Ectoparasites of dogs belonging to people in resource-poor communities in North West Province, South Africa

N R Bryson[a], I G Horak[a], E W Höhn[b] and J P Louw[c]

ABSTRACT

A total of 344 dogs belonging to people in resource-poor communities in North West Province, South Africa, was examined for ectoparasites, and all visible arthropods were collected from the left side of each dog. By doubling these numbers it was estimated that the dogs harboured 14 724 ixodid ticks, belonging to 6 species, 1028 fleas, belonging to 2 species, and 26 lice. *Haemaphysalis leachi* accounted for 420 and *Rhipicephalus sanguineus* for 14 226 of the ticks. Pure infestations of *H. leachi* were present on 14 dogs and of *R. sanguineus* on 172 dogs. Small numbers of *Amblyomma hebraeum, R. appendiculatus, R. evertsi evertsi* and *R. simus* were also collected. The predominance of *R. sanguineus* accounts for the high prevalence of canine ehrlichiosis (*Ehrlichia canis*) within the survey region, compared to canine babesiosis (*Babesia canis*), which is transmitted by *H. leachi,* and is a much rarer disease.

Key words: dogs, ectoparasites, *Haemaphysalis leachi,* resource-poor communities, *Rhipicephalus sanguineus.*

Bryson N R, Horak I G, Höhn E W, Louw J P **Ectoparasites of dogs belonging to people in resource-poor communities in North West Province, South Africa**. *Journal of the South African Veterinary Association* (2000) 71(3): 175–179 (En.). Department of Veterinary Tropical Diseases, Faculty of Veterinary Science, University of Pretoria, Private Bag X04, Onderstepoort, 0110 South Africa.

INTRODUCTION

Surveys carried out in various countries around the world have shown that *Rhipicephalus sanguineus* is an extremely widespread and common tick species on domestic dogs in southern Africa[1,8,11–13,18,22,24,27,28,32]. Tick surveys indicated that *Haemaphysalis leachi, R. sanguineus* and *R. simus* are the most prevalent species on domestic dogs[3,9,19,20,24,30]. This prevalence differs markedly between studies[3,8,9,24,27]. Dogs belonging to more affluent communities where sophisticated veterinary services are available to clients, tend to have a higher prevalence of *H. leachi*[3,9,10]. On the other hand, dogs from rural townships appear to have a higher prevalence of *R. sanguineus*[2,24,26].

It is almost a century since it was first demonstrated that the yellow dog tick, *H. leachi,* could transmit *Babesia canis* to dogs[15]. It can transmit the disease, known as canine babesiosis, both transstadially and transovarially[15,29]. In South Africa, *H. leachi* is the major vector of this disease, and appears to transmit a particularly virulent strain[14,32]. Although *R. sanguineus* transmits *B. canis* in other parts of the world[29,32], recent research in South Africa suggests that it may be unable to do so in this country[14]. Thus, although *R. sanguineus* is frequently collected from dogs suffering from canine babesiosis[9,14], it seems that it is not an important vector of this disease in South Africa. Serological and cross-immunity studies have revealed differences between the various strains of *B. canis* in South Africa, North Africa and in Europe[14,32], which possibly accounts for the different transmission profiles.

Rhipicephalus sanguineus is the only efficient tick vector of *Ehrlichia canis,* the aetiological agent of canine ehrlichiosis, a common tick-borne disease of dogs world-wide[4], and transmission takes place transstadially but not transovarially[5]. In southern Africa, canine ehrlichiosis is usually diagnosed on typical clinical signs and the identification of the specific morulae in the monocytes of stained blood smears[16,17]. Serological surveys carried out in Zimbabwe have indicated that *E. canis* is widespread in domestic dogs in that country[17]. It is also prevalent in dogs in Bloemfontein and its surrounding districts, Free State, South Africa[23]. *E. canis* may persist in the blood of infected dogs for more than 2 years, and appears to be present in the blood of chronically infected dogs[5], which then act as reservoirs for the infection.

