THE DISTRIBUTION OF HELMINTHS IN THE GASTROINSTESTINAL TRACTS OF DOGS IN ZARIA AND THE RELATIONSHIP BETWEEN WORM BURDEN AND EGG OUTPUTS

BY

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DECLARATION

I hereby declare that the work presented in this thesis is a record of my personal research under supervision. To the best of my knowledge, it has not been wholly presented previously for any other degree or in any other form.

All quotations, clearly distinguished by quotation marks, as well as source of information are duly acknowledged.

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CERTIFICATION

This thesis entitled "The Distribution of Helminths in the Gastrointestinal Tracts of Dogs in Zaria and The Relationship between Worm Burden and Egg Outpu ' by Komtangi, Marie Claire Neng meets up the regulations governing the awara of the degree of Master of Science in Parasitology and Entomology of Ahmadu Bello University, Zaria, Nigeria and is approved for its contribution to knowledge and literary presentation.

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DEDICATION

This thesis is dedicated to my dear mother Joan; my late father Damian; late Dr V.C. Ogbogu who was a member of my Supervisory Committee, my brothers and sisters and to all who contributed to my academic pursuits.

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ABSTRACT

An investigation was carried out to determine the prevalence and distribution of gastrointestinal helminth parasites of dogs in Zaria, Kaduna State, Nigeria. The relationship between qualitative and quantitative estimation of infection on one hand, and either of these methods and actual worm burden in infected dogs on the other hand were studied. Parasites of zoonotic importance were noted.

Whole gastrointestinal tracts were collected from four non-descript abattoirs in Zaria. Three hundred and sixty one samples were used for prevalence studies and 100 gastrointestinal and faecal samples from same animal were used for the comparative study.

The gastrointestinal tracts were processed by washing and sieving until the supernatant became clear, while the faecal samples were processed using the simple flotation technique with zinc sulphate sugar solution as the levitating media. For the faecal egg count, the Mcmaster egg counting technique was used.

Of the 361 gastrointestinal tracts examined, 99.9% had at least one or more helminth parasites. The

overall prevalence **of infection** were 58.1% for *Ancylostoma caninum,* 52.6% for *Dipylidium caninum,* 21.9% for *Taenia hydatigenaj,* 17.0% for *Taenia ovis,* 7.5% for *Toxocara canisj_* 1.7% for *Toxoascaris leonina,* 2.5% for *Ancylostoma braziliense,* 6.5% for *Spirocerca lupi* and 2.5% for *Rictularia* species.[4] Two (0.6%) of the 361 samples examined were not infected with any of the gastrointestinal helminth parasites. A high percent (65.3%) of the dogs had more than one parasite in the intestine.

The number of parasites present in the gastrointestinal tract ranged from 1-310 for *Dipylidium,* 1-276 for *Taenia* and 1-213 for hookworms. Not more than five *Rictularia* worms were encountered in any of the infected dogs, and infection with *Spirocerca lupi* had a parasite range between 5-17 worms.

With the exception of *Rictularia,* all other parasites encountered in this study are of public health importance.

The parasite length was found to decrease as the worm burden increase **in** hookworm and ascarid infections, with a negative correlation of -0.96 and -0.525 respectively.

As regards the relationship between the presence of eggs in the faeces and presence of parasites in the gastrointestinal tract, a highly significant difference was obtained in hookworms, ascarids, *Taenia* and *Spirocerca* infections; and a higher prevalence was obtained from the recovery of parasites from the intestine than from faecal examination.

It was also observed that as the worm burden in the gastrointestinal tract increases, the faecal egg count also increases.

It is concluded that infections with gastrointestinal helminth parasites in dog is endemic in Zaria and poses a significant public health problem. Also, the absence of helminth eggs in the faeces of a dogs, does not necessarily indicate absence of infection. Quantitative faecal analysis may give an indication of the degree of worm burden and. most probably, the degree of damage inflicted on the host. Furthermore the recovery of parasites during Necropsy is confirmed to be a better method for prevalence study.

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CHAPTER ONE

INTRODUCTION

The dog, *Canis familiaris*, which first became domesticated some 60,000 years ago by savage cave men, is considered the closest animal to man (Hull, 1963). Dogs have adapted themselves to economic usefulness, they are natural hunters, assisting in procurement of food supply as well as tending flock and herd in agricultural communities. Some breeds of dogs are also used extensively in crime detection and prevention and in leading the blind (Hull, 1963). The breeding and selling of dogs bring income into families engaged in such practices. In some communities, dogs are used as source of meat protein, as pets, watch animals and hunting guides (Elamah and Braide, 1981).

In spite of its usefulness, dogs could in some instances be a source of danger to the household and populace. Due to poor management and/or irresponsible ownership, dogs could become infected with pathogens dangerous to both the human populace and other domestic animals. The health hazards of dogs include bites which could result in the transmission of rabies if the dog is infected. Dogs are sometimes responsible for traffic

accidents. In addition, pathogens such as *Salmonella, Leptospira canicola,* induction of allergy, external parasites such as fleas, sacorptic mange, *Cheylectiella yasgun* and ringworm, and endoparasites such as *Toxocara sp,* tapeworms and hookworms may be transmitted to the human populace and other animals (Mckenzie, 1977).

In industrialized areas only, there are about 100 million dogs that act as reservoir of potential helminth infection (Merck and Bayer, 1996). Gastrointestinal helminths belong to two large phyla of the animal Kingdom. The phylum Platyhelminthes consists of flatworms (cestodes) and flukes (trematodes), while the phylum Nemathelminthes consist of nematodes or roundworms (Soulsby, 1982). Nematodes that commonly infect the gastrointestinal tract of dogs include the hookworms (*Ancylostoma* and *Uncinaria* species), roundworms (*Toxocara* and *Toxascsaris* species), whipworms *(Trichuris* species) and Oesophageal worm (*Spirocerca* species).

The cestodes that infect dogs belong to three genera; *Dipylidium, Taenia* and *Echinococcus,* while trematodes such as *Alaria* and *Nanophytes* species are scarcely reported in the gastrointestinal tract of dogs (Anderson, 1975; Soulsby, 1982; Smyth, 1994).

Gastrointestinal helminths constitute a major source of disease for dogs in the tropics and have been recognized as important public health problems in several parts of the world (Dada *et al.*, 1979). The prevalence rates of the diseases caused by these parasites are on the increase, and this is as a result of the high density of dogs mostly in the cities and irresponsible ownership (Carl, 1988).

Diagnosis of intestinal parasites mostly involve faecal examination using the simple flotation technique (Sloss *et al.*, 1978; Soulsby, 1982). With this technique, there is the impossibility of using the egg to distinguish between the various species of *Taenia* as well as between *Taenia* and *Echinococcus* infections. Also, the eggs of oesophageal worms, *Spirocerca lupi*, are hardly ever detected in the faeces of infected animals (Radhakrishnan and Tigrari, 1976).

There is a paucity of information regarding the extent to which laboratory quantification of infection using the conventional qualitative and/or quantitative techniques represents the actual worm burden in an infected animal. The number of dogs in Nigeria has ever been on the increase (Olufemi and Bobade, 1979; Ezeokoli, 1984), as has been the disease spreading potentials of the

dogs. A knowledge of the gastrointestinal tract helminths of dogs will be useful in assessing the degree of environmental contamination with infective eggs and/or larvae of zoonotic helminths. A knowledge of the relationship between conventional laboratory methods of estimating the degree of infection on one hand, and the actual worm burden of the different species present in the gastrointestinal tract on the other hand, will supply accurate information for the use of veterinary clinicians.

This study has therefore been designed to determine:

1) the prevalence of intestinal parasites in dogs slaughtered for human consumption in Zaria and the effect of sex on single and multiple infections.
2) the relationship between the laboratory qualitative and quantitative (egg count) estimation of infection and the actual worm burden in dogs.

CHAPTER TWO

LITERATURE REVIEW

2.1 Nematodes

Nematodes or roundworms are a group of worms responsible for most of the helminth diseases of veterinary importance (Brander *et al.*, 1991). They are unsegmented hair-like tubular worms ranging in size from a few millimeters to several centimeters. They occur in fresh water, the seas, in soil and are amongst the most successful parasites of plants and animals (Symth, 1994). The tissues or organs of every class of vertebrate and some invertebrates are said to be vulnerable to invasion by nematodes (Brander *et al.*, 1991). The parasites in vertebrates parasitize the eye, mouth, tongue, liver, lungs, body cavity and the alimentary canal, causing untold hardship (Soulsby, 1982; Symth, 1994).

Several nematode species have been reported to inhabit the gastrointestinal tract of the dog, of which the following have been commonly reported; Ascarid (*Toxocara* and *Toxascaris* species), hookworms (*Ancylostoma* and *Uncinaria* species), whipworms (*Trichuris* species), oesophageal worms *(Spirocerca* species) and *Strongyloides* species. Rare species such as *Physaloptera* has also been reported (Whitlock, 1960, Georgi,

1974; Soulsby 1982; Symth, 1994).

2.1.1 Ascarids

2.1.1.1 Morphology and Predilection Site

The members of this group are mostly large, stout polymyarian worms. They have three well developed lips-one dorsal and two ventral each of which usually bears two papillae. There is no buccal capsule or pharynx and the oesophagus lacks a posterior muscular bulb. The anterior part of the body is supplied with large cervical alae and bent dorsad.

The two species commonly reported from the dog are *Toxocara canis* and *Toxascaris leonina*, the former usually large, with females up to 18cm long and males up to 10cm long. The female genital organs extends anteriorly and posteriorly to the vulva region. The male tail has a terminal narrow appendage and caudal alae.

Ascarid have been reported to occupy virtually all the different regions of the alimentary canal, and this has been attributed to the presence of nutrients along the entire length of the small intestine (Mettrick and Podesta,1974).

2.1.1.2 Transmission

Eggs are almost entirely passed by puppies up to 5 weeks old and lactating bitches and rarely older animals (Beaver, 1956). The efficiency of the life cycle in dogs have been attributed to transplacental migration of larvae from infected bitches to their foetuses. By the time a pup is 4 weeks old, a female worm can shed 200,000 eggs daily into the faeces (Lightener *et al.*, 1978).

Oral infection of dogs more than 4 weeks old does not always lead to patent intestinal infection; this phenomenon has been called age resistance. Larvae swallowed by dogs of that age follow a somatic route of migration and encyst in numerous tissues. In pregnant bitches, dormant L2 larvae are reactivated by hormonal changes and migrating larvae infect the developing foetuses via the placenta (Glickman *et al.*, 1979). In lactating bitches puppies can also become infected by larvae in the milk (Stone and Girardeau, 1968). Lactating bitches themselves develop patent infections by ingesting eggs from their puppies' faeces. Another route of transmission is the ingestion of dormant larval stages of *T. canis* in the tissues of paratenic hosts such as rodents. Such larvae are said to develop directly to the adult stage in the dogs intestine without any migration (Jacobs *et al.*, 1977).

Eggs require oxygen and a warm temperature to embryonate and become infective. This takes about 2 - 6 weeks in temperate climate (Symth, 1994). In transplacental infection, larvae acquired by somatic migration are mobilized from tissues of the pregnant bitch from 40 days of pregnancy onwards. They migrate across the placenta and are transmitted via the umbilical vein to the foetal liver and other organs, so that third stage larvae are present in the liver and lungs of the puppy at birth. The larvae complete their development by migrating up to the trachea, after which they are swallowed, passing to the intestine where they become adults 20-40 days after birth (Soulsby, 1983). The ability to undergo such migration decreases rapidly as the puppy ages and by three months of age, majority of newly acquired infective larvae are distributed in the somatic tissues where they are said to remain dormant until reactivated at pregnancy and lactation (Soulsby, 1983).

2.1.1.3 **Epidemiology**

Ascarid infection of dogs has been reported from nearly all parts of the world, with infection rate approaching 100% for some population of pups (Glickman *et al.*, 1979). Serologic studies of dogs from human shelters and commercial breeding colonies support the belief that virtually all dogs

have been infected with *T. canis* (Glickman *et al.*, 1979). Variations in prevalence probably reflect differences in the age, sex and source of the dogs surveyed as well as differences in diagnostic procedure (necropsy versus faecal floatation).

Age is said to be an important factor influencing the susceptibility and distribution of dogs to ascarid infection and the incidence of patent infection. It occurs both in puppies and adult dogs, but the incidence and extent of infection is higher in puppies (Sprent, 1958). It has been proven experimentally that older dogs are less susceptible even in the absence of previous exposure to ascarids. In five studies involving 673 puppies belonging to 168 litters, 669 (99.4%) of dogs were infected with *T. canis* at birth (Barriga, 1988). In Minneapolis (Levine, 1980), the prevalence of *T. canis* ranges from 4.5 - 5.4% in adult dogs and up to 93% in puppies. A report from Iowa State stated that the highest prevalence (12.2%) of ascarid infection in puppies was recorded in two weeks to two months old puppies brought to the Iowa State University Clinic. In these puppies, there was a slow but steady downward decline in prevalence with increasing age (Lightener, *et al*, 1978).

The infection routes (in utero or transplacental passage of larvae or infection of the new born puppies through milk

or colostrum), emphasize the importance of the pupies as the host of adult ascarids. Age resistance exhibited by adult dogs contributes to their low prevalence (Glickman *et al.*, 1979).

