host animals but it is their presence on domestic animals that poses a threat to the livelihoods of people especially in sub-tropical areas (Jongejan & Uilenberg, 2004). Tick movement is facilitated by the movement of host animals from one area to another (Barre & Uilenberg, 2010). The continued presence of host animals together with suitable climatic conditions can lead to the establishment of a tick species in a given area (Lèger *et al*., 2013). Since ixodid ticks are important as vectors of causative agents of diseases of socio-economic importance in livestock, some of which are of zoonotic importance (Jongejan & Uilenberg, 2004), knowledge of tick distribution is relevant to understand risks of infection transmission and disease occurrence. The introduction of a tick species in an area has important implications on the epidemiology of the infections they transmit and subsequently on the livestock production potential of the area (Barre & Uilenberg, 2010).

A number of tick species are known vectors of disease causing pathogens as well as inflict direct damage on livestock in Africa (Horak *et al*., 2009; Spickett *et al*., 2011). Nationwide surveys on tick distribution in Zimbabwe were carried out between 1975-1980, 1988-1991, with the last known published survey conducted in 1996 (Peter *et al*., 1998). Recently, Sungirai *et al*. (2015) provided an update of the ecological distribution of ticks in Zimbabwe. The latter study, however, mainly focused on restricted parts (eastern and north-western) of the country. Therefore the present study aimed to provide an update on the distribution of ticks over a wider and more representative area and assess the potential shifts that may have occurred over the past years of ixodid ticks parasitising cattle in Zimbabwe. Such information will be crucial to animal health authorities for effective management and control of ticks and tick-borne diseases (TBDs) in this country (Bazarusanga *et al*., 2007).

Materials and Methods

Study area and sampling

In terms of agro-ecological areas, Zimbabwe is divided into six regions (Gambiza & Nyama, 2000). The ecological zones are shown on Figure 1, these being:

- Ecological region 1, where specialized and diversified farming is practiced.
- Ecological region 2, the intensive farming region.
- Ecological region 3, the semi-intensive farming region.
- Ecological region 4, the semi-extensive farming region.
- Ecological region 5, the extensive farming region.

