CHAPTER 3

Miscellaneous contributions

Introduction

In this chapter a number of miscellaneous finding made during the years of the research are listed. These have been incidental findings, but nevertheless interesting ones. The article on *Strobiloestrus* in cattle is included here as the fly larvae are normally parasitic in especially klipspringer, *Oreotragus oreotragus*. I was also involved in the compilation of the parasite lists of various animals that were seen as possible game ranch animals. The references below are listed in chronological order because of their miscellaneous nature.

HORAK, I.G. & BOOMKER, J., 1981. *Strobiloestrus* sp. larvae in cattle. *Journal of the South African Veterinary Association*, 52, 211 - 212.

HORAK, I.G., BOOMKER, J., KINGSLEY, SHIRLEY A. & DE VOS, V., 1983. The efficacy of ivermectin against arthropod and helminth parasites of impala. *Journal of the South African Veterinary Association*, 54, 251 - 253.

VAN HEERDEN, J., BOOMKER, J., BOOYSE, D.G. & MILLS, M.G.L., 1994. Research Communication: The wild dog *Lycaon pictus*: a new host for *Ancylostoma caninum*. *Journal of the South African Veterinary Association*, 65, 18 - 19.

PENZHORN, B.L., KRECEK, R.C., HORAK, I.G., VERSTER, A.J.M., WALKER, J.B., BOOMKER, J.D.F., KNAPP, S.E. & QUANDT, S.K.F. 1994. Parasites of African rhinos: a documentation. *Proceedings of a Symposium on "Rhinos as Game Ranch Animals", Onderstepoort, 9 & 10 September 1994*.

BOOMKER, J., HORAK, I.G., PENZHORN, B.L. & KEET, D.F. 1996. Parasites of African buffaloes: a documentation. *Proceedings of a Symposium on the African buffalo as Game Ranch Animal, Onderstepoort, 26 October 1996*.

BOOMKER, J., PENZHORN, B.L. & HORAK, I.G. 1997. Parasites of lions (*Panthera leo*) and leopards (*Panthera pardus*): a documentation. *Proceedings of a Symposium on Lions and Leopards as Game Ranch Animals, Onderstepoort, October 1997*.

STROBILOESTRUS SP. LARVAE IN CATTLE

I.G. HORAK* and J. BOOMKER*

ABSTRACT: Horak I.G., Boomker J. ***Strobiloestrus* sp. larvae in cattle.** *Journal of the South African Veterinary Association* (1981) **52** No. 3, 211–212 (En) Department of Parasitology, Faculty of Veterinary Science, University of Pretoria, P.O. Box 12580, 0110 Onderstepoort, Republic of South Africa.

A number of calves and a two year-old heifer in the Middelburg District of the Transvaal were found to harbour *Strobiloestrus* sp. larvae in nodules along their sides. Each nodule contained a single larva and these larvae developed from the early second stage to the third stage during the 25 day period between the first and last visit to the district.

A particular set of circumstances involving the presence of klipspringers, which are considered to be the normal hosts of *Strobiloestrus clarkii,* grazing practice, hair colour of the calves and tick control probably resulted in the cattle becoming infested. A pour-on formulation of an insecticide was highly effective against the larvae.

INTRODUCTION

The larvae of the warble flies, *Hypoderma bovis* and *Hypoderma lineata,* are parasites of the cutaneous and subcutaneous tissue of cattle in the Northern Hemisphere[3]. They are occasionally encountered in imported cattle in southern Africa but there is no record of their having become established in this region.

Warble flies do, however, occur in the Republic of South Africa. These belong to the genus *Strobiloestrus,* and their larvae are found in the skin and subcutaneous tissue of reedbuck, klipspringer and kudu and have also been recovered from a domestic goat[3] and from cattle[1].

The present paper describes an investigation following the earlier recovery of *Strobiloestrus* sp. larvae from warble-like lesions in the skin of cattle in the Middelburg District of the Transvaal[1].

HISTORY

During a visit to the farm Buffelskloof in the Middelburg District, raised, circumscribed nodules in the skin of the sides of a number of young calves were noticed[1]. A single oestrid larvae belonging to the genus *Strobiloestrus* was expressed from each of some of these nodules.

The farm was visited on two subsequent occasions. These visits revealed that a steep rocky cliff effectively divided it into a section of Highveld grasslands and another of Bushveld Savanna. Several klipspringers lived on this cliff.

The cattle on the farm were mainly Africander-type cows which were bred to a Charolaise and to two Brahman bulls. The age of the crossbred calves at the time of the investigation ranged between approximately five and nine months. During the summer months the cattle were sprayed once weekly with amitraz (Triatix: Coopers SA (Pty) Ltd), a tick detaching agent, administered by means of a spray race.

INVESTIGATION

The farm was originally visited on 3 March 1979 and the larvae expressed on that occasion were identified as being in the early second stage of development (Fig. 1). The farm was again visited on 9 March 1979 and it was found that 13 of 57 calves in one herd and one of 52 calves in another were infested. The majority of calves

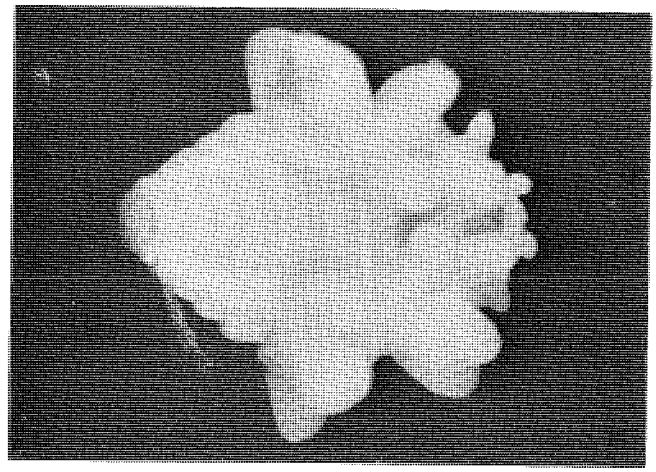

Fig. 1 Early second stage larva of *Strobiloestrus* sp. expressed from the skin of a calf. Actual length of larva 9,5 mm

in each of the herds was red in colour and had short hair but with the exception of one of the latter calves, the infested calves were yellow to fawn in colour and had medium length hair and were probably offspring of the Charolaise bull. No adult cattle appeared to be infested.

Infestation was characterized by the presence of circumscribed, raised nodules, approximately 15 mm in

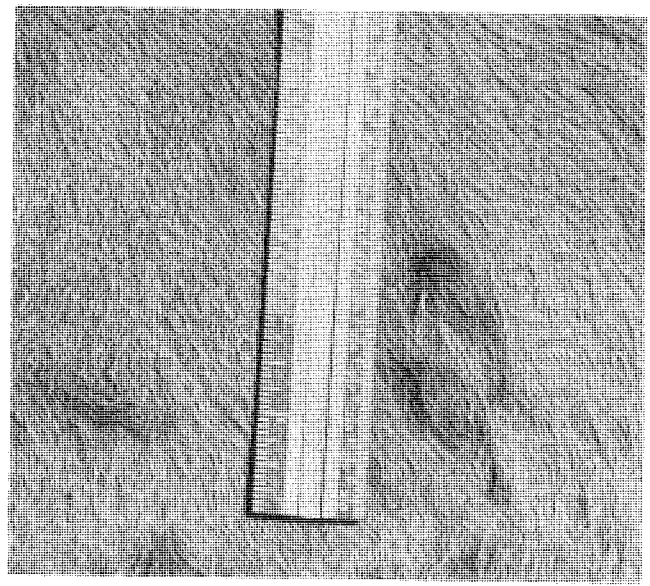

Fig. 2 Circumscribed, raised nodules caused by the larvae of *Strobiloestrus* sp. in the skin of a calf.

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diameter and 4 mm high, in the skin of the upper halves of the shoulders and sides (Fig. 2). Approximately two to 12 nodules were present in the skins of the infested calves, but one had 31 nodules.

A small opening was present in the centre of each nodule and a single larva could be expressed through this opening (Fig. 3). The larvae recovered from the nodules on this occasion were late second stage larvae.

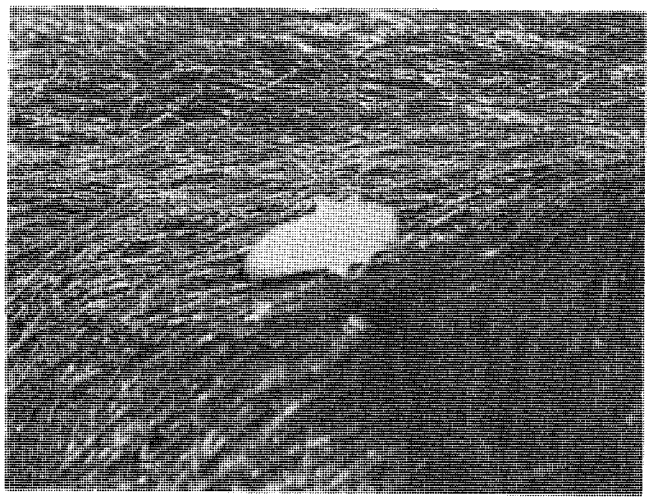

Fig. 3 Second stage larva of *Strobiloestrus* sp. expressed from a nodule in the skin of a calf.

The calf with the 31 nodules was treated with a pour-on formulation of famphur (Warbex: Coopers SA (Pty) Ltd.) administered on its hide along the length of its back.

The farm was visited again on 28 March 1979. The nodules on the treated animal had regressed in size and while larvae were still present these were in an advanced stage of decomposition. No nodules were seen on any of the other calves. A neighbouring farm was also visited on this occasion and a single, red-coloured two year-old heifer was found to be infested. Immature third stage larvae were expressed from the nodules on this heifer.

DISCUSSION

No specific identification of the *Strobiloestrus* infesting the calves could be made as according to Zumpt[3] these flies are not yet separable in the larval stage.

