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THE HELMINTH PARASITES OF VARIOUS ARTIODACTYLIDS FROM SOME SOUTH AFRICAN NATURE RESERVES

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ABSTRACT

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The helminth species composition and helminth burdens of 4 grey duikers, 12 bushbuck, 2 nyala, 2 giraffe, a steenbok, an oribi, a waterbuck and a tsessebe from the Kruger National Park (KNP); of a steenbok and a greater kudu from the farm Riekerts Laager, Transvaal; of a single blue duiker from the Tsitsikama Forest National Park, and of a blue wildebeest, a red hartebeest, a gemsbok and 2 springbok from the Kalahari Gemsbok National Park (KGNP) were collected, counted and identified

New parasite records are: *Agriostomum equidentatum* from the gemsbok, *Cooperia neitzi* from the bushbuck, *Cooperia* sp. from the gemsbok and the red hartebeest, *Cooperia yoshidai* from the waterbuck and the tsessebe, *Dictyocaulus viviparus* from the bushbuck, *Haemonchus bedfordi* from the waterbuck, *Haemonchus contortus* from the gemsbok, *Haemonchus krugeri* from the steenbok from the KNP, *Impalaia nudicollis* from the gemsbok and the red hartebeest, *Impalaia tuberculata* from the oribi and the waterbuck, *Impalaia* spp. from the kudu, *Longistrongylus meyeri* from the steenbok from Riekerts Laager and the gemsbok, *Longistrongylus sabie* from the steenbok from the KNP, *Longistrongylus schrenki* from the tsessebe, *Parabronema* sp. from the tsessebe and the red hartebeest, *Paracooperia serrata* from the gemsbok and the steenbok from the KGNP, *Pneumostrongylus calcaratus* from the bushbuck, *Strongyloides* sp. from the gemsbok, *Trichostrongylus* sp. from the gemsbok, the red hartebeest and the steenbok from the KGNP, *Trichostrongylus axei* from the blue duiker, *Trichostrongylus falculatus* from the bushbuck and the oribi, *Trichostrongylus instabilis* from the bushbuck, the steenbok from the KNP and the oribi and *Trichostrongylus thomasi* from the grey duikers and tsessebe.

Host specificity of the parasites was not marked and crossinfestation was common. This was not true for the giraffe, since none of the helminths of these animals were found in the antelope and vice versa.

INTRODUCTION

Many artiodactylids in game reserves die annually from accidents or diseases or are culled for research or other purposes not necessarily related to parasitological surveys. By collecting the internal parasites of such animals, valuable information on the species composition of their helminths and their helminth burdens can be obtained. This is particularly true in the case of rare species such as blue duiker, *Cephalophus monticola,* or species that are not well represented in a particular game reserve, such as nyala, *Tragelaphus angasi,* in the Kruger National Park (KNP).

The helminths recorded in this paper were recovered from 4 grey duikers, *Sylvicapra grimmia,* 1 blue duiker, *C. monticola,* 12 bushbuck, *Tragelaphus scriptus,* 2 nyala, *T. angasi,* 1 kudu, *Tragelaphus strepsiceros,* 2 giraffe, *Giraffa camelopardalis,* 3 steenbok, *Raphicerus campestris,* 1 oribi, *Ourebia ourebi,* 1 waterbuck, *Kobus ellipsiprymnus,* 1 tsessebe, *Damaliscus lunatus,* 1 red hartebeest, *Alcelaphus buselaphus,* 1 blue wildebeest, *Connochaetes taurinus,* 1 gemsbok, *Oryx gazella* and 2 springbok, *Antidorcas marsupialis.*

MATERIALS AND METHODS

Animals

The animals and the localities at which they were collected are listed in Table 1.

Collection of parasites

Apart from the blue duiker, only the formalinized gastro-intestinal tract of which was available, the gastro-intestinal parasites were collected in the field using the methods described by Reinecke (1973) and formalinized. The hearts, lungs and livers were processed as described by Horak (1978b) and were also formalinized. Since the parasites of the animals from the Kalahari Gemsbok National Park (KGNP) were collected in the field, where no waterbaths were available, digests, hearts and lungs were placed in the sun or near an open fire to reach the desired temperature.

One aliquot representing 1/10th of the volume of the ingesta was made separately for each of the abomasa, small and large intestines of the 4 grey duikers, the blue duiker, the steenbok, the springbok and the oribi, while 2 aliquots, each representing 1/50th of the volume of the ingesta were made for each of the remaining animals. All the aliquots and digests as well as the heart, lung and liver washings were examined microscopically.

In cases where more than one species of a genus was present, the males were identified specifically but not the females. The 4th stage larvae were identified to the generic level only.

RESULTS

The total numbers of helminths recovered from the gastro-intestinal tracts of the various animals are listed in Tables 2 and 3.

Grey duikers (Table 2)

Two cestode and 9 nematode species, were collected. *Trichostrongylus thomasi* is a new parasite record for these antelope.

Blue duiker (Table 2)

Trichostrongylus axei was the only helminth recovered and is a new record for the blue duiker.

