A systematic review of helminth infections of tragelaphine antelopes in Africa

By

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Submitted in partial fulfilment of the requirements for the degree of MSc (Tropical Animal Health) in the Department of Veterinary Tropical Diseases, Faculty of Veterinary Science, University of Pretoria

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DECLARATION

I, Maruchelle Cilliers declare that this mini-dissertation submitted to the University of Pretoria for the degree of Master of Science (Tropical Animal Health) in the Department of Veterinary Tropical Disease, Faculty of Veterinary Science, Has not been previously submitted by me for the degree at this or any other university, that it is my own work, and that all material contained therein has been duly acknowledged.

Signed: 

Date: 15-02-2020

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The tragelaphine antelopes comprise a group of nine species, namely *Tragelaphus eurycerus* (bongo), *Tragelaphus scriptus* (bushbuck), *Tragelaphus oryx* (common eland), *Tragelaphus derbianus* (giant eland), *Tragelaphus strepsiceros* (greater kudu), *Tragelaphus imberbis* (lesser kudu), *Tragelaphus buxtoni* (mountain nyala), *Tragelaphus angasii* (nyala) and *Tragelaphus spekii* (sitatunga) which are all confined to the African continent. Currently, a total of 72 species of helminth parasites from seven tragelaphine antelope species have been recorded, while no records exist for *T. imberbis* and *T. buxtoni.* Some helminth species are shared with domestic stock and only a few helminths have zoonotic implications. The clinical significance of most helminth species in tragelaphine antelopes is unknown. This information was compiled based on an extensive search for records in the literature ranging from the early nineteen-hundreds until August 2019. A synopsis of the results is presented in tabular form.

Chapter 1
Introduction

The tragelaphine antelopes, commonly known as the spiral horned antelopes (Family: Bovidae, Sub-family: Bovinae, Tribe: Tragelaphini) comprise a group of nine species, namely *Tragelaphus eurycerus* (bongo), *Tragelaphus scriptus* (bushbuck), *Tragelaphus oryx* (common eland), *Tragelaphus derbianus* (giant eland), *Tragelaphus strepsiceros* (greater kudu), *Tragelaphus imberbis* (lesser kudu), *Tragelaphus. buxtoni* (mountain nyala), *Tragelaphus angasi* (nyala) and *Tragelaphus spekii* (sitatunga) which are all confined to the African continent (Stuart & Stuart 2017). Sub-speciation in some tragelaphine antelope species is controversial (Stuart & Stuart 2017), but some species have been reported to interbreed (Furstenburg 2009). Apart from subsistence use of tragelaphine antelopes as a source of meat (bushmeat), the more significant commercial use comprises of biltong hunting, trophy hunting, animal trade and game ranching (Bothma & du Toit 2016).

The first host-helminth parasite checklists for the tragelaphine antelopes were compiled by Round (1968) and subsequently surveys and reports have contributed to knowledge on their helminth diversity. The aim of this study was to compile an up-to-date source of reference to the first records of the helminth parasites from tragelaphine antelopes. The author's intention was not to create a taxonomic work, but rather provide updated checklists that would provide some information to veterinarians, parasitologists, conservationists and game ranchers in helminth infection related matters.

1.1 *Tragelaphus eurycerus* (bongo)

Description: Large antelope (bull: 300 kg, cow 240 kg) with chestnut coat colour, with bulls being darker than cows; white vertical markings (10-16) on sides of torso, running from shoulder to hind part of body; face with white chevron; on both sides of face two white spots; horizontal white stripe on throat; limbs with white and black markings; short crest stretching from shoulder to hind part of body; tail hairy and brush-like at tip; bulls and cows carry horns (Stuart & Stuart 2011). Largest antelope found in the forest habitat (Ralls 1978). **Habitat:** Lowland and highland forests (Stuart& Stuart 2011). **Nutrition:** The bongo is a typical browser and feeds on a wide variety of plants which include herbaceous plants,

fungi, creepers and bamboo (Stuart& Stuart 2011). **Geographical distribution:** Central Africa: Angola, Cameroon, Benin, Central African Republic, Congo, Democratic Republic of Congo, Gabon; Western Africa: Ghana; Guinea, Ivory Coast, Liberia, Niger, Sierra Leone, Togo; Eastern Africa: Kenya; Northern Africa Sudan (IUCN Antelope Specialist Group 2016, *Tragelaphus eurycerus*). **Conservation status:** Near threatened (IUCN Antelope Specialist Group 2016, *Tragelaphus eurycerus*).

1.2 *Tragelaphus scriptus* (bushbuck)

The taxonomic status of *T. scriptus* is controversial at subspecies level as the variation in the coat colour and markings of the species from different geographical locations led to the rise of over 40 subspecies (Downs, Coates & Child 2016). **Description:** Medium-sized antelope (ram: 45-80 kg, ewe 30-42 kg) with light to dark brown coat, with rams being generally darker than ewes, long hair; rams with mane on middle of the back running from the shoulder up to the tail base; markings differ significantly in populations of various geographical origin, white spot behind eye typical feature, white spots arranged in rows and white vertical stripe-like markings on the hindquarters; bush-like tail; only rams carry horns (Stuart & Stuart 2011). **Habitat:** The bushbuck prefers shade-providing, riverine woodland and shrubland in the proximity of water (Stuart& Stuart 2011). **Geographical distribution:** Southern Africa: Botswana, Namibia, South Africa, Swaziland Central Africa: Angola; Cameroon, Central African Republic, Chad, Congo, Democratic Republic of Congo, Equatorial Guinea, Gabon; Western Africa: Benin; Burkina Faso, Gambia, Ghana ,Ivory Coast, Guinea; Guinea-Bissau, Liberia, Mali, Mauritania, Niger, Nigeria, Senegal, Sierra Leone, Togo; Eastern Africa: Burundi, Ethiopia, Kenya, Malawi, Mozambique,Rwanda, Somalia, Tanzania, Uganda, Zambia, Zimbabwe; Northern Africa: Sudan(IUCN Antelope Specialist Group 2016, *Tragelaphus scriptus*). **Nutrition:** The bushbuck is a typical browser and feeds on a variety of plant material which includes, leaves, shoots, fruits, flowers and grasses (Stuart& Stuart 2011). **Conservation status:** Least concern (IUCN Antelope Specialist Group 2016, *Tragelaphus scriptus*).

