# ECTOPARASITES AND GASTRO-INTESTINAL HELMINTHS OF *STREPTOPELIA SENEGALENSIS* LINNAEUS, 1766 (LAUGHING DOVE) AND *COLUMBA LIVIA DOMESTICA* GMELIN, 1789 (DOMESTIC PIGEON) IN ZARIA, NIGERIA

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**JULY, 2018**

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**DEPARTMENT OF ZOOLOGY,**

**FACULTY OF LIFE SCIENCES,**

**AHMADU BELLO UNIVERSITY,**

**ZARIA, NIGERIA**

**JULY, 2018**

## DECLARATION

I declare that the work in this dissertation entitled ECTOPARASITES AND GASTRO-INTESTINAL HELMINTHS OF *STREPTOPELIA SENEGALENSIS* LINNAEUS, 1766 (LAUGHING DOVE) AND *COLUMBA LIVIA DOMESTICA* GMELIN, 1789 (DOMESTIC PIGEON) IN ZARIA, NIGERIA has been carried out by me in the Department of Zoology. The information derived from literature has been duly acknowledged in the text and a list of references provided. No part of this dissertation was previously presented for another degree or diploma at this or any other institution.

Hamza Joseph _____ _____

Signature Date

## CERTIFICATION

The dissertation entitled ECTOPARASITES AND GASTRO-INTESTINAL HELMINTHS OF *STREPTOPELIA SENEGALENSIS* LINNAEUS, 1766 (LAUGHING DOVE) AND *COLUMBA LIVIA DOMESTICA* GMELIN, 1789 (DOMESTIC PIGEON) IN ZARIA, NIGERIA by HAMZA JOSEPH meets the regulations governing the award of the degree of M.Sc. Zoology of the Ahmadu Bello University, Zaria, and is approved for its contribution to knowledge and literary presentation.

| | | |
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# DEDICATION

To God the Father Almighty, and to my parents Late Rev. Joseph H. Mbaya, and Mrs. Ruth Joseph Mbaya.

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## ABSTRACT

Seventy one (71) each of *Streptopelia senegalensis* and *Columba livia domestica* were trapped/bought from the wild and the market, anaesthetised and examined for ectoparasites and gastro-intestinal helminths. 7(9.86%) *S. senegalensis* and 43(60.56%) *C. livia domestica* were infested with ectoparasites. *Streptopelia senegalensis* was infested by 2 species, *Goniodes* species (7.04%) and *Columbicola columbae* (2.82%) while *C. livia domestica* was infected by three species, *Goniodes* sp. (25.35%), *Columbicola columbae* (19.72%) and *Pseudolynchia caraniensis* (11.27%). Among the gastro-intestinal helminths recovered was the nematode, *Ascaridia galli* (25.35%) from *C. livia domestica.* The cestodes recovered included five morphologically distinct species of *Raillietina* (species 1, 2, 3, 4 and 5) recovered from both bird species with prevalences of 9.86%, 8.45%, 4.23% 2.82% and 2.82% respectively, in *S. senegalensis,* and 5.63%, 5.63%, 4.23%, 4.23% and 5.63% respectively, in *C. livia domestica.* Two additional cestodes, *Killigrewia delafondi* and *Choanotaenia* sp. were recovered from the two bird species with respective prevalences of 4.23% and 5.63% in *S. senegalensis,* and 2.82% and 4.23% in *C. livia domestica. Streptopelia senegalensis* had total/overall ectoparasite prevalences of 5.63% and 4.23% in the wet and dry seasons, and *C. livia domestica* had prevalences of 29.58% and 30.99% in wet and dry seasons, respectively. Similarly, seasonal overall prevalence of cestodes (23.94% and 28.17%) occurred in wet and dry seasons in *S. senegalensis,* and (22.54% and 9.89%) in *C. livia domestica.* Meanwhile, the only nematode recovered, and only from *C. livia domestica,* occurred in both the wet and dry seasons with prevalences of 18.31% and 7.04% respectively. Males of *S. senegalensis* and *C. livia domestica* had respective ectoparasite prevalences of 7.32% and 22.54%, while females had prevalences of 13.33% and 38.04% respectively. Cestodes had prevalences of 33.80% and 9.86% in males, and 18.31% and 22.54% in females of *S. senegalensis* and *C. livia domestica* respectively. A nematode prevalence of 7.04% in male and 18.31% in female *C. livia domestica* was recorded. The weight of the two birds did not appear to influence parasite prevalence in either the wet or the dry season. Ectoparasite and nematode prevalences with respect to *C. livia domestica* were significantly higher than those of *S. senegalensis* ($P<0.05$) but there were no significant differences in relation to the prevalences of the cestodes in both bird species ($P>0.05$). It is recommended that more studies be carried out on the parasitic fauna of *S. senegalensis* and *C. livia domestica* for a longer period of time, spread over at least two years to get a clearer picture of seasonal parasite infestation. The market or home cages of the domestic pigeons should be cleaned routinely to minimize reinfestation by ectoparasites and helminths.

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## LIST OF ABBREVIATIONS AND THEIR MEANINGS

| ABBREVIATIONS | MEANING |
|---|---|
| **µm** | Micrometer |
| **ab** | Abdomen |
| **bl** | Blunt end |
| ***C.*** *livia domestica* | *Columba livia domestica* |
| **m** | meters |
| **ec** | Egg capsule |
| *et al.,* | And others |
| **g** | Grams |
| **GIT** | Gastro-intestinal tract |
| **gp** | Genital pore |
| **he** | Head |
| **lg** | legs |
| **mm** | Millimeter |
| **mo** | Mouth |
| **NE** | Number examined |
| **NI** | Number infested |
| **No** | Number |
| **p** | Prevalence |
| **rs** | Rostellum |
| ***S.*** *senegalensis* | *Streptopelia senegalensis* |
| **sc** | Sucker |
| **SD** | Standard deviation |
| **sp.** | Species (Singular) |
| **spp**. | Species (Plural) |
| **sx** | Scolex |
| **tr** | Thorax |
| **wg** | Wings |
| **yp** | Young progglottids |

$\chi^2$ Chi-square

## DEFINITION OF TERMS

In general the term '**infestation**' refers to parasitic diseases caused by animals such as arthropods (i.e mites ticks and lice) and worms, but excluding conditions caused by protozoa, fungi, bacteria, and viruses which are called infections. https://en.m.wikipedia.org>wiki>infest

**Infestation** Parasitic attack or subsistence on the skin and or its appendages, as by insects, mites or ticks; sometimes used to denote parasitic invasion of the organs and tissues as by helminths. http://www.biology-online.org

**Infection** is caused by microorganisms or germs like viruses, protozoa and bacteria. They enter the internal body tissues and then multiply disrupting the normal body functions.

**Infection** is the process or the state wherein an infectious agent (such as pathogenic microrganisms, viruses, prions, viriods, nematodes and helminths) invade and multiply in the body tissues of the host.

# CHAPTER ONE

## 1.0 INTRODUCTION

Birds are widely distributed worldwide and are found in all the seven continents. They live and breed in terrestrial habitats (Newton, 2003). It is believed that the highest bird diversity occurs in the tropical regions of the world. It was also earlier thought that high diversity was as a result of higher speciation rates in the tropics (Serle *et al*., 1977). Birds are one of the largest source of animal protein eaten by humans (Oladele *et al.,* 2012). Nineteen species of Doves and pigeons (Family: Columbidae), were identified in Nigeria, of which fifteen occur in the Northern Guinea Savannah (Elgood *et al*., 1994).

The Laughing dove, *Streptopelia senegalensis* is distinguished from all other doves by the presence of a black spotted reddish fore neck, head is vinous, the mantle brown, the rump dark-grey and the underparts are vinous, becoming white on the belly (Serle *et al*., 1977). It is called the Laughing dove due to its distinctive coo vocalization that is reminiscent of human laughter.

This species is semi-tame and is abundant in villages and towns, spending much of its time on the ground, feeding on fallen grains or seeds (Adang *et al.,* 2008). According to Oniye *et al*. (2001), doves are hunted and eaten in Nigeria but recently the intensity has increased probably due to the harsh economic situation, coupled with increased demand for protein. Its wide acceptability as a cheap substitute to other animal-protein sources might explain why roasted Laughing dove is sold at ‘’suya’’ or barbecue spots in Zaria and other urban centres in northern Nigeria.

Domestic pigeons, *Columba livia domestica* are ubiquitous and associated with humans in many places around the world. These pigeons often occupy the premises of people

and contaminate surroundings with their droppings (Sivajothi and Sudhakara, 2015). They are used by humans as food, experimental animals, pets, and as cultural and religious symbols (Serle *et al*., 1977). Domestic pigeons do not migrate but if taken far away and released, they return to their nest from long distances, due to their good homing ability.

Birds can be parasitized by a wide variety of ectoparsasites such as lice, ticks, fleas, bugs; and helminths such as cestodes, nematodes and trematodes (Sivajothi and Sudhakara, 2015). According to Khater (1993), helminths are said to be the major cause of ill-health and poor performance in birds.

Pigeons can carry many parasites and pathogens to different flocks, thereby constituting a major source of infection and transmission of diseases (Marques *et al*., 2007 and Opara *et al*., 2012). They can also serve as a source for different zoonotic diseases (Soulsby, 1982). Parasitic infestations in pigeons and doves can be affected by food supply, geographic location, climatic conditions and the availability of intermediate hosts (Sivajothi and Sudhakara, 2015).

Columbids feed mainly on seeds, fruits or other food items small enough for them to swallow whole; they also supplement their diet with insects, slugs, maggots, snails and earthworms (Adang, 1999). These food items have been implicated as sources of helminth infestation of birds (Soulsby, 1982). For example, ants in the orders Pheidole and Tetramorium were reported to serve as intermediate hosts in the transmission of *Raillietina* species (Bolton, 1973 as cited by Adang *et al*., 2009b), while many larvae and adults of stored grain insect pests such as *Tenebrio* and *Tribolium* species, have been implicated as intermediate hosts of *Hymenolepis* species. (Chang, 1973, Allen, 2014). It is therefore safe to assume that birds may acquire helminth infestations from

their diets particularly as the diets of birds according to Malhotra and Capoor (1980) have been known to a greater extent to determine their parasitic fauna.

Nematodes can migrate from the intestine to the liver, trachea and lungs and back to the intestine to develop (Michel, 1974). While in these tissues, the parasites do not only cause intestinal obstruction, they also cause severe haemorrhagic enteritis, and consequently reduced egg production (Michel, 1974, Natala *et al*., 2009). Domestication and intensive rearing of pigeons have increased the awareness of clinical diseases and mortality from heavy infestation with endoparasites (Schock and Cooper 1978, Natala *et al*., 2009).

### 1.1 Statement of the Research Problem

In Nigeria, investigations on the parasites of columbids are scanty compared to the large volumes of information available on the parasites of other birds such as chicken, guinea fowl, turkey and duck (Abdu *et al*., 2002). Laughing Doves have potentials for domestication (Haruna *et al*., 1997). Domestic pigeons and Laughing doves are among the largest sources of animal protein eaten by people in Zaria, therefore there is need for extensive study on their ectoparasite and helminths for their management and documentation.

.

## 1.2 Justification

This study will provide comparative information on the prevalence, and species composition of ectoparasites and gastro-intestinal helminths of *Streptopelia senegalensis* (Laughing doves) and *Columba livia domestica* (Domestic pigeons) in Zaria, Nigeria.

In addition, information on the prevalence, composition of ectoparasites and gastro-intestinal helminths species found will provide further insight into the development of possible control measures, which may help in enhancing the survival of the birds and complement efforts towards public enlightenment in Zaria, Nigeria for conservation.

Wild and domestic birds undoubtedly contribute immensely to the daily supply of protein consumed in Zaria and other urban centers in northern Nigeria. Therefore, knowledge of their ectoparasites and helminths is necessary for the management of the domesticated ones (Basit *et al.,* 2006).

## 1.3 Aim

The aim of this study was to carry out a comparative study on the occurrence of ectoparasites and gastro-intestinal helminths of Laughing doves and Domestic pigeons around Zaria.

## 1.4 Objectives

The specific objective of the study are:

I. To investigate the prevalence of ectoparasites and gastro-intestinal helminths of *Streptopelia senegalensis* and *Columba livia domestica* in Zaria.

II. To determine the species composition of ectoparasites and gastro-intestinal helminths of *S. senegalensis* and *C. livia domestica* in Zaria, Nigeria.

III. To determine the seasonal occurrence and variation of ectoparasites and gastro-intestinal helminths of *Streptopelia senegalensis* and *Columba livia domestica.*

IV. To evaluate the association between the sex of birds and prevalence of infestation.

V. To compare the prevalence and species composition of ectoparasites and gastro-intestinal helminths of *Streptopelia senegalensis* and *Columba livia domestica.*

## 1.5 Hypotheses

I. Ectoparasites and gastro-intestinal helminths do not infect *Streptopelia senegalensis* and *Columba livia domestica* in Zaria.

II. The ectoparasites and gastro-intestinal helminths of *Streptopelia senegalensis* and *C. livia domestica* are not assorted.

III. The ectoparasites and gastro-intestinal helminths of *Streptopelia senegalensis* and *Columba livia domestica* do not show seasonality.

IV. The prevalence of ectoparasites and gastro-intestinal helminths in *Streptopelia senegalensis* and *Columba livia domestica* is not associated with the sex of the birds.

V. Prevalence and species composition of ectoparasites and gastro-intestinal helminths between *Streptopelia senegalensis* and *Columba livia domestica* do not vary significantly.

# CHAPTER TWO

## 2.0 LITERATURE REVIEW

### 2.1 The Columbids

Pigeons and doves belong to the order Columbiformes, Family: Columbidae. There are about five subfamilies within the Columbidae, 42 genera and 308 species. Columbids are easily recognizable and are more or less distributed world-wide (although they are not found in Antarctica, Sahara Desert (except during migration) and the Arctic) (Lack, 2003). They live in almost all types of terrestrial habitat from desert to dense forest and large urban areas, they are stocky, medium-sized and range from 15 to 75cm long. According to Serle *et al.* (1977), many have iridescent feathers on the neck, breast, back, wings and face; strong-winged, fast-flying birds with small heads, slender bills, short strong legs and soft, usually delicately coloured plumage. They range from solitary to extremely social. (Serle *et al.*, 1977).

Comparatively pigeons are larger than doves and are stoutly built with rounded or s quare tails. The doves are slender in form with long graduated tails: call generally cooing in character; this varies from species to species and is useful in identification (Serle *et al.*, 1977; Cheke, 2005).

Pigeons and doves feed on a wide variety of seeds or grains as well as fruits; they also supplement their diet with insects and other invertebrate organisms.

### 2.2 The Laughing Dove (*Streptopelia senegalensis*)

This dove is distinguished from all other doves by the presence of a black-spotted reddish fore neck, venous head, brown mantle, dark grey rump, grey-blue wing-coverts, conspicuous at rest and in flight and are found numerous in villages and towns (Serle *et al.*, 1977). It builds a nest of flimsy platform of twigs rootlets and tendrils, built in

small trees at a height of 1.2 to 5.4m (4 to 18ft) and lays white eggs (Serle *et al.*, 1977; Cheke, 2005).

### 2.3 The Domestic Pigeon (*Columba livia domestica*)

Domestic Pigeons are highly variable, urbanized and domesticated. They vary from blue-grey, pale cinnamon, and blackish to white in colour, and they inhabit bare rocky hills and buildings. Male and female are similar (in appearance) and they use ledges high on buildings as nest site, building a nest in a corner or in the angle between horizontal and vertical stones. They take flight with a clatter of wings, and often fly low, over the ground. They usually fly in pairs, small parties or large flocks. They feed on the ground in rock-strewn terrain and in field, sometimes mixing with other pigeons and doves (Goodwin, 1983).

### 2.4 Biology and Life-cycle of Columbids

Pigeons and doves are monogamous, and many have the same mate from year to year. They have numerous displays that are performed either on the ground or in the air. For example, while on the ground, males of some species squat, lift their tail, lower their head, twitch their wings and scratch the ground with their feet while calling. Some species have aerial displays that usually involve wing claps (most forest and ground living species do not have aerial displays). Aerial displays are used in courtship and to indicate territoriality. During pre-copulation display, a male inflates his crop, bows, spreads his tail feathers, pirouettes and calls. This display varies among species. Some species of pigeons and doves also engage in courtship feeding and/or mate guarding (Baptista *et al.*, 1992).

Breeding is triggered by food availability and photoperiod and can be seasonal or year-round, depending on the species. Some columbids breed colonially, some solitarily. The males bring nest material to the females who build the nest. The nest is built on a crevice, cliff, tree or the ground. Columbids will re-use nests and will build nests on top of abandoned bird nests. Nest building usually lasts two to four days and sites are defended (Wells and Wells, 2001).

Clutch size is usually one to two eggs (occasionally three). Frugivorous species usually lay only one egg. The eggs are white or buff coloured and unmarked. Both males and females incubate, but females usually spend more time incubating than males. Incubation lasts 11 to 30 days, and hatching can be either synchronous or asynchronous. Chicks fledge in 10 to 36 days (earlier if disturbed) and may continue to receive food from their parents for 30 to 40 days (Gibbs *et al.*, 2001).

Breeding pairs can have up to five broods in one breeding season. Their short breeding cycle allows pigeons and doves to have more broods to compensate for their small brood sizes and relatively high rates of susceptibility to predation. Fledglings grow their adult plumage a few months after fledging and reach sexual maturity in 6 to 12 months (Lack, 2003).

The chicks are usually fed with crop-milk for three to four days and are then fed with seeds and fruit, however, some continue to be fed with crop-milk even after they have fledged. Crop-milk is made in the crop of the adult birds and is 75 to 77 percent water, 11 to 13 percent protein, 5 to 7 percent fat and 1.2 to 1.8 percent minerals and amino acids. Nestling pigeons and doves grow rapidly because of the crop-milk. (Baptista *et al.*, 1992)

## 2.5 Ectoparasites of Pigeons and Doves

Most of the ectoparasites of pigeons are members of the Phylum Arthropoda. Pigeons and their nests are subject to a range of ectoparasites, which include lice, mites, ticks, bugs, fleas and flies (Petrak, 1969 cited by Adang *et al*., 2008).

### 2.5.1 Lice

Lice are common ectoparasites of birds and are confined to the suborder Mallophaga, (chewing lice). Mallophagans are very host-specific, but birds may harbor several species at the same time (Emerson, 1956). Clay (1957) stated that species distribution of bird lice generally coincides with the distribution of their hosts. Lice from the superclass Ischnocera are generally feather feeders only and feed in sharply defined areas while lice from the superclass Amblycera feed on blood and serum in addition to feathers (Soulsby, 1982).

Lice are transferred from one bird species to another if their hosts are in close contact. Intraspecific transmission of bird lice occurs mainly during host mating, breeding, roosting and dusting baths (Chang, 1973). Pigeon lice are frequently found on domestic fowls if the pigeons nest above or close to the chicken pens (Soulsby, 1982). Lice undergo simple (incomplete) metamorphosis and the total life-cycle is about 30 to 40 days on the host. One pair of lice may produce 120,000 descendants within a few months (Hofstad *et al.*, 1984; Piotr *et al.*, 2007).

Lice infestation causes local dermatitis, intense irritation resulting in discomfort, inability to eat, leading to poor growth and production, anemia, emaciation and death (George *et al.*, 1992; Zaria *et al*., 1996). Some of the parasites can also act as vectors and transmit various diseases to their host (Fabiyi, 1972 cited by Adang *et al*., 2009a).

Sick birds tend to be more heavily infested with lice than healthy birds. Factors of grooming and relative humidity may be important in determining variations in densities of body lice on birds. In nature, the size of the population of lice on a host is variable and may appear seasonal (Keymer *et al.* 1962; Piotr *et al.*, 2007).

Diagnosis of lice is established by discovery of eggs, nymphs or adults on the feathers. Some species of lice are site-specific, hence the common names of head, wing, body, feather or shaft lice. Lice on pigeons can be controlled by using the same methods and materials, which are used on commercial poultry (Hofstad *et al*., 1984). Several lice species have been reported on pigeons and doves. *Columbicola columbae*, an ectoparasite of pigeons and doves is very common. Its preferred site is the anterior part of the body, where it may cause mild pruritus, and is common with most pediculosis in columbids, but heavy infestations are usually seen only in diseased and debilitated birds (Petryszak *et al*., 2000).

Senlik *et al*. (2005) examined 100 *C. livia domestica* in Bursa Province of Turkey for ectoparaites and found that 72.0% of them infested by three species of lice, *Goniocotes bidentatus Columbicola columbae* and *Menopon gallinae*. A higher infestation rate was found in adults than in young pigeons. There were also no differences in the infestation rates of males and females. They found that infestation rate was higher during the summer months and lowest during the spring months.

Adang *et al*. (2008) also examined 382 (231 males and 151 females) doves trapped from different locations in Zaria, Nigeria and found 23.0% infested with three species of ectoparasites 3 namely: *Menopon gallinae* Linnaeus, 1758, *Columbicola columbae* Linnaeus, 1758, and *Goniodes* species. A total of 12 pigeons were also examined for

ectoparasites in Sebele Gaborone, Botswana, and one species of lice, *Columbicola columbae* was found (Mushi *et al.,* 2000).

Adang *et al*. (2009a) examined 30 (20 males and 10 females) Speckled pigeons trapped from the wild in Zaria and its environs. Eighteen (60.0%) of the birds were infested by three species of ectoparasites, comprising of lice; *Menopon gallinae* Linnaeus, 1758, *Columbicola columbae* Linnaeus, 1758 and flies; *Pseudolynchia canariensis* Macquart, 1840. Single, double and triple infestations occurred.

