*Ixodid ticks of African buffalo (*Syncerus caffer*), impala (*Aepyceros melampus*) and elephant (*Loxodonta africana*) in five protected park estates in the Zambezi valley, Zimbabwe*

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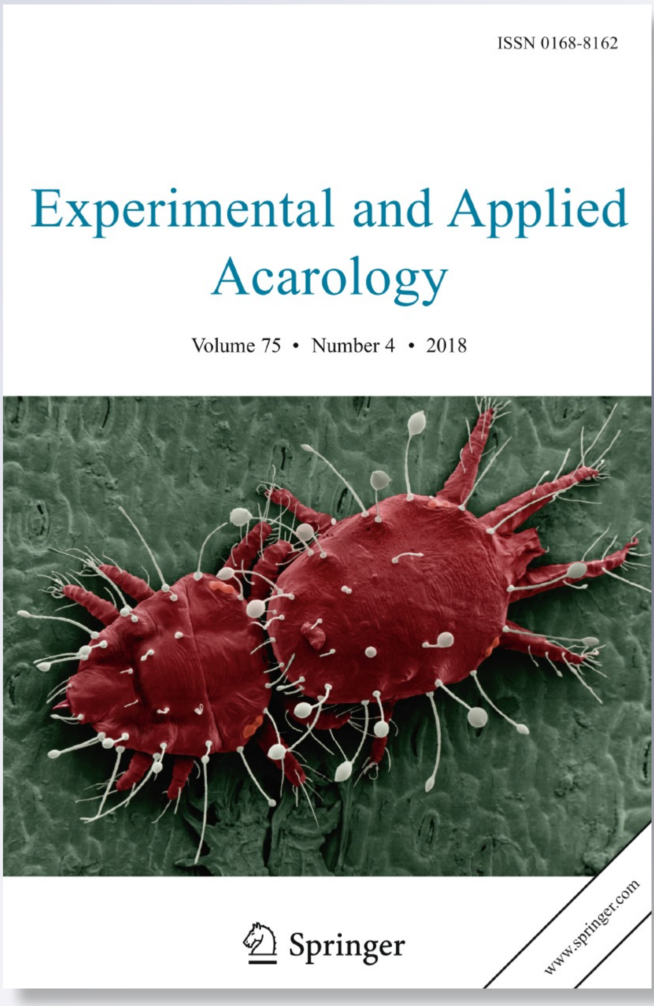

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Ixodid ticks of African buffalo (*Syncerus caffer*), impala (*Aepyceros melampus*) and elephant (*Loxodonta africana*) in five protected park estates in the Zambezi valley, Zimbabwe

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Abstract

Wildlife hosts many pathogens of economic importance and is considered as a reservoir of important tick-borne diseases of livestock in southern Africa. The species composition of ticks parasitizing buffalo (*Syncerus caffer*), impala (*Aepyceros melampus*) and elephant (*Loxodonta africana*) was investigated in five protected parks in the Zambezi valley, Zimbabwe. A total of 1104 adult ticks was collected from 75 adult animals comprising five buffaloes, five elephants and five impalas drawn from five protected wildlife parks. Five tick species belonging to two genera were recovered, with *Rhipicephalus decoloratus* being the most prevalent species in all the three animal groups. *Amblyomma hebraeum* was only recovered from buffaloes whereas *Rhipicephalus zambeziensis* was recovered from buffalos and elephants. Significant differences in mean tick species distribution and concentration were observed amongst the wildlife parks and these appeared to be influenced by the number of hosts in each park. The study revealed that buffaloes are the major host of *R. decoloratus* in the Zambezi valley. The presence of these ixodid ticks within the Zambezi valley may have significant ecological and economic impacts on wildlife conservation, domestic animals and human health.

