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OCCURRENCE OF HELMINTH INFECTIONS IN DOGS IN FIVE RESOURCE-LIMITED COMMUNITIES IN SOUTH AFRICA

by

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My son, if thou wilt receive my words, and bide my commandments with thee;

So that thou incline thine ear unto wisdom, and apply thine heart to understanding;

Yea, if thou criest after knowledge, and liftest up thy voice for understanding;

If thou seekest her as silver, and searchest for her as for hid treasures;

Then shalt thou understand the fear of the Lord, and find the knowledge of God.

For the Lord giveth wisdom: out of his mouth cometh knowledge and understanding.

Proverbs 2: 1 - 10

Dedicated to my parents

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DECLARATION

During the course of the project, Mr. H M Boshoff, Mr. T P Matjila, Ms. S.A. Milne, Dr. J.I. Rajput and Mr. E. Williams assisted with the collection of samples in some of the study areas. Ms. S. Mangera, Ms. S.A. Milne and Ms. R. Morobane supported the project by mounting some of the specimens for identification. Ms. E. Mayhew and Ms. C. Seegers made the drawings of body condition scoring and the maps used in this document.

With the exception of the assistance mentioned above, this dissertation is the candidate's own original work. It has not been previously submitted and is not currently being submitted in candidature for any other degree.

Candidate________________

W.N. Minnaar

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ABSTRACT

Occurrence of helminth infections in dogs in five resource-limited communities in South Africa

by

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SUMMARY

Our knowledge of helminth parasites of dogs in South Africa is limited. The current study describes the helminth status in dogs from five resource-limited areas, which included two cross-sectional surveys in Boksburg and Bloemfontein, and three Veterinary Needs Appraisals (VNAs) in Jericho, Zuurbekom and Mamelodi. The VNAs were supplemented with questionnaires that were completed with the assistance of the dog-owners, and provided information regarding veterinary care and preventive measures in terms of possible disease, the dog's home environment, diet, and the hygiene status. The prevalence of the various dog helminth species were recorded and compared with the current knowledge of these parasites in South Africa. Attempts were also made to find associations with environmental conditions and management strategies observed during the project. *Ancylostoma* spp. was the most important helminth in dogs due to a high overall occurrence (80%) as well as its importance as a zoonosis. Forty-two percent of dogs necropsied were infected with *Dipylidium caninum*, 21% with *Toxocara canis*, and 20% with *Toxascaris leonina*. Dog helminth parasites that were not well documented in the past such as *Spirocerca lupi* (14%), *Joyeuxiella* sp. (5%) and *Trichuris vulpis* (3%) were also found in this study. Recommendations for the control of helminth parasites in dogs in these areas were made. Although the main focus of helminth parasite control in practice is chemical deworming, additional measures such as regular removal of dog faeces from the environment and prevention of roaming of animals may be even more important. These offer effective worm control at affordable cost to the communities that need it most.

OPSOMMING

Ons kennis van wurmparasiete van honde in Suid-Afrika is beperk. Die huidige studie beskryf die wurmstatus in honde van vyf hulpbronbeperkte gebiede met inbegrip van twee opnames in Boksburg en Bloemfontein en drie Veterinêre Behoeftepeilings (VBPs) in Jericho, Zuurbekom en Mamelodi. Die VBPs is aangevul met vraelyste wat voltooi is met die hulp van die honde-eienaars, wat inligting verskaf het i.v.m. veterinêre sorg en siektevoorkomingsmaatreëls, sowel as die omgewing, dieet en higiënestatus van die honde. Die voorkoms van die onderskeie wurmspesies is genoteer en vergelyk met die huidige kennis van die parasiete in Suid-Afrika. Daar is ook gepoog om 'n verband te vind met die omgewingstoestande en betuurspraktyke soos waargeneem tydens die projek. *Ancylostoma* spp. was die belangrikste wurm in honde vanweë twee redes: 'n hoë algemene voorkoms (80%), sowel as sy belangrikheid as 'n soönose. Van al die honde wat nadoods ondersoek is, was 42% besmet met *Dipylidium caninum*, 21% met *Toxocara canis*, en 20% met *Toxascaris leonina*. Wurmparasiete van honde wat in die verlede in die literatuur verwaarloos is, byvoorbeeld *Spirocerca lupi* (14% voorkoms), *Joyeuxiella* sp. (6%) en *Trichuris vulpis* (3%) was ook teenwoordig gedurende hierdie studie. Aanbevelings vir die beheer van wurmparasiete in honde in die betrokke areas is gemaak. Alhoewel die klem by wurmparasietbeheer in die praktyk hoofsaaklik val op chemiese ontwurming, is alternatiewe bestuursmaatreëls, bv. gereëlde verwydering van hondemis uit die omgewing en die inperking van honde, waarskynlik meer belangrik. Hierdie maatreëls bied doeltreffende, bekostigbare wurmbeheer aan die gemeenskappe wat dit die meeste nodig het.

Chapter 1 General introduction

There is a need to provide veterinary health care to resource-limited communities at affordable costs. The effect of helminth parasites on the health of dogs in such communities in South Africa was not addressed previously (Connor et al., 1994). Prevalence, prevention and control of transmission of parasites to dogs and susceptible human hosts should be investigated further (Woodruff, 1975). This could ease the demands and constraints on the existing primary community health care system for humans, resulting in healthier communities and cost-effective management of resources.

In communities where there is less close contact between humans and dogs, the presence of roaming dogs may also pose a public threat of zoonotic disease (Miller, 1967). This is true particularly in communities where a lack of infrastructure allows dogs to roam and contaminate public areas such as playfields and school grounds with helminth parasite eggs (McCrindle et al., 1996). A study was therefore designed to focus on the helminth parasites which occur in dogs in resource-limited areas in South Africa.

The incidence and prevalence of the various helminth parasite species of dogs in South Africa have been poorly documented to date, and the importance of some of them has been underestimated (Ortlepp, 1934; Verster, 1979, 1986; Woodruff, 1975). The helminth parasite species previously reported, most of which are of zoonotic importance, include *Ancylostoma caninum*, *Ancylostoma braziliense*, *Toxocara canis*, *Toxascaris leonina*, *Spirocerca lupi*, *Trichuris vulpis*, *Dipylidium caninum*, *Joyeuxiella pascualei* and *Echinococcus granulosus*.

Areas were selected where minimal worm control in dogs existed. This was done to determine the prevalence and the extent of helminth parasites of dogs and their potential threat to humans in these communities. These facts would enable us to create an awareness of the situation and to develop recommendations for helminth control which will be effective, practical and affordable.

The nutrition, body condition score and health problems of the dogs and an assessment of their backyard environments were recorded for each household visited during Veterinary Needs Appraisals (VNAs) in Jericho, Zuurbekom and Mamelodi, and the Boksburg study. The information gathered was correlated with the data on helminth infections in order to assess what effects the helminths had on the animals (Chapter 7). Ideally, the effects that the zoonotic dog helminths had on the human population in these areas should have been included in the study, but no information was available due to lack of record keeping at the local hospitals and clinics.

Aims:

The aims of these studies were:

- to determine the occurrence and prevalence of helminth parasite infections in dogs from the resource-limited communities of Boksburg, Bloemfontein, Jericho, Zuurbekom and Mamelodi,
- to assess the health status and extent of veterinary care of dogs in those areas using a socio-economic questionnaire,

- to compare the zoonotic potential of dog helminth parasites in these resource-limited communities and
- to develop appropriate recommendations for helminth parasite control.

Chapter 2 Literature review

2.1 **Common helminth parasites of dogs in South Africa:** The distribution and prevalence of helminth parasites of dogs in South Africa are not well known. To date, only two publications (Ortlepp, 1934; Verster, 1979) have addressed the distribution of worm parasites of dogs in parts of South Africa. Ortlepp's study was restricted to the Pretoria area; Verster's report included other areas in South Africa.

Helminth parasites of dogs are important because they threaten the health and well-being of one of man's favourite pets, the dog, and can also infect humans. Zoonotic dog helminths possibly have more deleterious effects in humans than is commonly appreciated (Woodruff, 1975). It is difficult to diagnose zoonotic helminth infection in humans, as the worms rarely reach maturity (Woodruff, 1975) and therefore do not produce eggs that assist with the diagnosis.

The pathogenicity of a zoonotic worm varies (e.g., from the dermatitis caused by *Ancylostoma* spp. to the lethal consequences of *Echinococcus* spp. (Verster, 1986)). The latter is further complicated because the eggs of *Echinococcus* and *Taenia* spp. (e.g., *Taenia multiceps*) are indistinguishable and both can infect humans (Fripp, 1983).

Nematode parasites:

Hookworm disease is one of the major zoonotic diseases of the human population of warm, moist, tropical and subtropical countries (Fripp, 1983). In Pretoria 69% of dogs necropsied (Verster, 1979), and in Zimbabwe 38% of faecal samples examined (Mukaratirwa and Busayi, 1995) showed *Ancylostoma* spp. Obwolo et al. (1991) found that 100% of dogs in their study had eggs of *A. caninum* in their faeces. *A. caninum* (Fig. 2.1) has been known, on rare occasions, to reach the intestine of humans and develop there to maturity (Dove, 1932; Hunter and Worth, 1945). This worm, and *A. braziliense* (Fig. 2.2), are more commonly associated with the migration tracts they cause in the skin of humans following percutaneous infection.

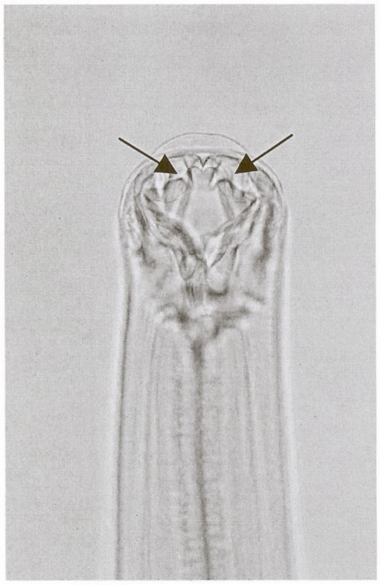

Fig. 2.1 ***Ancylostoma caninum*** **showing two pairs of three-pronged teeth (arrows)**

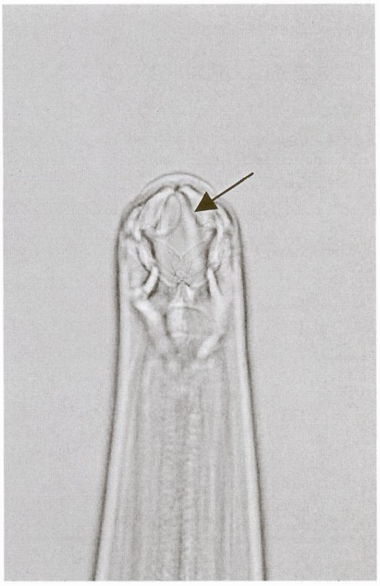

Fig. 2.2 ***Ancylostoma braziliense*** **showing ventral cutting plates (arrow)**

Biocca (1951) considered *A. braziliense* and *Ancylostoma ceylanicum* as two distinct species from descriptions of *A. ceylanicum* by Looss from Ceylon (modern day Sri-Lanka) in 1911 and *A. braziliense* by De Faria from Brazil in 1914 and 1916. Later, Rep (1966) regarded them as synonymous. Indeed, today *A. ceylanicum* is not included in most veterinary helminthological textbooks, which suggests that this parasite is still commonly accepted as being identical to *A. braziliense*. The author agrees with Biocca's statement for the reason that he (Biocca) was able to demonstrate anatomical differences between the two nematodes. He presented a valid argument that *A. braziliense* causes cutaneous larva migrans (CLM) in humans, whereas *A. ceylanicum* infects the small intestine in humans. For the purpose of this study, however, all hookworms identified in dogs that did not belong to the species *A. caninum*, and that resembled *A. braziliense* morphologically, were regarded as *A. braziliense*.

T. canis does not generally cause clinical disease in adult dogs, but does in pups. Infections of this parasite are relatively common; eggs are frequently found in the faeces of bitches and pups younger than one year old (Holland et al., 1991; Woodruff, 1975). In a study from Dublin, Ireland, all dogs were negative for helminth eggs on faecal flotation tests. However, 6.2% of the stray dogs and 5.3% of the canine faecal samples picked up from the streets were positive for *T. canis* eggs, and 51.2% of humans surveyed were seropositive for *T. canis* (Holland et al., 1991). In the same study, 38% of the soil samples from family gardens and 6% from public parks and open lots were also positive for *T. canis* eggs. This study suggests that the transmission rate of *T. canis* from the environment to humans is much higher than the transmission rate of this nematode between dogs or the levels of contamination of *T. canis* eggs in the environment. In a Zimbabwe survey, faecal samples from 7% of all the dogs tested contained eggs of *T. canis* (Mukaratirwa and Busayi, 1995). Toxocarosis in humans is probably more important than is recognised, as the infection rate is higher than previously realised; infections often remain undetected (Woodruff, 1975). Three human syndromes are recognised (Bass et al., 1983; Holland et al., 1991; Kinceková et al., 1996), viz. visceral larva migrans (VLM), ocular larva migrans (OLM), and covert toxocarosis (subclinical with or without eosinophilia). OLM is clinically indistinguishable from retinoblastomas (Woodruff, 1975).

The study by Verster et al. (1991) reported that heartworm, *Dirofilaria immitis*, does not occur naturally in South Africa, because it has not been detected in dogs (except for a few cases reported in imported dogs), though its vectors are present. Van Heerden et al. (1980) reported that it is common in Kenya and it has been reported in Mozambique (E V Schwan and R C Krecek, 1997, personal communication). *D. immitis* can also infect humans, and although infections are self-limiting, they may cause changes which are radiographically visible, called "coin lesions" which may be misinterpreted as neoplasia and consequently result in unnecessary thoracic surgery (Bowman, 1995).

In its natural host, the dog, *S. lupi* causes the development of granulomas in its predilection and aberrant sites. In the oesophageal walls these may cause difficulty in swallowing, chronic coughing and vomition, as well as ossifying spondylitis and hypertrophic osteopathy if situated in the aorta or thoracic oesophagus. This helminth is closely associated with oesophageal tumours, which originate in the granulomas, and may cause aneurysms if the wall of the aorta is involved (Fitzsimmons, 1966). The importance of this parasite of dogs is underestimated in Southern Africa (Mukaratirwa and Busayi, 1995; Reinecke, 1983), as it is more common than is realised. Obwolo et al. (1991) found that 47% of the faecal examinations from dogs in Zimbabwe had eggs *of S. lupi*. This nematode may also infect man (Woodruff, 1975).

T. vulpis in South Africa has been reported in Durban (Reinecke, 1983), where warm and wet conditions exist. Reinecke (1983) suggested that clinical signs develop only during severe infections. It is regarded as a zoonosis (Woodruff, 1975), although it has not been reported in humans in South Africa.

Cestode parasites:

In his study, Schoning (1994) determined that only half the dogs actually infected with cestodes gave positive results on faecal flotation. He found that tapeworms were best seen during necropsy. Schoning also considered that the use of the adhesive tape swab technique (Deplazes and Eckert, 1988) is the most efficient method for detection of taeniid infection in live dogs.

2.2 **Study areas:** Several criteria were used in selection of the five study areas in resource-limited communities. The first criterion was level of helminth control and intervention (i.e. deworming). Preference was given to minimal intervention. Secondly, existing linkages with the community were preferable. This was by current co-operation or animal welfare organisations that were already active in the area. Lastly, other factors considered were climate, accessibility, political stability and safety of co-workers. A summary of the study areas and the samples collected is given in Table 2.1.

