GASTRO-INTESTINAL HELMINTHS OF THE RED-EYED DOVE *STREPTOPELIA SEMITORQUATA* RÜPELL, 1837 IN ZARIA, KADUNA STATE, NIGERIA

BY

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BY

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DEPARTMENT OF BIOLOGICAL SCIENCES,
AHMADU BELLO UNIVERSITY, ZARIA

OCTOBER, 2014

DECLARATION

I hereby declare that the work in this thesis entitled "GASTRO-INTESTINAL HELMINTHS OF THE RED-EYED DOVE *STREPTOPELIA SEMITORQUATA* RÜPELL, 1837 IN ZARIA, KADUNA STATE, NIGERIA" was carried out by me in the Department of Biological Sciences under the supervision of Prof. T. O. L. Aken'Ova and Prof. P. A. Audu. No part of this thesis has been presented in any previous application for a higher degree. All sources of information are acknowledged by means of references.

Abdulhamid Burour IBRAHIM _____ _____

Signature Date

CERTIFICATION

This thesis entitled "GASTRO-INTESTINAL HELMINTHS OF THE RED-EYED DOVE *STREPTOPELIA SEMITORQUATA* RÜPELL, 1837 IN ZARIA, KADUNA STATE, NIGERIA" by Abdulhamid Burour IBRAHIM meets the regulations governing the award of the degree of Master of Science of Ahmadu Bello University, Zaria and is approved for its contribution to knowledge and literary presentation.

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DEDICATION

To
the loving memory of my beloved mother, **Nana Khadijah Buyon Ibrahim** for her extraordinary versatility in our lives
and
a celebrated Accountant par excellence - **Mohammed Sani Abubakar** (FCNA) for being the fulcrum of my academic successes.

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ABSTRACT

Helminthiasis is considered an important problem of wild birds and the status of gastro-intestinal helminths of the Red-eyed dove was unknown. Fifty-one (51) *Streptopelia semitorquata* were examined for helminths to provide information on their occurrence, prevalence, and species composition in the Zaria area of Kaduna State, Nigeria, between January 2012 and February 2013. The birds were humanely killed and dissected to expose the gastro-intestinal tract. Helminths were recovered and identified. Of these, 27 (52.94%) were infested with one or more of the five species of helminths, comprising only cestodes. These were *Raillietina* species 1 (40.7%), *Aporina* species (33.3%), *Raillietina* species 2 (7.4%), *Raillietina* species 3 (3.7%) and *Fimbriaria* species (7.4%). Single infestations were more common (37.25%) than double (11.76%) and triple infestations (3.92%). The mean intensities were 2.4±0.4 for *Raillietina* species 1, 1.9±0.3 for *Aporina* species, 1.5±0.5 for *Raillietina* species 2 and 1.0±0.0 for each of *Raillietina* species 3 and *Fimbriaria* species. There were no significant differences ($P>0.05$) in the mean intensities of infestation by the different cestodes in male and female birds. Infestation was significantly higher during the wet than in the dry season ($P<0.05$). *Raillietina* species 3 and *Fimbriaria* species are reported for the first time in *S. semitorquata* from Zaria. The helminths of *Streptopelia semitorquata* should be further investigated over a longer period of time; comparative studies of *S. semitorquata* and other columbids should be carried out and more efficient techniques of trapping *S. semitorquata* should be developed.

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CHAPTER ONE

1.0 INTRODUCTION

The Red-eyed Dove *Streptopelia semitorquata* is widely distributed in Africa south of the Sahara. It is a common, if not abundant, species in most habitats other than deserts (BirdLife International, 2006). It has adapted very well to the activities of humans, generally preferring woodland, especially alien tree plantations with pines (Hockey *et al.,* 2005). Its flight is quick, with regular beats and an occasional sharp flick of the wings which are characteristic of pigeons in general (BirdLife International, 2011).

Streptopelia semitorquata is a large, stocky pigeon, typically 34cm long. Its back, wings and tail are pale brown. When flying, it shows blackish flight feathers. The head and underparts are dark pinkish, shading to pale grey on the face. It has a black hind neck patch edged with white. The legs and a patch of bare skin around the eye are red. The call is a loud doo-doo-du-du. Males and females are similar, but juveniles are duller in colour than adults, and the body feathers are scalloped (BirdLife International, 2011).

This species of dove eats a wide range of seeds, as well as flowers, nuts, fruit and rarely insects. It forages on the ground, frequently under trees (Hockey *et al.,* 2005). It is frequently found in Zaria, Yankari and Hadejia woodlands (World Bird Info.net/distribution). The habit of the bird and its dependence on human activities for food predisposes it to being easily trapped or killed, as it is widely sold or traded in many Nigerian markets to augment income (Rowan, 1983). *Streptopelia semitorquata* is evaluated as least concern because it has an extremely large range, and hence does not approach the threshold for vulnerable under the range size criterion (BirdLife International, 2011). Over 20 species of pigeons and doves are cosmopolitan which have long been the subjects of intense ornithological and parasitological study (Akinpelu, 2008).

The first human impression about doves was that of a symbol of peace, love and fertility (Klingerman, 1978). In Nigeria, doves have been hunted and eaten but recently the intensity has increased, probably due to harsh economic situation coupled with increased demand for protein (Oniye *et al.,* 2000). The demand for the Red-eyed dove is of late on the increase as observed in 'suya joints' in Zaria and many urban settlements in northern Nigeria.

Helminths are said to be the major cause of ill-health and poor performance in birds (Khater, 1993). Avian cestodiasis constitutes one of the most common helminths causing serious damage among wild birds. It leads to loss of body weight, enteritis and death (Calneck *et al.,* 1997).

A considerable number of arthropods and snails have been implicated as intermediate hosts of helminths of wild birds (Soulsby, 1982). In heavy infections, helminths are known to cause morbidity and mortality in wild birds (Owen, 1972). Among the helminths of birds, nematodes and cestodes constitute the most important group (Nfor *et al.,* 1999; Ayeni *et al.,* 1983). *Ascaridia galli* has been incriminated as the most common and most important parasite of poultry (Hodasi, 1978; Pam *et al.,* 2006; Luka and Ndams, 2007). The cestodes of significant importance are *Raillietina* and *Hymenolepis* (Oniye *et al.,* 2000; Luka and Ndams, 2007). Helminths are known to compete

with the infected hosts for nutrients, lowering their productivity and in severe cases causing death by blocking the gastro-intestinal tract, especially when the worm burden is high (Soulsby, 1982). Helminth infections may have particularly deleterious or debilitating effects on birds, causing growth retardation, interfering with healthy development, and making older birds prone to secondary infections (Cheng, 1973). Unlike the well-documented helminths of other Nigerian domestic birds such as the domestic pigeon, chicken and guinea fowl, there is little or no published information on helminths of the Red-eyed dove in Nigeria.

1.1 Statement of Research Problem

The Red-eyed dove *Streptopelia semitorquata* constitutes a large population in Zaria (Fry, 1965; Del Hoyo, 1997; Adang, 2012) but the status of its gastro-intestinal helminths is unknown. Literature search indicates that there appear to be no earlier studies conducted on the gastro-intestinal helminths of the Red-eyed dove in northern Nigeria.

Helminthiasis is considered an important problem of wild birds (Jansen and Pandey, 1989; Abebe *et al.*, 1997). Information on the factors influencing helminth infestation of the birds is lacking.

Little attention is usually paid to diseases of wild animals because of the assumption that they are hardier than their domestic counterparts (Khater, 1993).

1.2 Justification

Wild birds undoubtedly contribute immensely to the daily supply of protein consumed worldwide (Basit *et al.*, 2006, Shehu *et al.*, 2009). Recent studies have shown the prevalence of helminth infestation of wild birds to be high (Adang, 2009).

Since helminthiasis is a threat to wild birds, an understanding of the factors causing these diseases, coupled with a thorough knowledge of the nature of their etiologic agents is of great significance in understanding the ecological niches of the birds.

In addition, information on the variety and composition of helminth species found will provide further insight into their diversity in an ecological habitat.

This research will also provide baseline data on the gastro-intestinal helminths of the Red-eyed dove.

1.3 Aim

The aim of this research is to establish the occurrence, prevalence and species composition of helminths in the gut of *Streptopelia semitorquata* in the Zaria area of Kaduna State, Nigeria.

1.4 Objectives

The objectives are to determine the:

1. prevalence of gastro-intestinal helminths of the Red-eyed dove;
2. intensity of infestation and species composition of the gastro-intestinal helminths;
3. relationship between intensity of infestation and the sex of host; and
4. seasonal infestation by the helminths.