An outreach programme has been conducted by the Veterinary Faculty of the Medical University of South Africa (MEDUNSA) at the Maboloka Outreach Clinic, North West Province, South Africa, for the past decade. The present surveys were conducted as components of 3 projects evaluating the health status of a population of dogs belonging to resource-poor communities in this region, and the dog owners were clients of this clinic or of the Veterinary Faculty itself. These projects also sought ways to elicit community participation in tick control[7].

Results emanating from this programme indicated that the dog population had an unusually high mortality rate, with a high prevalence of malnutrition, external and internal parasites, canine ehrlichiosis, distemper and genital tumours[24–27]. Various parameters pertaining to the dog population in the Maboloka area were compared with those of a healthy population of dogs in South Africa[25,26]. The Maboloka dogs were found to be markedly anaemic, and had very high serum gammaglobulin levels[26]. It was postulated that these abnormalities were due to large burdens of external and internal parasites coupled with malnutrition[26].

One of the objectives of this work was to compare the species composition of the tick population parasitising dogs in resource-poor communities in the North West Province of South Africa with those found in other surveys. Another was to ascertain whether the tick species present could be associated with specific tick-borne diseases.

MATERIALS AND METHODS

Three hundred and forty-four randomly selected dogs, all owned by clients of the Animal Hospital at the Faculty of Veterinary Science at MEDUNSA (25° 40'S, 27°56'E), or of the Outreach Clinic at Maboloka (25°26'S, 27°51'E), North West Province, were sampled for ectoparasites. The collections formed part of 3 separate projects. The 1st group of dogs formed

[a]Department of Veterinary Tropical Diseases, Faculty of Veterinary Science, University of Pretoria, Private Bag X04, Onderstepoort, 0110 South Africa.

[b]Department of Companion Animal Medicine and Surgery, Faculty of Veterinary Science, Medical University of Southern Africa, MEDUNSA, 0204 South Africa. (E-mail: hohn-erwin-w@lilly.com).

[c]Onderstepoort Veterinary Academic Research Unit, Faculty of Veterinary Science, University of Pretoria, Private Bag X04, Onderstepoort, 0110 South Africa.

Received: March 2000. Accepted: August 2000.

part of a project conducted during March/April 1989 evaluating the health status of dogs belonging to clients of the Animal Hospital. The owners of these dogs belonged mainly to the urban community of Garankuwa (25°40'S, 27°56'E) that virtually surrounds the University. The dogs were selected using tables of random numbers in a statistical package (IBM PC Version 3.0 1984). Only dogs older than 3 months or heavier than 2.5 kg were considered. Only 1 dog was sampled if there was more than 1 in a household.

The 2nd group formed part of a project conducted during March/April 1990 to evaluate changes in the health status of dogs at the Maboloka Outreach Clinic. The selection of dogs was random, with the Maboloka area divided into 4 quadrants with 25 dogs sampled in each quadrant. The 3rd group was also examined during 1990 at Maboloka, and consisted of dogs from 3 localities designated A, B and C. Fifty dogs from each of these localities were sampled only for ticks. The objective of this was to evaluate various methods of community participation in tick control, and to compare dogs at the 3 localities by cluster sampling.

Ectoparasites were collected from the dogs using a modification of a previously published method[8,24,27]. The anatomical areas of the dog sampled for parasites are illustrated in Fig. 1.

The sites sampled were the left eyelid and a 10-mm area around the eye (area 1); the left ear base, external and internal pinna and ear canal (area 2); left neck and shoulder (area 3); left front and back feet, carpus/tarsus distally (area 4); left dorsal tail root (50 × 50 mm) (area 5) and left ventral belly/groin (20 × 100 mm) (area 6). Collections were only made from the left side of the dog and the numbers of parasites collected doubled to approximate the total burden. All visible ectoparasites were removed by forceps, and the subsamples from each dog were pooled and stored in 70 % ethanol for later identification.

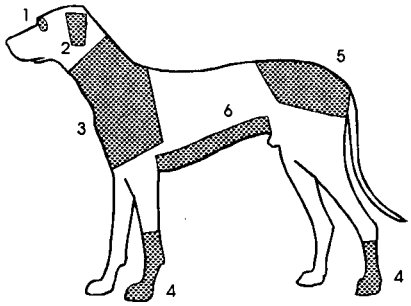

Fig. 1: **Anatomical areas of dog sampled for ectoparasites, only left side sampled**.