Table 2.1 **Village, province and categories of samples collected from dogs as well as questionnaires in five resource-limited study areas in South Africa**

Village and province	Boksburg, Gauteng	Bloemfontein, Free State	Jericho, North-West	Zuurbekom, Gauteng	Mamelodi, Gauteng
Blood samples	✓	✓	✓	✓	✓
Faecal samples	✓	✓	✓	✓	✓
Adhesive tape swabs	✓	✓	✓	✓	✓
Organ samples	✓	✓			
Questionnaires	✓		✓	✓	✓

Three of the five study areas were visited as part of a Veterinary Needs Appraisal (VNA) (Mettrick, 1993) commissioned by the national government, and the other two were used for long-term cross-sectional studies. In order to plan proactive strategies (such as vaccination and correct management) for animal disease control it is essential that the veterinary needs of target communities be well understood. It is also vital that the animal owners in resource-limited communities be actively involved in the assessment of their own needs and implementation of strategies. The VNA method offers a holistic approach to this problem (McCrindle, 1998). The three short-term study areas (Jericho, Zuurbekom and Mamelodi) were each visited for a one-week period during which a VNA was carried out. The dog-owners were also interviewed using a questionnaire (Chapter 6). The dogs were examined, and adhesive tape swab, faecal and blood samples were collected for further processing and examination for helminth parasites and haemoprotozoa in the laboratory.

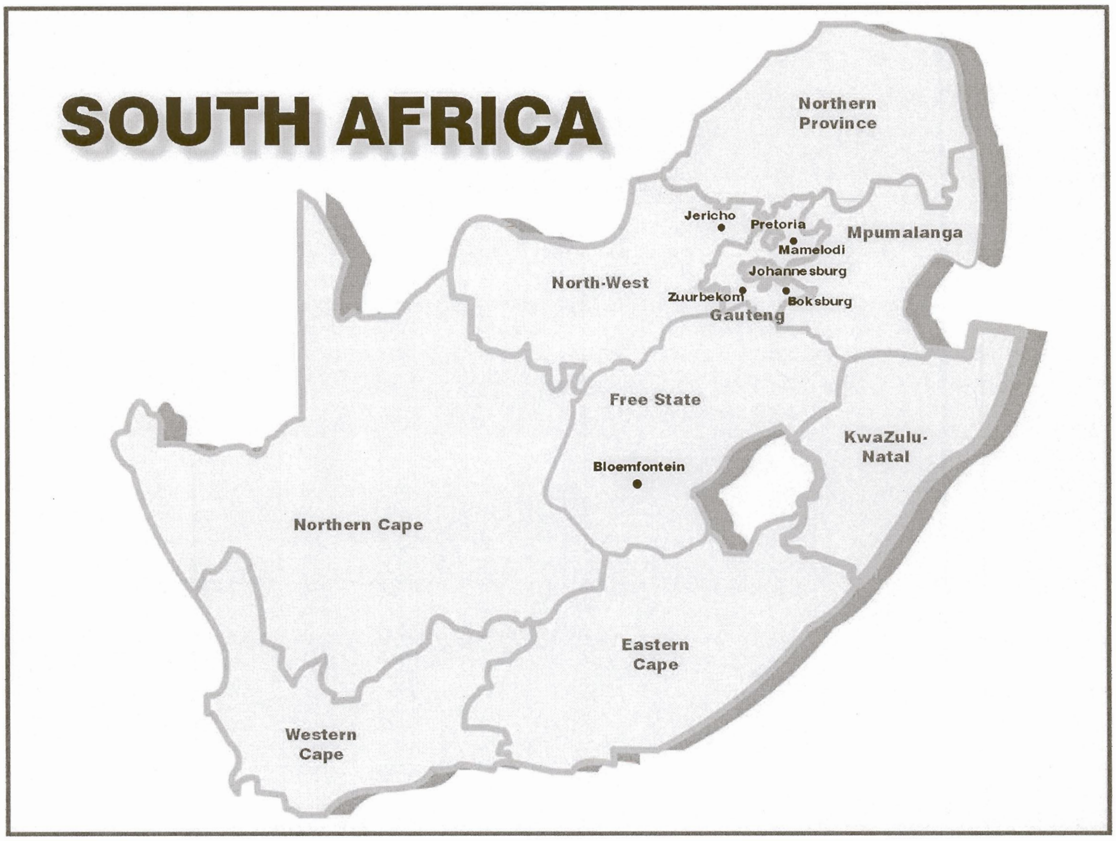

Fig. 2.3 **The geographic locality of the five study areas in South Africa. These included Jericho, Mamelodi, Zuurbekom, Boksburg and Bloemfontein**

The fourth study (Boksburg), one of the long-term cross-sectional studies, included questionnaires and collection of samples from live dogs (adhesive tape swabs, faecal and blood). Organ samples were also collected at necropsy from dogs, which had been impounded, and euthanazed by the Boksburg Society for the Prevention of Cruelty to Animals (SPCA). The fifth study, undertaken in Bloemfontein, was also cross-sectional; blood, faecal and adhesive tape swab samples were collected from euthanazed dogs at the Bloemfontein SPCA, but it was not possible to complete questionnaires, as there was no contact with the owners of the dogs.

2.3 **Biological samples from live animals and at necropsy:**

Sample collection from the live animal:

Permission was obtained from the owners before samples were collected from live dogs. In study areas where samples were collected from live dogs and where there was contact with the dog-owners, questionnaires were completed with information provided by the owners. The questionnaires (Appendix A) were completed by asking the owner the necessary questions in a semi-structured interview. The method for interviewing owners and the completion of questionnaires is discussed in Chapter 6. The aim was to determine the economic position of the owner and how this affected the dog's health and the care that it received, and the dog's social importance in the household. It also provided information on the dog's health, nutrition, movements and the environment in which it spent most of its life. For obvious reasons, aggressive dogs were not sampled. Sick or anaemic dogs were not sampled to avoid causing excessive stress.

Necropsy sampling:

These dogs, originating from resource-limited areas, had been impounded by the Boksburg and Bloemfontein SPCAs and were sampled after having been euthanazed through intravenous administration of a barbiturate overdose.

2.3.1 Blood samples

Blood was collected from the live animal in bleeding tubes that contained Ethylenediamine Tetraacetic Acid (EDTA) anticoagulant using the superficial antebrachial vein while the animal was restrained, preferably by its owner. When dogs were euthanazed, blood samples were collected directly from the heart immediately after death (Fig. 2.4).

Fig. 2.4 **Collection of a blood sample from a dog after euthanasia**

Each blood tube was identified and placed in a cooler for transportation to the laboratory (Fig. 2.5). The purpose of collecting blood samples was twofold: to examine blood smears for the presence of haemoprotozoan parasites and microfilariae in the blood, and to identify the latter to species level, if found present.

The blood samples were stored at *ca.* 4°C and were processed within two months of collection. Coagulation occurred if the samples were left longer than this before being processed, which posed problems with the application of the filter tests.

Fig. 2.5 **Equipment used for the collection and processing of blood samples**

Two blood smears were made in the laboratory, one thin and stained with Cam's Quick Stain (Diff Quick) (Pratt, 1985) and one thick, stained with Giemsa stain. All the samples were also screened using the modified filter technique (Sloss et al., 1994), in which transparent 3 μm aperture polycarbonate filters were employed. The blood was not haemolysed with formalin because this would have interfered with the subsequent staining of the filters. After filtration of a 0.5 ml volume of blood from each sample the filters were mounted on microscope slides, left to dry, and then stained with Giemsa stain. Thin blood smears were examined for the presence of haemoprotozoa and thick blood smears and filters were examined for microfilariae. When the presence of microfilariae was detected on a filter by light microscopy, another slide was prepared in a similar fashion. The filter was mounted and stained using the acid phosphatase staining technique (Balbo and Abate, 1972) to identify the microfilariae.

2.3.2 Faecal samples

Dogs were restrained for the collection of faecal samples (Reinecke, 1983; Sloss et al., 1994). One hand was protected by putting on a latex examination glove, and one finger of the gloved hand, preferably the index finger, was lubricated with liquid paraffin. The dog's tail was lifted away from the perineal area, and the lubricated finger inserted into the anus. About 2 g of faeces were then scooped out from the rectum, placed in the Faecalyzer® well which was then closed with a lid, marked, and placed in a cooled container (Fig. 2.6).

Faeces were not collected if the animal manifested evidence of some discomfort, especially if it was constipated. Occasionally there were no faeces in an animal's rectum because it had defaecated shortly before. In some cases fresh faeces were found close by. If the dog was the only one in the vicinity, or if the sampling team or a member of the household had observed it defaecating, a sample of the faeces was collected.

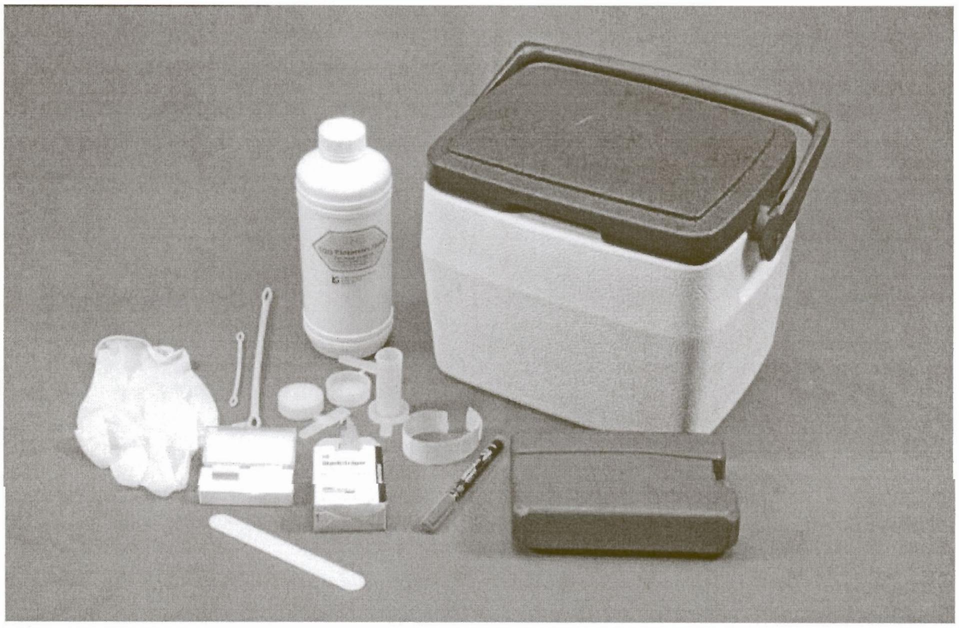

Fig. 2.6 **Equipment used for the collection and processing of faecal samples**

Collection of faecal samples at necropsy generally occurred during the evisceration procedure (Section 2.3.4) when the rectum was bisected. A faecal sample of about 1 - 2 g was collected from the rectum of each dog and placed in a Faecalyzer® well, which was then closed with a lid, marked, and placed in a cooled container.

Faecal samples for flotation tests (Pratt, 1985; Reinecke, 1983) give the best results if processed fresh or kept cool. Therefore, throughout these studies, faecal flotations were carried out within 24 hours. Under field conditions faecal samples may be kept for up to three days without deterioration of nematode eggs taking place, if stored (never frozen) at 5 - 7°C. No chemicals were used for preserving the faecal samples during this project.

The standard flotation technique was used for the examination of the faeces for the presence of nematode eggs. Although faecal flotation remains the best procedure for identifying intestinal nematodes (e.g., *Ancylostoma* spp., *T. canis*, *T. leonina* and *T. vulpis*) in live dogs, false negatives may occasionally occur, as the technique is dependent on the presence of eggs (Schoning, 1994). Occasionally some cestode eggs may be detected when this method is used. Each faecal sample was mixed with flotation fluid, which, due to its specific gravity being higher than that of the eggs, causes the latter to rise to the surface. The eggs were then picked up from the surface with a cover slip, which was mounted on a microscope slide and then examined with a light microscope using low magnification. The identification of helminth eggs was made according to Thienpont et al. (1979).

2.3.3 Adhesive tape swabs

Adhesive tape swabs (Deplazes and Eckert, 1988) were prepared to demonstrate cestode eggs, and/or segments, if present, on the peri-anal skin or hair from most of the dogs in the survey, including those euthanazed (Fig. 2.7). Most live dogs allowed the procedure to be performed without objecting to it. After restraining the animal, its peri-anal area was dabbed with the adhesive side of the tape (Fig. 2.8), which was then flattened with the adhesive down on a clean microscope slide.

Fig. 2.7 **Equipment used for collecting adhesive tape swabs**

Taeniid eggs are thick-shelled, and are able to withstand dry conditions and high and low environmental temperatures for up to a year. Swab samples do not therefore require any special treatment, even if left in a slide folder on the laboratory shelf for months, provided the place where it is stored is kept free of insects and rodents. In the laboratory, samples were examined at low magnification under a light microscope.

Fig. 2.8 **Collecting an adhesive tape swab from a dog in Mamelodi**

2.3.4 Organ samples

Organ samples (Jacobs et al., 1994) were collected from euthanazed dogs. The heart and lungs with trachea attached were removed after the aorta and cranial and caudal vena cava had been tied off about 10 cm from the heart, depending on the size of the dog. The cranial end of the oesophagus and rectum were also tied off and the entire gastro-intestinal tract was removed. These organs were placed in a cooler box with ice packs for transport to the laboratory. The Boksburg samples were processed over the next 3 days following their collection, and the Bloemfontein samples were frozen until processed.

For preserving organs for nematode and trematode recovery at a later stage, freezing (Jacobs et al., 1994) is the recommended method. However, in the current study, it was found that ice crystals damaged the soft tissue of the cestodes, which made their identification to species level by examination of mature proglottids almost impossible. The integrity of the internal structures became so disrupted that they could not be recognised, and the hooks become dislodged from the scolex. The ideal method for preserving cestodes for species identification is to "relax" them by placing them in lukewarm saline solution when fresh and thereafter in the preservative (e.g., 10% formalin or 70% alcohol). During this project collection of live material was not always possible. The organ samples were preserved by freezing and, although the taeniids could not be identified to species level, the number of scoleces could still be counted. Their presence was recorded as "taeniids" or *Taenia* spp.

The heart and its associated major blood vessels were opened up in the laboratory to determine whether any mature *D. immitis* were present. The trachea and bronchi were opened and examined for the presence of *Filaroides osleri*. Similarly, the entire gastro-intestinal tract was opened and its content and mucosal scrapings flushed over a 150 μm aperture sieve in two stages. The contents of the stomach were sieved first, followed by that of the small intestine and caecum. The material retained by the sieve was examined with the aid of a magnifying diamond sorting lamp. Any helminths present were recovered and preserved in 70% alcohol, a 70% alcohol and 5% glycerine mixture, or 10% formalin to be later identified, sexed and counted using a light- or stereo microscope under low magnification. The identification of helminths was according to Reinecke (1983).

Differentiation of dog ascarids

The identification of nematodes of dogs was done after the worms were mounted on a microscope slide under a cover slip with lactophenol as the clearing agent (Sloss et al., 1994). This "clears" the nematode, which enables the examination of its internal organs and other structures in order to identify it to species level.

The fourth-stage larvae (L_4) and some of the immature adults were small enough to mount as described above. However, technical difficulties arose with the mounting and examination of the mature ascarids of dogs. Firstly, the size of the microscope slides routinely used is too small for mounting these whole worms. Secondly, as the worms are quite robust and may be up to 2,5 mm thick, the surface tension of lactophenol is insufficient to prevent the lactophenol from running out of the space between the slide and the cover slip.