1.5 Hypotheses

1. The Red-eyed dove is not infested by gastro-intestinal helminths.
2. The intensity of infestation and species composition of the gastro-intestinal helminths are not remarkable.
3. There is no significant difference between the prevalence of infestation of male and female birds.
4. There is no significant relationship between seasonal infestation by the helminth.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Diversity of Columbids

Pigeons and doves belong to the order Columbiformes and family Columbidae. There are five subfamilies within the Columbidae, 42 genera and 308 species. They are easily recognizable and have a world-wide distribution (although they are not found in Antarctica Sahara desert and the high arctic) (Lack, 2003). They live in almost all types of terrestrial habitats from deserts to dense forests and large urban areas. Pigeons and doves are stocky birds that range from 15 to 75cm long. Many of the seed-eating columbids are buff, grey and brown coloured, while the fruit-eaters are often more brightly coloured. Many have ornamentation and iridescent feathers on the neck, breast, back, wings and face. They range from solitary to extremely social; the now extinct passenger pigeons (*Ectopistes migratorius*) are reported to have occurred in flocks of up to two million birds that were so dense that they blocked out the sun (Lack, 2003; Baptista *et al.,* 1992; Wells and Wells, 2001).

Pigeons and doves are a cosmopolitan family. Their highest diversity occurs in South America, Australia and the Pacific Islands. Some species, for example, Rock Doves (*Columba livia*) have been much distributed throughout much of their range (Baptista *et al.,* 1992; Frith, 1982; Gibbs *et al.,* 2001; Lack, 2003; Wells and Wells, 2001).

2.2 Distribution and of *Streptopelia semitorquata*

Streptopelia semitorquata (Red-eyed dove) occurs across sub-saharan Africa, including southern Africa, where it is common in northern Namibia, northern and south-eastern Botswana, Zimbabwe, Mozambique, Swaziland, Lesotho and South Africa. *Streptopelia semitorquata* is one of the common columbids in the Zaria area of Nigeria in the northern Guinea Savanna (Fry, 1965).

The global population size has not been quantified but the species is described as common to abundant throughout much of its range (Gibbs *et al.,* 2001). The population is suspected to be increasing owing to afforestation and water conservation projects (Del Hoyo *et al.,* 1997).

2.3 Predators of *Streptopelia semitorquata*

Among the predators are reptiles and birds. The only reptile species recognized is South African python, *Python natalensi*, while the species of birds are: *Accipiter rufiventris* (Rufous-chested sparrowhawk), *Accipiter tachiro* (African goshawk), *Accipiter Melanoleucus (*Black sparrowhawk*),* *Accipiter ovampensis* (Ovambo sparrowhawk), *Falco peregrines* (Peregrine falcon) and *Falco biarmicus* (Lanner falcon) (Hockey *et al.,* 2005).

2.4 Food of *Streptopelia semitorquata*

It eats a wide range of seeds, as well as flowers, nuts, fruits and rarely insects. It forages on the ground, frequently under trees (Hockey *et al*., 2005)

2.5 Helminths of Birds

Helminthiasis is the general term used for internal worm or helminth infestations. There are many species of helminths that infect birds, and these can vary considerably in caged birds. There has been very little published work around the world on the control of bird helminths other than through the use of selected anthelmintics or dewormers. In the period before intensification and effective anthelmintics, much of the literature on control programmes stemmed from personal experiences of producers rather than scientific evidence (Soulsby, 1982).

Birds have free access to the open air and the ground, from which they are liable to pick up infections, some of which have not been major problems as the perch around their habitats. Among the diseases encountered in a study of Danish organic bird farming were an increase in infestations of internal parasites, including the nematode species, *Ascaridia galli, Heterakis gallinarum* and *Capillaria* species (Permin and Hansen, 2003).

There are many species of helminths that infect columbids and these vary considerably in their their morphology. The food habit of columbids and the life-cycle of the parasites determine the variety of the infections they can acquire (Cheng, 1973). Columbids are free-range and thus acquire infections with a wide range of parasites having direct or indirect life-cycles because of their increased exposure to larger areas of land and various intermediate hosts and the eggs of parasites (Fabiyi, 1972a, b)

2.5.1 Prevalence of helminths of birds

The cestodes and trematodes are less pathogenic than the roundworms. A vast number of trematodes and tapeworms have been identified, with a wide range of bird hosts. The tapeworms require an intermediate host, such as earthworms or insects. Birds can become infected through ingestion of the intermediate host. The most important tapeworm is probably *Rallietina cesticillus*. The trematodes are more important parasites of wild-fowl and domesticated ducks and geese (Calnek *et al*., 1997).

The spatial distribution of parasites is known to vary greatly between host populations (Esch and Fernandez, 1993; Poulin 1998). Larval trematodes in intertidal snails are classical examples of parasites with a heterogenous spatial variation among hosts (Curtis and Hurd 1983; Poulin and Mouritsen, 2003, Fredensborg *et al.*, 2005). For many intertidal trematodes, the life-cycle includes a snail as first intermediate host, a second intermediate crustacean or mollusc host, and a bird as definitive host. Sexual reproduction takes place inside the gastro-intestinal tract of the bird host, and eggs are passed out into the external environment with the faeces of the bird (Sousa, 1991; Thomas *et al*., 1997; Mouritsen and Poulin, 2002).

The high mobility of birds compared to the other hosts in the trematode life-cycle makes them the main dispersal agents of trematodes. The spatial distribution of bird definitive hosts is therefore naturally assumed to be responsible for the often highly heterogenous spatial infection pattern of larval trematodes in their first intermediate hosts (Matthews *et al.*, 1985; Bustnes and Galaktionor, 1999; Marcogliese *et al.*, 2001, Skirnisson *et al.*, 2004).

Wehr (1963) reported *Ornithostrongylus quadriradiai* as a common parasite of *Columba livia domestica* and Eastern mourning Dove (*Zenaida macroura*) in north America. Barus (1966) surveyed the nematodes of birds in Czechoslovakia from 1955-1964. He autopsied a total of 500 birds and recovered *Ascaridia columbae, Heterakis gallinarum, Ancyclostoma anseris, Capillaria obsignata* and *Physaloptera* sp. in the columbids. Jackoski and Plank (1969) found that of the 56 pigeons trapped during the months of July and August, 1960 in Chicago, USA, 17.5% harboured helminths, 1.78% harboured *Ascaridia* sp. occurring in the small intestine and 5.34% harboured *Capillaria* sp.

Barrows *et al*. (1977) examined Mourning Doves (*Zenaida macroura*) for endoparasites in south east United States and found four nematodes - *Aproctella stoddardi, A. columbae* and *Dispharynx nasuta,* and two cestodes – *Sarcocystis* sp. and *Hymenolepis* sp., which included new host records. Angus (1978) reported the following trematodes in the small intestine of pigeons: *Echinosoma revolutum, Echinoparyphium recurvatum, Cotylurus cornutus* and *Cotylurus flabelliforms.*

Olsen and Braun (1980) also examined 609 Band-tailed pigeons (*Columba fasciata fasciata*) in Colorado and identified four nematodes, which were *Ascaridia columbae, Splendidofilaria columbensis, S. hibleri* and *Chandelerella robinson*. Of the 609 pigeons examined 76 (12.5%) harboured helminths. Conti and Forrester (1981) found two trematodes in Mourning doves (*Zenaida macroura*) and white-wing doves (*Zenaida asiatica*) in north and south Florida. Two cestode species were encountered among the hosts. Nematodes dominated numerically, accounting for 76% prevalence. Mariaux (1994) reported prevalence of 15.7% when he examined 1, 252 wild birds in

Ivory Coast. All the parasites he isolated were cyclophyllideans and most of them were found in new hosts.

Dede and Richards (1998) reported a prevalence of 66.7% of helminths in some columbids in the north-east Zone of Nigeria. Out of 30 pigeons examined, comprising 24 *Columba livia domestica*, 4 *Columba guinea* and 2 *Streptopelia decipiens*, 20 (66.7%) were infected by helminths. These comprised 15 (62.5%) *Columba livia domestica*, 3 (75.0%) *Columba guinea* and 2 (100.0%) *Streptopelia decipiens*. The helminths recovered were all cestodes and prominent among these were *Raillietina* species including *Raillietina joyeuxi, Raillietina columbiella* and *Raillietina cesticillus.*

Mushi *et al*. (2000) examined 12 adult pigeons from Sebele, Garborone, Botswana for the presence of helminths, and two nematodes *Dispharyx spiralis* (10.0%) and *Ascaridia columbae* (30.0%) were recovered. Most pigeons (80.0%) were infested with *Ascaridia columbae* often in association with *Raillietina* spp.

In a study conducted on 130 laughing doves (*Streptopelia senegalensis*) in Zaria, Oniye *et al.* (2000) reported aprevalence of 69.23% for the helminths infestation. The Parasites they isolated were *Raillietina echinobothrida* (41.53%), *R. tetragona* (4.61%), *Hymenolepis carioca* (20.0%), *Amoebotaenia cuneata* (1.53%) and *Ascaridia galli* (1.53%). Glass *et al*. (2002) reported a prevalence of 7.0% for trematodes while examining the helminth communities of 171 fledged white-wing doves (*Zenaida asiatica asiatica*) from an expanding eastern population in Texas, USA. He got 17% prevalence for cestodes.

