A comparison between tick species collected in a controlled and control free area on a game ranch in South Africa

Authors:
Bradley Schroder[1]
Brian K. Reilly[1]

Affiliations:
[1]Department of Nature Conservation, Tshwane University of Technology, South Africa

Correspondence to:
Bradley Schroder

Email:
bradley.schroder@gmail.com

Postal address:
Private Bag X680, Pretoria, 0001, South Africa

Dates:
Received: 27 Jul. 2012
Accepted: 18 Mar. 2013
Published: 24 Apr. 2013

How to cite this article:
Schroder, B. & Reilly, B.K., 2013, 'A comparison between tick species collected in a controlled and control free area on a game ranch in South Africa', *Journal of the South African Veterinary Association* 84(1), Art. #907, 5 pages. http://dx.doi.org/10.4102/jsava.v84i1.907

Despite the large number of collection records, there are no recent collections of ixodid ticks of this magnitude in the Waterberg area, Limpopo Province, South Africa. Free-living ticks on a commercial game farm were obtained by a total of 432 drag-samples in eight sample sites from September 2003 to August 2008. The ticks were collected to establish the difference between tick species and densities associated with acaricide-controlled (semi-intensive) and control-free areas on a game farm in the Thabazimbi District, Limpopo Province, South Africa. A total of eight tick species were collected, namely *Amblyomma hebraeum*, *Rhipicephalus* (*Boophilus*) *decoloratus*, *Haemaphysalis elliptica*, *Hyalomma rufipes*, *Rhipicephalus appendiculatus*, *Rhipicephalus evertsi evertsi*, *Rhipicephalus zambeziensis* and *Rhipicephalus* spp. The most abundant tick species collected was *Rhipicephalus* (*Boophilus*) *decoloratus*. The difference in species and numbers reflects the effectiveness of acaricide treatment against ticks and its relevance to tick numbers on a game farm.

Introduction

Ticks are blood-feeding external parasites of mammals, birds, and reptiles throughout the world (Vredevoe 2006). Ticks thus affect wildlife and domestic animal management worldwide, with approximately 896 species of ticks in three families having been described (Guglielmone *et al*. 2010). Research on South African ticks commenced nearly 200 years ago and since then over 80 tick species have been identified and documented (Walker 1991).

Ticks of all types are important vectors of animal and human pathogens. It was established that ticks were being controlled for a lack of a better method to control tick-borne diseases (TBD). Certain tick-borne diseases are of major importance throughout the world. In the United States of America, there are many diseases caused by tick-borne pathogens that include Lyme disease, ehrlichiosis, babesiosis, Rocky Mountain spotted fever, tularaemia and tick-borne relapsing fever (Vredevoe 2006). In Tanzania, diseases are listed as a major farming constraint, especially tick-borne diseases such as East Coast Fever (*Theileria parva*), anaplasmosis and cowdriosis (Swai *et al*. 2005).

In Zambia, tick-borne diseases, particularly *Theileriosis*, pose a serious threat to the development of the cattle industry. Tick infestation is considered to be one of the main constraints to successful game ranching in southern Africa (Horak 1980; Lightfoot & Norval 1981; Norval & Lightfoot 1982).

Several blood parasites are transmitted by ticks and have been incriminated as the cause of death in several wildlife species (Grobler 1981; Lightfoot & Norval 1981; Young & Basson 1973). These diseases include but are not limited to heartwater (*Ehrlichia ruminantium*) transmitted by *Amblyomma hebraeum*, redwater (*Babesia bigemina*) transmitted by *Rhipicephalus* (*Boophilus) decoloratus*, East Coast fever (*T. parva*) and corridor disease (*Theileria parva lawrencei*) transmitted by *Rhipicephalus appendiculatus* and *Rhipicephalus zambeziensis* (Lawrence, Norval & Uilenberg 1983).

Approximately 80% of the world's cattle population of 1281 million are at risk from ticks and tick-borne diseases (Stafford 2004). McCosker (1979) estimated global costs of control and productivity losses to be some $7000 million annually. In Africa, with 186 million head of cattle, ticks and tick-borne diseases are the most serious constraints to increased production (Stafford 2004).