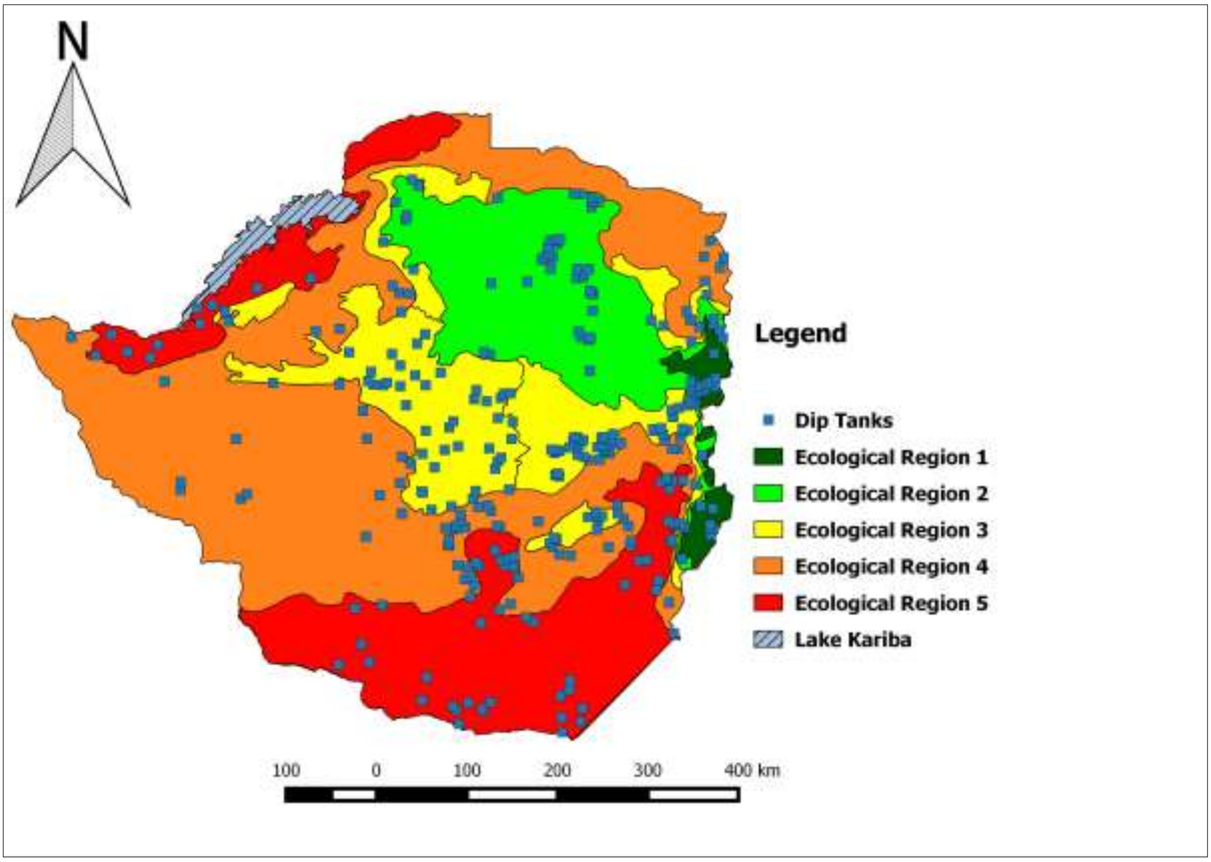

Figure 1: Map showing the ecological regions of Zimbabwe and the dip tanks at which tick collections were performed on cattle.

Ecological regions 1, 2 and 3 are also referred to as the Highveld, while regions 4 and 5 are referred to as the Lowveld (Norval *et al*., 1994). Further information on agro-ecological zones is given in Table 1.

Table 1: Characteristic features of agro-ecological regions of Zimbabwe*

Agro-ecological zone	Area (km²)	Rainfall(mm/year)	Temperature ranges /°C	Physical regions	Farming system	Number of dip tanks sampled
1	7000	>1000	10-15	Highveld (eastern highlands)	Specialized	17
2	58 600	750-1000	20.5-30	Highveld	Intensive	55
3	72 900	650-800	20.5-30	Highveld	Semi-intensive	109
4	147 800	450-650	30.5-35	Lowveld	Semi-extensive	76
5	104400	<450	>35	Lowveld	Extensive	65

*Adapted from Muchadeyi *et al*. (2007)

The collection, preservation and identification of samples were carried out following procedures explained by Sungirai *et al*. (2015) where the dip tank was the secondary sampling unit and cattle at a dip tank, the primary sampling unit. Following a literature search (from the internet search engines such as Google, Google Scholar and records at the

Department of Veterinary Services archives) no reliable estimate of the dip tank prevalence for each tick species could be obtained so an estimate of 50% was assumed as suggested by Thrusfield (2005). Therefore, the total number of dip tanks to be selected throughout the country was calculated to be 384, with a 95% Confidence Interval (CI). This translated to approximately 77 dip tanks per ecological zone on average, although this varied depending on the size of the ecological zone. The technical and logistical support for this study relied much on the network and personnel of the Department of Veterinary Services which is administered through provinces and districts. The country is made up of 59 districts within 11 provinces. Sampling was to be done in 55 districts and 7 dip tanks per district. However, accessibility to some areas was impossible due to either terrain or resource limitations and farmers' willingness to participate in the survey, hence not all dip tanks and districts were sampled.

A sampling frame of the total number of districts in the province and dip tanks in the district was obtained from the local veterinary office. Random selection of the districts and dip tanks was done by assigning a number to each element (district / dip tank). Random numbers, as many as the number of districts and dip tanks, were generated using Microsoft Excel 2007. The districts were then sampled according to the order of the assigned random numbers. Within each district, 7 dip tanks were sampled according to the first (i.e. 1-7) numbers randomly assigned. Ixodid ticks were collected from a total of 322 dip tanks (Figure 1) in 39 districts within 9 provinces. The metropolitan provinces of Harare and Bulawayo were excluded since they comprised urban settlements and communal cattle farming is not practised. The total number of dip tanks sampled per agro-ecological zone is given in Table 1.

Tick collections were performed on at least 5 heavily infested cattle per dip tank (Horak *et al*., 2009; Norval *et al*., 1984). The cattle were considered heavily infested according to the Animal Health Act (Cattle Cleansing) Regulation from 1993, which recognizes the presence of 10 or more live ticks on the animal or 5 or more engorged ticks present on each of 5 animals or more in a herd (Ndhlovu *et al*., 2009). A sub-sample of the ticks present on cattle was collected from all the predilection attachment sites which were: the base of tail, perianal region, perineum, legs, axillae, hooves, udder, scrotum, belly, dewlap, head and ears (De Clercq *et al*., 2012) using steel forceps. Adult tick specimens were collected to allow morphological identification up to the species level (Horak *et al*., 2009; Lorusso *et al*., 2013; Nyangiwe *et al*., 2013). The total number of ticks collected from each cattle and at each dip tank was recorded.

The morphological identification of ticks was done using identification keys as provided by Walker *et al*. (2003) as well as those by Walker *et al*. (2000) for the *Rhipicephalus* species.

Statistical analysis

Descriptive statistics were used to analyse the data by calculating the dip tank prevalence (i.e. ratio of dip tanks where a particular species were found to the total number of dip tanks sampled) and mean infestation rate per cattle, together with the corresponding 95% CI and standard errors of the mean respectively. Comparisons between the prevalence were done based on the 95% CI with overlapping intervals suggesting no significant differences between the prevalence of two tick species. Maps to show the distribution of each tick species were constructed using the Quantum GIS software (QGIS Development Team, 2009).