Keywords Ixodid ticks · *Rhipicephalus* spp. · Wildlife · Zambezi valley · Zimbabwe

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Introduction

Ixodid ticks present one of the greatest threats to livestock, human and wildlife health in (sub)-tropical countries (Mejia and Fuente 2006; Uilenberg 1994; FAO 1984). In wildlife the most common tick-borne pathogens cause anaplasmosis, babesiosis, theileriosis and heartwater (Uilenberg 1994; Wei et al. 2010); clinical cases are observed in non-immune animals introduced in an endemic area. Wild animals may also act as reservoirs of these pathogens (Mejia and Fuente 2006) and mingling together with domestic animals which is very common will result in susceptible animals being infected and mortalities recorded (Fyumagwa et al. 2009; Lawrence and Norval 1979). Apart from vectors of disease-causing pathogens, ticks cause injury to wildlife through bites which may lead to secondary infections, blood sucking activities may result in loss in body condition and the very essence of tick attachment makes the animal irritable and will thus engage in energy-costing activities such as self-grooming by scratching, biting and dust baths (Lightfoot 1978).

It has been noted that most boundaries between national parks and human habitations are porous and there is free movement of wild animals out of the national parks and domestic animals easily stray into national parks (Grobler 1981; Ndhlovu et al. 2009; Munang'andu et al. 2012). Such animal movements were observed in the study area. The recent government land reform programme in the last 20 years has resulted in changes in land-use patterns including the occupation of protected national parks and conservancies (Mavedzenge et al. 2006). This move is likely to result in a complex circulation of parasites between domestic and wild animals (Daszak et al. 2000).

There is a dearth of information on the parasites of free-ranging wildlife in Zimbabwe with most publications being done in the 1980s (Lightfoot and Norval 1981; Norval and Lightfoot 1982; Horak et al. 1983). The purpose of the study was to get an overall insight of ixodid ticks infesting wildlife and their spatial distribution in protected park estates in the Zambezi valley.

Materials and methods

Study sites

The study was conducted in five wildlife protected parks in the Zambezi valley in northern Zimbabwe, Hurungwe Safari Area (2878 km^2), Mana Pools National Park (2196 km^2), Sapi Safari Area (1180 km^2), Chewore Safari Area (3,390 km^2) and Dande Safari Area (523 km^2). Mana Pools National Park covers most parts of the Zambezi valley and it is surrounded by these safari areas (Fig. 1). These parks estates are adjacent to farming communities except Sapi safari area which is surrounded by other parks and they share the same climate, wildlife and soils.

The mean annual rainfall ranges from 700 to 800 mm confined to the months of November to March, with summer temperatures varying from 25 to 40 °C in October and April (Department of Metrological Services 1981). Winter temperatures vary between 10 and 26 °C in June to August. The relative humidity is usually below 40% throughout the year and no frost is experienced (ZNPWMA 2009).

The Zambezi valley is endowed with several mammalian species, reptiles and birds. The bulk of the biomass is made up of African elephant (*Loxodonta africana*),