1.3 *Tragelaphus oryx* (common eland)

Description: Large antelope, very much cattle-like in appearance (largest antelope species in the world, bull: 700-900 kg, cow: 450 kg) with fawn coat colour, hair short; bulls with

dewlap and a characteristic patch of long dark hair on the forehead; bulls and cows carry horns; dark mane stretching dorsally over the neck (Stuart & Stuart 2011). **Habitat:** Open woodland and savanna (Stuart & Stuart 2011). **Nutrition:** The common eland is largely a browser but will also feed on grasses. Other parts of their diet consist of excavated bulbs, roots, wild cucumbers and fruits (Stuart & Stuart 2011). **Geographical distribution:** Southern Africa: Botswana, Lesotho, Namibia, South Africa, Swaziland; Central Africa: Angola; Democratic Republic of Congo; Eastern Africa: Ethiopia; Kenya; Malawi; Mozambique; Rwanda, Tanzania, Uganda, Zambia, Zimbabwe; Northern Africa: Sudan (IUCN Antelope Specialist Group 2016, *Tragelaphus oryx*). **Conservation status:** Least concern (IUCN Antelope Specialist Group 2016, *Tragelaphus oryx*).

1.4 *Tragelaphus derbianus* (giant eland, Lord Derby's eland)

Two subspecies are considered, namely the easternone *(*entity*, Tragelaphus derbianus gigas)* and the westernone *(Tragelaphus derbianus derbianus)* (IUCN Antelope Specialist Group 2017), *Tragelaphus derbianus* ssp *gigas;* IUCN Antelope Specialist Group 2017, *Tragelaphus derbianus*). **Description:** Large, very much cattle-like in appearance (bull: 450-907 kg, cow: 450 kg) with chestnut coat colour, hair short; dewlap and shoulder hump which both are more pronounced in bulls; without patch of long dark hair on the forehead; white vertical markings (12-15) on side of torso; face with white chevron; bulls and cows carry horns (Stuart & Stuart 2011). **Habitat:** The giant eland is found in woodland savanna (Stuart & Stuart 2011). **Nutrition:** The giant eland is largely a browser but will also feed on grasses. The most important source of food are the leaves and shoots of the hardwood tree French doka (*Isoberlinia doka*) (Stuart & Stuart 2011). **Geographical distribution:** *Tragelaphus d. gigas* is currently a resident in Cameroon, Central African Republic, Chad and Sudan, whereas *Tragelaphus d. derbianus* is currently a resident in the Western African states of Guinea, Mali and Senegal (IUCN Antelope Specialist Group 2017, *Tragelaphus derbianus* ssp *gigas;* IUCN Antelope Specialist Group 2017, *Tragelaphus derbianus*). **Conservation status:** *Tragelaphus d. gigas* is listed as vulnerable, whereas *Tragelaphus d. derbianus* is listed as critically endangered (IUCN Antelope Specialist Group 2017, *Tragelaphus derbianus* ssp *gigas;* IUCN Antelope Specialist Group 2017, *Tragelaphus derbianus* ssp *derbianus*).

1.5 *Tragelaphus strepsiceros* (greater kudu)

Description: Large antelope (bull: 250 kg, cow 180 kg) with grey-brown coat colour, hair short; dewlap and shoulder hump; white vertical markings (6-10) on both sides of torso which are more pronounced in bulls; face with white chevron; bulls and cows with mane on neck; bulls with long-haired fringe stretching from throat to chest; legs are long and slender; only bulls carry characteristically shaped deeply spiraled very long horns (Stuart & Stuart 2011). **Habitat:** The greater kudu prefers woodland savanna where *Acacia* predominates (Stuart & Stuart 2011). **Nutrition:** The greater kudu is largely a browser and feeds mainly on *Acacia* trees and shrubs. During the raining season also grasses form part of the diet (Stuart & Stuart 2011). **Geographical distribution:** Southern Africa: Botswana, Namibia, South Africa, Swaziland; Central Africa: Angola, Central African Republic, Chad, Democratic Republic of Congo; Eastern Africa: Eritrea, Ethiopia; Kenya, Malawi, Mozambique, Tanzania, Zambia, Zimbabwe (IUCN Antelope Specialist Group 2016, *Tragelaphus strepsiceros*). **Conservation status:** Least concern (IUCN Antelope Specialist Group 2016, *Tragelaphus strepsiceros*).

1.6 *Tragelaphus imberbis* (lesser kudu)

Description: Medium-sized antelope (ram: 100 kg, ewe: 62 kg) with greyish-brown coat colour, ewes fawn-reddish coat colour; white vertical markings (up to 15) on both sides of the torso; two white prominent markings on throat; white and black markings on inner part of upper legs; colouration of lower legs reddish-brown; only bulls carry horns which are similar to the greater kudu deeply spiraled and long (Stuart & Stuart 2011). **Habitat:** The lesser kudu prefers densely grown *Acacia/Commiphora* woodlands (Stuart & Stuart 2011). **Nutrition:** The lesser kudu is mainly a browser, however during the rainy season the species is also a highly selective grazer (Stuart & Stuart 2011). **Geographical distribution:** Mostly a resident of the Eastern African states of Ethiopia, Kenya, Somalia, Tanzania and Uganda as well as of southern Sudan (IUCN Antelope Specialist Group 2016, *Tragelaphus imberbis*). **Conservation status:** Near threatened (IUCN Antelope Specialist Group 2016, *Tragelaphus imberbis*).