An alternative method for clearing and examining the ascarids was developed during this study. The mature adults were immersed in lactophenol in 20 ml screw-cap containers for two to three days until they had cleared sufficiently. They were then placed in the lid of a 12 cm petri dish, and its base was placed inside the lid and on top of the worms in order to flatten them for examination. Sufficient lactophenol was poured between the lid and the base of the petri dish to immerse the worms and to enable most of the air bubbles to escape, which allowed improved visualisation.

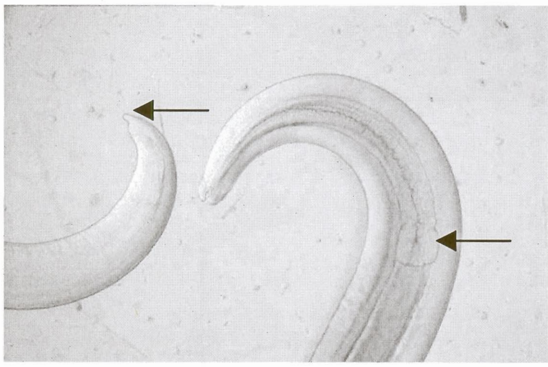

Fig. 2.9 ***Toxocara canis*** **head and tail, terminal appendage on the male tail (left arrow) and oesophageal bulb (right arrow)**

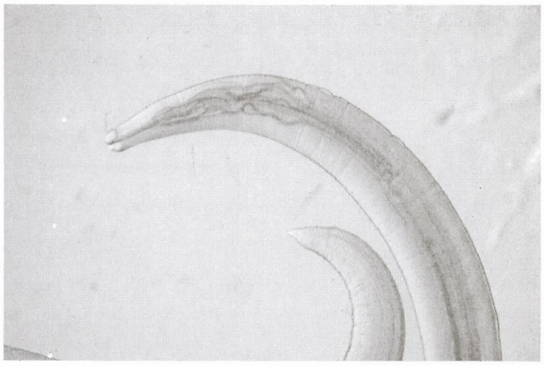

Fig. 2.10 ***Toxascaris leonina*** **head and tail. Note there is no oesophageal bulb, nor is there a terminal appendage on the male tail**

Four to six worms could be accommodated in one petri dish and they were examined under a stereo microscope to distinguish *Toxocara* from *Toxascaris* and to differentiate between the sexes without damaging the specimen by searching for eggs. The two species are differentiated from each other on the basis of their oesophagus morphology: *Toxocara* has an oesophageal bulb, whereas *Toxascaris* does not (Figs. 2.9 - 2.10).

2.4 **Estimation of body condition:** Estimation of a dog's body condition may serve as a tool to assess whether there are problems with its health or nutrition. Because the size and breed of a dog has an influence on its weight and may vary even in healthy dogs (Laflamme, 1993), it is more practical to advise owners on the condition of their dogs with the use of a body condition scoring (BCS) system such as the nine-point system of Laflamme (Laflamme et al., 1994).

For the present study, there was a need for a BCS system to assess the overall condition of the dog. It is desirable to be able to objectively measure body condition and correlate it with factors such as nutritional status or levels of helminth parasitism that may attribute to lower BCS.

The principle of BCS was originally developed as a visual estimation of body fat proportion for assessing the adequacy of nutrition, and it is at present commonly used in production systems such as cattle, sheep, goats, horses and donkeys. Veterinarians often use live mass estimation based on BCS for calculating drug doses for treatment of animals. Although this method can be variable as a means of estimating the live mass of animals (Jones et al., 1989), it was used here as an overall measure of condition in large numbers of dogs in communities. The intent was to make a comparison between BCS and animal health practices, nutritional practices, levels of parasitism and other environmental factors.

BCS is significantly correlated with body weight for large dog breed females only, and highly correlated with percent overweight for large and small breed dogs of both sexes (Laflamme, 1993). The practical application of BCS in dogs may be more valid in order to determine the nutritional status, and in the presence of optimal nutritional conditions to diagnose chronic conditions such as parasitism and other debilitating diseases.

The BCS system used in this study is given in Table 2.2. This system is modified from the original nine-point system (Laflamme et al., 1994). Figs. 2.11 - 2.15 illustrate the characteristics used in this study. This five-point system was developed for the current study.

Table 2.2: **Body condition scoring (BCS) system for dogs (modified from Laflamme et al., 1994)**

Body condition scoring (BCS)	Description
1	Very thin. Ribs, lumbar vertebrae, pelvic bones and all bony prominences easily visible. No palpable fat. Some loss of muscle mass (Fig. 2.11).
2	Thin, underweight. Ribs easily palpated with minimal fat cover, tops of lumbar vertebrae and pelvic bones may be visible. Waist easily noted, viewed from above. Waist and abdominal tuck evident (Fig. 2.12).
3	Ideal. Ribs palpable without excess fat covering. Waist observed behind ribs when viewed from above. Abdomen tucked up when viewed from the side (Fig. 2.13).
4	Heavy, overweight. Ribs palpable with fat cover. Fat deposits become evident over lumbar area and base of tail. Waist may become barely visible. Abdominal tuck may be absent (Fig. 2.14).
5	Obese. Ribs not palpable under very heavy fat cover. Heavy fat cover over thorax, spine, lumbar area and base of tail. Fat deposits may be present on neck and limbs. Waist and abdominal tuck absent. Obvious abdominal distension (Fig. 2.15).

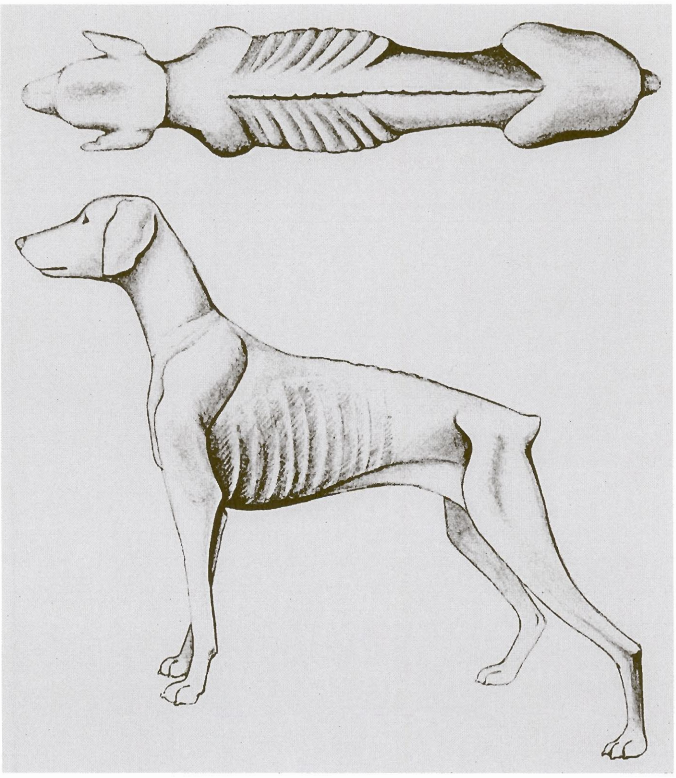

Fig. 2.11 **Dog condition score 1**

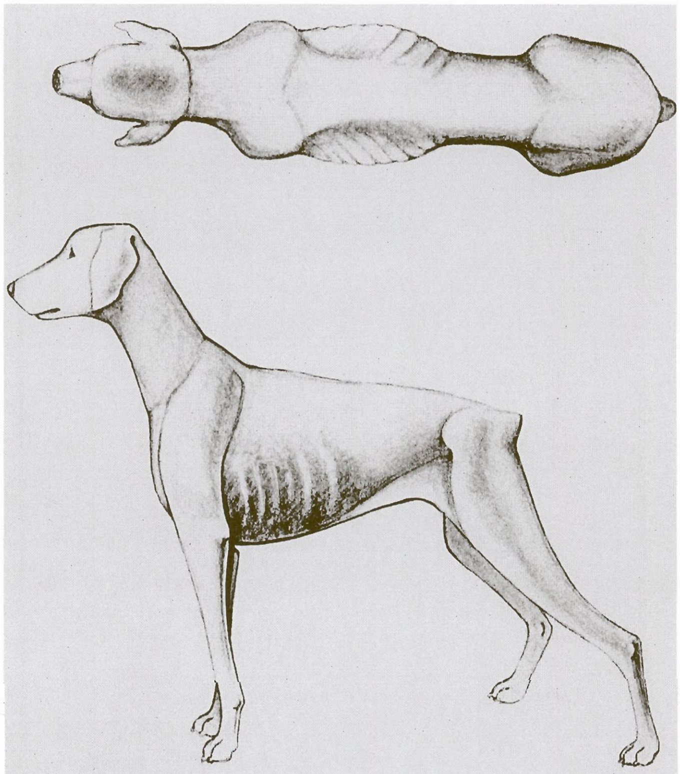

Fig. 2.12 **Dog condition score 2**

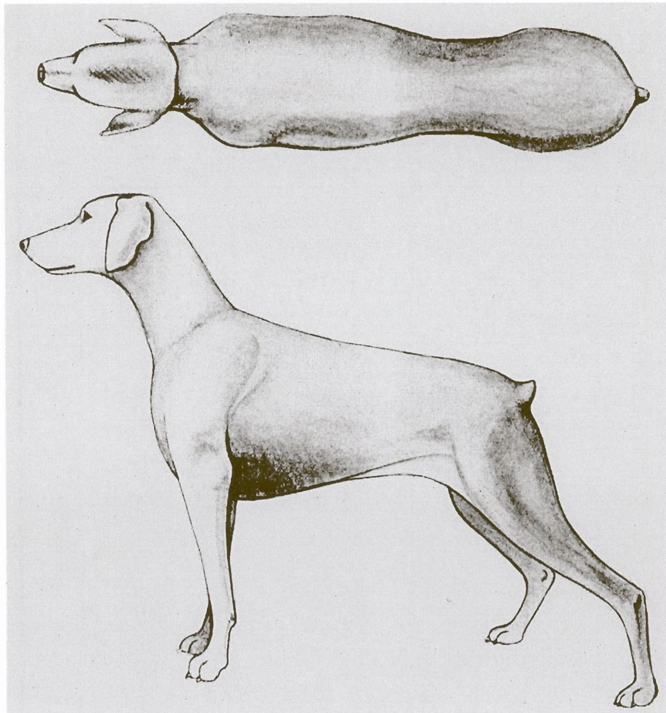

Fig. 2.13 **Dog condition score 3**

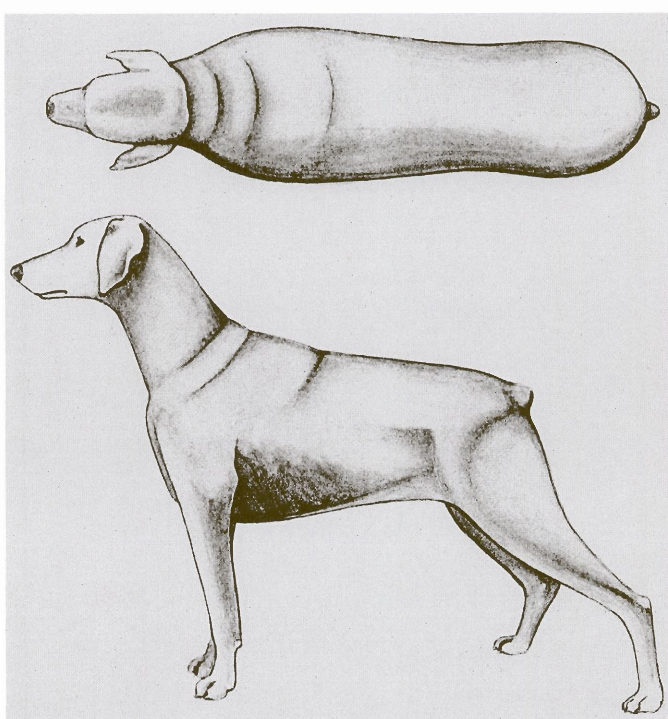

Fig. 2.14 **Dog condition score 4**

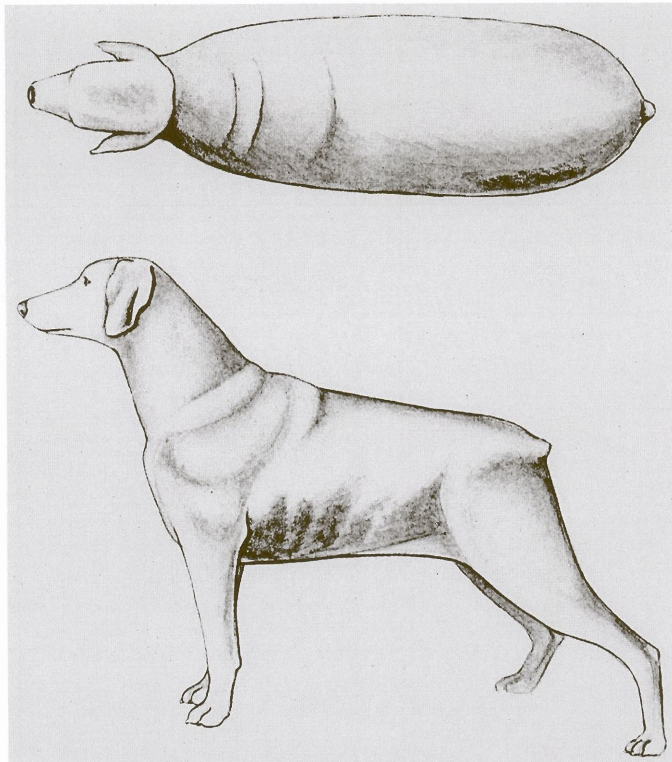

Fig. 2.15 **Dog condition score 5**

This method was particularly useful, as the scoring of body condition is quite consistent throughout and allows for the full spectrum of dog breeds of all shapes and sizes. It is objective and provides the means for easy, accurate assessment in all respects.

2.5 **Criteria for estimation of dog age:** Estimation of dog age is important because it is information required to determine the status of health levels in dogs. For example, younger dogs are more susceptible to helminth disease as evidenced by the clinical picture. The age categories were pups, sub-adults, adults and old dogs. The cut-off ages for these four groups were chosen for specific reasons.

Young dogs were regarded as pups if they were suckling from the bitch, and were still dependent on her milk for most of their nutritional needs. Pups may also be infected with *A. caninum* through the milk. Young pups of domestic dogs have maternal immunity only, as their own immune systems are developing and only gain full function at about the age of ten to twelve weeks (Tizard, 1996). The limits set for this age category were birth to three months (complete maternal independence).

Sub-adults are fully independent as far as their nutritional needs are concerned. They have a well-developed digestive capacity and a high metabolic rate, as they are still growing. They are typically very active, playful and inquisitive. The immune system is not yet mature and competent, and the animal is developing into sexual maturity. Milk teeth are being replaced with permanent teeth, and the dog's hair coat and body conformation are maturing. This age category is defined as three months to one year.

Adult dogs are more mature, socialised dogs with fully developed, competent immune systems and have reached sexual maturity. They are normally more resistant to diseases and helminth infections. Dogs in this category are one to eight years of age.

Old dogs have specific characteristics that may or may not make them more susceptible to diseases and parasitism. The following signs may be present: tartar on teeth and bad breath, canine teeth worn down, greying, senile cataracts, chronic kidney failure, calluses, aggression due to deterioration of senses, overgrown nails, deafness, arthritis, cancer, obesity or weight loss. The onset of old age in dogs is around eight years (Odendaal, 1998).