This study was undertaken on a commercial game ranch in the Waterberg District of the Limpopo Province, South Africa. In this specific undertaking, rare and threatened ungulates such as roan antelope (*Hippotragus equinus equinus*) are being semi-intensively bred in breeding camps ranging in size from 20 ha to 50 ha for commercial and biodiversity purposes. Furthermore, high value disease-limited species such as buffalo (*Syncerus caffer*) are also ranched intensively. The roans are being bred until the population reaches a predetermined stocking ratio, after which, the animals are sold with the ultimate objective of increasing the size of the metapopulation. The roan antelope are kept separate from other species due to their low tolerance for competition. All predators have been excluded from the breeding camps to limit mortalities. Despite satisfactory breeding results of roan antelope throughout South Africa, theileriosis specifically is seen as one of the main causes for the abnormally high mortality rate in calves and one of the reasons for the population decline (Van der Vegt 2007, unpublished data).

African buffaloes may be infested with exceptionally large numbers and species of ixodid ticks (Yeoman & Walker 1967). The buffaloes share areas ranging from 450 ha to 1100 ha with giraffe (*Giraffa camelopardalis*), blue wildebeest (*Connochaetes taurinus*), white rhinoceros (*Ceratotherium simum*), black rhinoceros (*Diceros bicornis*), impala (*Aepyceros melampus*), kudu (*Tragelaphus strepsiceros*), waterbuck (*Kobus ellipsiprymnus*), gemsbok (*Oryx gazella*) and zebra (*Equus burchelli*).

The main tick-related problems affecting the semi-intensive commercial game ranching operation are corridor disease (*T. parva lawrencei*) in the buffaloes and acute *Theileriosis* in juvenile roan antelopes (A.C. Uys 2003, personal communication).

Although wild animals native to a specific area are seldom affected by the endemic tick-borne blood parasites, translocation of hosts and/or ticks into non-endemic areas can cause severe losses amongst naïve animals (Lightfoot & Norval 1981). In addition to tick-borne diseases, other direct effects of ticks on their hosts include tick toxicosis, metabolic disturbances, anaemia and tick worry, which can result in production losses and/or deaths (O'Kelly & Seifert 1969). Tick-bite wounds can also become secondarily infected with bacteria and maggots, potentially leading to death (Lightfoot & Norval 1981).

A larval tick survey was undertaken in order to determine the species composition in the controlled (semi-intensive) and control-free areas on the game ranch. These results will ultimately be used to establish whether the use of acaricides has an effect on tick numbers by comparing the tick numbers in the controlled area with those in the control free area.

Materials and methods

Study area

The wildlife breeding farm 'Hoopdal' KQ96 is 2210 ha in area and is located in the Thabazimbi district, Limpopo Province, South Africa. It is bounded by longitudes 24°16′16.07″S and 24°20′43.56″S, latitudes 27°29′42.89″E and 27°26′57.85″E, with altitudes ranging from 993 m to 1035 m above sea level. The farm consists mainly of plains (Van Staden 2002) and is located in the Waterberg region in the north-western corner of the mixed Bushveld (Acocks 1988). The vegetation comprises Mixed Bushveld and Sourish Mixed Bushveld of the Savanna Biome (Low & Rebelo 1996). Mucina and Rutherford (2006) classified the area as Western Sandy Bushveld, comprising tall open woodland to low woodland in which broad-leaved as well as microphyllous tree species are prominent. Rainfall during the study period amounted to a mean annual rainfall of 826.64 mm. The mean minimum monthly temperature during the study period was 12.81 °C, ranging from 0.5 °C to 19 °C. The mean maximum annual temperature during the same period was 30.13 °C, ranging from 22.0 °C to 40.5 °C (Figure 1).

Drag-sampling

Drag-sampling with flannel strips was chosen as a means of recovering immature ticks questing on vegetation (Zimmerman & Garris 1985), using a technique described by Petney and Horak (1987). Drag-sampling was performed on a monthly basis at the same time each month (20th – 26th) for a period of 5years from September 2003 to August 2008. A grassland and a woodland zone were selected for dragging in each of the controlled and control-free areas. Ten flannel strips (1000 mm x 100 mm) were attached with Velcro tape to a 1200 mm-long wooden spar. Each collection was made by dragging the spar by means of a loop of rope attached at either end for a distance of 300 m over the vegetation. Each