RESULTS

The ticks collected from the dogs are listed in Tables 1, 2, 3. The dominant tick species collected in the 3 surveys were *H. leachi* and *R. sanguineus,* with the latter tick outnumbering the former in all instances (Table 1). The total numbers of *R. sanguineus* collected from dogs examined at the Animal Hospital (Group 1) and the percentage of dogs infested with this tick were markedly lower than for the dogs at the Maboloka Outreach Clinic (Groups 2 and 3). With the exception of the larger burdens and greater number of dogs infested with *H. leachi* at locality C, Group 3, the tick burdens of the dogs in Groups 2 and 3 were similar. In all, 6 ixodid tick species were recovered from the dogs. Pure infestations of 4 species were present on 188 dogs and mixed infestations on 60 dogs, while 96 animals harboured no ticks (Tables 2, 3).

The other ectoparasites collected from the dogs in Groups 1 and 2 are summarised in Table 4. Two flea species, a louse species and the larvae of a calliphorid fly were recovered from the dogs. The number of fleas collected and the number of dogs infested at Maboloka (Group 2) considerably exceeded the number collected and the number of dogs infested at the Animal Hospital (Group 1). Most fleas on the dogs at the Animal Hospital belonged to a subspecies of the cat flea *Ctenocephalides felis strongylus,* while most at Maboloka were poultry fleas, *Echidnophaga gallinacea.* The prevalence of *C. felis strongylus* was higher than that of *E. gallinacea* at both localities.

DISCUSSION

Many surveys of ixodid ticks have been conducted in southern Africa, but only a few have involved dogs. A veterinary practitioner found the most common tick on dogs in Harare, Zimbabwe, to be *H. leachi* (51 %), followed by *R. sanguineus* (31 %) and *R. simus* (9.5 %). *Boophilus decoloratus, R. appendiculatus, R. evertsi evertsi* and *R. pravus* were also present, indicating that the dogs must have had contact with domestic ruminants[3].

In Eastern Cape Province, South Africa, *H. leachi* comprised 71.4 % and *R. simus* 15.7 % of the total number of ticks collected once or more each week from 4 domestic dogs over 3 years[10]. *R. sanguineus*

Table 1: **Major ixodid tick species collected from dogs during 3 surveys conducted in North West Province, South Africa.**

Group	No. of dogs	*Haemaphysalis leachi*				*Rhipicephalus sanguineus*				
		Nymphs	Males	Females	No. infested	Larvae	Nymphs	Males	Females	No. infested
1 (Medunsa)	94	0	20	16	7	4	94	194	118	32
2 (Maboloka)	100	4	2	4	4	206	1444	1366	602	75
3 (Maboloka) A	50	0	58	4	8	364	1478	1090	646	45
B	50	0	24	14	7	96	1468	1622	800	37
C	50	0	116	158	29	112	456	2138	1250	39

Table 2: **Ixodid ticks collected from 344 dogs during 3 surveys in North West Province, South Africa.**

Species	Total number collected						No. infested
	Larvae	Nymphs	Males	Females	Total	Relative % abundance	
A. hebraeum	20	6	2	0	28	0.19	11
H. leachi	0	4	220	196	420	2.85	55
R. appendiculatus	10	0	0	2	12	0.08	4
R. evertsi evertsi	2	0	0	0	2	0.01	1
R. sanguineus	782	3618	6410	3416	14226	96.62	228
R. simus	0	0	20	16	36	0.25	11

Table 3: **The prevalence of tick infestation on 344 dogs in North West Province, South Africa.**

Tick species	Number of dogs harbouring:		
	pure infestations	mixed infestations	no ticks
Amblyomma hebraeum	1		
Haemaphysalis leachi	14		
		60	96
Rhipicephalus sanguineus	172		
Rhipicephalus simus	1		

Table 4: **Arthropods collected from dogs during 2 surveys conducted in North West Province, South Africa.**