Ehrenford (1957) in the United States found that male dogs are more commonly infected than females. In 13 to 36 months old dogs, this author reported 29% prevalence in 268 males and 4.9% in 242 female. A number of studies have demonstrated that many dogs, particularly females, get rid of the intestinal infection spontaneously about puberty (Soulsby, 1983; Barriga, 1988).

The prevalence of ascarid infection is said to be influenced by the diagnostic method. The prevalence of *T. canis* using faecal examination is said to underestimate the rate by between 25 - 35% (Jacobs *et al.*, 1977). Recovery of parasites at necropsy have reported between 99 - 100% prevalence among puppies while only 51% was reported using faecal examination (Fabiyi, 1983; Barriga, 1988).

A large reservoir of *Toxocara* egg in the environment has been reported to pose a constant hazard to the dog and man (Jacobs et al., 1977). Borg and Woodruff (1973) reported that 24.4% of 800 soil samples from public places in London contained *Toxocara* ova, many of which were infective for mice. Ascarid eggs are extremely resistant to chemical and

climatic agents. They may survive in an appropriate external environment for about six years (Levine.1980). The period which is most likely favourable for the survival of *T. canis* eggs is the cooler and wetter parts of the year (Dunsmore *et al.*, 1984).

2.1.2 Hookworms

2.1.2.1 Morphology and Predilection Site

The general morphology of hookworm has been described by Whitlock (1960), Soulsby (1982) and Symth (1994). Females are usually larger than males, their respective mean lengths measuring 10 - 16mm long and 6 - 12mm. They are reported to be fairly rigid and gray or reddish in colour depending on the presence of blood in their alimentary canal. The vulva opens in almost one third of the body length from the posterior end and the female has two ovaries. The conspicuous buccal cavity is armed with a pair of chitinous plates that bear teeth. *Ancylostoma caninum* bears three teeth each on the ventral margines, *A. braziliense* bears two teeth while *Uncinaria stenocephala* does not bear dorsal teeth but a pair of chitinous plates on the ventral border. The anterior end is bent dorsally and the oral aperture is directed antedorsally. The bursae in the males are well developed and spicules are 0.8 - 0.95mm long.

Adults occur in the small intestine of the dog and have been reported throughout the entire length of the small intestine (Krupp, 1961). The type and amount of nutrient vary along the length of the intestine and the resulting gradients largely defined the optimal sites for various luminal dwelling nematodes. For hookworms, the jejunum is the most preferred site of attachment (Krupp, 1961). Hookworms were found to be more numerous in this area than in the duodenum, ileum, caecum and colon. It was observed that when worms were present in the caecum and colon, some were always in the duodenum.

2.1.2.2 **Transmission**

The life cycle of hookworms has been discussed by various authors (Miller, 1971; Soulsby, 1982; Symth, 1994). Adult female hookworms produce an average of 16,000 eggs per day. Eggs are not resistant to dessication, thus commonly found only in moist surroundings. The optimal temperature for development is between 23 and 30°C for *A. caninum* and slightly higher for *A. braziliense*. The infective stage larvae is reached within a week at these temperature. A variety of developmental pathways may occur following infection.

Oral infection may lead to direct development of adult worms, although a proportion of orally ingested larvae will penetrate the buccal and pharyngeal epithelia and undergo migration.

After oral infection, larvae enter the gastric glands or crypts of Lieberkuhn for a few days and return to the lumen where they moult to the fourth stage about three days after infection. The prepatent period is 15 - 18 days in young dogs.

Prenatal infection of the foetus occurs by intrauterine infection. Colostral or lactogenic infection of pups occur by the passage of larvae through milk to the suckling puppy.

Skin penetration leads to migration to the lungs by tracheal route to the intestine. Subsequent maturation may occur or, there may be somatic migration of larvae, followed by dormancy in the musculature.

In puppies, larvae that penetrate the skin and reach the blood vessels or lymphatic vessels are carried via the thoracic duct to the heart and lungs. Larvae pass into the alveoli and migrate up the bronchioles, bronchi and trachea and are swallowed and mature in the small intestine. The fourth stage larvae are seen in the trachea, larynx, pharynx and oesophagus 44 - 72 hours, and fourth stage larvae are found in the intestine 4 days after infection. The fourth

moult to the immature adult occurs on the 6th day. Development of the reproduction systems commence on the 12th day, and by the 17th day all worms are mature.

An additional source of infection is the ingestion of paratenic host bearing infective larvae. Miller (1971) observed that in mouse, the third stage larvae of *A. caninum* accumulate and persist for almost the entire life of the host.

2.1.3.3 **Epidemiology**

Ancylostomiasis or hookworm disease in dogs is caused by two species of *Ancylostoma; A. caninum, A. braziliense* and U. *stenocephala,* with *A. caninum* being the most common and most pathogenic species. The hookworms that infect dogs are subtropical and tropical in their distribution, the restriction being largely due to environmental humidity and dessication (Miller, 1971; Georgi, 1974).

Ancylostoma caninum is reported to occur in all suitable areas, while *A. braziliense* appears to be limited to distinct geographical areas. *Uncinaria stenocephala* has lower temperature requirements and occurs around the world north and south of the tropical hookworm belts (Miller, 1971).

Ancylostoma caninum is the most frequent parasite

reported in dogs during routine faecal examination and during recovery of parasites at necropsy (Lightener *et al.*, 1978; Carl, 1988). Evidence of *A. caninum* infection was encountered in 35.8% of dogs during faecal examination in the Missouri Veterinary Teaching Hospital (Visco *et al.*, 1977), and 68% of stray dogs examined during necropsy in Malaysia were infected (Macadam *et al.*, 1984). Of the nematode parasites encountered in a survey of dingo and feral dogs in Victoria, *U. stenouphala* was by far the most common parasite reported, with a prevalence of 49.5% (Coman, 1972). In the Republic of South Africa, *A. braziliense* was recorded as the most frequent nematode parasite with a prevalence of 6.2% reported during necropsy (Vester, 1979).

Hookworm infections have been commonly reported in pups less than six months of age and there is a decrease in the prevalence of hookworm parasitism in dogs more than six month old (Visco *et al.*, 1977). An age-related decrease in prevalence of hookworm infection in dogs has also been demonstrated by Lightener *et al* (1978). The highest prevalence (11.8%) was recorded in dogs two weeks to two months old, with a slow and steady downward trend with increasing age. The high prevalence recorded among puppies agrees with what is known about the life cycle of the

parasite with the transplacental and transmammary routes playing important roles (Soulsby, 1982).

Age resistance to hookworm has been reported by Miller (1965) who demonstrated natural age resistance in dogs known to be free of previous exposure to infection with any hookworm species. A sex mediated difference was also observed in the degree of age resistance between dogs and bitches. Higher resistance were observed in bitches (Miller, 1965).

Environmental temperatures and humidity are other factors that influence the distribution of hookworms. Hookworm distribution rarely extends into the arid regions (Miller, 1971). None of the hookworm eggs is resistant to dessication, thus they are only found in moist surroundings, and slightly sandy moist soil (Soulsby, 1982). The optimal temperature for development is between 23 and 30°c for A. *caninum* and slightly higher for *U. stenocephala* and *A. braziliense*. The highest prevalence of hookworm infection in Ames Iowa was recorded in June and July (Lightener *et al*, 1978).

2.1.3 *Spirocerca Species*

2.1.3.1 Morphology and Predilection Site

The parasites are stout, usually coiled in a spiral, and pink in colour. Males are 30 - 54mm long and females 54 - 80mm long. A tri-lobed lip and a short pharynx is present. The males bear four pairs of lateral alae, one unpaired median cloacal papillae, two pairs of post cloacal papillae at the tail, and a group of minute papillae at the tip of the tail. The left spicule is longer (2.45 - 2.8mm) than the right spicule (0.475 - 0.75mm) (Soulsby 1982).

The predilection sites have been studied by various authors (Chabra and Singh, 1977; Corkish, 1977). The oesophagus is the usual final site of the parasite (Danks *et al.*, 1977), but it has been found in other sites such as the stomach wall, lumber fascia and mediastinum, the wall of the rectum and lung tissue, the dorsal aorta and renal artery (Wandara 1976; Ivoghli, 1977).

2.1.3.2 Transmission

The life cycle of *Spirocerca lupi* has been described by Hoskins (1966) and Georgi (1974). Eggs passed in the faeces of the host hatch after ingestion by coprophagus beetles. The larvae develop to the infective stage and become encysted in the beetle, chiefly on the tracheal tubes. Beetles could

be swallowed by paratenic hosts such as reptiles, domestic and wild birds and rabbits in which case the larvae again become encysted in the oesophagus, mesentery or other organs. The final host (the dog) becomes infected by ingesting either beetles containing the infective larvae or a paratenic host containing the encysted larvae. Feeding of dogs with viscera of chicken containing infected larvae is an important source of infection. On being liberated in the stomach of the definitive host, the larvae penetrate the stomach wall and, reaching the arteries, migrate within the wall of the gastro-epiloic, gastric and coeliac arteries to the aorta, reaching the upper thoracic aorta in about three days. The majority migrate to the oesophagus in the third month, with patency occuring between five and six months.

2.1.3.3 Epidemiology

Spirocerca species is consmopolitan and has been reported all over the world in the majority of warm countries (Ivoghli 1977; Danks, *et.al.*, 1977). Necropsy examination of 856 stray dogs in Malaysia revealed that 198 (23.1%) were infected with *S. lupi* (Retnasabapathy and Khoo, 1976). Ivoghli (1977) observed during necropsy examination of a dog in Iran that many *Spirocerca lupi* were protruding from nodules in the wall of the aorta. Also, the death of 62

captive malagasy lemurs (57.6%) were attributed to *S lupi* infestation (Blancou and Albignacs, 1978).

The prevalence of *S. lupi* is higher in males than females. In India, rates of 81% and 58% were recorded in male and female dogs respectively, and all infected animals were over six months of age (Singh *et al.*, 1970; Radhakrishnan and Tigrari, 1976). The higher prevalence in older dogs is as a result of the prolonged life span of the parasite. Mogrels are reported to show a higher prevalence (56%) than alsatians (30%) (Corkish, 1977).

2.1.4 *Trichuris species*

2.1.4.1 Morphology and Predilection Site

Worms of this genera are characteristised by the possession of an enormously elongated capillary-like oesophagus or pharynx, whose internal cavity is so small that it is difficult to locate even in sections. The parasite is 45 - 72m long and the sheath bears small spines on the proximal end. The mouth has no lips, and the vulva is at the junction of the thread-like and thickened region of the body. The eggs have a characteristic barrel shape with an opercular plug at each end.

The preferred site of this parasite is the caecum, then the colon. It was observed that in heavy infestation, the

parasite had spread to the rectum and to the end of the ileum (Soulsby, 1982).

2.1.4.2 **Transmission**

The life cycle is simple and direct. Eggs require a warm moist environment for embryonation, after which they become exceptionally resistant to environmental conditions and may remain viable for years (Georgi, 1974). Embryonated eggs after ingestion by the definitive host hatch near the caecum into which the larvae migrate. Maturation process is totally within the intestine, it does not involve somatic migration and occurs over a 70 - 80 days period after ingestion of the infective egg. The slow development has been related possibility to scarcity of food material in the site (Symth, 1994).

2.1.4.3 **Epidemiology**

Heavy infection with *Trichuris vulpis* is common among puppies and may cause anaemia (Brander *et al.*, 1991). Whipworm infections are found to be less prevalent in pups less than six months old, and castrated males and spayed females have decreased prevalence of infection compared with their intact counterparts (Visco *et. al.*, 1977 infection). *Trichuris vulpis* in dogs generally appear at later ages,

reaching their highest prevalence in hosts 1 - 2 years old, and no seasonal trend is reported (Lightener *et al.*, 1978).

A survey of faecal samples in Germany (Hinz and Blatz, 1985) revealed an infection rate of 3.2%. Similarly, 18.5% of dog's faeces examined in Missouri were found to habour the parasite (Visco *et al.*, 1977). Although the prevalence of gastrointestinal helminth parasites are reported to be higher during necropsy examinations (Donald, 1952), no dog was infected with *T vulpis* in a survey of 260 dogs during Necropsy in South Africa (Vester, 1979). Similarly in Lusaka, Zambia (Islam and Chizyuka, 1983); Malaysia (Macadam *et al.*, 1984, and Baghdad in Iraq (Tarish *et al.*, 1986), no case of *T vulpis* was reported among dogs examined during necropsy.

2.1.5 *Strongyloides species*

2.1.5.1 Morphology and Predilection Site

Strongyloides species occur in the small intestine of dogs with adults largely localised in the duodeno-jejunal region (Symth, 1994). In form, they are slender and small, and characterized by the possession of an unusually long oesophagus which in the female extends 1/3 - 2/5 of the body length. The parasitic female is about 2.2mm long and 0.034mm

thick, while the male is 0.7mm long. The anal opening is ventral and the tail is pointed.

2.1.5.2 **Transmission**

The life cycle of *Strongyloides stercoralis* is very complex. In the parasitic generation the adults are always females and usually pathogenic. The males only appear in the free-living part of the cycle. The eggs hatch into rhabditoid larvae within the intestine and are expelled in the faeces. The first stage larvae can develop into filariform larvae which directly parasitize the host via the oral route or by skin penetration. Alternately, the larvae can develop within 2 - 3 days to free-living soil-residing females, which after copulation, produce eggs that hatch to rhabditoid larvae identical to those passed from the intestine of the host. The rhabditoid larvae becomes infective (filariform) larvae and parasitize the host via the oral or cutaneous routes. Only female worms are ultimately found in the intestine (Anderson, 1975; Symth, 1994).