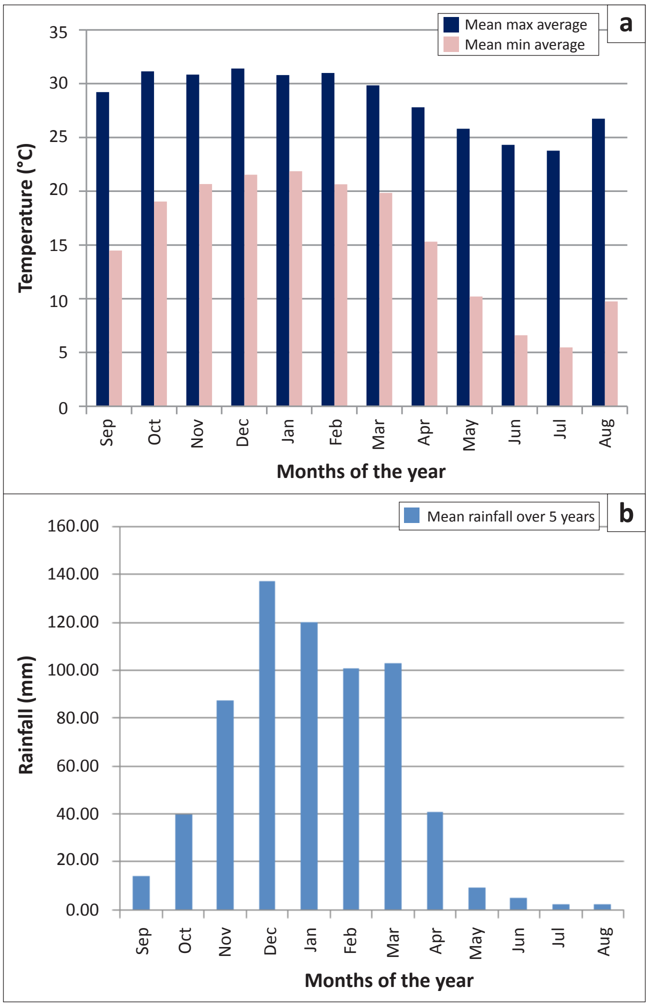

FIGURE 1: Temperatures and rainfall in the study area from September 2003 to August 2008, (a) mean minimum and maximum temperatures and (b) rainfall.

month, four drag samples were performed in the woodland areas and four drag samples in the grassland areas for both the controlled and control-free areas. After each drag, all the ticks were removed from the flannel strips using fine-point tweezers and placed in 70% alcohol. The ticks were identified at the Department of Veterinary Tropical Diseases, Faculty of Veterinary Science, University of Pretoria.

Statistical methods

Because of their over-dispersed nature, the tick drag-results were sampled and logarithmically transformed (log [x + 1]) (Petney, Van Ark & Spickett 1990). The transformation to standard logarithms and not natural logarithms was chosen because the mean to variance ratio approaches one.

The Wilcoxon test for matched pairs is a simple non-parametric test for comparing the medians of two matched samples. It calls for the calculation of a test statistic T whose probability distribution is known. In the test, one observation in a matched pair is subtracted from the other. Observations must therefore be measured on an *interval* scale (Fowler *et al.* 2003).

The null hypothesis H_0 is that there is no difference in median tick numbers between the two sets of data. The alternative hypothesis, $H\alpha$, is that there is a difference, but with no prediction for which way the difference will lie (i.e. a two-tailed test) (Fowler *et al*. 2003) (Table 2).

Results

The tick species recovered and the total numbers of ticks collected during the 60-month monitoring period are summarised in Table 1. Eight tick species were recovered, namely *A. hebraeum, H. rufipes, Haemaphysalis elliptica, R. evertsi evertsi*, *R. appendiculatus*, *R. zambeziensis*, *R.* (*Boophilus*) *decoloratus* and *Rhipicephalus* spp.

Of the 6836 ticks collected, the most abundant tick species recorded was *R.* (*Boophilus*) *decoloratus*, and this species was mainly collected in the controlled areas of the game farm.

Table 1 shows the species collected with the percentage collected in the controlled and control-free areas of the game farm. The higher numbers of *R. (Boophilus) decoloratus* collected in the controlled area as compared to the lower numbers in the control-free area, a differences of 9.8%, is attributed to the fact that acaricide treatment has an effect on tick numbers. The acaricide used in the controlled area was 'Drastic Deadline'® (Bayer Animal Health Division, Isando). The acaricide was applied using two application methods simultaneously: feed bins with an extended outer rim holding the acaricide (this was undertaken with every feed) and the tick-off pressure plate system at the entrance to the waterhole (this was refilled monthly).

The difference in tick numbers collected between the two areas was recorded as 9.8%. This is explained by the number of *R.* (*Boophilus*) *decoloratus* collected in the controlled area. This shows a high probability that this tick species had become resistant to the acaricide treatment being applied in the study area.

Significant differences were found between the tick numbers collected in the controlled and control-free areas for the study period for each individual species (Table 2).