Group	No. of dogs	Number of arthropods collected and number of dogs infested (*n*)			
		Ctenocephalides felis strongylus **Adult**	***Echidnophaga gallinacea*** **Adult**	***Heterodoxus spiniger*** **Adults/nymphs**	***Cordylobia anthropophaga*** **Larvae**
1 (Medunsa)	94	64 (21)	12 (3)	10 (2)	2 (1)
2 (Maboloka)	100	230 (41)	714 (30)	16 (4)	0

was not found on these dogs. In a study at the Veterinary Faculty, University of Pretoria, Onderstepoort, 77.0 % of 395 dogs diagnosed with *B. canis* infection were infested with *H. leachi,* and 37.0 % and 18.7 % with *R. sanguineus* and *R. simus* respectively[9]. The dogs in both these surveys, like those in the Zimbabwe survey, belonged to owners from more affluent communities than those in the current survey. In contrast to the results of earlier surveys conducted in the same region as the current survey and in which no *H. leachi* was recovered[24,27], small numbers were collected during this study. Canine babesiosis is not common at Maboloka[24,27], and this is probably directly related to the low prevalence *H. leachi* on dogs in this region.

H. leachi is present in the eastern half and southern regions of South Africa and throughout Zimbabwe, even in those lowveld and other arid areas where the average annual rainfall might seem too low for the tick's survival[19]. In South Africa and Zimbabwe the preferred hosts of adult *H. leachi* are all members of the family Canidae (including jackals), hyaenas, the large cats, and viverrids, while the larvae and nymphs prefer murid rodents[10,19]. It has been suggested that the distribution of *H. leachi* is affected more by the abundance of rodent hosts for the immature stages than by climate[19]. Dogs belonging to wealthy owners with large suburban gardens and probably getting regular exercise outside the garden confines, and dogs in semi-rural or rural environments are both likely to come into contact with ticks nurtured on rodents and thus tend to have a high prevalence of *H. leachi* infestations. In 2 surveys currently being conducted by I.G.H., *H. leachi* is one of the dominant species on dogs belonging to members of rural communities in northeastern KwaZulu-Natal, as well as on farm dogs in southeastern North West Province, South Africa. *R. sanguineus* has not been collected from any of the dogs in these surveys.

Various surveys conducted world-wide indicate that *R. sanguineus* is a common parasite of dogs and that its distribution may be expanding. In 1946 it was listed from 26 states in the United States of America; it has now been recorded from all 50 states[34]. It has also spread to regions of Argentina where it was not previously present[6]. In Queensland, Australia, it was the most prevalent tick on 112 sheep dogs examined[1], and in a survey of stray dogs in the Rabat region of Morocco, it was found on 68 % of the dogs[22]. Of 105 stray dogs examined at the Central Veterinary Laboratory in Kabul, Afghanistan, nearly 30 % had ticks, and 10 of these were infested with *R. sanguineus*[13]. In Oklahoma and Arkansas, USA, 870 domestic dogs were examined and a total of 74 865 ticks collected, of which 62 % were *R. sanguineus*[12]. The last survey also indicated that *R. sanguineus* was more frequently present on the head, neck and back of the dogs, as well as being present between the toes[12]. Thirty percent of 820 dogs examined by Nigerian veterinarians at various clinics had ticks, and 160 were infested with *R. sanguineus*[31].

A survey conducted in Porto Alegre City, Brazil, indicated that 93.2 % of the 450 dogs examined were infested with *R. sanguineus* and that it was by far the most abundant species[28]. In addition, a total of 31 out of 32 farm dogs examined in municipalities in Rio de Janeiro were infested with this tick[33]. Recent work in Israel has demonstrated that *R. sanguineus* is common on dogs there[18]. The large number of *R. sanguineus* collected in the present survey is in agreement with the findings of previous workers in this region, who also found it to be the predominant tick species[24,27].