Bushbuck (Table 2)

One cestode and 13 nematode species were recovered of which *Cooperia neitzi, Trichostrongylus instabilis, Trichostrongylus falculatus, Dictyocaulus viviparus* and *Pneumostrongylus calcaratus* are new parasite records for these antelope.

Nyala (Table 2)

Both the nyala were males; the younger one (No. 1) did not harbour any worms. The older male (No. 2) had

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TABLE 1 The collection data for the various artiodactylids examined during this study

Species	Number	Date	Locality
Grey duiker	4	Feb. 80–Jan. 81	Malelane, Kruger National Park; 25°28′S; 31°31′E
Blue duiker	1	Oct. 76	Tsitsikama Forest National Park, Cape Province; 33°54′–33°57′S; 23°51′–23°56′E
Nyala	2	Oct. 81	Pafuri, Kruger National Park; 22°26′S; 31°10′E
Bushbuck	3	Oct. 81	Pafuri, Kruger National Park; 22°26′S; 31°10′E
Bushbuck	9	Oct. 79–Nov. 82	Skukuza, Kruger National Park; 24°58′S; 31°35′E
Giraffe	2	July 80	Lower Sabie, Kruger National Park; 25°07′S; 31°50′E
Steenbok	1	Nov. 79	Riekerts Laager, Transvaal; 24°30′S; 28°29′E
Steenbok	1	Oct. 82	Malelane, Kruger National Park; 25°28′S; 31°31′E
Steenbok	1	Oct. 84	Kalahari Gemsbok National Park; Approx. 24°30′–25°47′S; 20°–20°52′E
Oribi	1	July 79	Pretoriuskop, Kruger National Park; 25°10′S; 31°16′E
Waterbuck	1	Feb. 83	Pretoriuskop, Kruger National Park; 25°10′S; 31°16′E
Tsessebe	1	June 83	Pretoriuskop, Kruger National Park; 25°10′S; 31°16′E
Kudu	1	Oct. 79	Riekerts Laager, Transvaal; 24°30′S; 28°29′E
Red Hartebeest	1	Oct. 84	Kalahari Gemsbok National Park; Approx. 24°30′–25°47′S; 20°–20°52′E
Blue Wildebeest	1	Oct. 84	Kalahari Gemsbok National Park; Approx. 24°30′–25°47′S; 20°–20°52′E
Springbok	2	Oct. 84	Kalahari Gemsbok National Park; Approx. 24°30′–25°47′S; 20°–20°52′E
Gemsbok	1	Oct. 84	Kalahari Gemsbok National Park; Approx. 24°30′–25°47′S; 20°–20°52′E

1561 worms, none of which could be identified specifically. The *Cooperia* sp. that was recovered is closely related to *Cooperia rotundispiculum* but was not identical with it.

Giraffe (Table 2)

Only 2 species of worms, *Parabronema skrjabini* and *Monodontella giraffae* were recovered and both are known to occur in giraffe.

Kudu (Table 2)

Of the worms recovered from this animal *T. instabilis* and the *Impalaia* sp. females are new parasite records.

Steenbok (Table 3)

The paramphistome and the nematodes *Longistrongylus meyeri, Longistrongylus sabie, Haemonchus krugeri,* and *T. instabilis* are new parasite records.

Oribi (Table 3)

T. instabilis, T. falculatus and *Impalaia tuberculata* are new parasite records for this antelope.

Waterbuck (Table 3)

Haemonchus bedfordi, Cooperia yoshidai and *I. tuberculata* are new nematode records for waterbuck.

Tsessebe (Table 3)

C. yoshidai, Longistrongylus schrenki, T. instabilis, and *T. thomasi* appear to be new parasite records for this antelope.

Gemsbok (Table 3)

The following helminths appear to be new parasite records: *Haemonchus contortus, L. meyeri, Paracooperia serrata, Impalaia nudicollis, Strongyloides* and *Agriostomum equidentatum.*

Blue wildebeest (Table 3)

The only worms recovered were *H. bedfordi,* which is a known parasite of blue wildebeest.

Springbok (Table 3)

All the worms recovered in this survey are known to occur in springbok.

Red hartebeest (Table 3)

I. nudicollis and the *Parabronema* sp. are new parasite records.

Discussion

Grey duiker

The mean helminth burdens and the species composition of the helminths recovered from the duikers from the KNP show some similarity to those of the duikers from the central Transvaal (Boomker, Du Plessis & Boomker, 1983). The mean total worm burden of the duikers from the KNP was 704 worms and that of the duikers from the central Transvaal was 870 (Boomker *et al.,* 1983). Certain parasites such as *T. axei* and *C. pectinata* are frequently found in domestic animals, and were also present in the duikers from the central Transvaal. In the KNP they were replaced by parasites such as *T. thomasi, C. hungi* and *C. neitzi,* which are found almost exclusively in wild antelope. This is attributed to the relatively closed ecosystem in the KNP, where domestic ruminants are as a rule not found and the fact that the duikers from Riekerts Laager had contact with sheep, goats and cattle.

Blue duiker

The only parasite thus far recorded from the blue duiker in South Africa is *Moniezia expansa* (Gough, 1908). No record of nematodes from this antelope from South Africa could be found in the literature and *T. axei* is thus the first and only one recorded.