Results

Dip tank prevalence of ixodid tick species

A total of 21 954 adult hard ticks were collected from 1 355 cattle during the survey. The dip tank prevalence together with the confidence intervals are presented in Table 2.

Tick species identified included *Amblyomma hebraeum* Koch (65.2%, n=210/322), *Rhipicephalus evertsi evertsi* Neumann (65.2%, n=210/322), *Hyalomma rufipes* Koch (62.4%, n=201/322), *Rhipicephalus appendiculatus* Neumann (60.6%, n=195/322), *Rhipicephalus decoloratus* Koch (61.8%, n=199/322), *Hyalomma truncatum* Koch (37.9%, n=122/322), *Rhipicephalus microplus* Canestrini (32%, n=103/322), *Amblyomma variegatum* Fabricius (14.9%, n=48/322). The brown ticks *Rhipicephalus* near *punctatus* Walker and Horak (7.1%, n=23/322), *Rhipicephalus simus* Koch (5.6%, n=18/322), *Rhipicephalus lunulatus* Neumann (4%, n=13/322), *Rhipicephalus* cf. *turanicus* Pomerantsev (3.4%, n=11/322) and *Rhipicephalus compositus* Neumann (0.3%, n=1/322) were less common.

Ticks of the *R. turanicus* species were identified as *R.* cf. *turanicus* because of their morphological differences (i.e. denser punctations on the *scutum* and more narrow angular adanal plates), enabling to distinguish Southern African specimens from those from North Africa, the Middle East and the Far East (Beati & Keirans, 2001).

Ecological distribution of ixodid tick species

Distribution of collected ticks according to the ecological zone is illustrated in Figures 2a and 2b. Prevalence of each tick species according to the ecological zone is presented in Table 2.

Rhipicephalus decoloratus and *R. evertsi evertsi* were the most common tick species in all the ecological regions. *Amblyomma variegatum*, *H. rufipes* and *R. decoloratus* were seen to be more widespread in the arid Zambezi valley where there were also pockets of occurrences of *R. microplus* (see figure 2b). *Rhipicephalus microplus* was more prevalent in ecological regions 1 and 2. *Amblyomma variegatum* was not found in ecological region 1 whilst *A. hebraeum* had a patchy distribution in the region, the same observation was made for the tick

Table 2: Mean tick burden on cattle and associated prevalence (cattle, dip tank and ecological region)

Tick species	Total number of ticks collected	Mean tick burden on cattle ±standard error	Prevalence of ticks on cattle /% (N=1355)	95% Confidence Interval of prevalence on cattle		Dip tank prevalence of ticks / % (N=322)	95% Confidence Intervals for dip tank prevalence		Ecological Region Prevalence /% with 95% Confidence Interval Estimates				
				Lower limit	Upper limit		Lower limit	Upper limit	1(n=17 dip tanks)	2 (n=55 dip tanks)	3 (n=109 dip tanks)	4 (n=76 dip tanks)	5 (n=65 dip tanks)
Amblyomma hebraeum	5151	7.5±0.3	50.9 (n=690)	48.2	53.6	65.2 (n=210)	60.0	70.4	17.6 (0-36, n=3)	23.6 (12.4-34.9, n=13)	74.3 (66.1-82.5, n=81)	84.2 (76-92.4, n=64)	75.4 (65-86, n=49)
Amblyomma variegatum	776	7.2±0.9	8 (n=109)	6.6	9.4	14.9 (n=48)	11.0	18.8	0(n=0)	29.1 (17.1-41.1, n=16)	14.7 (8-21, n=16)	6.6 (1.1-12.1, n=5)	16.9 (7.8-26.0, n=11)
Hyalomma rufipes	2317	4.8±0.3	35.4 (n=480)	32.9	37.9	62.4 (n=201)	57.1	67.7	35.2 (12.5-58, n=6)	60 (47-73, n=33)	60.6 (51.4-69.7, n =66)	59.2 (48.2-70.3, n=45)	78.5 (68.5-88.4, n=51)
Hyalomma truncatum	796	3.7±0.3	15.7 (n=213)	13.8	17.6	37.9 (n=122)	32.6	43.2	17.6(0-35.8, n=3)	63.6 (50.9-76.3, n=35)	33 (24.2-41.9, n=36)	28.9 (18.8-39.1, n=22)	40 (28.1-51.9, n=26)
Rhipicephalus appendiculatus	2448	5.9±0.3	30.8 (n=418)	28.3	33.3	60.6 (n=195)	55.2	65.9	76.5 (56.3-96.6, n=13)	81.8 (71.6-92, n=45)	66.1 (57.2-74.9, n=72)	50 (38.8-61.2, n=38)	41.5 (29.6-53.5, n=27)
Rhipicephalus compositus	3	3.0±0.0	0.07 (n=1)	0	0.2	0.3 (n=1)	0	0.9	0(n=0)	0.9 (0-2.7, n=1)	0(n=0)	0(n=0)	0(n=0)
Rhipicephalus decoloratus	5239	9.4±0.5	40.1 (n=555)	37.5	42.7	61.8 (n=199)	56.5	67.1	52.9 (29.2-76.6, n=9)	70.9 (58.9-82.9, n=39)	67.9 (59.1-76.7, n=74)	69.7 (59.4-80.1, n=53)	36.9 (25.2-48.7, n=24)