2.6 **Statistical analyses:** The SAS® System* was used for the statistical analyses of the data collected in the five study areas. The data collected were the following: total helminth occurrence; occurrence of *A. caninum*, *S. lupi*, *T. canis*, *D. caninum*, *Joyeuxiella* sp. and *Taenia* spp.; four age groups; five body condition score indices; dog diets (i.e., commercial dog food, leftovers, maize-based and meat); four climatic seasons; faecal flotation results; whether or not dogs were treated with dewormers; five Economic Situation Score (ESS) indices. SAS® is an integrated system of software that provides complete control over data management, analysis and presentation.

Two statistical methods were used for analyses of data collected during this project. The "general linear modelling" procedure (PROC GLM) and the regression procedure (PROC REG) were applied for finding associations between the dependent and independent variables (named above). The relevant data were entered into the SAS programme to test the hypotheses discussed in Chapters 3-5 (i.e., for all five study areas).

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Chapter 3 Helminth occurrence in dogs from resource-limited communities in Boksburg, Gauteng Province

3.1 **Background:** Boksburg is an urban community in Gauteng; the town centre is situated at 28°18'E; 26°12'S. The surrounding veld type is the central version of Bankenveld (Acocks, 1975) with sour grass, sandy soil, an annual rainfall of 700-750 mm and frosty winters.

The low-income informal settlement suburbs around the business and older residential areas were targeted mainly because it was desirable to collect samples from animals which had not received worm control interventions (i.e., not been treated with deworming remedies) and to interview their owners.

Figs. 3.1 and 3.2 represent maps of the sampling area. The purpose of the interviews was to assess the management of the dog and environment where they were kept. This

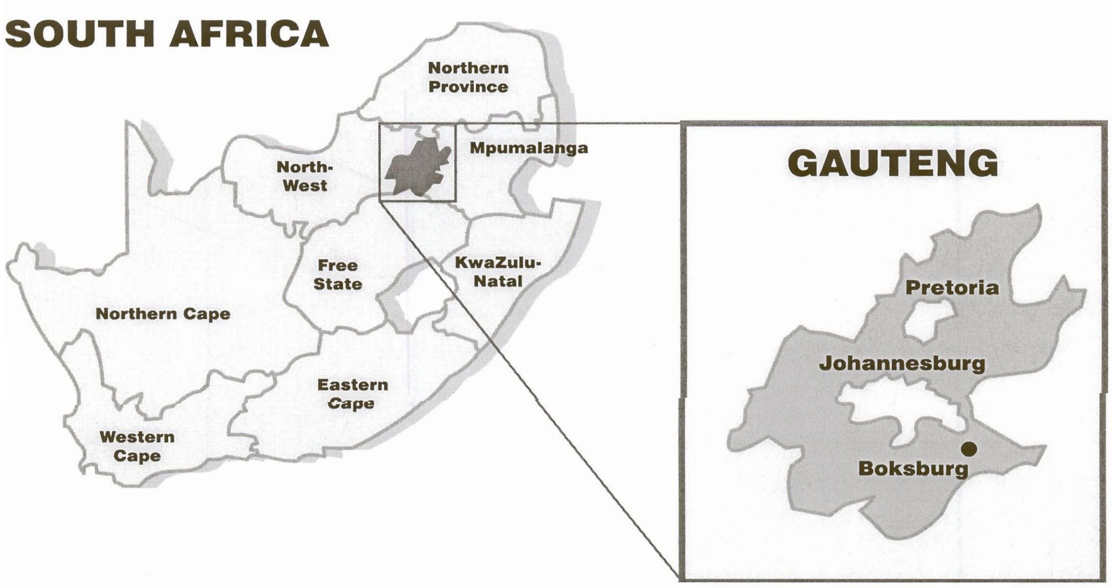


Fig. 3.1 **The geographic locality of Boksburg in Gauteng Province**

was particularly useful as exposure to the common problems the residents of poor communities have with their dogs created a better understanding as to what extent their everyday life contributed to the level of parasitism and overall health of their dogs.

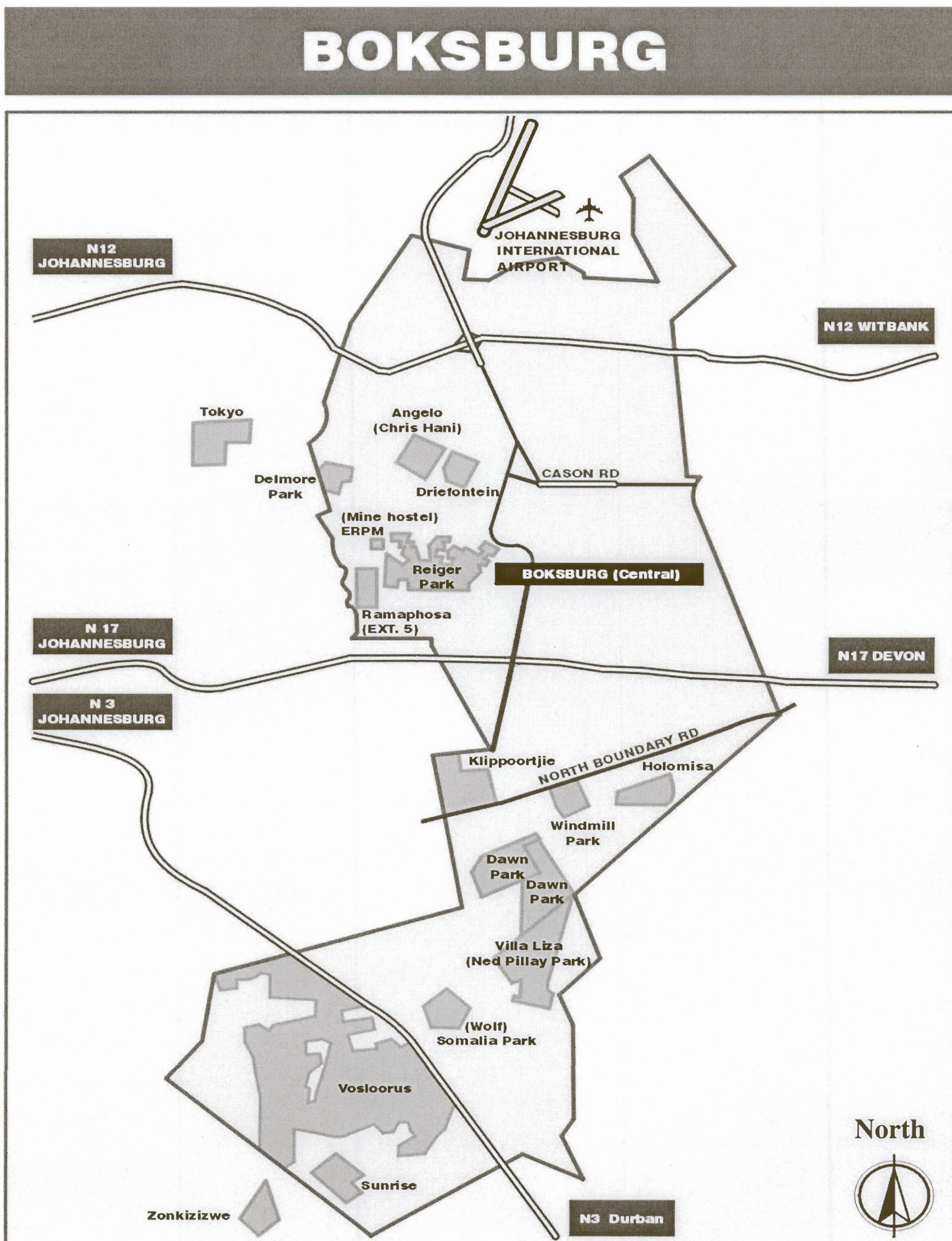


Fig. 3.2 **Area map of Boksburg**

The communities visited (Fig. 3.2) were: Tokyo, Angelo, Delmore Park, Driefontein, ERPM (Mine hostel), Reiger Park, Boksburg Central, Ramaphosa (Ext. 5), Klippoortjie, Holomisa, Windmill Park, Dawn Park, Villa Liza, Wolf (Somalia Park), Vosloorus, Sunrise and Zonkizizwe.

The residents were mostly African. They were largely Zulu or Sotho speaking, although some also spoke Tsonga, Xhosa or Setswana. A number were illegal immigrants from Zimbabwe and Mozambique, and many were unemployed.

3.2 **Materials and methods:** This was a long-term cross-sectional study. The sampling period was from 30 April 1997 - 27 May 1998. Information on and samples from the live animal (Chapter 2) were obtained during visits to the residents (Fig. 3.3) in the resource-limited communities surrounding Boksburg, and included: questionnaires, blood samples, adhesive tape swabs and faecal samples. Impounded, homeless dogs were euthanazed by the SPCA and the following samples were collected monthly at necropsy examination: blood samples, adhesive tape swabs, faecal samples and organ samples.

Fig 3.3 **Interviewing dog-owners in Holomisa, outside Boksburg**

3.3 **Results:** The results of the blood sample analyses of 132 dogs and the adhesive tape swab results of 148 dogs are given in Table 3.1. The total numbers and species of helminths recovered from 69 dogs that were examined at necropsy from the Boksburg area are in Table 3.2. Figs. 3.4 - 3.8 give the results of helminth species identified in 164 faecal samples and 69 necropsies from dogs in Boksburg. A total of 163 faecal flotations were performed, and *Ancylostoma* spp. eggs were observed in 77.3%.

Of all the statistical procedures applied to the data in this chapter, there were few significant differences between the means of the data categories. Those that were positively infected included significantly increased incidences of *T. canis* in the pup age group (P=0,0001) and *D. caninum* during the summer months (P=0,0233).

It is well documented that *T. canis* occurs more commonly in pups (Holland et al., 1991; Jacobs et al., 1994; Woodruff, 1975) than in adult dogs; this is supported by the Boksburg findings (P=0,0001).

The only breed difference found with regard to helminth parasite incidence, was a higher tendency of infection with *A. caninum* in Boel-type breeds compared to all other breeds (P=0,0001), and terrier breeds compared to the breed-types of sheepdogs, retrievers, toy dogs and crossbreeds (P=0,0001 throughout) in Boksburg.

Table 3.1 **Number and results of blood samples and adhesive tape swabs examined in dogs from Boksburg**

Test	Number tested	Number positive	Percentage (%)
Thin blood smears (Diff Quick)	132	1 (*Babesia canis*)	0.8
Thick blood smears (Giemsa)	132	0	0
Blood filters	132	3 *Dipetalonema reconditum*	2.3
Adhesive tape swabs	148	3 *Dipylidium caninum*	2.0
		3 Taeniid	2.0
		2 *Toxocara canis*	1.4

Table 3.2 **Helminth species recovered from 69 necropsy examinations of dogs in Boksburg**

Date	Dog number	*Ancylostoma caninum*		*Ancylostoma braziliense*		*Toxocara canis*		*Toxascaris leonina*		*Spirocerca lupi*		*Trichuris vulpis*		*Dipylidium caninum* (scoleces)	*Joyeuxiella pascualei* (scoleces)	*Taenia* spp. (scoleces)
		♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀			
28/05/1997	2.2	28	33	1	3	0	0	0	1	0	0	0	0	3	0	0
28/05/1997	2.3	10	21	0	0	2	1	0	0	0	0	0	0	0	0	0
25/06/1997	3.1	26	42	0	0	0	0	1	2	0	0	0	0	1	0	0
25/06/1997	3.2	2	4	0	0	1	0	0	0	0	0	0	0	4	0	0
25/06/1997	3.3	3	7	0	0	0	0	0	0	0	0	0	0	3	0	0
25/06/1997	3.4	53	68	4	11	0	0	0	0	0	0	0	0	1	0	0
09/07/1997	R1	51	75	0	0	2	0	0	0	2	0	0	0	2	0	1
09/07/1997	R2	0	3	0	0	1	0	0	0	0	0	0	0	0	0	0
09/07/1997	R3	3	6	0	0	4	3	0	0	0	0	0	0	0	0	0
30/07/1997	4.1	3	1	0	0	3	0	0	0	0	0	0	0	0	0	0
30/07/1997	4.2	1	0	0	0	2	1	0	0	0	0	0	0	8	0	0
30/07/1997	4.3	53	95	0	0	0	0	0	0	0	0	0	0	6	0	0
30/07/1997	4.4	3	4	0	0	0	0	0	0	125	18	0	0	6	0	0
27/08/1997	5.1	27	42	1	2	0	0	0	0	4	14	0	0	0	0	0
27/08/1997	5.2	122	152	2	2	0	0	12	4	0	0	0	0	0	0	0
27/08/1997	5.3	37	44	10	15	0	0	0	0	28	16	0	0	110	0	0
27/08/1997	5.4	17	31	0	0	0	0	0	0	0	0	0	0	0	0	0
27/08/1997	5.5	16	20	0	0	2	0	0	0	7	0	1	0	16	0	0
27/08/1997	5.6	26	21	9	11	0	0	0	0	0	0	0	0	64	0	0
27/08/1997	5.7	47	89	9	3	0	0	6	0	20	0	0	1	11	0	0
27/08/1997	5.8	10	7	2	2	0	0	0	0	0	0	0	0	9	0	0
27/08/1997	5.9	165	223	35	8	0	0	0	0	0	0	0	0	0	0	0
27/08/1997	5.10	10	25	0	0	0	0	0	0	0	0	0	0	0	0	0
27/08/1997	5.11	1	1	0	0	22	0	0	0	0	0	0	0	0	0	0
27/08/1997	5.12	1	3	0	0	20	0	0	0	0	0	0	0	0	0	0
27/08/1997	5.13	3	7	0	0	31	0	0	0	0	0	0	0	0	0	0
01/10/1997	6.1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0
01/10/1997	6.2	1	1	0	0	0	0	0	0	0	0	0	0	0	38	0
05/11/1997	7.1	5	5	0	0	0	0	0	0	0	0	0	0	0	0	0
05/11/1997	7.2	4	3	2	2	0	0	0	0	0	0	0	0	0	0	0
05/11/1997	7.3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
03/12/1997	8.1	1	2	0	0	0	0	0	0	0	0	0	0	32	0	0
03/12/1997	8.2	28	36	0	0	10	0	0	0	0	0	0	0	0	39	0
03/12/1997	8.3	3	11	3	3	0	0	0	0	0	0	0	0	9	0	0

Table 3.2 **Helminth species recovered from 69 necropsy examinations of dogs in Boksburg (continued)**