Bushbuck

The helminth parasites of bushbuck from South Africa have been recorded by Veglia (1919), Mönnig (1928, 1931, 1933), Le Roux (1929, 1930a, b) and Ortlepp (1961). Gibbons & Khalil (1980) and Boomker & Kingsley (1984) found *Paracooperia tragelaphi* and *P. devossi* in East and South African bushbuck respectively. The present paper adds 3 trichostrongylids and 2 lungworms to the existing list.

The *Trichostrongylus* spp. could have been acquired from any of the antelope present in the KNP, since both *T. instabilis* and *T. falculatus* are the species most frequently encountered in the small intestine (Horak & Boomker, 1983, unpublished data).

The name *T. instabilis* for a *Trichostrongylus* sp. resembling *T. colubriformis* but with a short hook and a markedly bent spicular shaft, is retained here for reasons given by Horak (1980) and Boomker *et al.,* (1983).

The occurrence of *T. falculatus* is somewhat of an enigma. In the semi-arid areas, such as the Karoo it is the dominant *Trichostrongylus* spp. during the cold and dry winter months (Viljoen, 1964, 1969). In the summer rainfall areas, such as the Transvaal Highveld the worms are present in small numbers in winter (Horak & Louw, 1977; Horak, 1978a). *T. colubriformis* is the dominant worm in the non-seasonal rainfall areas where the winters are mild and frost seldom occurs (Muller, 1968). In the KNP, which falls within the summer rainfall area, the winters are also mild and this probably accounts for the small numbers of *T. falculatus* recovered.

The members of the genus occur in larger numbers during the cooler months of the year (Reinecke, 1964,

1983) but *T. falculatus* in the semi-arid areas may increase markedly in spring if preceded by good rains (Viljoen, 1964, 1969). Horak (1978c), however, recovered the largest numbers of *T. falculatus* from cattle in the northern Transvaal during December (summer). Horak & Louw (1978) found worms of this genus to be abundant in cattle on the Transvaal Highveld during June while few worms occurred from July–September. The largest *Trichostrongylus* spp. burdens in cattle in the northern Transvaal were present during December, and very few worms were present from July–October (Horak, 1978c). From the present data it is apparent that *Trichostrongylus* spp. are more abundant in the bushbuck at Skukuza from June–October, a finding which is contrary to that of Horak (1978c) from an area that has a similar climate as the KNP.

C. neitzi is commonly encountered in antelope in the KNP (Boomker, 1983, unpublished data) and its presence in bushbuck is therefore to be expected. The *Cooperia* sp. from 1 of the bushbuck and 1 of the nyala shot at Pafuri and 1 bushbuck from Skukuza is very closely related to *C. rotundispiculum*. However, its spicules are shorter and it has 18–20 longitudinal cuticular ridges as opposed to the 14 present in *C. rotundispiculum* (Gibbons, Lynda M., 1983, personal communication).

O. harrisi has been described from bushbuck (Le Roux, 1930a) and has recently also been found in red duiker (*Cephalophus natalensis*) (Boomker, Keep & Flamand, 1984) and nyala from Natal game reserves (Boomker, 1983, unpublished data).

H. vegliai appears to be the most common *Haemonchus* sp. occurring in the browsing antelope and its presence in bushbuck is therefore not unexpected. It was also found in the grey duikers in this study and in those from the central Transvaal (Boomker *et al.*, 1983) and has been found in kudu, both from the central Transvaal and the KNP (Boomker, 1983, unpublished data).

P. devossi seems to be a recently acquired parasite of bushbuck in the KNP as was discussed by Boomker & Kingsley (1984).

C. sagittus is a common parasite of the tragelaphine antelope (Round, 1968) and has also been found in Cape buffalo *Syncerus caffer* (McCully, Van Niekerk & Basson, 1967), domestic cattle in the Transvaal (Boomker, 1979, unpublished data) and nyala from Natal (Keep, 1971).

D. viviparus was recovered from 2 animals, a young female from Pafuri and an adult male from Skukuza. Both these animals were debilitated and we assume that the infestation became established because of their enfeebled state. The epidemiology of this parasite is largely unknown. Isolated foci occur in the mist belt of the Drakensberg, both in Natal and Transvaal, and it is rife on irrigated pastures. No explanation for its occurrence in bushbuck in the KNP can be offered, and it must be assumed that the bushbuck are abnormal hosts, since only 5th stage worms were recovered.

P. calcaratus was originally described from an impala (Mönnig, 1932), and a single male was found in 1 of the bushbuck only. This animal was collected in November, 1982, during a severe drought in the KNP when as many as 1 000 impala and numerous bushbuck, kudu and warthog congregated daily on the irrigated lawns of the golf course in the staff village at Skukuza. This lungworm probably originated from an impala. It has spicules slightly shorter than those recorded by Mönnig (1932), which is an indication that the bushbuck is probably an abnormal host.

Nyala

Keep (1971) recorded some of the parasites of nyala from some of the Natal game reserves, but nothing is known about those from the KNP. No comments can be made on the parasites collected during this survey, since both the nematode genera that were recovered could not be identified specifically.