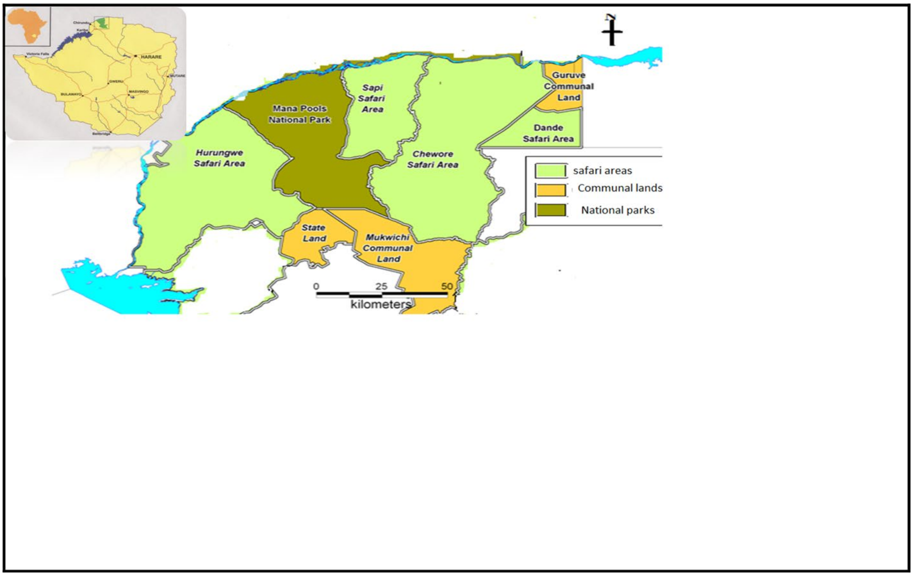

Fig. 1 Map of Zambezi valley. *Source*: Mana Pools national park general management plan unpublished 2008

hippopotamus (*Hippopotamus amphibious*), Cape buffalo (*Syncerus caffer*), and other common species are waterbuck (*Kobus ellipsiprymnus*), impala (*Aepyceros melampus*), kudu (*Tragelaphus strepsiceros*), sable (*Hippotragus niger*), eland (*Taurotragus oryx*), bushbuck (*Tragelaphus*), warthog (*Phacochoerusae aethiopicus*). Antelope still occur and the area supports the most western occurrence of nyala (*Tragelaphus angasi*). The large predators are well represented by lion (*Panthera leo*), leopard (*Panthera pardus*), cheetah (*Acinonyx jubatus*), African wild dog (*Lycaon pictus*) and spotted hyena (*Crocuta crocuta*) (Du Toit 1993; ZNPWMA 2009). The last wildlife population estimates reported by Mackie (2002) show that Mana Pools has the highest number of buffalos impalas and elephants (n = 12,715), followed by Chewore (n = 11,753), Hurungwe (n = 6573), Dande (n = 3708) and Sapi (n = 3277).

Tick collection

Adult visible ticks were collected from buffaloes, elephants and impalas in the five protected parks between January and April 2016. A total of 75 adult animals comprising 5 buffaloes, 5 elephants and 5 impalas was drawn from each protected park. The animals were part of those targeted for destocking. Ticks were collected from the right side after the animal was laid flat on the ground. These parasites were handpicked from the animal skin, head, ears, perineum area and placed into air tight vials and preserved with 70% ethanol. Tick identification was done using morphological keys described by Walker et al. (2003).

Data analysis

The tick burden per animal (buffalo, elephant and impala) in each protected park estate were compared as well as the proportion (percent) of animals infested together with the 95% confidence interval estimates. The non-parametric Kruskal–Wallis test was used together with the Scheffé method to compare the tick loads amongst the animals and the different parks.

Results

A total of 1104 adult ticks were recovered from the 75 animals. Five tick species belonging to two genera were identified with the abundance of each in the following descending order: *Rhipicephalus decoloratus* (93.3%), *R. appendiculatus* (8.0%), *R. zambeziensis* (6.7%), *R. evertsi evertsi* (1.3%) and *Amblyomma hebraeum* (1.3%) (Table 1). *Rhipicephalus decoloratus* was the most prevalent tick and was collected on all the animals studied.

Table 1 Adult tick species and percentage of host animals infested in the five protected park estates