2.1.5.3 **Epidemiology**

Strongyloidosis is an infection of small intestine of dogs caused by *Strongyloides stercoralis*. This parasite has a world wide distribution especially in humans, infecting 500

to 100 million people. In most cases, the infection co-exists with hookworm infections but with a lower prevalence (WHO, 1989).

The parasite does not seem to be common among dogs world over. Several surveys by both faecal examination and recovery of parasites at necropsy did not show infection with *Strongyloides stercoralis* (Coman, 1972; Visco *et al.*, 1977; Vester, 1979). However, Ugochukwu and Ejimadu (1985) reported a prevalence of 14.9% of 254 dogs examined at the Calabar veterinary Clinic.

2.2 Cestodes

2.2.1 Morphology and Predilection Sites

Cestodes or tapeworms are flat, segmented ribbon-like worms, adults of which may be a few millimeters or several meters in length and live exclusively in the small intestine. Typically, a cestode is divided into a scolex, bearing attachment organs, followed by a short unsegmented region, the neck, succeeded by a chain of prolottids termed the strobila (Symth, 1994). The organs of attachment are mostly of three types; bothria, bothridia and acetabula. The scolex may be additionally armed with hooks. A mobile cone or rostellum, usually armed and retractable is also present in the taeniid scolex.

The strobila for most adult cestodes is divided into segments or prolottids. The most posterior prolottid becomes ripe first and when fully mature consists mainly of a branched uterus packed with eggs. Such a segment is said to be gravid (Soulsby, 1982).

With the exception of the Cyclophyllidean genus *Dicecocestus* which is dioecious and dimorphic, cestodes are monoecious. Testes are in small dispersed groups or large well-formed bodies. Cirrus and cirrus sacs are usually highly developed. In females, except in species with a double reproductive system, the ovary is single with two lobes. Most cestodes are hermaphrodites.

Only rarely do cestodes inhabit any other site than the intestine, and the exact position of the adult worm in the intestine is said to be determined, possibly, by the degree of saline and glucose concentration optimum to the species and by metabolic requirements (Rees, 1967).

The cestode is attached by the scolex, thus the form of the mucosa relative to the structure of the scolex is also reported to be a determining feature in location of the parasite within the host (Rees, 1967).

Dipylidium caninum occurs in the ileum, but as the worm burden increases the posterior segment of the jejunum is occupied (Mettrick and Podesta, 1974). In single worm

infections the scolex of 5 - 6 day old worms were observed attached about one third of the way down the small intestine from the pyloric-duodenal sphincter (Mettrick and Podesta, 1974). Heavy infections lead to worms being scattered over a wider region of the intestine (Holmes, 1961).

2.2.2 Transmission

With very few exceptions, completion of the life cycle in cestodes requires that their larval forms develop in intermediate hosts which differ in the different species of cestodes. *Dipylidium caninum* uses the dog and cat fleas *Ctenocephalides canis, C. Felix* and *Trichodectes* species as intermediate hosts, while *Echinococcus* and *Taenia* species use various ungulates (sheep, goat cattle, rabbit) as their intermediate hosts. Tapeworm larvae in the intermediate host usually assume a variety of forms such as the tiny spherical cycsticercoids of *Dipylidium in* the flea or the huge fluid-filled hydated cysts of *Echinococcus granulosus* in mammals (Soulsby, 1982).

The intermediate host ingest eggs on pasture, in food or drinking water, and the hexacanth embryos are liberated from the ingested eggs by the action of stomach enzymes. The hooked larvae penetrate the gut wall and are distributed throughout the body via the blood and lymph system. Larvae

develop into infective forms (bladder worms) in the predilection sites in the hosts. The cyst containing a rudimentary scolex becomes ingested either with an invertebrate host or with a portion of a vertebrate intermediate host by the final host, the dog. In the intestinal tract of the dog, the scolex evaginates and attaches itself to the intestinal mucosa where the worm develops into the adult form (Merck and Bayer, 1996).

2.2.3 Epidemiology

Tapeworms are known to be distributed all over the world and various groups of dogs are reported to be predisposed to specific cestodes by their feeding habits (Merck and Bayer, 1996). Farm dogs, butchers' dogs and some hunting dogs are predisposed to *Taenia hydatigena*. Hunting dogs are more frequently infected with *Taenia pisiformis* by ingesting hare and rabbit, while, sheep dogs on the other hand commonly habour *T. multiceps* and *T. ovis* having ingested their cyst with sheep brains and sheep meat (Merck and Bayer, 1996). Through grooming, dogs are predisposed to ingesting flea, containing the intermediate host of *D. caninum*. Other predisposing factors of cestode infection include age, sex seasonal variation, level of environmental contamination and survival of egg on pasture (Arundel, 1972; Hackett and

Walters, 1980; Soulsby, 1983).

Dipylidium caninum is the most common cestode of dogs and is found in most countries all over the world, with the highest prevalence (82.0%) reported from Iraq (Merck and Bayer, 1996). Other reports show that during necropsy examination, the prevalence of *D. caninum* is always higher than other cestodes. A prevalence rate of 89% was recorded in Athens, Georgia (Donald, 1952) and 72% reported from Oklahoma country, Oklahoma (Rubin, 1952).

Taenia species are said to be cosmopolitan in their distribution with prevalence ranging from 71% in Italy to 18% in Mid-Wales (Merck and Bayer, 1996). *Taenia pisiformis* and *T. ovis* are the commonest *Taenia* species, and *T. hydatigena* and *T multiceps* are also reported all over the world (Soulsby, 1982; Symth, 1994).

The highest prevalence (70.6%) of *Echinococcus* species and of hydatid disease is reported from Kenya (Merck and Bayer, 1996). China has a prevalence of 70%, Australia 61%, Libya 35.9% and Spain 1.96% (Merck and Bayer, 1996).

The importance of age and sex on the distribution of cestode infections was observed by Visco *et. al.* (1977). Cestode infections were diagnosed in all age groups, but were most commonly encountered in dogs 13 to 24 months old. From

a survey in Iowa, no significant different was observed with respect to age and sex in the distribution of cestode infections (Franson *et al.*, 1978). Neither the age of the host nor previous exposure affected infection with *Taenia* species in dogs.

On pasture, there is rapid dispersion of cestode eggs from the site of contamination for distance up to 80 meters, and eggs may be spread by wind or arthropods (Soulsby, 1982). Cestode eggs are said to remain viable for over 6 months in Melbourne Australia (Arundel, 1972). Dessication is the most deleterious factor to the survival of cestode eggs, and the eggs of *E granulosus* and *T. pisiformis* are reported to be more susceptible than those of either *T ovis* or *T. hydatigena* (Arundel, 1972).

2.3 Digenetic Trematodes

2.3.1 Morphology and Predilection Site

Digenetic trematodes are non-segmented and dorso-ventrally flat worms, never more than a few centimeters in length. They parasitize the alimentary canal or its associated organs. They have a relatively simple adhesive organ consisting of an anterior or oral sucker at the anterior end of the body and a ventral sucker or acetabulum. They are hermaphrodites with the exception of the members of

the family Schistomatidae and Dioymazoidae. Their life cycle like those of tapeworms always involves one or more intermediate hosts, in which diverse larval forms are capable of multiplying asexually (Brander *et al.*, 1991).

2.3.2 ***Nanophyetus salmincola***

The parasite infects the small intestine and colon of the dog. Geographic distribution is limited to areas where the dog has access to salmon and trout infected with metacercariae of *N. salmincola*, principally along the rivers Oregon and associated northern Pacific Coast region of the United States (Anderson, 1975).

2.3.2.1 **Transmission**

Eggs passed in faeces develop slowly and hatch within three months or longer. Pleuronectid stream snails act as the first intermediate host. The liberated cercariae parasitize members of the salmon and trout (which act as the second intermediate hosts) through the skin. Within the fish, the metacercaria occurs primarily in the kidney. When these metacercariae are ingested by the definitive host, the flukes develop to maturity in 5 days and adults may survive for 18 - 250 days.

2.3.3 **Alaria species**

These are small flukes of the genus *Alaria* that parasitize the small intestine of the dog. They range from 2 - 6mm in length and the flat expanded anterior part is much longer than the posterior cyclindrical part. The suckers are very small and an adhesive organ is present.

The following species, *Alaria canis, A. americana, A. mustalae* and *A. ausaemoides* as reported by different authors reviewed by Soulsby (1982), are reportedly found in dogs in North America.

The life cycle of *Alaria* species has been described by Georgi (1974) and Soulsby (1982). Eggs containing miracidium hatches releasing free swimming miracidia which enter *Helisoma* snails. Cercariae leave the snail and penetrate the skin of tadpoles and frogs, where they encyst as metacercariae in muscles. The definitive host becomes infected on eating the intermediate host after which the fluke undergo migration through the thoraxic tracheal route to the small intestine. Paratenic hosts such as snakes, mouse, rats and birds could be involved in the life cycle.

2.4 Epidemiology of GastrointestinalHelminths of dogs in Nigeria

Reports in Nigeria have confirmed the existence of intestinal helminth infection in almost every part of the country (Idowu *et. al.*, 1977; Oduye and Otesile, 1977; Saror *et. al*, 1979; Fabiyi, 1983). Several efforts have been made to assess the prevalence of these parasites and a higher prevalence rate has been reported from the southern parts of the country than in the north. Ugochukwu and Ejimadu (1985) recorded a prevalence of 86.97% in Calabar, while Ezekoli (1984) reported that 55.2% of dogs in Zaria were infected with intestinal helminths, both surveys done by faecal examination.

Ancylostoma caninum is the most prevalent parasite in Nigeria during routine faecal examination (Olufemi and Bobade, 1979; Fabiyi, 1983, Du-Sai and Abdullahi, 1989). In a five years record of cases from the Small Animal Clinic in Ahmadu Bello University, Zaria, 72.8% of dogs examined had hookworm infections, either singly or in combination with other intestinal parasites (Tekdek and Umoh, 1985). Hookworm infection has also been reported to be the most single aetiological agent of canine anaemia in Ibadan (Oduye and Otesile, 1977).

Other intestinal parasites reported during routine faecal examination in Nigeria include *T. canis, T. leonina, T. vulpis, S. stercoralis, Sp. lupi, Dipylidium* and *Taenia* species in Ibadan (Olufemi and Boabade, 1979), Calabar (Ugochukwu and Ejimadu, 1985), Kainji (Okaema, 1985), Lagos (Fashuyi, 1981), Zaria (Du-Sai and Abdullahi 1989) and Plateau State (Ajayi and Duhlinska, 1997).

Prevalence of gastrointestinal helminths in Nigeria is higher during recovery of parasites at necropsy than recovery of eggs in faeces. A hundred percent prevalence was obtained using the former method in Zaria (Dada *et al.*, 1979), Calabar (Elamah and Braide, 1981) and Jos (Fabiyi, 1983).

Echinococcus granulosus is one of the least reported intestinal helminths of dogs in Nigeria, even though hydatid cysts have been reported in a good number of domestic animals (Dada and Belino, 1978). Reports during necropsy revealed that only one (0.6%) out of 180 stray dogs in Zaria haboured *Echinococcus granulosus* (Dada *et al.*, 1979), while 9 (6.21%) out of 145 stray dogs in Kano had the infection (Dada and Belino, 1978). In Calabar (Ugochukwu and Ejimadu, 1985), and Kainji (Okaeme, 1985), 2 (0.78%) out of 254 dogs and 1 (3%) out of 26 dogs were reported to habour *Echinococcus granulosus* respectively.

In a survey during the examination of gut samples in Niger Delta (Arene, 1984), out of 60 dogs obtained from local butchers in the Port Harcourt area, *E. granulosus* was revealed in 51 and *T. canis* in 34 dogs. Other parasites found were *D. canis* (53), *T.* hydatigena (26) and *T. leonia* (2).

Prevalence rates of gastrointestinal helminths are quite higher in the south than in the north, probably because of bioclimatic elements like high relative humidity, heavy rainfall and high ambient temperature that favour the development and transmission of gastrointestinal parasites (Okon and Akinpelu, 1982; Ugochukwu and Ejimadu, 1985).

Young dogs have been reported to be more susceptible to intestinal helminths than older dogs infected with hookworms and ascarids (Saror *et. al.*, 1979; Folaranmi *et. al.*, 1984; Tekdek and Umoh, 1985; Udonsi and Agunama 1991). Dogs less than one year have often been incriminated for infection with *Toxocara canis* (Fabiyi, 1983). Out of 9 young dogs surveyed in Jos Plateau, 8 haboured moderate to heavy *T. canis* infection. Tapeworms have been reported amongst all age groups, but most commonly in mature animals (Ezeokoli; 1984, Elamah and Braide, 1981; Folaranmi *et. al.*, 1984).

Indigenous Nigerian dogs are said to be more exposed to infections with gastrointestinal helminths than non-

indigenous breeds (Ezeokoli, 1984; Fashuyi, 1981; Chiejina and Ekwe, 1986) and stray dogs show higher prevalence rate than well cared for dogs (Dada *et al.*, 1979; Umoh and Asake, 1982; Du-Sai and Abdullahi, 1989). The reason for the high prevalence of our indigenous dog is as a result of poor sanitation and irresponsible ownership (Saror *et. al.*, 1979).