Many of the earlier records of *R. sanguineus,* from hosts other than domestic dogs, probably refer to *R. turanicus,* a tick with which it is easily confused[34]. Because all stages of development of *R. sanguineus* make virtually exclusive use of dogs as hosts[34], animals that are confined in kennels, houses or small gardens, or are chained, are more likely to be infected with this tick[9]. Forty-two percent of the dogs at Maboloka were either chained or kept in cages[24,27], providing ideal conditions for the tick to flourish[12]. The smaller proportion of dogs infested and the lower burdens of *R. sanguineus* on the dogs surveyed at the Animal Hospital of MEDUNSA compared with those at the Maboloka clinic, probably reflect the more affluent urban environment from which the owners of the former dogs come as opposed to that of the latter. The large population of *R. sanguineus* on the dogs at the Outreach Clinic is clearly one of the most important reasons for the high prevalence of canine ehrlichiosis in animals served by this facility[24,27].

Another characteristic of our survey was the almost total absence of *R. simus.* As mentioned earlier, this species accounted for 9.5 %, of the ticks collected from dogs in Harare, Zimbabwe, and 15.7 % and 18.7 % from dogs in the Eastern Cape Province and at the Veterinary Faculty, Onderstepoort, South Africa, respectively[3,9,10]. It is also one of the dominant species on dogs currently being surveyed by I.G.H. in northeastern KwaZulu-Natal and on farm dogs in

southeastern North West Province, South Africa. *R. simus* is widespread in the moister regions of southern Africa and the adults prefer domestic dogs, large wild carnivores, suids, equids and domestic cattle as hosts[34]. The immature stages prefer murid rodents[20,34]. In Zimbabwe it has been noted that *R. simus* rarely occurs in communal grazing areas because of overgrazing[20]. Similar conditions existed at Maboloka, where many of the dogs were restrained in a very arid environment, especially during winter. This was probably not conducive to vegetation cover, or the survival of rodent hosts.

The presence of *Amblyomma hebraeum, R. appendiculatus* and *R. evertsi evertsi* on the dogs probably reflects contact with other domestic livestock kept by the owners and confined close to the dogs at night.

Surveys for arthropods on dogs have been conducted world-wide. Moroccan researchers recorded 18 species of parasites on stray dogs, but considered only the fleas and ticks to be of economic importance[22]. Ninety-five percent of the dogs harboured ctenocephalid fleas, with *C. canis* constituting 75 % of the flea population and *C. felis* the remaining 25 %[22]. No lice were found on the dogs. A survey performed on 112 sheep dogs in Queensland, Australia, found that 13 % of dogs had fleas, of which 78 % were *C. felis* and 21 % *E. gallinacea*[1]. In Afghanistan, 105 stray dogs were examined for parasites. More than ⅓ were infested with fleas, and 3 species, namely *C. canis, Pulex irritans* and *Ceratophyllus fasciatus,* were recovered[13]. No lice were collected.

A number of surveys on the prevalence of insect species on dogs have been described in sub-Saharan Africa. In Nigeria 820 dogs were examined at 4 veterinary clinics; 26 % of these animals were infested with *C. canis* and 28 % with the louse *Trichodectes canis*[31]. Both *C. canis* and *C. felis* were present on kennelled dogs near Onderstepoort, South Africa, with the latter species predominating[8].

An extensive cross-sectional study of dogs at Maboloka, conducted by staff of the Veterinary Faculty at MEDUNSA, revealed that *E. gallinacea* (70 %) was the predominant flea, with *C. canis* (2 %) and *C. felis* (28 %) also present in a representative sample of 299 fleas[24,27]. Four dogs were infested with *Heterodoxus spiniger* and 1 with *Trichodectes canis.* The larvae of *Cordylobia anthropophaga* were also present[24,27].

The close association between the dogs and the free-ranging chickens of their owners probably accounts for their heavy burdens of *E. gallinacea.* The large numbers of *E. gallinacea* recovered, despite its lower prevalence than that of *C. felis strongylus,* reflects its tendency to stick fast in clumps, thus making it easier to see and collect. The smaller number of fleas and lower prevalence of infestation at the Animal Hospital compared to the Outreach Clinic, is probably related to the more affluent urban environment of their owners. Only 1 louse species (*Heterodoxus spiniger*) was recovered in the present survey, and then only in small numbers, and from only 6 of 194 dogs.