Giraffe

Fertile hydatid cysts have been recorded from a giraffe in an Australian zoo (Kelly, Boray & Dixon, 1968) and Sachs, Gibbons & Lweno (1973) found 3 *Haemonchus* spp. in East African giraffe. Pester & Laurence (1974) found *Moniezia expansa* and Shoho & Sachs (1975) *Setaria labiatopapillosa* and *Pseudofilaria giraffae* in East and South African giraffe.

Ivashkin (1956) experimentally infested larvae of the fly *Haematobia titilans* (= *Lyperosia titilans*) with 1st stage larvae of *Parabronema skrjabini* obtained from camels. He found encysted 2nd stage larvae of this nematode in the pupae of the flies and concluded that the infested flies had to be eaten by the final host for the life cycle to be completed. Various species of *Haematobia* are present in South Africa and they are considered to be almost permanent parasites, leaving their hosts only to lay eggs (Howell, Walker & Neville, 1978). It is not known, however, whether the South African species of *Haematobia* are the intermediate hosts of *P. skrjabini*.

M. giraffae is a parasite of the bile ducts of giraffe and, being a hookworm, it is assumed that infestation occurred percutaneously.

Kudu

Condy (1972) recorded the helminths of kudu in Zimbabwe. The worms recovered from the kudu from Riekerts Laager were similar to those of the steenbok and grey duikers from the same locality (Boomker *et al.*, 1983). The *Trichostrongylus* spp. recovered from the steenbok and grey duikers, however, were not present in the kudu.

Steenbok

Virtually the same worms as those occurring in grey duikers from Riekerts Laager were found in the steenbok from the same locality, the only addition being *L. meyeri* and the *Skrjabinema* spp. (Boomker *et al.*, 1983). These worms could have been acquired from any of the antelope present on the farm or from sheep and goats outside the confines of the farm (Boomker *et al.*, 1983).

Similar parasites were recovered from the steenbok from the KNP, the difference being the presence of *H. krugeri, L. sabie* and *T. instabilis,* and the absence of *T. axei* and *L. meyeri*.

The larger helminth burden of the steenbok from the KNP is ascribed to the drought experienced at the time, which resulted in its emaciated and weakened condition, and hence greater susceptibility to infestation.

In addition to the *Skrjabinema* spp., which were found in the steenbok from all the localities, the steenbok from the KGNP harboured only *P. serrata* and a *Trichostrongylus* species. *P. serrata* was described from a springbok (Mönnig, 1931), which is the commonest antelope in the KGNP, and the steenbok could easily have acquired this parasite from the springbok. The as yet unnamed *Trichostrongylus* sp. has spicules that are dissimilar in appearance. They are 120–134 and 136–148 μm long and an earshaped, sclerotized protuberance is present on the shaft of the longer one.

Oribi, waterbuck and tsessebe

Although the antelope were shot at exactly the same locality, the rhino camp near Pretoriuskop in the KNP, there are distinct differences, both in halminth burdens

TABLE 2 The helminth burdens of the browsing artiodactylids from various localties

Species	Locality and date	No.	Age	Sex	*Parabronema skrjabini*			*Monodontella giraffae*		*Haemonchus vegliai*			*Ostertagia harrisi*			*Trichostrongylus* spp.	*Trichostrongylus axei*	*Trichostrongylus falculatus*	*Trichostrongylus instabilis*	*Trichostrongylus thomasi*	*Cooperia* spp.			*Cooperia punctata*
					L4	♀	♂	♀	♂	L4	♀	♂	L4	♀	♂	♀	♂	♂	♂	♂	L4	♀	♂	♂
Grey Duiker	*Malelane*																							
	February	'80	10	Prime adult	♂	—	—	—	—	—	0	0	10	—	—	—	33	0	0	0	20	0	130	0	—
	May	'80	12	Old adult	♂♀	—	—	—	—	—	0	12	4	—	—	—	48	0	0	0	22	0	3	0	—
	May	'80	13	Prime adult	♂♀	—	—	—	—	—	53	0	0	—	—	—	0	0	0	0	1	0	13	0	—
	January	'81	17	Young adult	♂♀	—	—	—	—	—	2	10	10	—	—	—	0	0	0	0	0	0	0	0	—
Blue Duiker	*Tsitsikama*																							
	October	'76	—	Not known		—	—	—	—	—	—	—	—	—	—	—	200	210	—	—	—	—	—	—	—
Bushbuck	*Pafuri*																							
	October	'81	1	Prime adult	♂	—	—	—	—	—	0	197	191	0	0	0	0	0	0	0	0	0	0	0	0
	October	'81	2	Old	♂♀	—	—	—	—	—	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	October	'81	3	Young adult*	♂♀	—	—	—	—	—	0	0	0	0	0	0	0	0	0	0	0	50	1 457	1 426	0
	Skukuza																							
	October	'79	4	Adult	♂♀	—	—	—	—	—	0	75	75	0	125	75	0	0	0	0	0	0	0	0	0
	October	'79	5	Very old	♂♀	—	—	—	—	—	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	August	'80	6	Yearling	♂♀	—	—	—	—	—	0	0	0	0	125	50	25	0	0	0	0	0	0	0	0
	October	'80	7	2 years	♂♀	—	—	—	—	—	0	0	0	0	0	0	0	0	0	0	0	0	75	0	0
	June	'82	8	Juvenile	♂♀	—	—	—	—	—	50	50	26	1	36	5	545	0	2	132	0	0	25	0	0
	June	'82	9	Juvenile	♂♀	—	—	—	—	—	0	25	0	380	1 738	1 097	126	0	100	0	0	25	0	0	0
	November	'82	10	Adult	♂♀	—	—	—	—	—	0	25	75	0	0	0	25	0	0	50	0	0	150	0	0
	November	'82	11	Adult	♂♀	—	—	—	—	—	0	0	0	0	203	154	360	0	165	0	0	0	0	0	0
	November	'82	12	Adult*	♂♀	—	—	—	—	—	0	57	55	0	81	97	0	0	0	0	0	0	125	75	0
Nyala	*Pafuri*																							
	October	'81	1	Adult	♂	—	—	—	—	—	0	0	0	0	0	0	—	—	—	—	—	0	0	0	—
	October	'81	2	Adult	♂	—	—	—	—	—	0	25	0	0	0	0	—	—	—	—	—	4	1 052	480	—
Giraffe	*Lower Sabie*																							
	July	'80	1	Adult	♂	404	7 372	11 050	186	145	0	0	0	—	—	—	—	—	—	—	—	0	0	—	0
	July	'80	2	Adult	♂	0	823	1 213	215	370	0	0	0	—	—	—	—	—	—	—	—	0	0	—	0
Kudu	*Riekerts Laager*																							
	October	'79	—	Old	♂	—	—	—	—	—	0	69	41	—	—	—	90	0	0	20	0	0	262	0	71