Sharmin *et al.,* (2011) examined a total of 24 pigeons in Bangladesh and recorded Five species of mallophagan bird lice namely; *Lipeurus caponis, Menopon gallinae, Columbicola columbae, Menacanthus stramineus, Colpocephalum turbinatum*, with *Columbicola columbae* having the highest prevalence.

2.5.2 Mites

The common free-living ectoparasitic mites of birds belong to the Family Dermanyssidae and these include the chicken mite, northern fowl mite and tropical fowl mite (Loomis, 1984). Mites of many species occur in pigeons but only a few are pathogenic (Keymer, 1969). The pigeon feather mite *Falculifer rostralis* and the depluming mite *Cnemidocoptes mutans* occasionally damages the plumage and can be difficult to eradicate (Petrak, 1969). All mites of the family Dermanyssidae, Genus *Dermanyssus* remain for long and emerging from the shelter of the nest material or adjacent sites for brief periods of attachment to the host where they engorge with blood. The chicken mite, *Dermanyssus gallinae* also known as the red mite, roost mite or poultry mite has been reported on pigeons (Keymer, 1969; Petrak, 1969; Chang, 1973; Soulsby, 1982).

The life-cycle of mites may be completed in as little as 7 days (Petrak, 1969; Arends *et al*., 1984). The mite spends much of its life-cycle away from its host, the adult and nymph only visiting birds to feed mainly at night. Infestation leads to restlessness of the birds at night due to irritation. In heavy infestation, anaemia usually occurs due to loss of blood. De Vaney *et al*. (1977) reported low egg production, decreased weight, seminal fluid, red blood cell counts and packed cell volume as well as low mean haemoglobin concentration as a result of infestation. Human beings may also be attacked, through invasion of human dwellings by mites from outdoor pigeon nests, causing itching and dermatitis (Soulsby, 1982).

Adang *et al.,* (2008) examined a total of 382 (231 males and 151 females) doves trapped from different locations in Zaria, and found the mite, *Dermanyssus gallinae* 1 (0.23%).

2.5.3 Ticks

Ticks belonging to the superfamily Ixodoidea of the Acarina, are characterized by possession of a pair of stigmata posterior or lateral to the coxa and associated with a roundish or kidney-shaped plate. Ticks infesting birds belong to the Family Argasidae (soft-bodied ticks or fowl ticks). They have no scutum (dorsal shield) and except for the larvae, feed intermittently in all stages. Reduced productivity in infested birds is associated with anaemia, but also possibly due to tick-producing toxic substances (Petrak, 1969). Ticks transmit diseases such as avian spirochaetosis, tularemia, piroplasmosis, anaplasmosis, certain rickettsial and many viral diseases, including encephalitis (Goethe and Kunze, 1973).

According to Arends *et al*. (1984), the complete life-cycle of fowl ticks takes about 7-8 weeks during warm weather and longer during cold seasons. Adult ticks remain inactive in cracks and crevices during cold weather and adults may live without a blood meal for more than four years.

Birds suffer chiefly from tick infestation during the warm dry season. Loss of blood may reach proportions of a fatal anaemia, there may be emaciation, weakness, slow growth and lowered production. Ruffled feathers, poor appetite and diarrhoea are signs suggesting tick infestation (Reid, 1956). Control requires treatment of premises and approved ascaricides (Soulsby, 1982).

*Argas perscus* was reported on domestic birds with a prevalence of (3.1%) and (3.3%) from Zaria and Markudi by Adang *et al.* (2008) and Adelusi *et al.* (2014) respectively. Borji *et al.* (2012) also examined a total of 300 Pigeons for ectoparasite in Mashhad city in north-eastern Iran and found a prevalence of *Argas reflexus* (3.5%).

2.5.4 Bugs

The family Cimicidae in the order Hemiptera includes several blood-sucking bugs of birds. These insects have mouthparts adapted for piercing the skin and sucking body fluid. They are flattened dorsoventrally and adult are 2 to 5 mm long x 1.5 to 3 mm. The colour varies according to species from brown to yellow or red. Bites from attack by a large number of bugs are usually followed by swellings and itching, caused by injection of saliva into the wounds. This large number of bugs may lead to anaemia, decreased egg production, increased feed consumption and lower peak egg production.

According to Arends *et al*., (1984), the most widespread of these bugs is the common bedbug (*Cimex lectularis*), which attacks pigeons, poultry, humans and other mammals.

A closely related species *Cimex columbarius* is found on pigeons in Europe. Rothschild and Clay (1957) stated that few wild birds are attacked by bugs because the bugs can survive only if the host is the type that returns to its old nest, and the nest must be in a situation where it will remain fairly dry. *Triatoma sanguisuga* was found to harbour the virus of Eastern Equine Encephalomyelitis in Kansas, with naturally occurring viral infections found in pigeons (Arends *et al*., 1984).

Control should be directed against day-time hiding places of the bugs in cracks and crevices. Spraying the birds with pyrethrum will also be helpful if an infestation is high (Petrak, 1969).

2.5.5 Fleas

Fleas (Order Siphonaptera) are small brownish or black insects with laterally compressed bodies enabling them to run rapidly through the feathers. The adults although devoid of wings, have well-developed legs and are able to leap considerable distances as well as run. The mouthparts are specially adapted for piercing the skin of their host and for sucking blood from various host species. They are cosmopolitan in distribution, although more abundant in temperate and warm climates (Petrak, 1969).The sticktight flea *Echidnophaga gallinacea* has been reported from pigeons among other host species (Arends *et al*., 1984). This flea causes irritation and blood loss especially in young birds and infested birds may be seriously damaged leading to death. Egg production is lowered in older birds. The European chicken flea *Ceratophyllus gallinae* has also been reported in pigeons (Arends *et al*., 1984). This flea stays on birds only long enough to feed, while its immature stages occur in nests and other surroundings. Birds (pigeons and doves) returning to old haunts can become infested with fleas that have remained quiescent for long periods (Soulsby, 1982).

Control measures for fleas are removal of infested litter and through spraying to kill immature fleas. In Scotland, tests have shown control of *Ceratophyllus gallinae* by using the pyrethroid permethrin as a 0.125-0.25% spray to nest boxes and litter (Tritchner, 1983). Domestic animals such as poultry, dogs and cats should be kept away from infested birds, as they are potential sources of re-infestation (Arends *et al*., 1984). A flea prevalence of 4.4% was reported by Adelusi *et al*., (2014) from domestic birds in three residential areas (Wurukum, North Bank and Logo II, Makurdi, Nigeria).

2.5.6 Flies

*Pseudolynchia canariensis*, is an important parasite of domesticated pigeons in warm or tropical areas (Soulsby, 1982). It has been known since 1896 in the southern half of the United States and in many other countries. The pigeon fly is a member of the Family Hippoboscidae or louse flies. The body is dorsoventrally flattened, and the head is provided with a short stout beak. It is dark brown, 6 mm long and has a pair of transparent, tapering wings with the venation reduced and concentrated along the anterior border. The claws are strong and spurred. The life-cycle of pigeon fly is unusual in that the larva matures inside the female and pupates immediately upon being ejected. The pupal stage requires about 30 days, adults live for about 45 days and deposit four or five young ones (Benbrook, 1965).

These pigeon flies move rapidly through the feathers and suck blood, particularly from nesting pigeons 2-3 weeks of age (George and Abdu, 1989). They may also bite humans, inflicting a painful skin wound that persists for several days (Soulsby, 1982). Infested pigeons suffer from blood loss and irritation. The fly may also transmit a protozoan blood cell parasite, *Haemoproteus columbae*, the cause of a malaria-like disease of pigeons (Lapage 1961).Organophosphorus compounds and manual removal

can be used in the treatment and control of pigeon flies; periodic inspection in case the birds become reinfested is also an important control measure (Soulsby, 1982).

Adang *et al.* (2008) reported a total of 382 (231 males and 151 females) doves trapped from different locations in Zaria, Nigeria were examined, and 88 (23.0%) of the birds were infested by six species of ectoparasites; the fly *Pseudolynchia canariensis* Macquart, 1840 to have prevalence of 5.0%.

Similarly, Adang *et al*. (2009a) reported that a total of 30 (20 males and 10 females) Speckled Pigeons trapped from the wild in Zaria and its environs, were examined for ectoparasites. Eighteen (60.0%) of the birds were infested by three species of ectoparasites, of which the fly *Pseudolynchia canariensis* Macquart 1840 had a prevalence of 30.0%. A total of 12 pigeons were also examined for ectoparasites in Sebele Gaborone Botswana, and the fly, *Pseudolynchia canariensis* was reported to have (50 %) prevalence (Mushi *et al.*, 2000).

## 2.6 Helminths of Pigeons and Doves

There are many species of helminths that infect columbids which vary considerably in size and shape. The food habit of columbids and the life-cycle of the parasites determine the variety of their infestations (Chang, 1973). Columbids are free-range and thus acquire infestations of a wide range of parasites with direct or indirect life-cycles because of their increased exposure to larger areas of land and various intermediate hosts and the eggs of the parasites (Fabiyi, 1972 cited by Adang *et al*., 2009a).

### 2.6.1 Trematodes

The life-cycle of all trematodes parasitizing birds requires a mollusc as an intermediate host and some species also use a second intermediate host (Hofstad *et al*., 1984). Over

twenty species of flukes are said to occur in birds, and the oviduct flukes *Prosthogonimus macrorchis* and *P. ovatus* appear to be the most frequent parasite of many wild and domestic birds (Soulsby, 1982).

### 2.6.2 Cestodes

Cestodes are found more frequently in warmer seasons, when intermediate hosts are abundant (Soulsby, 1982). Birds become infested by eating the intermediate hosts which are crustaceans, earthworms, slugs, snails or leeches, thus allowing the larval stages of the tapeworms (cysticercoids) access to the intestine. Important cestodes of columbids include duodenal cestodes: *Amoebotaenia cuneata*, *Hymenolepis cantaniana*, and *H. carioca;* and *Raillietina cesticillus*, *Raillietina tetragona* and *Raillietina echinobothrida* from the small intestine (Soulsby, 1982).

Natala *et al*. (2009) reported helminth species found in domestic pigeons in Zaria, as follows: *Raillietina tetragona* (4.9%), *Raillietina cesticillus* (3.0%), *Raillietina echinobothrida* (7.6%) and *Capillaria anatis* (0.8%). The following helminth species were also found among local and exotic chickens slaughtered in Gwagwalada, Abuja (FCT) Nigeria: *Raillietina echinobothrida* (19.60%), *R. tretragona* (22.20%), *Hymenolepis carioca* (23.00%), *Hetarakis gallinarum* (31.00%) and *Syngamus trachea* (1.80%) (Matur *et al.,* 2010).

A total prevalence of infestation of 87.8% of helminth species was recorded in Bauchi among local chikens; they included the following cestodes: *Raillietina tetragona* (38.5%), *Raillietina echinobothrida* (42.0%), *Raillietina cesticillus* (10.5%), *Choanotaenia infundibulum* (3.3%) and *Raillietina magninumida* (8%) (Yoriyo *et al.,* 2008).

2.6.3 Nematodes

Nematodes constitute the most important group of helminths of columbids. In the number of species and the amount of damage caused, they far exceed the cestodes and trematodes. Avian nematodes often have a broad host range and accordingly, nematodes found in columbids may constitute a hazard for commercially raised birds (Soulsby, 1982). Nematodes of importance in columbids include *Syngamus trachea* found in the trachea, *Dispharynx nasuta, Tetrameres americana, T. fissipina, Microtetrameres helix* that infect the proventriculus, *Amidostomum anseris, A. skrjabini, A. raillieti* and *Epomidiostomum uncinatum* found in the gizzard; nematodes such as *Capillaria obsignata C. columbae, Ascaridia columbae, Ornithostrongylus quadriradiatus* specific to the intestine, *Subulura brumpti, Trichostrongylus tenuis* and *Heterakis gallinarum* found in the caecum (Soulsby, 1982).

A total of 132 pigeons were examined for gastro-intestinal parasites in YSR Kadapa District in Andhra Pradesh, India and the following parasites were recorded: *Ascaridia columbae* (33.3%), *Eimeria* species (31.0%), *Capillaria columbae* (17.4%) (Sivajothi and Sudhakara, 2015).

Natala *et al*. (2009) reported helminth species found in domestic pigeons in Zaria, as follows: *Ascaridia columbae* (1.2%), *Ascaridia galli* (1.2%) and *Capillaria anatis* (0.8%). The nematode *Ascaridia galli* was found among local and exotic chickens slaughtered in Gwagwalada, Abuja (FCT) Nigeria, with a prevalence of 51.60% (Matur *et al.,* 2010).

Yoriyo *et al.* (2008) repoted the following nematodes: *Ascaridia styphlocerca* (4.5%), *Heterakis brevispiculum* (18.0%), *Subulura brumpti* (15.5%), *Gongylonema congolense* (40.5%) from local chicken in Bauchi.

# CHAPTER THREE

## 3.0 MATERIALS AND METHODS

### 3.1 Study Area

Birds were collected (Laughing dove were trapped while Domestic pigeons were purchased) in Zaria , which is located at approximately latitude 11˚3' North of the equator and longitude 7˚42' East of the Greenwich meridian in Kaduna State, Nigeria (Fig.1). The dry season in Zaria lasts for a period of six months (November to April), and the rainy season is from May to October (Hore, 1970). The annual rainfall ranges between 1,000 mm and 1,114 mm and the mean daily temperature is 27°C. The relative humidity ranges from 70 - 80% in August to about 15-20% in December (Yusuf and Associates, 1981).

The natural vegetation is typically Northern Guinea Savanah and is composed of shrubs, herbs, grasses and sparsely spaced trees (Hore, 1970). The dominant trees within the area include *Mangifera indica, Gmelina arborea, Delonix regia, Azadirachta indica, Eucalyptus citriodora, Albizia lebbeck, Khaya senegalensis, Spathodea campanulata, Psidium guajava* and *Carica papaya*. There are randomly located farmlands and a good number of tall buildings surrounded by trees. Some of these trees serve as nesting, roosting and resting sites for the columbids (Fry 1966).

### 3.2 Ethical Clearance

Ethical clearance was obtained from Ahmadu Bello University Zaria, Committee on Animal Use and Care, with approval number ABUCAUC/2016/028 (Appendix I).

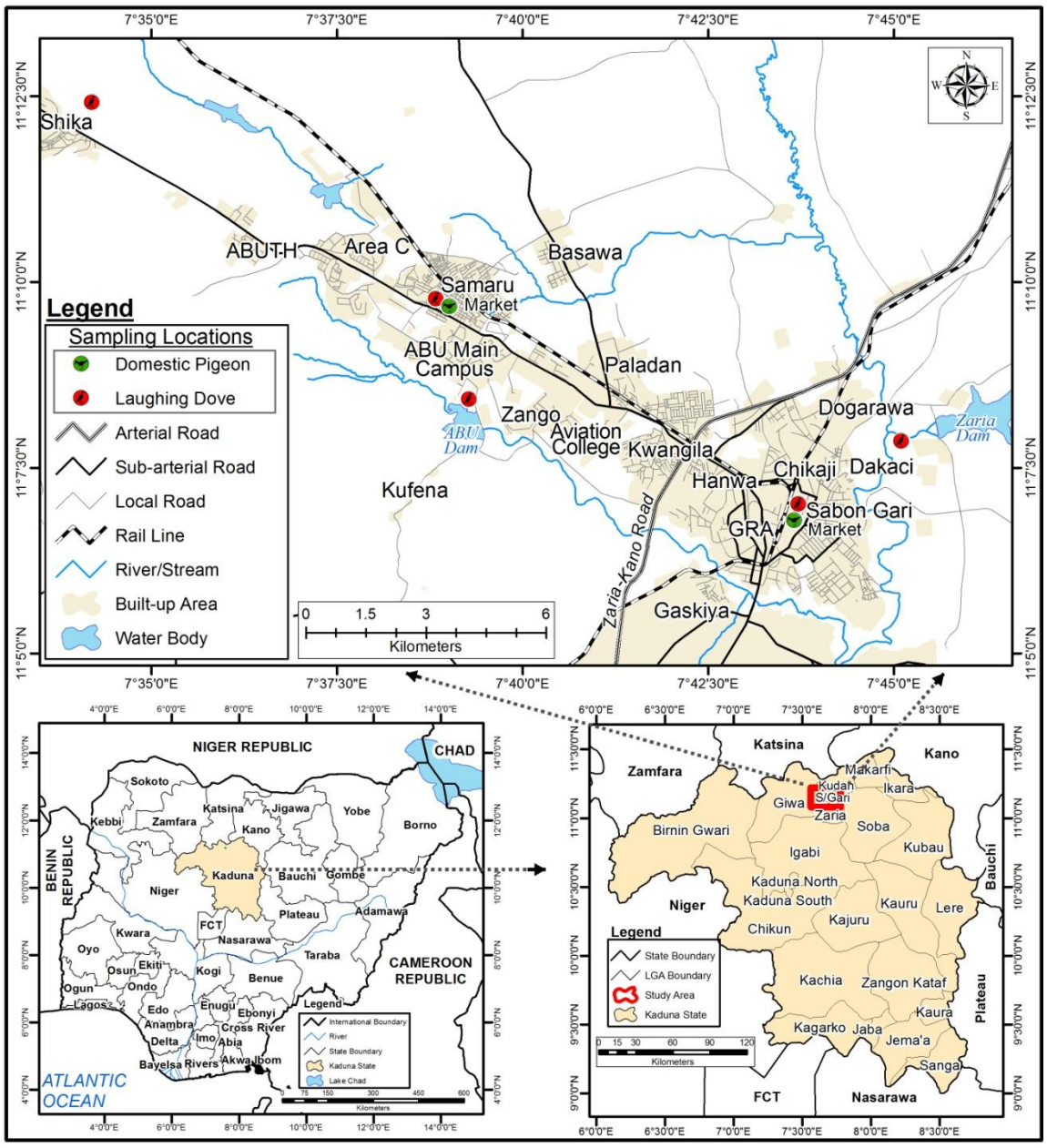



**Fig. 1:** Map of Zaria showing Sampling Locations
**Source:** Map Gallery, Department of Geography, Ahmadu Bello University, Zaria

### 3.3 Bird Collection

Domestic pigeons (*Columba livia domestica*) (Plate I) were purchased for the period of six months (three months each of rainy and dry season) from Sabon-gari and Samaru markets in Zaria.

Laughing doves *(Streptopelia senegalensis*) (Plate II) were trapped for the period of six months (three months each of rainy and dry season) from the wild at various locations in Zaria (Fig.1) using a locally made baited traps (Plate III), which were placed on a tree, roof top or on the ground.

The birds were taken to the Parasitology and Entomology Laboratory of the Department of Zoology, Faculty of Life Sciences, Ahmadu Bello University Zaria for identification and parasitological examination.

### 3.4 Examination of Birds in the Laboratory

3.4.1 Identification of birds

The trapped and purchased birds were identified with reference to Serle *et al.* (1977).

3.4.2 Anaesthetising the birds

The birds were anaesthetised in a wooden box containing cotton wool soaked in a few drops of chloroform. The box was covered tightly for 1 to 2 minutes then the birds were removed when immobilised.



**Plate I:** *Columba livia domestica* Gmelin, 1789 (Domestic pigeon)



**Plate II:** *Streptopelia senegalensis* Linnaeus, 1766 (Laughing dove)



**Plate** III: A Locally made bird-baited trap. Made of wood and binding wire, with two oppenings, with a life bait placed in it, the trap triggers are at the enterance of the two oppenings. Measurement; Length – 75cm, Width – 40cm and Hieght – 45cm, distance between the wires – 1cm (though the size vary).

### 3.4.3 Sex determination

The sex of each bird was determined by examining the cloaca for presence or absence of a cloacal protuberance, indicating the male and female sex respectively (Miller and Wagner, 1955).

The sex of the bird was later confirmed after dissection and observing for the presence of testes or ovaries in the male or female, respectively.

### 3.4.4 Weight and length determination

The weight of the birds was measured using a Sartorius electronic weighing balance. It was achieved by placing the birds on the weighing balance, which was allowed to stabilise for a few seconds before recording the weight in grams (g). The total length of the birds was determined using a meter rule. The measurement was taken from the tip of the beak to tip of the tail in centimetres (cm).

## 3.5 Examination of Birds for Ectoparasites and Gastro-Intestinal Helminths

### 3.5.1 Screening for ectoparasites

The plumage of each bird was thoroughly brushed onto a white tray for the collection of ectoparasites. The feathers of the head, the neck, under the wings, body, legs and cloaca were raised and thoroughly examined with a hand lens for ectoparasites. Ectoparasites such as mites and ticks attached to the body parts, which could not be removed by brushing, were gently dislodged with a pair of forceps. The ectoparasites were counted, fixed and preserved in 70% alcohol Beck and Devis (1971). Later, the ectoparasites were mounted on microscope slides in a drop of glycerine under a dissecting microscope and examined under a stereo microscope.

3.5.2 Dissection of birds and examination of the gastro-intestinal tract

The feathers on the ventral surface of the anaesthetised birds were plucked, after which an incision was made from the anal region to the breast; the gastro-intestinal tract (GIT) was extracted intact and placed in 0.09% physiological saline in a Petri dish. The GIT was slit open longitudinally under a dissecting microscope. Any helminths found were recovered with the aid of a pair of forceps and Pasteur pipette. The horny layer of the gizzard was peeled off to expose any embedded parasites. Nodules were teased gently and any embedded helminths were detached gently with a pair of forceps (Beck and Devis, 1981).

The mucosa of the whole gut was scraped into Petri dish and examined under the dissecting microscope for any helminths. All the helminths collected were counted according to their attachment site, placed in cavity blocks containing tap water/ physiological saline.

The crop of each was extracted intact, placed in a Petri dish and contents were collected, dried, sorted, identified and preserved in a specimen bottle.