The life cycle of flies of the genus *Strobiloestrus* is unknown[3] and consequently the sites on which the eggs are deposited and the route by which the larvae reach the skin are also not known. The opening in the skin in the centre of each nodule serves both for respiration, as the larval spiracles are applied to it, and as exit for the mature third stage larvae. The fact that at each visit to the farm the larvae recovered were in a more advanced state of development and in one animal on an adjoining farm had reached the third stage indicates that the larval life cycle could probably be completed in cattle. The absence of nodules on the untreated calves on the third visit to Buffelskloof was probably due to the fact that the larvae had left the skin either as mature third stage larvae or perhaps as immature larvae. If these larvae had died in the skin, nodules containing dead larvae would possibly still have been present as they were in the case of the treated calf.

The infestation of calves at Buffelskloof probably resulted from a particular set of circumstances prevailing on the farm. Firstly the presence of a large number of klipspringers, a definitive host of the larvae of *Strobiloestrus clarkii*[3]. Secondly the cattle grazed part of the cliff on which the klipspringers occurred thus presumably entering the habitat of the flies. Thirdly the presence of calves somewhat similar in colour to the klipspringers, a fact which may have led to the flies laying eggs on these calves. Lastly the cattle were regularly sprayed with a tick-detaching agent which had no insecticidal effect. If such an insecticidal effect had been present the larvae would probably have been killed in an early stage of development before they caused the formation of nodules.

The fact that warbles caused by the larvae of *Strobiloestrus* spp. have not become an economic problem in cattle in South Africa can probably be ascribed to the regular application of acaricides, which usually also have an insecticidal effect, to cattle in extensive regions of the subcontinent.

Pour-on formulations of insecticides are used extensively for the control of warbles, caused by *Hypoderma* spp., in the Northern Hemisphere[2] and famphur in a pour-on formulation was highly effective against the larvae of *Strobiloestrus* sp. in the present investigation. In addition the stockowner was advised to alternate tick-detaching agents and acaricides with an insecticidal effect in his tick control programme in order to prevent a recurrence of the condition.

ACKNOWLEDGEMENTS

We wish to thank Mr. J.P. van Heerden, on whose farm the infestation occurred, for his cooperation with the investigation and for use of the facilities on the farm.

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THE EFFICACY OF IVERMECTIN* AGAINST HELMINTH AND ARTHROPOD PARASITES OF IMPALA

I.G. HORAK**, J. BOOMKER***, SHIRLEY A. KINGSLEY*** and V. DE VOS****

ABSTRACT: Horak I.G.; Boomker J.; Kingsley Shirley A.; De Vos V. **The efficacy of ivermectin against helminth and arthropod parasites of impala.** *Journal of the South African Veterinary Association* (1983) **54** No. 4, 251-253 (En). Tick Research Unit, Rhodes University, 6140 Grahamstown, Republic of South Africa.

The efficacy of ivermectin, injected subcutaneously at a dosage rate of 200 mcg/kg live mass, was determined against nematodes, ixodid ticks and lice infestations acquired by free-living impala, *Aepyceros melampus*, in the Kruger National Park. Although the parasite burdens of the untreated control animals varied considerably, ivermectin appeared to be highly effective against 7 nematode species and effective against 3 others. Of the 4 tick species recovered, only *Boophilus decoloratus* appeared to have been affected. In the case of the lice infestations, ivermectin was highly effective against 3 species of *Linognathus*, but ineffective against the 2 *Damalinia* species present.

Key words: Ivermectin, lice, tick, nematode infestation, impala.

INTRODUCTION

The efficacy of ivermectin against parasitic nematodes in cattle and sheep has previously been demonstrated[1,2,10]. It is also effective against single-host ticks[5] and some multi-host ticks[6] on cattle and against sucking lice[5,8]. The present paper records its efficacy against helminth and arthropod parasites of impala, *Aepyceros melampus*, a wild ruminant species.

MATERIALS AND METHODS

Fourteen free-living impala, of various ages and both sexes, were caught without the use of chemicals during May 1982 in the vicinity of Skukuza, in the south of the Kruger National Park. These animals were confined at Skukuza in an enclosure (70 x 30 m), in which they had free access to water and were fed dry hay cut from the veld. There was also a little grass on which they could nibble, in the enclosure.

Six animals were treated with ivermectin administered subcutaneously at a dosage rate of 200 mcg/kg live mass on the day after their capture and 2 untreated animals were slaughtered at the same time. The treated animals were marked with paint on the rump and ran with the untreated controls until they had all been slaughtered.

Six to eight days after treatment, 3 treated impala and 3 untreated controls were slaughtered. Fourteen and 15 days after treatment the remaining two treated impala and two controls were slaughtered. One of the treated animals and one of the controls, destined to be slaughtered at the latter occasion, had been caught by a leopard during the intervening period.

Helminths and arthropods were recovered from these animals as previously described[4]. The lungs were, however, not processed for worm recovery.

Table 1: THE ANTHELMINTIC EFFICACY OF IVERMECTIN IN IMPALA

Impala No.	Age	Sex	Treatment	Day slaughtered	Numbers of nematodes recovered														
					Longistrongylus sabie		*Haemonchus krugeri*		*Trichostrongylus thomasi*	*Trichostrongylus colubriformis*	*Cooperia hungi*		*Cooperioides hamiltoni*	*Impalaia tuberculata*		*Strongyloides* sp.	*Gaigeria pachyscelis*	*Oesophagostomum columbianum*	
					4th	Adult	4th	Adult	Adult	Adult	4th	Adult	Adult	4th	Adult	Adult	Adult	4th	Adult
1	29 months	M	Control	0	0	27	0	6	0	0	0	32	27	0	0	0	26	0	0
2	17 months	M	Control	0	0	96	0	53	179	1457	0	205	531	0	252	400	25	25	0
3*	Adult	F	Control	6	620	106	90	0	353	0	0	1680	453	0	101	0	0	0	3
4°°	29 months	F	Control	6	0	3	0	0	111	681	0	278	278	0	26	515	1	0	1
5*	Adult	F	Control	7	0	1	0	25	84	53	25	229	157	25	0	625	0	50	0
6	29 months	F	Ivermectin	8	1	0	0	0	0	0	0	1	51	0	0	73	0	0	0
7	17 months	F	Ivermectin	8	0	0	0	0	0	0	0	50	105	0	0	1	0	0	0
8*	17 months	M	Ivermectin	8	0	1	0	1	0	0	0	128	100	0	0	57	0	0	0
9°°	17 months	M	Control	14	1	9	0	25	463	2329	1	553	431	0	79	156	4	0	25
10°°°	Adult	M	Control	15	100	552	25	25	1029	5147	228	734	1329	575	462	200	1	0	75
11	17 months	M	Ivermectin	15	0	0	0	0	0	75	0	125	1	0	0	50	0	0	0
12	17 months	F	Ivermectin	15	0	0	0	0	0	25	0	0	52	0	0	25	0	0	0

*Infested with adult paramphistomes 4th = Fourth stage larvae
°*Trichostrongylus falculatus* 47 Adults
°°*Trichostrongylus falculatus* 474 Adults, *Cooperia neitzi* 145 Adults
°°°*Cooperioides hepaticae* 269 Adults

*Ivomec: MSD (Pty) Ltd.
**Tick Research Unit, Rhodes University, 6140 Grahamstown.
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****National Parks Board, Skukuza.

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RESULTS

The nematode burdens of the impala are summarized in Table 1.

With the exception of *Cooperia hungi*, *Cooperoides hamiltoni* and *Strongyloides* sp., against which efficacy seemed variable, ivermectin was highly effective against the various nematode species present in the impala.

The ixodid tick burdens of the impala are summarized in Table 2.

The tick burdens of the control and treated animals generally decreased the longer the animals were kept in the enclosure prior to slaughter. With the exception of the treated animals slaughtered 15 days after treatment, on which there may have been some activity against adult *Boophilus decoloratus*, ivermectin appeared to have had no effect on the adult or immature stages of the other ticks.

The lice burdens of the impala are summarized in Table 3.

Ivermectin was highly effective against the sucking lice *Linognathus aepycerus*, *Linognathus nevilli* and *Linognathus* sp., but had no apparent effect on the biting lice *Damalinia aepycerus* and *Damalinia elongata*.

DISCUSSION

Thirteen species of nematodes were recovered from the impala and, as can be expected with naturally acquired infestations, the worm burdens varied considerably. Although ivermectin was generally highly effective against most nematodes present its efficacy against *Cooperia hungi* and the related *Cooperioides hamiltoni* was variable. A similar phenomenon has also been noted with *Cooperia curticei* in sheep[10]. The efficacy against *Strongyloides* sp. also appeared variable. The effect of ivermectin against this genus has apparently not previously been determined in ruminants.