Foronda *et al*. (2004) reported four nematode species in 50 wild doves (*Columba livia*) from the city of Santa Cruz de Tenerife in the Island of Tenerife (Canary Archipelago). These were *Tetrameres fissispina* (4.0% prevalence and 99.5±34.1 mean intensity), *Dispharynx spiralis* (8.0% prevalence and 46.8±11.6 mean intensity), *Ascaridia columbae* (40.0% prevalence and 8.4±8.8 mean intensity and *Aonchotheca* sp. (18.0% prevalence and 6.0±3.1 mean intensity). The only cestode they identified was *Raillietina miracanth* with 44.0% prevalence.

Audu *et al*. (2004) carried out a survey on helminths of domestic pigeons (*Columba livia domestica*) in Zaria, between May and August, 2002 (rainy season). Out of the 60 pigeons examined, 26 (43.4%) were infested by helminths. They identified the cestodes *Raillietina tetragona, Raillietina cesticillus* and *Raillietina echinobothrida. Raillietina echinobothrida* was the most prevalent cestode occurring in 15 (25.0%) birds, followed by *Raillietina tetragona* and *Raillietina cesticillus* in 12 (20.0%) birds each. Sex-related prevalence of the helminths was 25.0% in female and 18.3% in male birds.

Bean *et al*. (2005) recovered nine species of helminths from *Streptopelia decoacto* (5 nematodes, 2 cestodes and 2 trematodes) in a study of sixty-three Eurasian collared doves in Florida, from June to December, 2001. The most prevalent helminths were *Ascaridia columbae* (73.0%), *Fuhrmannetta crassula* (28.6%), *Ornithostrogylus quadriradiatus* (12.7%) and *Bruscapillaria obsignata* (11.1%). In the study, the helminths with the greatest mean intensity were *Tanaisia bragar* (13.5%), *Ascaridia columbae* (9.3) and *Ornithostrongylus quadriadiatus* (7.1). The mean intensity of *A. columbae* in Eurasian Collared doves (9.3) was found similar to that of white-winged doves

(*Zenaida asiatica*) (9.1), both in Florida. The mean intensities in both cases were however significantly higher than that in the native mourning doves (*Zenaida macroura*) (3.7). *Fuhrmannetta crassula* was reported for the first time in columbids from Florida.

Gadzama *et al*. (2005) recorded a prevalence of 44.0% in 25 *Streptopelia senegalensis* examined for helminths in Zaria. Three species of cestodes, *Raillietina tetragona* (28.0%), *Raillietina echinobothrida* (8.0%) and *Hymenolepis carioca* (4.0%) and one nematode, *Ascaridia galli* (1%) were identified

Senlik *et al*. (2005) carried out a one-year study (April 2002 to March 2003) in pigeons in Turkey to determine the occurrence of helminth species and to evaluate the effect of host age, sex and season on prevalence and intensity of infestation. A total of 100 domestic pigeons (31 young and 69 adults) were necropsied and examined. Seventy four were infested with helminths. Two nematode species identified were *Baruscapillaria obsignata* (63.0%) and *A. columbae* (42.0%). There were significant differences between the prevalence of *A. columbae* and *B. obsignata* by host age and male and female birds. Significantly, the highest prevalence of *A. columbae* was observed in the autumn months, but there was no significant difference in the seasonal prevalence of *Baruscapillaria obsignata*. Only one cestode was recovered (*Raillietina echinobothrida*).

In a study of gastro-intestinal helminths of domestic pigeons in Makurdi metropolis in Benue State, Nigeria, Atsineke and Banke (2006) reported an overall prevalence of 43(86%) in the 50 pigeons they examined. They identified six helmiths species including one cestode, *Raillietina cesticillus* (68%) and five nematodes. Twenty-three (92.0%) male and 20 (80.0%) female birds were infested. A total of 27 (54%) had mixed infections while 16 (46.0%) had single infections. Basit *et al.* (2006) reported three nematodes in a study of 100 wild and 100 domestic pigeons in Pakistan. Sixty out of 100 wild pigeons were found positive for single or mixed infestation of *Ascaridia columbae, Capillaria obsginata* and *Ascaridia galli*, whereas 55 out of 100 samples from domestic pigeons were found to have single or mixed infestations of the above mentioned parasites. The overall prevalence was 57%, whereas prevalences of 60% and 55% respectively were obtained in wild and domestic pigeons.

Natala *et al.* (2009) examined 250 pigeons and reported prevalences of 4.9%, 3.0%, 7.6%, 1.2%, 1.2% and 0.8% for *Raillietina tetragona*, *Raillietina cesticillus*, *Raillietina echinobothrida*, *Ascaridia columbae*, *Ascaridia galli* and *Cappillaria anatis* respectively in a survey on parasites of domesticated pigeons in Zaria.

Radfar *et al.* (2011) in a study of 102 pigeons in South Knora-San, Iran, reported prevalences of 16.6%, 1.96%, 13.8%, 18.6% and 32.4% for *Ascaridia columbae*, *Hadjelia truncate, Cotugnia digonopora, Raillietina magninumida* and *Raillietina echinobothrida.*

Helminths of six columbids from Zaria have been reported by Adang (2012). The columbids examined were *Columba livia domestica* (240), *Streptopelia senegalensis* (382), *Streptopelia decipiens* (48), *Columba guinea* (28), *Turtur abyssinicus* (32) and *Streptopelia vinacea* (6). The helminths he identified included the cestodes *Raillietina tetragona* 154 (20.9%), *Raillietina*

echinobothrida 100 (13.6%), *Raillietina magninumida* 15 (2.0%), *Raillietina cesticillus* 37 (5.0%), *Amoebotaenia cuneata* 25 (3.4%), *Hymenolepis carioca* 39 (5.3%) and *Hymenolepis cantaniana* 46 (6.3%) and the nematodes were *Heterakis gallinarum* 11 (1.5%), *Ascaridia galli* 10 (1.4%) and *Ascaridia columbae* 27 (3.7%).

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 Study Area

The study was carried out in Zaria, which lies in the northern Guinea Savanna zone, within 11°03'N, 07°42'E (Figure 3.1), a region that has a tropical Savanna climate with distinct wet (May to October) and dry (November to April) seasons. The mean annual rainfall is about 1,047.08mm (Happold, 1987). The dusty, dry, cold harmattan wind is observed between November and January. Zaria is characterized by mainly open woodland vegetation (Hore, 1970; Gibbs *et al*., 2001).

3.2 Collection of Birds

Fifty-one (51) doves were trapped between January 2012 and February 2013 using locally made traps while some were shot by hunters within Zaria at the following locations:

1. Ahmadu Bello University Dam;
2. Area A Staff residential quarters (Ahmadu Bello University campus);
3. Nigerian Army Barracks (Depot), Sabon gari;
4. Institute of Agricultural Research farms;
5. Area G Staff residential quarters (Ahmadu Bello University);
6. Ahmadu Bello University farm, Shika; and
7. Shika area.