3.5.3 Washing, fixing and preservation of helminths

The worms were washed by sucking and pipetting tap water for three (3) to four (4) times, and were fixed in a near boiling water and presevered in 5% formalin in a sample bottle and a label written with pencil was placed inside.

**3.6 Staining, Dehydrating, Clearing and Mounting**

3.6.1 Staining

The preserved worms were washed in distilled water to remove the preservative (formalin) and stained overnight in 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 almost completely removed and rinsed in distilled water. The worms were neutralised using a 0.3% solution of ammonia to stop destaining.

3.6.2 Dehydrating

The worms were dehydrated in a graded series of ethanol 30%, 50%. 70%, 90% and 100% for 40 minutes to1hour each, depending on the size of the worm.

3.6.3 Clearing and mounting

The absolute alcohol (100%) was gradually replaced with methyl salicylate and eventually pure methyl salicylate in which they were left for at least 30minutes to 1 hour to clear. During this process, the cavity blocks were kept covered to avoid rehydration from the atmosphere. The cleared worms were mounted on microscope slides in thinned Canada balsam under a dissecting microscope. The worms were then examined in detail under the ×4, ×10 and ×40 objectives of a stereo microscope.

**3.7 Measurement and Identification of Parasites**

The length of the parasites were measured using a calibrated ocular micrometer under the microscope and a meter rule.

The parasites were identified with reference to the text in Soulsby (1982) and the assistance of Prof. T. O. L. Aken'Ova in the Department of Zoology, Ahmadu Bello University Zaria, and Prof. Boyko Georgiev of the Institute of Biodiversity and Ecosystem Research, Bulgarian Academy of Sciences.

### 3.8 Data Analysis

Prevalence and intensity of ectoparasites and helminths of *Streptopelia senegalensis* and *Columba livia domestica* were calculated using descriptive statistics and prevalences were expressed as percentages (%) (Bush *et al.*, 1997; Lajos *et al.*, 2000).

Student's *t*-test was used to compare the prevalences of ectoparasites and gastro-intestinal helminth infestations between species, sexes and seasons.

Odd's Ratio analysis was used to determine the association between parasite infestation according to species and sex of birds and seasons.

Microsoft Excel Version (2013) and SPSS version 20.0 were the softwares used for statistical analysis.

# CHAPTER FOUR

## 4.0 RESULTS

### 4.1 Ectoparasites, Gut Helminths and Crop Contents of *Streptopelia senegalensis* and *Columba livia domestica*

Among seventy one (71) each, of *Streptopelia senegalensis* and *Columba livia domestica* examined for ectoparasites and gastro-intestinal helminths, a total of 12 arthropods (two species) and 357 helminths (seven species of only cestodes) were recovered from *Streptopelia senegalensis,* and a total of 165 arthropods (three species) and 715 gastro-intestinal helminths comprising 156 nematodes (one species) and 559 cestodes (seven species) were recovered from *Columba livia domestica* (Table 4.1).

The crop contents of *Streptopelia senegalensis* were: maize grains, guinea corn and millet and those of *Columba livia domestica* were: cowpea, rice, melon seed, millet, guinea corn, egg shell, pepper seeds, broken grains and unidentified grass seeds (Appendix II).

Helminths (cestodes and nematodes) were recovered mainly from the duodenum, the small intestine and rarely from the large intestine.

### 4.2 Descriptions of Ectoparasites

***Gonoides* sp.** Linnaeus, 1758 (Plate IV, Fig. 2)

Body brownish, dorsoventrally flattened, slender; total length 210.37µm, head 52.59 µm long, abdomen 128.71µm long, maximum width at mid abdomen, 102.42 µm.

**Table 4.1**: A summary of infestation data of arthropods and helminths recovered from 71 each of *Streptopelia senegalensis* and *Columba livia domestica*

| Birds species | Parasites | No. of species | No. of birds infested (%) | No. of parasites recovered | Range | Mean intensity± SD |
|---|---|---|---|---|---|---|
| ***S. senegalensis*** | Arthropods | (2 spp.) | 7 (9.86) | 12 | 1-6 | 1.7±1.89 |
| | Helminths | | | | | |
| | (a) Nematodes | (0) | 0 (0.00) | | | 0±0.00 |
| | (b) Cestodes | (7 spp.) | 37 (52.11) | 357 | 1-60 | 9.7±12.38 |
| ***C. livia domestica*** | Arthropods | (3 spp.) | 43 (60.57) | 165 | 1-47 | 3.8±7.11 |
| | Helminths | | | | | |
| | (a) Nematodes | (1 sp.) | 18 (25.35) | 156 | 1-36 | 8.7±11.30 |
| | (b) Cestodes | (7 spp.) | 23 (32.39) | 559 | 1-105 | 24.3±23.08 |

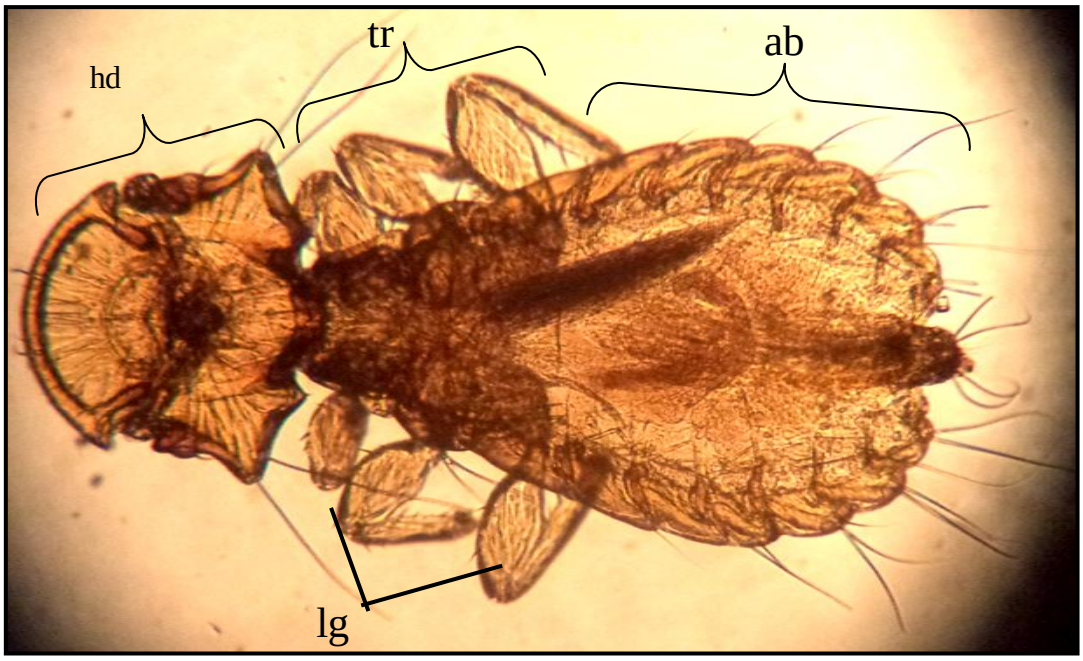



**Plate IV** Ventral view of *Gonoides* sp. Showing head (hd), thorax (tr), abdomen (ab) and legs (lg)

Scale-bar = 120µm

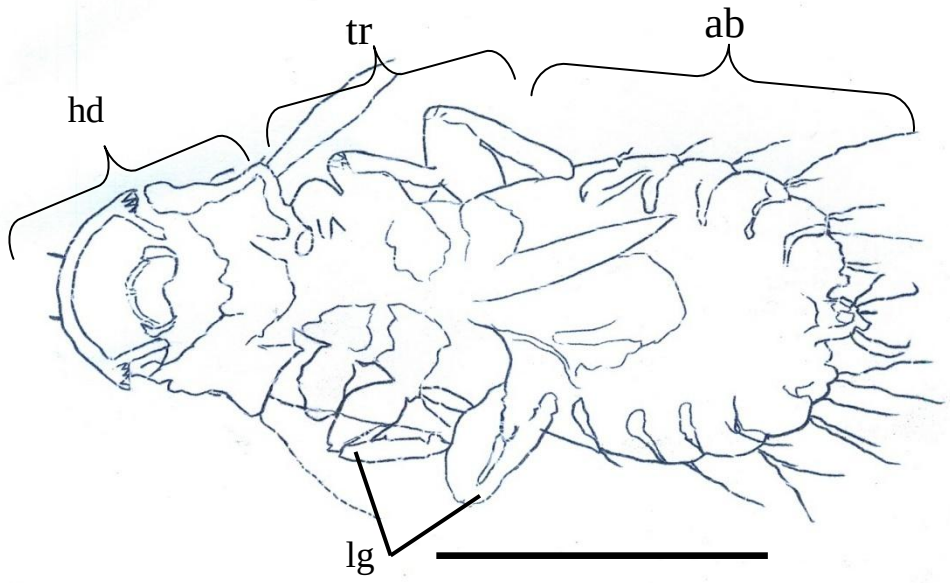



**Fig. 2**: Ventral view of *Gonoides* sp. Showing head (hd), thorax (tr), abdomen (ab) and legs (lg)

Scale-bar = 90µm

***Columbicola columbae*** Melcomson, 1937 (Plate V, Fig.3)

Body brownish, dorsorventrally flattened, wingless, longer than wide, pair of setae on the anterior part of the head, total length 249.74µm, head 57.09 µm long, abdomen 151.38 µm long, maximum width at mid abdomen 45.85 µm.

***Pseudolynchia canariensis*** Macquart, 1839 (Plate VI and VII; Fig. 4 and 5)

Body dorsoventrally flattened, grey-brown, wings two, transparent, 690.85µm long, head 174.15µm long, abdomen 473.66µm long, maximum width at mid abdomen 364.45µm.

**4.3 Descriptions of Gastro-Intestinal Helminths**

***Ascaridia galli*** Schrank, 1788 (Plates VIII and IX, Figs. 6 and 7)

Body creamy white, cylindrical, semi-translucent. 35,mm long, 2 mm wide.

***Raillietina* species 1** Fuhrman, 1920 (Plate X, Fig. 8 and Plate XI and Fig. 9)

Body white, elongated, flattened with inverted-funnel-shaped segments, Scolex small with 4 round suckers, rostellum armed with 2 rows of hooks, anterior proglottids 17.3 µm long, and 51.9 µm wide, scolex 22.18 µm long, 19.44 µm wide, suckers 11.07 µm long, 6.92 µm wide, total length 15,000µm. Unilateral genital pores, one per proglottis several eggs per capsule and gonads.

***Raillietina* species 2** Fuhrman, 1920 **(**Plate XI; Fig. 9) and (Plate XIII, Fig. 11)

Body creamy white, elongated, flattened with inverted funnel-shaped proglottids, Scolex small, 4 suckers round shape, anterior proglottids 34.6 µm long, 129.5 µm wide, containing egg capsules scolex 13.89 µm long, 15.09 wide, suckers 4.63 µm long, 3.46 µm wide, total length 25,000µm. Unilateral genital pores, one per proglottis several eggs per capsule.

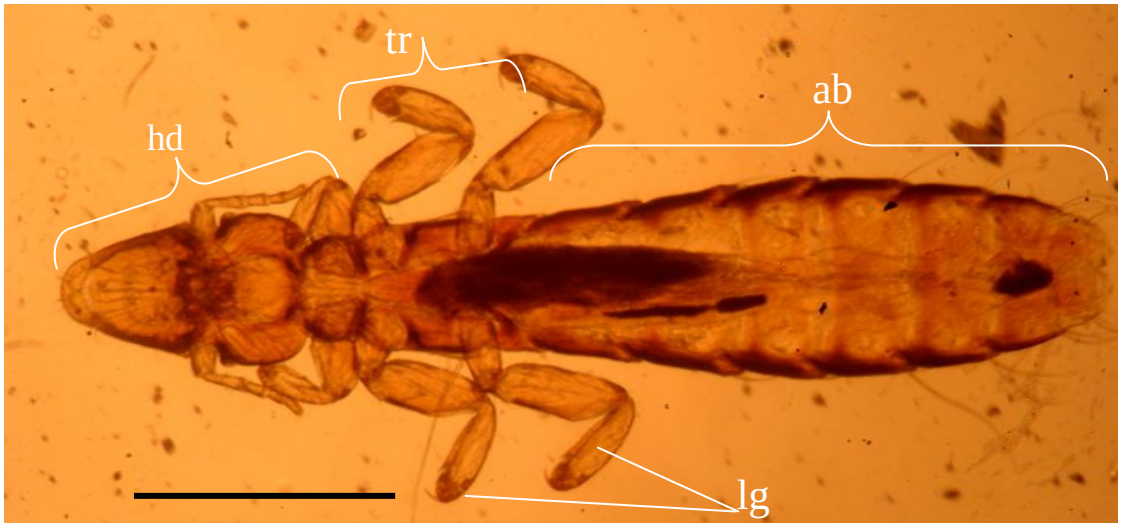



**Plate V:** Ventral view of *Columbicola columbae*, showing head (hd), thorax (tr), abdomen (ab) and legs (lg)

Scale-bar = 130µm

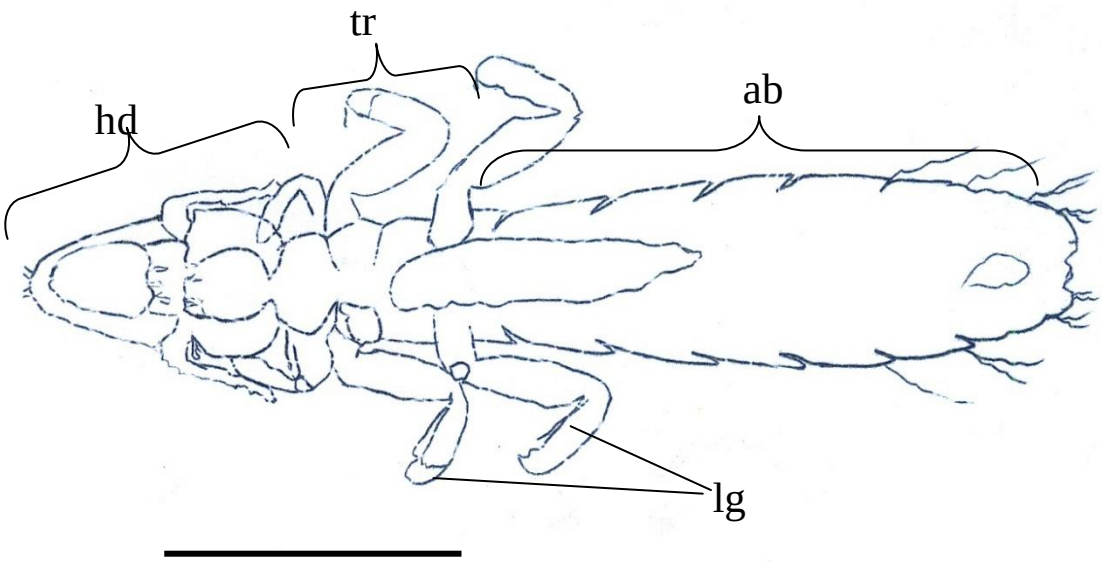



**Fig. 3** Ventral view of *Columbicola columbae,* showing head (hd), thorax (tr), abdomen (ab) and legs (lg)

Scale-bar = 130µm

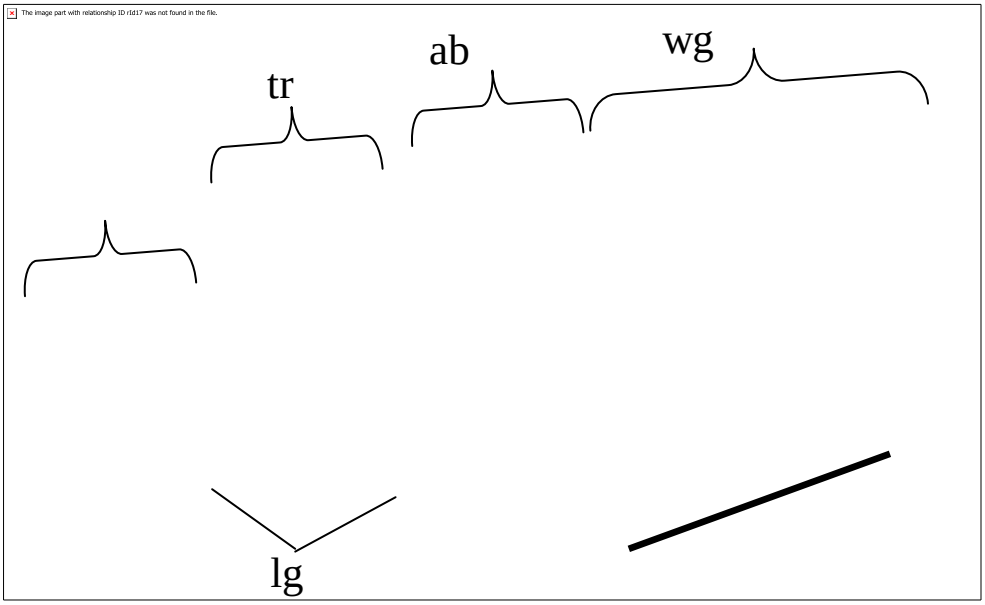



**Plate VI:** Ventral view of *Pseudolynchia canariensis.* Showing head (hd), thorax (tr), abdomen (ab), wings (wg) and legs (lg)

Scale-bar = 230µm

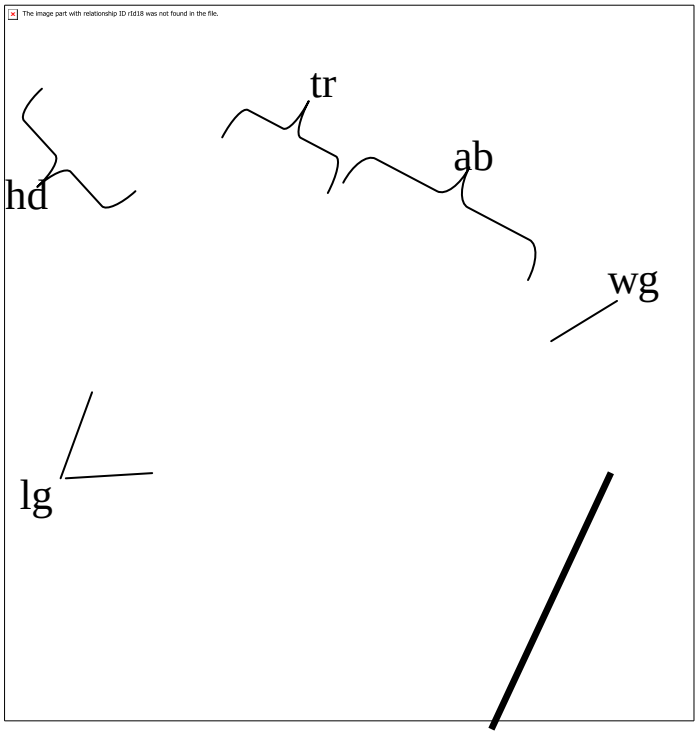



**Plate VII:** Dorsal view of *Pseudolynchia canariensis* Showing head (hd), thorax (tr), abdomen (ab), wings (wg) and legs (lg)

Scale-bar = 230µm

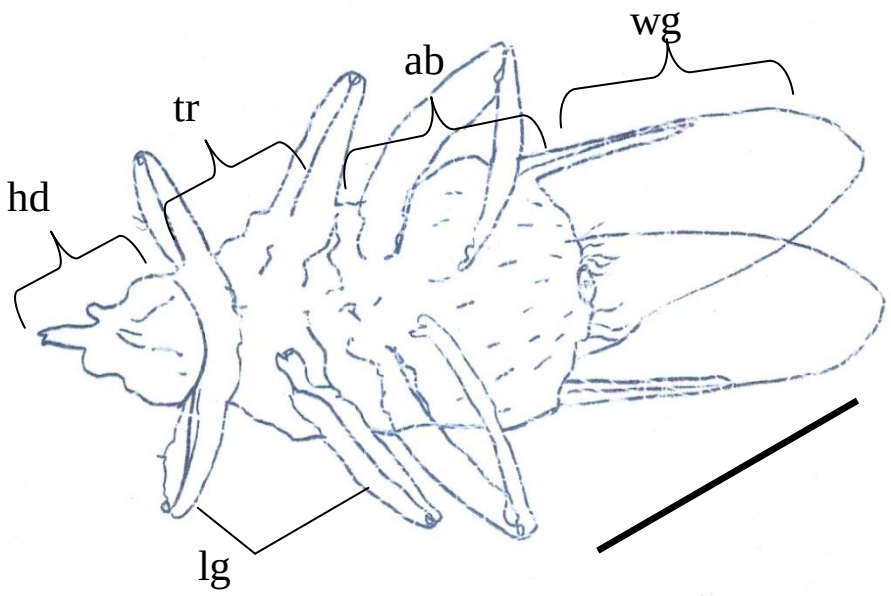



**Fig.4:** Ventral view of *Pseudolynchia canariensis* Showing head (hd), thorax (tr), abdomen (ab), wings (wg) and legs (lg)