1.7 *Tragelaphus buxtoni* (mountain nyala)

Description: Large antelope (bull: 200-225 kg, cow: 150-200kg) with greyish-brown coat colour; four indistinct white vertical markings on both sides of torso; face with white chevron; two semilunar white patches on throat and lower neck; bulls and cows with mane stretching from the neck to the tail base; bush-like tail with dark upper side and white inner side; only bulls carry horns (Stuart & Stuart 2011). **Habitat:** The mountain nyala prefers mixed woodland, heath and moorland at higher altitudes (Stuart & Stuart 2011). **Nutrition:** The mountain nyala is largely a browser feeding on herbaceous plants, however also grasses form part of the diet (Stuart & Stuart 2011). **Geographical distribution:** The mountain nyala is only found in Ethiopia (IUCN Antelope Specialist Group 2016, *Tragelaphus buxtoni*). **Conservation status:** Endangered (IUCN Antelope Specialist Group 2016, *Tragelaphus buxtoni*).

1.8 *Tragelaphus angasii* (nyala)

Description: Medium-sized antelope (bull: 108 kg, ewe: 62 kg); rams with coat colour ranging from slate-grey to darkish brown, with fringe of dark and long hair stretching from inter-mandibular region to the posterior ventral abdomen, with whitish long-haired mane stretching from occipital region to the tail base; ewes with coat colour ranging from yellowish-brown to chestnut, short and smooth hair; bulls and ewes with white vertical markings (bulls: 8-14, ewes 18) on each side of the torso, become indistinct in older animals; face with white chevron and two white spots below the eyes; only bulls carry horns (Stuart & Stuart 2011). **Habitat:** Natural habitats are dry savanna woodland and next to creeks, streams and rivers with thicket (Stuart & Stuart 2011). **Nutrition:** The nyala is a mixed browser and grazer with grasses forming an important part of the diet during the rainy season (Stuart & Stuart 2011). **Geographical distribution:** Southern Africa: Botswana, Namibia, South Africa, Swaziland; Eastern Africa: Malawi, Mozambique, Zimbabwe (IUCN Antelope Specialist Group 2016, *Tragelaphus angasii*). **Conservation status:** Least concern (IUCN Antelope Specialist Group 2016, *Tragelaphus angasii*).

1.9 *Tragelaphus spekii* (sitatunga)

Description: Medium-sized antelope (ram: 115 kg, ewe: 55 kg); with brown-reddish long-haired coat; only rams carry horns (Stuart & Stuart 2011). **Habitat:** The sitatunga is a

swamp-dwelling antelope and the natural habitats are aquatic environments with lush vegetation (*e.g.* reedbeds); adjoining woodlands are utilized for browsing (Stuart & Stuart 2011). **Nutrition:** Sitatungas feed on a variety of reeds (e.g. papyrus) aquatic, floodplain and dryland grasses; adjoining woodlands provide browse (Stuart & Stuart 2011). **Geographical distribution:** Southern Africa: Botswana, Namibia; Central Africa: Angola, Cameroon, Central African Republic, Chad, Congo, Democratic Republic of Congo, Equatorial Guinea, Gabon; Western Africa: Benin, Gambia, Ghana, Guinea, Guinea-Bissau, Nigeria, Senegal; Eastern Africa: Burundi, Kenya, Mozambique, Rwanda; Tanzania, Uganda, Zambia, Zimbabwe; Northern Africa: Sudan (IUCN Antelope Specialist Group 2016, *Tragelaphus spekii*). **Conservation status:** Least concern (IUCN Antelope Specialist Group 2016, *Tragelaphus spekii*).

Chapter 2
Literature survey procedure

Host-helminth parasite checklists (Table 3.1-Table 3.8) have been collated based on an extensive search for records in the literature ranging from the late eighteen-hundreds until August 2019. Only the first record for a helminth of a tragelaphine host in a country is listed. Sources of information included Round (1986), the database CAB direct and the search engine Google Scholar. Annual reports, laboratory reports, dissertations and theses were considered as well.

In the checklists the helminths are arranged according to their taxa i.e. trematodes, cestodes and nematodes. Within these categories, genera and species are listed alphabetically. Species names were updated according to current nomenclature with synonyms listed as given when first recorded. Country names have been updated as currently in use.

Chapter 3
Helminth parasites of tragelaphine antelopes

The literature survey found first time records for a total of 72 species of helminths belonging to the classes Trematoda (trematodes) and Cestoda (cestodes) within the phylum Platyhelminthes, and the class Nematoda (nematodes) in the phylum Aschelminthes. No literature records of helminth infections were found for *Tragelaphus imberbis* (lesser kudu) and *Tragelaphus buxtoni* (mountain nyala).

The trematodes recorded belong to seven genera, namely *Calicophoron* (one species), *Carmyerius* (four species), *Cotylophoron* (two species), *Fasciola* (three species), *Gastrothylax* (one species), *Paramphistomum* (two species) and *Schistosoma* (four species).

The cestodes recorded belong to seven genera, namely *Avitellina* (three species), *Diplocotyle* (one species), *Echinococcus* (metacestode - species not specified), *Moniezia* (two species), *Stilesia* (one species), *Taenia* (metacestodes, with two species identified), *Thysaniezia* (one species).

The nematodes recorded belong to 25 genera, namely *Agriostomum* (two species), *Ashworthius* (one species), *Bronchonema* (one species), *Bunostomum* (one species), *Camelostrongylus* (one species), *Cooperia* (ten species), *Cooperioides* (one species), *Dictyocaulus* (one species), *Elaeophora* (one species), *Gaigeria* (one species), *Gongylonema* (one species), *Haemonchus* (four species), *Impalaia* (three species), *Nematodirus* (two species), *Oesophagostomum* (two species), *Onchocerca* (unidentified species), *Ostertagia* (three species), *Parabronema* (unidentified species), *Paracooperia* (two species), *Pneumostrongylus* (one species), *Setaria* (five species), *Skrjabinema* (unidentified species), *Strongyloides* (one species), *Thelazia* (one species) and *Trichuris* (unidentified species).