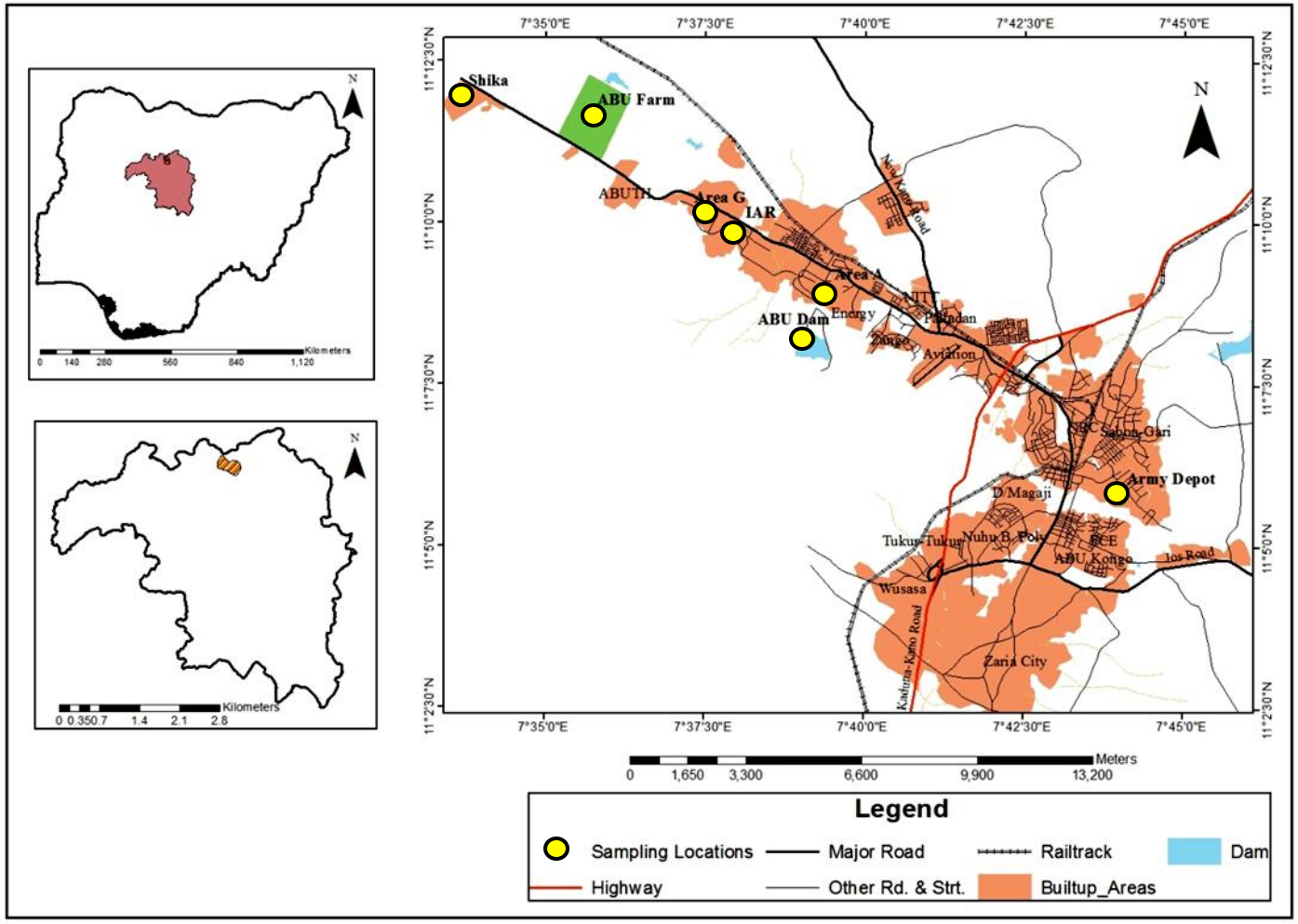


Figure 3.1: Map of sampling locations ( ) Zaria

Source: Satellite images of Zaria (Department of Geography, Ahmadu Bello University, Zaria)

The choice of the locations was based on the occurrence of woodland vegetation coupled with the presence of large numbers of the birds. The charateristic colouration of the birds is shown in Plates I and II.

After trapping/shooting, the birds were conveyed to the Postgraduate Entomology and Parasitology Laboratory of the Department of Biological Sciences, Ahmadu Bello University, Zaria.

3.3 Treatment of Birds

The live birds were humanely killed and their total weight taken using a spring balance. The birds were partially feathered and dissected to expose the gastro-intestinal tract which was cut out and placed in a Petri dish containing physiological saline. The degutted weight was then taken.

The gastro-intestinal tract was separated into its component sections, placed in separate Petri dishes, and then slit open longitudinally in distilled water, under a dissecting microscope. Crop contents were collected in Petri dishes for sorting and identification of components.

3.4 Treatment of Helminths

All helminths found were carefully removed using a pair of forceps and placed in cavity blocks containing distilled water. Worms were fixed in hot water and preserved in 5% formalin in labelled specimen bottles.



Plate I: *Streptopelia semitorquata*

Location: Area A, A.B.U. main campus



Plate II: Male (L) and female (R) *Streptopelia semitorquata* in courtship

Location: Area A, A. B. U. main campus.

3.4.1 Staining, dehydrating, clearing and mounting

The preserved worms were washed in distilled water to remove the preservative (formalin) and stained overnight in a weak solution of 3% Ehrlich's acid haematoxylin in a cavity block. The worms were then rinsed with distilled water to remove excess stain and destained in 0.3% hydrochloric acid until the colour was almost completely removed, then rinsed with distilled water. The worms were neutralized using a 0.3% solution of ammonia to stop destaining completely and to 'blue' them.

The worms were dehydrated in a graded series of ethanol (30%, 50%, 70%, 90% and 100%) for 1 hour each. The absolute alcohol (100%) was gradually replaced with methyl salicylate and eventually, pure methyl salicylate, in which they were left for at least 30 mins to 1 hour to clear. During processing, the cavity blocks were kept covered to avoid rehydration from the atmosphere. The cleared worms were mounted on microscope slides in thinned Canada balsam, after which they were examined with a light microscope at objective magnifications of ×4 and ×10, and eyepiece magnification of ×10.

3.4.2 Identification and measurement of worms

All worms were identified using the descriptions in Cheng (1973), Soulsby (1982), Shahin *et al*. (2011), Bootbooncho and Wongsawad (2012) and the helminth Database of the Museum of Natural History, London. Parasitic worm Experts in The Natural History Museum, London, South Australian Museum and the Institute of Biodiversity and Ecosystem Research, Sofia, Bulgaria were also consulted.

Measurements of worms were made using a meter rule and a calibrated ocular micrometer.

3.5 Data Analysis

Prevalence of infestation was determined and expressed as a percentage; mean intensity of infestation was determined using: total number of worms recovered divided by the number of infested birds (Bush *et al.*, 1997).

Chi-square was used to determine any association between intensity of infestation and sex of birds, and between intensity of infestation and seasons. Analysis of variance (ANOVA) was used to determine differences in the mean intensities of the worms. Values of $P \leq 0.05$ were taken to be significant

CHAPTER FOUR

4.0 RESULTS

4.1 Prevalence of Helminths and Crop content of *S. semitorquata*

Out of the 51 *Streptopelia semitorquata* examined, a total of 27 (52.94%) were infested by cestodes and no other helminth. Five species of cestodes were identified. Eleven (40.7%) of the birds were infested by *Raillietina* species 1, 9 (33.3%) by *Aporina* species, 2 (7.4%) by *Raillietina* species 2, 1 (3.7%) by *Raillietina* species 3 and 2 (7.4%) by *Fimbriaria* species (Table 4.1).

A total of 49 worms were recovered of which 26 (53.06%) were *Raillietina* species 1, 17 (34.69%) were *Aporina* species, 3 (6.12%) were *Raillietina* species 2, 1 (2.04%) were *Raillietina* species 3, and 2 (4.08%) were *Fimbriaria* species. The mean intensities of the helminths were: 2.4±0.398 for *Raillietina* species 1, 1.9±0.26 for *Aporina* species, 1.5±0.50 for *Raillietina* species 2, 1.0±0.00 for *Raillietina* species 3, and 1.0±0.0 for *Fimbriaria species*. There were no significant differences ($P>0.05$) between the mean intensities of the different species. The predilection site of all the *Raillietina* species and *Aporina* species was the ileum only, while *Fimbriaria* species was restricted to the duodenum (Table 4.1).

The crop contents observed were: Maize grains, cowpea, *Jatropha* seeds, rice, groundnuts, *Cummis melo* (Yoruba, Igbo: *Egusi;* Hausa*: Agushi*), unidentified grass seeds and ants.

Table 4.1: Prevalence, intensity and predilection site of helminths in *Streptopelia semitorquata* (n= 51)

S/N	Parasite	Number infested	Prevalence (%)	No. of parasites	Mean Intensity	Range	Site of recovery
1.	*Raillietina* species 1	11	21.56	26(53.06)	2.4±0.4	1-5	Ileum
2.	*Aporina* species	9	17.64	17(34.69)	1.9±0.3	1-3	Ileum
3.	*Raillietina* species 2	2	3.92	3(6.12)	1.5±0.5	1-2	Ileum
4.	*Raillietina* species 3	1	1.96	1(2.04)	1.0±0.0	1	Ileum
5.	*Fimbriaria* species	2	3.92	2(4.08)	1.0±0.0	1-2	Duodenum

***P* = 0.364, df= 4 (Not significant)**

4.2 Prevalence of Single and Mixed Infestations

Single infestation had a prevalence of 19 (38%) while 6 (12%) and 2 (3.2%) were infested with two and three species respectively (Table 4.2).

4.3 Helminth Infestation of Male and Female Birds

A total of 25 male and 26 female birds were examined out of which 15 (60.00%) males and 12 (46.10%) females were infested (Table 4.3 and Table 4.4). A total of 29 (59.18%) cestodes were recovered from the males and 20 (40.81%) from the females. Although more male birds harboured cestodes than the females, the difference was not significant ($P>0.05$)

4.4 Seasonal prevalence of helminths

Cestodes were recovered from *Streptopelia semitorquata* during the wet and dry seasons with the highest prevalence in the wet season (65.51%) and lowest (36.36%) in the dry season (Table 4.5). Chi-square test showed a significant difference in prevalence between wet and dry seasons. Odds Ratio revealed that birds were at a significantly increased risk of parasite infestation in the wet season (3.325 times more) than in the dry season.