Environmental contamination with parasite ova also facilitates the dissemination of gastrointestinal helminths. Through examination of faecal and soil samples in eastern Nigeria (Nsukka and Enugu), 13 (13%) out of 100 soil samples collected were positive for *Toxocara* eggs, and 86 (25.95%) out of 262 faecal samples were positive for *Toxocara* eggs (Chiejina and Ekwe, 1986). In Zaria, 28 out of 115 aoil samples examined were positive for ova of *Toxocara* species (24.35%), with the highest number of positive cases (46.43%), recorded from children's play ground and football pitch. This result confirms that contamination with *Toxocara* eggs is widespread in the soil in public places and play ground, and this act as a source of infection to dogs (Galadima *et. al.*, 1989).

2.5 Immune Response to Gastrointestinal Parasites

Helminth infection in animals initiate a complex set of specific immune mechanisms which include the elements of cell-mediated and antibody dependent immunity against the worms and their products (Bloch and Malveaux, 1985). Inflammatory reactions are thought to play very important protective roles in immune response to intestinal parasites. Intestinal inflammation is a very complex process, resulting in profound structural and functional changes, and in release of a wide variety of mediators, and each potentially capable of damaging the worm (Symth, 1994). In animals, mast cells have been reported to be among the first to come in contact with noxious substances and antigenic materials during infection (Moqbel, 1986). Degranulation of mast cells are said to release profound vasoactive amides that interacts with the tissues of both host and parasite (Jarret and Miller, 1982; Symth, 1994). The activation of mast cells by these stimuli results in the generation and release of other inflammatory mediators such as leukotrienes, prostaglandins, or platelet activating factor (Katz *et. al.*, 1985).

Other cells infiltrating the mucosa during infection include lymphocytes and granulocytes, especially eosinophils (Symth, 1994). These cells are known to release cytokinine

enzymes and basic proteins, all of which affect the viability of the worms (Moqbel, 1986). An increase in the number of peripheral blood and tissue eosinophil occurs in helminth infections especially during invasive stages of the parasite (Kayes, 1985). An intense eosinophilic infiltration of the mucosa with an elevated peripheral eosinophil count was reported in a 7 year old girl, presumptively caused by dog hookworm *Ancylostoma caninum* (Shantz *et al.*, 1993). Eosinophils have been shown to possess the ability to destroy helminths *in vitro* (Butterworth, 1984). These eosinophils appear to serve at least two roles. Firstly, they contain enzymes capable of neutralizing the vasoactive agents released from mast cells. Secondly, eosinophils in conjunction with antibodies (probably of the IgG type) are capable of killing some helminth larvae and hence also serve a protective function (Tizard, 1977). Although not much systematic study has been made on the role of neutrophils or macrophage during helminth infection, it is suggested that these cells may also contribute to the exacerbation of these inflammatory reactions (Moqbel, 1986).

Studies on hymenolepid cestode species in rodents show that immunity can operate effectively during adult cestode infections, and the important effect is to destrobilate the worm, leaving only the scolex, neck region and a short part

of the body (Smyth, 1994). Re-growth of these forms appear to be inhibited. Though yet to be proven, an effect or role to antibody and complement have been assigned to this response (Smyth, 1994). Infection of host with taeniid eggs also generates a rapid and highly effective immune response. This gives complete protection against further egg infections because it prevents development of the mucosal cysticercoids, immunity being almost absolute within 2 - 3 days (Smyth, 1994).

Specific antibodies have been demonstrated in intestinal secretions following infection with gastrointestinal helminths (Wells, 1963). Although conventional antibodies of IgM, IgG and IgA classes are produced in response to helminth antigens, there is an increasing body of evidence that suggests that the most significant immunoglobulin class involved in resistance to helminths is IgE (Tizard, 1977). Studies have shown that .IgE plays an important role in the development of many allergic conditions (Roitt *et. al.*, 1984). Reagenic IgE antibody formation has been identified following an impressive number of helminth infection in man, dogs, rats, mice and guinea pigs (Dobson, 1972; Bloch and Malveaux, 1985). Roitt *et. al* (1984), reported 100% elevation of IgE serum level in rats infected with gastrointestinal helminths.

Immunoglobulin E has been reported to be of considerable benefit in controlling worm burdens, and one of the best example is the "self-cure" reaction seen in sheep infected with gastrointestinal nematodes, *particularly Haemonchus contortus* (Tizard, 1977). Immunoglobulin E has other roles to play in the reduction of helminth burdens in animals. Macrophage are seen to bind to helminth larvae through IgE-mediated pathway to cause destruction of the larvae. Also, by mediating mast cell degranulation, IgE stimulates release of eosinophils chemotactic pool, resulting in the release of large numbers of eosinophils into the circulation (Tizard, 1977). It is for this reason that eosinophilia is characteristic of helminth infections.

While IgE-mediated reponse is perhaps the most significant mechanism of resistance to helminths, antibodies of other immunoglobulin classes also play protective role (Tizard, 1977). Migrating helminth larval stage is powerfully immunogenic and its antigen stimulates strong protective responses (Rickard and Williams, 1982). Immune mechanisms involving IgA or IgG antibodies may operate and effectively prevent further development of the larval stage (Smyth, 1994). In infections with *Nippostrongylus braziliense* both IgG and IgM were detected (Dobson, 1972; Bloch and Malveax 1985). Specific IgM, IgG and IgA

antibodies have been observed to develop in dogs two weeks after challenge with (Ancylostoma ceylenicum Carrol and Grove, 1986).

The overall effect of both the cell-mediated and humoral responce of the host to helminth infections may be manifested by encapsulation of the worms or their larval tissues, a regression of growth and development of the larval stages of the worms, resistance to reinfection, inhibition of egg production or worms damage and/or expulsion from the intestine (Clegg and Smyth, 1978; Befus, 1986; Ito *et al.*, 1988; Smyth, 1994).

2.6 Diagnosis of Intestinal Parasites

2.6.1 Parasitological Diagnosis

Diagnosis of parasitic infection still depends heavily on parasitological findings. The microscopic appearance of eggs in the faeces of infected animals is still the method widely dependent on for diagnosis (Georgi, 1974). Several diagnostic techniques for microscopic examinations have been published by Sloss *et. al.* (1978) and Soulsby (1982). Such techniques include: direct or simple smear technique, simple flotation technique and the qualitative concentration method. For the simple flotation technique advantage is taken of the low specific gravity of most helminth eggs to separate them

from the faeces. The purpose of the concentration method is to detect light infections by concentrating a small volume of faeces, also taking advantage of the low specific gravity of the helminth egg.

For parasitogical diagnosis of tapeworms, arecoline hydrobromide at 1 - 2 mg/kg body weight has been used to obtain a purge, and the purged material is examined microscopically for the presence of cestodes (Arundel, 1972).

The Kato-Katz techniques, which is reported to be faster, has also been successful in the diagnosis of intestinal nematode infection (Fashuyi, 1981). Infection rate of local dogs using this method was found to be 97.8%. Briefly, this technique involves filtration of fecal sample through a nylon mesh. Measurement of equal quantity of filtrate with perforated plastic plates and use of cellophane foils previously soaked for 24 hours in Dafix solution in place of glass cover slips (Fashuyi, 1981).

Although parasitological diagnosis if successful provides unequivocal evidence of infection, they are limited, especially when applied to low-level infections, and single sex infections. Moreover, diagnosis is not also possible prior to patency of an infection and also to infection where parasites occur in deeper tissues.

2.6.2 **Immunological Diagnosis**

Immunological diagnostic test have a valuable role to play not only in situations where the parasitological methods are unapplicable, but also in large-scale examination of populations in endemic areas (Smyth, 1994). Many immunological diagnostic tests, which includes the indirect hemagglutination (Enyenihi, 1970), agar-gel precipitation (Martin, 1972), complement fixation (Soulsby, 1963) and immunofluorescence (Houba, 1980), have been used in the past. The use of these tests had a great deal of success, but the provision of appropriate antigens and achievement of sufficient sensitivity and specificity created considerable problems. Advances in the knowledge of parasitic antigens and the ability to synthesize and clone suitable molecules have considerably improved the situation. It is now possible to select antigens known to have high specificity for use in a variety of sensitive tests, of which the Enzyme-Linked Immunosorbent Assay (ELISA) and its derivatives are most prominent (Smyth, 1994). ELISA, using antigen or antibody absorbed into the surface of plastic tubes, microtitre wells or dip sticks, has rapidly become the most popular serological techniques for the diagnosis of helminth infections (Voller *et. al.*, 1976; Neva *et. al.*, 1981). This technique can be used to determine the presence of parasite

antigens in body fluids or faecal materials.

The application of this technique using *Echinococcus granulosus* proteoscolex antigens for diagnosis of naturally acquired *E. granuloses* infection in dogs, gave a sensitivity of 72.9% (Gasser and *et. al.*, 1990).

The sensitivity and specificity of the indirect florescent antibody test (IFAT) and ELISA for the diagnosis of non-patent ascarid and hookworm infection in dogs was determined by Schever (1989). Enzyme linked immunosorbent assay was more sensitive than IFAT.

Various cestode antigens have been analyzed quantitatively using SDS-PAGE and Western blotting with serum of dogs infected with cestode (Richard and Williams, 1982). Antigens were prepared from *Taenia hydatigena, T. pisiformis* and *E. granulosus*.

New techniques for *in vitro* culture, molecular analysis and the application of hybridoma and recombinant DNA technologies provide tools for potential immunodiagnosis of helminth infections (Soulsby and Lyold, 1986).

2.7 Control of Intestinal Helminths

The best method of control is prevention. Transmission pattern of intestinal helminths are complicated and certain

preventive measures may need to be continued for a year or more before a parasite is eradicated (Tjaart *et. al.*, 1986).

Several ways of controlling intestinal parasites have been put forward by veterinarians and other medical personnel (Arundel, 1970; Soulsby, 1982; Tjaart *et al.*, 1986; Gasser *et al.*, 1990). These preventive measures include prevention of environmental contamination with dog feaces, reduction of dog population, education of the public about the zoonotic potential of intestinal helminths, proper abattoir practices and prevention of contact with intermediate hosts by definitive hosts. The key to long terms control is the interruption of transmission. This involves continuous scrutiny of the factors that determine the occurrence and distribution of helminth infection in the dog populations.

This surveillance include the collection, analysis, interpretation and distribution of relevant data for appropriate action.

For the control of ascarid and hookworm infections prevention of environmental contamination with dogs faeces is important. A number of regulations to reduce contamination with dog's faeces have been put forward (Barriga, 1988). Dogs are prohibited in public places, banned from children play ground and sand boxes. Infected animals are isolated and treated, and dog owners are required to pick up their

pet's wastes.

Proper sanitation measures must be observed in the rearing of dogs. Special precautions should be taken with bitches nursing puppies. Her faeces and that of her puppies must be collected and burnt. Puppies should be reared in an enclosure until they are weaned, and the floor should be regularly cleaned of faeces to prevent the ingestion of eggs. Earth or sandy floors should be dug over and spread with lime to hasten dissipation of eggs (Soulsby, 1983; Barriga, 1988).

Another preventive measure is the reduction of the dog population. Due to problems associated with rearing dogs (bites, noise, waste pollutions, spilled garbage and disease transmission), the dog population in most cities is controlled by enacting local ordinances that required the licensing of those owned dogs, and removal from streets and destruction of those animals that appear not to have owners (Tjaart *et. al.*, 1986).

For the control of cestodes, several factors are important to prevent reinfection of dogs with tape worms. The relative incidence of tapeworms in any area may be expected to remain constant unless some drastic change is made in animal husbandry or in preventive medicine programs (Arundel, 1972).

The prevention of dog tapeworm *Dipylidium caninum* is achieved by control of the intermediate hosts (dog flea). Flea collars are now a very popular means of control (Soulsby, 1982). This consists of a plastic strip impregnated with dichlorvos in proportion of 9.3%. Carbaryl formulated as shampon is also available for dogs. Dog premises must be thoroughly cleaned, cracks and cervices thoroughly vacuum-cleaned and an effective insecticide blown into likely breeding places (Soulsby, 1982).

Proper abbatoir practices such as preventing dogs from having access to raw offal by burying or burial have been suggested for prevention of *Taenia* and *Echinococcus* species (Arundel, 1972).

2.8 Chemotherapy of Helminth Infection in Dogs

About half of all pets have parasite infections that require treatment (Brander *et al.*, 1991). Several anthelmintic drugs have been employed for the treatment of intestinal helmiths (Anderson, 1975; Blood *et. al.*, 1986; Merck and Bayer, 1996). The following have been reported effective for the treatment of various intestinal helminths.

2.8.1 Piperazine Salts

Salts of piperazine are effective in removing adult ascarid from the intestine of dogs and have low toxicity for this species (Anderson, 1975). It causes flaccid paralysis of the worm and the parasite lose their attachment to the intestinal wall and are expelled by peristalsis. A dose of 100 mg/kg body weight is effective against all adult ascarid in dogs, while 200 mg/kg will remove immature worms from puppies one to two weeks of age. The efficacy of piperazine in treatment of dog ascarid is over 90% (Tjaart *et. al.*, 1986). Although relatively ineffective against other parasites of dogs, it remains the ascaricide of choice.