Scale-bar = 230µm

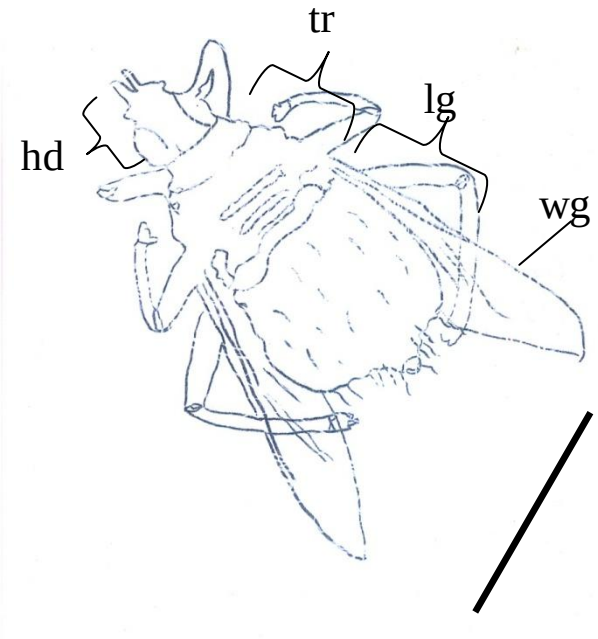



**Fig. 5** Dorsal view of *Pseudolynchia canariensis* Showing head (hd), thorax (tr), abdomen (ab), wings (wg) and legs (lg)

Scale-bar = 230µm

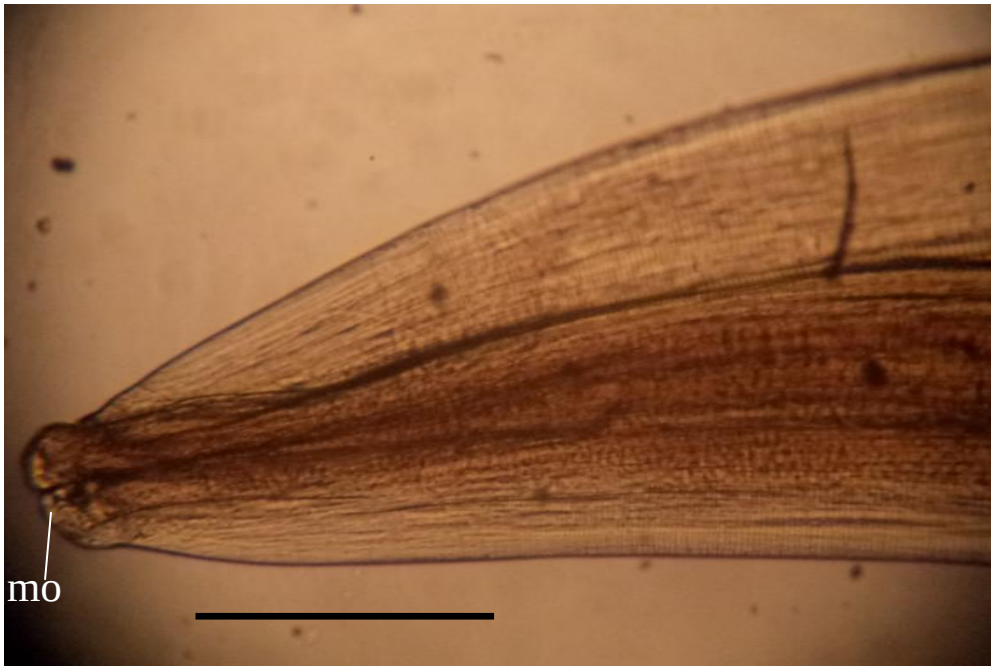



**Plate VIII:** Anterior end of a male *Ascaridia galli,* showing tooth like structure in the mouth (mo)

Scale-bar = 190µm




**Plate IX**: Posterior end of a male *Ascaridia galli,* showing the blunt end (bl)

Scale-bar = 190µm

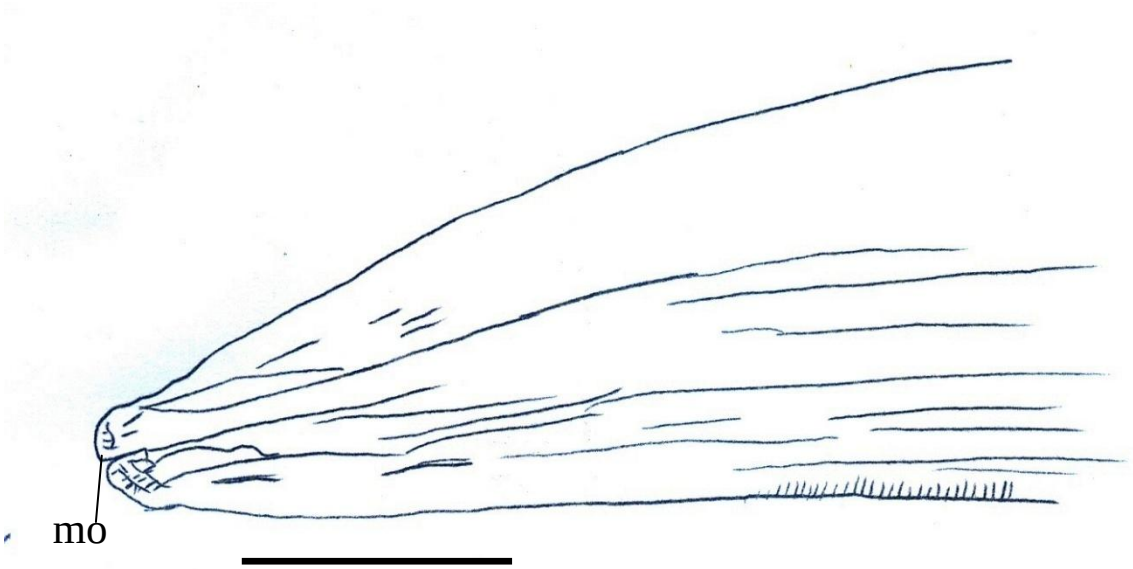



**Fig. 6:** Anterior end of a male *Ascaridia galli* showing the tooth like structure in the mouth (mo)

Scale-bar = 180µm

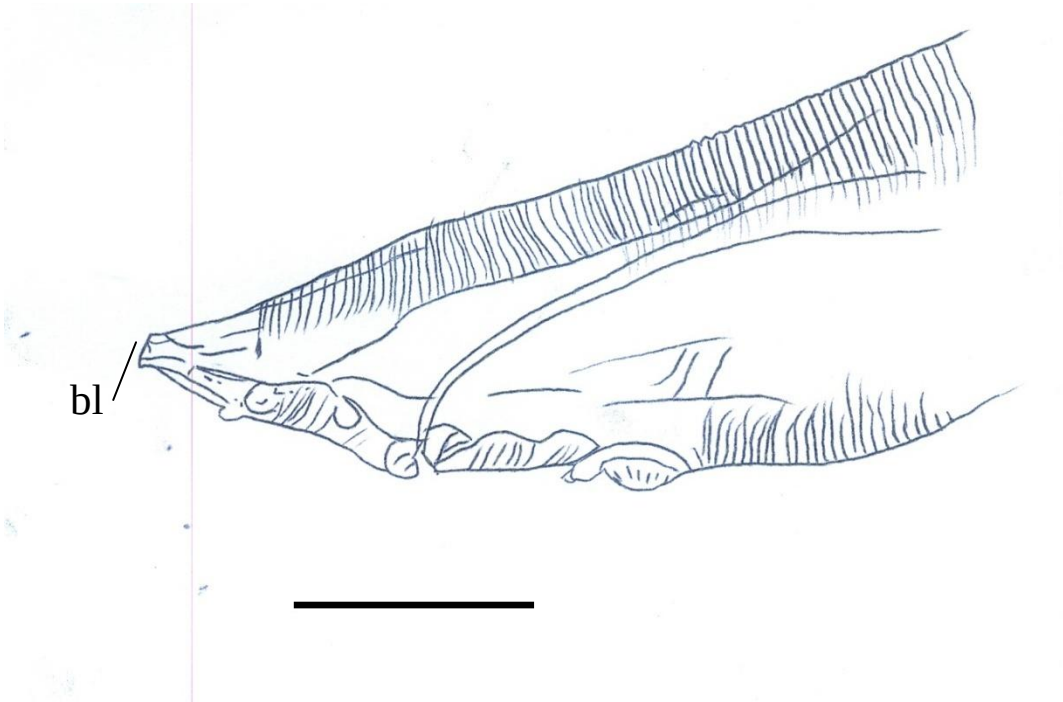



**Fig. 7:** Posterior end of a male *Ascaridia galli,* showing the blunt end (bl)

Scale-bar = 190µm

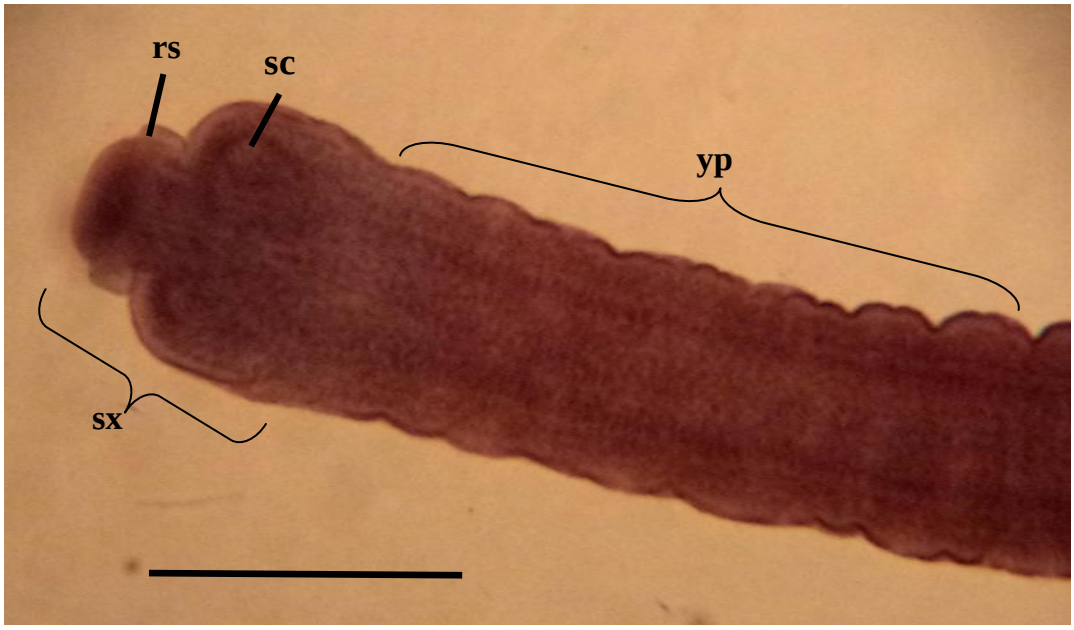



**Plate X:** Anterior portion of *Raillietina* species 1 showing Scolex (sx), with two of four suckers (sc), a protruded rostellum (rs) armed with hooks and a few young proglottids (yp)

Scale-bar = 10µm

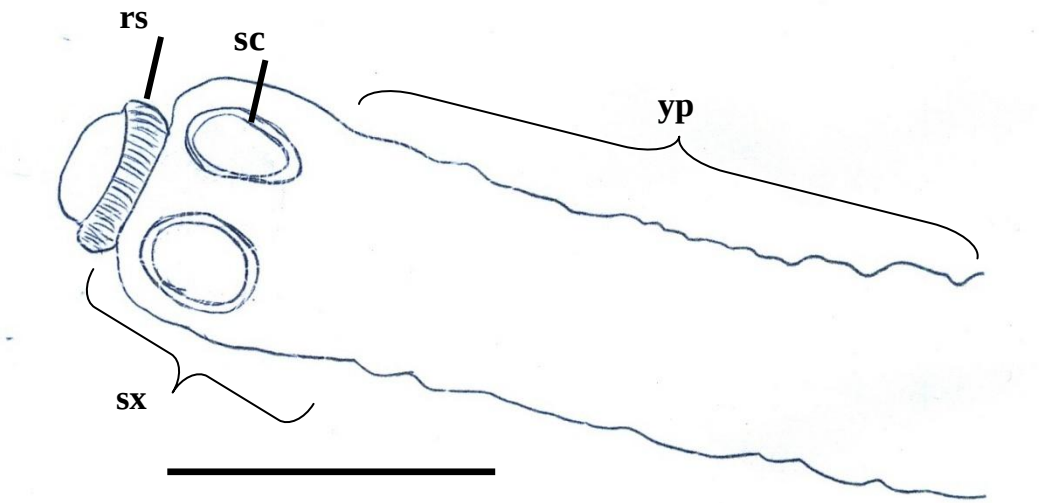



**Fig. 8**: Anterior portion of *Raillietina* species 1 showing Scolex (sx), with two of four suckers (sc), a protruded rostellum (rs) armed with hooks and a few young proglottids (yp)

Scale-bar = 8µm




**Plate XI:** Mature proglottids of *Raillietina* species 1 showing unilateral genital pores (gp) and gonads

Scale - bar = 11 µm

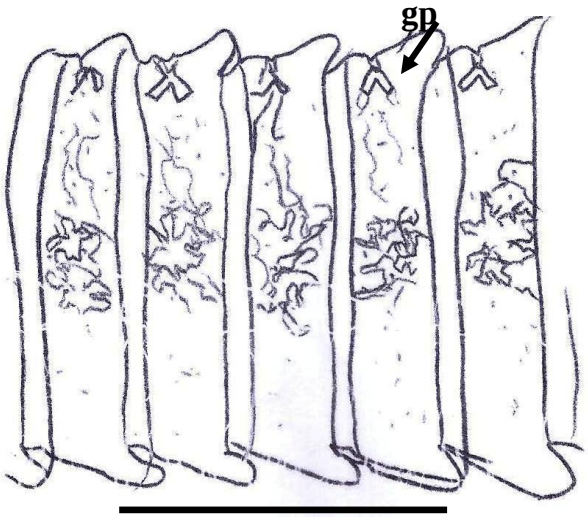



**Fig. 9:** Mature proglottids of *Raillietina* species 1 showing unilateral genital pores (gp) and gonads

Scale-bar = 11 µm

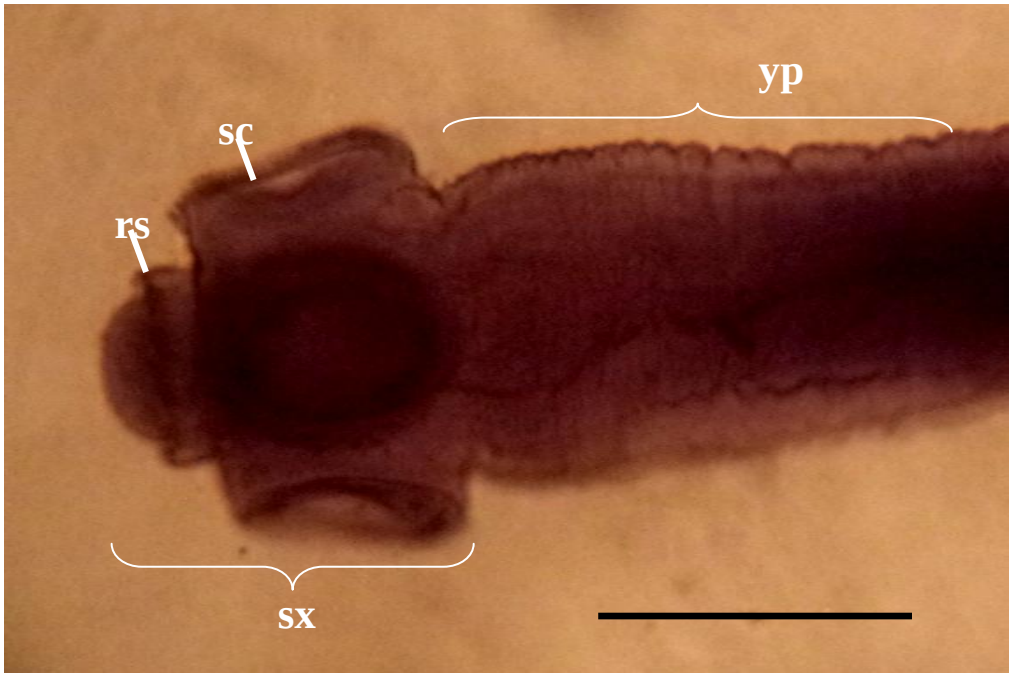



**Plate XII:** Anterior portion of *Raillietina* species 2 showing Scolex (sx) with three of four suckers (sc) and protruded rostellum (rs) armed with hooks and a few young proglottides (yp)

Scale-bar = 10µm

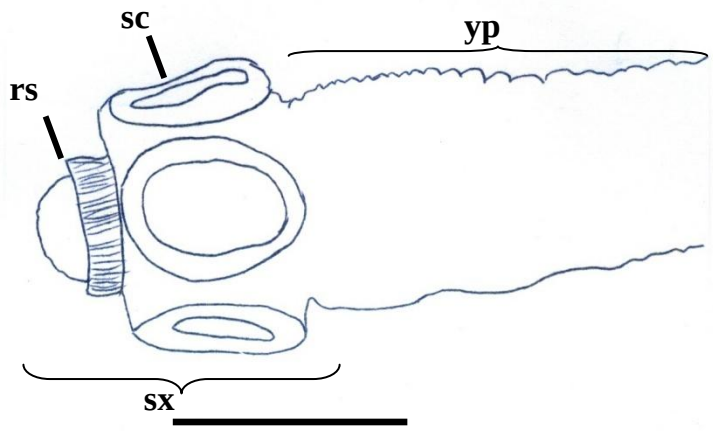



**Fig. 10**: Anterior portion of *Raillietina* species 2 showing Scolex (sx) with three of four suckers (sc) and protruded rostellum (rs) armed with hooks and a few young proglottides (yp)

Scale-bar = 8µm

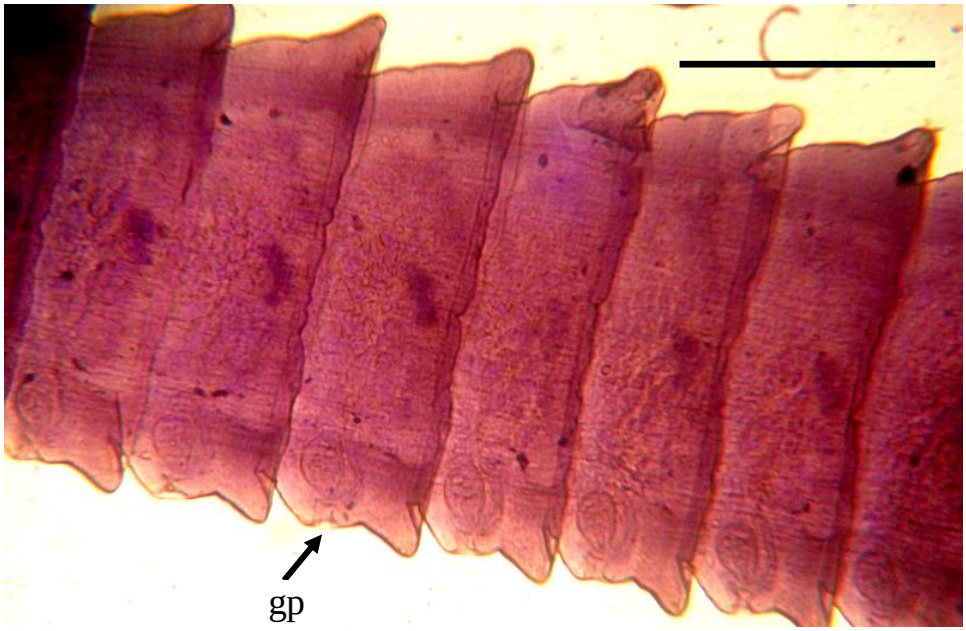



**Plate XIII:** Mature Proglottids of *Raillietina* species 2 forming a saw-like edge, showing unilateral genital pores (gp) and gonads.

Scale-bar = 120µm

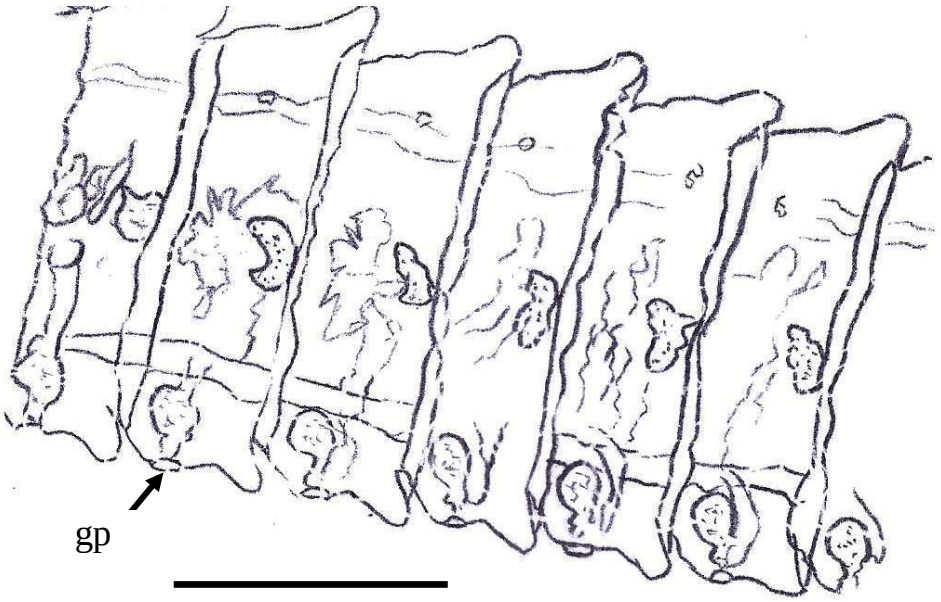



**Fig. 11**: Mature Proglottids of *Raillietina* species 2 forming a saw-like edge, showing unilateral genital pores (gp), cirrus sac, gonads.

Scale-bar = 120µm

***Raillietina* species 3** Fuhrman, 1920 (Plate XIV Fig. 12 and Plate XV, Fig. 13)

Body creamy white, elongate, dorsoventrally flattened, finely segmented; scolex relatively small, 17.42 µm long and 13.85 µm wide; suckers 4, oval; proglottids with, inverted funnel shape, containing egg capsules, wider posteriorly than anteriorly, 83.04µm long, 117.64 µm wide; worm length 21,000 µm. Unilateral genital pores, one per proglottis, several eggs per capsule.