03/12/1997	8.4	39	48	0	0	7	9	0	0	0	1	0	0	0	0	0
03/12/1997	8.5	4	6	0	0	13	10	0	0	0	0	0	0	0	0	0
03/12/1997	8.6	3	8	0	0	0	0	0	0	0	0	0	0	2	0	0
03/12/1997	8.7	2	6	0	0	19	16	0	0	0	0	0	0	0	0	0
03/12/1997	8.8	35	33	0	0	11	10	0	0	0	0	0	0	0	0	0
03/12/1997	8.9	45	53	0	0	10	3	0	0	0	0	0	0	0	0	0
07/01/1998	9.1	52	50	0	0	0	0	0	0	0	0	0	0	23	0	0
07/01/1998	9.2	27	21	2	0	4	5	0	0	0	0	0	0	130	0	1
07/01/1998	9.3	0	0	0	0	44	57	0	0	0	0	0	0	0	0	0
07/01/1998	9.4	0	0	0	0	48	42	0	0	0	0	0	0	0	0	0
07/01/1998	9.5	4	4	1	0	0	0	0	0	0	0	4	1	42	0	0
07/01/1998	9.6	0	3	0	0	0	0	0	0	0	0	0	0	29	0	0
07/01/1998	9.7	0	1	0	0	9	13	0	0	0	0	0	0	0	0	0
25/02/1998	11.1	4	5	0	0	1	1	0	0	0	0	0	0	30	0	0
25/02/1998	11.2	7	4	0	0	0	0	0	0	6	0	0	0	5	0	0
25/02/1998	11.3	0	7	0	0	3	1	0	0	3	0	0	0	288	0	0
25/02/1998	11.4	623	977	0	0	0	0	0	0	6	7	0	0	0	0	0
25/02/1998	11.5	54	40	0	0	7	0	0	0	0	0	0	0	0	0	0
25/03/1998	12.1	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25/03/1998	12.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25/03/1998	12.3	7	12	0	0	0	0	0	0	0	0	0	0	0	0	0
25/03/1998	12.4	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25/03/1998	12.8	24	35	0	0	0	0	0	0	0	0	0	0	67	0	0
25/03/1998	12.9	7	7	0	0	0	3	0	0	0	0	0	0	0	0	0
25/03/1998	12.10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25/03/1998	12.11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25/03/1998	12.12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25/03/1998	12.13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27/05/1998	14.1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
27/05/1998	14.2	7	6	0	0	0	0	0	0	0	0	0	0	0	0	0
27/05/1998	14.3	18	31	0	0	0	0	0	0	0	0	0	0	0	0	0
27/05/1998	14.4	3	5	0	1	0	0	0	3	0	0	0	0	57	0	1
27/05/1998	14.5	29	50	0	0	0	0	0	0	0	0	2	6	0	96	0
27/05/1998	14.6	182	203	0	0	0	0	8	11	0	0	0	0	0	0	0
27/05/1998	14.7	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	69	1 944	2 698	81	63	276	175	27	21	197	56	7	8	959	174	3

Fig. 3.4 Helminth parasite species identified in faecal flotations of dogs (n=164) from Boksburg

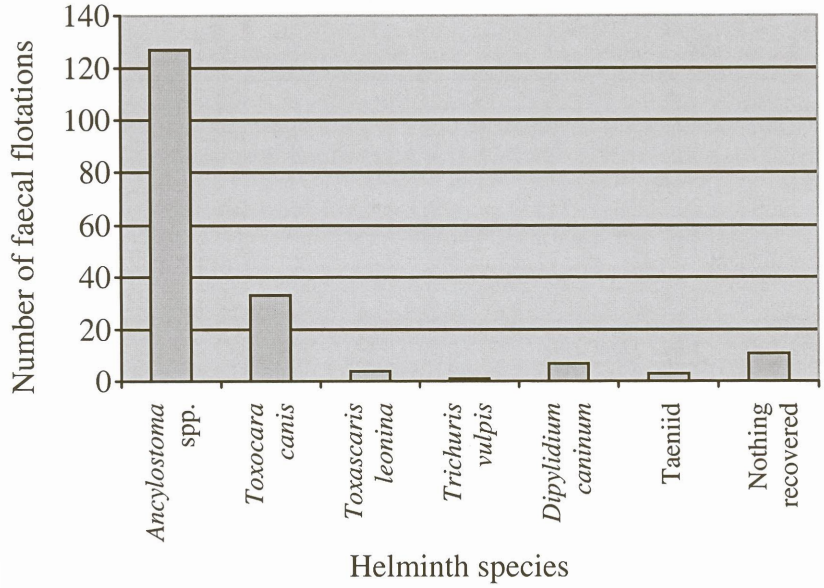


Fig. 3.5 Mean number of nematodes recovered per infected dog necropsied in Boksburg

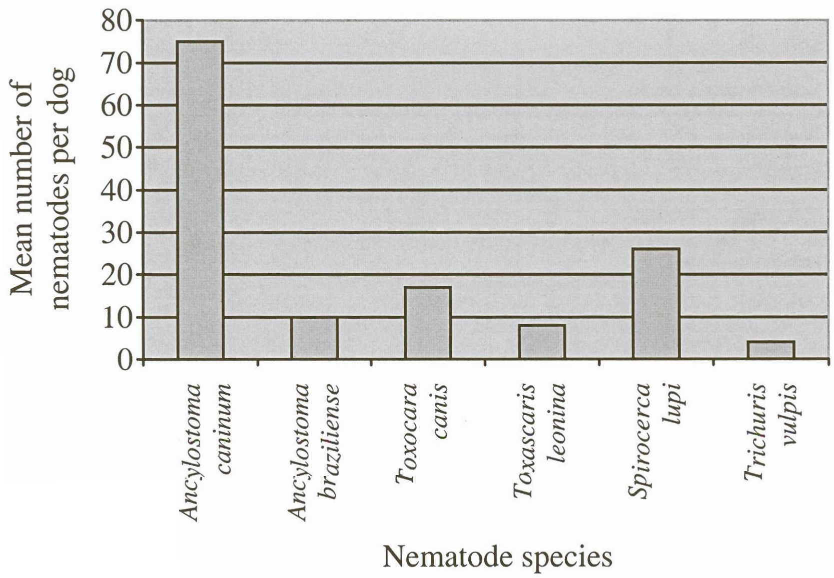


Fig. 3.6 Nematode species identified and number of dogs infected (n=69) in Boksburg

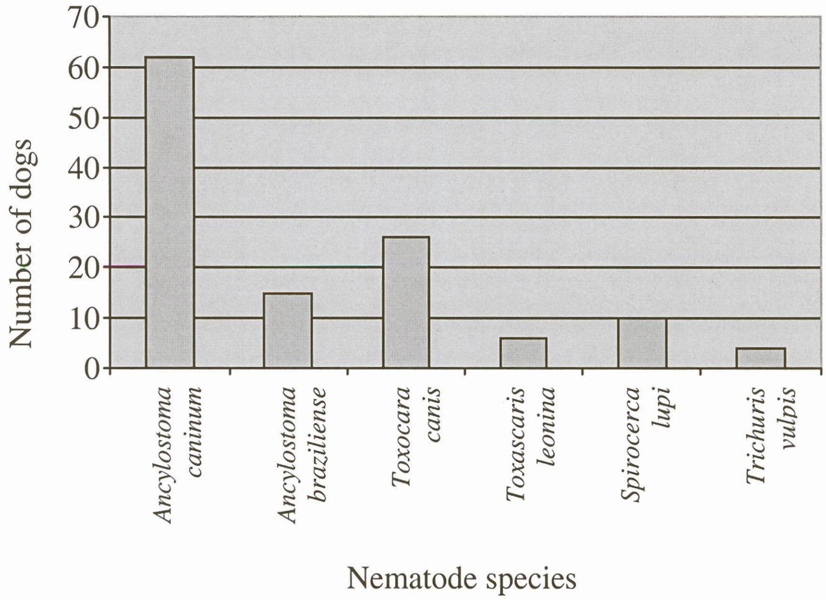


Fig. 3.7 Mean number of cestodes recovered per infected dog necropsied in Boksburg

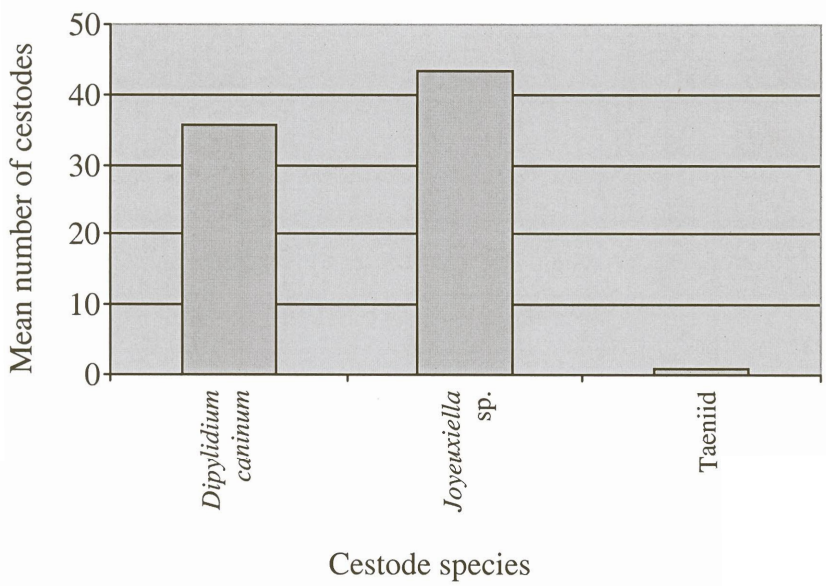
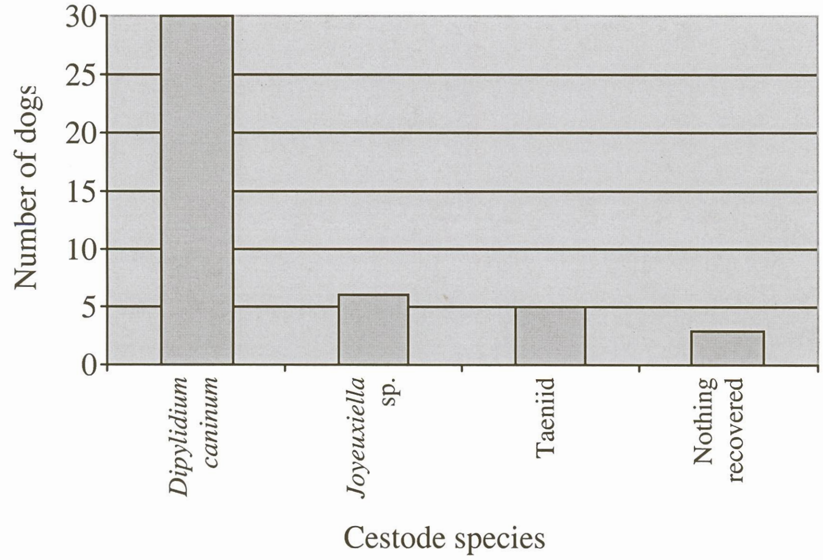


Fig. 3.8 Number of dogs from which cestodes were recovered (n=69) in Boksburg



3.4 **Discussion:**

Adhesive tape swabs:

Taenia hydatigena was recovered from three euthanazed dogs. Adhesive tape swabs were also collected from two of these dogs and both swabs showed the presence of taeniid eggs. However, in only one adhesive tape swab of 27 infected dogs was *D. caninum* observed. This finding suggests that this diagnostic method is not sensitive for detection of *D. caninum*.

Blood samples:

The only parasite observed in the blood smears was one in which *Babesia canis* was observed. The smear was made from the blood of a dog with severe icterus. The SPCA did not confirm diagnosis of babesiosis before the dog had been euthanazed.

Faecal flotations:

Faecal samples were collected and the flotation tests done on 61 of the dogs euthanazed to compare with the helminths recovered from the organs. Distinguishing between the eggs of *A. caninum* and *A. braziliense* microscopically is not possible. One flotation showed the presence of *Ancylostoma* spp. eggs, but no *Ancylostoma* spp. were recovered from the organs. The same phenomenon was seen with three *T. canis* positive faecal samples. This could possibly be as a result of the dog ingesting nematode eggs and not the infective larvae. The eggs, not being infective yet, then pass harmlessly through the intestine.

Faecal egg counts on carnivore faeces may be inaccurate (Miller, 1966), as the fibre and bulk content of the diet or the consistency of the faeces will influence the results. One may also argue that the number of eggs found on flotation only reflect the population of patent *Ancylostoma* spp. females present. The number of eggs produced per female per day also varies as the duration of the nematode infection progresses. *A. braziliense* females also produce less eggs per day than do *A. caninum* females, and the presence of immature stages and the male : female ratio of *A. caninum* will also influence the egg yield per gram faeces (Miller, 1966). It is still uncertain to what extent concurrent infection with other species of nematodes and environmental factors such as limited (dog) freedom to roam, re-infection rate, nutrition, clinical disease, etc., will have on the faecal egg count.

Necropsy recovery:

A. caninum: This was the most common helminth encountered. The actual number of *A. caninum* as a fraction of the total *Ancylostoma* spp. hookworms recovered from the

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Necropsy recovery:

A. caninum: This was the most common helminth encountered. The actual number of *A. caninum* as a fraction of the total *Ancylostoma* spp. hookworms recovered from the intestines at necropsy is more reliable as differentiation between *A. caninum* and *A. braziliense* can not be made by faecal flotation. In this study area, 97% of all *Ancylostoma* spp. recovered from 61 infected dogs, i.e. a total of 4 642 hookworms, were *A. caninum*.

The fact remains that the incidence of *A. caninum* at the levels encountered in Boksburg is a cause for concern. Only a few owners were aware of the possibility of their dogs harbouring internal parasites although some (11%) treat their dogs against worms.

A. braziliense: Although *A. braziliense* was less common in dogs from Boksburg (23% dogs infected with *Ancylostoma* spp.), its mere presence in the community is significant. It does not cause anaemia to the same extent and severity as seen with *A. caninum*, (Miller, 1967) but it is well known as a zoonosis that may cause cutaneous larval migrans in humans. As medical records were unavailable, the occurrence of larval migration in human patients could not be expressed in numbers for that area.

T. canis: This nematode was recovered from 25 of 69 dogs. Fifteen (i.e. more than one-fifth) of these dogs were infected with gravid females. These are probably responsible for recontamination of the home environment, and again could pose a threat to public health, as this species is also zoonotic.

These data also support the theory that *T. canis* favours pups or immature dogs, bitches in late pregnancy and lactating bitches. Of the 25 dogs infected with *T. canis*, 17 were pups, two subadults, two lactating bitches, and only four were adults. The reason why these four adult dogs harboured *T. canis* is uncertain, but may be related to sub-clinical disease or recent recovery from disease, nutritional deficiencies, or stress-related relaxation of immunity. Many dogs in these communities are fed only maize porridge, and often one may find that a lack of protein may undermine the efficiency of the immune system. The number of worms recovered from the adult dogs was low, two to four on average, except for one dog that had 10 adult *T. canis* males in its small intestine.

T. leonina: The occurrence of *T. leonina* in the Boksburg study area is considerably less than *T. canis*. Only six dogs were infected. The most recovered were 19 from an apparently healthy dog. Another dog had 16 adult *T. leonina* in the small intestine, and this dog's immunity was clearly compromised as it was also suffering from parvoviral enteritis. The other dogs infected carried an average of just more than three worms each.

S. lupi: This is a nematode of which the importance is greatly underestimated on both prevalence and pathogenicity. *S. lupi* is diagnosed in the live dog only when oesophageal granulomas cause physical obstruction, or from resulting secondary osteosarcomas. On diagnosis, the condition is already far advanced (Harrus et al., 1996), and the prognosis is guarded. Some of these cases are misdiagnosed, as opacity of oesophageal or aortic granulomas only show up on x-ray film when calcification of lesions takes place. Oesophageal endoscopy may show granulomas, but this procedure is seldom performed on patients. Faecal flotation and sedimentation techniques are not very effective for the same reason, and the sensitivity thereof is questionable (Evans, 1983; Markovics and Medinski, 1996), as patent females have to be present to produce eggs. The author also performed several faecal sedimentation tests (Sloss et al., 1994) without demonstrating a single *Spirocerca* sp. egg. Many dogs probably die from old age or other causes while being asymptomatic hosts to this parasite, without the owner ever knowing.

In this study area, 10 dogs were infected with *S. lupi*. One dog harboured as many as 143 adult worms of which 8 were situated in the aorta and 135 in numerous nodules embedded in the oesophagus. Sixteen of the worms that were found in the oesophagus (12%) were patent females.