Table 2: THE ACARICIDAL EFFICACY OF IVERMECTIN ON IMPALA

Impala No.	Treatment	Day slaughtered	Numbers of ticks recovered													
			Amblyomma hebraeum			*Boophilus decoloratus*				*Rhipicephalus appendiculatus/ zambeziensis*				*Rhipicephalus evertsi evertsi*			
			Larvae	Nymphae	♂	Larvae	Nymphae	♂	♀	Larvae	Nymphae	♂	♀	Larvae	Nymphae	♂	♀
1	Control	0	464	192	0	1776	1568	256	250	448	0	36	12	240	0	0	2
2	Control	0	1216	386	0	3744	1904	528	146	432	0	14	2	304	96	2	0
3	Control	6	58	18	0	320	678	288	124	8	0	24	8	12	20	0	0
4	Control	6	50	46	2	360	798	244	130	0	0	10	10	120	8	0	0
5	Control	7	32	34	0	396	1026	266	132	12	0	16	6	56	106	0	0
6	Ivermectin	8	94	54	0	464	864	234	248	14	0	6	8	24	8	0	0
7	Ivermectin	8	546	54	0	376	384	130	60	10	0	0	2	56	0	0	0
8	Ivermectin	8	144	0	0	624	1280	216	80	8	0	2	2	64	96	0	0
9	Control	14	26	16	0	0	354	116	98	16	0	4	0	2	8	0	0
10	Control	15	10	16	0	30	600	298	128	12	6	2	0	0	6	18	0
11	Ivermectin	15	12	2	0	36	196	6	12	4	6	4	2	4	0	0	0
12	Ivermectin	15	58	4	0	214	210	42	28	0	0	2	2	0	4	0	0

Table 3: THE INSECTICIDAL EFFICACY OF IVERMECTIN ON IMPALA

Impala No.	Treatment	Day slaughtered	Numbers of lice recovered									
			Damalinia aepycerus		*Damalinia elongata*		*Linognathus aepycerus*		*Linognathus nevilli*		*Linognathus* sp.	
			Nymphae	Adults	Nymphae	Adults	Nymphae	Adults	Nymphae	Adults	Nymphae	Adults
1	Control	0	0	0	0	16	0	0	0	0	0	0
2	Control	0	880	512	160	96	64	96	0	0	64	96
3	Control	6	18	4	4	6	14	20	36	12	0	4
4	Control	6	4	4	16	12	32	36	0	4	0	12
5	Control	7	0	6	4	20	0	2	2	2	0	0
6	Ivermectin	8	6	2	4	4	0	0	0	0	0	0
7	Ivermectin	8	8	32	1160	650	0	0	0	0	0	0
8	Ivermectin	8	32	0	464	184	0	0	0	0	0	0
9	Control	14	10	2	0	2	60	62	0	0	0	2
10	Control	15	96	0	16	12	140	198	54	46	52	216
11	Ivermectin	15	12	0	6	2	0	0	0	0	0	0
12	Ivermectin	15	76	38	28	26	0	0	0	0	0	2

The impala harboured 4 species of ixodid ticks. As they were probably not exposed to further infestation in the pen, their tick burdens decreased fairly rapidly as the ticks engorged and dropped off. This makes interpretation of the results difficult, but with the possible exception of *B. decoloratus*, ivermectin was not effective against the tick species present. As *B. decoloratus* is a one-host tick, the apparent efficacy against the adult ticks may partially have been due to an effect against the immature stages resulting in delayed maturation. Improved control of *B. decoloratus* and possibly the other ticks, too, can probably be obtained by regular short interval treatment of animals[6,7].

The efficacy of ivermectin against *Linognathus* spp. and its inefficacy against *Damalinia* spp. on cattle has previously been reported[8]. The present experiment shows a similar pattern for these lice genera on impala.

Although free-living wild ruminants are seldom treated for parasites such treatment is advisable upon capture and translocation[3]. Ivermectin with its low toxicity[9] and high efficacy against most parasitic nematodes, sucking lice and the parasitic larvae of several fly species[5] would appear to be the drug of choice on such occasions.

ACKNOWLEDGEMENTS

We wish to thank the National Parks Board of Trustees for placing the impala at our disposal. The assistance of Messrs B.D. de Klerk and E.J. Williams with the necropsies and parasite collections is gratefully acknowledged.

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BOOK REVIEW **BOEKRESENSIE**

HANDBOOK OF VETERINARY NEUROLOGIC DIAGNOSIS

JOHN E. OLIVER & MICHAEL D. LORENZ

W.B. Saunders Company, Philadelphia. 1983 pp IX and 371. Figs. 179, Tables 109. Price R47,50. (ISBN 0-7216-6967-0)

Professors Oliver and Lorenz are to be congratulated on a well-written text providing a logical approach to the solving of neurological disorders in animals. The dog has been used as the model in their book with brief reference to appropriate species differences.

The text is divided into two major sections. The first dwells on the essential fundamentals of neurologic diagnosis such as the history, physical examination of the nervous system, localization of lesions in the nervous system and ancillary diagnostic aids. A chapter dealing briefly with the principles of medical treatment has also been included.

The second part of the text presents the most common clinical neurological problems presented to the clinician such as seizures, blindness, coma and paresis of a limb. The anatomic diagnosis is firstly reviewed, followed by a diagnostic and treatment plan. A brief discussion on the major differential diagnostic conditions is also presented.

A very useful and stimulating self-assessment section concludes every chapter throughout the book.

The text is amply illustrated with numerous photographs, sketches, diagrams and tables.

This book is a must for veterinary clinicians and students with an interest in veterinary neorology. I have no hesitation in strongly recommending it as a valuable aid in the diagnosis of neurological disorders.

J. van Heerden

THE WILD DOG (*LYCAON PICTUS*): A NEW HOST FOR *ANCYLOSTOMA CANINUM*

J VAN HEERDEN*, J BOOMKER**, D G BOOYSE** and M G L MILLS+

ABSTRACT

Faecal nematode egg counts performed on one captive and 49 free-ranging wild dogs (*Lycaon pictus*) revealed the presence of eggs of *Ancylostoma* spp. in 12 (24%) of the animals. The captive wild dog pup showed anorexia, general malaise, pale mucous membranes and black stools. Adult male and female *Ancylostoma caninum* were recovered from an approximately 3-month-old pup which died of distemper-like disease and a 9-year-old severely debilitated captive wild dog. A single adult *A. caninum* was also recovered from the intestines of a free-ranging wild dog in the Kruger National Park. These findings confirm the wild dog to be a host for *A. caninum*.

Key words: Wild dog, *Lycaon pictus, Ancylostoma caninum*

Van Heerden J.; Boomker J.; Booyse D.G.; Mills M.G.L. **The wild dog (*Lycaon pictus*): A new host for *Ancylostoma caninum*.** *Journal of the South African Veterinary Association* (1994) 65 No. 1, 18-19 (En.) Department of Companion Animal Medicine and Surgery, Faculty of Veterinary Science, Medical University of Southern Africa, 0204 Republic of South Africa.

Ancylostoma caninum is a common nematode parasite of canids and occasionally felids in many parts of the world. In South Africa it is likewise a common parasite in the domestic dog. In Africa, it has been recorded in the cheetah (*Acinonyx jubatus*), black-backed jackal (*Canis mesomelas*), side-striped jackal (*Canis adustus*), golden jackal (*Canis aureus*), fennec (*Vulpes zerda*), African wild cat (*Felis lybica*), small-spotted genet (*Genetta genetta*), bat-eared fox (*Otocyon megalotis*), Cape fox (*Vulpes chama*) and leopard (*Panthera pardus*)[3]. Anderson[1], however, considered *A. caninum* to be a parasite of canids, whereas *A. tubaeforme*, *A. ceylanicum* and *A. braziliense* occur in both canine and feline hosts. Earlier records on felids and mustelids should therefore be treated with reserve.

Although eggs of *Ancylostoma* spp. have been identified in the faeces of captive[5] and free-ranging wild dogs (*Lycaon pictus*) (J Richardson 1992, private practitioner, Nairobi, Kenya, personal communication, and J W McNutt and S Osofsky, 1994 Botswana Wild Dog Research Project, Maun, Botswana), neither adult nor larval hookworms have been recovered from this carnivore. This report documents the presence of *A. caninum* in both captive and free-ranging wild dogs.

A wild dog pup, born in captivity, was presented with anorexia, general malaise, very pale mucous membranes and black stools. At least one littermate had died of a severe anaemia. The packed cell volume was 0,08. A faecal flotation revealed the presence of numerous eggs of *Ancylostoma* spp.. The pup was treated with an anthelmintic and given an intravenous infusion of canine blood; it made an uneventful recovery.

Only 2 out of 9 captive wild dogs autopsied and processed for intestinal helminth recovery yielded *A. caninum*. Nine male and 3 female nematodes were found in the small intestine of an approximately 3-month-old pup which had died of a distemper-like disease, following vaccination against canine distemper. Two male and 2 female nematodes were recovered from the small intestine of an approximately 9-year-old, severely debilitated, male wild dog, which was clinically anaemic and had severe dental attrition. The packed cell volume of this animal was 0,22.

Faecal specimens (n=49) from free-ranging wild dogs were collected during August 1990, December 1991 and March 1993 in the southern part of the Kruger National Park. Most specimens were collected directly from the rectums of immobilised animals. Eleven or 22,4% of the faecal specimens were found to contain eggs of *Ancylostoma* spp. The hookworm egg counts varied from 100 to 1 300 per gram of faeces. Physical examination of immobilised wild dogs failed to reveal clinical signs of ancylostomosis. In addition, a single adult female *A. caninum* was recovered from the intestinal contents of a free-ranging wild dog that had been run over by a vehicle in the Kruger National Park.

Hookworms can perhaps be regarded as the most pathogenic nematode parasite of young domestic dogs and cats. The pups of domestic dogs are usually infected via the colostrum or milk of their dams and *Ancylostoma* larvae may be found in the milk during the first 20 d of lactation[4]. The percutaneous and transplacental routes of infection appear to be far less important in hookworm disease in domestic dog pups[2].

The most common, untoward side-effects in domestic dogs include anaemia, hypoproteinaemia and diarrhoea. The classical clinical signs in heavily infected pups, are pale mucous membranes and the production of black tarry faeces. In captive wild dog pups, infection with *Ancylostoma* spp. has been associated

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with anaemia, loss in body condition, weakness and diarrhoea[5].

Immunity to hookworm infections in domestic dogs is influenced by age, diet and the number of infective larvae[1]. Pups and malnourished domestic dogs are considered to be more susceptible, and this is in agreement with our findings of infections in suspected immuno-compromised wild dogs.

Although hookworm infections have not been found to be pathogenic in free-ranging wild dogs, ancylostomosis may well become a contributing mortality factor in pups or subadults under adverse conditions. The social organisation of wild dogs, which usually implies living in a pack, would facilitate transmission. The denning period, in particular, during which pups and the rest of the pack are restricted to the den and surroundings, may be conducive to the spread of infection. In captive wild dogs, ancylostomosis should definitely be considered as an important disease syndrome similar to that experienced in domestic dogs. Factors that compound the condition in both domestic and captive wild dogs, include the difficulty in the eradication of hookworms in both the dam and the environment.