Rhipicephalus evertsi evertsi	2379	4.5±0.3	39.3 (n=532)	36.7	41.9	65.2 (n=210)	60.0	70.4	64.7 (42-87.4, n=11)	58.2 (45.1-71.2, n=32)	67 (58.1-75.8, n=73)	65.8 (55.1-76.5, n=50)	67.7 (56.3-79.1, n=44)
Rhipicephalus lunulatus	79	4.2±0.7	1.4 (n=19)	0.8	2.0	4.0 (n=13)	1.9	6.2	0(n=0)	0(n=0)	9.2 (3.8-14.6, n=10)	3.9 (0-8.3, n=3)	0(n=0)
Rhipicephalus microplus	2307	8.5±0.5	20 (n=271)	17.9	22.1	32.0 (n=103)	26.9	37.1	70.6 (48.9-92.2, n=12)	49.1 (35.9-62.3, n=27)	24.8 (16.7-32.9, n=27)	23.7 (14.1-33.2, n=18)	29.2 (18.2-40.3, n=19)
Rhipicephalus near *punctatus*	180	5.5±0.9	2.4 (n=33)	1.6	3.2	7.1 (n=23)	4.3	10.0	29.4 (7.8-51, n=5)	12.7 (3.9-21.5, n=7)	5.5 (1.2-9.8, n=6)	5.2 (0.2-10.2, n=4)	1.5 (0-4.5, n=1)
Rhipicephalus simus	95	4.1±0.9	1.7 (n=23)	1.0	2.4	5.6 (n=18)	3.1	8.1	5.9 (0-17.1, n=1)	5.4 (0-11.5, n=3)	10.1 (4.4-15.8, n=11)	1.3 (0-3.9, n=1)	3.1 (0-7.3, n=2)
Rhipicephalus cf. *turanicus*	119	9.2±3.5	1.0 (n=13)	0.5	1.5	3.4 (n=11)	1.4	5.4	0(n=0)	7.3 (0.4-14.1, n=4)	4.6 (0.7-8.6, n=5)	0 (n=0)	3.1 (0-7.3, n=2)

species *H. rufipes* and *H. truncatum*. The lesser known *Rhipicephalus* species (*R.* near *punctatus*, *R. simus*, *R. lunulatus*, *R.* cf. *turanicus* and *R. compositus*) had a sparse distribution, being virtually absent in most areas.