T. vulpis: Whipworms were found in four dogs, with the highest count of eight worms in one dog. Reinecke (1983) refers to the distribution of *T. vulpis* in the Durban area. The low prevalence in Boksburg may be attributed to the geographic distribution since this nematode prefers a warmer and wetter environment than in the drier region of the current study.

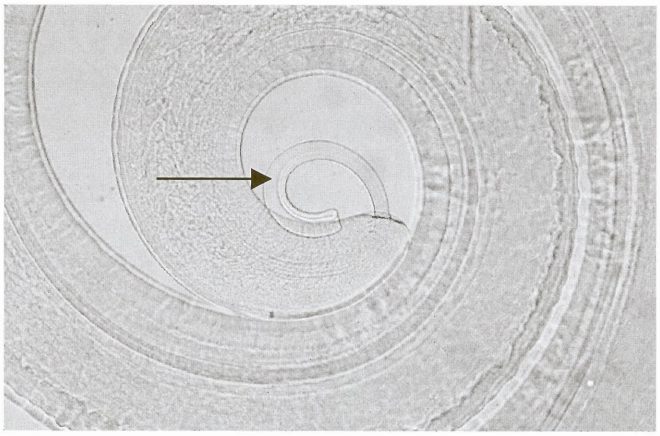

Fig. 3.9 ***Trichuris vulpis*, male prepuce (arrow)**

Cestodes: *D. caninum* is by far the most common cestode of dogs in this area, and of all the helminths, the occurrence of *D. caninum* is second only to *A. caninum*. In the

Boksburg area, 44% dogs were hosts to this tapeworm, with up to 288 scoleces recovered from one dog. The intermediate host that transmits this tapeworm, the common flea (*Ctenocephalides* spp.), was present on many of the dogs that were infected.

The presence of *D. caninum* in the dogs suggests that neither flea control nor deworming with a cestocide is being implemented. In a resource-limited community such as this it is possible to imagine that fleas and therefore also *D. caninum* would be abundant.

The level of infection with *Joyeuxiella* sp. (6%) was only one-seventh as high as *D. caninum*. *T. hydatigena* was present in 3 dogs.

Although some owners said that they treated their dogs regularly for internal parasites, no significant change in the helminth results of the faecal flotations of their dogs could be demonstrated.

Recommendations for dog-owners in the Boksburg area:

The most practical control measure to reduce the chance of transmission of helminth parasites between dogs and from dogs to humans is to prevent contamination of the environment with infective eggs and larvae by regular removal of dog faeces from the living area. Therefore, faeces should be picked up at least on a daily basis, and disposed of by either throwing it into a long-drop toilet pit, burying or burning it. Regular municipal garbage disposal may not be the answer, as dogs often roam the area, knock over garbage cans and scavenge for food, and may therefore become infected. In the Boksburg area, bitches should be dewormed before breeding, shortly before and about three weeks after whelping to reduce the transmission of infective larvae to the pups in the milk. Taeniid and ascarid eggs may cling to the dog's coat, therefore the dog should also be washed. The control of vermin such as mice and flies that can act as paratenic hosts should also be considered. *S. lupi*, *T. canis* and *T. leonina* were identified from necropsy samples from the Boksburg area, therefore dogs from particularly semi-rural areas should be prevented from eating dung beetles, frogs, mice, lizards or uncooked chicken scraps. Flea control using dips, pour-ons, flea powders and flea collars will also help prevent transmission of *D. caninum*.

From a public health point of view, with many dog helminths being infectious also to humans, education in the community to ensure an understanding of the reasons for introducing new or different habits is called for. Helminth larvae and eggs might be ingested by eating or placing hands in the mouth or not rinsing fresh vegetables before eating. Children should avoid playing where dogs have defaecated, and people should prevent direct skin contact with the soil, e.g., wearing shoes especially in sandy areas. Small children ought to be prevented from eating soil.

There was a constant SPCA presence in the resource-limited communities of Boksburg. The residents knew the personnel and co-operated with them. In addition to enforcing animal health regulations, the SPCA could also extend their involvement in the communities by educating animal owners on parasite control, either by providing information during their daily visits in the areas, or by organising information days.

Well-informed owners will also be aware of alternative opportunities when seeking veterinary help. The communities are situated close to Boksburg town, where veterinary advice and services are available. There are opportunities for future research projects, and the communities could also benefit from this as the animal owners now know that research will eventually improve animal and community health and therefore serve for the upliftment of living standards in the community.

Chapter 4 Helminth occurrence in dogs from resource-limited communities in Bloemfontein, Free State Province

4.1 **Background:** The informal settlement areas surrounding Bloemfontein in the Free State Province are similar to the study areas around Boksburg in terms of infrastructure, economic and social structures as described in Chapter 3. This study area is situated at 28°13'E; 29°07'S and consists of transitional dry *Cymbopogon* - *Themeda* veld (Acocks, 1975). This is characterized by mixed, grassy false Karoo vegetation, with doleritic formations and sandy soil to turf. It is flat country, with an annual rainfall of 450 - 500 mm.

The community is urban, and the dogs from which the samples were collected originated from the low-income informal settlement suburbs and older residential areas (Figs. 4.1 and 4.2).

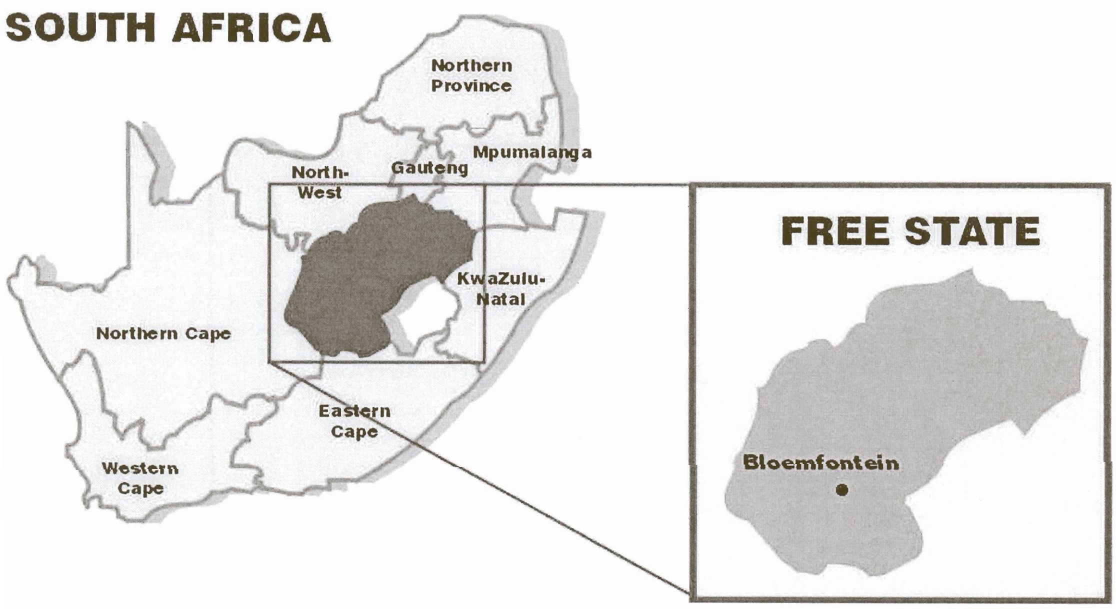

Fig. 4.1 **The geographic locality of Bloemfontein in Free State Province**

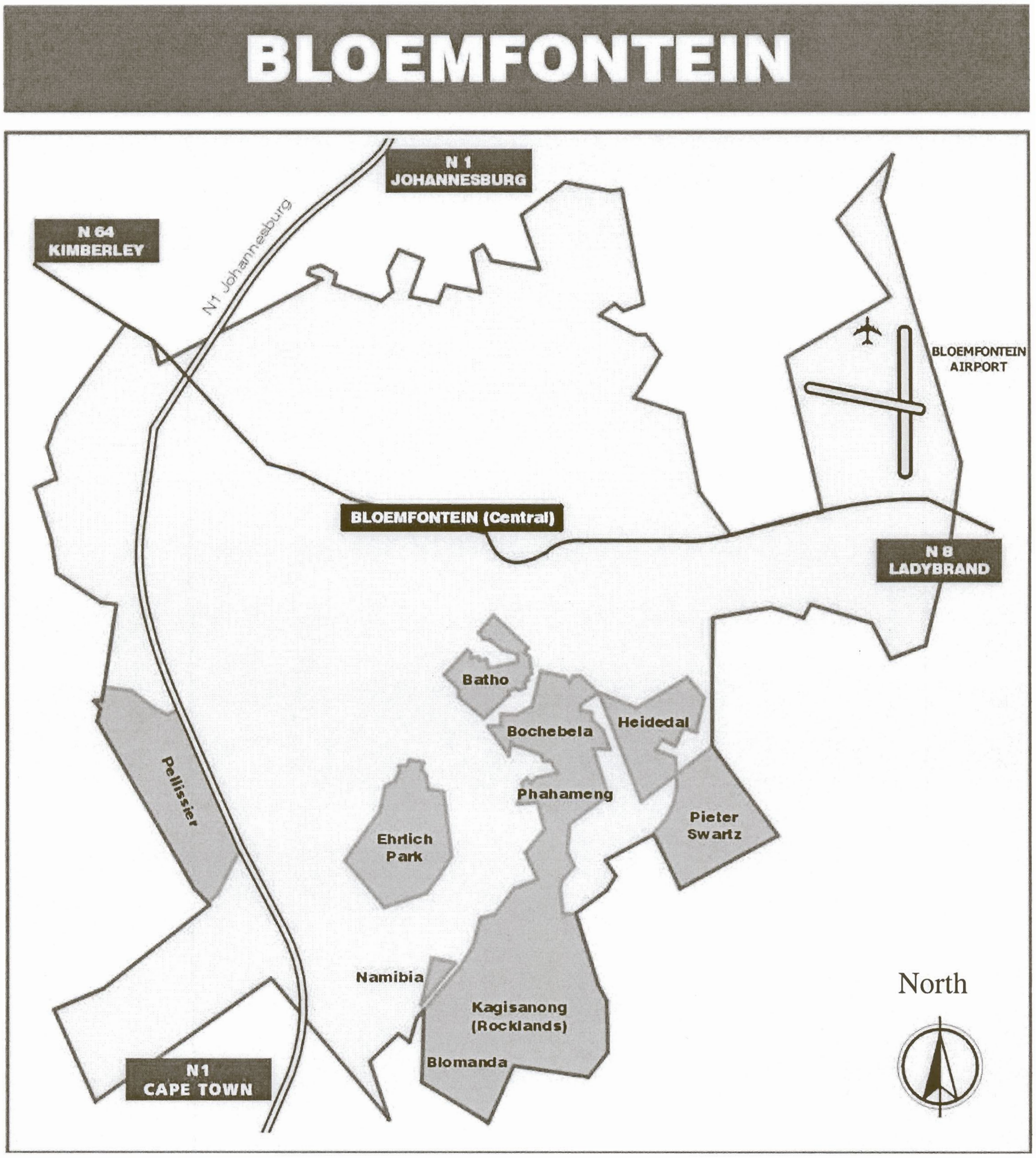

Fig. 4.2 **Area map of Bloemfontein**

The residents in the area are predominantly Sesotho-speaking. Many of the residents work in the city of Bloemfontein; there is a high degree of unemployment and poverty in these settlement suburbs.

The dogs impounded by the SPCA originated from the following settlement areas: Batho, Bochebela, Heidedal, Pellisier, Ehrlich Park, Phahameng, Pieter Swartz, Namibia, Kagisanong (Rocklands) and Blomanda.

4.2 **Materials and methods:** Necropsy samples were collected from dogs from the areas mentioned above during the period 21 May 1998 - 02 July 1999. The collection of samples in Bloemfontein was done in collaboration with the Department of Entomology and Zoology of the University of the Orange Free State. This department has a good working relationship with the Bloemfontein Branch of the Society for the SPCA and was therefore prepared to collect samples needed for this part of the project from stray and homeless dogs euthanazed by the SPCA. There were no questionnaires for this study, because there were no owners involved (the dogs were homeless).

Fig. 4.3 **A dog being necropsied in Bloemfontein by Mr. Eddie Williams**

Cardiac blood samples were collected in EDTA tubes as described in Chapter 2, and stored in a refrigerator for processing later.

Following euthanasia, adhesive tape swabs were collected from each dog and examined as described in Chapter 2. The faecal samples were collected during the necropsy procedure and the faecal flotation tests were done in Bloemfontein (Chapter 2) on the same day.

Organ samples were collected as described in Chapter 2, and then stored in a freezer. The organs (frozen), blood samples and adhesive tape swabs were collected every four months and transported to the Department of Veterinary Tropical Diseases, Faculty of Veterinary Science, University of Pretoria, Onderstepoort, 15 km north of Pretoria, where they were processed further.

4.3 **Results:** The total number and species of helminths recovered from 63 dogs in Bloemfontein are given in Table 4.1. Figs. 4.4 - 4.8 include the helminth species identified in faecal flotations and numbers of nematodes and cestodes recovered from dogs that were necropsied.

The 57 blood samples were negative for haemoprotozoa and microfilariae. Of the 63 adhesive tape swabs collected, 19 were positive for taeniid eggs, and two for *D. caninum* eggs.

Few significant differences were found between the various criteria to which the statistical procedures mentioned in Chapter 2 were applied. A significant increase was found in the prevalence of infection with *A. caninum* during spring compared to summer (P=0,0003), winter (P=0,0003) and autumn (P=0,0002). In contrast with the findings of the Boksburg study area, sub-adult dogs tended to carry significantly higher burdens of *D. caninum* compared to adult dogs (P=0,0316).