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Book review/Boekresensie

CYTOLOGY AND HAEMATOLOGY OF THE HORSE

Editors, R L Cowell & R D Tyler

American Veterinary Publications, Thornwood Drive, Goleta, California 93117 1993, pp 242 (ISBN 939674-34-3)

This practical, easy-to-read, yet remarkably complete manual, will be used very often in a practice where there is an interest in equine cytology, and will give anyone who would like to add the fascinating, rewarding and cost-effective field of cytology to his diagnostic armour the confidence, reference and support to do so.

It is very clearly written with step-by-step, detailed instructions on how to separate specimens from different fluids and tissues; description of the pitfalls in staining, transporting and interpretation of cytological specimens; and excellent explanations, complimented with diagrams and colour photographic plates on the recognition of cytological features from normal to inflammatory, infectious and neoplastic features in each system. In most sections, other tests which complement cytology and aid in diagnostics are also mentioned, with emphasis on the relevance of each, i.e. cytology's place as seen in perspective to the "whole" of diagnostic procedures.

There are 11 chapters, beginning with a complete and simple introduction on sample collection in general, staining and trouble-shooting, the principles of identification of cells and their tissues-of-origin, signs of inflammation and infections, and criteria of malignancy.

The subsequent chapters each deal with a specific tissue, area or fluid: cutaneous and subcutaneous lesions: masses, cysts and fistulous tracts; the eyes and occular adnexa; the oral and nasal cavities; pharynx, guttoral pouches and paranasal sinuses; the lower respiratory tract; the gastrointestinal tract; the lymph nodes; pleural fluid; peritoneal fluid; synovial fluid; cerebrospinal fluid; the endometrium; semen evaluation; peripheral blood smears, and bone marrow. In addition to each chapter having its own excellent colour plates and diagrams, 7 additional colour plates appear at the end of the book. One of the very few errors in the book occurs in Plate 5 where the captions to 5E and 5G have been reversed).

One of the chapters of note for practicality, is the one on peritoneal fluid - it covers predictions for colic cases when the fluid analyses are compared with blood values of eg. glucose, lactate, total nucleated cell count, fibrinectin and enzymes. The pathogenesis of the biochemical changes in peritoneal fluid compared with those in bood in colic is given, and several flow diagrams help with interpretation of fluid findings.

The chapters on the reproductive tracts, emphasise the cytological differences with different cycle stages in the mare, and the part played by semen evaluation in the whole fertility examination, with an example of a comprehensive semen examination sheet as well as various methods of semen preparation for the haemocytometer method of measuring sperm concentration. There are clear diagrams and photographs of all the sperm abnormalities - classified as head, neck, midpiece and tail problems.

Haematological "reference intervals" are given in the chapter on peripheral blood smears.

This book is very highly recommended and many of the cytological principles apply to all species, as anyone already practising cytology will realise.

J H Williams

Proceedings of a Symposium on "Rhinos as Game Ranch Animals", Onderstepoort, 9 & 10 September 1994

Parasites of African rhinos: a documentation

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INTRODUCTION

In free-living wild animals a balance usually exists between hosts and parasites. Both have evolved together over the millennia. The presence of parasites under these conditions is usually incidental and of limited clinical significance. Under stressful conditions, such as droughts and especially human interference such as capture, captivity, transportation and release into strange surroundings, the host's immune system is suppressed, the balance is disturbed and parasite populations may escalate to such an extent that clinical symptoms become evident.

In this paper we attempt to document all the parasites that have been recovered from both black (*Diceros bicornis*) and white rhinos (*Ceratotherium simum*). Very few, if any, quantitative studies have been conducted; the records are primarily random collections or observations.

PROTOZOA

Trypanosoma species

Trypanosoma brucei[9, 23], *Trypanosoma congolense*[24] and *Trypanosoma vivax*[23,25] have been reported from black rhinos. These tsetse fly-borne blood parasites cause Nagana in livestock. Wild animals born in tsetse-infested areas often serve as reservoir hosts of trypanosomes, but clinical trypanosomosis only manifests when these animals are stressed. Mortalities due to trypanosomosis have been reported in recently captured young black rhinos in Tanzania after 9–25 days in captivity[23]. The deaths of four out of five white rhinos introduced to the tsetse-infested Zambezi Valley of Zimbabwe were attributed to trypanosomosis[47].

As these rhinos originated from KwaZulu Natal and had been kept in a tsetse-free area in southern Zimbabwe, they had never been exposed to trypanosomes. Chronic trypanosome-related health problems, including abortions, arose in white rhinos introduced into Meru National Park in Kenya from KwaZulu-Natal[25].

Babesia and *Theileria* species

Large Babesias, as yet unnamed, have been reported from black rhinos in Kenya[6] and from white rhinos in KwaZulu-Natal[5]. Babesiosis was regarded as the cause of death of two black rhinos[23]. Small piroplasms, either *Babesia* sp. or *Theileria* sp. but probably the latter, have been reported from black rhinos in East Africa[6,7] and KwaZulu-Natal[5,15]. Small piroplasms were seen in 42,8% of young white rhinos and 23,9% of adults examined in KwaZulu-Natal[5].

Balantidium

Balantidiosis has been reported in white rhinos[37]; the paper was not seen by us.

ARTHROPODS

Ticks

The majority of tick species are not host-specific, but are found on a great variety of vertebrate hosts. It is not surprising, therefore, that 40 tick species have been recovered from black and white rhinos (Table 1), though there is little doubt that the vast majority of these records represent incidental infestations only. Three species, however, are primarily rhino parasites. Two, *Amblyomma rhinocerotis* and *Dermacentor rhinocerinus*, have been collected from both black and white rhinos in many parts of eastern, central and southern Africa[16,50]. The third species, *Amblyomma personatum*, has been recorded from black rhinos, originally from Gabon and Kenya and subsequently also from Tanzania[50,55,58]. With the great reduction in black rhino numbers that has occurred in recent years this tick could easily become extinct. A fourth species, *Amblyomma sparsum*, has a strong predilection for black rhinos, although it has been recorded from a wide range of other mammalian hosts and also reptiles[50,55,58]. All these ticks are large, ornate species. Unfed adults of *A. rhinocerotis* are *ca.* 9 mm long and have a pattern of dark reddish-brown spots and stripes on an ochre-yellow background. *Dermacentor rhinocerinus* are 6-8 mm long and the male bears yellow-ochrous blotches on a chocolate-brown background[16,61]. The male of *A. personatum* is distinguished by having a dark brown figure resembling a flying bird on the pale background of its scutum. *Amblyomma sparsum* also has a brownish pattern of spots and stripes against a yellowish background. As its name implies, *Cosmiomma hippopotamensis* was originally described from hippos (*Hippopotamus amphibius*), but black rhinos are now regarded as its most likely host[4,55]. Common sites of tick attachment are skin folds in the perineal region, in and around the ears and around the eyes.

Flies

Glossina species – tsetse flies

Although the occurrence of trypanosomes in rhinos indicates that tsetse flies may feed on rhinos, they are not generally considered to be preferred hosts of the flies. In Kenya, however, *Glossina longipennis*, a tsetse species living in low densities in the typical dry bushveld habitat favoured by black rhinos, was found to feed primarily on rhinos[24,57]. Stereo-electron

micrographs of the labellar armature of *G. longipennis* indicate that it is specialised for feeding on elephants and rhinos[35].

Gyrostigma species – rhinoceros bot flies

This genus is closely related to *Gasterophilus,* the horse bot flies. *Gyrostigma pavesii* occurs in both rhino species. The flies are 24-35 mm long, with an orange and reddish head, a predominantly deep black thorax with a central reddish line, and a black abdomen with a reddish tip[61]. The adults are short-lived and do not feed, their mouthparts being rudimentary. The female deposits her eggs mainly in front of and below the anterior horn and between the two horns. The larvae that hatch from the eggs are *ca.*2 mm long. These larvae are thought to migrate in the epidermal tissue of the cheeks and mouth to the oesophagus. The second and third larval stages are found in the stomach, where they grow up to 4 cm long. Mature larvae leave the host with the faeces and pupate in the soil. The flies hatch after *ca.* 6 weeks. Zumpt[61] stated that the adults are rarely seen in the field and represent great rarities for the collector. This is largely explained by the fact that they live only a few days. Another reason lies in their behaviour: they stay in the close vicinity of rhinos, their only hosts, and who would approach a rhino armed only with a fly-net? *Gyrostigma conjungens,* a smaller species, parasitises black rhinos in East Africa.

Rhinomusca dutoiti

This blood-sucking fly is closely related to the stable fly (*Stomoxys calcitrans*). The larvae develop only in rhino dung, and the adults feed on both rhino species[60, 61]. These flies are somewhat larger than a house fly (*Musca domestica*), and have a stout, horn-coloured proboscis. A similar species, *Rhinomusca brucei*, occurs in East Africa.

Lyperosia species

This small fly has been found in association with black rhinos in Kenya[32]. The adult flies spend their life closely associated with their host, and the females fly down and lay their eggs on freshly deposited dung before returning to their feeding place on the host. The use of dung middens by rhinos ensures a continuously moist breeding place for the flies.

HELMINTHS

The diversity of helminth species is extensive. At least 40 known species have been reported in the two rhinos discussed here (Table 2). While most of these are nematodes, two trematodes and two cestodes have been reported. Several strongylid nematode genera predominate, including *Khalilia*, *Kiluluma*, *Murshidia* and *Quilonia*. The most abundant species is a small pinworm, *Probstmayria*, which was recorded in black rhinos in South Africa and Namibia in numbers of 399 000 000 in a single animal (R.C. Krecek, unpublished). *Probstmayria* is an example of a nematode not previously recorded. Its absence from the literature may be attributed to the method of previous collections. *Probstmayria* is 2-3 m in size and unless collection of the worm parasites is complete, i.e. quantitative samples are collected for microscopic examination, it is quite possible to miss recovery of these nematodes. Often new species are revealed in a host when quantitative studies are undertaken. In recent zebra helminth studies, six new nematode species were revealed when quantitative studies were done[41].