3.1 Helminth parasite spectrum of *Tragelaphus eurycerus* (bongo)

Apart from a single record of the nematode *Elaeophora sagitta,* the helminth diversity is unknown (Huchzermeyer, Penrith & Elkan 2001) (Table 3.1). *Elaeophora sagitta*is a common nematode of tragelaphine antelopes which affects the cardiopulmonary circulation with potentially fatal outcome (Young & Basson 1976). It is one of very few helminths of game

where information is available on the pathogenicity (McCully, van Niekerk & Basson 1967; Pletcher, Boomker, de Vos & Gardiner 1989).

3.2 Helminth parasite spectrum of *Tragelaphus scriptus* (bushbuck)

A total of 29 species comprising trematodes, cestodes and nematodes have been recorded from bushbuck. No Helminths identified to species level have been reported from the genera i.e. *(Gastrothylax, Gaigeria* and *Impalaia)* (Table 3.2).

Trematodes recorded from bushbuck belong to four genera, namely *Carmyerius, Cotylophoron, Gastrothylax* and *Schistosoma* with four species reported from *Carmyerius* (two species)*, Cotylophoron* (one species) and *Schistosoma* (one species)*.*

Cestodes recorded from bushbuck belong to four genera, namely *Avitellina, Moniezia, Stilesia* and *Taenia* with five species reported. Regarding the *Taenia* spp., ungulates act as intermediate hosts of the metacestode. The definitive hosts for these cestodes are carnivores as well as humans. *Cysticercus bovis,* the metacestode of *Taenia saginata,* the cattle tapeworm, or unarmed tapeworm of humans, has been identified and recorded from Kenya (Nelson, Heisch, & Furlong 1962).

Nematodes were the most numerous harbouring 15 genera comprising of 20 species. Genera recorded are, *Ashworthius, Cooperia, Dictyocaulus, Elaeophora, Gongylonema, Gaigeria, Haemonchus, Impalaia, Oesophagostomum, Ostertagia, Paracooperia, Pneumostrongylus, Setaria, Thelazia* and *Trichostrongylus.* No nematodes from the genera *Gaigeria* and *Impalaia* have been identified at species level have contributed to information of nematode diversity of bushbuck in South Afirca (Boomker, Horak & de Vos 1986; Boomker, Keep & Horak 1987).

3.3 Helminth parasite spectrum of *Tragelaphus oryx* (common eland)

A total of 28 helminth species have been recorded from common eland. Records for the genera *(Schistosoma, Echinococcus, Onchocerca, Skrjabinema* ans *Trichuris)* remain unidentified at species level (Table 3.3).

Trematodes belonging to four genera namely, *Carmyerius, Cotylophoron, Paramphistomum* and *Schistosoma* harboured three species, *Carmyerius* (one species)*, Cotylophoron* (one species) and *Paramphistomum* (one species).

Cestodes recorded from common eland belong to four genera, namely *Avitellina, Echinococcus, Moniezia,* and *Thysaniezia* with six species reported. Ungulates are intermediate hosts for the taeniid *Echinococcus* with metacestodes in various organs. Some *Echinococcus* spp. have major zoonotic implications with humans acting as intermediate hosts by the accidental ingestion of eggs that are passed in the faeces of carnivore definitive hosts (Romig, Ebi & Wassermann 2015).

Of the helminths recorded, nematodes were the most common helminth with 15 genera comprising of 19 species. Genera recorded are, *Bronchonema, Bunostomum, Cooperia, Dictyocaulus, Elaeophora, Haemonchus, Impalaia, Nematodirus, Oesophagostomum, Onchocerca, Ostertagia, Setaria, Skrjabinema, Trichostrongylus* and *Trichuris.* Nematodes form the genera *Onchocerca, Skrjabinema* and *Trichuris*a have not been identified to a species level. Latest, more systematic surveys which have contributed to the knowledge of the nematode diversity of common eland in South Africa (Mares, Amaral & Fachada 1984; Boomker, Horak, Watermeyer & Booyse 2000).

3.4 Helminth spectrum of *Tragelaphus derbianus* (giant eland)

Apart from a single record of the nematode species *Setaria labiatopapillosa* from a giant eland in Malawi, the helminth diversity is unknown (Thwaite 1927) (Table 3.4).

3.5 Helminth spectrum of *Tragelaphus strepsiceros* (greater kudu)

A total of 37 parasitic helminth species have been recorded from the greater kudu. Records for the genera *(Avitellina, Echinococcus, Taenia, Thysaniezia, Dictyocaulus, Onchocerca, Parabronema* and *Trichuris)* remain unidentified to a species level (Table 3.5).

Trematodes (five species) were recorded from four genera *Cotylophoron* (one species)*, Fasciola* (two species) *Paramphistomum* (two species) and *Schistosoma* (one species). The reported *Fasciola* sp., namely *Fasciola hepatica* and *Fasciola gigantica* have zoonotic implications, however, game species appear to have very limited significance in the

contamination of the environment (Mas-Coma, Esteban & Bargues 1999) with minimal effect on disease epidemiology. *Schistosoma mattheei* which is shared with domestic ruminants as principal hosts, has limited zoonotic implications and the species is also known to hybridize with the highly pathogenic *Schistosoma haematobium* of humans (Standley, Dobson & Stothard 2012).

Records from greater kudu yielded six genera of cestodes, namely *Avitellina, Diplocotyle, Echinococcus, Moniezia, Taenia* and *Thysaniezia* with three identified species reported.