***Raillietina* species 4** Fuhrman, 1920 (Plate XVI, Fig. 13 and Plate XVII, Fig. 15)

Body creamy white, elongate, dorsoventrally flattened; scolex small, 17.30 µm long, 17.30 µm wide; 4 suckers, worm 8000 µm long. Unilateral genital pores, one per proglottis several eggs per capsule.

***Raillietina* species 5** Fuhrman, 1920 (Plate XVIII, Fig. 16)

Body creamy white, elongate, dorso-ventrally flattened, finely segmented; wider posteriorly than anteriorly; scolex big, 39.21 µm long, 43.83 µm wide; 4 suckers, 9.23 µm long, 10.38 wide, 5,500µm long. Unilateral genital pores, one per proglottis several eggs per capsule.

***Killigrewia delafondi*** Raillet, 1892 (Plate XIX, Fig. 17)

Body white, elongate, flattened, segmented, wider at posterior than anterior; scolex small, 4 oval shape suckers, scolex 17.99 µm long, 23.53 µm wide, suckers 13.84 µm long, 11.76 µm wide, 5000 µm long. Unilateral genital pores, two per proglottis several eggs per capsule.

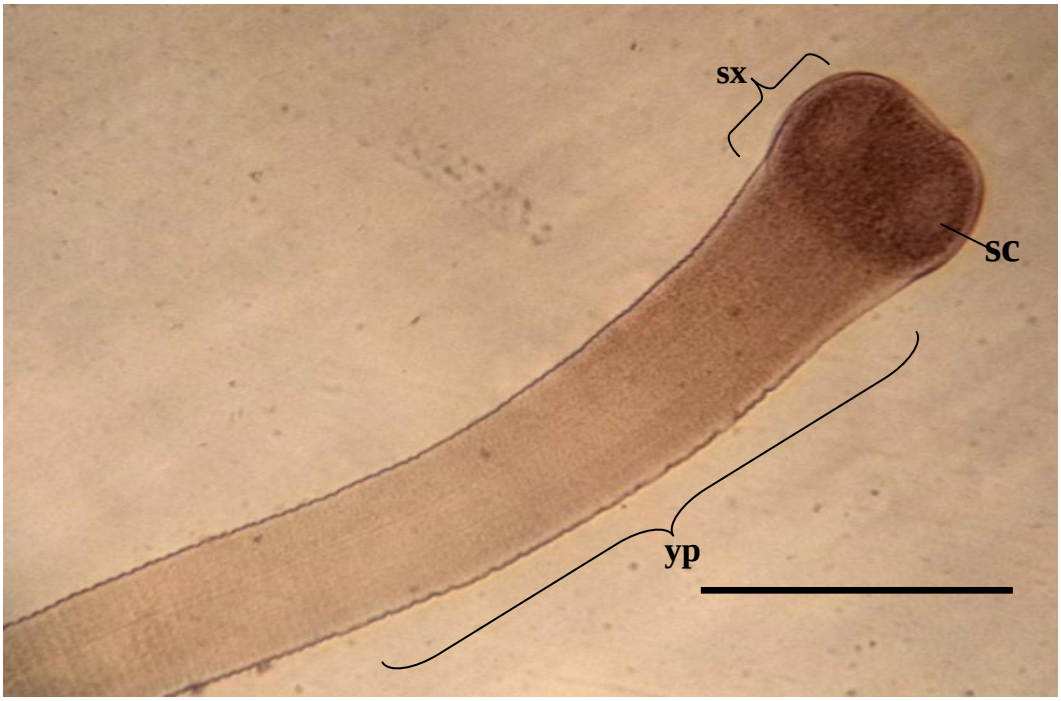



**Plate XIV:** Scolex (sx) and young proglottids (yp) of *Raillietina* species 3 showing two of four suckers (sc)

Scale-bar = 10µm

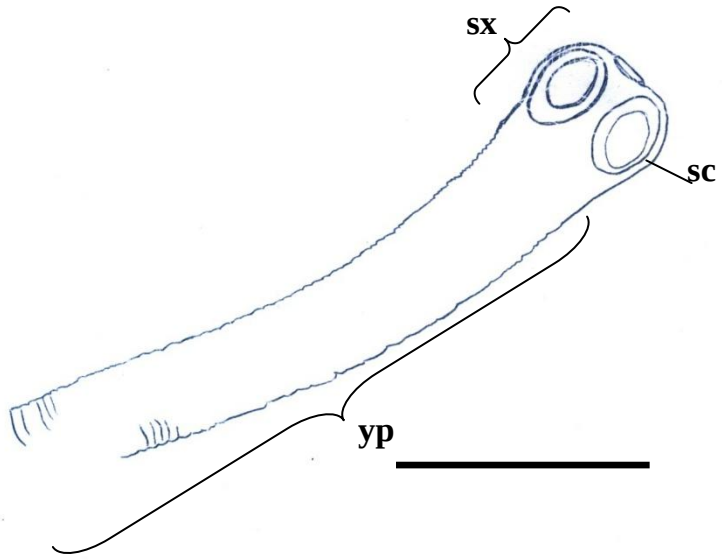



**Fig. 12**: Scolex (sx) and young proglottids (yp) of *Raillietina* species 3 showing two of four suckers (sc)

Scale-bar = 8µm

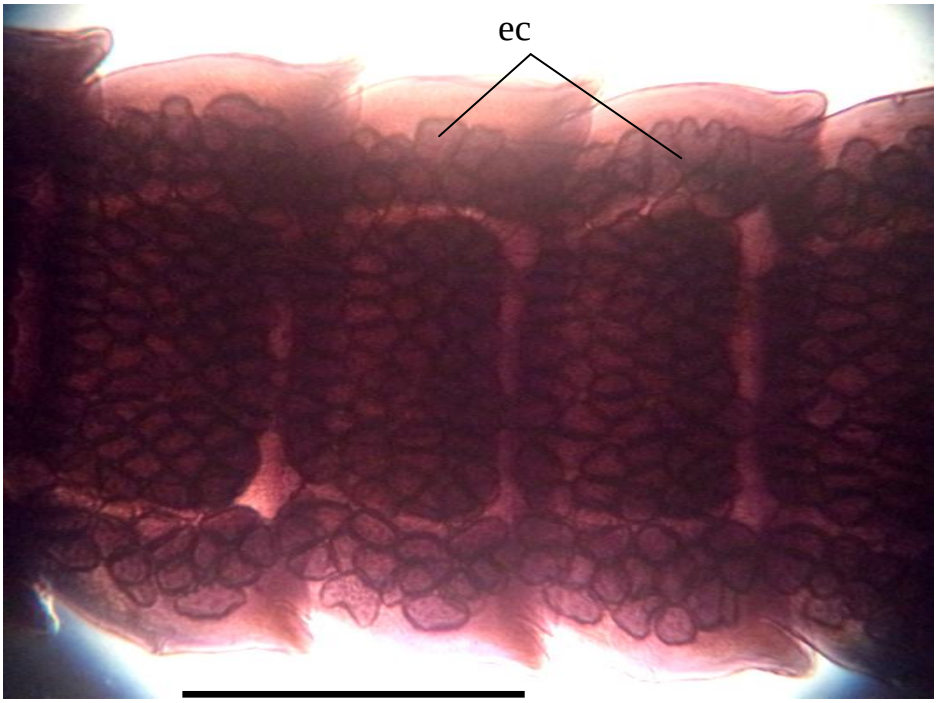
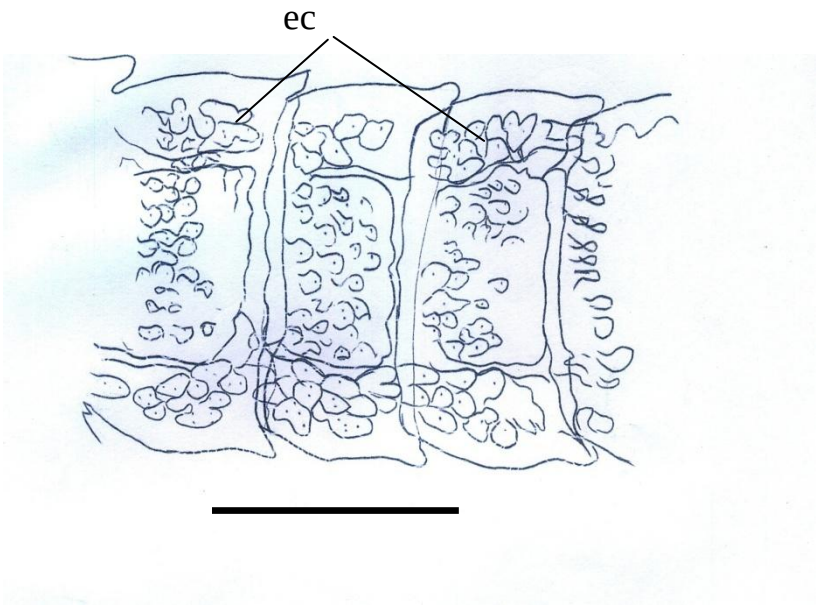



**Plate XV:** Gravid Proglottids of *Raillietina* species 3 showing egg capsules (ec) containing numerous eggs

Scale-bar = 60µm




**Fig, 13**: Gravid Proglottids of *Raillietina* species 3 showing egg capsules (ec) containing numerous eggs

Scale-bar = 40µm

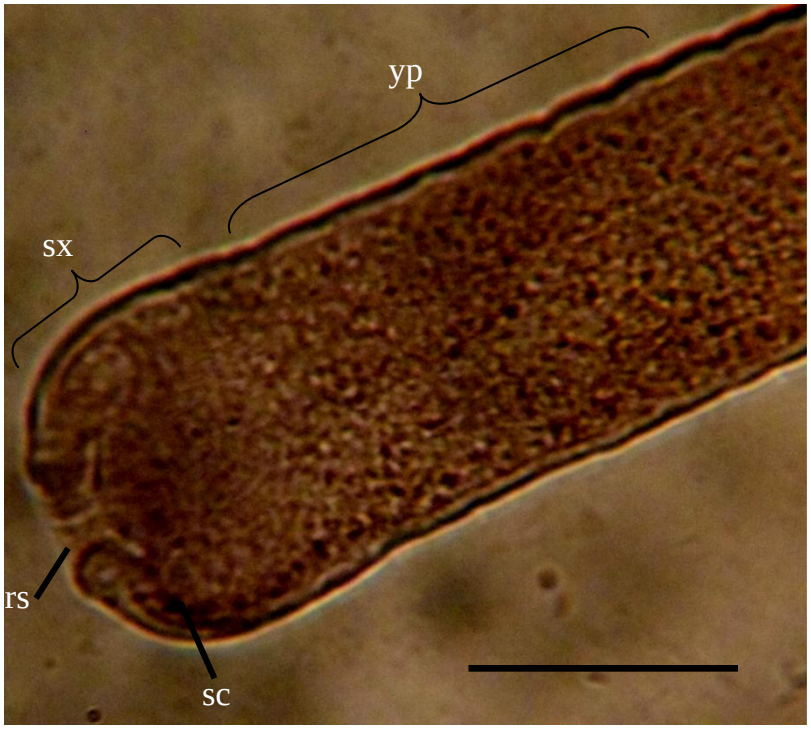



**Plate XVI:** Anterior proglottids (yp) of *Raillietina* species 4 showing scolex (sx), two of four suckers (sc) and a rostellum (rs)

Scale-bar = 15µm

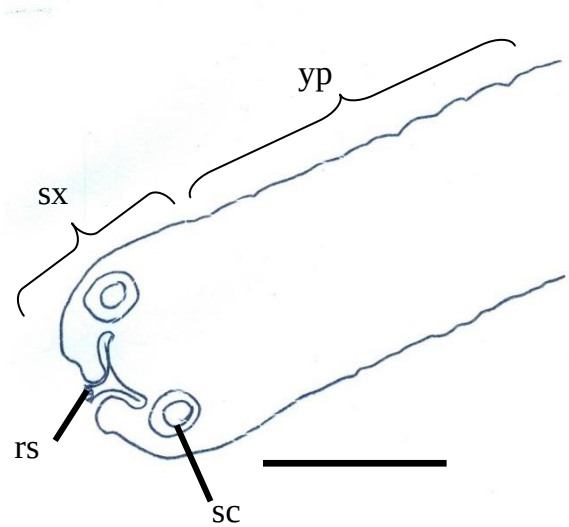



**Fig. 14:** Anterior proglottids (yp) of *Raillietina* species 4 showing scolex (sx), two of four suckers (sc) and a rostellum (rs)

Scale-bar = 10µm

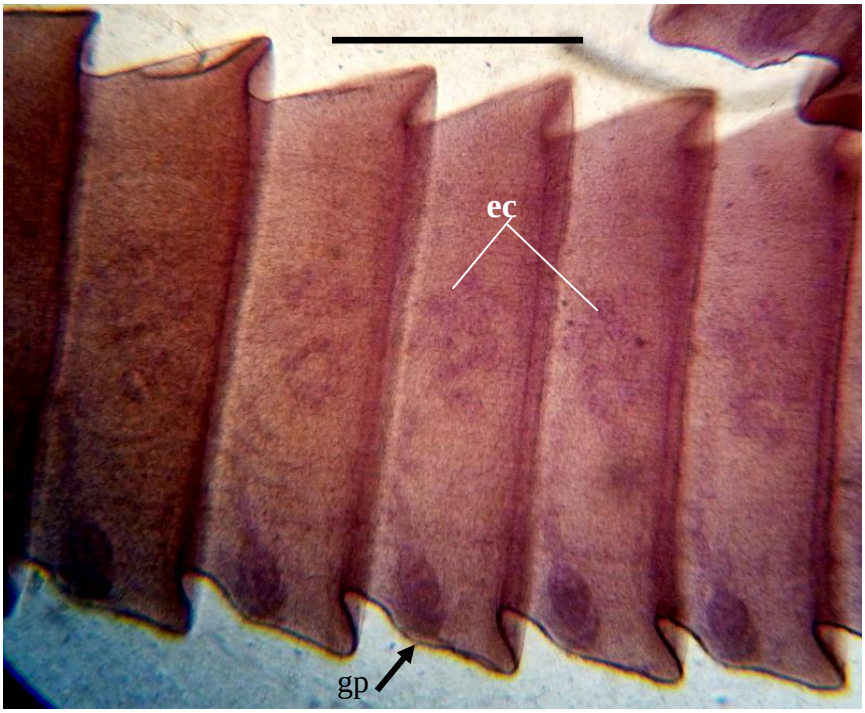



**Plate XVII:** Mature proglottides of *Raillietina* species 4 showing genital pores (gp) and egg capsule (ec)

scale-bar = 12 µm

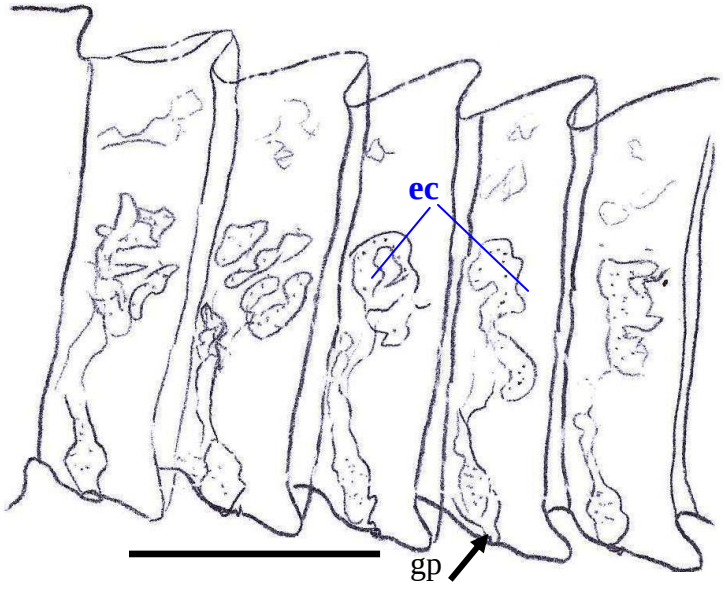



**Fig.15:** Gravid proglottides of *Raillietina* species 4 showing genital pores (gp) and egg capsule (ec)

Scale -bar = 12 µm

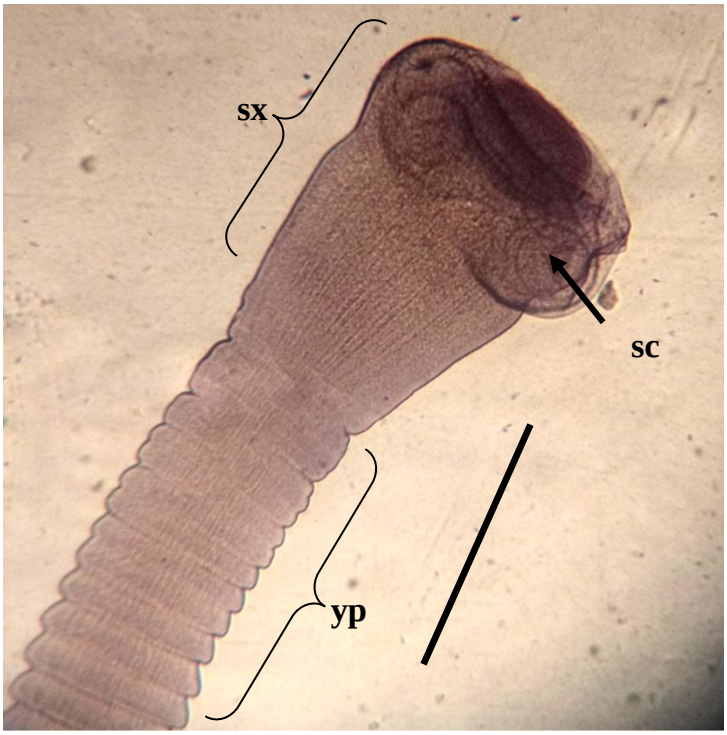



**Plate XVIII:** Anterior portion of *Raillietina* species 5 showing scolex (sx), two of four suckers (sc) and a few young proglottids (yp)

Scale-bar = 25µm

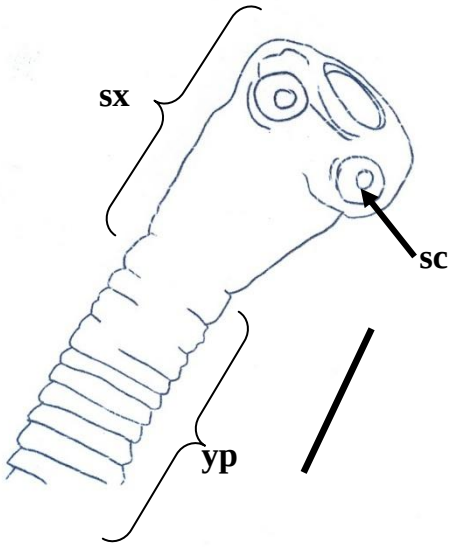



**Fig. 16:** Anterior portion of *Raillietina* species 5 showing scolex (sx), two of four suckers (sc) and a few young proglottids (yp)

Scale-bar = 20µm

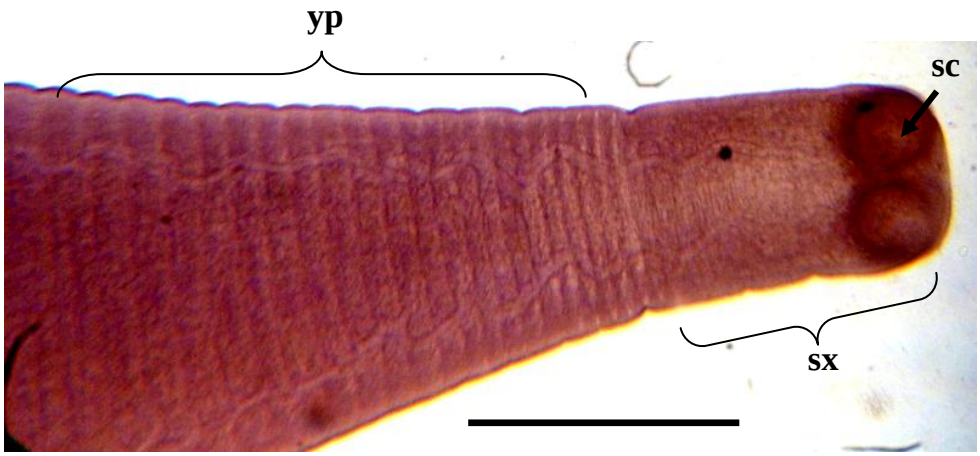



**Plate XIX:** Anterior portion of *Killigrewia delafondi* (synonym *Aporina delafondi*) showing scolex (sx), two of four suckers (sc) and few young proglottids (yp)

Scale-bar = 16µm

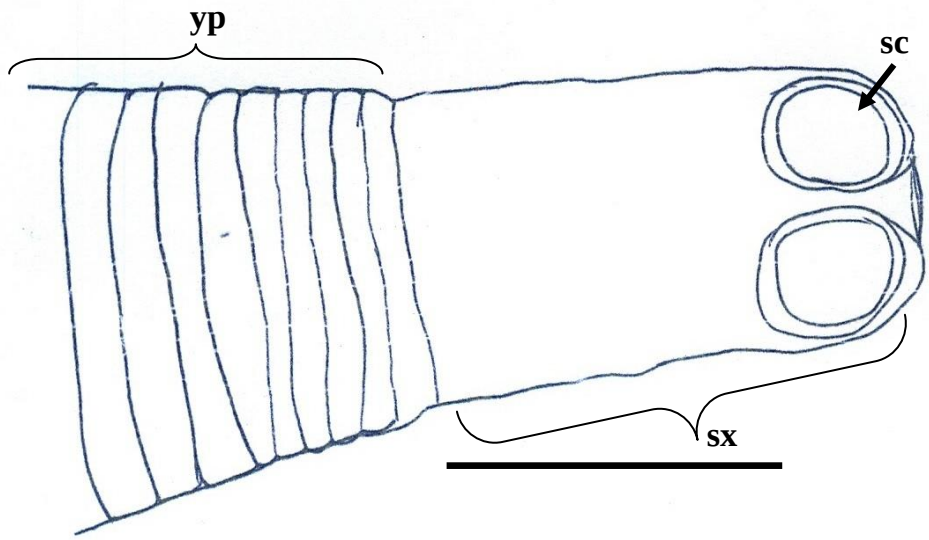



**Fig. 17**: Anterior portion of *Killigrewia delafondi* (synonym *Aporina delafondi*) showing scolex (sx), two of four suckers (sc) and few young proglottids (yp)

Scale-bar = 20µm

***Choanotaenia* species** Bloch, 1779 (Plate XX, Fig. 18 and Plate XXI, Fig.19)

Body white, elongate, dorso-ventrally flattened, segmented, 23mm long; wider posteriorly than anteriorly; scolex small, with 4 ovoid suckers, 25.95 µm long, 17.40 µm wide; sucker10.38 µm long, 10.38 µm wide. Unilateral genital pores, one per proglottis several eggs per capsule.