4.5 Descriptions of the cestodes recovered

***Raillietina* species 1 (Plate III, Fig. 4.1)**

Body white, elongate, flattened, segmented; wider at posterior than anterior; gravid proglottid, 95.2 µm long, 277.2 µm wide. Genital pore single, 32.2 µm from anterior margin of the proglottid; whole worm 31,000 µm long.

Table 4.2: Prevalence of single and mixed infestation of helminths in *Streptopelia semitorquata* (n=51)

Infestation type	Parasite	Number of birds infested	Prevalence (%)
Single	*Raillietina* species 1	4	37.25
	Aporina species	1	

	Fimbriaria species	1	
	Raillietina species 1 *Aporina* species	5	
Double	*Aporina* species *Raillietina* species 2	1	11.76
	Raillietina species 1 *Aporina* species *Raillietina* species 3	1	
Triple	*Raillietina* species 1 *Aporina* species *Raillietina* species 2	1	3.92
	Total	**27**	**52.93**

Table 4.3: Prevalence of individual cestode species in male (n=25) and female (n=26) *Streptopelia semitorquata*

Sex	Parasite	Number infested	Prevalence (%)	Number of parasites
Male	*Raillietina* species 1	07	28.0	15
Female		04	15.4	11
Male	*Aporina* species	05	20.0	10
Female		04	15.4	07
Male	*Raillietina* species 2	01	4.0	02
Female		01	3.8	01
Male	*Raillietina* species 3	0	0	0
Female		01	3.8	01
Male	*Fimbriaria* species	02	8.0	02
Female		0	0	0

Table 4.4: Prevalence of cestode infestation in male and female *Streptopelia semitorquata*

Sex	Number of birds Examined	Number of birds Infested	Prevalence (%)
Male	25	15	60.00
Female	26	12	46.10
Total	51	27	52.94

χ^2 = 0.239, df 1, *P*>0.05 (statistically not significant)

Table 4.5: Seasonal prevalence of cestodes of *Streptopelia semitorquata*

Season	No. of birds examined	No. of birds infested	Prevalence (%)
Wet	29	19	65.51
Dry	22	8	36.36
Total	51	27	52.94

χ^2= 0.037, df 1, *P*<0.05 (significant)

***Aporina* species (Plate IVa, Fig. 4.2a; Plate IVb, Fig. 4.2b)**

Body white, elongate, flattened, segmented; wider at posterior than anterior; gravid proglottid 43.4 µm long, 490 µm wide. Anterior extremity, 21 µm wide; whole worm 23,500 µm long.

***Raillietina* species 2 (Plate V, Fig. 4.3)**

Body white, elongate, flattened with inverted funnel-shaped segments overlapping one another. Anterior proglottid 14 µm long, 35 µm wide; posterior proglottid 49 µm long, 67.2 µm wide. Whole worm 4000 µm long.

***Raillietina* species 3 (Plate VI, Fig. 4.4)**

Body white, elongate, dorso-ventrally flattened, finely segmented; wider posteriorly than anterioriorly; proglottid 7 µm long, 238 µm wide. Anterior extremity of worm 39.2 µm wide. Proglottids arranged to have saw-edged appearance.

***Fimbriaria* species (Plate VII, Fig. 4.5)**

Body white, elongate, sub-cylindrical, with folded expansion anteriorly; 7 µm wide at anterior end, 77 µm wide at folded expansion.

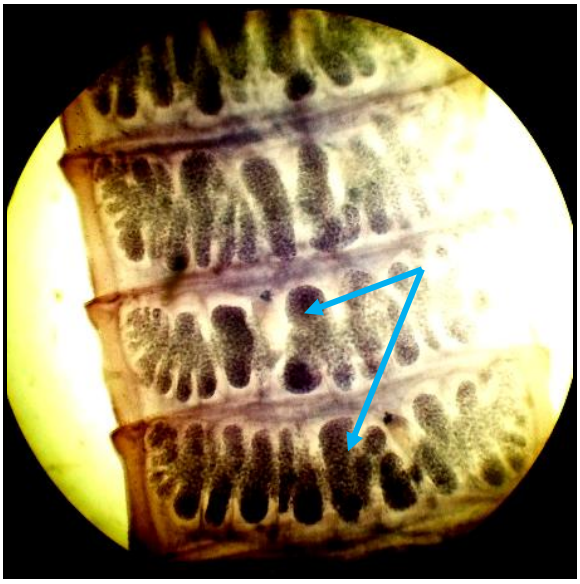


Plate III: Gravid proglottides of *Raillietina* species 1 showing egg pouches (arrows) ×40

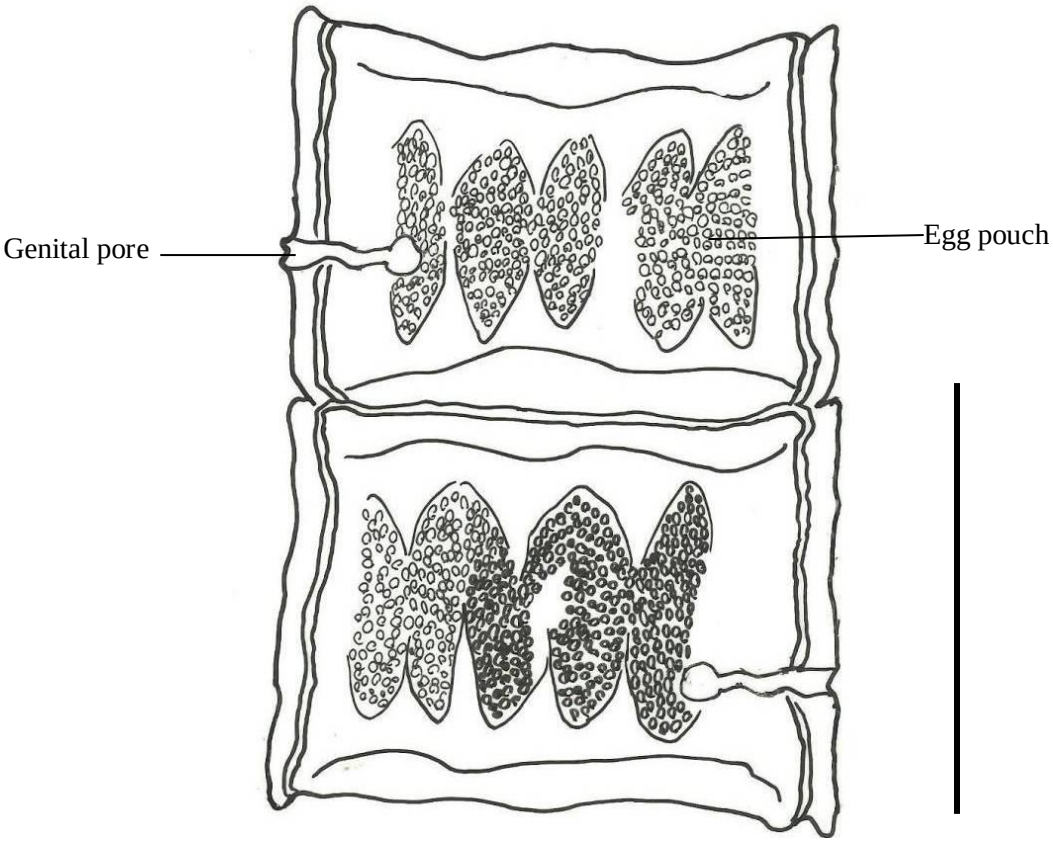


Figure 4.1: *Raillietina* sp. 1. Internal structure of gravid proglottides showing terminal genitalia and egg pouches. Magnification: ×580, *Scale-bar*: 100 mμ

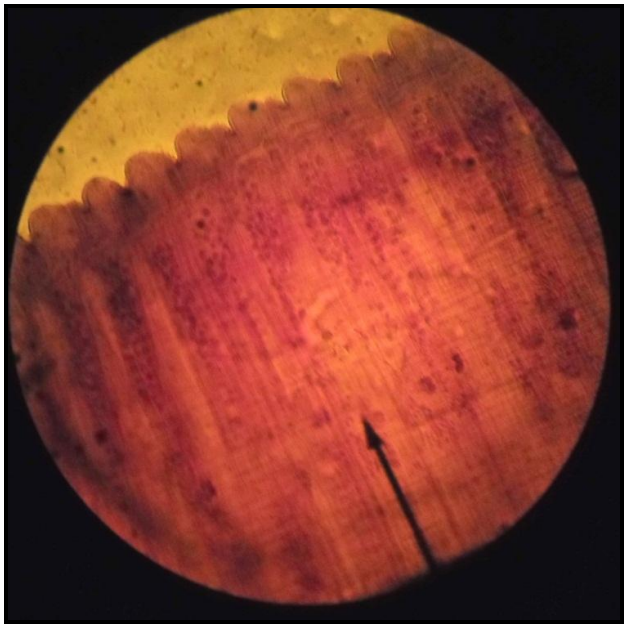


Plate IVa: Mature proglottides of *Aporina* species showing contour edges of the proglottides and testes ×40