— Not known to occur in this host
A Adult
L4 4th stage larvae
5th 5th stage
ND Not done
\+ Slight infestation
++ Moderate infestation
Epg Eggs per gram faeces
* Severely debilitated

TABLE 2 The helminth burdens of the browsing artiodactylids from various localties *(continued)*

Species	Locality and date	No.	Age	Sex	*Cooperia pectinata*	*Cooperia neitzi*	*Cooperia acutispiculum*	*Cooperia hungi*	*Impalaia* spp.		*Impalaia tuberculata*	*Paracooperia devossi*		*Oesophagostomum* spp.	*Gaigeria* spp.	*Longistrongylus* spp.	*Dictyocaulus viviparus*	*Pneumostrongylus calcaratus*	*Setaria* spp.	*Cordophilus sagittus*	Larvae of *Taenia* spp.	*Stilesia hepatica*	Total helminth burden	Epg
					♂	♂	♂	♂	L4	♀	♂	♀	♂	L4	♀	L4	5th	♂	A	A				
Grey Duiker	*Malelane*																							
	February '80	10	Prime adult	♀♂	0	30	50	0	0	490	340	—	—	10	0	0	—	—	1	—	0	+	1 114	100
	May '80	12	Old adult	♀♂	0	0	0	11	8	3	13	—	—	0	0	0	—	—	1	—	0	++	125	0
	May '80	13	Prime adult	♀♂	0	0	2	0	307	1	0	—	—	1	0	162	—	—	2	—	1	0	543	0
	January '81	17	Young adult	♀♂	0	0	0	0	388	282	352	—	—	0	0	0	—	—	0	—	8	0	1 052	300
Blue Duiker	*Tsitsikama*																							
	October '76	—	Not known		—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	410	ND
Bushbuck	*Pafuri*																							
	October '81	1	Prime adult	♀♂	—	0	—	—	—	—	—	0	0	0	0	—	0	0	1	2	0	0	391	ND
	October '81	2	Old	♀♂	—	0	—	—	—	—	—	0	0	0	0	—	0	0	0	4	0	0	4	0
	October '81	3	Young adult*	♀♂	—	0	—	—	—	—	—	0	0	0	0	—	14	0	0	0	3	0	2 950	0
	Skukuza																							
	October '79	4	Adult	♀	—	0	—	—	—	—	—	0	0	0	0	—	0	0	0	0	0	0	350	ND
	October '79	5	Very old	♀	—	0	—	—	—	—	—	0	0	0	0	—	0	0	0	0	0	0	0	ND
	August '80	6	Yearling	♀	—	0	—	—	—	—	—	0	0	0	0	—	0	0	0	0	0	0	200	ND
	October '80	7	2 years	♀	—	25	—	—	—	—	—	0	0	0	0	—	0	0	0	0	0	0	100	ND
	June '82	8	Juvenile	♀♂	—	25	—	—	—	—	—	2	3	0	0	—	0	0	0	2	0	0	904	0
	June '82	9	Juvenile	♀♂	—	0	—	—	—	—	—	359	252	0	25	—	0	0	0	0	0	0	4 127	0
	November '82	10	Adult	♀♂	—	125	—	—	—	—	—	26	51	0	0	—	0	1	2	0	0	0	530	0
	November '82	11	Adult	♀♂	—	0	—	—	—	—	—	419	219	0	25	—	0	0	0	0	0	0	1 545	ND
	November '82	12	Adult*	♀♂	—	0	—	—	—	—	—	187	261	0	0	—	6	0	0	0	0	0	944	ND
Nyala	*Pafuri*																							
	October '81	1	Adult	♀♂	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0	0	0	—	0	0
	October '81	2	Adult	♀♂	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0	0	0	—	1 561	0
Giraffe	*Lower Sabie*																							
	July '80	1	Adult	♀♂	0	—	—	—	0	0	0	—	—	—	—	—	—	—	0	—	0	—	19 157	0
	July '80	2	Adult	♀♂	0	—	—	—	0	0	0	—	—	—	—	—	—	—	0	—	0	—	2 621	0
Kudu	*Riekerts Laager*																							
	October '79	—	Old	♂	20	0	0	0	0	10	0	0	0	0	0	—	—	—	0	0	0	—	583	ND