Of the helminths recorded, the nematodes comprised the most genera (n=19) and species (n=29). Genera recorded are, *Agriostomum, Cooperia, Cooperioides, Dictyocaulus, Elaeophora, Gaigeria, Haemonchus, Impalaia, Nematodirus, Oesophagostomum, Onchocerca, Ostertagia, Parabronema, Paracooperia, Setaria, Strongyloides, Thelazia, Trichostrongylus* and *Trichuris.* For the genera *Onchocerca, Skrjabinema* and *Trichuris* a species remain unidentified (Boomker *et al.* 1986; Boomker, Anthonissen & Horak 1988; Boomker, Horak & de Vos 1989; Boomker, Horak & Knight 1991b). More systematic surveys which have contributed to the knowledge of the nematode diversity of greater kudu have been carried out in Namibia and South Africa.

3.6 Helminth spectrum of *Tragelaphus angasii* (nyala)

A total of 24 parasitic helminth species have been recorded from nyala. Specimens from three of the genera *(Taenia, Thysaniezia* and *Onchocerca)* recorded unidentified species (Table 3.6).

Trematodes recorded from nyala belong to four genera, namely *Calicophoron, Cotylophoron, Paramphistomum* and *Schistosoma* with 5 species reported.

Cestodes recorded from nyala belong to three genera, namely *Moniezia, Taenia* and *Thysaniezia* with a single species reported from *Moniezia*.

Nematodes were the most species rich 16 genera comprising 18 species. Genera recorded are *Camelostrongylus, Cooperia, Dictyocaulus, Elaeophora, Gaigeria, Gongylonema, Haemonchus, Impalaia, Oesophagostomum, Onchocerca, Ostertagia, Paracooperia, Setaria, Strongyloides, Teladorsagia and Trichostrongylus.* No species have been identified within

the genus *Onchocerca* a species has not been identified. Systematic surveys on parasitic nematode of nyala have been done in Nigeria and South Africa. (Boomker, Horak & Flamand 1991a; Boomker, Booyse, Watermeyer, de Villiers, Horak & Flamand 1996; Ibrahim, Mbaya, Geidam, Gambo, Sanda & Kelechi 2012 and Vincent, Hitchins, Bigalke & Bass 1968).

3.7 Helminth spectrum of *Tragelaphus spekii* (sitatunga)

A total of 10 species of parasitic helminth comprising trematodes and nematodes have been recorded from sitatunga. The genera *(Haemonchus* and *Onchocerca)* harboured unidentified species (Table 3.7).

Since *Tragelaphus spekii* prefer an aquatic –type of habitat, it was not surprising that the trematodes were the most species rich having five genera comprising eight species belonging to *Carmyerius, Cotylophoron, Fasciola, Gastrothylax* and *Schistosoma*.

No cestodes have been recorded from this antelope species.

The number of recorded nematodes from sitatunga is limited to three genera, namely *Haemonchus, Onchocerca* and *Strongyloides*, with two identified species, one each from *Haemochus* and *Strongyloides.*

Table 3.1: Checklist of helminths from bongo with first record

Helminth species	Locality of host	References (first record)
Nematodes		
Cordophilus sagittus	**Congo**	**Huchzermeyer*et al.* 2001**

Table 3.2: Checklist of helminths from bushbuck with first record

Helminth species	Locality of host	References (first record)
Trematodes		
Carmyerius gregarius	**Egypt** (Giza Zoological garden)	**Ezzat 1945**
Carmyerius mancupatus	**Cameroon** **Guinea**	**Fischoeder 1901** **Joyeux & Baer 1928**
Cotylophoron cotylophorum	**DRC**	**Strong & Shattuck 1930**
***Gastrothylax* sp.**	**Guinea**	**Henry & Joyeux 1920**
***Schistosoma* sp.**	**Zambia**	**LeRoux 1957**
Schistosoma leiperi	**Uganda**	**Malek & Ongom 1984**
Cestodes		
Avitellina centripunctata	**Guinea-Bissau**	**Tendeiro 1948**
***Taenia* sp. - metacestodes** *(Cysticercus* sp.*)*	**South Africa** **Zambia**	**LeRoux 1930a** **LeRoux 1957**
***Taenia hydatigena* - metacestode** *(Cysticercus tenuicollis)*	**Guinea-Bissau**	**Tendeiro 1948**
***Taenia saginata* - metacestode** *(Cysticercus bovis)*	**Kenya**	**Nelson *et al.*1965**
Moniezia expansa	**Kenya** **DRC**	**Hudson 1934** **Mahon 1954**
Stilesia hepatica	**Tanzania** **Zambia**	**Fuhrmann 1909** **Zieger *et al*. 1998**
Nematodes		
Ashworthius pattoni	**South Africa**	**LeRoux 1930b**
***Cooperia* sp.**	**South Africa**	**LeRoux 1930a**
Cooperia neitzi	**South Africa**	**Boomker*et al.* 1986**
Dictyocaulus viviparus	**South Africa**	**Boomker *et al*. 1986**
Elaeophora sagittus *(Cordophilus sagittus)*	**Cameroon** **Malawi** **Kenya &Tanzania** **Uganda** **Burundi** **South Africa**	**Von Linstow 1907** **Turner 1925** **Mönnig 1926** **Mettam 1932** **Vuylsteke 1956** **Ortlepp 1961**
***Gongylonema* sp.**	**South Africa**	**Keep 1983**
Gonglyonema pulchrum	**DRC**	**Baylis 1939**

Table 3.2: (cont.)