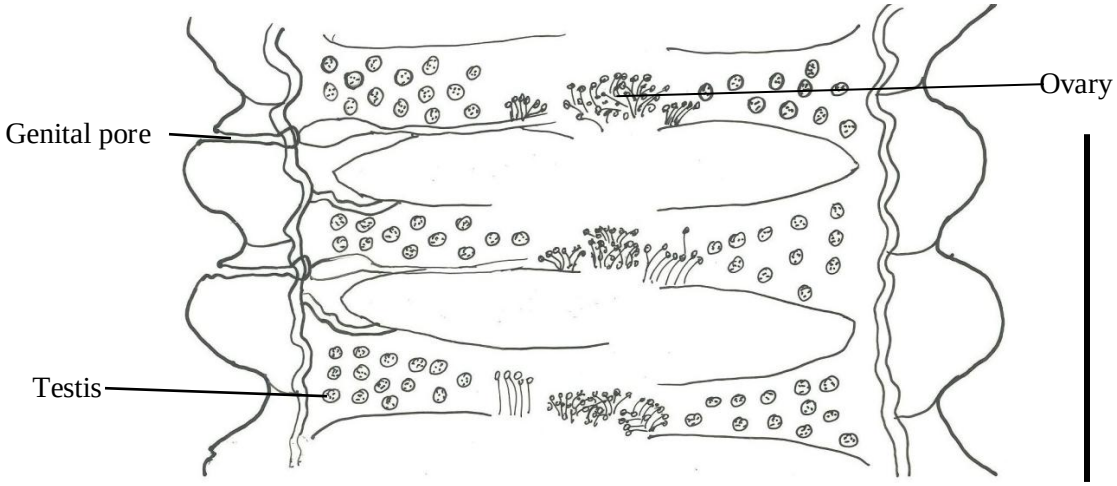


Figure 4.2a: *Aporina* sp. Internal structure of gravid proglottides showing terminal genitalia, testes and ovaries. Magnification: ×460, *Scale-bar*: 100 mμ

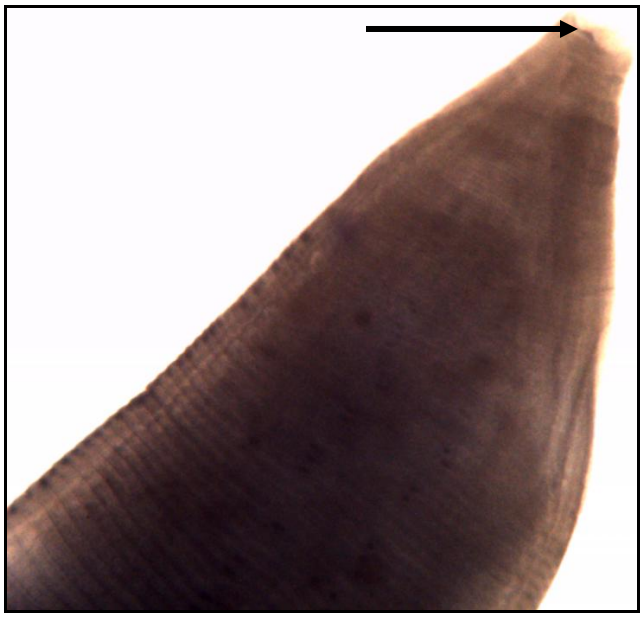


Plate IVb: Scolex and anterior proglottides of *Aporina* species
Note the suckers at the anterior end (arrow) ×100

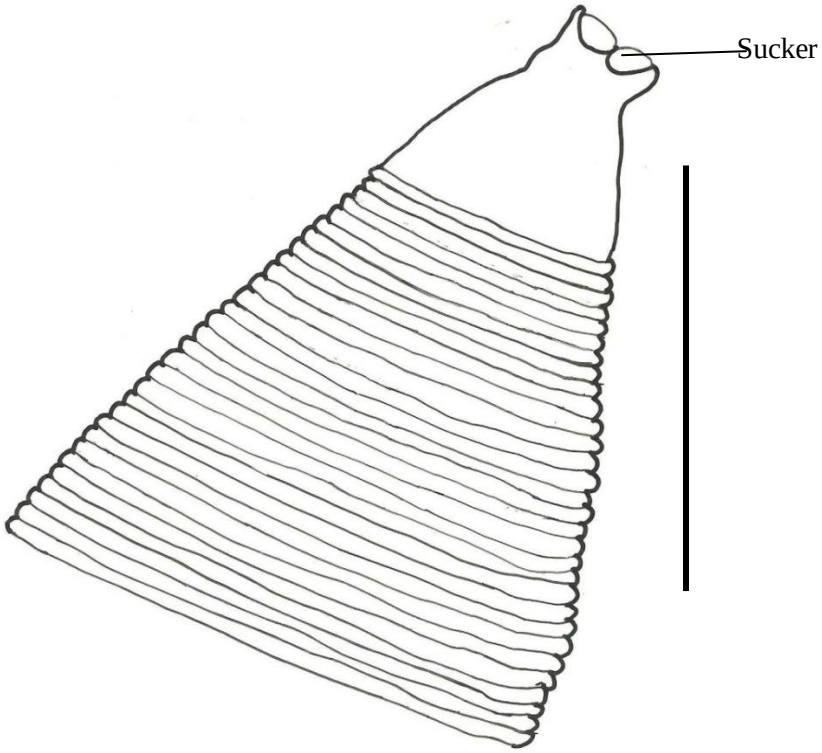


Figure 4.2b: Anterior portion of *Aporina* sp. showing suckers and anterior proglottides.
Magnification: ×360, *Scale-bar*: 25 mμ

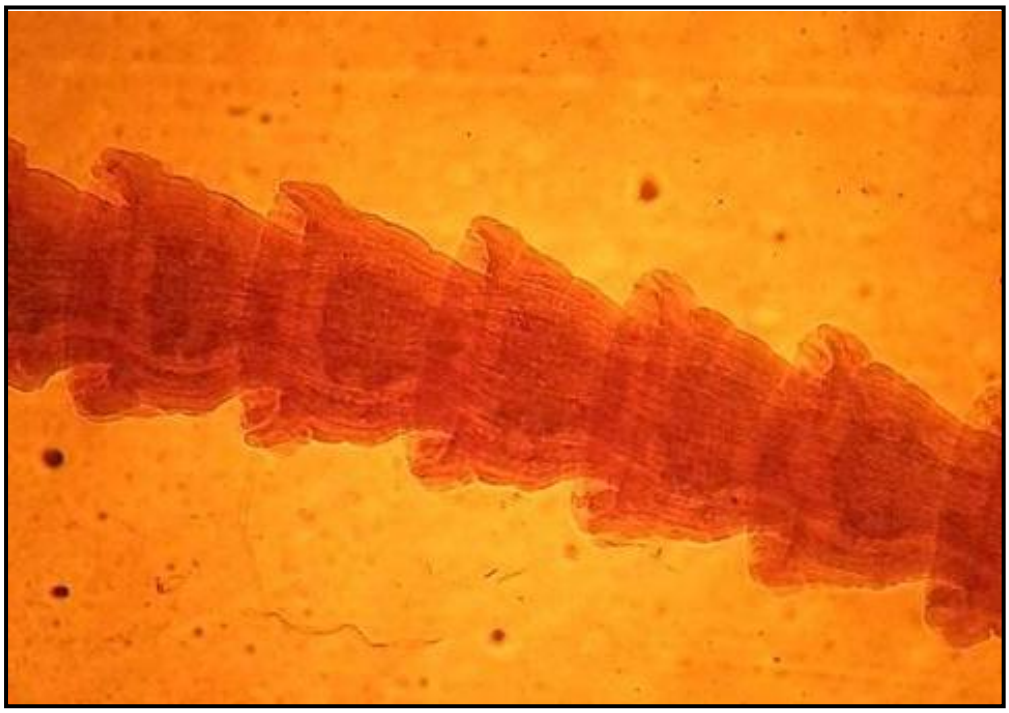


Plate V: Some mature proglottides of *Rallietina* species 2. Note the inverted-funnel-like proglottides. Magnification: ×40