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Table 1: A list of ticks recovered from white and black rhinos

Tick species	White rhino	Black rhino		Reference
		S. Africa	E. & C. Africa	
Amblyomma cohaerens			X	14
Amblyomma eburneum			X	54
Amblyomma gemma			X	54, 58
Amblyomma hebraeum	X	X		1, 50
Amblyomma lepidum			?	50
Amblyomma personatum*			X	50, 54, 58
Amblyomma rhinocerotis*	X	X	X	1, 22, 50, 54
Amblyomma sparsum			X	50, 54, 58
Amblyomma tholloni			X	50, 54, 58
Amblyomma variegatum	X		X	50, 54, 58
Cosmiomma hippopotamensis*		X		4, 55
Dermacentor rhinocerinus*	X	X	X	1 22, 50, 54, 58
Haemaphysalis leachi	?	?		50
Haemaphysalis silacea		X		Horak (unpubl.)
Hyalomma albiparmatum			X	50, 54, 58
Hyalomma impeltatum			X	58
Hyalomma impressum			X	31
Hyalomma marginatum rufipes			X	50, 54
Hyalomma truncatum	X	X	X	1, 50
Rhipicephalus appendiculatus	X	X	X	1, 50, 54
Rhipicephalus sp. near *bequaerti*		X		1
Rhipicephalus capensis		?		50
Rhipicephalus compositus			X	50, 54, 58
Rhipicephalus humeralis			X	50, 54, 58
Rhipicephalus hurti			X	54, 58
Rhipicephalus jeanneli			X	54, 58
Rhipicephalus kochi			X	58
Rhipicephalus longus			X	54
Rhipicephalus lunulatus			X	56
Rhipicephalus maculatus	X	X	X	1, 50, 54
Rhipicephalus muehlensi		X		1, 50, 54
Rhipicephalus pravus			X	54
Rhipicephalus pulchellus			X	50, 54, 58
Rhipicephalus sanguineus			X	31, 50
Rhipicephalus senegalensis			?	50
Rhipicephalus simus	X	X	X	1, 50, 54, 58
Rhipicephalus supertritus			X	50
Rhipicephalus zambeziensis	X			Horak (unpubl.)
Rhipicephalus ziemanni			?	50
Rhipicephalus zumpti		X		1

* Rhinos are preferred hosts

Table 2: Helminth parasites of white and black rhinos

Parasite	White rhino	Black rhino S. Africa	Black rhino E. & C. Africa	Reference
Trematodes				
Brumptia bicaudatum			X	21
Gastrodiscus aegyptiacus	X			45
Cestodes				
Anoplocephala diminuta			X	40
Anoplocephala gigantea	X	X	X	27, 33, 34, 38, 43, 44, 61
Nematodes				
Grammocephalus intermedius			X	28
Habronema spp.	X			59
Habronema khalili		?	?	11
Khalilia rhinocerotis			X	28
Kiluluma africana		X	X	26, 46, 48, 61
Kiluluma brevicauda			X	49
Kiluluma brevivaginata			X	49
Kiluluma cylindrica			X	49
Kiluluma goodeyi		X	X	26, 49, 61
Kiluluma macdonaldi			X	46, 49
Kiluluma magna		X	X	11, 26, 46, 48
Kiluluma pachyderma		X	X	11, 26, 48
Kiluluma rhinocerotis		X	X	11, 26, 46, 48
Kiluluma solitaria		X	X	11, 26, 46, 48
Kiluluma stylosa			X	19, 20, 42, 53
Murshidia africana			?	8, 11
Murshidia aziza			X	8, 11, 28
Murshidia bozasi			X	8, 11, 28
Murshidia memphisia			X	8, 11, 28
Murshidia omoensis			X	8, 11, 28, 29
Murshidia pugnicaudata	X			Boomker & Booyse (Unpubl.)
Necator americanus			*	3
Oxyuris equi		X		26
Oxyuris karamoja	X	X	X	2, 40, 52, 61
Parabronema rhinocerotis			X	17
Parabronema roundi			X	12, 40
Physocephalus sexalatus		?	?	11
Probstmayria species		X		Krecek & Boomker (unpubl.)
Quilonia africana			X	8, 11, 29
Quilonia parva			X	8, 29
Setaria africana		X		10
Stephanofilaria dinniki		X	X	13, 18, 39, 40, 51
Strongylus tremletti			X	23, 38
Thelazia sp.			X	40
Trichuris sp.			**	36

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PARASITES OF AFRICAN BUFFALOES: A DOCUMENTATION

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INTRODUCTION

In South Africa, the parasites of buffalo have not received much attention, despite the animals' relative abundance in this country. Although Young & van den Heever[102] and Basson *et al.*[6] examined the carcasses of many buffaloes culled in the Kruger National Park (KNP), no surveys of the parasites have been conducted and those parasites that are known have been collected incidentally. A survey involving thousands of buffaloes was conducted in Mozambique, and despite the numbers of animals involved, few parasites were reported on.

In this paper we attempt to bring together the literature pertaining to the parasites of buffaloes. The list is by no means complete as much of the older literature was inaccessible. We further attempted to separate those parasites recorded from South Africa from those of the rest of Africa, and those occurring in *Syncerus caffer caffer* from those of *Syncerus caffer nanus*.

PROTOZOA AND RICKETTSIAS (Table 1)

Babesia **species and** ***Anaplasma*** **species**
Although common in cattle, in which these organisms cause severe disease, they have to the best of our knowledge not yet been recorded from buffaloes in South Africa. Both of these organisms are transmitted by the blue tick, *Boophilus decoloratus*.

Theileria **and** ***Haematoxenus*** **species**
Buffaloes have long been known to be the main carriers of the *Theileria* spp., of which *T. parva parva*, *T. parva lawrencei* and *T. mutans* are transmissible to cattle. The first two subspecies are transmitted by one or more of the *Rhipicephalus* spp., and are highly pathogenic to cattle, causing East Coast Fever and Corridor Disease, respectively. *Theileria mutans* is a non-clinical infection that is transmitted by *Amblyomma hebraeum*. A fourth species, *Theileria barnetti* appears to be specific to buffaloes. Clinical disease or deaths due to these organisms, as well as the *Haematoxenus* spp. which are closely related to the *Theileria* spp., appear to be rare in buffaloes.

Trypanosoma **species**
A number of *Trypanosoma* spp. have been recorded in buffaloes in East and Central Africa, but none have been reported from buffaloes from the KNP. It is, however, quite possible that buffaloes in the northern game reserves in KwaZulu-Natal are infected since the vectors, *Glossina* spp., occur there. *Trypanosoma brucei*, *T. congolense* and *T. vivax* cause nagana in cattle but do not seem to affect the buffaloes adversely.

Sarcocystis **spp.**
These organisms are sometimes visible as elongated white spots in especially the tongue, oesophagus and muscles of buffaloes. In the KNP, 59 % and 86 % of buffaloes examined were

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positive[6 102]. Although not thought to be infective to man, the presence is aesthetically unacceptable.

Coccidia

Coccidia occur in the small intestine an are excreted as oocysts, which have a tough shell and can survive in the environment for quite a while. Despite these organisms being present in varying numbers in most animals examined, nothing about the species and numbers that occur in buffaloes is known.

HELMINTHS (Table 2)

A large diversity of helminths occurring in almost every organ in the animals, have been recorded. Out of the 81 species and/or genera listed, only 32 occur in buffaloes in South Africa.

Nematodes

With the exception of the *Elaeophora* spp. which occur in distensions of the blood vessels of the lung and in aneurysms of the coronary vessels, the *Gongylonema* sp. in the mucosa of the oesophagus, the *Onchocerca* spp. and *Parafilaria bassoni* in the subcutaneous tissue, the *Setaria* spp. free in the abdominal cavity and the *Thelazia* spp. in the conjunctival sac of the eyes, all the nematodes occur in the intestinal tract. Apart from *Elaeophora poeli*, *Oesophagostomum synceri*, *Onchocerca synceri* and *Toxocara manzadiensis*, which appear to occur only in buffalo, all the nematodes have been recorded from sheep, cattle or antelope. Quantitative surveys have not been reported and our limited experience indicate that buffaloes do not harbour large burdens. For example, four buffaloes from the KNP harboured a mean of 1 086 (range 148 - 2 017) nematodes, and four from the Hluhluwe-Umfolozi Park 2 096 (range 0 - 8 383). Taking the nematode species diversity into account, the burdens are not significant and animals should be in no way inconvenienced by the worms.

Trematodes

Only five of the 24 trematode species and/or genera have been found in South Africa. An interesting record is that of *Schistosoma haematobium*[6], which is primarily a parasite of man. Other noteworthy trematodes are the *Fasciola* spp. which also occur in domestic ruminants.

Cestodes

Surprisingly few cestodes have been recorded, all of which are the typical herbivore cestodes and all of which have been recorded from a number of antelopes. The larval cestodes may have some significance, depending on their potential infectivity for humans. The larvae of *Taenia saginata* have as yet only been found in Angola[78] but there is little doubt that they occur in buffalo in South Africa as well.

ARTHROPODS AND PENTASTOMES (Table 3)

Ticks

A total of 59 species and/or genera of ticks have been reported as occurring on buffaloes. Many of these ticks are the vectors of protozoal and other diseases, e.g. *Boophilus decoloratus* for *Babesia* and *Anaplasma*, *Rhipicephalus appendiculatus*, *R. maculatus*, *R. muehlensi* and *Amblyomma hebraeum* for the *Theileria* spp. and *A. hebraeum* for heartwater (*Cowdria ruminantium*). However, none of the ticks is specific for buffaloes and most occur in larger numbers on antelopes, although several of the *Rhipicephalus* spp. prefer buffaloes. A noteworthy record is that of *Amblyomma tholloni*, which occurs almost exclusively on elephant, with few records of other hosts[20 96].