***Gaigeria* sp.**	**South Africa**	**Boomker *et al*. 1986**
Haemonchus bedfordi	**South Africa**	**LeRoux 1930b**
Haemonchus contortus	**Kenya** **South Africa**	**Round 1968** **Veglia 1919**
Haemonchus vegliai	**South Africa**	**LeRoux 1930a**
***Impalaia* sp.**	**South Africa**	**Keep 1983**
***Microfilaria* sp.**	**South Africa**	**Neitz 1931**
***Oesophagostomum* sp.**	**South Africa**	**Boomker *et al.* 1987**
Oesophagostomum columbianum	**South Africa Kenya**	**Mönnig 1928** **Round 1968**
Ostertagia harrisi	**South Africa**	**LeRoux 1930b**
Paracooperia devossi	**South Africa**	**Boomker& Kingsley 1984**
Pneumostrongylus calcaratus	**South Africa**	**Boomker *et al.* 1986**
***Setaria* sp.**	**Guinea** **Kenya** **South Africa**	**Henry & Joyeux 1920** **Nelson, Heisch & Furlong 1962** **Boomker *et al.* 1986**
Setaria africana	**South Africa** **Zambia**	**Ortlepp 1961** **Yeh 1959**
Setaria caelum	**DRC**	**Van den Berghe & Vuylsteke 1936**
Setaria cervina	**Tanzania**	**Leiper 1909**
Setaria labiatopapillosa	**Kenya** **DRC** **Uganda** **Guinea-Bissau** **Malawi** **Zambia** **South Africa**	**Boulenger 1921** **Van den Berghe & Vuylsteke 1936** **Thwaite 1927** **Tendeiro 1951** **Thwaite 1927** **Thwaite 1927** **Veglia 1919**
Setaria yorkei	**South Africa** **Zambia**	**Ortlepp 1961a** **Thwaite 1927**
Thelazia rhodesii	**Zimbabwe**	**Fitzsimmons & Condy 1967**
***Trichostrongylus* sp.**	**South Africa**	**Boomker *et al.* 1986**
Trichostrongylus falculatus	**South Africa**	**Boomker *et al.* 1986**
Trichostrongylus instabilis	**South Africa**	**Boomker *et al.* 1986**

Table 3.3: Checklist of helminths from common eland with first record

Helminth species	Locality of host	References (first record)
Trematodes		
Carmyerius mancupatus	**DRC**	**Prudhoe 1957**
Cotylophoron cotylophorum	**Zambia** **Uganda** **DRC**	**LeRoux 1932** **Mettam 1932** **Prudhoe 1957**
Paramphistomum mircobothrium	**DRC**	**Prudhoe 1957**
***Schistosoma* sp.**	**Zambia**	**LeRoux 1957**
Cestodes		
***Avitellina* sp.**	**South Africa**	**Mares *et al.* 1984**
Avitellina centripunctata	**Kenya** **DRC** **Zambia**	**Mönnig 1933** **Baer &Fain 1955** **Round 1968**
Avitellina edifontaineus *(syn. Anootypus edifontaineus)*	**Tanzania**	**Woodland 1928**
Avitellina monardi *(syn. Anootypus monardi)*	**Angola**	**Fuhrmann 1933**
***Echinococcus* sp. - metacestode**	**France** (Jardin d'Acclimatation)	**Blanchard 1886**
***Moniezia* sp.**	**South Africa**	**Mares *et al.* 1984**
Moniezia benedeni	**South Africa** **Tanzania** **Zambia**	**Boomker *et al*. 2000** **Hudson 1934** **Zieger *et al*. 1998**
Moniezia expansa	**Kenya**	**Mönnig 1933**
Thysaniezia giardi	**South Africa** **Zambia**	**Gough 1908** **LeRoux 1932**
Nematodes		
Bronchonema magna	**South Africa**	**Boomker *et al*. 2000**
Bunostomum trigonocephalum	**South Africa**	**Gough 1908**
Cooperia africana	**Kenya**	**Mönnig 1932**
Cooperia neitzi	**Zambia**	**LeRoux 1950**

Table 3.3: (cont.)

Cooperia rotundispiculum	**South Africa**	**Boomker *et al*. 2000**
Cooperia verrucosa	**Kenya**	**Mönnig 1932**
Dictyocaulus viviparus	**South Africa**	**Ortlepp 1961**
Elaeophora sagitta *(Cordophilus sagittus)*	**South Africa**	**Young & Basson 1976**
Haemonchus bedfordi	**South Africa**	**Mares *et al.* 1984**
Haemonchus contortus	**Kenya** **DRC**	**Mönnig 1933** **Gutterres 1947**
Haemonchus mitchelli	**Kenya** **South Africa** **Uganda** **Zambia** **South Africa**	**Mönnig 1933** **LeRoux 1929** **Mettam 1932** **LeRoux 1932** **Boomker *et al.* 2000**
Impalaia taurotragi *(Minutostrongylus taurotragi)*	**Zambia**	**LeRoux 1936**
Impalaia tuberculata	**Kenya**	**Mönnig 1933**
***Nematodirus* sp.**	**USA** (New York Zoological Park)	**McClure 1932**
Nematodirus spathiger	**South Africa**	**Boomker *et al*. 2000**
Oesophagostomum walkeri	**Kenya**	**Mönnig 1932**
***Onchocerca* sp.**	**DRC** **Zambia**	**Strong 1937** **LeRoux 1932**
***Ostertagia* sp.**	**South Africa**	**Boomker *et al*. 2000**
Ostertagia circumcincta	**RSA** **Zambia**	**LeRoux 1929** **LeRoux 1932**
Setaria labiatopapillosa	**Kenya**	**Mettam 1932**
***Skrjabinema* sp.**	**South Africa**	**Boomker *et al*. 2000**
Trichostrongylus falculatus	**South Africa**	**Boomker *et al*. 2000**
Trichostrongylus leiperi	**Zambia**	**LeRoux 1950**
***Trichuris* sp.**	**USA** (Philadelphia Zoological Gardens)	**Canavan 1931**

Table 3.4: Checklist of helminths from giant eland with first record

Helminth species	Locality of host	References (first record)
Nematodes		
Setaria labiatopapillosa	**Malawi**	**Thwaite 1927**