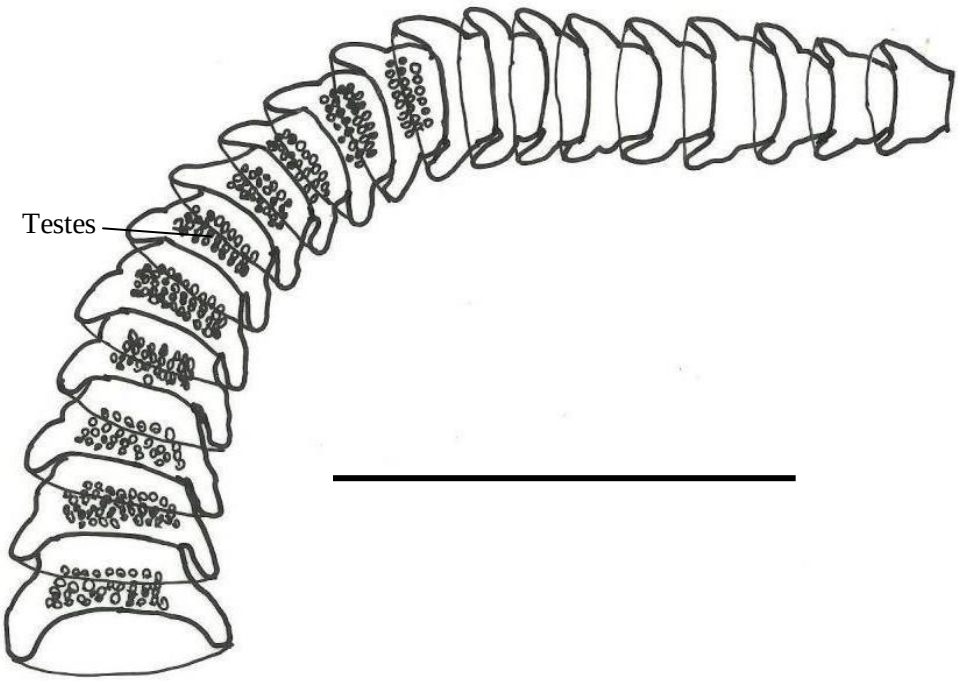


Figure 4.3: *Raillietina* sp. 2. Internal structure of the inverted funnel-like mature proglottides showing testes. Magnification: ×200, *Scale-bar*: 100 mμ

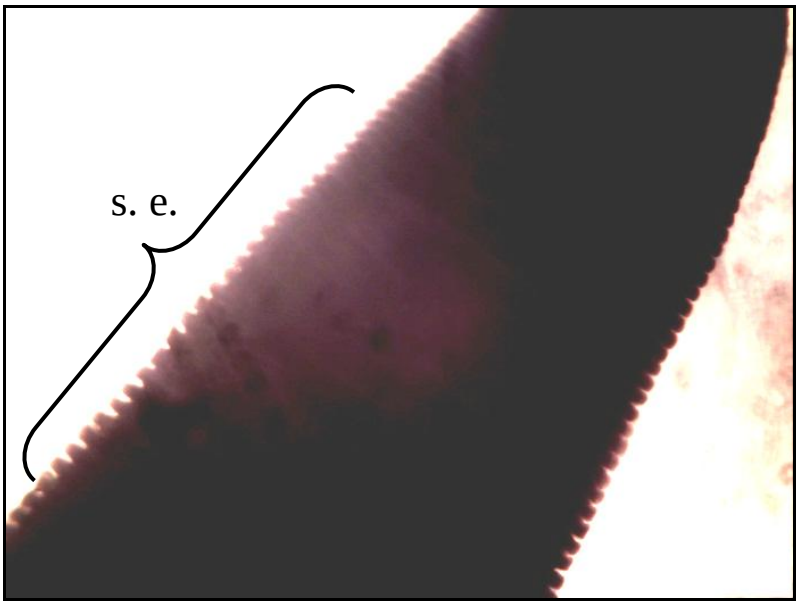


Plate VI: Proglottides of *Raillietina* species 3
Note the saw-like edge (s. e.) formed by the proglottides ×100

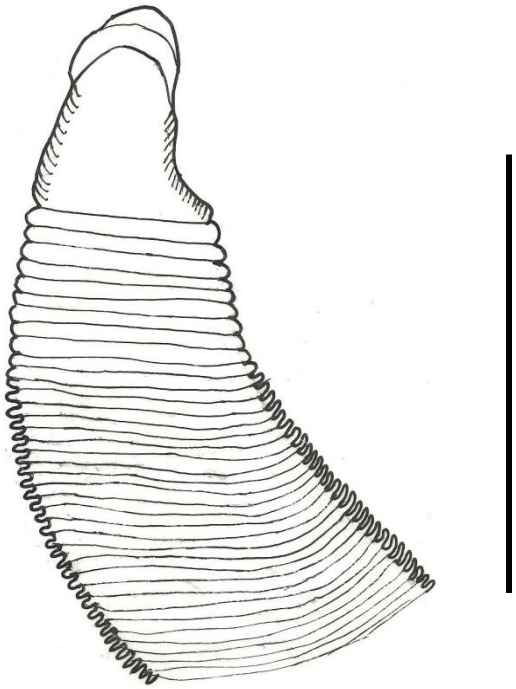


Figure 4.4: *Raillietna* sp. 3. The anterior proglottides showing the scolex and characteristic saw-like edge of proglottides. Magnification: ×260, *Scale-bar*: 200 mμ.

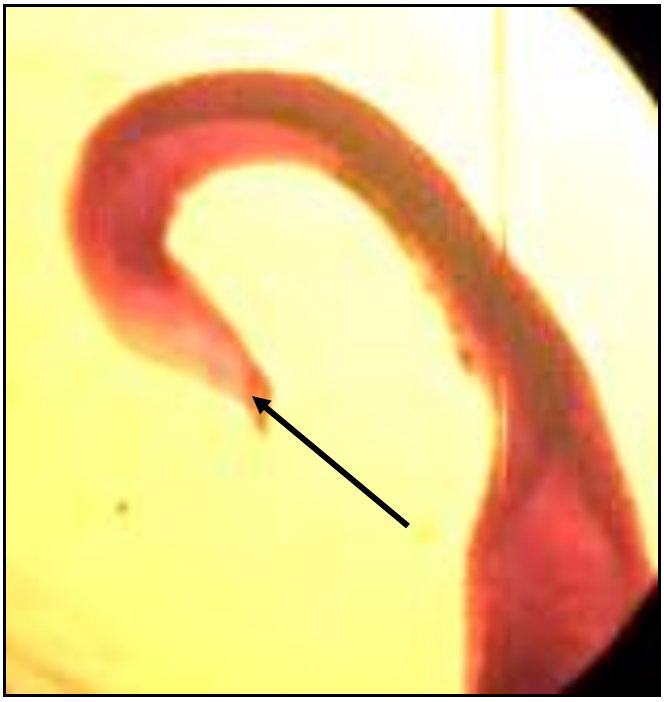


Plate VII: Anterior end of *Fimbriaria* species. Note the pseudo-scolex (arrowed) Magnification: ×40

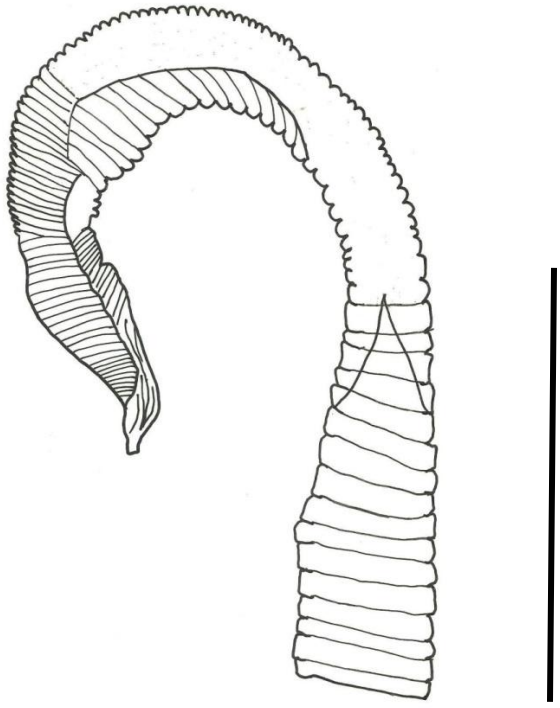


Figure 4.5: *Fimbriaria* sp. Internal structure showing the pseudo-scolex and proglottides. Magnification: ×110, *Scale-bar*: 25 mμ

CHAPTER FIVE

5.0 DISCUSSION

This is apparently the first study of the helminths of *Streptopelia semitorquata* in the Zaria area, and probably in northern Nigeria. Infestation data will therefore be compared with those from other species of pigeons, rather than of *S. semitorquata*.

The identification and measurements of the cestodes recovered in this study were mostly based on the findings of other workers. The scolices, which are the main structures for identification, were not available in some worms. Some gross morphological features of gravid proglottides, with the characteristic shapes and measurements of mature ones were additional features used for identification. The putative three species of *Raillietina* recovered from *S. semitorquata* have been described in this report using mainly the characteristics of their proglottides. It would have been more preferable to describe the characteristics of their scolices, along with those of the proglottides but this was not possible because the scolices were not clearly visible in some cases due to contraction; the scolices in other worms were damaged or inadvertently lost during worm recovery. Contraction might have arisen due to the fact that worms had died and not in a suitable state for fixation and further processing for microscopy. As a result of the difficulty of catching the birds alive, the majority of them were shot and killed as mentioned earlier. In most cases, the dead birds had to be refrigerated overnight before dissection; this rendered the worms unsuitable for processing because they had died. The morphology of the scolex of cestodes is central to their identification but because these were not clearly seen, *Raillietina* species were designated species 1, 2 and 3.