Mites

Demodex infections in buffalo present as cutaneous nodules[102] and were present in 10 % of the buffaloes examined[6], while infections with *Psoroptes* cause a scaly alopecia that is greyish in colour[6]. Basson *et al.*[6] believe that the incidence in buffaloes in the KNP is fairly high.

Flies
Only a few of the flies that are associated with buffaloes have been identified. The Tabanidae are large blood-sucking flies that have a high irritation value but are opportunistic feeders. Others, like the *Haematobia* spp., are more permanently associated with the animals and they breed in freshly deposited dung. It appears that the majority of the flies have nuisance value but some are also vectors for diseases such as Wesselsbron Disease, Bluetongue and possible Ephemeral Fever and Lumpy Skin Disease[102].

Lice
Only two species of lice, both the so-called 'blue' or blood-sucking, have been described. No data as to infection rates and seasonal occurrence are available.

Pentastomes
The large carnivores, especially lions, are the final hosts of the pentastomes and various antelopes and buffaloes, the intermediate hosts. The pentastomes occur in the cardio-vascular system, notably the blood vessels of the liver and in the heart. They cause large migration tracts in the parenchyma of the liver but despite their size (8 - 10 mm) they seem to cause little damage[6,102]. The incidence in buffaloes in the KNP varied from 64 %[102] to 69 %[6].

CONCLUSION

A large number of parasites are associated with buffalo, many of which are transmissible to other wildlife as well as to man and his domestic animals. Of particular importance are the theilerioses, fasciolosis, taenioses and sarcoptic mange. In view of this situation, one should carefully consider the consequences of introducing buffalo onto a game farm.

A large diversity of helminths have been recorded, with at least 20 identified species of nematodes, five trematodes, two adult cestodes and three larval cestodes being recorded from buffaloes in South Africa. A fairly constant feature is the presence of *Elaeophora poeli* in the blood vessels of the heart and lungs in buffaloes from Mozambique, and the presence of *Onchocerca nelsoni* in the majority of buffalo throughout Africa.

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Table 1: The protozoan parasites of African buffaloes

GENUS AND/OR SPECIES	SOUTH AFRICA	REST OF AFRICA	REFERENCES
Babesia spp.	-	+	26, 46
Anaplasma centrale	-	+	11, 26, 51
Anaplasma marginale	-	+	14
Anaplasma spp	-	+	46
Haematoxenus veliferus	-	+	86
Haematoxenus sp.	-	+	101
Sarcocystis spp.	+	+	6, 26, 34, 102
Theileria barnetti	-	+	10
Theileria parva lawrencei	+	+	55, 56, 58, 102
Theileria parva parva	-	+	5, 56, 57
Theileria mutans	+	+	11, 56, 57
Theilerial piroplasms	+	+	14, 57
Trypanosoma brucei	?	+	1, 14, 57
Trypanosoma congolense	?	+	1, 14, 99, 102
Trypanosoma theileri	?	+	3
Trypanosoma vivax	?	+	1, 99
Trypanosoma uniforme	?	+	1, 99
Coccidia oocysts	+	+	36[a], 102

[a] Found in *Syncerus caffer nanus*

Table 2: The helminth parasites of African buffaloes

GENUS AND/OR SPECIES	SOUTH AFRICA	REST OF AFRICA	REFERENCE
NEMATODES			
Agriostomum gorgonis	+	+	6, 38, 102
Ashworthius lerouxi	0	+	18
Bunostomum sp.	0	+	20
Chabertia ovina	0	+	12, 34
Cooperia fuelleborni	+	+	6, 20, 30, 38, 102
Cooperia hungi	-	+	30, 38
Cooperia pectinata	+	+	38, 42[a]
Cooperia punctata	+	+	38, 42[a]
Elaeophora poeli	-	+	8, 12, 20, 27, 74, 75
Elaeophora sagitta	+	+	38, 48
Gaigeria pachyscelis	-	+	18
Gongylonema pulchrum	-	+	38
Gongylonema sp.	-	+	70
Haemonchus bedfordi	+	+	6, 20, 29, 38, 41, 42[a], 62, 102
Haemonchus contortus	+	+	6, 17, 26, 29, 32b, 38, 42[a]
Haemonchus sp.	+	-	102
Impalaia tuberculata	-	+	38
Longistrongylus meyeri	-	+	20, 38
Longistrongylus schrenki	+	-	Boomker & Horak, unpubl
Mammomonogamus sp.	-	+	69
Oesophagostomum radiatum	+	-	6, 102
Oesophagostomum synceri	-	+	85
Onchocerca armillata	-	+	75
Onchocerca gibsoni	-	+	66, 67
Onchocerca synceri	+	+	6, 75, 102
Onchocerca sp.	-	+	20, 81
Ostertagia ostertagi	+	-	Boomker & Horak, unpubl
Ostertagia sp.	-	+	20
Parabronema skrjabini	+	+	6, 12, 20, 102

Parabronema sp.	+	-	62
Parafilaria bassoni	+	-	40
Setaria africana	-	+	16
Setaria bicoronata	-	+	38
Setaria labiatopapillosa	-	+	16, 20, 26, 49, 53, 68, 72, 73, 80, 84, 87
Setaria nelsoni	-	+	76
Thelazia lachrymalis	+	-	6
Thelazia rhodesii	+	+	6, 20, 102
Thelazia sp.	+	-	102
Toxocara manzadiensis	-	+	92
Toxocara vitulorum	-	+	92
Trichuris barbertonensis	-	+	20, 38
Trichuris globulosa	+	+	6, 32, 102
Trichuris sp.	+	+	34, Boomker & Horak, unpubl
Trichostrongylus axei	+	-	6, Boomker & Horak, unpubl
Trichostrongylus colubriformis	-	+	28
Trichostrongylus deflexus	+	?	Boomker & Booyse, unpublished
Trichostrongylus sp.	+	-	102
Ascaridoidea	-	+	36[b]
Strongyloidea	-	+	36[b]
Microfilariae	-	+	4
Unidentified filarids	+	-	102
TREMATODES			
Calicophoron calicophorum	-	+	91
Calicophoron clavula	-	+	25, 38
Calicophoron microbothrium	+	+	6, 20, 38, 62, 65, 82, 102
Calicophoron phillerouxi	-	+	20, 25, 91
Calicophoron raja	-	+	25, 38
Calicophoron sukari	-	+	25, 91
Calicophoron sukumum	-	+	25, 91
Calicophoron sp.	-	+	36[b]
Carmyerius endopapillatus	-	+	21, 22

Carmyerius exporus	-	+	38, 65
Carmyerius gregarius	-	+	21, 22, 53
Cotylophoron cotylophorum	+	+	6, 20, 17, 44, 47, 49, 62, 65, 80, 88, 102
Cotylophoron fuelleborni	-	+	20, 54
Cotylophoron indicum	-	+	20
Cotylophoron macrosphinctris	-	+	20
Dicrocoelium hospes	-	+	33
Fasciola gigantica	-	+	9, 53
Fasciola hepatica	+	+	19, 62, 72, 73, 80
Fasciola sp.	-	+	36[b]
Gigantocotyle gigantocotyle	-	+	38
Schistosoma haematobium	+	-	6
Schistosoma leiperi	-	+	43
Schistosoma margrebowiei	-	+	43
Schistosoma mattheei	+	+	6, 43, 102
CESTODES			
Adult			
Avitellina centripunctata	+	+	2, 6, 38, 62, 102
Moniezia benedeni	-	+	38
Moniezia expansa	-	+	38
Stilesia hepatica	-	+	38, 79
Thysaniezia giardi	-	+	77
Thysaniezia ovilla	-	+	31
Larvae			
Cysticercus sp.	+	+	42[a], 43, 102
Diphyllobothrid tapeworm	-	+	69
Echinococcus sp.	+	+	6, 34, 102
Taenia gonyamai	+	-	6, 89
Taenia regis	+	-	6
Taenia saginata	-	+	34, 78

[a] Recovered from sheep after artifical infection with larvae obtained from the faeces of animals in the Johannesburg Zoological Gardens

[b] Found in *Syncerus caffer nanus*

Table 3: The arthropod and pentastome parasites of African buffaloes

GENUS AND/OR SPECIES	SOUTH AFRICA	REST OF AFRICA	REFERENCE
TICKS			
Amblyomma astrion	-	+	64, 83, 96
Amblyomma cohaerens	-	+	34, 64, 83, 96
Amblyomma eburnum	-	+	83
Amblyomma gemma	-	+	83, 94, 97
Amblyomma hebraeum	+	+	4, 7, 36[a] 37, 39, 59, 83, 94, 102
Amblyomma lepidum	-	+	83, 97
Amblyomma marmoreum	+	-	Horak, unpublished
Amblyomma pomposum	-	+	45, 83
Amblyomma sparsum	-	+	64, 83, 95, 96
Amblyomma splendidum	-	+	83
Amblyomma tholloni	+	+	20, 94, 83
Amblyomma variegatum	-	+	36[a], 64, 83, 97
Boophilus decoloratus	+	+	4, 7, 15, 37, 39, 83, 102
Boophilus microplus	+	+	83
Dermacentor rhinocerinus	+	+	83
Haemaphysalis aciculifer	?	?	51, 95
Haemaphysalis hoodi	?	+	26
Haemaphysalis leachi	?	+	26
Haemaphysalis parmata	-	+	83
Haemaphysalis silacea	+	-	37
Hyalomma albiparmatum	-	+	51
Hyalomma rufipes	+	+	15, 35, 39, 83, 94, 95
Hyalomma truncatum	+	+	4, 15, 35, 39, 83, 97
Ixodes cumulatimpunctatus	-	+	83
Ixodes lewisi	-	+	13, 51
Ixodes pilosus	+	-	4, 39, 83
Ixodes rasus	-	+	51
Ixodes sp.	+	-	83
Rhipicephalus appendiculatus	+	+	4, 7, 37, 39, 60, 83, 102