Table 3.5: Checklist of helminths from greater kudu with first record

Helminth species	Locality of host	References (first record)
Trematodes		
Cotylophoron cotylophorum	**Zambia** **Zimbabwe**	**LeRoux 1934** **Mettrick 1962**
Fasciola gigantica	**Zambia**	**Zieger *et al.* 1998**
Fasciola hepatica	**South Africa**	**van Wyk & Boomker 2011**
Paramphistome sp.	**South Africa**	**Boomker *et al*. 1989**
Paramphistomum cervi	**South Africa**	**Veglia 1919**
***Schistosoma* sp.**	**Zambia**	**LeRoux 1957**
Schistosoma mattheei	**South Africa**	**Boomker *et al*. 1989**
Cestodes		
***Avitellina* sp.**	**South Africa**	**Boomker *et al*. 1989**
Diplocotyle serrata	**Africa (not further specified)**	**von Linstow 1901**
***Echinococcus* sp. - metacestode**	**South Africa**	**Boomker *et al*. 1989**
Moniezia benedeni	**South Africa**	**Boomker *et al*. 1989**
Moniezia expansa	**Namibia**	**Boomker *et al*. 1988**
***Taenia* sp. - metacestodes** *(Cysticercus sp)*	**South Africa**	**LeRoux 1930b**
***Thysaniezia* sp.**	**Namibia**	**Boomker *et al*. 1988**
Nematodes		
***Agriostomum* sp.**	**Zambia** **Namibia**	**LeRoux 1932** **Boomker *et al*. 1988**
Agriostomum cursoni	**South Africa**	**Mönnig 1933**
Agriostomum gorgonis	**Zambia** **South Africa**	**LeRoux 1934** **Boomker *et al.* 1989**
***Cooperia* sp.**	**Namibia** **South Africa**	**Boomker *et al*. 1988** **Boomker *et al*. 1989**
Cooperia acutispiculum	**South Africa** **Namibia**	**Boomker 1982** **Boomker *et al*. 1988**
Cooperia fuelleborni	**South Africa**	**Boomker *et al.* 1989**
Cooperia hungi	**South Africa**	**Boomker *et al*. 1989**

Table 3.5: (cont.)

Cooperia neitzi	**South Africa** **Namibia**	**Mönnig 1932** **Boomker *et al*. 1988**
Cooperia pectinata	**South Africa**	**Ortlepp 1961**
Cooperia punctata	**South Africa**	**Ortlepp 1961**
Cooperia rotundispiculum	**South Africa**	**Boomker *et al.* 1991b**
Cooperia yoshidai	**South Africa**	**Boomker *et al*. 1989**
Cooperioides hamiltoni	**Namibia**	**Boomker *et al*. 1988**
***Dictyocaulus* sp.**	**South Africa**	**Boomker *et al*. 1991b**
Elaeophora sagitta *(Cordophilus sagittus)*	**South Africa** **Namibia**	**Mönnig 1926** **Boomker *et al*. 1988**
Gaigeria pachyscelis	**South Africa**	**Ortlepp 1961**
Haemonchus contortus	**South Africa**	**Veglia 1919**
Haemonchus vegliai	**South Africa** **Zambia** **Namibia**	**LeRoux 1929** **LeRoux 1932** **Boomker *et al*. 1988**
***Impalaia* sp.**	**South Africa** **Namibia**	**Boomker *et al*. 1986** **Boomker *et al*. 1988**
Impalaia nudicollis	**Namibia**	**Boomker *et al*. 1988**
Impalaia tuberculata	**Namibia** **South Africa**	**Boomker *et al*. 1988** **Boomker *et al*. 1989**
Nematodirus helvetianus	**South Africa**	**Boomker *et al.* 1991b**
***Oesophagostomum* sp.**	**South Africa**	**van Wyk & Boomker 2011**
Oesophagostomum walkeri	**Zambia**	**LeRoux 1940**
***Onchocerca* sp.**	**Unknown locality** **Namibia**	**Ortlepp 1961** **Boomker *et al.* 1988**
Ostertagia circumcincta	**South Africa** (Johannesburg Zoological garden)	**LeRoux 1930a**
Ostertagia ostertagi	**South Africa**	**Boomker *et al*. 1991b**
***Parabronema* sp.**	**South Africa**	**Boomker *et al*. 1989**
Paracooperia devossi	**Namibia** **South Africa**	**Boomker *et al*. 1988** **Boomker *et al*. 1989**
***Setaria* sp.**	**South Africa**	**Boomker *et al*. 1989**
Setaria africana	**South Africa**	**Ortlepp 1961**

Table 3.5: (cont.)

Strongyloides papillosus	**South Africa**	**Boomker *et al*. 1989**
Thelazia rhodesii	**Zimbabwe**	**Fitzsimmons & Condy 1967**
***Trichostrongylus* sp.**	**South Africa** **Namibia**	**Boomker *et al.* 1986** **Boomker *et al.* 1988**
Trichostrongylus deflexus	**South Africa**	**Boomker *et al.* 1986**
Trichostrongylus falculatus	**Namibia** **South Africa**	**Boomker *et al.* 1988** **Boomker *et al*. 1989**
Trichostrongylus instabilis	**South Africa**	**Boomker *et al.* 1986**
Trichostronglylus thomasi	**Namibia**	**Boomker *et al*. 1988**
***Trichuris* sp.**	**USA** (Philadelphia Zoological Gardens) **South Africa**	**Weidman 1928** **Boomker *et al.* 1989**