Myiasis, caused by the larvae of *Cordylobia anthropophaga,* is common in the survey region[24,27], and some dogs examined at the Clinic have had more than 50 larvae embedded in their skins. The very low prevalence of *C. anthrophaga* in this survey was possibly due to the difficulty in detecting larvae in the skin of dogs that are not visibly affected, particularly if these larvae are in the 1st instar. Another factor that may have played a role is that *C. anthropophaga* is seasonal in its occurrence and is especially prevalent in midsummer, whereas these surveys were conducted in late summer.

ACKNOWLEDGEMENTS

The cooperation of the dog owners at the MEDUNSA Animal Hospital and the Maboloka Outreach Clinic is greatly appreciated. Dr Jane Walker of the Onderstepoort Veterinary Institute is thanked for advice with some of the tick identifications, and Mrs Ann van den Berg for secretarial assistance. The project was funded by the Faculty of Veterinary Science of the Medical University of Southern Africa.

REFERENCES

1. Cornack K M, O'Rourke P K 1991 Parasites of sheep dogs in the Charleville district, Queensland. *Australian Veterinary Journal* 68: 149
2. Eckersley G N, Höhn E W, Reyers F, Turner G V, Wolmarans L 1992 A comparison between the disease status of hospitalized dogs from developed and developing communities. *Journal of the South African Veterinary Association* 63: 2–6
3. Goldsmid J M 1963 Ticks infesting dogs in the Salisbury area of Southern Rhodesia. *Journal of the South African Veterinary Association* 34: 609–610
4. Green C E, Harvey J W 1984 Canine ehrlichiosis. In Green C E (ed.) *Clinical microbiology and infectious diseases of the dog and the cat*. W B Saunders, Philadelphia: 545–561
5. Groves M G, Dennis G L, Amyx H L, Huxsoll D L 1975 Transmission of *Ehrlichia canis* to dogs by ticks (*Rhipicephalus sanguineus*). *American Journal of Veterinary Research* 36: 937–940
6. Guglielmone A A, Vinabal A E, Mangold A J, Aguirre D H, Galdo A B 1989 An epizootiological study on ticks of the *Rhipicephalus sanguineus* group in the Lerma Valley, Salta, Argentina. *Revista de Medina Veterinaria Buenos Aires* 70: 230–237
7. Höhn E W, Williams J H, Kirkpatrick R D 1992 A qualitative study of the attitudes of members of a developing community towards their dogs and veterinary services. *Journal of the South African Veterinary Association* 63: 121–124
8. Horak I G 1982 Parasites of domestic and wild animals in South Africa. XIV. The seasonal prevalence of *Rhipicephalus sanguineus* and *Ctenocephalides* spp. on kennelled dogs in Pretoria-North. *Onderstepoort Journal of Veterinary Research* 49: 63–68
9. Horak I G 1995 Ixodid ticks collected at the Faculty of Veterinary Science Onderstepoort, from dogs diagnosed with *Babesia canis* infection. *Journal of the South African Veterinary Association* 66: 170–171
10. Horak I G, Jacot-Guillarmod A, Moolman L C, De Vos V 1987 Parasites of domestic and wild animals in South Africa. XXII. Ixodid ticks on domestic dogs and on wild carnivores. *Onderstepoort Journal of Veterinary Research* 54: 573–580
11. Jagger T, Banks I, Walker A 1996 Travelling ticks. *The Veterinary Record* 139: 476
12. Koch H G 1982 Seasonal incidence and attachment sites of ticks (Acari Ixodidae) on domestic dogs in South Eastern Oklahoma and North Western Arkansas, USA. *Journal of Medical Entomology* 19: 293–298
13. Le Riche P D, Soe A K, Alemzada Q, Sharifi L 1988 Parasites of dogs in Kabul, Afghanistan. *British Veterinary Journal* 144: 370–373
14. Lewis B D 1994 Isolation of a vector specific strain of *Babesia canis* and a preliminary investigation of its use in developing a vaccine. MSc thesis, University of Pretoria
15. Lounsbury C P 1901 Transmission of malignant jaundice of the dog by a species of ticks. *Agricultural Journal of the Cape of Good Hope* 19: 714–724
16. Matthewman L A, Kelly P J, Mahan S M, Semu D, Tagwira M, Bobade P A, Brouqui P, Mason P R, Majok A, Raoult D 1993 Infections with *Babesia canis* and *Ehrlichia canis* in dogs in Zimbabwe. *The Veterinary Record* 133: 344–346
17. Matthewman L A, Kelly P J, Bobade P A, Tagwira M, Mason P R, Majok A, Brouqui P, Raoult D 1993 Western blot and indirect fluorescent antibody testing for antibodies reactive with *Ehrlichia canis* in sera from apparently healthy dogs in Zimbabwe. *Journal of the South African Veterinary Association* 64: 111–115
18. Mumucuoglu K Y, Burgan I, Ioffe-Uspensky I, Manor O 1993 *Rhipicephalus sanguineus*: observations on the parasitic stage on dogs in the Negev Desert of Israel. *Experimental and Applied Acarology* 17: 793–798
19. Norval R A I 1984 The ticks of Zimbabwe. IX. *Haemaphysalis leachi* and *Haemaphysalis spinulosa. Zimbabwe Veterinary Journal* 15: 9–17
20. Norval R A I, Mason C A 1981 The ticks of Zimbabwe. II. The life cycle and distribution of hosts of *Rhipicephalus simus,* Koch 1844. *Zimbabwe Veterinary Journal* 12: 2–9
21. Norval R A I, Daillecourt T, Pegram R G 1983 The ticks of Zimbabwe. VI. The *Rhipicephalus sanguineus* group. *Zimbabwe Veterinary Journal* 13: 38–46
22. Pandey V S, Dakkak A, Elmamoune M 1987 Parasites of stray dogs in the Rabat region, Morocco. *Annals of Tropical Medicine and Parasitology* 81: 53–55
23. Pretorius A M, Kelly P J 1998 Serological survey for antibodies reactive with *Ehrlichia*