Discussion

The mean number of ticks recovered per drag-sample per month over the 5-year study period was 15.82. This is lower than the 168 ticks collected by monthly dragging in the Kruger National Park by Horak (1998) and the 138 ticks collected per drag in Zambia by Zieger, Horak and Cauldwell (1998) and the 80 ticks collected per drag in 'Hoopdal' KQ96 by Schroder, Uys & Reilly (2006). Ticks removed by drag samples depend on many factors such as microclimatic conditions in specific sites at specific times, host numbers on the site, host species and favourability and host utilisation of the habitat. Thus, variations are expected between sites and even between the same sites over the years.

The presumed reason for *R.* (*Boophilus*) *decoloratus* numbers being so high in the controlled area as opposed to the other seven tick species found during the study period is bad management of acaricide treatment, resulting in this tick species becoming impervious to the acaricide treatment. This is known as tick resistance and has been confirmed especially in this species by Baker (1982), Du Toit, Graf and Bekker (1941), Solomon (1983) and Walker (1991).

Tick resistance has been detected in *R.* (*Boophilus*) *decoloratus* after controlled field trials and laboratory tests that confirm their resistance (Mekonnen 2005). Figure 2 shows the individual tick numbers collected for each tick species in the controlled and control-free areas.

TABLE 1: Ticks collected on the farm 'Hoopdal' KQ96 from September 2003 to August 2008.

Tick species	Number of ticks collected					Semi-intensive		Control free	
	Larvae	Nymphs	Males	Females	Total	*n*	%	*n*	%
Amblyomma hebraeum	1010	2	0	0	1012	126	12.45	886	87.55
Rhipicephalus (*Boophilus*) *decoloratus*	4603	0	0	0	4603	2720	59.09	1883	40.91
Rhipicephalus appendiculatus	546	111	1	12	670	108	16.12	562	83.88
Rhipicephalus zambeziensis	21	2	0	0	23	11	47.83	12	52.17
Rhipicephalus evertsi evertsi	521	0	0	0	521	116	22.26	405	77.74
Haemaphysalis elliptica	0	0	1	0	1	0	0.00	1	100.00
Hyalomma rufipes	4	0	0	0	4	1	25.00	3	75.00
Rhipicephalus spp.	0	2	0	0	2	1	50.00	1	50.00
Total number	**6705**	**117**	**2**	**12**	**6836**	**3083**	-	**3753**	-
Percentage (%)	**98.08**	**1.71**	**0.03**	**0.18**	-	**45.10**	-	**54.90**	-

TABLE 2: The eight tick species collected according to their significance.

Tick species	Significant ($p < 0.05$)	Non-Significant ($p > 0.05$)
Amblyomma hebraeum	T = 0	-
Rhipicephalus (*Boophilus*) *decoloratus*	-	T = 1
Rhipicephalus appendiculatus	T = 0	-
Rhipicephalus zambeziensis	-	T = 3
Rhipicephalus evertsi evertsi	T = 0	-
Hyalomma rufipes	T = 0	-
Haemaphysalis elliptica	T = 0	-
Rhipicephalus sp.	T = 0	-
Tick species significance	6	2

Source: The table is adapted from Fowler et al., 2003, published work entitled '*Practical statistics for field biology*'
T, Wilcoxon test statistic.

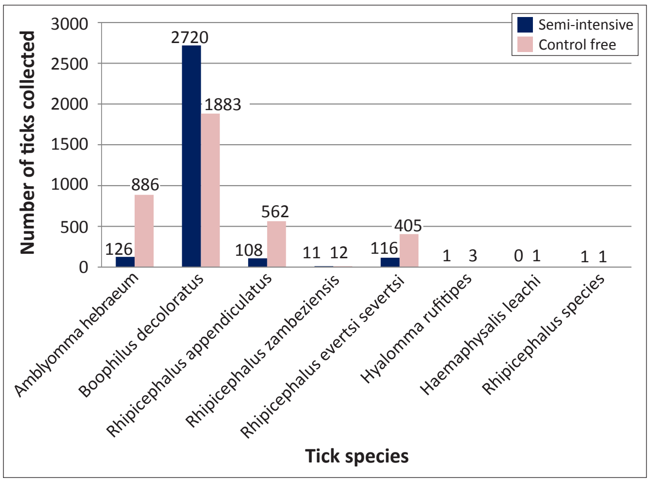

FIGURE 2: Tick numbers per species collected in the controlled (semi-intensive) and uncontrolled areas of the study area.