Table 3.6: Checklist of helminths from nyala with first record

Helminth species	Locality of host	References
Trematodes		
Calicophoron calicophorum	**South Africa**	**Round 1968**
Cotylophoron cotylophorum	**South Africa**	**Round 1968**
Cotylophoron jacksoni	**South Africa**	**Dixon 1964**
Paramphistome sp.	**South Africa**	**Boomker *et al*. 1991a**
Paramphistomum microbothrium	**South Africa**	**Dixon 1964**
Schistosoma mattheei	**South Africa**	**Boomker *et al*. 1991a**
Cestodes		
Moniezia benedeni	**South Africa**	**Boomker *et al*. 1996**
***Taenia* sp. - metacestodes**	**South Africa**	**Boomker *et al*. 1991a**
***Thysaniezia* sp.**	**South Africa**	**Boomker *et al*. 1991a**
Nematodes		
***Camelostrongylus* sp.**	**South Africa**	**Boomker *et al*. 1996**
Camelostrongylus harrisi	**South Africa**	**Vincent *et al.* 1968**
***Cooperia* sp.**	**South Africa**	**Boomker *et al.* 1986**
Cooperia hungi	**South Africa**	**Boomker *et al*. 1996**
Cooperia rotundispiculum	**South Africa**	**Boomker *et al*. 1991a**
Dictyocaulus viviparus	**South Africa**	**Keep 1971**
Elaeophora sagitta *(Cordophilus sagittus)*	**South Africa**	**Ortlepp 1961**
Gaigeria pachyscelis	**South Africa**	**Boomker *et al*. 1991a**
***Gongylonema* sp.**	**South Africa**	**Boomker *et al*. 1991a**
Gongylonema verrucosum	**South Africa**	**Vincent *et al.* 1968**
***Haemonchus* sp.**	**South Africa**	**Keep 1971**
Haemonchus vegliai	**South Africa**	**Boomker *et al.* 1991a**
Impalaia tuberculata	**South Africa**	**Boomker *et al.* 1991a**
***Oesophagostomum* sp.**	**South Africa**	**Boomker *et al.* 1991a**

Table 3.6: (cont.)

***Onchocerca* sp.**	**South Africa**	**Boomker *et al.* 1996**
Ostertagia harrisi	**South Africa**	**Vincent *et al.* 1968**
Ostertagia trifurcata	**South Africa**	**Keep 1971**
Paracooperia horaki	**South Africa**	**Boomker 1986**
***Setaria* sp.**	**South Africa**	**Boomker *et al.* 1991a**
Setaria africana	**South Africa**	**Yeh 1959**
Setaria labiatopapillosa	**South Africa**	**Mönnig 1931**
Strongyloides papillosus	**South Africa**	**Boomker *et al.* 1996**
Teladorsagia trifurcata	**South Africa**	**Keep 1971**
Trichostrongylus deflexus	**South Africa**	**Boomker *et al.* 1991a**
Trichostrongylus falculatus	**South Africa**	**Boomker *et al*. 1991a**

Table 3.7: Checklist of helminths sitatunga with first record

Helminth species	Locality of host	References (first record)
Trematodes		
Carmyerius exoporus	**Malawi**	**Maplestone 1923**
Carmyerius spatiosus	**Zambia** **Zimbabwe**	**LeRoux 1934** **Pike & Condy 1966**
Cotylophoron cotylophorum	**Zambia**	**LeRoux 1934**
Fasciola tragelaphi	**Zimbabwe**	**Pike &Condy 1966**
Gastrothylax crumenifer	**Zambia**	**LeRoux 1932**
Schistosoma bovis	**Rwanda**	**van den Berghe 1934**
Schistosoma leiperi	**Zambia**	**LeRoux 1932**
Schistosoma magrebowiei	**Zambia**	**LeRoux 1933**
***Schistosoma* sp.**	**Zambia**	**LeRoux 1957**
Nematodes		
Haemonchus contortus	**Nigeria**	**Ibrahim *et al.* 2012**
***Haemonchus* sp.**	**Zambia** **Uganda**	**LeRoux 1934** **Mettam 1932**
***Onchocerca* sp.**	**Zambia**	**LeRoux 1937**
Strongyloides papillosus	**Nigeria**	**Ibrahim *et al.* 2012**

Table 3.8: Checklist of helminths from *Tragelaphus* sp. (not specified) with first record

Helminth species	Locality of host	References (first record)
Nematodes		
Setaria africana	**Egypt** (Cairo Zoological Garden)	**Yeh 1959**
Setaria labiatopapillosa	**Sudan** **Egypt** (Giza Zoological Garden) **DRC**	**Boulenger 1921** **Ezzat 1945** **Vuylsteke 1956**

Chapter 4
Conclusions

Up-to date host-helminth parasite checklists for the tragelaphine antelopes were compiled. A total diversity of 72 trematode, cestode and nematode helminth species have been recorded from the nine species of tragelaphine antelopes. No records of helminth infections were found for the lesser kudu and the mountain nyala and only a single helminth species has been recorded from the bongo. Because of the precarious conservation status of these three tragelaphine antelope, ranging from 'near threatened' to critically endangered', the diversity of the helminth parasites will probably be largely remain unknown. Some helminths are game specific, whereas others are shared with domestic stock. With very few exceptions, the pathogenicity and the effect on morbidity and mortality of most game-specific helminth species is unknown. A notable exception is the filariid *Elaeophora sagitta* which affects the cardiopulmonary circulation of the tragelaphine antelopes wit potential fatal outcomes (McCully *et al.* 1967; Young & Basson 1976; Pletcher *et al.* 1989; Huchzermeyer *et al*. 2001). Very few species recorded form the tragelaphine antelope have zoonotic implications and the epidemiological importance of the tragelaphine antelopes acting as reservoir hosts is not significant when compared to domestic stock. As only comparatively few geographically isolated systematic surveys have been conducted on helminth infections of selected tragelaphine antelope species, comparisons of the diversity between host species are pure speculative.

Chapter 5
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Research Ethics Committee

PROJECT TITLE	**A Systematic review on helminth infections of tragelaphine antelope (Family: Bovidae, Sub-Family: Bovinae; Tribe: Trangelaphini) in Africa**
PROJECT NUMBER	**REC032-18**
RESEARCHER/PRINCIPAL INVESTIGATOR	**Maruchelle Cilliers**

STUDENT NUMBER (where applicable)	
DISSERTATION/THESIS SUBMITTED FOR	**MSc**

SUPERVISOR	**Dr E Volker Schwan**

APPROVED	Date **5 June 2018**
CHAIRMAN: UP Research Ethics Committee	Signature M.M. Duncan