2.8.2 Dichlorvos (2,2-dichlorovinyl dimethyl phosphate)

This organophosphate is particularly valuable as a broad spectrum anthelmintic for dogs, being active against *T. canis, T. leonina, Tr. vulpis U. stenocephala* and A. *caninum* (Brander *et. al.*, 1991). Doses of 12 - 15mg/kg body weight used as either single or a split dose. High efficiency has been reported when the split dose treatments is administered (Soulsby, 1982). Arundel (1970) obtained 100% efficiency against roundworms in 117 dogs, when a dose of 20mg/kg was given in the evening and followed by a

similar dose in the morning. Dichlorvos given orally at a dose rate of 30-60 mg/kg is quite effective in removing adult whipworms, *Trichuris vulpis*. When given in the feed for five days at a rate of 200 ppm, dichlorvos showed 9.85% efficacy (Arundel, 1970).

2.8.3 Mebendazole (Methyl 5-benzoyl-1 H-benzimidazole-2-yl Carbamate)

This is a benzimidazole compound highly effective against ascarids and major species of dog hookworms (Soulbsy, 1982) WHO, (1989). It inhibits glucose uptake by the parasites, leading to glycogen depletion and death. Studies of animals with ascarid, hookworms and whipworms reported cure rates of 100% using a dose of 100mg/kg twice daily (Hass, *et. al.*, 1975).

2.8.4 Cesticides

Cesticides are anthelmintics used for the treatment of cestode infections. All compounds used, except arecoline bromide, cause disintegration of the worm so that specimens cannot be identified in the faeces (Arundel, 1972). Arecoline hydrobromide has been used for more than 100 years (Gemmel, 1958). It acts in two ways; firstly it causes paralysis of the worm so that the parasites loses

its hold on the intestine, and secondly it induces purgation, thus sweeping related worms out of the intestine (Soulbsy, 1982). At a dose of 1-2 mg/kg, 90-100% of worms were removed in several trials in Australia (Arundel, 1970). Toxic side effects of this anthelmintic includes vomiting, convulsion and unconsciousness; which may sometimes be observed 30 minutes after administration (Anderson, 1975).

Bunamidine hydrochloride (Scholaban) at a dose of 25 - 50 mg/kg, has been reported to be highly effective in removing common *Taenia* species, *D. caninum* and *E. granulosus* from dogs by causing dissolution of the tapeworms including the scolex. The drug is reportedly efficient when administered on an empty stomach. Sudden deaths, due to the drug's effect on the heart (Brander *et al.*, 1991) is an occasional side effect of the drug.

Praziquantel (Droncit) (2-cyclohexylcarbonyl-1,2,3,6,7,11), at 5mg/kg given as a single oral dose reliably destroys both the mature and immature stages of giant tape worms in the intestine. The excellent result of this drug is said to stemmed from a high degree of efficacy at very low tissue concentrations, rapid adsorption, rapid homogeneous distribution via the blood stream and subsequent active excretion through the intestinal mucosa and in the bile (Merck and Bayer, 1996). These properties

[redacted]

and 1mg of praziquantel per kilogram body weight in adult dogs and 15mg of febentel and 1.5mg of praziquantel per kilogram body weight for puppies. Vercom paste has been shown to be 94 - 100% effective against hookworms, roundworms and tapeworms. A few mild and self limiting side effects are reported, these including salivation, emesis or gagging, soft stool, reduced appetite, depression and paste rejection (Tjaart, *et al.*, 1986).

CHAPTER THREE

MATERIALS AND METHODS

3.1 Recovery of Parasites at Necropsy

The gastrointestinal tracts of dogs obtained from non-descript abattoirs around Zaria, Kaduna State, were used as samples for the recovery of intestinal parasites. Four non-descript slaughter houses were visited during the period of study, at least one visited each day. These non-descript abattoirs were located in Samaru, Bassawa Barracks, Sabon Gari and Darcaci.

Three hundred and sixty one samples were collected during the period of December 1995 to September 1997. After slaughter, the entire gastrointestinal tract after isolation from the abdomen, was retrieved and immediately ligated at the oesophagus, stomach, small intestine and large intestinal junctions for the purpose of estimation of regional distribution of the worms. The samples were transported to the laboratory in labelled polythene bags. There was no information on the history of the dogs, but their sexes were determined by their genitalia.

In the laboratory the different regions of the gastrointestinal tract were separated and processed separately. Each region was opened longitudinally and the

contents were discharged into a pan. The mucosa lining was also scraped into the pan, and care was taken to collect all washing and ingesta. The collected ingesta were transferred into a bucket. To wash the ingesta, water was added generously, followed by stirring. The parasites and heavy materials were allowed to settle to the bottom after which the supernatant fluid was decanted by filtering through a 50 mesh per inch sieve. The washing was repeated until the supernatant fluid was clear. The contents were then poured into a Petri dish, a little at a time and scanned under a magnifying glass on a well lit perspex viewing board (Picker X-ray Cooperation, New York). The parasites observed were removed from the sediment and separated into genera based on their morphological characteristics. The parasites were then preserved in 10% formalin for further identification. The adult nematode worms were further separated into sexes, after which all the worms were counted and measured using a graph sheet.

3.2 Identification of Parasites Isolated

Although most of the parasites could be identified by macroscopic features, all worms were subjected to microscopic examination.

Identification was done according to the criteria described by Whitlock (1960) and Soulsby (1982).

The preserved worms were mounted in lactophenol which apart from clearing the worms, causes them to be stretched out, facilitating the study of relevant organs for identification.

The cestodes were isolated into two groups viz: *Dipylidium* and *Taenia* species. *Dipylidium caninum* was easily recognised by its characteristic barred cucumber or rice-shaped gravid segments. The second group consisted of all other *Taenia* species. For the most part hook measurements using a micrometer were found to be the only practicable means for identification. No attempt was made to identify those lacking a scolex.

3.3 Paired Sample Collection

One hundred gastrointestinal tracts and faecal samples were collected from the same animals for comparison of the qualitative/quantitative egg outputs and parasite burden.

3.4 Qualitative Faecal Examination

Faecal samples collected from the rectum of animal just before slaughter were transpsorted to the laboratory in labelled polythene bags. A small quantity of fresh

faeces was thoroughly mixed in a mortar with a glass rod in about 10mls of Zinc Sulphate as flotation media, with a specific gravity of 1.2. The suspension was filtered through layers of cotton gauze into centrifuge tubes placed vertically in rubber racks. With the aid of a plastic dropper, the $ZnSO_4$ solution was added to each tube until a convex meniscus was formed. A glass cover slip was gently placed on the meniscus, care being taken to avoid trapping air bubbles as well as overflowing of the Zinc Sulphate solution. This technique is based on the principle that nematode and cestode eggs float on $ZnSO_4$ solution at specific gravity of 1.2 (Sloss *et al.*, 1978). After about three minutes, when any parasite eggs present in the fluid would have clung to the cover slip, each cover slip was carefully removed by a straight upward motion, placed on a clean glass slide and directly examined under the light microscope at X10 objective; or X100 when necessary (FAO, 1966).

The results were recorded as follows:

\+ =1 - 10 eggs present on a cover slip

\++ =11 - 20 eggs present on a cover slip

\+++ =21 ->50 eggs present on a cover slip

3.5 Quantitative Faecal Technique

The method used for the quantitative analysis (egg count) was the modified McMaster egg count technique (FAO, 1966, Soulsby, 1982;).

The multiplication factor for obtaining the eggs per gramme of faeces (egg) was calculated as follows:

0.30ml = x eggs (i.e. Volume of the 2 Mcmaster slide wells)

Therefore 12ml = (x/30)12

2g of faeces = 40 x eggs

Therefore 1 gramme of faeces = 40x/2 = 20x

Thus, the factor with which the total number of eggs counted in the two chambers was multiplied to get the number of eggs /g of faeces was 20.

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3.6 Statistical Methods

The worm burden in each group of worms (genus) was computed, and the relationship between parasite burden and size of the parasite was determined using correlation analysis, while the regression analysis was used to determine the relationship between the egg count and female worm burdens of the different parasites isolated. Fisher's exact test was carried out to determine the level of dependence between the presence of eggs in the faeces on the presence of parasites in the gastrointestinal tract.

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The mean intensity of each group of helminth infection was calculated (Margolis *et. al.*, 1982).

CHAPTER FOUR

RESULTS

4.1 Results

Of the 361 dogs sacrificed, 359 (99.4%) were found to be infected by nine different types of gastrointestinal helminths. The parasites, the members of dogs infected and the parasite rates were, *Dipylidium caninum*, 190(52.6%); *Taenia ovis*, 61(16.9%); *Taenia hydatigena*, 79(21.9%); *Toxascaris leonina*, 6(1.7%); *Toxocara canis*, 27(7.5%); *Ancylostoma caninum*, 246(68.1%); *Ancylostoma braziliense*, 9(2.5%); *Spirocerca lupi*, 25(6/.9%) and *Rictularia* sp., 9(2.5%). See Table 1, Plates I-VIII.

Mixed infection were common, as 236(65.4%) of the 361 dogs harboured 2 to 4 parasite types. These were distributed as follows: two parasite types 176(49.0%); 3 parasite 56(15.6%); and four parasite types, 3(0.8%). Only 123(34.1%) dogs harboured single parasite infections, while 2(0.6%) dogs carry no infection.

Of the single infections, hookworms were the most prevalent with an infection of 16.1% in 58 dogs. The combination of hookworm and *Dipylidium caninum* infection was the most common among the double infections, occurring in 73(20.2%) dogs. For the triple infections, the trio of

hookworms, *Dipylidium caninum* and *Taenia* sp. Were the most common, occurring in 28(7.6%) dogs, while in the case of infection caused by parasite types, 1(0.3%) one dog each carry the combination of hookworms, *Taenia* sp., *Dipylidium caninum* and ascarids; hookworms, *Taenia* sp., ascarids and *Rictularia* sp.; and hookworms, *Taenia* sp., ascarids and *Spirocerca lupi* respectfully. (Table 2).

It is shown in table 3 that 228(63.2%) male dogs and 131(36.3%) female dogs carried infection and that the two parasite-free-dogs were males. Of the 228 parasitised male dogs 74(32.5%) carried single infections, 110(48.2%) carried double infection, 41(18.0%) had triple infections and 3(1.3%) had infections due to four parasite types. Of the 131 parasitised female dogs, 49(37.4%) carried single infections, 67(51.1%) were parasitised by groups of two worms, and 15(11.5%) by groups of three worms.

Table I: Prevalence of Gastrointestinal helminths in necropsied dogs in Zaria, Nigeria (n=361)

Parasite species	No. of animals infected	% of animals infected
Dipylidium caninum	190	52.6
Taenia hydatigena	79	21.9
Taenia ovis	61	16.9
Toxoascaris leonina	6	1.7
Toxocara canis	27	7.5
Ancylostoma caninum	246	68.1
Ancylostoma braziliense	9	2.5
Spirocerca lupi	25	6.5
Rictularia sp.	9	2.5



Plate I: Anterior Portion of an adult hookworm (*Ancylostoma* sp) (X 60)



Plate II: Anterior Portion of adult *Diphylidium caninum* (X60)



Plate III: *Taenia ovis* (Scolex) (X60)



Plate IV: *Taenia hydatigena* (Scolex) (X60)

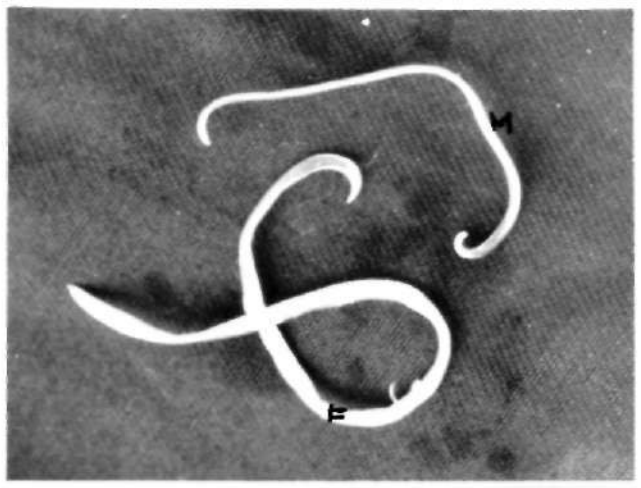


Plate V: Male and Female Ascarids (X50)



Plate VI: *Spirocerca lupi* in nodule



Plate VII: Anterior Portion of *Rictularia* species (X60)



Plate VIII: Middle Portion of *Rictularia* species (X60)

Table 2: Frequency Distribution of Negative, Single and Mixed (multiple) Gastrointestinal infections in dogs at Necropsy (n = 361)