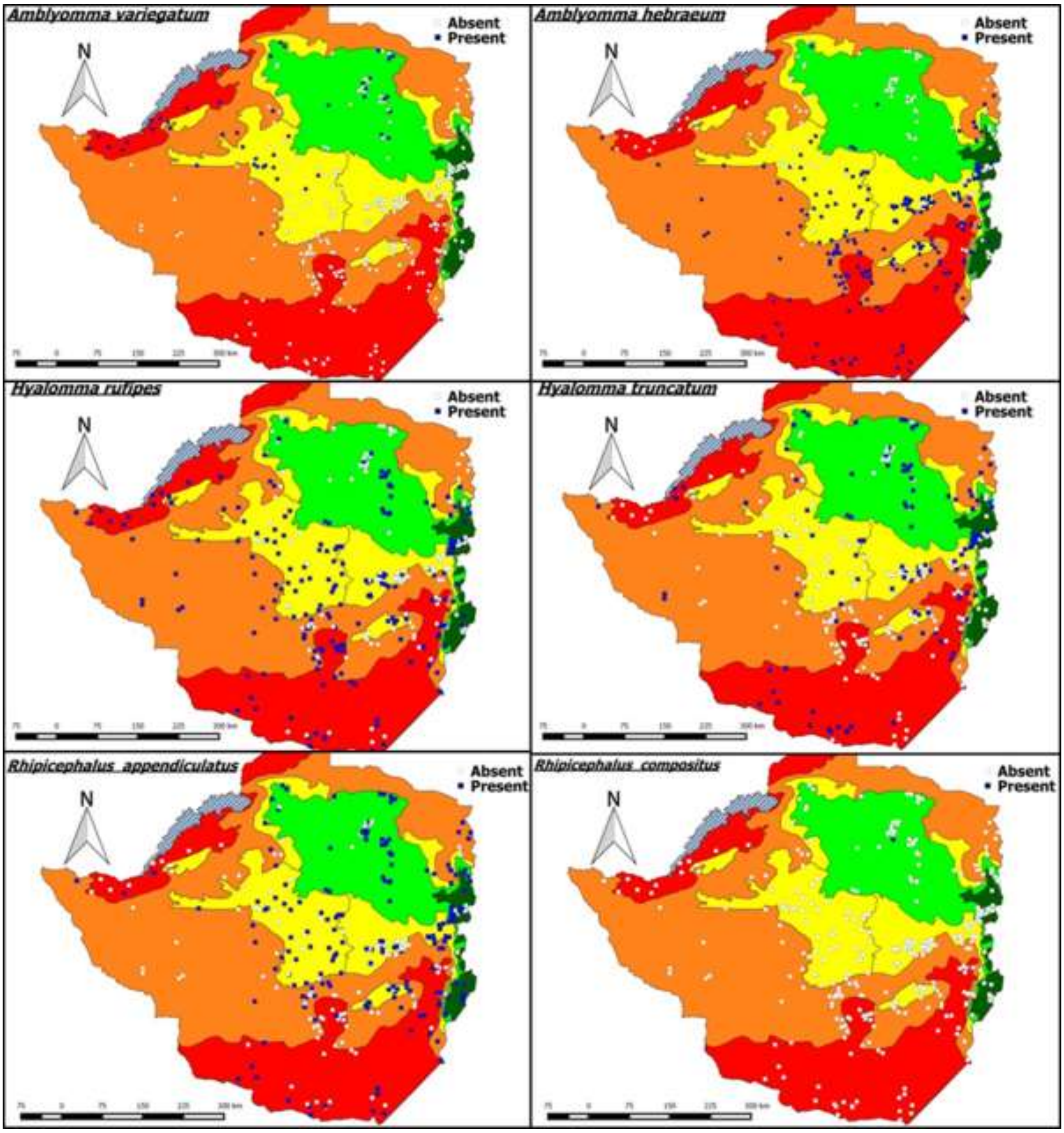

Figure 2a: Distribution of ixodid ticks in Zimbabwe: *Amblyomma variegatum, Amblyomma hebraeum, Hyalomma rufipes, Hyalomma truncatum, Rhipicephalus appendiculatus* and *Rhipicephalus compositus.*