### 4.4 Ectoparasites and Gastro-Intestinal Helminths Recovered from *Streptopelia senegalensis* and *Columba livia domestica*

Two ectoparasite species, *Goniodes* sp. 5(7.04%), *Columbicola columbae* 2(2.82%) were recovered from *Streptopelia senegalensis* whereas three species, *Goniodes* sp. 18(25.35%), *Columbicola columbae* 14(19.72%) and *Pseudolynchia canariensis* 8(11.27%) were recovered from *Columba livia domestica* (Table 4.2).

Among the gastro-intestinal helminths recovered, only one nematode *Ascaridia galli* 18(25.35%) was recovered and only from *Columba livia domestica* (Table 4.3).

Seven morphologically distinct species of cestodes were recovered as follows: *Raillietina* species 1, 2, 3, 4, and 5 with respective numbers and prevalences of 7(9.86%), 6(8.45%), 3(4.23%), 2(2.82%) and 2(2.82%) from *Streptopelia senegalensis*, and 4(5.63%), 4(5.63%), 3(4.23%), 3(4.23%) and 4(5.63%) from *Columba livia domestica*. The other two species were *K. delafondi* and *Choanotaenia* sp. with respective numbers and prevalences of 3(4.23%), and 4(5.63%) from *Streptopelia senegalensis*, and 2(2.82%), and 3(4.23%) from *Columba livia domestica* (Table 4.3).

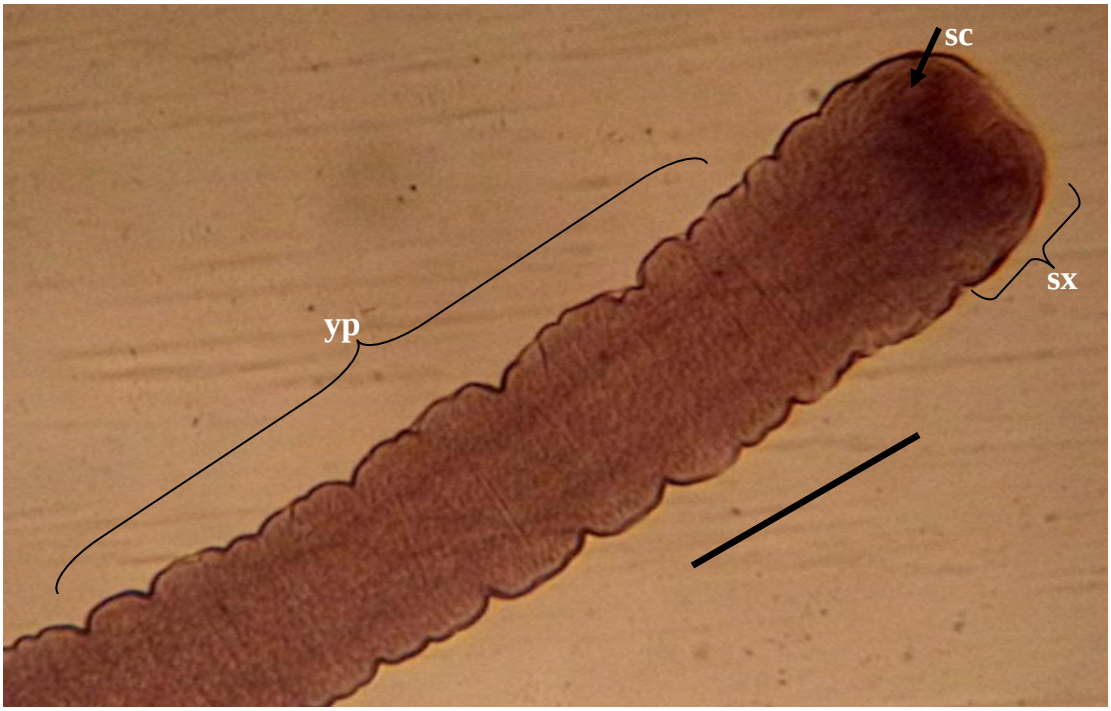



**Plate XX**: Anterior portion of *Choanotaenia* species showing scolex (sx), two of four suckers (sc) and few young proglottids (yp)

Scale-bar = 20µm

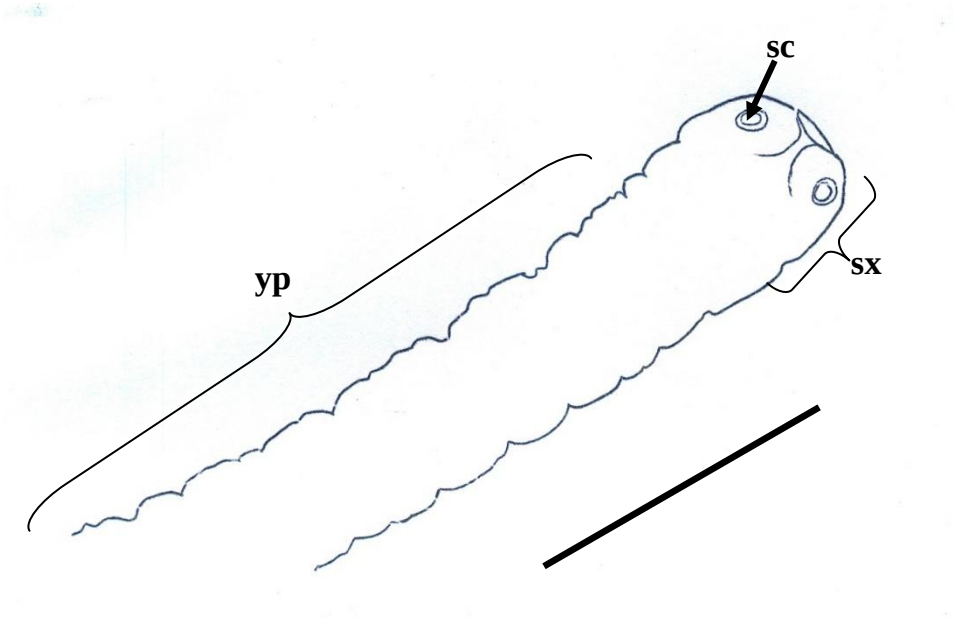



**Fig. 18**: Anterior portion of *Choanotaenia* species showing scolex (sx), two of four suckers (sc) and few young proglottids (yp)

Scale-bar = 20µm

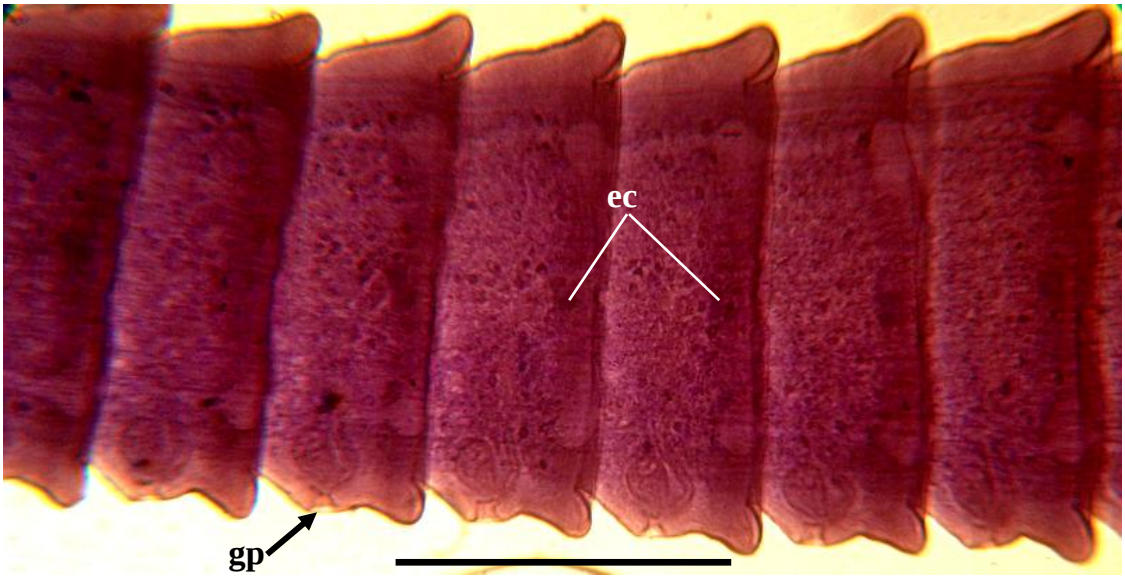



**Plate XXI:** Mature proglottids of *Choanotaenia* sp. showing unilateral genital pores (gp) and egg capsules (ec)

Scale-bar = 14 µm

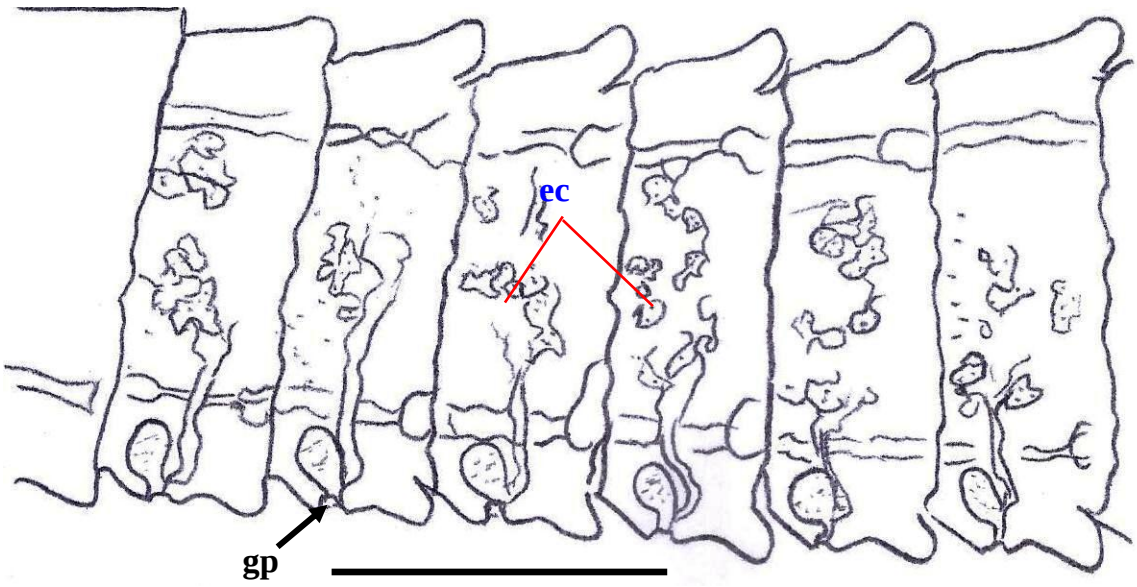



**Fig 19:** Mature proglottids of *Choanotaenia* sp. showing unilateral genital pores (gp) and egg capsules (ec)

Scale-bar = 14 µm

**Table 4.2** Ectoparasites recovered from 71 each of *Streptopelia senegalensis* and *Columba livia domestica.*

| Birds species | Parasites | No. infested (%) | No. of parasites | Range | Intensity (Mean ±SD) |
|---|---|---|---|---|---|
| ***S. senegalensis*** | *Goniodes* sp. | 5 (7.04) | 8 | 1-3 | 1.6±1.0 |
| | *Columbicola columbae* | 2 (2.82) | 4 | 1-2 | 2.0±1.4 |
| ***C. livia domestica*** | *Goniodes* sp. | 18 (25.35) | 75 | 2-6 | 4.2±2.6 |
| | *Columbicola columbae* | 14 (19.72) | 66 | 1-4 | 4.7±2.2 |
| | *Pseudolynchia canariensis* | 8 (11.27) | 24 | 2-4 | 3.0±1.9 |

**Table 4.3** Summary of helminth infestation of *Streptopelia senegalensis* (n=71) and *Columba livia domestica* (n=71).

| Bird species | Helminth Phylum | Parasites | No. infested (%) | No. of Parasites | Range | Intensity (mean ±SD) |
|---|---|---|---|---|---|---|
| ***Streptopelia senegalensis*** | Cestoda | *Raillietina* sp. 1 | 7 (9.86) | 89 | 3-7 | 12.71±10.6 |
| | | *Raillietina* sp. 2 | 6 (8.45) | 57 | 2-8 | 9.50±6.3 |
| | | *Raillietina* sp. 3 | 3 (4.23) | 78 | 1-5 | 26.00±8.2 |
| | | *Raillietina* sp. 4 | 2 (2.82) | 18 | 1-3 | 9.00±2.8 |
| | | *Raillietina* sp. 5 | 2 (2.82) | 61 | 3-6 | 30.50±17.7 |
| | | *K. delafondi* | 3 (4.23) | 15 | 1-4 | 5.00±2.0 |
| | | *Choanotaenia sp.* | 4(5.63) | 39 | 2-4 | 9.75±2.4 |
| | Nematoda | ___ | 0(0%) | 0 | 0 | 00±00 |
| ***Columba livia domestica*** | Cestoda | *Raillietina* sp. 1 | 4 (5.63) | 131 | 4-6 | 32.75±16.9 |
| | | *Raillietina* sp. 2 | 4 (5.63) | 128 | 3-7 | 32.00±14.4 |
| | | *Raillietina* sp. 3 | 3 (4.23) | 92 | 2-5 | 30.67±5.7 |
| | | *Raillietina* sp. 4 | 3 (4.23) | 87 | 1-6 | 29.00±6.2 |
| | | *Raillietina* sp. 5 | 4 (5.63) | 57 | 2-4 | 24.25±4.3 |
| | | *K. delafondi* | 2 (2.82) | 12 | 1-3 | 6.00±2.8 |
| | | *Choanotaenia* sp. | 3 (4.23) | 52 | 1-4 | 17.33±12.0 |
| | Nematoda | *A. galli* | 18 (25.35) | 156 | 3-8 | 8.67±11.29 |

### 4.5 Ectoparasites and Helminths in *Streptopelia senegalensis* and *Columba livia domestica*

Out of 71 of each of the two birds examined, 7(9.86%) and 43 (60.57%) *S. senegalensis* and *C. livia domestica* respectively, were infested with ectoparasites (Fig. 22).

Significantly more *C. livia domestica* than *S. senegalensis* were infested by ectoparasites ($P<0.05$); the prevalence of cestodes in *S. senegalensis* was higher than in *C. livia domestica* (52.11% versus 32.39%), the difference in prevalence was not significant ($P>0.05$); of the two birds, only *C. livia domestica* was infested by one nematode (25.35%), which was completely absent from *S. senegalensis* (Fig. 20).

Odd's Ratio showed *S. senegalensis* to be significantly associated with ectoparasite and cestode infestations (5.629 to 35.021), (1.149 to 4.488) while *C. livia domestica* was not (0.029 to 0.178) (0.223 to 0.870) (Appendix III).

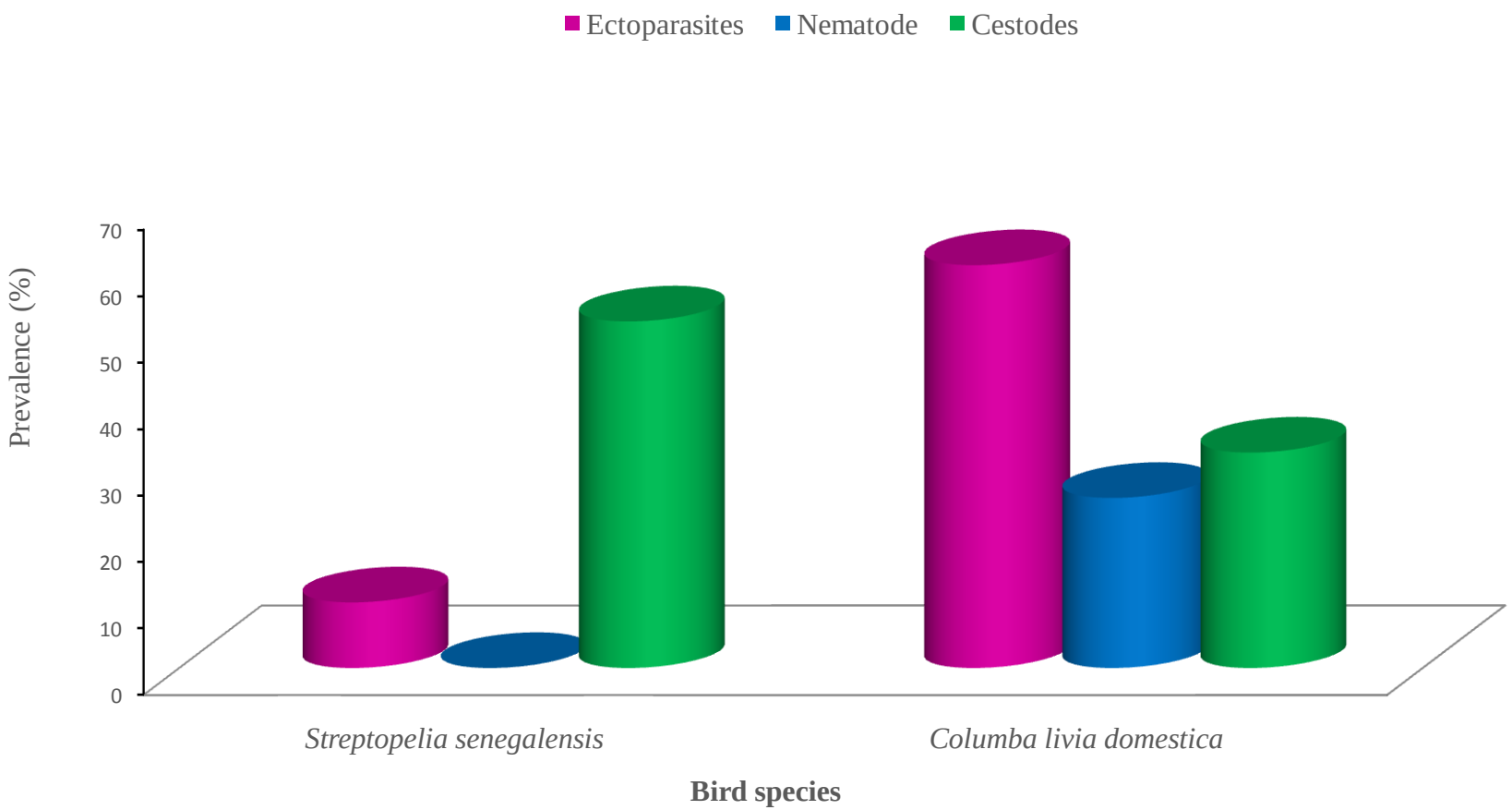



**Fig. 20:** Overall prevalence of ectoparasites and helminths of *Streptopelia senegalensis* and *Columba livia domestica.*

### 4.6 Ectoparasite and Helminth Infestations of Male and Female*Streptopelia senegalensis* and *Columba livia domestica*

A total of 41 male and 30 female birds were examined out of which 3(7.32%) males and 4(13.33%) females of *Streptopelia senegalensis* were infested; although more females than males were infested, the difference was not significant (P>0.05). A total of 32 males and 39 females *Columba livia domestica* were examined, out of which 16 (50.00%) males and 27(69.23%) females were infested. More females than males were infested and the difference in prevalence was significant (P<0.05) (Fig. 21).

24(58.54%) male and 13(43.33%) female *S. senegalensis* were infested with cestodes only and no other helminth. Male birds harbored more cestodes than females but the difference was not significant (P>0.05). In *Columba livia domestica*, a total of 32 males and 39 females were examined, 5(15.63%) males and 13(33.33%) females were infested with nematodes and 7(21.86%) males and 16(41.03%) females were infested with cestodes. More female birds harbored the two helminths than males but the difference was not significant (P>0.05) (Fig.21).

Ectoparasite and cestode infestations in *S. senegalensis* had no significant association with male and female infestation with respective Odd's Ratio confidence interval (0.402 to 9.441; 0.209 to 1.404) and (0.106 to 2.486; 0.712 to 4.768). Similarly, 0.852 to 5.941; 0.843 to 8.643 and 0.867 to 7.124 males and 0.168 to 1.173; 0.116 to 1.186 and 0.140 to 1.154 females Odd's Ratio confidence intervals indicate no significant association of infestation with ectoparasites, cestodes and nematodes respectively in *C. livia domestica* (Appendix V).