Rhipicephalus bequaerti	-	+	83
Rhipicephalus capensis	+	+	83
Rhipicephalus cliffordi	-	+	51, 52
Rhipicephalus complanatus	-	+	83
Rhipicephalus compositus	-	+	83
Rhipicephalus dux	-	+	83
Rhipicephalus evertsi evertsi	+	+	7, 15, 37, 83, 102
Rhipicephalus evertsi mimeticus	+	+	83
Rhipicephalus follis	+	?	Horak, unpublished
Rhipicephalus hurti	-	+	83
Rhipicephalus jeaneli	?	?	51
Rhipicephalus kochi	-	+	83
Rhipicephalus longicoxatus	-	+	83
Rhipicephalus longus	-	+	83
Rhipicephalus lunulatus	+	+	95
Rhipicephalus maculatus	+	+	7, 37, 83
Rhipicephalus masseyi	-	+	83
Rhipicephalus muehlensi	+	+	37, 83
Rhipicephalus pravus	+	+	83
Rhipicephalus pulchellus	-	+	83
Rhipicephalus reichenowi	-	+	83, 93, 103
Rhipicephalus sculptus	-	+	83
Rhipicephalus senegalensis	-	+	83
Rhipicephalus simus	+	+	15, 34, 37, 83, 95
Rhipicephalus sulcatus	-	+	63
Rhipicephalus supertritus	-	+	83
Rhipicephalus tricuspis	+	+	15, 83
Rhipicephalus turanicus	+	-	63
Rhipicephalus zambeziensis	+	+	60, Horak, unpublished
Rhipicephalus ziemanni	-	+	83
MITES			
Demodex cafferi	-	+	61
Demodex pienaari	+	?	6, 102, 105

Demodex sp.	+	-	102
Psoroptes sp.	+	-	6, 102
Sarcoptes sp.	+	-	102
FLIES			
Glossina spp.	-	+	1, 98
Haematobia thirouxi potans	+	-	23, 24, 102,104
Hippoboscid flies (includes keds)	+	-	102
Stomoxys sp.	+	-	102
Tabanidae	+	+	Boomker & Keet, unpublished
LICE			
Haematopinus bufali	+	+	7, 26, 50, 102
Linognathus sp.	+	-	101
PENTASTOMIDA			
Linguatula multiannulata	-	+	71, 90
Linguatula serrata	+	+	6, 26, 71, 102
Neolinguatula nuttalli	-	+	71

[a] Found in *Syncerus caffer nanus*

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PARASITES OF LIONS (*PANTHERA LEO*) AND LEOPARDS (*PANTHERA PARDUS*) : A DOCUMENTATION

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INTRODUCTION

As is the case with many of the wild animals in South Africa, the helminths of lions and leopards are poorly known. Young[112] listed some of the diseases and parasites found in lions in the Kruger National Park, but those occurring in leopards are largely unknown. Those helminths that have been found in these carnivores have been collected incidentally, and no surveys have been conducted.

In this paper we attempt to bring together the existing literature pertaining to the parasites of free-living lions and leopards. The parasite records have been divided into those occurring in South Africa and those occurring in the rest of Africa. Records of helminth parasites collected from these carnivores in zoological gardens have not been included, as have the numerous records from India, China and Japan.

PROTOZOA AND RICKETTSIAE (Tables 1 and 2)

Babesia spp.
Elsa, the famous lioness, is said to have died of babesiosis[1]. Various babesias have been found in lion blood smears, but specific identification has not been confirmed. A small *Babesia*, morphologically indistinguishable from *B. felis*, was found on blood smears of all lions examined in Kruger National Park (KNP)[84] and also in Kenya and Tanzania[9, 20]. The KNP parasite has been shown to be serologically distinct from *B. felis*[57]. A large *Babesia* was also found, albeit rarely, in KNP lions[84]. *Babesia pantherae*, a large piroplasm, was described from leopards in Kenya[29]. Small Babesias, morphologically similar to *B. felis*, have been seen in blood smears of leopards in Kenya and KNP[20] (own observations - BLP).

Hepatozoon
Hepatozoon sp., morphologically resembling *H. canis*, commonly occurs on blood smears of lions and leopards in the KNP and East Africa[9, 15, 20, 45, 62, 112]. *Microbesnoitia leoni* [22, 23] has been shown to be a junior synonym of *Hepatozoon canis*[33].

Trypanosoma sp.
Trypanosoma congolense and *Trypanosoma brucei* have been reported from lion blood smears[10, 14, 21, 31, 36, 69, 91]. In the Serengeti National Park and Ngorongoro Conservation Area, Tanzania, 28 % of the lions were infected with *Trypanosoma* sp.[9]. It has been postulated that lions may become infected with trypanosomes by feeding on infected animals[66].

Trypanosoma congolense has been reported from leopard blood smears[14]. Leopards have been incriminated as a possible reservoir of *Trypanosoma brucei rhodesiense* in an outbreak of human sleeping sickness in Uganda[43]. *Trypanosoma evansi* has been reported from leopards in India[27, 28, 95].

Encephalitozoon cuniculi
Encephalitozoon cuniculi has been reported from a litter of lion cubs born at a breeding centre in the Lowveld of Northern Province (P.S. Rogers, personal communication).

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Coccidia

Isospora leonina, *Isospora pantheri* and *Isopora mohini* were described from captive lions in India, while *Isospora felis* oocysts have been recovered from lion faeces[3, 47, 59, 61]. *Isospora* species are commonly reported from captive lions[56, 85]. In Serengeti National Park and Ngorongoro Crater, Tanzania, 53% of lions sampled were shedding unidentified coccidian oocysts[70].

Table 1: The protozoan parasites of lions

GENUS AND/OR SPECIES	SOUTH AFRICA	REST OF AFRICA	REFERENCE
Babesia sp.	+	+	1, 8, 9, 20, 57, 84
Encephalitozoon	+	?	P.S. Rogers, pers. comm.
Hepatozoon sp.	+	+	9, 15, 20, 45, 62, 112
Unidentified coccidia	-	+	70
Microbesnoitia (syn. *Hepatozoon*)	+	+	22, 23, 33
Sarcocystis sp.	+	+	23, 32, 83, 97
Trypanosoma spp.	+	+	10, 14, 21, 31, 36, 69, 91

Table 2: The protozoan parasites of leopards

GENUS AND/OR SPECIES	SOUTH AFRICA	REST OF AFRICA	REFERENCE
Babesia pantherae	-	+	29
Babesia sp.	+	?	20
Hepatozoon sp.	+	+	9, 15, 20, 45, 62, 112
Isospora spp.	-	+	39
Microbesnoitia (syn. *Hepatozoon*)	+	+	20, 45, 62
Trypanosoma brucei	-	+	43
Trypanosoma congolense	+	?	14

Isospora rivolta oocysts have been recovered from leopard faeces[47, 60], while unidentified *Isospora* species oocysts have been reported from captive leopards[39]. Two distinctly different *Isospora* oocysts have been reported from leopards in Thailand[83].

Cryptosporidium
Oocysts of *Cryptosporidium* species have been recovered from a captive leopard[110].

Sarcocystis sp.
A *Sarcocystis* sp. recovered from a lioness in Nairobi National Park, Kenya[23] has been named *Sarcocystis felis*[32], and *Sarcocystis* cysts were found in the myocardium of a leopard in India[97]. *Sarcocystis*-like oocysts have been reported from the faeces of leopards in Thailand[83].

Besnoitia besnoiti
The definitive host of this tissue cyst-forming coccidian in Africa is still unknown. Attempts to infect lions and leopards were unsuccessful[30].
Microbesnoitia leoni

See *Hepatozoon* sp.

Table 3: The helminth parasites of lions

GENUS AND/OR SPECIES	SOUTH AFRICA	REST OF AFRICA	REFERENCE
TREMATODES			
Pharyngostomum cordatum	-	+	13, 50
CESTODES			
Diphyllobothrium theileri	-	+	13
Dipylidium sp.	-	+	50
Echinococcus granulosus felidis	+	+	80, 103, 104, 105
Mesocestoides sp.	-	+	48, 50
Taenia gonyamai (= *T. hlosei*)	±	+	23, 81
Taenia hydatigena	-	+	40, 78
Taenia regis (=*T. bubesi*)	+	+	7, 11, 58
Taenia taeniaeformis	±	-	37
Taenia sp.	-	+	48, 75
NEMATODES			
Ancylostoma paraduodenale	-	+	18, 50
Ancylostoma tubaeforme	+	+	50, 112
Cylicospirura subaequalis	-	+	93, 94, 99
Cylicospirura sp.	+		112
Dirofilaria repens	-	+	44, 50
Dirofilaria sudanensis	+	+	108, 112
Filaria leonis	-	+	11
Filaria martis	-	+	6
Filaria latala	+	-	24
Galonchus perniciosus	-	+	50
Gnathostoma spinigerum	-	+	50
Gnathostoma sp.	-	+	41, 49
Lagochilascaris major	-	+	34, 35, 51, 55
Ollulanus tricuspis	-	+	50
Physaloptera praeputialis	-	+	5, 25, 48, 50
Physaloptera malayensis	+	-	112
Physaloptera sp.	-	+	41
Toxocara canis	-	+	23, 68
Toxocara cati	-	+	12, 67, 68, 102
Toxascaris leonina	-	+	50
Trichinella spiralis	+	+	8, 73, 74

Toxoplasma
Acute disseminated toxoplasmosis has been reported from captive lions in Nigeria[77], while antibodies to *Toxoplasma gondii* were found in sera from lions in Etosha National Park, Namibia, and captive lions in the USA[82, 89, 98]. Captive lions in Kazakhstan were reported to be final hosts of *T. gondii*[86] however, the evidence presented appears rather suspect.

Toxoplasma-like oocysts have been reported from leopards in Thailand[83]. Serum from a single captive leopard in California was negative for *Toxoplasma* antibodies[89].

Giardia sp.
Cysts of *Giardia* species have been reported from leopards in Thailand [83].

HELMINTHS (Tables 3 and 4)

Nematodes
Relatively few nematode species have been collected from these carnivores. The more important ones are *Trichinella* (from a zoonotic point of view), the various hookworms (*Galonchus*, *Ancylostoma*), which may cause clinical disease in the animals, and the ascarids *Toxocara* and *Toxascaris*, both from a zoonotic and a disease causing point of view.