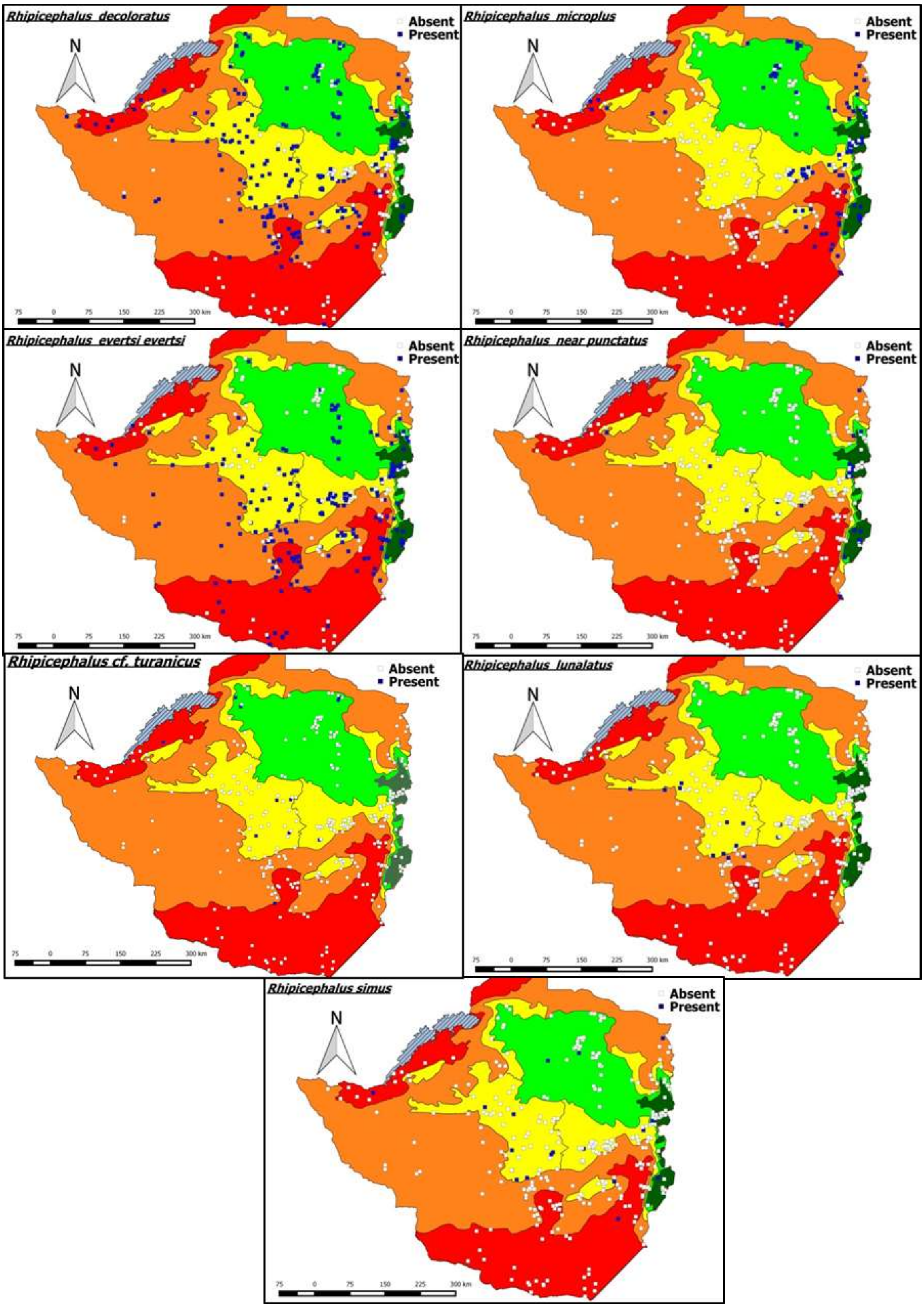

Figure 2b: Distribution of ixodid ticks in Zimbabwe: *Rhipicephalus microplus, Rhipicephalus decoloratus, Rhipicephalus evertsi evertsi, Rhipicephalus* near *punctatus, Rhipicephalus turanicus, Rhipicephalus lunalatus* and *Rhipicephalus simus.*

Prevalence of ticks on cattle

The prevalence of the tick species on cattle are presented in Table 2, together with the confidence intervals.

Amblyomma hebraeum (n=5151) was the most common tick species on cattle being recorded on 690 animals followed by *R. decoloratus* (n=5239, 555 cattle) and *R. evertsi evertsi* (n=2379, 532 cattle). In descending order, the following tick species were commonly found on cattle, namely: *H rufipes* (n=2317, 480 cattle), *R. appendiculatus* (n=2448, 418 cattle), *R. microplus* (n=2307, 271 cattle), *H. truncatum* (n=796, 213 cattle), *A. variegatum* (n=776, 109 cattle), *R.* (near) *punctatus* (n=180, 33 cattle), *R. simus* (n=95, 23 cattle), *R. lunulatus* (n=79, 19 cattle), *R.* cf. *turanicus* (n=119, 13 cattle) and *R. compositus* (n=3, 1 cattle).

Discussion

Nationwide surveys on the distribution of ixodid ticks in Zimbabwe were previously carried out between 1975-1980, 1988-1991 and in 1996 (Peter *et al*., 1998). In this study, it was observed that whilst the distribution of other ixodid tick species has remained unchanged, there have been changes in the distribution of *A. variegatum, A. hebraeum* and *R. microplus*. Although the sampling strategy was designed in a standardized way with a view of getting as much a representative sample as is possible, this could not be entirely achieved. In some cases, sampling was influenced by the availability of resources, accessibility of dip tanks and farmers willingness to participate in the survey. Such limitations were also experienced by Peter *et al.* (1998) and De Clercq *et al.* (2012).

Amblyomma variegatum and *A. hebraeum* are normally parapatric species. In the Sub-Saharan region, *A. variegatum* has a wide distribution with a southern limit in Mozambique, Zimbabwe and Botswana while a northern limit is observed for *A. hebraeum* which is also present in South Africa and Swaziland (Bournez *et al*., 2015). In Zimbabwe, the traditional foci of *A. variegatum* have been the west and north-western parts of Zimbabwe corresponding to the Lowveld region. The results of this survey indicated that this tick species has moved northwards, being common in ecological region 2 of the country which is in the north-eastern Highveld. The tick species continues to be abundant in the Zambezi Valley which is in the northern Lowveld region. It is also important to note that *A. variegatum* was not collected in the eastern Highveld and western Lowveld parts of the country in sharp contrast to past reports (Peter *et al*., 1998). However, *A. hebraeum* is still not common in the northern Highveld where *A. variegatum* has now shifted to and is the dominant species. The climatic niches of these two *Amblyomma* species are different (Estrada-Peña *et al*., 2008), but the most important factor influencing their distribution is the range of available alternative hosts, especially wildlife (Norval *et al*., 1994). In Zimbabwe, *A. hebraeum* infests a wide range of wildlife species, whilst the wildlife host range of *A. variegatum* seems to be limited to the buffalo (*Syncerus caffer*) (Norval *et al*., 1994). Moreover, in Zimbabwe, the distribution of the buffalo has been confined to the National Parks to avoid spread of diseases like Foot and Mouth (FMD) while other wildlife species such as the giraffe (*Giraffa camelopardalis*), kudu (*Tragelaphus strepsiceros*), eland (*Taurotragus oryx*) and warthog (*Phacochoerus africanus*), which can be alternative hosts for *A. habreum,* are widespread in the country (Norval *et al*., 1994). This could explain the expansion of the distribution of *A. hebraeum* in the western Lowveld where there is the Hwange National Park, the habitat of several ungulate species which can serve as hosts for the ticks. In addition, in the eastern highlands (Highveld) there has been a noticeable increase in commercial wildlife farming which would provide alternative hosts for *A. hebraeum*. Furthermore, according to previous studies (Estrada-Peña *et al*., 2008), the expansion of *A. hebraeum* in the Highveld could be driven by intense periods of drought. Accordingly, in the north-eastern Highveld, *A. variegatum* has a high prevalence which could be attributed to the warmer temperatures and less intense dry periods observed in this area (Estrada-Peña *et al*., 2008).