Conclusions

In conclusion, it is evident that of the eight tick species collected on the farm 'Hoopdal' KQ96 in the Thabazimbi District, Limpopo Province, South Africa, six of the tick species were more prevalent in the control-free area, one species was found equally in both areas and only one species, *R.* (*Boophilus*) *decoloratus*, was found predominantly in the controlled area during the study period, September 2003 until August 2008.

Thus it is evident that acaricide treatment is an important management tool to control ticks and tick-borne diseases. It is therefore essential that tick loads and presence should be monitored regularly to ensure that acaricide treatments are used during peak tick load periods and not on a permanent basis; this will result in more effective use of the acaricide in terms of the number of tick deaths and ensure that the ticks will not become resistant to the acaricide treatment. This will ultimately lead to less acaricide being used, which will be more cost effective. A study by Mekonnen (2002) confirmed that the use of acaricides at high frequencies and high concentrations was one of the main causes of tick resistance and financial loss.

Acknowledgement

I would like to acknowledge the input from Dr A.C. Uys for the identification of the individual ticks.

Competing interests

The authors declare that they have no financial or personal relationship(s) which may have inappropriately influenced them in writing this article.

Authors' contributions

B.S. (Tshwane University of Technology) M-Tech Qualification collected the data and wrote the manuscript. B.K.R. (Tshwane University of Technology) supervisor and co-author.

References

Acocks, J.P.H., 1988, *Veld types of South Africa*, 3rd edn., Botanical Research Institute, Pretoria (*Memoirs of the Botanical Survey of South Africa,* no. 57).

Baker, J.A.F., 1982, 'Some thoughts to resistance on ixodicides by ticks in South Africa', *Symposium on ectoparasites on cattle*, South Africa Bureau of Standards, Pretoria, South Africa 15 to 16 March 1982, p. 53–67.

Du Toit, R., Graf, H. & Bekker, P.M., 1941, 'Resistance to arsenic as displayed by the single host blue tick *B. decoloratus* (Koch) in a localized area of the Union of South Africa', *Journal of the South African Medical Association* 12, 50–58.

Fowler, J., Cohen, L. & Jarvis, P., 2003, *Practical statistics for field biology*, 2nd edn., John Wiley & Sons, London.

Grobler, J.H., 1981, 'Parasites and mortality of sable antelope *Hippotragus niger* (Harris, 1838) in the Matopos, Zimbabwe', *Koedoe* 24, 119–123. http://dx.doi.org/10.4102/koedoe.v24i1.623

Guglielmone, A.A., Robbins, R.G., Apanaskevich, A., Petney, T.N., Estrada-Pena, A., Horak, I.G., Shao, R. & Barker, S.C., 2010, The Argasidae, Ixodidae and Nuttalliellidae (Acari: Ixodida) of the world: A list of valid species names, *Zootaxa 2528*, p. 1–28, Magnolia Press, Auckland.

Horak, I.G., 1980, 'The control of parasites in antelope in small game reserves', *Journal of the South African Veterinary Association* 51, 17–19.

Horak, I.G., 1998, 'The relationship between ticks, hosts and the environment in the Kruger National Park, South Africa', in L. Coons & M. Rothschild (eds.), *Second international conference on tick-borne pathogens at the host-vector interface: A global perspective: Proceedings and abstracts,* Kruger National Park, South Africa, 28 August to 01 September 1995, vol. 2, 413–426. PMid:7452652

Lawrence, J.A., Norval, R.A. & Uilenberg, G., 1983, '*Rhipicephalus zambeziensis* a vector of bovine *Theileria*', *Tropical Animal Health and Production* 15, 39–42. http://dx.doi.org/10.1007/BF02250760, PMid:6405516

Lightfoot, C.J. & Norval, R.A.I., 1981, 'Tick problems in wildlife in Zimbabwe, 1. The effects of tick parasitism on wild ungulates', *South African Journal of Wildlife Research* 11, 41–45.

Low, A.B. & Rebelo, A.G., 1996, *Vegetation of South Africa, Lesotho and Swaziland*. Department of Environmental Affairs and Tourism, Pretoria.

McCosker, P.J., 1979, *Global aspects of the management and control of ticks of veterinary importance*. *Recent advances in acarology II*, p. 45–53, Academic Press, New York.

Mekonnen, S., 2002, *Multi-host ticks in commercial and communal farming areas in the Eastern Cape and North-West Provinces of South Africa,* MSc thesis, Department of Veterinary Tropical Diseases, Faculty of Veterinary Science, University of Pretoria.