— Not known to occur in this host

A Adult
L4 4th stage larvae
5th 5th stage
ND Not done

\+ Slight infestation
++ Moderate infestation
Epg Eggs per gram faeces
* Severely debilitated

TABLE 3 The helminth burdens of grazing antelope and of grazing and browsing antelope from various localities

Species	Locality and date	Age	Sex	*Paramphistomes*	*Haemonchus* spp.		*Haemonchus bedfordi*	*Haemonchus contortus*	*Haemonchus krugeri*	*Trichostrongylus* spp.			*Trichostrongylus axei*	*Trichostrongylus falculatus*	*Trichostrongylus instabilis*	*Trichostrongylus thomasi*	*Longistrongylus* spp.		*Longistrongylus sabie*	*Longistrongylus schrenki*	*Longistrongylus meyeri*	*Cooperia*-like	*Cooperia* spp.		*Cooperia hungi*	*Cooperia yoshidai*
				A	L4	♀	♂	♂	♂	L4	♀	♂	♂	♂	♂	♂	L4	♀	♂	♂	♂	L4	♀	♂	♂	♂
Steenbok	*Malelane* October '82	Adult	♂	0	104	1 854	—	0	1 412	0	820	0	0	260	210	—	0	42	11	—	0	—	—	—	—	—
	Riekerts Laager November '79	Young adult	♂	121	0	0	—	0	0	78	342	0	50	250	0	—	5	22	0	—	2	—	—	—	—	—
	Kalahari October '84	Adult	♂	0	0	0	—	0	0	0	50	10	0	0	0	—	0	0	0	—	0	—	—	—	—	—
Oribi	*Pretoriuskop* July '79	Adult	♂	0	0	0	—	0	—	22	107	—	—	30	37	0	0	0	—	—	—	13	53	—	—	34
Waterbuck	*Pretoriuskop* February '83	Adult	♀	11	25	508	305	0	—	0	0	—	—	—	—	—	0	0	—	0	—	0	1 950	—	125	375
Tsessebe	*Pretoriuskop* February '83	Old	♀	0	0	123	0	260	—	0	10	—	—	—	1	4	0	3	—	2	—	0	304	—	0	53
Gemsbok	*Kalahari* October '84	Adult	♂	0	66	352	403	25	—	0	228	128	—	—	—	—	0	25	—	—	25	0	6	1	—	—
Blue wildebeest	*Kalahari* October '84	Adult	♂	0	0	80	30	0	—	0	0	—	0	0	—	0	—	—	—	—	—	0	0	—	—	—
Springbok	*Kalahari* October '84	Young adult	♀	0	31	31	—	0	—	0	32	—	—	31	—	—	0	0	—	—	—	35	—	—	—	—
	October '84	Young adult	♂	0	271	50	—	2	—	0	179	—	—	103	—	—	0	0	—	—	—	0	—	—	—	—
Red hartebeest	*Kalahari* October '84	Old	♂	—	0	426	250	0	—	0	25	25	—	—	—	—	—	—	—	—	—	0	1	1	—	—

— Not known to occur in this host
A Adult
L4 4th stage larvae
\+ Slight infestation
++ Moderate infestation

TABLE 3 The helminth burdens of grazing antelope and of grazing and browsing antelope from various localities *(continued)*