canis and *E. chaffeensis* in dogs from the Bloemfontein area, South Africa. *Journal of the South African Veterinary Association* 69: 126–128
24. Rautenbach G H 1986 A cross-sectional, descriptive study of the health status of a canine population at Maboloka. M Med Vet thesis, University of Pretoria
25. Rautenbach G H, Booth C A, Höhn E W 1987 A comparison of health parameters in two different canine populations. Part I: haematological data. *Journal of the South African Veterinary Association* 58: 179–182
26. Rautenbach G H, Joubert H F 1988 A comparison of health parameters in two different canine populations. Part II: clinical pathology data. *Journal of the South African Veterinary Association* 59: 135–138
27. Rautenbach G H, Boomker J, De Villiers I L 1991 A descriptive study of the canine population in a rural town in southern Africa. *Journal of the South African Veterinary Association* 62: 158–162
28. Ribeiro V L S, Weber M A, Fetzer L O, De Vargas C R B 1997 Species and prevalence of tick infestation of stray dogs in Porto Alegre City, R S, Brazil. *Ciencia Rural* 27: 285–289
29. Shortt H E 1936 Life history and morphology of *Babesia canis* in the dog tick *Rhipicephalus sanguineus. Indian Journal of Medical Research* 23: 885–920
30. Theiler G 1962 The Ixodidae parasites of vertebrates in Africa south of the Sahara (Ethiopian Region), Project S 9958. Report to the Director of Veterinary Services, Onderstepoort
31. Ugochukwu E I, Nnadozie C C 1985 Ectoparasite infestations of dogs in Bendel State, Nigeria. *International Journal of Zoonoses* 12: 308–312
32. Uilenberg G, Franssen F F J, Perié N N, Spanjer A A M 1989 Three groups of *Babesia canis* distinguished and a proposed nomenclature. *The Veterinary Quarterly* 11: 33–40
33. Vianna L F C G, Bittencourt A J 1995 Tick prevalence on farm dogs in municipalities of Rio de Janeiro. *Ecossistema* 20: 202–208
34. Walker J B, Keirans J E, Horak I G 2000 *The genus* Rhipicephalus *(Acari, Ixodidae): a guide to the brown ticks of the world*. Cambridge University Press, Cambridge