Parasite species	Frequency of Occurrence	
	Total	%
A. NO INFECTIONS	2	0.6
B. SINGLE PARASITE INFECTIONS	**123**	**34.07**
Hookworm	58	16.1
Dipylidium	37	10.2
Taenia	23	6.4
Ascarids	2	0.6
Spirocerca	3	0.8
C. MIXED PARASITE INFECTIONS		
i. TWO PARASITES	**178**	**49.3**
Hookworm + *Dipylidium*	73	20.2
Hookworm + *Taenia*	53	14.4
Hookworm + *Spirocerca*	12	3.3
Hookworm + ascarids	6	1.7
Hookworm + *Rictularia*	2	0.6
Taenia + *Dipylidium*	22	6.1
Taenia + *ascarids*	2	0.6
Taenia + *Spirocerca*	1	0.3
Dipylidium + *ascarids*	4	1.1
Dipylidium + *Spirocerca*	3	0.3
ii. THREE PARASITES	**56**	**15.55**
Hookworm + *Dipylidium* + *Taenia*	28	7.6
Hookworm + *Taenia* + *ascarids*	2	0.6
Hookworm + *Dipylidium* + *Spirocerca*	2	0.6
Hookworm + *Dipylidium* + *Rictularia*	2	0.6
Hookworm + *Dipylidium* + ascarids	10	2.8
Hookworm + *Taenia* + *Rictularia*	2	0.6
Hookworm + ascarids + *Rictularia*	1	0.3
Hookworm + *Taenia* + *Spirocerca*	2	0.6
Taenia + *Dipylidium* + ascarids	3	0.8
Taenia + *Dipylidium* + *Spirocerca*	3	0.8
Taenia + *Dipylidium* + *Rictularia*	1	0.3
iii. FOUR PARASITES	**3**	**0.83**
Hookworm + *Taenia* + *Diphlidium* + ascarids	1	0.3
Hookworm + *Taenia* + ascarids + *Rictularia*	1	0.3
Hookworm + *Taenia* + ascarids + *Spirocerca*	1	0.3
Total	361	

Table3: Frequency Distribution of Gastrointestinal Helminths in male and female Dogs at necropsy (n = 361)

Sex	Male		Female	
Parasites	No.	%	No.	%
A. NO INFECTIONS	**2**	**0.9**	**0**	**0**
B. SINGLE PARASITE INFECTIONS	**74**	**32.17**	**49**	**37.40**
Hookworm	30	13.4	28	21.4
Dipylidium	24	10.4	13	9.9
Taenia	17	7.4	6	4.6
Ascarids	1	0.4	1	0.7
Spirocerca	2	0.9	1	0.7
C. MIXED PARASITE INFECTIONS				
i. TWO PARASITES	**110**	**48.2**	**67**	**51.5**
Hookworm + *Dipylidium*	40	17.4	33	25.2
Hookworm + *Taenia*	34	14.8	18	13.7
Hookworm + *Spirocerca*	9	3.9	3	2.3
Hookworm + ascarids	4	1.7	2	1.5
Hookworm + *Rictularia*	2	0.9	0	0
Taenia + *Dipylidium*	15	6.5	7	5.3
Taenia + ascarids	1	0.4	1	0.7
Taenia + *Spirocerca*	1	0.4	0	0
Dipylidium + ascarids	1	0.4	3	2.3
Dipylidium + *Spirocerca*	3	1.3	0	0
ii. THREE PARASITES	**41**	**18.0**	**15**	**11.5**
Hookworm + *Dipylidium* + *Taenia*	19	8.3	9	6.9
Hookworm + *Taenia* + ascarids	2	0.9	0	0
Hookworm + *Dipylidium* + *Spirocerca*	2	0.9	0	0
Hookworm + *Dipylidium* + *Rictularia*	2	0.9	0	0
Hookworm + *Dipylidium* + ascarids	8	2.5	2	1.5
Hookworm + *Taenia* + *Rictularia*	2	0.9	0	0
Hookworm + ascarids + *Rictularia*	0	0	1	0.7
Hookworm + *Taenia* + *Spirocerca*	1	0.4	1	0.7
Taenia + *Dipylidium* + ascarids	1	2.4	2	1.5
Taenia + *Dipylidium* + *Spirocerca*	3	1.3	0	0
Taenia + *Dipylidium* + *Rictularia*	1	0.4	0	0
iii. FOUR PARASITES	**3**	**1.3**	**0**	**0**
Hookworm + *Taenia* + *Dipylidium* + ascarids	1	0.4	0	0
Hookworm + *Taenia* + ascarids + *Rictularia*	1	0.4	0	0
Hookworm + *Taenia* + ascarids + *Spirocerca*	1	0.4	0	0
Total	288	63.2	131	36.3

Table 4 shows that *Dipylidium caninum* had the highest intensity with a mean (parasite burden/dog) of 26.11 ± 2.05 parasites and a range of 1-310 per dog. *Taenia* species had a mean of 20.28 ± 3.17 and a range of 1-276. Hookworm species, although the highest in terms of prevalence rate, had a mean intensity of 14.66 ± 1.21 per dog and a worm burden range of 1-213.

The heaviest *Dipylidium* infection was obtained in a female dog where 310 worms were recorded. Of the 190 dogs infected with *D. caninum* 24.7% haboured 1-10 worms, 54.1% had 11-50 worms and 23.1% had more than 50 worms. The sex specific rate of *Dipylidium* infection was higher in males than females, but were not significantly different ($P>0.05$).

Of the hookworm - infected dogs, 59.6% had 10 worms or less, 38.0% harboured 11-50 worms and about 4.7% had more than 50 worms. In the 156 male dogs infected, the mean worm intensity was 16.22±1.9 as opposed to 12.43±1.37 in the 104 infected female dogs. There was a significant difference between the worm burdens in the males and females at ($P<0.05$).

Infections due to *Toxocara canis* and *Toxascaris leonina* were presented with low burdens of infection and an overall mean intensity of 4.76±0.73 parasites. Twenty-one

male dogs were infected with a mean intensity of 4.2±0.8 parasites, and 11 female dogs with a mean intensity of 5.7±1 .34.

Table 4: Mean Intensity of Gastrointestinal Helminths of dogs at necropsy (n=361).

Parasite Species	Total No. of parasites recovered	Mean intensity ± SE
Hookworm	3724	14.66±1.12
Dipylidium	4961	26.11±2.05
Taenia	2901	20.28±3.17
Ascarids	157	4.76±0.73
Spirocerca	197	7.88±0.63
Rictularia	23	2.56±0.38
Total	11963	33.23±

The heaviest *Taenia* infection was encountered in a female dog that harboured 276 *T. ovis*. Most infections with *T. hydatigena* had just one worm in the entire gastrointestinal tract.

Spirocerca lupi infection had a mean intensity of 7.88±0.63 worms. Seventeen of the infected dogs had *Spirocerca* worms ranging from 1-11 in number confined in one paraoesophageal nodule, while the remaining 8 infected animals had parasites ranging from 8-17 worms in two paraoesophageal nodules. A spiruroid, *Rictularia* species had a mean parasite intensity of 2.56±0.38 worms and a range of 1-5 parasites.

The parasite length measured at different levels of infection showed that for hookworms, the male length varied from 5mm to 9.2mm while the females measure 8.4 to 15.7mm. There was a negative correlation of -0.96 when parasite length was compared with the parasite burden. The length of male and female ascarids ranged from 9-13cm and 12-16.7cm respectively, and a negative correlation of -0.525 was obtained when compared with the worm burden at different levels of infection. Thus as the worm burden increased, the worm length decreased and vice-versa.

Results of the comparison of the egg output to hookworm burden of the dogs examined is shown in Table 5. Qualitative representation of infection as "+" corresponded to a mean worm burden of 6 in the intestine, while "+++" corresponded to a mean burden of > 48 in the intestine.

Table 5: Relationship between qualitative egg output and parasites burden for hookworm infection (100 samples)

Egg output	Parasite burden	Comment
+ (1-10)	6.7 ± 2.8	Light
++ (11-20)	16.2 ± 3.7	Moderate
+++ (21->50)	33 ± 11.4	Heavy

Table6: Comparison of necropsy results and Faecal egg Examination of 100 dogs examined concurrently

Parasites	% Prevalence of Parasites recorvered	% Prevalence of eggs from faeces of same animals	Difference
Dipylidium	59	2	57
Taenia	57	5	52
Hookworm	76	48	28
Spirocerca	9	0	9
Ascarids	12	4	8
Rictularia	2	0	2
Total	215	59	

Of the 100 dogs whose gastrointestinal tract and faecal samples were examined concurrently for worms and eggs, 100% prevalence was obtained at necropsy while only 53% prevalence was obtained by faecal examination (Table 6 and appendix 1). Hookworm infection was the highest in prevalence both during the recovery of parasite from the intestinal tracts and by detection of eggs in faecal samples, with a difference of 28% between the two prevalence rates, while cestodes had the least prevalence during faecal examination. In *Dipylidium* infection only two faecal samples were positive for eggs, while five dogs had *Taenia* eggs in their faeces.

When the Fishers exact test was used to determine the relationship between presence of parasite in the gastrointestinal tract and the presence of eggs in the faeces, the results indicated that there was significant difference between the egg output and presence of parasites in the gastrointestinal tract ($P<0.01$). There was no significant difference between the presence of egg and parasite in *Dipylidium* infection ($P<0.05$).

There was a positive correlation in hookworm and ascarid infections when the relationship between egg count and female worm counts were determined using regression analysis (Fig 1 and 2). For hookworms, the regression

equation r = +0.8708, while that of ascarid was r = +0.9987. As the parasite burden increased the egg count also increased. Even though the overall egg count increased, it was further observed that the number of eggs produced by each female worm during crowding, was less than when there were fewer female parasites (Fig 3).

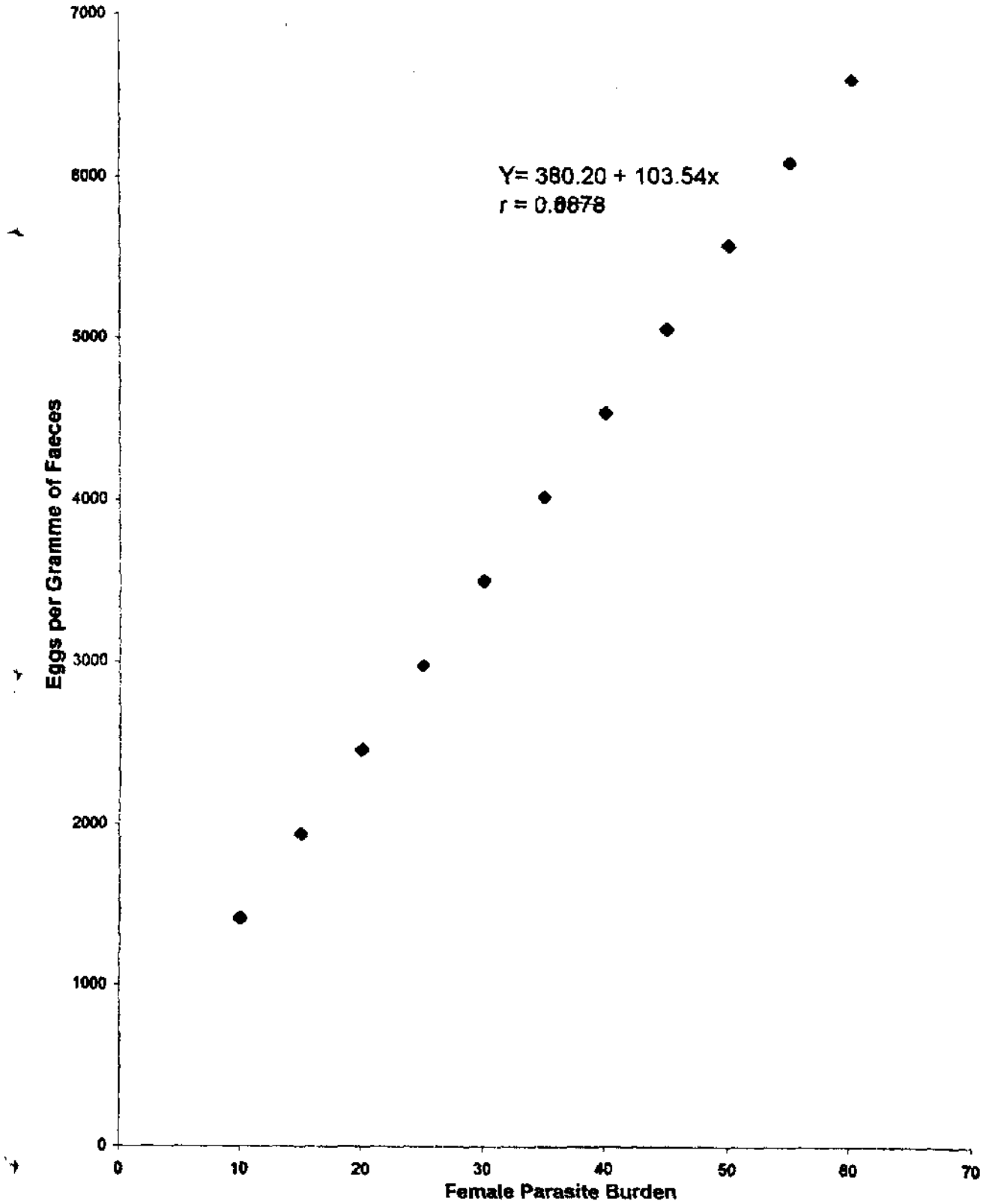


Fig 1: Relationship between female parasite burden and Eggs/g of faeces in hookworm infections