Species	Locality and date	Age	Sex	*Cooperia fuelleborni*	*Cooperioides antidorci*		*Paracooperia serrata*		*Impalaia* spp.		*Impalaia nudicollis*	*Impalaia tuberculata*	*Parabronema* spp.		*Oesophagostomum columbianum*			*Skrjabinema* spp.	*Strongyloides* spp.	*Setaria* spp.	*Agriostomum equidentatum*			*Avitellina*	*Moniezia expansa*	*Stilesia hepatica*	Total helminth burden
				♂	♀	♂	♀	♂	L4	♀	♂	♂	♀	♂	L4	♀	♂	A	♀	♀	L4	♀	♂				
Steenbok	*Malelane* October '82	Adult	♂	—	—	—	0	0	0	688	0	357	—	—	0	0	0	20	—	0	—	—	—	0	0	++	5 778
	Riekerts Laager November '79	Young adult	♂	—	—	—	0	0	10	71	0	50	—	—	0	0	0	70	—	2	—	—	—	3	2	0	1 078
	Kalahari October '84	Adult	♂	—	—	—	60	80	0	0	0	0	—	—	0	0	0	9 080	—	0	—	—	—	0	0	0	9 280
Oribi	*Pretoriuskop* July '79	Adult	♂	15	—	—	—	—	0	97	0	61	—	—	0	1	4	—	—	3	—	—	—	0	—	0	477
Waterbuck	*Pretoriuskop* February '83	Adult	♀	525	—	—	—	—	0	150	0	75	—	—	8	0	25	—	—	0	—	—	—	—	0	+	4 082
Tsessebe	*Pretoriuskop* February '83	Old	♀	0	—	—	—	—	0	29	0	52	1	1	—	—	—	125	—	0	—	—	—	—	—	—	968
Gemsbok	*Kalahari* October '84	Adult	♂	—	—	—	905	943	457	832	530	—	—	—	0	0	0	—	650	0	1	250	50	0	0	—	5877
Blue wildebeest	*Kalahari* October '84	Adult	♂	—	—	—	—	—	—	—	—	—	—	—	0	0	0	—	0	—	0	0	0	0	0	0	110
Springbok	*Kalahari* October '84	Young adult	♀	—	93	49	131	96	0	30	41	0	—	—	0	0	0	—	0	—	0	30	0	—	0	—	630
	October '84	Young adult	♂	—	62	57	439	340	0	32	71	0	—	—	0	0	0	—	236	—	0	10	10	—	0	—	1 862
Red hartebeest	*Kalahari* October '84	Old	♂	—	—	—	—	—	0	527	251	—	87	182	0	0	0	—	0	—	—	—	—	—	0	0	1 774

— Not known to occur in this host
A Adult
L4 4th stage larvae
\+ Slight infestation
++ Moderate infestation

and composition. The only parasites found in all 3 animals were *I. tuberculata* and *C. yoshidai*. The latter was described from a reedbuck *Redunca arundinum* by Mönnig (1939), but has subsequently also been recovered from mountain reedbuck *Redunca fulvorufula* (Baker & Boomker, 1973), and blesbok (Evans, 1978; Horak, Brown, Boomker, De Vos & Van Zyl, 1982b), while the former is one of the commonest nematodes of antelope (Boomker, 1977; Gibbons, Durette-Desset & Daynes, 1977). Despite the fact that the antelope had similar feeding habits and shared the same habitat, only the host-specificity shown by the parasites can be offered to explain the differences in the helminth composition and burdens.

Longistrongylus thalae (syn. *Pseudomarshallagia thalae*) has been found in an oribi (Gibbons, 1981) and Bindernagel & Todd (1972) have recorded *Trichostrongylus* spp. from the same host.

Of the helminths listed as occurring in oribi (Round, 1968) only 3 are mentioned by Ortlepp (1961). They are *H. contortus* and *Onchocerca* sp., for which no localities were recorded, and *Setaria scalprum,* which was recorded from South Africa (Ortlepp, 1961). No comparisons can therefore be made and all the worms recovered in this study should be considered new parasite records for this antelope.

H. bedfordi has been recovered from sheep artificially infested with larvae obtained from the faeces of a waterbuck in the Johannesburg Zoological Gardens (Le Roux, 1930b). Its presence in naturally infested waterbuck is herewith confirmed.

No previous listing of the parasites of the tsessebe could be found in the literature and the results obtained in this study cannot be compared with those of other surveys.

Blue wildebeest

Horak, De Vos & Brown (1983) published the results of a survey of the parasite of blue wildebeest from the KNP. A small number of *H. bedfordi* only were recovered from the blue wildebeest from the KGNP. The same species were found in the animals from the KNP but because of insufficient data no comparisons could be made.

Springbok

Horak, Melzer & De Vos (1982a) listed the parasites they found in springbok from the western Transvaal and the western Cape Province and De Villiers, Liversidge & Reinecke (1985) those of springbok from a farm near Kimberley in the north-western Cape Province, respectively.

All the worms found in this survey are known parasites of springbok. Fewer species and lower burdens were, however, found in this survey than were found in the surveys conducted by Horak *et al.* (1982a) and De Villiers *et al.* (1985). This is ascribed to the extremely arid conditions in the KGNP.

Gemsbok and red hartebeest

Other than those published by Round (1968), no records of helminths of gemsbok and red hartebeest from South Africa exist in the literature. The gemsbok harboured a greater variety and a larger burden than the red hartebeest, which could be the result of different feeding habits.

General considerations

Of the above-mentioned animals, grey and blue duikers, bushbuck, nyala and kudu are almost exclusively browsers, feeding on the leaves, fruits and seeds of a large variety of woody plants and forbs (Dorst & Dandelot, 1972). Grass is seldom eaten by these antelope and then only when it is young and succulent or in the absence of browse (Hofmann, 1973). Giraffe are exclusively browsers feeding particularly on the shoots, leaves, flowers and pods of the leguminous trees, often to a height of 6 m above ground (Dorst & Dandelot, 1972). Steenbok, springbok and gemsbok are both grazers and browsers and will even dig for roots and tubers, while oribi, waterbuck, blue wildebeest, red hartebeest and tsessebe are grazers and will only occasionally feed on the leaves and shoots of dicotyledonaceous plants (Dorst & Dandelot, 1972).