Park estate	Tick species	Males	Female	Total	% animals infested
Buffalo					
Chewore	*Rhipicephalus decoloratus*	24	27	51	100 (5/5)
Sapi	*R. decoloratus*	5	7	12	100 (5/5
	R. zambeziensis	1	1	2	20 (1/5)
Dande	*R. decoloratus*	6	11	17	100 (5/5)
	Amblyomma hebraeum	2		2	20 (1/5)
Mana Pools	*R. decoloratus*	51	157	208	60 (3/5)
	R. appendiculatus	11	37	48	60 (3/5)
Hurungwe	*R. decoloratus*	40	62	102	100 (5/5)
	R. appendiculatus	8	4	12	20 (3/5)
Elephants					
Chewore	*R. decoloratus*	7	32	39	80 (4/5)
	R. zambeziensis	1	2	3	40 (2/5)
Sapi	*R. decoloratus*	14	28	42	100 (5/5)
	R. zambeziensis	1	6	7	40 (2/5)
Dande	*R. decoloratus*	1	6	7	80 (4/5)
Mana Pools	*R. decoloratus*	28	103	131	100 (5/5)
	R. appendiculatus	1	3	4	40 (2/5)
Hurungwe	*R. decoloratus*	57	28	85	100 (5/5)
Impala					
Chewore	*R. decoloratus*	23	25	48	100 (5/5)
Sapi	*R. decoloratus*	27	7	34	80 (4/5)
Dande	*R. decoloratus*	36	13	49	100 (5/5)
	R. evertsi evertsi	2		2	20 (1/5)
Mana Pools	*R. decoloratus*	23	88	111	100 (5/5)
Hurungwe	*R. decoloratus*	38	50	88	100 (5/5)

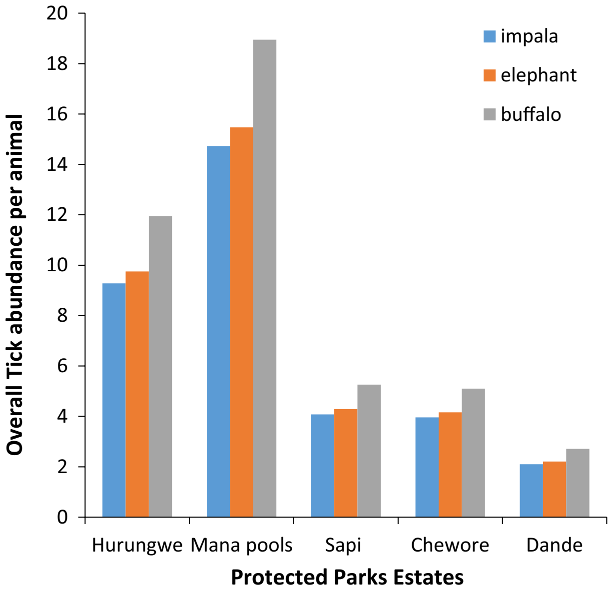

Fig. 2 Mean number of ticks in the five protected parks

Overall tick abundance in the five parks is shown in Fig. 2. Buffaloes had the highest tick load followed by elephants and then impala. Animals tended to have mixed tick species infections in all parks with the exception of buffalo in Chewore, elephant in Dande and Hurungwe and impala in all estates with the exception of Dande that only had *R. decoloratus* infections.

Mana Pools national park had the highest tick load (mean rank = 67.4) followed by Hurungwe (52.1), Chewore (30.2), Sapi (24.5) and lastly Dande (15.9) ($\chi^2 = 57.345$, $p < 0.05$). *Rhipicephalus decoloratus* was found across all the 5 parks followed by *R. appenduculatus* which was found in 2 parks. There were only two specimens of *R. evertsi evertsi* and two of *A. hebraeum* and they were only found in Dande park estate.