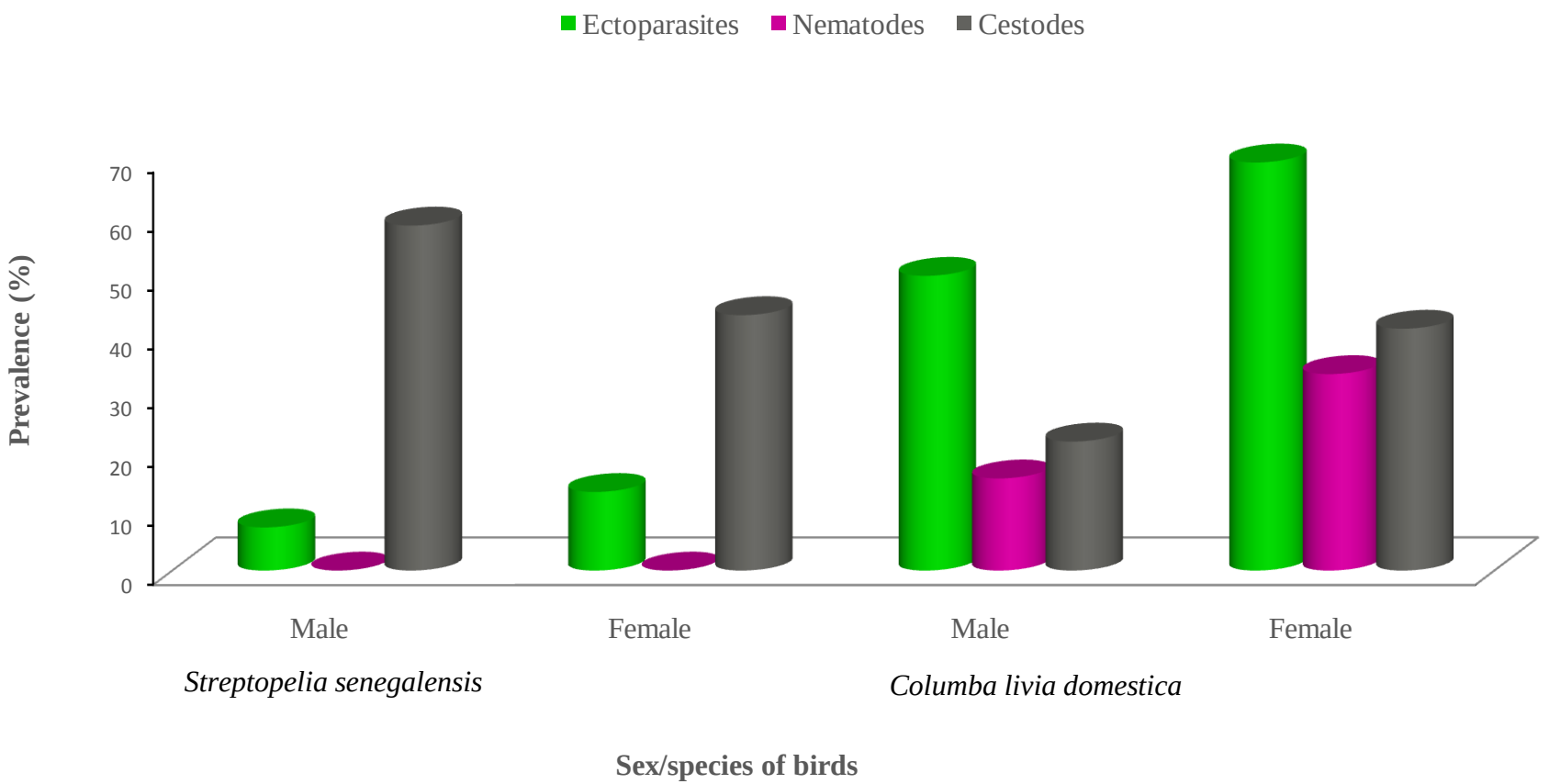



**Fig. 21:** Prevalence of ectoparasites and helminths in male and female *Streptopelia senegalensis* and *Columba livia domestica*

### 4.7 Seasonal Occurrence of Ectoparasites and Helminths on *Streptopelia senegalensis* and *Columba livia domestica*

Ectoparasites were recovered in the wet and dry seasons from *Streptopelia senegalensis*; the prevalences in the wet season 4(12.12%) and 3(7.89%) in the dry season were relatively low and the slight difference between them was not significant (P>0.05); similarly, in *Columba livia domestica* the highest prevalence occurred in the dry season 22(62.86%) and lowest 21(58.33%) in the wet season; the prevalences were similar and not significantly different (P>0.05).

Cestodes were also recovered during wet and dry seasons from *Streptopelia senegalensis* with similar prevalences of 51.52% and 52.63% respectively, and as expected, the difference was not significant (P>0.05). Nematodes and cestodes were both recovered in the wet and dry seasons from *Columba livia domestica*; the higher prevalence (36.11%) of the only nematode recovered was obtained in the wet season and the lower prevalence (14.29%) in the dry season, but the difference was not significant (P>0.05). Similarly, cestodes had the higher prevalence of 16(44.44%) in the wet season and the lowest 9(20.00%) in the dry season; also the difference was not significant (P>0.05) (Fig. 22).

Odd's Ratio confidence interval of 0.129 to 3.004; 0.411 to 2.660 in the wet season and 0.243 to 5.685; 0.204 to 1.356 in the dry season shows no significant association with ectoparasite and cestodes infestations in *S. senegalensis*. Meanwhile, Odd's Ratio confidence interval (1.140 to 11.771) and (1.209 to 10.069) shows significant association with nematode and cestode infestation in the dry season respectively in *C. livia domestica* but they were not significantly associated to the wet season (0.092 to 0.946); (0.109 to 0.900) respectively. Similarly, there was no significant association

with ectoparasites in the wet (0.466 to 3.136) and dry (0.368 to 2.473) seasons in *C. livia domestica* (Appendix IV).

### 4.8 Single and Mixed Infestations by Ectoparasites on *Streptopelia senegalensis* and *Columba livia domestica*

Single infestation had a prevalence of 6 (8.45%) and 1(1.41%) for two or double infestation on *Streptopelia senegalensis* (Table 4.4); single infestation had a prevalence of 15(21.13%) and 17(23.94%) for double infestation on *Columba livia domestica* (Table 4.4).

### 4.9 Single and Mixed Infestations with Cestodes in *Streptopelia senegalensis* and *Columba livia domestica*

Prevalences of 4.23%, 19.71% and 14.08% for single, double and triple infestations respectively occurred in *Streptopelia senegalensis* (Table 4.5); prevalences of 2.83%, 18.31% and 11.28% were obtained in *Columba livia domestica* for single, double and triple (Table 4.6).

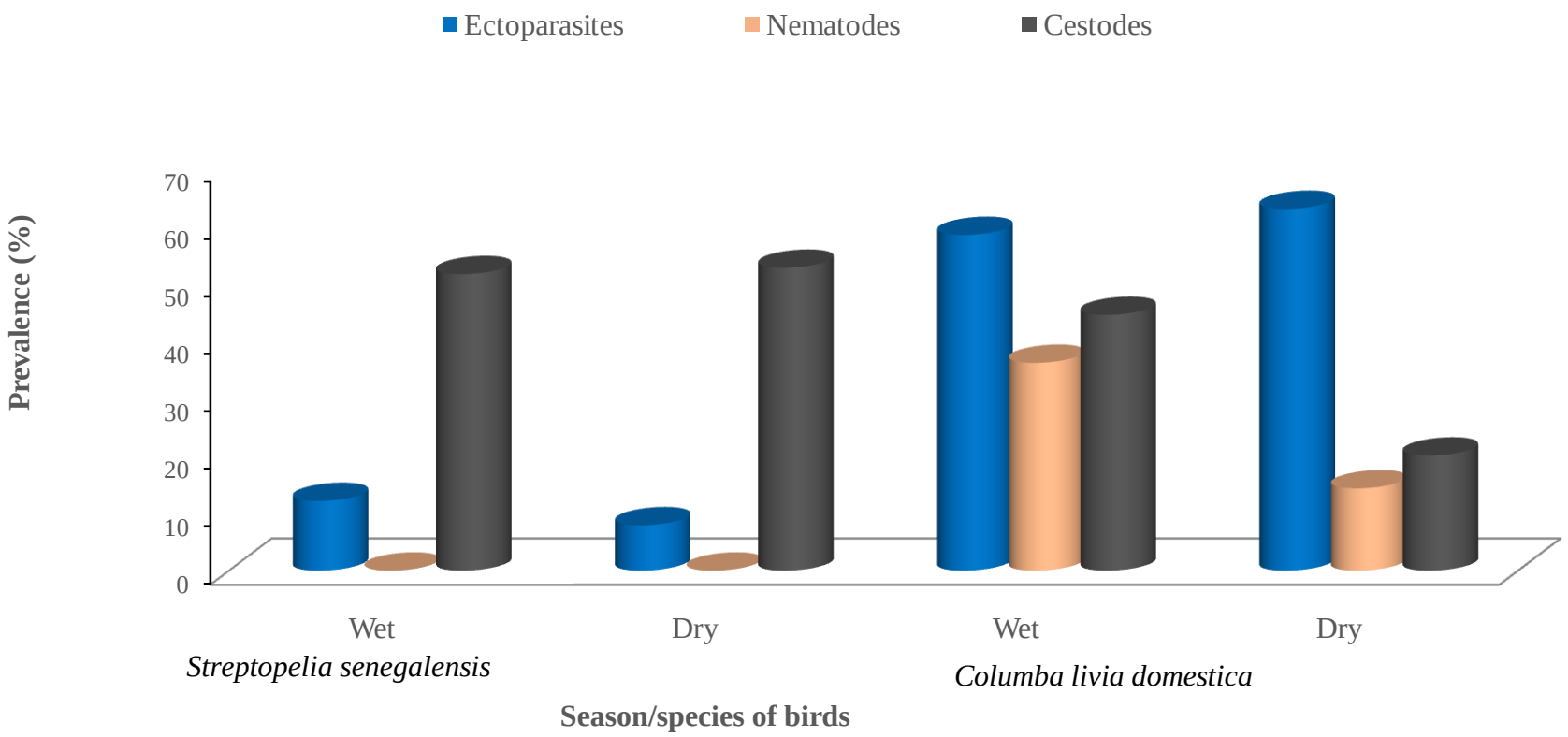



**Fig.22:** Seasonal prevalences of ectoparasites and helminths of *Streptopelia senegalensis* and *Columba livia domestica.*

**Table 4.4** Single and mixed infestations by ectoparasites on *S. senegalensis* and *C. livia domestica* (n=71).

| Birds species | Infestation type | Parasites | No. infested | Prevalence (%) |
|---|---|---|---|---|
| ***S. senegalensis*** | Single | *Goniodes* sp. | 4 | 8.45 |
| | | *Columbicola columbae* | 2 | |
| | Double | *Goniodes* sp. | | |
| | | *Columbicola columbae* | 1 | 1.41 |
| ***C. livia domestica*** | Single | *Goniodes* sp. | 9 | |
| | | *Columbicola columbae* | 6 | 21.13 |
| | | *Pseudolynchia canariensis* | 0 | |
| | Double | *Goniodes* sp. | | |
| | | *Columbicola columbae* | 12 | |
| | | *Pseudolynchia canariensis* | | 23.94 |
| | | *Columbicola columbae* | 5 | |
| | Triple | *Goniodes* sp. | | |
| | | *Columbicola columbae* | | |
| | | *Pseudolynchia canariensis* | 4 | 5.63 |

**Tables 4.5** Single and mixed infestations by cestodes in *S. senegalensis* (n=71).

| Birds species | Infestation type | Parasites | No. infested | Prevalence (%) |
|---|---|---|---|---|
| ***S. senegalensis*** | Single | *K. delafondi* | 3 | 4.23 |
| | Double | *Choanotaenia* sp. | 7 | |
| | | *Raillietina* sp. 3 | | |
| | | *Raillietina* sp. 4 | | |
| | | *Raillietina* sp. 2 | 4 | 19.71 |
| | | *Raillietina* sp.1 | | |
| | | *Raillietina* sp. 5 | 3 | |
| | Triple | *Raillietina* sp. 5 | | |
| | | *Raillietina* sp. 2 | 6 | |
| | | *Raillietina* sp. 4 | | 14.08 |
| | | *Raillietina* sp. 3 | | |
| | | *Raillietina* sp. 1 | 4 | |
| | | *Choanotaenia* sp. | | |

**Table 4.6** Single and mixed infestations by cestodes in *C. livia domestica* (n=71).

| **Bird species** | **Infestation type** | **Parasites** | **No. infested** | **Prevalence (%)** |
|---|---|---|---|---|
| ***C. livia domestica*** | Single | *K. delafondi* | 2 | 2.83 |
| | Double | *Raillietina* sp. 5 | | |
| | | *Raillietina* sp.1 | 3 | |
| | | *Raillietina* sp. 2 | | |
| | | *Raillietina* sp. 4 | 5 | |
| | | | | 18.31 |
| | | *Choanotaenia* sp. | | |
| | | *Raillietina* sp.1 | 3 | |
| | | *Raillietina* sp.1 | | |
| | | *Raillietina* sp.2 | 2 | |
| | Triple | *Raillietina* sp. 5 | | |
| | | *Raillietina* sp.1 | 5 | |
| | | *Choanotaenia* sp. | | |
| | | | | 11.28 |
| | | *Raillietina* sp. 4 | | |
| | | *Raillietina* sp.3 | 3 | |
| | | *Raillietina* sp.2 | | |

### 4.10 Ectoparasite and Gastro-Intestinal Helminth Infestations of *Streptopelia senegalensis* and *Columba livia domestica* According to Weight

The weights of *Streptopelia senegalensis* ranged from 40 – 100g. The highest ectoparasite prevalence [3(15.0%)] was recorded in the weight class 71-80g and the highest cestode prevalence [13(65.0%)] was recorded in the same weight class of *Streptopelia senegalensis* (Table 4.7). The weights of *Columba livia domestica* ranged from 140 – 300g. The highest ectoparasites prevalence [8(88.9%)] was recorded in the weight class 201-220g and the highest cestode and nematode prevalences [6(66.7%)] and [2(100%)] were recorded in weight class 181-200g and 281-300g of *C. livia domestica* respectively (Table 4.8).

**Table 4.7** Ectoparasite and gastro-intestinal helminth infestations of *Streptopelia senegalensis* according to weight

| **Weight interval (g)** | **No. of birds examined** | **No. infested by Ectoparasites (%)** | **No. infested by Cestodes (%)** |
|---|---|---|---|
| **40-50** | 4 | 0 | 0 |
| **51-60** | 7 | 0 | 2(28.5) |
| **61-70** | 12 | 1(8.3) | 4(33.3) |
| **71-80** | 20 | 3(15.0) | 13(65.0) |
| **81-90** | 18 | 2(11.1) | 12(66.6) |
| **91-100** | 10 | 1(10.0) | 6(60.0) |

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**Table 4.8** Ectoparasite and gastro-intestinal helminth infestations of *Columba livia domestica* according to weight

| Weight interval (g) | Number of birds examined | Number infested by Ectoparasites (%) | Number infested by Cestodes (%) | Number infested by Nematodes (%) |
|---|---|---|---|---|
| **140-160** | 1 | 1(100) | 0(0.0) | 0(0.0) |
| **161-180** | 2 | 1(50.0) | 0(0.0) | 0(0.0) |
| **181-200** | 9 | 4(44.4) | 6(66.7) | 2(22.2) |
| **201-220** | 9 | 8(88.9) | 0(0.0) | 0(0.0) |
| **221-240** | 22 | 15(68.2) | 8(36.4) | 9(40.9) |
| **241-260** | 15 | 8(53.3) | 6(40.0) | 3(20.0) |
| **261-280** | 10 | 6(60.0) | 6(60.0) | 3(30.0) |
| **281-300** | 2 | 2(100) | 1(50) | 2(100) |

# CHAPTER FIVE

## 5.0 DISCUSSION

A variety of ectoparasitic arthropods (three species) and gastro-intestinal helminths comprising one nematode (Nematoda) and seven cestode (Platyhelminthes) species were recovered in appreciable numbers from Laughing doves and Domestic pigeons in this study. The parasites have previously been reported in similar studies and surveys around the world (Senlik *et al.,* 2005, Marques *et al.,* 2007, Sabuni *et al.,* 2010 and Borji *et al*., 2012) and in the study area (Shotter, 1978; Oniye *et al.,* 2001; Adang *et al*., 2008; Natala *et al*., 2009). The parasites were encountered in/on various parts of the birds and their prevalences varied from species to species.

The ectoparasites (*Gonoides* sp., *Columbicola columbae* and *Pseudolynchia canariensis*) have been reported previously in the study area (Shotter, 1978; Adang *et al.,* 2008 and Natala *et al.,* 2009) but no descriptions were given; it was therefore not possible to compare the material obtained in this study with theirs. Reports have shown that the Pigeon fly *Pseudolynchia canariensis* has been recorded on a Lizard buzzard from Lake Kariba in Zimbabwe (Shotter, 1978). This implies that although it is called the Pigeon fly, it is not restricted to pigeons but has a wider host range.

Among the cestodes, five species of *Raillietina* were recovered in this study. Oniye *et al*. (2001); Adang *et al*. (2008); Natala *et al*. (2009) and Abdulhamid (2014) also recovered an unspecified number of *Raillietina* species during similar studies in the study area. Neither measurements nor descriptions of the parasites were presented by the researchers for comparison with those recovered in this study. The two other cestodes recovered here, *Choanotaenia* sp., and *Killigrewia delafondi* (as *Aporina delafondi*) were also

reported previously in the study area (Oniye *et al*., 2001 and Natala *et al.*, 2009), in other parts of Nigeria (Dadi-Mamud *et al*., 2012) and in Turkey (Senlik *et al*., 2005). *Killigrewia delafondi* from Columbiformes was formerly a synonym of *Aporina delafondi* but Beveridge (1994) validated *K. delafondi*, and restricted *A. delafondi* to parakeets in South America and considered *K. delafondi* to occur in other birds, especially columbids, around the world.

In addition to similar helminths obtained in this study, Shotter (1978) reported a digenean in the genus *Echinostoma* (*E. revolutum*) in Zaria, which he said was the first record in Africa. Judging from the 92% prevalence of infestation he recorded, cestodes appear to be the most important parasites of Speckled pigeon.

The only nematode recovered, *Ascaridia galli*, was previously reported by Adang *et al*. (2008), however, no descriptions/measurements were given for comparison. *Ascaridia galli* has also been reported in other parts of Nigeria (Dadi-Mamud *et al*., 2012 in Lapai and Adelusi *et al*., 2014 in Markurdi) and in other parts of the world (Mushi *et al*., 2000 in Sabele, Botswana; Senlik *et al*., 2005 in Turkey; Marques *et al*., 2007 in Egypt; Sabuni *et al*., 2010 in Kenya). However, it is not possible to say whether *A. galli* reported in these studies is morphologically similar to what was obtained in this study, since no descriptions were given. Its wide distribution implies that it is a major helminth infecting pigeons and doves as observed by Soulsby (1982). The *Killigrewia delafondi* recovered in this study is morphologically similar to that reported previously by Abdulhamid (2014) as *Aporina delafondi* from *Streptopelia semitorquata* in the study area.

The overall ectoparasite prevalences of 60.56% and 9.86% obtained on *C. livia domestica* and *S. senegalensis* respectively, are lower than 72.0% of Senlik *et al*. (2005)

on *C. livia domestica* in Bursa Province, Turkey. The environment, climatic conditions and number of birds examined (71 versus 100) might explain the reason for the variations. Adang *et al.* (2009a) obtained a similar prevalence of 60.0% when he examined 30 Speckled pigeon as obtained in *C. livia domestica,* in this study.

The significant association of *S. senegalensis* with ectoparasite and cestode infestations might be attributed to the fact that they are wild and thereby fly around freely, far and wide, in search of food and suitable nesting site, which might have exposed them more to these parasites, unlike *C. livia domestica*, which are domesticated and fed, with their cages/nests cleaned regularly, thereby reducing their chances of being infested.

The higher prevalence of ectoparasites on *C. livia domestica* obtained in the wet season compared to *S. senegalensis* in the same season (58.33% versus 12.12%) could be attributed to dirty cages of the former and their interaction with other domestic birds. Similarly, a higher prevalence of ectoparasites (62.86%) on *C. livia domestica* than on *S. senegalensis* (7.89%) in the dry season could be attributed to the ability of *C. livia domestica* to form large gregarious flocks which may increase the contact between individuals, thereby enhancing intra-specific transfer/exchange of ectoparasites. The ability of *C. livia domestica* to form large gregarious flocks may also account for the higher prevalence of ectoparsites in the dry season compared to the wet season.

The statistically significant difference in prevalence found between the ectoparasites of *C. livia domestica* and *S. senegalensis* all through the period of study, can be attributed to the different rates of interaction of the two birds with other domestic birds such as chickens, turkey, and ducks (Natala *et al*. 2009), since the former are domesticated and usually raised commercially. The handling of these birds in the market and how they

were observed to be kept between cages of other domestic birds coming from different places, might probably contribute to the higher prevalence recorded in this study.

The three ectoparasites recovered in this study (*Gonoides* sp., *Columbicola columbae* and *Pseudolynchia canariensis*) have been reported previously in Zaria by Shotter (1978), Adang *et al*. (2008) and Natala *et al*. (2009). In addition to these three, Adang *et al*. (2008) found two others, *Argas persicus* Oken, 1818 and *Menopon gallinae* Linnaeus, 1758, which were also reported by other researchers in Zaria (e.g., Shotter, 1978 and Natala *et al*., 2009). Soulsby (1982) stated that they were among the major ectoparasites of doves and pigeons. The fact that *C. livia domestica* in this study had more species of ectoparasites than *S. senegalensis* may be related to the former exploiting a wider range for feeding, roosting, nesting and territoriality, therefore coming in contact with these parasites, as noted by Goodwin (1983). It can also be attributed to the extent of interaction with other domestic birds.