Mekonnen, S., 2005. *Acaricide resistance profiles of a single and multi-host ticks in commercial and communal farming areas in the Eastern Cape and North-West Provinces of South Africa*, MSc thesis, Department of Veterinary Tropical Diseases, Faculty of Veteriniary Science, University of Pretoria.

Mucina, L & Rutherford, M.C., 2006, *The vegetation of South Africa, Lesotho and Swaziland*, South African National Biodiversity Institute (SANBI), Pretoria.

Norval, R.A.I. & Lightfoot, C.J., 1982, 'Tick problems in wildlife in Zimbabwe. Factors influencing the occurrence and abundance of *Rhipicephalus appendiculatus*', *Zimbabwe Veterinary Journal* 12, 2–9.

O'Kelly, J.C. & Seifert, G.W., 1969, 'Relationship between resistance to *Boophilus microplus*, nutritional status, and blood composition of Shorthorn x Hereford cattle on high and low planes of nutrition', *Australian Journal of Biological Science* 22, 1497–1506.

Petney, T.N. & Horak, I.G., 1987, 'Comparative host usage by *Amblyomma hebraeum* and *Amblyomma marmoreum,* (Acari, Ixodidae) the Southern African vectors of the disease heartwater', Tick Research Unit, Rhodes University, Grahamstown, and Department of Parasitology, Faculty of Veterinary Science, University of Pretoria, Onderstepoort, South Africa.

Petney, T.N., Van Ark, H. & Spickett, A.M., 1990, 'On sampling tick populations: The problem of over dispersion', *Onderstepoort Journal of Veterinary Research* 57, 123–127. PMid:2216344

Schroder, B., Uys, A.C. & Reilly, B.K., 2006, 'A survey of free living ixodid ticks on a commercial game farm in the Thabazimbi District, Limpopo province, South Africa', *Journal of the South African Veterinary Association* 77, 141–144. http://dx.doi.org/10.4102/jsava.v77i3.362, PMid:17137055

Solomon, K.R., 1983, 'Acaricide resistance in ticks', *Advances in Veterinary Science and Comparative Medicine* 27, 273–296. PMid:6359833Stafford, K.C., 2004, *Ticks and tick control*, Connecticut Agricultural Experiment Station, New Haven.

Swai, E.S., Mbise, A.N., Kessy, V., Kaaya, E., Sanka, P. & Loomu, P., 2005, 'Farm constraints, cattle disease perception and tick management practises in pastoral Masai community – Ngorongoro, Tanzania', *Livestock Research for Rural Development* 17, Article #17, accessed April 2005 and re-accessed 04 April 2013 from http://www/lrrd.org/lrrd17/2/swai17017.htm.

Van Der Vegt, D., 2007, 'Roan antelope (*Hippotragus equinus*)', unpublished MSc thesis, Department of Environmental and Animal Sciences, Van Hall Larenstein University, Leeuwarden.

Van Staden, P.J., 2002. 'An ecological study of the plant communities of Marakele National Park', MSc thesis, Centre for Wildlife Management, University of Pretoria.

Vredevoe, L., 2006, 'Background information on the biology of ticks', PhD thesis, Department of Entomology, University of California, Davis, accessed April 2005 and re-accessed 04 April 2013 from http://entomologyUcdavis.edu/faculty/rbkimsey/tickbio.html.

Walker, J.B., 1991, 'A review of the Ixodid ticks (Acari, Ixodidae) occurring in Southern Africa', *Onderstepoort Journal of Veterinary Research* 58, 81–105. PMid:1881661

Yeoman, G.H. & Walker, J.B., 1967, *The ixodid ticks of Tanzania. A study of the zoogeography of the Ixodidae of an East African country*, Commonwealth Institute of Entomology, London. PMCid:1901500

Young, E. & Basson, P. A., 1973, 'Heartwater in eland', *Journal of the South AfricanVeterinary Association* 44, 185–186. PMid:4769851

Zieger, U., Horak, I.G. & Cauldwell, A.E., 1998, 'Dynamics of free-living ixodid ticks on a game ranch in the Central Province, Zambia', *Onderstepoort Journal of Veterinary Research* 65, 49–59. PMid:9629590

Zimmerman, R.H. & Garris, G.I., 1985, 'Sampling efficiency of three dragging techniques for the collection of nonparasitic *Boophilus microplus* (Acari: Ixodidae) larvae in Puerto Rico', *Journal of Economic Entomology* 78, 627–631. PMid:4008746