When the mean helminth burdens of the antelope in this survey are compared, the following emerges: the 20 browsers harbour a mean of 887 worms, the 5 grazers 1 390,8 and the 6 mixed feeders, i.e. both grazing and browsing antelope, 4 063,5 worms. Giraffe are not included here because of their specialized feeding behaviour and because they are not antelope. We think that the feeding habits and the habitat preferences are responsible for these differences.

Grey duikers favour almost any kind of habitat with the exception of dense forests and deserts. The reason for their low helminth burdens have been commented on by Boomker *et al.* (1983).

Blue duiker are found exclusively in dense forest (Dorst & Dandelot, 1972) and, in the KNP, bushbuck and nyala favour the riverine or hillside forests and thick bush. Kudu are usually found in open savannah, but also occur in dense bush or light forest (Dorst & Dandelot, 1972). Within their chosen habitat the animals may roam considerably and are consequently subject to reinfestation with their own parasites to a limited extent only. Furthermore, apart from kudu and nyala, which occur in family groups, all the other antelope occur singly or in pairs, and are hence unlikely to contaminate their environment to any significant degree. It is usually only when animals are sick or injured that they stay in one place and become infested with their own parasites, with a resulting increase in helminth burdens. This was presumably the case with bushbuck No. 3, whose burden was considerably higher than the mean for the 3 bushbuck from Pafuri.

Bushbuck No. 9 had 4 102 worms, 3 215 of which were *D. harrisi*. This is the highest total worm burden for bushbuck from Skukuza. The bushbuck frequently visited the gardens of the residents of the staff village at Skukuza. Since these are watered regularly, favourable conditions for the survival of the infective larvae are probably created. Conversely, bushbuck No. 5, a very old male taken at the same locality, harboured no worms. This is possibly due to increased immunity after prolonged exposure. Michel (1963) found that resistance to the establishment of infestation developed in calves after prolonged exposure to *Ostertagia ostertagi*. It is possibly also true for *O. harrisi,* provided that the parasite elicits the same immune response as that evoked by *O. ostertagi*. Although the resistance to *O. ostertagi* differs markedly from that of *H. contortus* (=*H. placei*), a similar comparison could probably be made in the case of *H. vegliai* in bushbuck and *H. contortus* (=*H. placei*) in cattle (Fitzsimmons, 1969).

On the other hand, immunity is hardly likely to eliminate the entire worm burden and it is also quite possible that the burdens of browsing antelope are never large enough to elicit an immune response. In the latter case, bushbuck No. 5 may simply have lost whatever infestation it had and did not become reinfested.

Although giraffe are often found in herds (Dorst & Dandelot, 1972) their feeding habits are such that they will not easily become infested with the nematodes regu-

larly occurring in antelope. They could, however, acquire these helminths when grazing, though such acquisition occurs very seldom, if at all; for instance, during droughts when they are forced to graze to survive.

Steenbok, being both grazers and browsers, could conceivably become infested with the parasites of both groups of artiodactylids. However, the present limited data do not indicate this. Because steenbok often dig for roots and tubers, they could easily become infested with the anoplocephalid tapeworms that use oribatid mites as intermediate hosts. This appears to be the case in the steenbok from Riekerts Laager, but not in the animal from the KNP. In addition, *Stilesia hepatica* was found in the grey duikers from the KNP, and the tapeworm fragments found in the liver of the waterbuck are probably those of *S. hepatica*. This indicates that the grazers and the antelope that browse at ground level are the ones most likely to become infested with the anoplocephalid tapeworms.

An interesting finding is the occurrence of an unidentified *Parabronema* sp. in the waterbuck from the KNP and in the gemsbok and the red hartebeest from the KGNP. *Parabronema* spp. are known to occur in rhino and giraffe. The waterbuck was shot in the rhino camp, where a number of white rhino, *Ceratotherium simmum* are kept, but not giraffe. Neither giraffe nor rhino are present in the KGNP, and no explanation can be offered for the presence of the *Parabronema* sp. in these antelope.

From this study it appears that many of the helminths of antelope are not very host specific. This is borne out by the fact that *T. instabilis* occurred in bushbuck, the steenbok, the tsessebe and the oribi from the KNP. *T. falculatus* was recovered from bushbuck, the steenbok from the KNP and Riekerts Laager, and the oribi. *I. tuberculata* occurred in the steenbok from the KNP and Riekerts Laager, the oribi, the waterbuck and the tsessebe, while *I. nudicollis* occurred in the gemsbok, both the sprinbok and the red hartebeest from the KGNP. *C. yoshidai* occurred in the oribi, the waterbuck and the tsessebe, and *C. hungi* was found in the oribi and the waterbuck. A *Parabronema* sp. was found in the waterbuck, the gemsbok and the red hartebeest. The helminths from the giraffe, however, were not found in any of the antelope, nor were the worms of the antelope found in the giraffe.

It seems as if the antelope tolerate each other's helminths, an indication of a well-developed host-parasite relationship resulting from long-standing associations.

The fencing of game reserves and game parks limit the natural movements of animals and confine them to a limited space where they may easily become infested with each other's worms. It also appears from this and other studies (Horak, 1980; Boomker *et al.*, 1983) that antelope are better hosts for the parasites of domestic animals than domestic animals are for those of antelope.

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