In the present study the co-existence of the *Amblyomma* species was observed in the central Highveld and this corroborates previous observations (Peter *et al*., 1998). When these two species have overlapping distributions, *A. variegatum* was observed to dominate (Norval, 1983). The central area would serve as a hybrid zone limiting the spread of either of the tick species down south or up north (Sutherst, 1987). In this zone, there is exclusive competition between the two species which results in a parapatric distribution (Norval *et al*., 1994; Rechav *et al*., 1982). The parapatric relationship between *A. hebraeum* and *A. variegatum* could be further explained by the occurrence of competition between these two species for the same attachment sites on the host, leading to reproductive interference and cross-mating (Bournez *et al*., 2015).

Rhipicephalus microplus was found to be present in the interior region (south-eastern Lowveld and northern Highveld) of the country as well as in the northern Lowveld with appreciable occurrences in areas close to Lake Kariba. There have been no records of the occurrence of this tick species in this area either in the published literature (Katsande *et al*., 1996; Norval *et al*., 1983) or according to the authors' knowledge. The traditionally known areas for *R. microplus* have been the eastern Highveld which is characterized by cooler temperatures and higher rainfall (Katsande *et al*., 1996). Although this tick species has spread to other areas, it is seen to be largely confined to the Highveld region. These areas have lower temperatures and high rainfall (Gambiza & Nyama, 2000), creating suitable habitats for *R. microplus*.

It was also interesting to note the presence of *R. microplus* both in the southern and northern Lowveld of the country, although these areas do not possess a suitable climate for the proliferation of this tick species. This could be attributed to movement of animals, especially cattle, which increased in particular during and after the land reform programme in Zimbabwe (Mavedzenge *et al*., 2008).

In contrast, *R. decoloratus* has a wider distribution than *R. microplus*. This could be attributed to the fact that *R. decoloratus* tolerates a wide range of temperature and rainfall conditions and has the ability to infest alternative hosts including wildlife species (Lynen *et al*., 2008).

The displacement of *R. decoloratus* by *R. microplus* which has been recorded in other countries (Tønnesen *et al*., 2004; De Clercq *et al*., 2012; Nyangiwe *et al*., 2013) has so far not been apparent in Zimbabwe. In this study, indeed, *R. microplus* occurred in approximately 50% (52/103) of the dip tanks where *R. decoloratus* was recorded. The reasons for this current balanced co-occurrence could be related to the presence of alternative hosts for *R. decoloratus* despite the relative reproductive advantage of *R. microplus*. The presence of alternative hosts particularly in colder and dry areas will tend to reduce the competitive advantage that *R. microplus* has over *R. decoloratus* (Sutherst, 1987). Another factor that could lead to the failure of *R. microplus* to displace *R. decoloratus* is the tick control strategy being adopted in Zimbabwe. Over the years, the country has embarked on government subsidised dipping where tick control in the communal areas which have more than 60% of the cattle population is done weekly during the rainy season and fortnightly in the dry season (Peter *et al*., 1998). This kind of tick control is intensive and it has been observed that more than 70% of communal farmers participate in these programs (Sungirai *et al*., 2016). Although the resistance status of these two species is not known in Zimbabwe, in Tanzania it was observed that *R. decoloratus* would be more refractory to acaricides as compared to *R. microplus* and this would ensure a gradual displacement of the latter (Lynen *et al*., 2008).

Other tick species collected in this study were *H. rufipes*, *H. truncatum*, *R. appendiculatus*, *R. compositus*, *R. evertsi evertsi*, *R. lunulatus*, *R.* near *punctatus*, *R. simus* and *R.* cf. *turanicus*. *Hyalomma* species tolerate a wide range of climatic environments although they are common in the most arid regions of the tropics (Walker et al., 2003). The distribution of *H. truncatum* is expected to be wider than that of *H. rufipes,* this is because the former parasitises a diverse number of hosts while the latter prefers larger wild ungulates at the adult stage (Norval *et al*., 1982). Since this study was focused on sampling from cattle, this could explain the wider distribution and higher prevalence of *H. rufipes* as compared to *H. truncatum*.