Discussion

Rhipicephalus decoloratus, *R. appendiculatus*, *R. zambeziensis*, *R. evertsi evertsi* and *A. hebraeum* were the tick species found parasitizing some wildlife mammals within the Zambezi valley. These findings are partly in agreement with the findings of Ndhlovu et al. (2009) who found that in Zimbabwe the common ticks which affect cattle and wildlife include *R. decoloratus, R. appendiculatus*, *R. evertsi evertsi* and *A. hebraeum*. Previous reports by Lightfoot and Norval (1981) had suggested that tick problems in wildlife areas in Zimbabwe were almost invariably caused by *R. appendiculatus*. Our study revealed that *R. decoloratus* was the most dominant tick species. The high prevalence of *R. decoloratus* in all the animal species across all five parks could be attributed to its being a one-host tick and thus remains attached to the host for a long period of time as suggested by Walker et al. (2003). Apart from being a cattle tick, various wildlife spp. are preferred hosts for this tick species (Lynen et al. 2008). A survey by Sungirai et al. (2015) in Zimbabwe revealed that *R. appendiculatus* is found in all ecological regions but is highly prevalent in ecological region 1, 2 and 5 and this agrees with the findings of this study since ecological region 5 covers some parts of the Zambezi valley. The findings of *R. zambeziensis* within the Zambezi valley concurs with findings of Ndhlovu et al. (2009) who identified the tick species in similar climatic conditions in the southern Lowveld where it co-existed with *R. appendiculatus*. The high numbers of *R. appendiculatus* as compared to those of *R. zambeziensis* suggest that the former could be outcompeting the latter in this region of the Zambezi Valley.

Buffaloes were parasitized by four tick species and had the highest infestation level. Buffaloes could have accumulated highest ticks load because they are gregarious (Ward 1975), have a wide home range and they are non-territorial, thereby allowing them to attract a wide range of different ticks from different ecosystems. In addition, Horak et al. (1983) found more *R. decoloratus* on buffaloes than other animals in Hluhluwe and Thomas Baines Reserve and this agrees with findings of this study. They concluded that both host preference and host habitat probably plays a role in the increase in ticks load in buffalos as compared to impalas.

Impalas had lower tick burdens than buffaloes and this could be attributed to the fact that they have a small home range (du Toit 1990), are territorial and this prevents them from attracting other ticks from different territories. Horak et al. (1983) suggested that the proportion of adult ticks carried by animals appears to be in direct relationship to the physical size of the host species. This suggestion seems to agree with the findings of our study especially on buffaloes and impalas. Since host-seeking activities of most of these ticks involves awaiting host at a vantage position on vegetation (Lightfoot and Norval 1981), ticks have greater chances of attaching on buffaloes than on impalas because of greater body surface. Contrary to that, elephants have an even bigger surface area, but in this study had low tick loads. This could be attributed to factors such as the hard skin surface and wallowing which prevents larvae and nymphs from attaching on the skin. Differences in the attractiveness of various host spp. to various species of ticks could be another factor. Further to the north in Africa, ticks like *Amblyomma tholloni* and *Dermacentor circumguttatus* are rarely found on other host species than elephants (Fowler and Mikota 2008). The greatest number of tick species and the highest tick load in wildlife was recorded in Mana Pools National park and this among other factors could be attributed to the fact that Mana Pools does not allow traditional safari hunts since it is a National park established for non-consumptive tourism (ZNPWMA 2009). In safari areas there were less tick loads probably because of the trophy hunts that could be removing the old and heavily parasitized animals (Ward 1975). No tick control was done in all the safari areas. Further studies on tick loads in the safari areas are suggested.

Amblyomma hebraeum and *R. evertsi evertsi* were recovered in buffalo in South Africa (Anderson et al. 2013; Horak et al. 2007) and Zimbabwe (Norval et al. 1991). In our study *A. hebraeum* was only recovered in buffalo in one protected park estate and *R. evertsi evertsi* was only recovered in impala from one estate. Sungirai et al. (2015) and Norval et al. (1992) confirmed that, traditionally *A. hebraeum* was limited to the southern parts of Zimbabwe and appeared to spread in the eastern highlands. However in this study, this tick species was recovered in Dande suggesting that this tick species has migrated north. Ndhlovu et al. (2009) reported that apart from cattle, wildlife species are the preferred hosts of *A. hebraeum*. It is important to note that such type of studies as much as they provide valuable information may not identify all the tick species in an area (Peter et al. 1998; Sungirai et al. 2017), a case in point being the total absence of *Amblyomma variegatum* and *Hyalomma* species which would otherwise be expected in this part of Zimbabwe especially in buffalo. Norval et al. (1992) reported that *R. evertsi*

evertsi was found in most parts of Zimbabwe except in the Zambezi valley, the identification of this species in the Dande parks estate suggest that this tick is now present in the Zambezi valley. From these findings it is hypothesised that there could be an exchange of ticks between cattle and wildlife since the porosity of the Zambezi valley parks estates allows inwards and outwards free movement of animals. There would be need to sample for ticks in communal areas adjacent the estate to test the significance of this hypothesis.