Cestodes
A large variety of species of the genus *Taenia* are present in the carnivores[107] and this appears to be the main genus of cestodes in these animals. All the *Taenia* spp. utilise ruminants as intermediate hosts, which implies that the ruminant should be eaten by the carnivore in order for the life cycle to continue.

Trematodes
A single trematode species has been reported from the intestines of lions and leopards, and it appears to be an incidental finding.

ARTHROPODS (Tables 5 and 6)

Ticks
Only 12 species of ticks were found on lions and leopards in the Kruger National Park. Lions were often heavily infested with the larvae and nymphs of *Amblyomma hebraeum* and these carnivores also seem to be a favoured host of the adult stages of the yellow dog tick, *Haemaphysalis leachii*. Two of 16 lions examined had heavy burdens of the brown ticks *Rhipicephalus appendiculatus*, one a heavy burden of *Rhipicephalus simus* and yet another a heavy burden of *Rhipicephalus zambeziensis*. Leopards were not infested to the same degree as lions and the most commonly encountered tick was *Rhipicephalus zambeziensis*.

Several of the ticks are implicated in the transmission of especially protozoal and bacterial diseases. The ticks also have a worrying effect on the animals, and those with the longer mouthparts may leave wounds through which other organisms may enter, such as bacteria (causing abscesses) and helminths (by the intermediate hosts feeding on the wounds).

Mites
Sarcoptes has caused severe clinical mange in free-living lions in the Kruger National Park, but no records of mites occurring on leopards could be found in the literature.

Flies
Hippobosca longipennis is a winged fly and is semi-permanently associated with carnivores in general. It is an avid blood sucker with a high irritation value, and may also be responsible for the transmission of bacterial and/or viral diseases. Adult females produce a fully mature third instar larva, one at a time, which immediately pupates in the soil.

Cordylobia anthropophaga, the Tumbu fly, is strongly attracted to urine or faeces and will deposit its eggs on dry sand contaminated with urine of faeces. The first instar larvae must enter the skin of a suitable host, in which it will cause a large boil (warble). After two moults the fully developed third instar larvae drops out of the boil in the skin and pupates in the soil. The lesion is irritating and can easily become infected.

Fleas
Both *Echidnophaga larina* and *Echidnophaga gallinacea* are stick-tight fleas of which the females burrow deeply into the skin, especially of the feet and that around the eyes. These females have expanded bodies and are difficult to remove. Once the eggs have been laid the females die and fall out of the skin. Both species are extremely common in Africa and it is said that both are vectors of bubonic plague, although not very good ones [38].

Table 4: The helminth parasites of leopards

GENUS AND/OR SPECIES	SOUTH AFRICA	REST OF AFRICA	REFERENCE
TREMATODA			
Pharyngostomum cordatum	-	+	13
CESTODA			
Diphyllobothrium decipiens	-	+	40
Diphyllobothrium theileri	-	+	13
Diphyllobothrium ? pretoriensis	-	+	42
Taenia acinonyxi	-	+	58
Taenia ingwei	+	+	81, 63, 64
Taenia regis (= *T. bubesi*)	+	-	107
Taenia sp.	-	+	75
NEMATODA			
Ancylostoma braziliense	-	+	2, 17
Ancylostoma caninum	-	+	2
Cyathospirura chevreuxi	-	+	4
Cyathospirura seurati	-	+	96
Cylicospirura subaequalis	-	+	94
Dracunculus medinensis	-	+	52, 53, 54
Filaria martis	-	+	100
Filaria russeli	-	+	100
Galonchus perniciosus	-	+	13, 88
Gnathostoma spinigerum	-	+	99
Onchocerca sp.	-	+	16
Physaloptera praeputialis	+	+	4, 16, 19, 41, 67, 79, 92
Toxocara cati	-	+	96, 109
Trichinella spiralis	+	+	8, 72, 73, 76
Troglostrongylus subcrenatus	-	+	87
Vigisospirura grimaldiae	-	+	96

Ctenocephalides felis is a jumping flea with a cosmopolitan distribution. Apart from causing physical damage, it also is a vector for numerous pathogens, including the tapeworm *Dipylidium*.

Lice

No records of lice were encountered in the literature, which is not really surprising since carnivores in general seem to have few louse species.

Pentastomes

The two genera that are listed in the tables occur as adults in the nasal cavities of the carnivores. *Armillifer* is a large pentastome with characteristic annulations and the infective nymphal stages occur encapsulated in various tissues of their intermediate hosts, the ruminants. The infective nymphal stages of *Linguatula*, however, wander freely through especially the livers of their ruminant intermediate hosts.

Acanthocephala

The spiny-headed worms are poorly known in Africa as a whole, and only the genus *Oncicola* has been recorded, once from a leopard in the Camerouns [65] and once from the same host in the Congo [13]. The worms attach to the mucosa of the stomach and intestine by means of several rows of well-developed hooks on a retractable proboscis. No records of pathology or deaths as a result of infection with these worms could be found in the literature.

Table 5: The arthropod and pentastomid parasites of lions

GENUS AND/OR SPECIES	SOUTH AFRICA	REST OF AFRICA	REFERENCE
INSECTS: FLIES			
Hippobosca longipennis	+	-	38
INSECTS: FLEAS			
Echidnophaga larina	+	-	38
Ctenocephalides felis	+	-	38
TICKS			
Ornithodoros moubata	-	+	101
Amblyomma eburneum	-	+	101
Amblyomma gemma	-	+	101
Amblyomma hebraeum	+	+	101, 112, I.G. Horak, unpublished
Amblyomma marmoreum	+	-	I.G. Horak, unpublished
Amblyomma sparsum	-	+	101
Boophilus microplus	-	+	101
Boophilus decoloratus	+	+	101, I.G. Horak, unpublished
Haemaphysalis leachii	+	+	101, 112, I.G. Horak, unpublished
Haemaphysalis spinulosa	+	-	I.G. Horak, unpublished
Ixodes sp.	-	+	101
Rhipicentor bicornis	-	+	101
Rhipicentor nuttalli	-	+	101
Hyalomma truncatum	+	+	101, 112, I.G. Horak, unpublished
Rhipicephalus appendiculatus	+	+	101, 112, I.G. Horak, unpublished
Rhipicephalus armatus	-	+	101
Rhipicephalus capensis	?	+	101
Rhipicephalus compositus	-	+	101
Rhipicephalus evertsi evertsi	+	-	112, I.G. Horak, unpublished
Rhipicephalus evertsi mimeticus	-	+	101
Rhipicephalus kochi	-	+	101
Rhipicephalus longus	-	+	101
Rhipicephalus pravus	-	+	101
Rhipicephalus pulchellus	-	+	101
Rhipicephalus reichenowi	-	+	101
Rhipicephalus sanguineus	+	+	101, 112
Rhipicephalus senegalensis	-	+	101
Rhipicephalus simus	+	+	101, 112, I.G. Horak, unpublished
Rhipicephalus sulcatus	-	+	101
Rhipicephalus supertritus	-	+	101
Rhipicephalus tricuspis	-	+	101
Rhipicephalus turanicus	+	-	I.G. Horak, unpublished
Rhipicephalus zambeziensis	+	-	I.G. Horak, unpublished
MITES			
Sarcoptes scabei	+	-	111
PENTASTOMES			
Armillifer armillatus	+	-	113
Linguatula serrata	+	-	112
Linguatula nuttalli	+	-	113

Table 6: The arthropod, pentastomid and acanthocephalan parasites of leopards

GENUS AND/OR SPECIES	SOUTH AFRICA	REST OF AFRICA	REFERENCE
INSECTS: FLIES			
Cordylobia anthropophaga	+	-	38, 113
Hippobosca longipennis	+	-	38
INSECTS: FLEAS			
Echidnophaga gallinacea	+	-	38
Echidnophaga larina	+	-	38
Ctenocephalides felis	+	-	38
TICKS			
Amblyomma hebraeum	-	+	101
Amblyomma nuttalli	-	+	101
Amblyomma tholloni	-	+	101
Amblyomma variegatum	-	+	101
Haemaphysalis aciculifer	-	+	101
Haemaphysalis leachi	-	+	101
Haemaphysalis parmata	-	+	101
Ixodes cavipalpus	-	+	101
Ixodes cumulatimpunctatus	-	+	101
Ixodes moreli	-	+	101
Ixodes muniensis	-	+	101
Ixodes pilosus	-	+	101
Ixodes oldi	-	+	101
Ixodes rasus	-	+	101
Ixodes vanidicus	-	+	101
Rhipicentor bicornis	-	+	101
Rhipicentor sp.	-	+	101
Hyalomma truncatum	-	+	101
Rhipicephalus appendiculatus	-	+	101
Rhipicephalus armatus	-	+	101
Rhipicephalus capensis	-	+	101
Rhipicephalus compositus	-	+	101
Rhipicephalus e. evertsi	+	-	I.G. Horak, unpublished
Rhipicephalus pravus	-	+	101
Rhipicephalus pulchellus	-	+	101
Rhipicephalus sanguineus	-	+	101
Rhipicephalus senegalensis	-	+	101
Rhipicephalus simus	-	+	101
Rhipicephalus sulcatus	-	+	101
Rhipicephalus tricuspis	-	+	101
Rhipicephalus turanicus	+	-	I.G. Horak, unpublished
Rhipicephalus zambeziensis	+	-	I.G. Horak, unpublished
Rhipicephalus ziemanni	-	+	101
PENTASTOMIDA			
Armilifer annulatus	+	-	113
ACANTHOCEPHALA			
Oncicola dimorpha	-	+	65
Oncicola fraterna	-	+	13

CONCLUSION

As is evident from the tables, a large number of parasites occur in and on lions and leopards. However, the diversity is small when compared to those that occur in ruminants, and the few records from South Africa is an indication that a lot of work still remains to be done as far as the parasites of these carnivores are concerned.

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