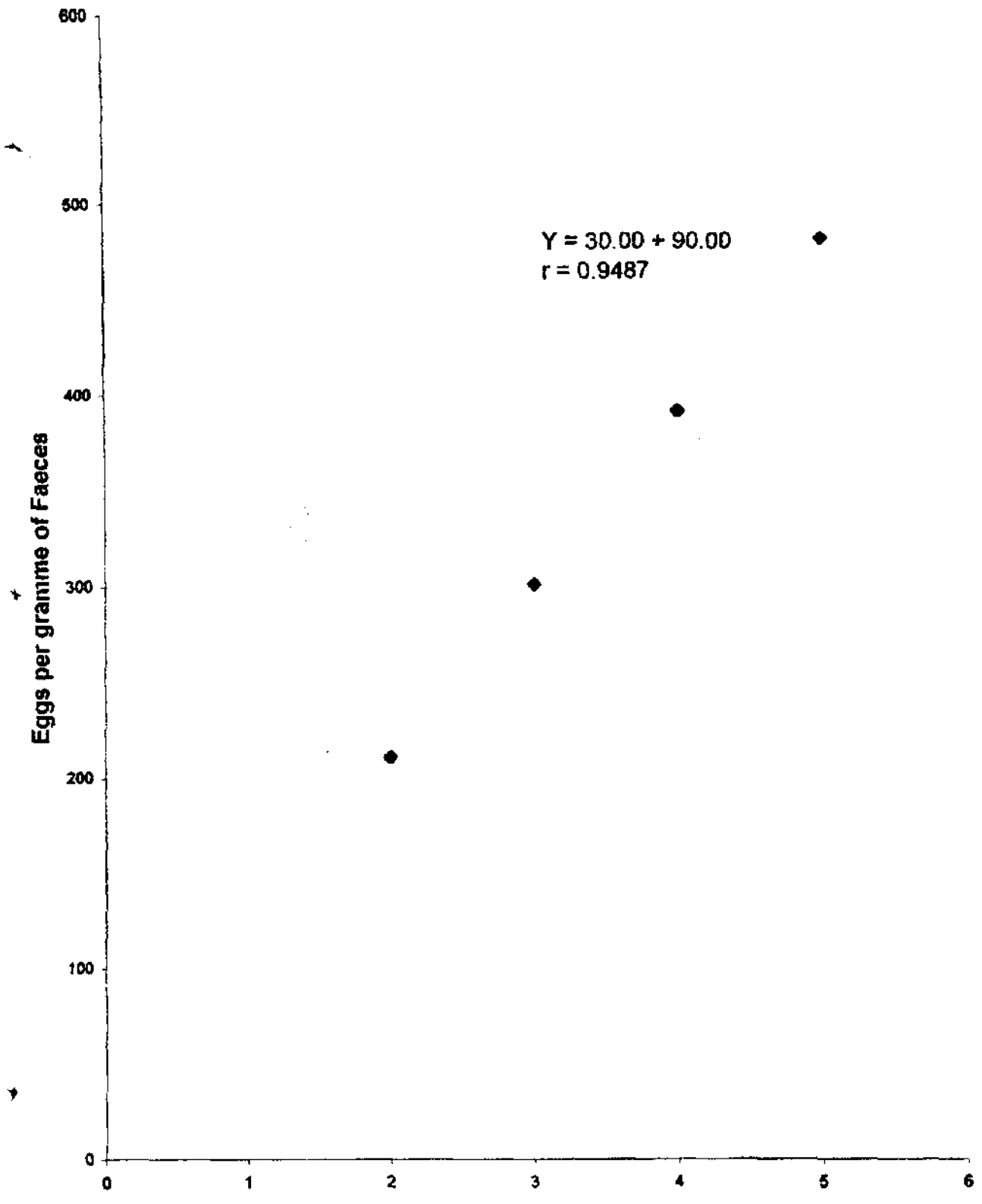


Fig 2: Relationship between female parasite burden and Eggs/g of Faeces in ascarid infections

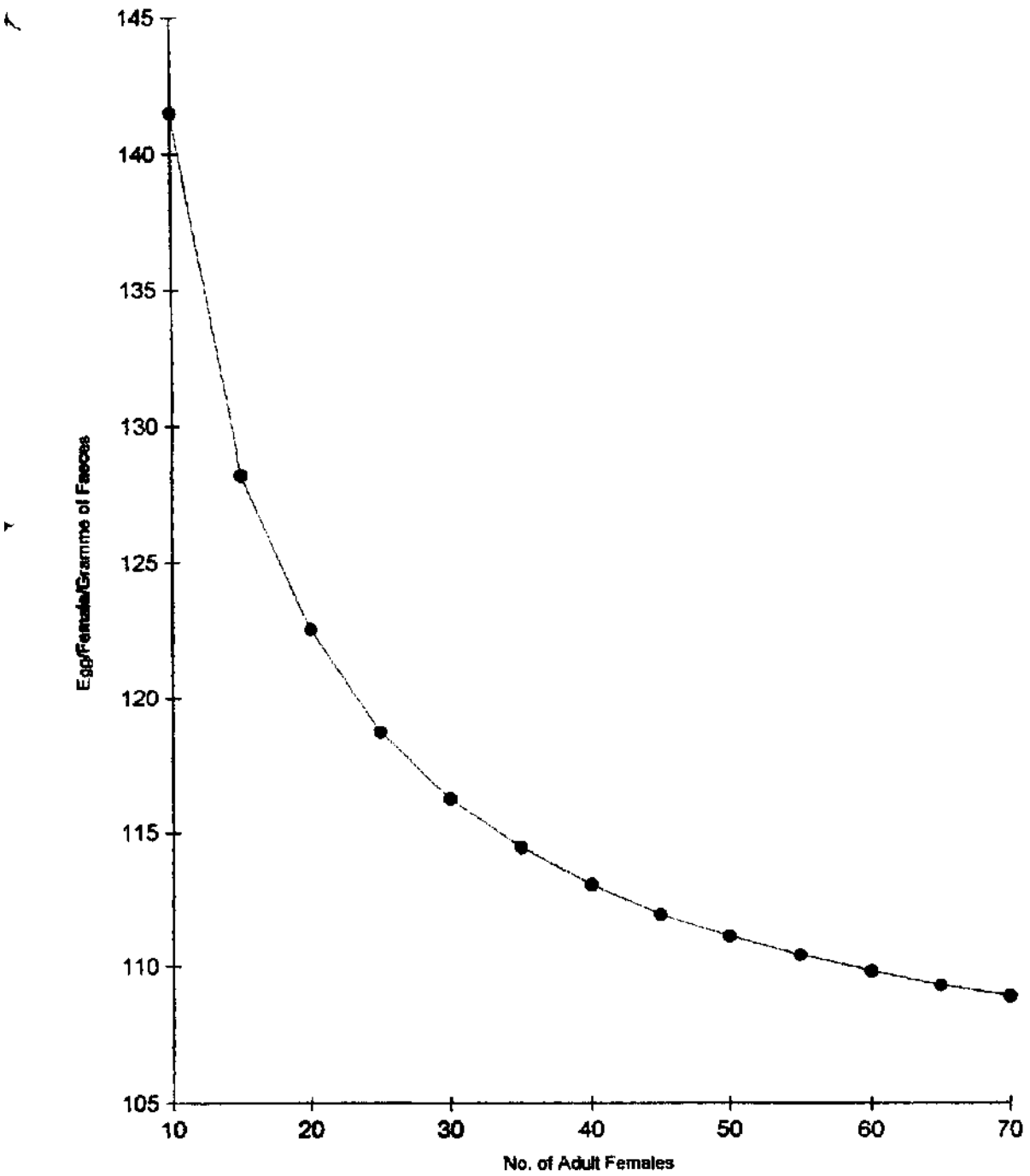


Fig. 3: Mean Eggs/Female/g of Faeces in Hookworm Infections

CHAPTER FIVE

DISCUSSION

5.1 Discussion

The study has revealed a high prevalence of gastrointestinal parasites in dogs in Zaria area, and confirmed the fact that the recovery of parasites from the intestinal tract during post mortem examination is a more reliable method for determining the prevalence of gastrointestinal parasites for epidemiologic studies (Vester, 1979). The high prevalence could be related to the non-challant attitude of dog owners to give proper veterinary attention to their household pets, poor nutrition which serves as a predisposing factor to many diseases including parasitic diseases and the stray nature of dogs which exposes them to parasitic infections. The results obtained in the present study agree with other works carried out in Zaria (Dada *et. al.*, 1979), Jos Plateau (Fabiyi, 1983) and Sabah, Malaysia (Macadam *et. al.*, 1984), though the prevalence of individual parasites were slightly lower in the present study.

The highest prevalence recorded in hookworm infection agrees with the work of Fabiyi (1983), who recorded a prevalence of 84% in Jos Plateau. The high prevalence of

this parasite is probably due to the number of possible routes of infection through which the dogs can be exposed, transplacental, transmammary, oral and susbcutaneously. It may not also be unconnected with the fact that there could be a high level of environmental contamination with hookworm eggs that act as possible source of infection to the dog. *Dipylidium caninum* is the second most prevalent parasite encountered and the most prevalent cestode recorded in this study. This result are similar with that of Fabiyi (1983), in Jos Plateau, Kumar and Sahai (1972) in India and Schawaldar (1976) in Switzerland. All these researchers reported on a higher incidence of *D. caninum* than other tapeworms of dogs. The slightly lower prevalence recorded in the present study is rather unexpected since the parasite is quite common in this area (Dada et.al., 1979). Despite the low prevalence individual burdens were quite high, suggesting high rates of reinfection within the same animal (Soulsby, 1982). The predominance of *D. caninum* in comparison to other cestodes may be related to the easy availability of the intermediate hosts, the dog and cat flea. Flea infestation is reported to be a continuing problem and control is known to be difficult (Utteridge, 1984).

Two *Taenia* species, *T. hydatigena* and *T. ovis*, were

next in order of prevalence, with prevalence rates lower than that reported by Dada *et.al.*, (1979). This may be attributed to the fact that dogs do not have access to infected offals of the intermediate host. The low prevalence rate may also suggest that much fewer sheep are being slaughtered, probably because of the present economic situation in the country.

The fact that most animals examined during this study were adult dogs contributed to the low prevalence of ascarid encountered, since ascarid infections in the dog is only common among young dogs and lactating bitches (Anderson, 1975; Soulsby, 1983). Adult dogs have also been reported to develop resistance to ascarid infection even in the absence of previous infection (Greve, 1971).

The scavenging and roving habits of the dog might account for the present incidence of *S. lupi* which is known to have as carriers or transport host, other animals including, dung beetles, toads, lizards, rats, bats and chicken, which are often devoured by dogs.

A spiruroid, *Rictularia* species reported in the present survey has not been previously recorded in Zaria. In the absence of more detailed knowledge of the parasite and its life cycle, it is difficult to suggest reasons for its observation in the present study, the low incidence and

intensity among the animals that were infected.

Trichuris vulpis appears to be an uncommon parasite of dogs in Zaria (Dada *et.al.*, 1979). In this present work, no incidence of the adult parasite was encountered from the intestinal tract of the dogs examined, though a few eggs were seen in the faeces of one dog during faecal examination. The presence of eggs without the parasite could be because the parasite may have died or passed out spontaneously.

It is note worthy that the cestode, *Echinococcus granulosus*, was not observed in the samples examined. This was not surprising because so far, only Dada *et.al.* (1979) has ever reported the presence of *E. granulosus* in a single dog in this region. The high incidence of cystic hydatid infection from the camel and other slaughtered food animals in Kano (Dada *et.al.*, 1980), suggests the presence of *E. granulosus* in this region. The absence of this parasite in dogs in Zaria may be suggestive that apart from the sheep dog cycle, other cycles may be involved.

The high prevalence of mixed infection (65.4%) compared with single infection could be because parasites can cohabit without causing any harmful effect on each other (Mettrick and Podesta, 1974). Such high level of cohabitation could be seen between the hookworms and

Dipylidium.

The difference in the sexes, with predominance of the males could be because more males were slaughtered, while most females were kept for breeding until when necessary. The few parasites found in abnormal regions apart from the small intestine may result from competition, especially observed in multiple infections. The parasites may compete for attachment sites in the viability zone but are unsuccessful and generally become established in other areas. There is also evidence that host antibodies elicited in response to worm antigens may make the normal site of the worms unattainable and cause the parasite to migrate to other intestinal regions (Mettrick and Podesta, 1974). Also, because of the migratory habit of the worm especially the larvae, some enter the veins and get carried to other organs beside the oesophagus.

The worm burdens of the parasites showed that infection in this region ranges from low to high. Most of the dogs had low infections, but in those with heavy infection, the parasite burdens measured up to 213. This high intensity may be due to autoinfection because of poor hygiene. It was observed that female parasites were more abundant, especially in hookworm infection, where a male to female ratio of 1:4-4:6 was observed. The sex ratio and

female worm burden and intensity is important in the evaluation of fecundity and pathogenecity (Udonsi and Agunama, 1991).

It was generally observed that as the parasite burden increased or in heavy infections, there was a reduction in the size of the parasite. There was a negative correlation between the adult worm burden and size of hookworm and ascarid infections. This, together with the stunted specimens encountered during heavy cestode infection could be an indication of crowding which leads to competition. Stunted specimens under conditions of crowding in some cestode has been attributed to the effect of carbohydrate deprivation on the growth of worms (Mettrick and Podesta, 1974).

The higher prevalence of parasite recorded during worm recovery at necropsy as compared to faecal examination goes to further confirm the reliability of recovering parasites from the intestine at necropsy as a better method to determine the prevalence of intestinal parasitism for epidemiologic studies. Due to the absence of an outlet for *Spirocerca* eggs, the number of dogs with eggs present in the faeces was less than the number with parasites in the nodules. *Spirocerca* eggs, because of their small size hardly floats in levitating media (Vester, 1979).