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Table 4.1 **Helminth species recovered from 63 necropsy examinations of dogs in Bloemfontein**

Date	Dog number	*Ancylostoma caninum*		*Ancylostoma braziliense*		*Toxocara canis*		*Toxascaris leonina*		*Spirocerca lupi*		*Trichuris vulpis*		*Dipylidium caninum* (scoleces)	*Joyeuxiella pascualei* (scoleces)	*Taenia* spp. (scoleces)
		♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀			
21/05/1998	1	0	0	0	0	0	0	0	0	0	0	0	0	31	0	0
20/06/1998	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20/06/1998	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20/06/1998	4	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0
20/06/1998	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20/06/1998	6	0	1	0	0	0	0	2	6	0	0	0	0	3	0	0
22/06/1998	7	0	1	0	0	0	0	1	5	0	0	0	0	6	0	3
21/08/1998	10	5	10	0	0	0	0	0	0	0	0	0	0	0	0	3
21/08/1998	11	0	0	13	12	1	0	0	0	0	0	0	0	3	0	2
21/08/1998	12	0	0	1	5	7	9	0	0	0	0	0	0	19	0	3
21/08/1998	13	0	0	3	3	0	0	9	36	3	7	0	0	3	0	0
21/08/1998	14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8
21/08/1998	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14/09/1998	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14/09/1998	17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14/09/1998	18	0	0	17	24	0	1	0	0	1	0	0	0	1	0	2
14/09/1998	19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14/09/1998	20	0	1	5	3	0	0	0	2	4	8	0	0	1	0	0
14/09/1998	21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14/09/1998	22	0	0	0	0	0	0	0	0	0	0	0	0	20	0	0
14/09/1998	23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14/09/1998	24	0	0	0	0	1	5	0	4	0	0	0	0	0	0	0
16/09/1998	25	0	0	0	0	5	1	0	0	0	0	0	0	4	0	2
08/10/1998	26	0	0	0	0	0	0	0	2	0	0	0	0	1	0	6
08/10/1998	27	0	0	0	0	0	0	2	1	0	0	0	0	0	0	0
08/10/1998	28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
08/10/1998	29	0	0	0	0	0	0	0	0	0	0	0	0	106	0	0
29/10/1998	30	13	14	24	30	0	0	2	1	0	0	0	0	0	0	2
29/10/1998	31	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0
29/10/1998	32	0	0	0	0	1	0	0	0	0	0	0	0	0	14	0
29/10/1998	33	21	16	4	10	0	0	0	0	0	0	0	0	4	0	0
29/10/1998	34	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1

Table 4.1 **Helminth species recovered from 63 necropsy examinations of dogs in Bloemfontein (continued)**

11/12/1998	35	0	0	0	0	2	1	0	0	0	0	0	0	0	0	2
11/12/1998	36	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10/01/1999	37	0	0	0	0	0	0	0	0	12	11	0	0	0	0	0
10/01/1999	38	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10/01/1999	39	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
03/03/1999	40	0	0	0	0	0	0	6	8	0	0	0	0	0	0	0
03/03/1999	41	1	2	0	0	0	0	0	0	0	1	0	0	1	0	4
03/03/1999	42	0	0	0	1	0	0	0	2	0	0	0	0	21	0	0
03/03/1999	43	6	13	0	0	0	1	0	0	0	0	0	0	0	0	2
03/03/1999	44	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1
03/03/1999	45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18/03/1999	46	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18/03/1999	47	0	1	0	0	0	0	0	0	0	0	0	0	5	0	2
18/03/1999	48	0	3	8	9	0	0	2	1	2	2	0	0	1	0	0
18/03/1999	49	2	4	0	1	0	1	0	0	0	0	0	0	21	0	0
18/03/1999	50	0	0	0	0	0	0	0	0	0	0	0	0	33	0	0
18/03/1999	51	0	0	0	0	6	13	0	0	0	0	0	0	0	0	0
22/04/1999	52	0	0	0	0	0	0	16	45	0	0	0	0	0	0	0
22/04/1999	53	0	0	0	0	0	0	2	0	1	3	0	0	0	0	3
22/04/1999	54	6	8	0	0	0	0	6	11	0	0	0	0	0	0	0
22/04/1999	55	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12/06/1999	56	0	0	1	0	0	0	7	4	3	1	0	0	1	0	1
12/06/1999	57	0	1	0	0	1	0	0	0	0	0	0	0	22	0	1
12/06/1999	58	0	1	0	0	0	0	7	9	0	0	0	0	78	0	0
12/06/1999	59	0	2	0	0	0	0	5	13	0	0	0	0	0	0	0
02/07/1999	60	0	0	0	0	0	2	2	2	0	0	0	0	32	0	0
02/07/1999	61	1	0	0	0	0	0	0	0	0	0	0	0	0	0	4
02/07/1999	62	0	0	0	0	0	0	0	0	0	0	0	0	2	0	3
02/07/1999	63	0	0	0	0	0	0	0	0	0	0	0	0	6	0	5
02/07/1999	64	0	0	0	0	0	0	10	20	0	0	0	0	2	0	0
02/07/1999	65	0	0	0	0	0	0	18	19	0	0	0	0	30	0	0
Total	63	55	79	77	98	28	39	97	191	26	33			458	23	60

Fig. 4.4 Helminth parasite species identified in faecal flotations of dogs (n=63) from Bloemfontein

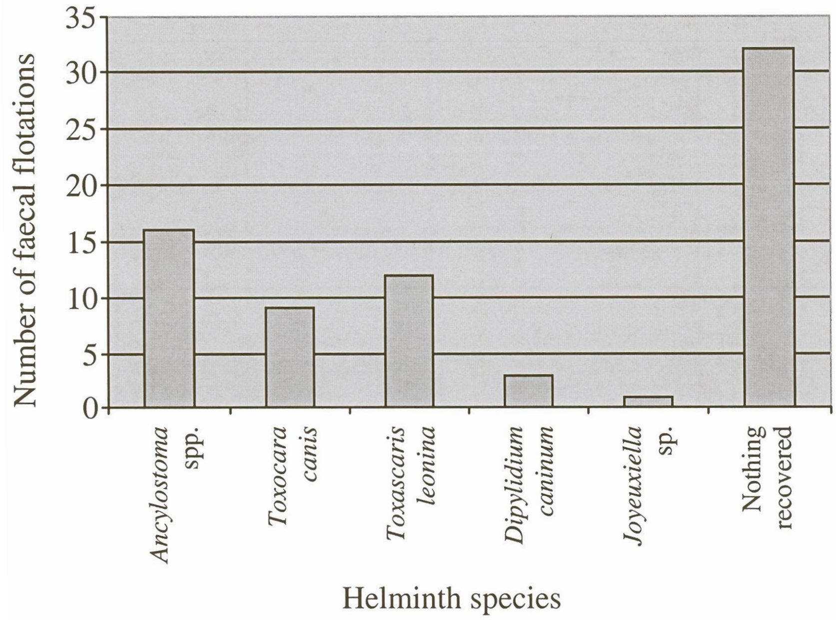


Fig. 4.5 Mean number of nematodes recovered per infected dog necropsied in Bloemfontein

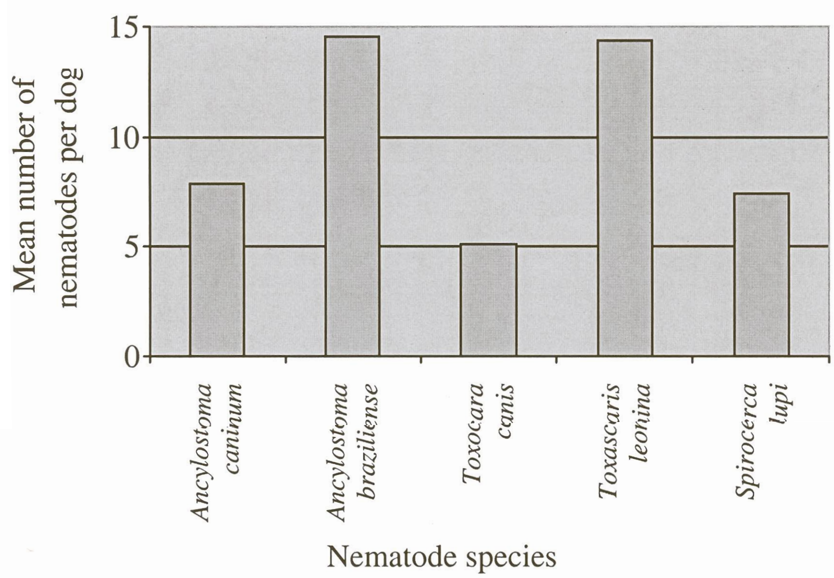


Fig. 4.6 Nematode species identified and number of dogs infected (n=63) in Bloemfontein

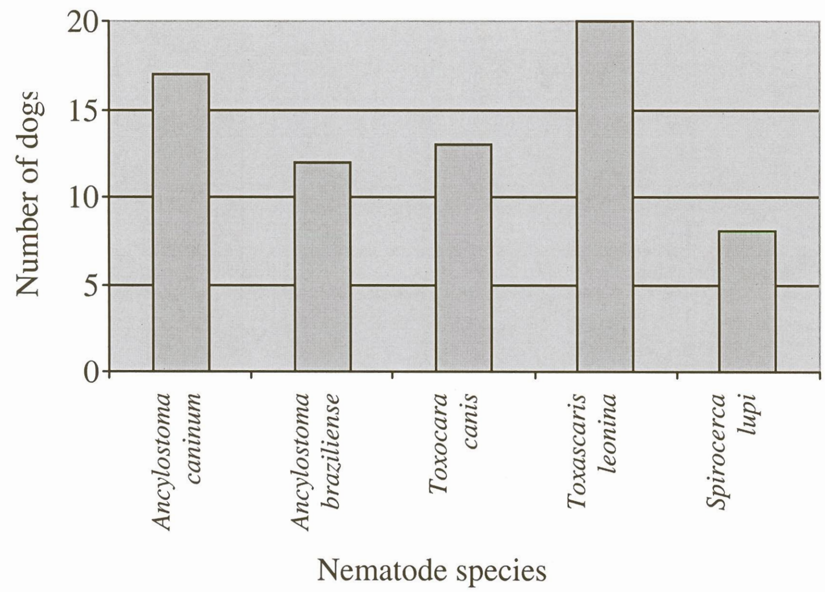


Fig. 4.7 Mean number of cestodes recovered per infected dog necropsied in Bloemfontein

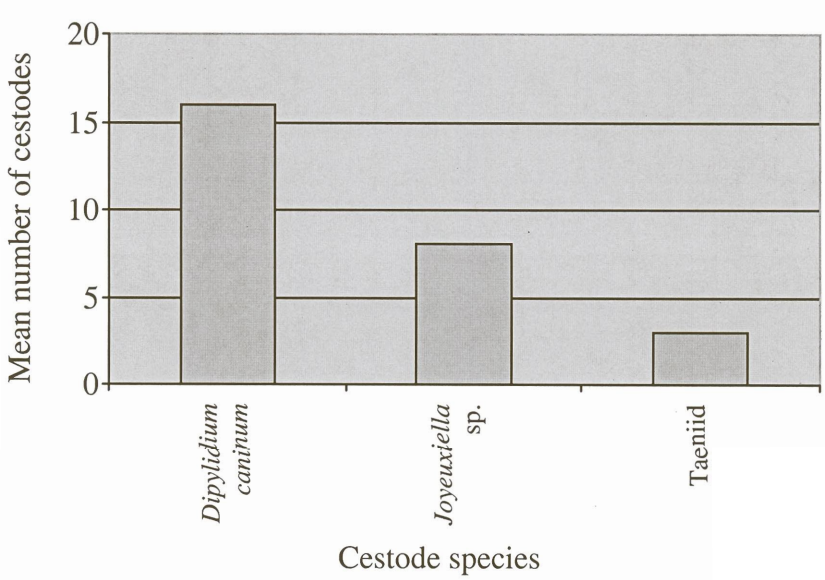
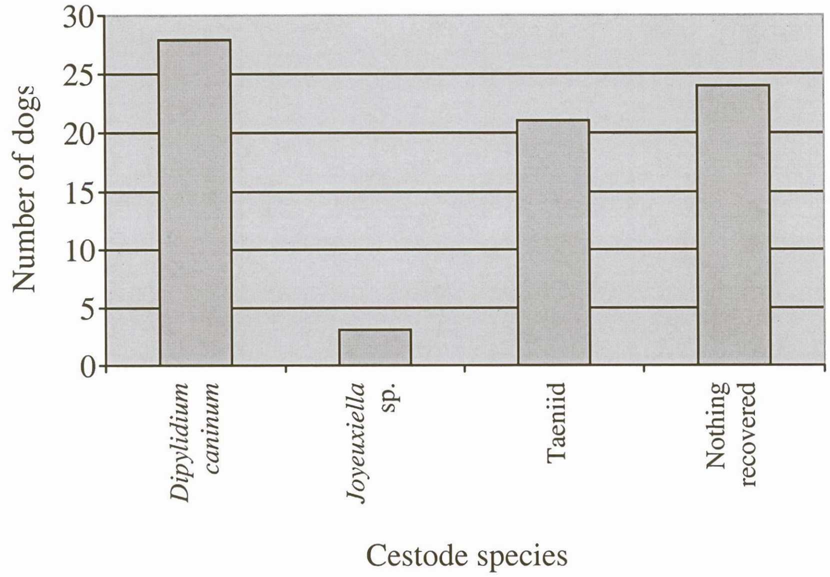


Fig. 4.8 Number of dogs from which cestodes were recovered (n=63) in Bloemfontein



4.4 Discussion:

Ancylostoma spp.: Although adult *Ancylostoma* spp. were recovered in 40% of the necropsy samples, only one-quarter of the faecal flotations were positive for eggs of *Ancylostoma* spp. The prevalence of *Ancylostoma* in dogs in Bloemfontein was low, and in some dogs there were only males present, which would explain the absence of eggs in the faeces. The incidence of *A. caninum* was much lower, and the incidence of *A. braziliense* higher in Bloemfontein than in Boksburg, although the overall numbers were still low.

T. canis: Thirteen dogs were infected. Only 10 dogs were infected with female worms; infection in nine of these dogs was detected using the faecal flotation method.

T. leonina: Thirty-two percent of the dogs necropsied were infected with *T. leonina*, but only 19% of faecal samples were positive on faecal examination. The incidence of this ascarid in dogs and cats in Bloemfontein is much higher when compared with Boksburg.

S. lupi: In this study area, 13% of the dogs were infected with *S. lupi*.

Fig. 4.9 ***Spirocerca lupi* in the oesophagus of a dog from Bloemfontein (arrow)**

D. caninum: Necropsy results included 28 dogs infected with *D. caninum* while faecal flotation examination revealed that only three samples and two adhesive tape swabs were positive. The results in the live animal are low underlining the difficulty of diagnosis of this cestode in the live animal.

J. pascualei: There were three infected dogs, and only one positive faecal flotation. Diagnosing *Joyeuxiella* in the live animal is more difficult, because the eggs occur singly, whereas with the related *Dipylidium* they occur in batches, making them more easily visible. Also, the eggs are thin-walled, and they blend in with the background under the microscope, unlike taeniid eggs which tend to stand out as a result of the thick shell.

Taenia spp.: Adhesive tape swabs from all 19 dogs positive at necropsy were also positive for *Taenia* eggs. This is a 100% correlation between the two methods.

The higher prevalence of *A. caninum* during spring as compared to summer, winter and autumn was possibly the result of the dry, cold Free State winters.

Recommendations for the dog-owners of Bloemfontein:

Dog faeces should not be allowed to build up near the houses and must therefore be removed daily as it could result in reinfection of dogs and infection of children especially. Breeding and suckling bitches ought to be dewormed, and pups also from as young as three weeks. Pups may be reared in enclosed pens with concrete floors, which must be cleaned thoroughly every day. Flea control with chemicals (dips, powders, spot-on and flea collars) and regular use of a vacuum cleaner are also important in the Bloemfontein study area. For the prevention of infection with *S. lupi*, *T. canis and T. leonina*, dogs should not be allowed to eat lizards, frogs, mice, dung beetles or raw chicken scraps. In order to control cestodes, the dogs must be prevented from feeding on carrion, raw abattoir scraps or killing and eating other animals.

The members of the Bloemfontein community should be made aware of the dangers of visceral larva migrans, cutaneous larva migrans and other helminth zoonoses related to the findings in their dogs. They must be taught to wash hands, fruit and vegetables before eating, and cleaning nails regularly, especially after working with soil. Dogs ought to be kept away from public parks and children's playgrounds where their faeces may contaminate the environment.

There is active involvement of both the Bloemfontein SPCA and the Department of Zoology and Entomology of the University of the Orange Free State in the surrounding communities. The opportunities exist therefore to further strengthen linkages with these communities and to educate the animal owners on parasite control. The same comments mentioned on the involvement of the SPCA in Boksburg (Chapter 3) also apply to the Bloemfontein SPCA. As the university has a strong research interest in the communities, they have the opportunity to obtain information and data in exchange for animal owner education and veterinary assistance. The State Veterinarian's office and the Provincial Veterinary Laboratory are both situated in Bloemfontein, and should be made aware of the zoonotic potential of these parasites. They may also play an important role in extension and service delivery in the resource-limited communities of Bloemfontein.