The slightly lower prevalence of infestation by ectoparasites on *C. livia domestica* obtained in this study than by Adang *et al*. (2008), (60.57% versus 73.8%), can be attributed to the fact that fewer birds were examined in this study than by Adang *et al*. (2008) (71 versus 240). The prevalence obtained for *S. senegalensis* in this study (9.86%) is also lower than what was obtained by Adang *et al*. (2008) (23.0%). This might also be related to the higher number of birds examined by the latter.

Prevalences of ectoparasite mixed and single infestations on *C. livia domestica* were similar (23.94 and 21.13% respectively) but showed a slight difference in *S. senegalensis,* in which single infestation was more prevalent. The slightly higher prevalence of single infestation than mixed infestation in *S. senegalensis* may probably be due to the habit of aggregation and interaction with other birds in *C. livia domestica,*

which is not the case in the former. Similar findings have been reported by Petryszak *et al*. (2000), Mushi *et al*. (2000) and Senlik *et al*. (2005).

Comparatively higher prevalence of ectoparsites on males of *C. livia domestica* than males of *S. senegalensis* (50.00% versus 7.32%), similarly, females *C. livia domestica* harbored more of these ectoparasites than females of *S. senegalensis* (69.23% versus 13.33%). This could be attributed to the close interaction of *C. livia domestica* with other domestic birds such as chickens, ducks, turkeys and also to the ectoparasites that have remained for a long time in their cages thereby influencing reinfestation.

The prevalence of cestodes recorded in this study (32.39%) in *C. livia domestica* is lower than the 43.4% recorded by Abdu *et al.* (2004); 86.0% by Atsineka and Banke (2006) and 73.3% recorded by Adang *et al*. (2008). Similarly, the prevalence of 52.11% obtained in *S. senegalensis* is lower than 62.5% recorded by Dede and Richards (1998), and 69.2% recorded by Oniye *et al.* (2001); but slightly higher than 44.0% reported by Gadzama *et al.* (2005) on *S. senegalensis*. The variations in prevalence of cestodes obtained in this study and previous reports may be related to the availability and abundance of intermediate hosts or infective stages of the parasites, as well as the number of birds examined.

The crop contents of the birds under study indicates that they feed on grains, however, cestodes, which occurred in abundance in both birds are known to use arthropods as intermediate hosts (Soulsby, 1982). No arthropods were found in the crop contents of the birds, any such arthropods might have been missed during examination as a result of their partial breakdown. Although, Abdulhamid (2014) recovered unidentified ants in the crop of *S. semitorquata* and suggested that they could be intermediate host of the cestodes.

The diets of birds have been known to determine, to a great extent the composition of their parasitic fauna (Malhotra and Capoor, 1980). Pigeons feed on grains of all kinds as well as on insects and other invertebrate organisms (Adang, 1999), which may carry infective stages of these parasites.

Similar prevalences of cestodes in *S. senegalensis* were obtained in the dry season and in the wet season (52.63% versus 51.52%) even though a higher prevalence was obtained in the wet season in *C. livia domestica* than in the dry season (44.44% versus 20.00%). The variation in prevalence between seasons might probably be attributed to availability of intermediate host which are said to influence the infestation rate of these birds Soulsby (1982).The number of birds examined might also explain the reason for the variation.

The significant association of *C. livia domestica* with cestode and nematode infestations in the dry season implies that the rate of their interaction with other domestic birds and ability to form large gregarious flock, might have increased their chance of being infested. It can also be related to the harvest period where there is abundant supply of food items/materials on which they feed indiscriminately, increasing their chances of picking the infective stages of the cestode.

Among the cestodes identified (to Generic and specific rank) in this study (*Raillietina* sp. 1, *Raillietina* sp. 2, *Raillietina* sp. 3, *Raillietina* sp. 4, and *Raillietina* sp. 5, *K. delafondi*, and *Choanotaenia* sp.), *Raillietina* species, *K. delafondi Choanotaenia* sp. have been reported by other researchers in Zaria (Adang *et al.*, 2009a and Abdulhamid, 2014) and other parts of the world Mushi *et al.,* 2000 and Senlik *et al.,* 2005). This is an indication of a wide distribution of the parasites among columbids and geographical zones (Kennedy, 1975 cited by Adang *et al*., 2009b).

*Raillietina* species dominated the cestode recovery in this study. This agrees with the findings of Shahin *et al*. (2011) who reported up to four species of *Raillietina* namely; *R. tetragona, R. echinobothrida, R. cesticillus* and *R.* species 4 in Egypt and Abdulhamid (2014) who reported three species namely *Raillietina* species 1, 2 and 3 in *Streptopelia semitorquata* in Zaria.

The recovery of helminths (cestodes and nematodes) from mainly the duodenum especially its loop, small intestine suggests site specificity, providing nutrition and conducive environment for the parasites. Cestodes do not have a gut and would therefore live in an environment (such as the duodenum) where digested food is ready for absorption through their tegument (Kennedy, 1975 cited by Adang *et al*., 2009b).

The occurrence of mixed infestation with cestodes in this study suggests that different species of cestodes can coexist in the same general part of the gut but occupying different nutritional niches as observed by Kennedy, 1975 cited by Adang *et al*. (2009b).
This may explain the occurrence of mixed infestations by *Raillietina* spp., *K. delafondi*, and *Choanotaenia* sp. in *S. senegalensis* and *C. livia domestica.* According to Kennedy (1975), inter-specific competition can occur and is usually detrimental to one or both species but is fairly rare and occurrence is of little significance in controlling the size and diversity of parasite populations. Atsineka and Banke (2006) reported more mixed infestations than single infestation, similarly Audu *et al*. (2004) also reported double infestation (cestodes and other helminths) to be higher than single infestation and triple infestation. Single infestation seems to be more favoured than mixed infestation, though it may appear as if there is no definite pattern of infestation.

*Ascaridia galli*, the only nematode species recovered from *C. livia domestica* in this study, was previously reported by Dede and Richards (1998); Audu *et al.* (2004) and Adang *et al*. (2009b) in *C. livia domestica.* The birds do not go feeding directly on the nematode infective stage as in the case of cestodes, whose intermediate hosts are known to form an important part of the birds diet. Nematode eggs are only accidentally consumed with food. This might explain the reason why only *A. galli* was recovered in this study. Most of the nematodes infesting columbids have a direct life-cycle, so the probability of them being infested might be low (Kennedy, 1975 cited by adang *et al*., 2009b). It is likely also that the environment from which *S. senegalensis* were trapped or captured was not contaminated by the eggs/infective stage of nematodes or the birds were not infested at the time they were trapped. This might explain the reason why only *C. livia domestica* was infested by nematodes in this study because they are about the only columbids that are domesticated and are very close to human habitation which might be contaminated with nematode eggs from poultry faeces and other domestic birds.

The fact that more males of *S. senegalensis* than females (58.53% and 43.33% respectively), were infested by cestodes can be attributed to females being more sedentary during egg incubation with low feeding rate (Gibbs *et al.*, 2001), which might reduce their chances of being infested. It could also be attributed to the higher number of male than female birds examined (41 versus 30). On the other hand, more female *C. livia domestica* than males (41.03% versus 21.88%) were infested. This disparity may have resulted from some physiological differences as observed by Kennedy cited by Adang *et al*. (2009b).

The sex of the two bird species had no significant association with either ectoparasite or helminth infestation, suggesting that the sex of the birds had no influence or did not play a role in their infestation.

Although the difference in cestode infestation between the wet and the dry season was not significant, the slight variation (51.52% versus 44.44%) in *S. senegalensis* and *C. livia domestica* respectively can be attributed to the fact that the later are domesticated, unlike the former that are wild and range freely, picking any possible food item around, which will increase their chances of being infested.

The fact that nematode infestation in *C. livia domestica* was higher in the wet season compared to the dry season (36.11% versus 14.29%), can be explained in terms of food not being as readily available in the wet season as at harvest time which makes the birds feed on any available food materials, increasing their chances of picking up the infective stages of the nematode.

# CHAPTER SIX

## 6.0 CONCLUSIONS AND RECOMMEDATIONS

### 6.1 Conclusions

I. Ectoparasites and helminths occur in *S. senegalensis* and *C. livia domestica* in Zaria.

II. The ectoparasites of *S. senegalensis* are: *Gonoides* sp. (7.04%) and *Columbicola columbae* (2.82%) while those of *C. livia domestica* are *Goniodes* sp., (25.35%) *Columbicola columbae* (19.72%) and *Pseudolynchia canariensis* (11.27%). Gastro-intestinal helminths of *S. senegalensis* are nematode: (0.00%); cestodes: *Raillietina* sp. 1 (9.86%), *Raillietina* sp. 2 (8.45%), *Raillietina* sp. 3 (4.23%), *Raillietina* sp. 4 (2.82%), *Raillietina* sp. 5 (2.82%), *Killigrewia delafondi* (4.23%) and *Choanotaenia* sp. (5.63%) while those of *C. livia domestica*, are nematode: *Ascaridia galli* (25.35%); cestodes: *Raillietina* sp. 1 (5.63%), *Raillietina* sp. 2 (5.63%), *Raillietina* sp. 3 (4.23%), *Raillietina* sp. 4 (4.23%), *Raillietina* sp. 5 (5.63%), *Killigrewia delafondi* (2.82%) and *Choanotaenia* sp. (4.24%).

III. Ectoparasite prevalences on *Streptopelia senegalensis* and *Columba livia domestica* are: 9.86% and 60.56%, respectively; cestode prevalences are 52.11% and 32.39% respectively; the only nematode recovered has a prevalence of 25.35% in *C. livia domestica*, and is absent in *S. senegalensis* (0%).

IV. Ectoparasite prevalence is slightly higher in the wet season (5.63%) than in the dry season (4.23%) on *S. senegalensis*; but slightly higher in the dry season (30.99%) than in the wet season (29.58%) on *C. livia domestica*; the only nematode recovered (*C. livia domestica*) is more prevalent in the wet season than in the dry season (18.31% versus 7.04%) while none was recovered in *S. senegalensis*; cestode prevalence in the dry

season (28.17%) is higher than in the wet season (23.94%) in *S. senegalensis* but higher in the wet season (22.54%) than in the dry season (9.89%) in *C. livia domestica*.

V. Ectoparasites and gastro-intestinal helminths are not significantly associated with the sex of the birds.

VI. There is a statistically significant difference between the prevalence of ectoparasites on *C. livia domestica* and *S. senegalensis* in the wet and dry seasons, and male and female birds ($P<0.05$). There is no significant difference in prevalence of infestation by cestodes in *S. senegalensis* and *C. livia domestica* ($P>0.05$).

### 6.2 Recommendations

I. More studies should be carried out on the parasitic fauna of *S. senegalensis* and *C. livia domestica* for a longer period of time, spread over at least two years to get a clearer picture of parasite infestation patterns.

II. The rate of interaction between *C. livia domestica* and other domestic birds should be examined to find out how this affects their infestation with ectoparasites and gastro-intestinal helminths.

III. The market or home cages of the *C. livia domestica* should be cleaned routinely to minimize reinfestation by ectoparasites and helminths.

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# APPENDIX I

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**Appl No.:** ABUCAUC/2016/Biological Sci.028. **Date:** 20th November, 2016

**Approval No:** ABUCAUC/2016/028.

Professor T.O.L. Aken'Ova
Department of Biological Sciences.
Faculty of Life Sciences
Ahmadu Bello University,
Zaria.

Sir,

**APPROVAL OF RESEARCH STUDY 'ECTOPARASITES AND HELMINTHS OF THE LAUGHING DOVE *STREPTOPELIA SENEGALENSIS LINNAEUSE*, 1766 AND THE DOMISTIC PIGOEN *COLUMBA LIVIA DOMESTIC* GMELIN, 1789 IN ZARIA'**

This is to convey the approval of the ABUCAUC to you for the aforestated study domiciled in the Department of Biological Sciences. The approval is predicated on the assumption that you shall maintain and care for the Experimental Animals as approved after the visitation of the Committee.

Monitoring of the Research by spot checks, invitations or any other means the Committee deems fit shall be undertaken at the convenience of the Committee.

This approval can and shall be revoked should a significant breach in the terms and condition of the approval occur. It is hence your responsibility to ensure that the agreed terms are maintained to the end of the Study.

The said approval shall be posted on the ABUCAUC Page on the University's website.
Note upon completion of the research, ethical clearance certificate will be issued.

U.D. Abdullahi
For: Chairman, ABUCAUC.

Cc. Director, DAPM
Director, IC &ICT
Dean, Faculty of Life Sciences
HOD, Biological Sciences
Dr. D.M. Shehu




## APPENDIX II

**Crop contents of *Streptopelia senegalensis* and *Columba livia domestica***



Maize



Rice



Unidentified Broken grains



Pepper seed



Grains of Millet



Cowpea



Melon seeds



Guinea corn



Piece egg shell

## APPENDIX (III)

Ectoparasites and gastro-intestinal helminths of *Streptopelia sesnsgalensis* and *Columba livia domestica* according to species

| **Birds** | **Parasites** | **Number infested (%)** | $\chi^2$ | **Odd's Ratio value** | **Confidence interval** |
|---|---|---|---|---|---|
| ***Streptopelia senegalensis*** | Ectoparasites | 9(9.86) | 40.007[a] | 14.041 | 5.629-35.021 |
| | Cestodes | 37(52.11) | 5.657[a] | 2.271 | 1.149-4.488 |
| ***Columba livia domestica*** | Ectoparasites | 43(60.57) | 40.007[a] | 0.071 | 0.0029-0.178 |
| | Cestodes | 23(32.39) | 5.657[a] | 0.440 | 0.223-0.870 |
| | Nematodes | 18(25.35) | 20.613[a] | 0.746 | 0.652-0.855 |

**Note:** $\chi^2$ = Chi-square

(**APPENDIX IV)**

Ectoparasites and gastro-intestinal helminths of *Streptopelia sesnsgalensis* and *Columba livia domestica* according to seasons

| **Birds** | **Parasites** | **Season** | **Number examined** | **Number infested (%)** | $\chi^2$ | **Odd's Ratio value** | **Confidence interval** |
|---|---|---|---|---|---|---|---|
| ***Streptopelia senegalensis*** | Ectoparasites | Wet | 33 | 4(12.12) | 0.355[a] | 0.621 | 0.129-3.004 |
| | | Dry | 38 | 3(7.89) | 0.41[a] | 1.176 | 0.243-5.685 |
| | Cestodes | Wet | 33 | 17(51.52) | 0.009[a] | 1.046 | 0.411-2.660 |
| | | Dry | 38 | 20(52.63) | 1.782[a] | 0.526 | 0.204-1.356 |
| ***Columba livia domestica*** | Ectoparasites | Wet | 36 | 21(58.33) | 0.152[a] | 1.209 | 0.466-3.136 |
| | | Dry | 35 | 22(62.86) | 0.009[a] | 0.955 | 0.368-2.473 |
| | Cestodes | Wet | 36 | 13(36.11) | 4.467[a] | 0.295 | 0.092-0.946 |
| | | Dry | 35 | 5(14.29) | 5.071[a] | 3.664 | 1.140-11.771 |
| | Nematode | Wet | 36 | 16(44.44) | 4.842[a] | 0.313 | 0.109-0.900 |
| | | Dry | 35 | 7(20.00) | 5.592[a] | 3.489 | 1.209-10.069 |

**Note:** $\chi^2$ = Chi-square

(**APPENDIX V**)

Ectoparasites and gastro-intestinal helminths of *Streptopelia senegalensis* and *Columba livia domestica* associated with sex

| **Birds** | **Parasites** | **Sex** | **Number Examined** | **Number Infested (%)** | $\chi^2$ | **Odd's Ratio value** | **Confidence interval** |
|---|---|---|---|---|---|---|---|
| ***Streptopelia senegalensis*** | Ectoparasites | Males | 41 | 3(7.32) | 0.706[a] | 1.949 | 0.402-9.441 |
| | | Females | 30 | 4(13.33) | 0.706[a] | 0.513 | 0.106-2.486 |
| | Cestodes | Males | 41 | 24(58.53) | 1.605[a] | 0.542 | 0.209-1.404 |
| | | Females | 30 | 13(43.33) | 1.605[a] | 1.86 | 0.712-4.786 |
| ***Columba livia domestica*** | Ectoparsites | Males | 32 | 16(50.00) | 2.722[a] | 2.250 | 0.852-5.941 |
| | | Females | 39 | 27(69.23) | 2.722[a] | 0.444 | 0.168-1.173 |
| | Cestodes | Males | 32 | 5(15.63) | 2.193[a] | 2.70 | 0.843-8.643 |
| | | Females | 39 | 13(33.33) | 2.193[a] | 0.370 | 0.116-1.186 |
| | Nematodes | Males | 32 | 7(21.88) | 2.944[a] | 2.484 | 0.867-7.124 |
| | | Females | 39 | 16(41.03) | 2.944[a] | 0.403 | 0.140-1.154 |

**Note:** $\chi^2$ = Chi-square

(**APPENDIX VI**)

Prevalence of ectoparasites in Male and Female *Streptopelia senegalensis* and *Columba livia domestica*

| | ***S. senegalensis*** | | | ***C. livia*** | ***domestica*** | |
|---|---|---|---|---|---|---|
| **SEX** | **N.E** | **N.I** | **P (%)** | **N.E** | **N.I** | **P (%)** |
| **Male** | 41 | 3 | 7.32 | 32 | 16 | 50.00 |
| **Female** | 30 | 4 | **13.33** | 39 | 27 | **69.23** |
| **TOTAL** | 71 | 7 | 9.86 | 71 | 43 | 60.56 |

NOTE: **NE**= Number of birds examine, **NI**= Number of birds infested, **P**= prevalence

(**APPENDIX VII**)

Prevalence of Nematodes in Male and Female *Streptopelia senegalensis* and *Columba livia domestica*

| | ***S. senegalensis*** | | | ***C. livia*** | ***domestica*** | |
|---|---|---|---|---|---|---|
| **SEX** | **N.E** | **N.I** | **P (%)** | **N.E** | **N.I** | **P (%)** |
| **Male** | 41 | 0 | 0 | 32 | 5 | 15.61 |
| **Female** | 30 | 0 | 0.00 | 39 | 13 | **33.33** |
| **TOTAL** | 71 | 0 | 0.00 | 71 | 18 | 25.35 |

NOTE: **NE**= Number of birds examine, **NI**= Number of birds infested, **P**= prevalence

(**APPENDIX VIII**)

Prevalence of Cestodes in Male and Female *S. senegalensis* and *C. livia domestica*

| | ***S. senegalensis*** | | | ***C. livia*** | ***Domestica*** | |
|---|---|---|---|---|---|---|
| **SEX** | **N.E** | **N.I** | **P (%)** | **N.E** | **N.I** | **P (%)** |
| **Male** | 41 | 24 | **58.54** | 32 | 7 | 21.86 |
| **Female** | 30 | 13 | 43.33 | 39 | 16 | **41.03** |
| **TOTAL** | 71 | 37 | 52.11 | 71 | 23 | 32.39 |

NOTE: **NE**= Number of birds examined, **NI**= Number of birds infested, **P**= prevalence

(**APPENDIX IX**)

Seasonal prevalence of Ectoparasites in *S. senegalensis* and *C. livia domestica*

| | ***S. senegalensis*** | | | ***C. livia*** | ***domestica*** | |
|---|---|---|---|---|---|---|
| **SEASON** | **N.E** | **N.I** | **P (%)** | **N.E** | **N.I** | **P (%)** |
| **WET** | 33 | 4 | **12.12** | 36 | 21 | 58.33 |
| **DRY** | 38 | 3 | 7.89 | 35 | 22 | **62.86** |
| **TOTAL** | 71 | 7 | 9.86 | 71 | 43 | 60.56 |

NOTE: **NE**= Number of birds examine, **NI**= Number of birds infested, **P**= prevalence

(**APPENDIX X**)

Seasonal prevalence of Nematodes *Streptopelia senegalensis* and *C. livia domestica*

| | ***S. senegalensis*** | | | ***C. livia*** | ***domestica*** | |
|---|---|---|---|---|---|---|
| **SEASON** | **N.E** | **N.I** | **P (%)** | **N.E** | **N.I** | **P (%)** |
| **WET** | 33 | 0 | 0.00 | 36 | 13 | **36.11** |
| **DRY** | 38 | 0 | 0.00 | 35 | 5 | 14.29 |
| **TOTAL** | 71 | 0 | 0.00 | 71 | 18 | 25.35 |

NOTE: **NE**= Number of birds examine, **NI**= Number of birds infested, **P**= prevalence

(**APPENDIX XI**)

Seasonal prevalence of Cestodes in *S. senegalensis* and *C. livia domestica*

| | ***S. senegalensis*** | | | ***C. livia*** | ***domestica*** | |
|---|---|---|---|---|---|---|
| **SEASON** | **N.E** | **N.I** | **P (%)** | **N.E** | **N.I** | **P (%)** |
| **WET** | 33 | 17 | 51.52 | 36 | 16 | **44.44** |
| **DRY** | 38 | 20 | **52.63** | 35 | 7 | 20.00 |
| **TOTAL** | 71 | 37 | 52.11 | 71 | 23 | 32.39 |

NOTE: **NE**= Number of birds examine, **NI**= Number of birds infested, **P**= prevalence

(**APPENDIX XII**)

Overall prevalence of ectoparasite and helminths infestation in *S. senegalensis* and *C. livia domestica*

| | *S. senegalensis* | *C. livia* | *domestica* |
|---|---|---|---|
| Ectoparasites | 9.86 | 60.57 | |
| Nematode | 0 | 25.57 | |
| Cestodes | 52.11 | 32.39 | |