Gallivan et al. (1995) recovered *A. hebraeum*, *R. decoloratus*, *R. appendiculatus*, *R. evertsi evertsi* and *Rhipicephalus muehlensis* in impala, *A. melampus* in a protected game park in northern Swaziland. Munang'andu et al. (2009) reported that buffaloes in Lochniva National Park and Lower Zambezi National Park were infested with *R. appendiculatus*, *Rhipicephalus* species and *A. variegatum*. They also reported that these buffaloes harboured *Theileria parva* which had previously only been reported in livestock in Zambia. Findings of our study revealed that *R. decoloratus*, *R. appendiculatus* and *R. zambeziensis* were common in buffalo thereby corroborating studies done within the southern African region. The African buffalo, *S. caffer* is the natural reservoir host of *T. parva*, which is transmitted by the tick species *R. appendiculatus* and *R. zambeziesnis* (Allsop 2010). Pascucci et al. (2011) reported that 57% of buffaloes on the Namibian side of the Caprivi Strip that shares borders with Zimbabwe, Zambia and Botswana were positive for *T. parva*. These findings corroborate Fyumagwa et al. (2009) who reported that in Ngorongoro Crater, Tanzania, *R. appendiculatus* and *R. decoloratus* were vectors of *Anaplasma marginale*. *Amblyomma* transmits tick-borne diseases such as *Erlichia ruminantium* that causes red water (Allsop 2010).

Amblyomma hebraeum is a tick of veterinary importance as it is associated with heartwater in domestic and wild ruminants as well as fever in humans (Horak et al. 2018). The finding of *R. decoloratus* on wild animals poses a threat to wildlife as it transmits the protozoan parasite *Babesia bigemina* which causes bovine babesiosis (red water) (Walker et al. 2003). This tick species also transmits *Anaplasma marginale* which causes bovine anaplasmosis (gall sickness). Heavy infestation by *R. decoloratus* may damage the hides and reduces the growth rate of animals (Walker et al. 2003). *Rhipicephalus appendiculatus* and *R. zambeziensis* transmit *T. parva* which causes theileriosis mostly in domestic livestock and buffaloes are the reservoir hosts (Norval et al. 1991). Eygelaar et al. (2015) recovered *Theileria*, *Babesia*, *Anaplasma* and *Erlichia* parasites from buffaloes in northern Botswana game parks and it is postulated that Zambezi valley buffaloes that move across the borders between Zimbabwe and neighbouring countries could also have the same tick-borne diseases. There is need to substantiate these claims.

Since these tick species have a wide range of hosts, from wildlife to domestic hosts, ecologist and other authorities should encourage re-fencing of protected areas so that stray domestic animals cannot enter park estates and wild animals should not come out to communal lands. The use of tick control in wildlife using Duncan applicators is recommended in the safari park estates. Our study indicates that, the presence of *R. decoloratus*, *R. appendiculatus*, *R. zambeziensis*, *R. evertsi evertsi* and *A. hebraeum* within the Zambezi valley may have significant ecological and economic impacts in wildlife conservation, domestic animals and human health. The economic and medical importance of ticks is recognized especially when there is transmission of diseases among humans, animals and wildlife. *Rhipicephalus decoloratus* was found to be the prevalent tick species across all protected parks estates within Zambezi valley and it is a tick species of veterinary importance. In this regard, the study contributes to the body of knowledge on arthropod parasites of wildlife in the Zambezi valley and surrounding areas.

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Compliance with ethical standards

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

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