Raillietina species have been recovered from pigeons by many workers, including an unidentified species from *Streptopelia semitorquata* by Mariaux (1994) in Ivory Coast. The morphological features and some measurements of *Raillietina* and *Aporina* species in the present study agree with the descriptions of Soulsby (1982), Lalchandama (2009), Shahin *et al*. (2011) and Bootbooncho and Wongsawad (2012). Furthermore, the pseudo-scolex of *Fimbriaria* species with a folded expansion found in the present study also concurs with the description of Soulsby (1982).

The overall prevalence of cestodes (which were the only helminths recovered) in *Streptopelia semitorquata* recorded in this study (52.9%) is slightly higher than the values of 48.3% and 43.4% respectively recorded by Adang (2008) and Audu *et al.* (2004) in domestic pigeons in Zaria. It is also higher than the prevalence reported by Gadzama *et al*. (2005) in the Laughing Dove in Zaria as well as 43.8% and 50.0% recorded in the Black-billed Wood Dove and Vinaceous Dove (44.0%) respectively, by Adang (2008) in Zaria. The differences between the prevalence of helminths in this study and those of other researchers may be attributed to the food and feeding habits of the columbids and probably availability of intermediate hosts containing the infective stages of the parasites. However, higher prevalences of helminth infestation of doves (62.5%, 57.9% and 69.2%) were obtained by Dede and Richards (1998), Oniye (2000) and Adang (2008) respectively in the Laughing Dove in North-East Nigeria, Zaria and Zaria respectively. Higher prevalences were also obtained in the Mourning Dove and Speckled Pigeon (100% and 75%, respectively) by Dede and Richards (1998) in North-Eastern Nigeria and in the Speckled Pigeon (60.7%) by Adang (2008) in Zaria.

The differences in prevalence may probably have also been influenced by the number of birds examined as well as the environmental conditions within the study area. This study was conducted for 12 months, which might not have been long enough to collect sufficient infestation data, whereas Adang *et al*. (2008) conducted their study for 24 months in Zaria. Host identity may also be responsible for the differences observed. One other factor that affected the number of birds caught for this study was the difficulty of catching them. The traps used were not very effective as it was only able to catch a few birds. A hunting rifle was used to shoot the birds in some cases but this method is not very desirable as it killed the birds. It is preferable to kill the birds in the laboratory so that any parasites can be retrieved alive for fixation and preservation. Dead helminths do not generally make good preparations for microscopy, as has been mentioned earlier.

Some of the cestodes identified in this study (*Raillietina* and *Aporina* species) have been reported in columbids by various researchers in Zaria, and in other parts of the world (Olsen and Braun, 1980; Conti and Forrester, 1981; Mushi *et al*., 2000; Barrows *et al*., 2002; Glass *et al*., 2002; Foronda *et al*., 2004; Bean *et al*., 2005; Senlik *et al*., 2005). However, *Raillietina* species 3 and *Fimbriaria* species have not previously been reported in doves in Zaria; these two cestodes are therefore being reported in the study area for the first time.

The prevalence of *Raillietina* species 2 in this study (6.12%) (Zaria) was lower than the 7.2% and 59.4% obtained in Eqypt by Lauzao *et al*. (1985) and Shahin *et al*. (2011) respectively, the 37.8% obtained by Abebe *et al*. (1997) in Ethiopia, the 9.37% obtained by Ramadan and Abouzanda (1989) in Saudi Arabia, the 25.03% obtained by Samad *et al*. (1986) in Bangladesh and the 12% obtained by Poulsen *et al*. (2002) in Ghana. The differences in infestation data obtained between this and the other studies might be due to differences in climatic conditions and host identity.

It is surprising that nematodes were not recovered in this investigation since they are known to be quite common. For instance, Oniye *et al*. (2000) reported a prevalence of 1.53% for nematodes in *Streptopelia senegalensis*. Atsineke and Banke (2006) and Basit *et al*. (2006) also isolated nematodes from *Columba livia domestica*. It is likely that the environment from which the birds were trapped or captured in this study was not contaminated by nematode eggs. It is also possible that nematodes occurred but might have been missed during examination. Nonetheless, this study agrees with that of Dede and Richards (1998) who also did not recover nematodes in their study on columbids in North-Eastern Nigeria. They similarly suggested that the environment was probably not contaminated by nematode eggs; that there was no direct feeding link between the nematodes and columbids.

Raillietina species were the dominant cestodes recovered in this study. This concurs with the findings of Shahin *et al*. (2011) who reported several species of *Raillietina* in a research conducted in Egypt on *Gallus gallus domestica*. The unidentified ants observed in the crop contents of *S. semitorquata* in this study are likely to be intermediate hosts of some of the cestodes recovered. Soulsby (1982) reported that ants of the genera *Theidole* and *Tetramorium* served as intermediate hosts in the transmission of helminths.

Some of the cestodes recovered in this study have also been reported in columbids (Oniye *et al*., 2000) in Zaria, and elsewhere. This is an indication of a wide distribution of the parasites among

different hosts and geographical zones (Kennedy, 1975). The predilection site for all the cestodes in this study, the small intestine, particularly the duodenal loop, and ileum, suggests site-specificity. This implies that these areas present a nutritionally rich and conducive environment for the parasites.

This study revealed that single infestation (i.e. with one species of cestode) was more common than infestation with mixed cestode species. This gradation of infestation suggests that food consumed at a particular time may determine the establishment of single or mixed infestation, or that the first parasite to establish in the host quickly reproduces and occupies space thereby inducing a host response which may prevent the establishment of others (Lalchhandama, 2009). Furthermore, the host's diet may determine the establishment of single or mixed infestation among helminths. Gause's law of competitive exclusion states that "complete competitors cannot coexist". If two populations of the same species attempt to occupy the same niche, eventually, either one will replace the other or their characteristics will change, such that their niches no longer overlap (Crompton, 1973; Esch *et al*., 1993). This may account for the low prevalence of double and triple infestations between the cestodes, in this study. Dede and Richards (1998) also found single infestation to be the most common. However, Audu *et al*. (2004) reported double infestation (cestodes and other helminths) to be higher than single infestation and triple infestation. Atsineke and Banke (2006) also reported mixed infestations to be higher than single infestations.

Although infestation of male birds was higher than of females, the difference was not statistically significant, indicating that both sexes were equally exposed to the acquisition of helminth infestations particularly as their feeding and food habits are not different. It was observed that both male and female birds generally move and feed together and would therefore be equally exposed to the eggs and intermediate hosts of these parasites. Pigeons and doves are known to pair up for life (monogamous) (Lack, 2003). Glass *et al*. (2002) stated that the sex of doves had no effect on the abundance of helminths because both male and female birds use the same habitat for breeding duties in the same manner. The normal physiological differences between male and female animals do not appear to have played a role in the degree of infestation of male and female *S. semitorquata*.

Farming activities in Zaria during the wet season may have exposed the eggs of cestodes that are hidden below the surface of the soil for the birds to ingest particularly as they visit newly cultivated farms in a large flock to feed on spilled grains. The higher prevalence observed in the wet season could be due to the fact that insects and other invertebrates which serve as food to the birds, and probably habour the intermediate hosts of these parasites are more abundant during wet season than in the dry season. This could also be attributed to the fact that more birds were captured and examined in the wet season than in the dry season. Shukla *et al*. (2012) also observed that infestation of helminths was higher in the wet season than in the dry season and said that temperature as well as the feeding activities was the major controlling factors in helminth infestation of the birds.

CHAPTER SIX

6.0 CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

The gastro-intestinal helminths of *S. semitorquata* in Zaria are:

1. *Raillietina* species 1
2. *Raillietina* species 2
3. *Raillietina* species 3
4. *Aporina* sp.
5. *Fimbriaria* sp.

Streptopelia semitorquata is a new host record for the *Raillietina* and *Aporina* species in the Zaria area, to the best of my knowledge.

One species of *Fimbriaria* is reported for the first time in doves in the Zaria area.

Zaria is a new geographical location for the cestodes of the Red-eyed dove.

The sex of *S. semitorquata* has no effect on the prevalence of their gastro-intestinal helminths.

Cestode infestation is higher in the wet than in the dry season.

6.2 Recommendations

Comparative studies on the helminths of *Streptopelia semitorquata* and other columbids should be carried out.

More resources for the identification of the parasitic worms of *S. semitorquata* should be acquired and made readily available.

The helminths of the Red-eyed dove should be further investigated over a longer period of two or more seasons.

The great difficulty experienced in catching the birds calls for the design and development of more efficient and bird friendly techniques for trapping the Red-eyed dove.

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