The relative infrequency with which *Taenia* infections were detected in the faecal examination is probably due to the higher specific gravity (1.2251) of their eggs (David and Lindguist, 1982). *Taenia* eggs are said to be much smaller than hookworm and ascarid eggs. They have heavier specific gravities because their mass unit volume is greater due to the absence of a pervitellus space in them. As a result of this, *Taenia* eggs often do not rise to the surface of conventional levitating media like the one used in the this research (Zinc sulphate + sugar with specific gravity of 1.2). The higher prevalence resulting from direct worm recovery at necropsy might be due to the fact that there are always non egg laying immature worms as well as adults in the host.

Infection of hookworm was highest as determined by qualitative faecal examination as compared with other species. This could be as a result of the fact that hook worm eggs are very light, with a specific gravity of 1.055, far lower than the specific gravity of the conventional flotation media, thus eggs could easily float. It was observed that between 5 to 6 worms needed to be present in the intestinal tract for eggs to be recorded as "+" in the faecal examination. Infection with "+" signifies low infection, "++" moderate and "+++" high infection. From

above results, 21 dogs had low hookworm infection while 15 had moderate and 17 had high hookworm infection. The presence of between 35 and 53 parasites in the intestine, indicated as "+++" in faecal examination shows that such animal is heavily infected with hookworms.

The relationship between the presence of parasites in the gastrointestinal tract and the presence of eggs in the faecal as determined by the Fishers exact test shows that, there could be parasites in the gastrointestinal tract without eggs found in the faeces of the animal.

Egg counts varied with worm burden in the intestine. As the parasite burden increased, the worm burden also increased and vice versa. The tremendous increase seen in hookworm infection could be due to the fact that adult female hookworms produce an average of 16,000 egg per day, depending on the number of adults present, and patency is only about 17 days after infection. The increase in egg count is suggestive of a large number of worms in the gut.

The decreasing egg per female per gram of faeces may be accounted for by the fact that under conditions of repeated infections, an immune response is stimulated that inhibit colonization by many worms and depressed eggs production of those that did colonize (Caroll and Groove, 1986).

With the exception of *Rictularia* species, it has already been reported that all the parasites encountered during this study cause known zoonoses (Arambulo and Steele, 1976).

From the point of view of public health, the most important result is that 70.4% of the dogs examined were infected with *Ancyclostoma* species, a worm whose larvae cause lesions in man, consisting of bullae with indurated edges which may burst and become secondarily infected. Fabiyi (1983) reported that this may account for some of the leg ulcers frequently seen in inhabitants in Jos Plateau. Also important is *Toxocara canis* which may be involved in the petit mal-like convulsions, bronchitis and granulomatous lesions of the eye with which *T. canis* has been associated with elsewhere (Beaver, 1969). *Spirocerca lupi* is known to infect man (Fitzsimmons, 1960) and is therefore a further potentially important human infection from dogs in this area, especially since humans in this area are fund of eating poultry which constitute important paratenic host of S *lupi*. The high prevalence of *D caninum* in this survey is a threat to humans, especially children, who due to their close contact with pets and their frequent lack of hygiene, represent a large percentage of human infections with *D caninum*.

5.2 SUMMARY AND CONCLUSION

The investigation on gastrointestinal helminths of dogs shows that these parasites are endemic in the area of study. The prevalence rate was highest for hookworm infection, followed by *Dipylidium caninum*, and *Taenia* species respectively. Prevalence was higher in males than females.

More than half of the positive cases occurred in cohabitation, with the highest relationship seen in the existence of hookworm and *Dipylidium* occurring together.

Almost all parasites, with the exception of *S. lupi* were recovered from the small intestine, with a few recoveries from the caecum, colon and rectum.

Crowding effect was noticed when nematode lengths were found to decrease as the parasite number in the gastrointestinal tract increases. In cestode infections from general observations, the size of the worm is, roughly speaking, inversely proportional to the number of worm present in the intestine.

The prevalence of the parasites recovered during postmortem was generally higher in all species than the presence of eggs in the faeces of same animals. Cases were

recorded where parasites were present in the gastrointestinal tract but no egg seen in the faeces of the animal. This was very prominent in tapeworm infection.

As the parasite burden in the intestine increased, the egg count also increased, and vice versa. This was observed in hookworm and ascarid infections.

Thus surveillance, stray dog control and better health care should be intensified in this region, since the prevalence of dog helminth is high.

Dogs habouring *Taenia ovis* and *Taenia hydatigena* can be potential sources of infection for sheep and small ruminants. Good abattoir practices should be adopted, careful supervision and effective meat inspection, immediate destruction of infected organs, prevention of dogs into the abattoir and practice of good husbandry will go a long way to control the infestation of dogs with these *Taenia* species.

As long as preventive measures are not initiated the risk of migrans visceralis as well as other zoonoses will remain unchanged or even increase if the number of dogs will further increase.

Education of public about the zoonotic potential of these parasites could be the area theoretically most susceptible to current improvement. Education on the

virtues and dangers of pets in elementary secondary schools and of the pet owner through humane societies could go a long way towards establishing habits of repsonsible pet ownership.

The institution of strict anthelmintic regiment is necessary especially among pups and lactating bitches. Dogs should be dewormed regularly by owners.

The egg counts per gram of faeces indicates the level of environmental contamination. Since the number of parasites and eggs increases concurrently, so also there will be a high level of environmental contamination in this area.

For a proper knowledge of the number and species of gastrointestinal helminth parasites, the simple flotation method is not the most reliable, especially as early infection would not be easily detected. Also, because of the inability to differentiate between *Taenia* eggs, the species of cestode abundant in an area and its effects on man and livestock could not be determined. Even though the recovery of intestinal helminths at necropsy is tedious, it could be considered the most reliable method to determine the prevalence of these parasites for epidemiologic studies.

Also, the quantitative faecal analysis may give an

indication of the worm burden and the degree of damage inflicted on the host.

A more detailed study of the life cycle, clinical signs and pathogenesis of *Rictularia* species are needed for any conclusion to be made concerning the parasite.

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APPENDIX

Sample No.	Helminths Type Recovered	No. Recovered	Eggs Types Seen
1.	A. caninum	2	No egg found
	D. caninum	23	No egg found
2.	A. caninum	2	No egg
	T. ovis	3	No egg
	T. canis	11	No egg
		4	+ve (egg seen)
3.	A. cainum	5	No egg found
	T. ovis	1	No egg found
	D. caninum	7	No egg found
4.	A. caninum	17	Egg seen
5.	T. hydatigena	1	No egg seen
	D. caninum	15	No egg seen
6.	A. caninum	15	Egg seen
7.	A. caninum	11	Egg seen
	T. Hydatigena	1	No egg
	D. caninum	17	No egg
8.	A. caninum	7	Egg seen
	T. ovis	1	No egg
	D. caninum	7	Egg seen
9.	T. ovis	14	Egg seen
10.	D. caninum	9	No egg seen
11.	A. caninum	5	Egg seen
	T. canis	11	Egg seen
12.	A. caninum	3	No egg seen
	Spirocerca	5	No egg seen
13.	T. hydatigena	13	No egg seen
	D. caninum	27	No egg seen
14.	A. caninum	2	No egg seen
15.	D. caninum	11	No egg seen
16.	A. caninum	7	No egg seen
	T. ovis	1	No egg seen
	D. caninum	47	No egg seen
17.	T. caninum	54	Egg seen
18.	T. ovis	27	Egg seen
	T. canis	1	No egg seen
19.	A. caninum	21	Egg seen
	D. caninum	24	No egg
20.	A. caninum	2	No egg seen
	D. caninum	2	Nes
	T. canis	1	Nes
21.	A. caninum	4	Egg seen
	T. ovis	2	No egg seen
	T. leonina	6	No egg seen
22.	A. caninum	17	Egg seen
23	A. canis	5	No egg seen
	T. ovis	6	No egg seen
			No egg seen
24.	A. canis	27	Egg seen
	T. ovis	70	Egg seen
25	T. hydatigena	1	No egg seen
	D. caninum	7	No egg seen
	Trichuris	-	Egg seen

26.	A. caninum	14	Egg seen
	T. ovus	19	No egg seen
27.	D. caninum	11	Egg seen
28.	A. caninum	6	Egg seen
	T. hydatigena	3	No egg seen
	D. caninum	11	No egg seen
29.	T. caninum	3	No egg seen
	D. caninum	5	No egg seen
30.	A. caninum	27	Egg seen
31.	A. caninum	14	Egg seen
32.	D. caninum	37	Egg seen
33.	A. caninum	32	Egg seen
	D. caninum	29	No egg seen
34.	A. caninum	21	Egg seen
	D. caninum	57	No egg seen
35.	A. caninum	9	Egg seen
36.	A. caninum	59	Egg seen
	D. caninum	5	No egg seen
37.	A. caninum	40	Egg seen
38.	A. caninium	11	Egg seen
39.	A. caninum	14	Egg seen
	T. hydatigena	2	No egg seen
	D. caninum	7	No egg seen
40.	A. caninum	13	Egg seen
			No egg seen
41.	T. hydatigena	17	Egg seen
42.	T. hydatigena	1	No egg seen
	D. caninum	16	No egg seen
43.	T. ovis	1	No egg seen
	D. caninum	57	No egg seen
44.	A. braziliense	12	Egg seen
45.	A. caninum	5	No egg seen
	D. caninum	43	No egg seen
46.	A. caninum	45	Egg seen
	D. caninum	3	No egg seen
47.	A. caninum	2	No egg seen
48.	A. caninum	5	No egg seen
	Spirocerca	6	No egg seen
49.	D. caninum	17	No egg seen
50.	T. pisiformis	6	No egg seen
51.	A. caninum	10	No egg seen
	D. caninum	22	
52.	A. caninum	10	Egg seen
53.	A. caninum	15	Egg seen
	T. ovis	3	No egg seen
54.	A. caninum	2	No egg seen
	D. caninum	21	No egg seen
55.	A. caninum	16	Egg seen
56.	A. caninum	6	No egg seen
	T. hydatigena	6	No egg seen
57.	T. ovis	212	No egg seen
	D. caninum	14	No egg seen
58.	D. caninum	23	No egg seen
59.	A. caninum	1	No egg seen
	T. ovis	1	No egg seen
60.	A. caninum	5	Egg seen
	T. hydatigena	1	No egg seen
	D. caninum	1	No egg seen

61.	D. caninum	2	No egg seen
62.	A. caninum	5	Egg seen
	T. hydatigena	1	No egg seen
	D. caninum	1	No egg seen
63.	A. caninum	5	Egg seen
	D. caninum	7	Egg seen
64.	A. caninum	7	No egg seen
	T. hydatigena	7	No egg seen
	D. caninum	10	No egg seen
65.	D. caninum	21	No egg seen
66.	T. hydatigena	2	No egg seen
	D. caninum	23	No egg seen
67.	A. caninum	43	Egg seen
	T. hydatigena	9	No egg seen
	D. caninum	19	No egg seen
68.	T. hydatigena	4	No egg seen
	D. caninum	17	Egg seen
	Spirocerca		No egg seen
69.	T. ovis	43	No egg seen
	D. caninum	21	No egg seen
	T. canis	5	Egg seen
70.	A. caninum	3	No egg seen
	T. ovis	13	No egg seen
	D. caninum	13	No egg seen
71.	A. caninum	8	Egg seen
	T. hydatigena	1	No egg seen
72.	A. caninum	17	Egg seen
	T. ovis	31	No egg seen
73.	A. caninum	13	Egg seen
	T. hydatigena	5	No egg seen
74.	A. caninum	23	Egg seen
	D. caninum	37	No egg seen
75.	T. hydatigena	2	No egg seen
	D. caninum	11	No egg seen
76.	T. hydatigena	4	No egg seen
	D. caninum	1	No egg seen
77.	A. caninum	9	No egg seen
	Spirocerca	6	Egg seen
78.	A. caninum	11	Egg seen
79.	A. caninum	5	Egg seen
	D. caninum	15	No egg seen
	T. leonina	1	No egg seen
80.	A. braziliensa	23	No egg seen
	T. hydatigena	3	No egg seen
81.	A. caninum	3	Egg seen
	D. caninum	1	No egg seen
82.	A. caninum	43	No egg seen
	T. hydatigena	12	No egg seen
83.	A. caninum	123	Egg seen
	Spirocerca	4	Egg
84.	A. caninum	67	Egg seen
	Spirocerca	11	No egg seen
85.	A. caninum	2	No egg seen
	T. canis	3	Egg seen
86.	A. caninum	5	No egg seen
	T. canis	3	No egg seen
87.	A. braziliense	67	No egg seen
	T. ovis	22	No egg seen
	Spirocerca		No egg seen

88.	D. caninum	17	No egg seen
89.	A. caninum	31	No egg seen
	D. caninum	27	No egg seen
90.	A. caninum	189	No egg seen
	T. hydatigena		No egg seen
91.	A. caninum	1	No egg seen
	T. hydatigena	12	No egg seem
92.	A. caninum	73	Egg seen
	T. hydatigena		No egg seen
93.	D. caninum	27	No egg seen
94.	A. caninum	3	No egg seen
	T. hydatigena	17	No egg seen
	D. caninum		No egg seen
95	A. caninum	7	No egg seen
96.	A. caninum	19	Egg seen
	D. caninum	3	No egg seen
	T. leonina	7	Egg seen
	Spirocerca	9	Egg seen
97.	A. caninum	3	No egg seen
98.	A. caninum	22	Egg seen
		16	No egg seen
99.	A. caninum	13	Egg seen
100.	A. caninum	4	No egg seen
	D. caninum	41	No egg seen