In this study, *R. appendiculatus* was one of the most common tick species collected and had a higher prevalence in the Highveld region compared to the Lowveld. The climatic conditions of high rainfall, cooler temperatures and host availability (Hove *et al*., 2008) provide a suitable environment for the proliferation of *R. appendiculatus* in this region.

Rhipicephalus evertsi evertsi is regarded as the most widely distributed *Rhipicephalus* species in sub-Saharan Africa (Horak *et al*., 2009). In this study, it had the highest prevalence (65.2%) at the dip tank level together with *A. hebraeum* and was also widely distributed in all the ecological regions of the country.

In the present study *R.* (near) *punctatus* had a patchy distribution in all the ecological regions of the country although it was most common in the Highveld. In sub-Saharan Africa, *Rhipicephalus* (near) *punctatus* is found mainly in Zimbabwe, Zambia and Northern Mozambique (Guglielmone *et al*., 2013) being present in tropical and sub-tropical grasslands as well as savannas and shrub lands.

Rhipicephalus simus is a widely distributed tick species in Zimbabwe (Walker *et al*., 2003), although there were very few collections in this study. As noted by Peter *et al*. (1998), such kind of studies on the occurrence of ixodid ticks in cattle although very sensitive have a high risk of yielding false negatives. This applies to all other tick species in this study and those that were not observed at all, more so for *R. simus* which has a predilection for the tail brush and around the feet of cattle. These attachment sites are normally overlooked during tick collection, an observation also noted by Spickett *et al*. (2011).

Rhipicephalus lunulatus was only found in ecological regions 3 (Highveld, semi -intensive farming) and 4 (Lowveld, semi-extensive farming). In ecological region 4, *R. lunulatus* was found in areas adjacent to ecological region 3 confirming reports of Walker *et al*. (2003) that this tick species is widespread in Savanna climates.

There were isolated occurrences of *R.* cf. *turanicus* in this study and this conforms with reports of Walker *et al*. (2003). There was one collection of *R. compositus* in the Highveld region, this tick species is expected to be common in this region at medium to high altitudes and mean annual rainfall of above 700 mm (Walker *et al*., 2000). The low prevalence of *R. compositus* might be related to false negative results associated with such types of studies. In addition, the immature stages of this tick are common on creek rats (*Pelomys fallax*) and these may contribute to the abundance of adult individuals of this tick (Walker *et al.,* 2000). Although the distribution of *P. fallax* was not investigated in this study and is not known in Zimbabwe, the collection of *R. compositus* has been associated with areas where the creek rats have been recorded (Walker *et al*., 2000).

In the light of the consistent dipping practices by communal farmers in Zimbabwe reported by Sungirai *et al.* (2016), the mean tick burden recorded on cattle in this study was considered as relatively high (Lorusso *et al*., 2013) for most species. This could be attributed to the likely emergence of acaricide resistance especially to amitraz which is the one commonly used by farmers to control ticks. This is especially seen for the one host ticks, *R. decoloratus* and *R. microplus,* which recorded the highest tick burdens as compared to other tick species. One host ticks are known to develop resistance more readily than two or three host tick species (Mekonnen *et al*., 2002). Future studies would be desirable to assess the status of acaricide resistance in boophilid ticks in Zimbabwe.

The widespread distribution of *A. hebraeum*, *R. evertsi evertsi*, *R. decoloratus* and *R. appendiculatus* might have implications in cattle producing areas on the epidemiology of heartwater, anaplasmosis, babesiosis and theileriosis, respectively. Furthermore, the spread of *A. variegatum* may have serious implications on the occurrence of dermatophilosis as was noted during field observations in this study. In indigenous cattle producing areas, the diseases anaplasmosis and babesiosis are usually characterized by endemically stable situations when tick control is minimal (Norval *et al*., 1983, 1984). Short interval dipping may disrupt endemic stability and increase susceptibility of cattle to the diseases and when the supply of acaricides becomes inconsistent this may lead to cattle mortalities as it has been observed in the past (Norval *et al.*, 1983, 1984). The situation might be different for heartwater and theileriosis (by *Theileria parva*) where endemically stable situations are rare (Irvin *et al.*, 1996, Minjauw & McLeod, 2003).

Conclusion

The present study indicates that there have been shifts in the distribution of the most important ixodid ticks parasitising cattle in Zimbabwe. Future studies assessing the potential impact of these shifts on the epidemiology of cattle TBDs and consequent economic repercussions are advisable.

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Conflict of Interest

The authors declare that there is no conflict of interest in this study.

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