Chapter 5 Helminth occurrence in dogs from resource-limited communities in Jericho, North-West Province, and Zuurbekom and Mamelodi, Gauteng Province

5.1 Background:

Jericho:

Jericho is a rural community and consists of mainly small-scale communal farmers. The community was situated on deep sandy soil, with quartzite and granite kopjes breaking the even landscape. The veld type was mixed bushveld (Acocks, 1975), with dense, fairly tall growth, with open tufted grazing. The grass was coarse and wiry. An average annual rainfall of 450 - 550 mm and a maximum average summer temperature of 31°C and minimum of 1°C in winter characterised this area.

Except for Jericho itself, there were smaller villages in the area that developed around agricultural practices (Figs. 5.1 and 5.2). There was a tribal social structure and the people maintained the traditional heritage and values. There was a strong commitment to the tribal system of a chief and headmen. Setswana is spoken in the area.

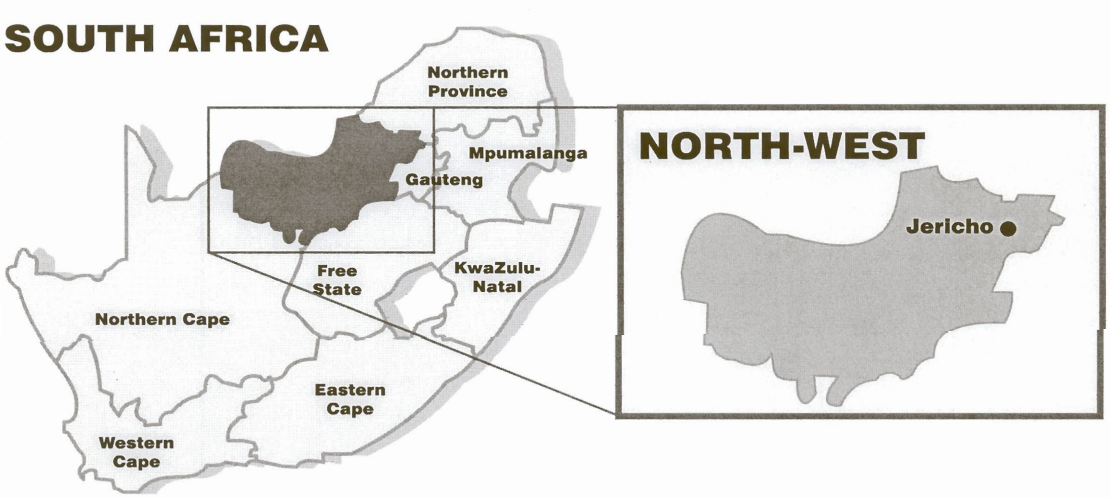


Fig. 5.1 **The geographic locality of Jericho in North-West Province**

JERICHO

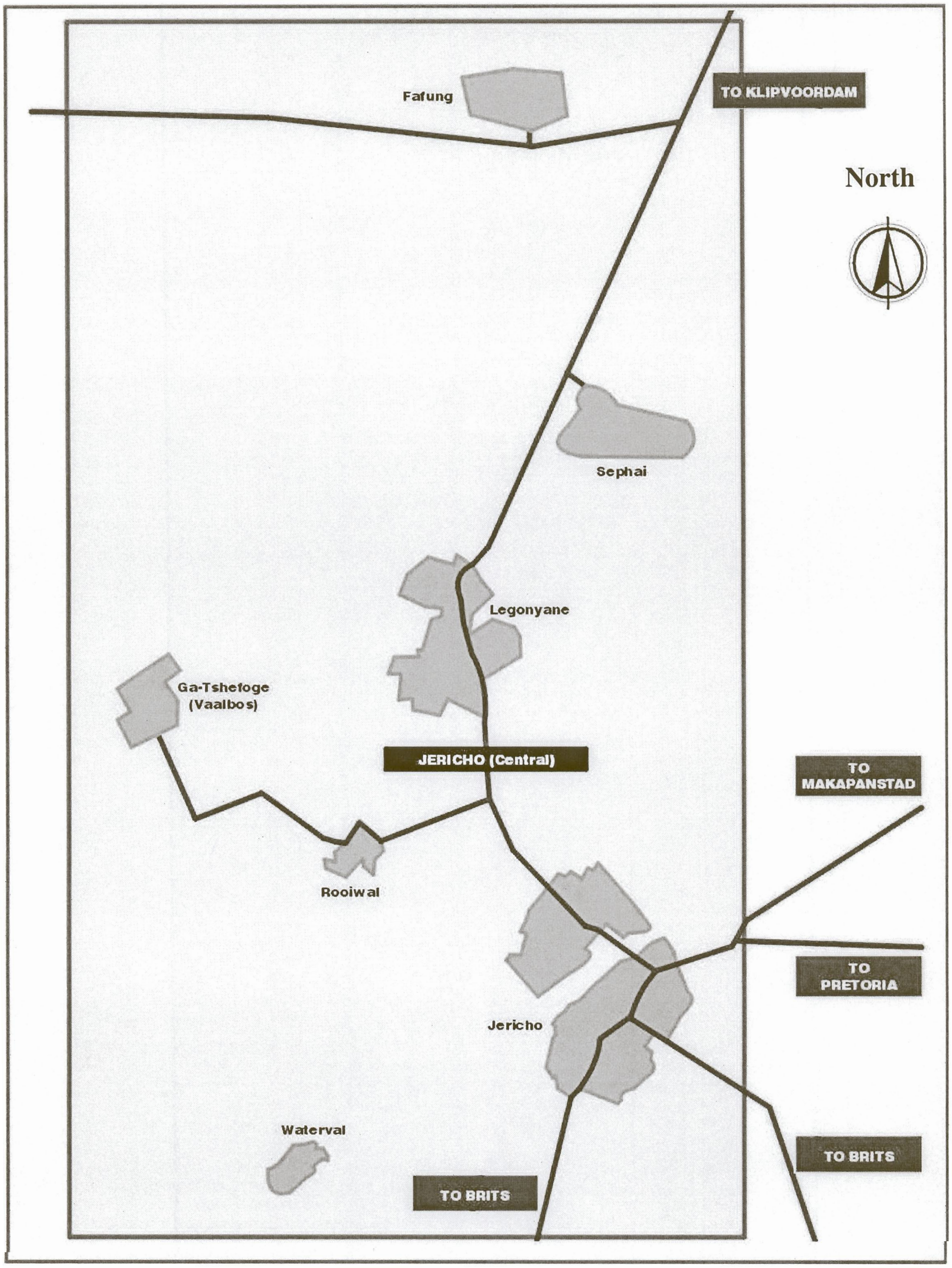


Fig. 5.2 **Area map of Jericho**

Most of the animal owners were either unemployed or pensioners, and they made a living from their livestock. Some were employed elsewhere in cities such as Brits and Pretoria, and the women or elderly family members were responsible for the livestock. The livestock was kept in a communal system with no boundaries separating individually owned animals. The owners themselves mostly slaughtered small stock, whereas cattle were sold to speculators from outside the community, or to the three butchers *via* the two slaughter facilities in the area.

The villages included in the study were Fafung, Sephai, Legonyane, Vaalbos, Rooiwal, Jericho Central and Waterval.

Zuurbekom:

Zuurbekom is situated at 27°45'E; 26°18'S, south-east of the South Western Township (Soweto) in the Gauteng highveld (Figs. 5.3 and 5.4). The veld type is the sparser, more tufted northern variation of *Cymbopogon - Themeda* veld, which is sour grassland (Acocks, 1975) on sandy soil. The underlying rock formation is dolomite, with a high sinkhole risk and therefore drilling for water in the area is prohibited. Average annual rainfall is 640 mm, and the winters are frosty.

Zuurbekom is a formal settlement area. It consisted of 29 000 ha that was in the process of being divided into smaller lots and distributed to 800 emerging farmers under the Gauteng Provincial Government's Farmer Settlement Programme (July 1997).

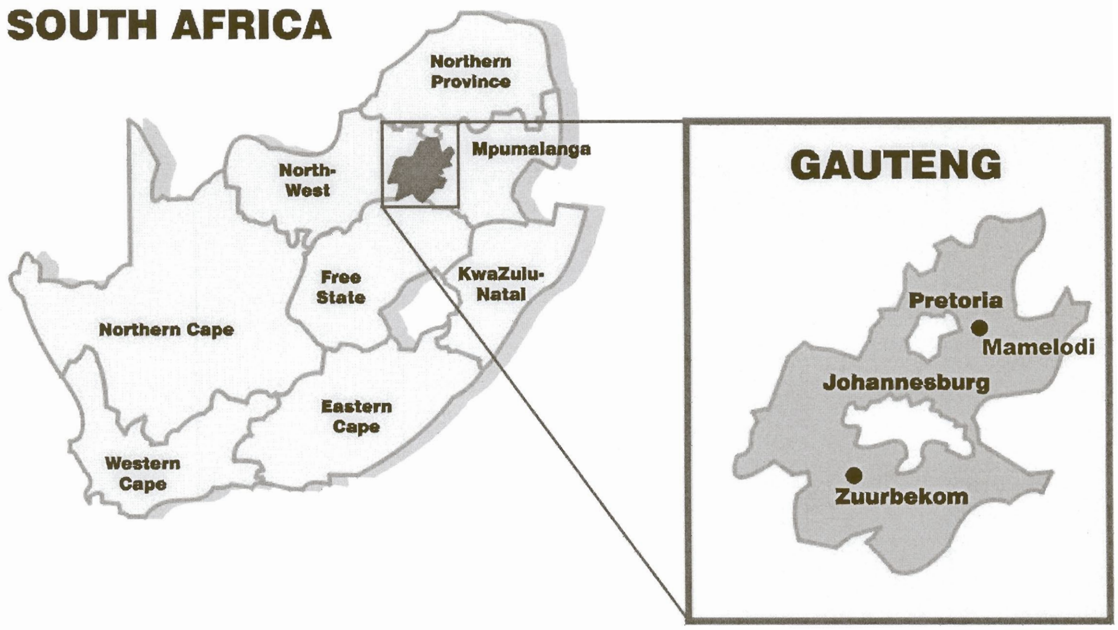


Fig. 5.3 **The geographic locality of Zuurbekom and Mamelodi in Gauteng Province**

The community was made up of various ethnic groups of people and the languages spoken were Zulu, Setswana, Sesotho and Sepedi. Three farming systems were observed, ranging from traditional communal grazing systems to small-scale emerging farming systems to more modern speculating and fattening systems.

This community is close to the densely populated urban townships of Soweto, Lenasia and Sharpeville, which are situated east, south-east and south of Zuurbekom, respectively. The advantage of being close to the townships was easy market access.

There is no traditional leader system governing the Zuurbekom area due to the ethnic diversity of the recently settled community. The Zuurbekom Farmer's Association assists with the collective decision-making process. The community is hard working, and the VNA teams were told that whatever little crime occurred in the area was merely spillover from the neighbouring townships.

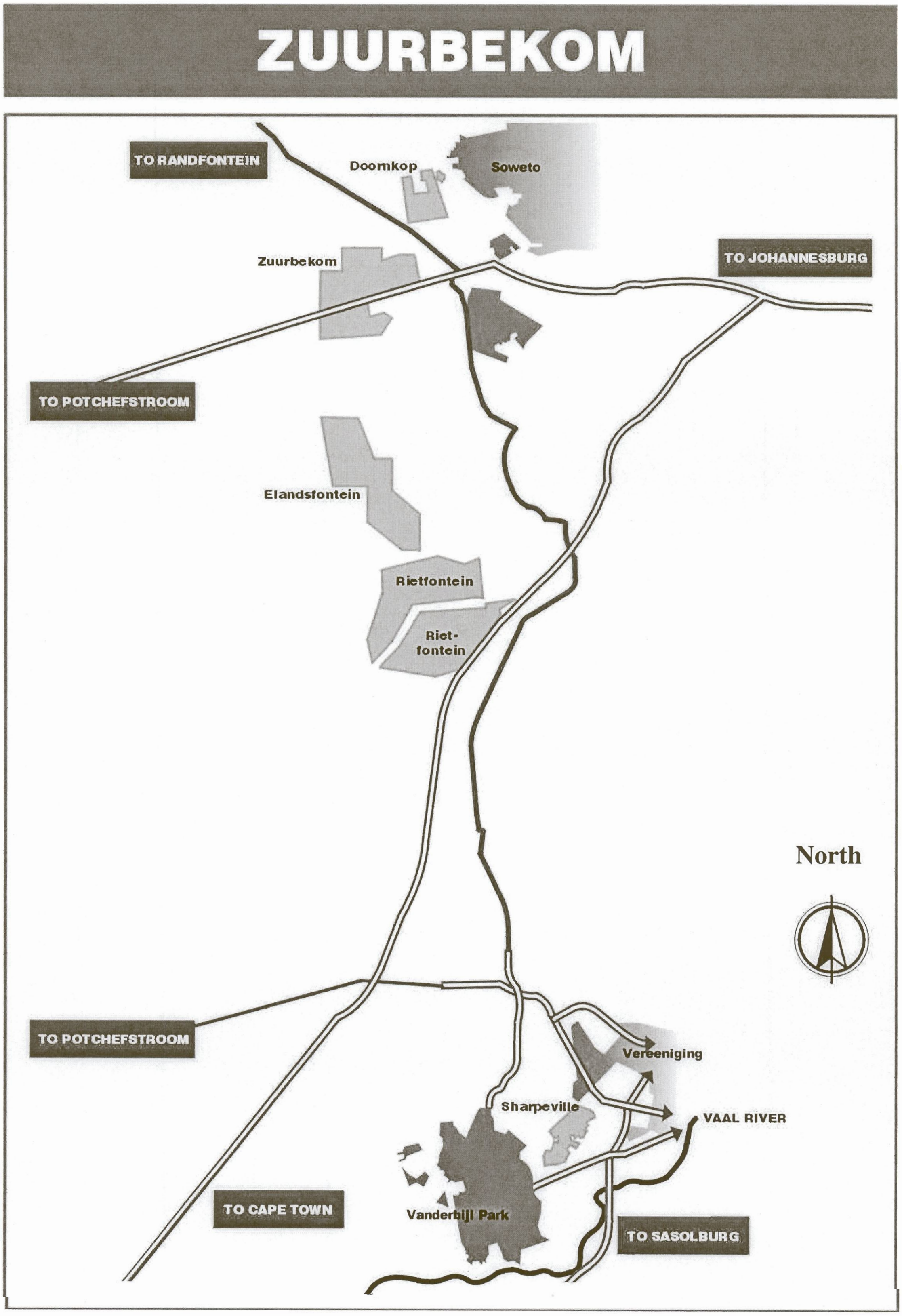


Fig. 5.4 **Area map of Zuurbekom**

The villages included in the study were Doornkop, Zuurbekom, Elandsfontein, Rietfontein and Sharpeville.

Mamelodi:

The informal settlements of Mamelodi East were the focus of this study area. The township of Mamelodi East was situated at 28°22'E; 25°39'S. The veld type (Acocks, 1975) in Mamelodi is similar to that of the Boksburg study area. The central version of Bankenveld receives 700 - 750 mm rainfall annually, and the winters are frosty, although on average slightly warmer than Boksburg. The sour grass is found on stony to sandy soil, occasionally broken up by bushveld vegetation and surrounded by rocky hills of quartzite and dolomite formations.

McCrindle (1999) identified two types of informal settlement. These were. "spontaneous urban housing" which is a settlement process outside the framework of formal township and development, and "official site and service schemes", which is a planning framework that encompasses legal townships and offers tenure and basic services. Both types of settlement were present in the area.

Mamelodi is situated east of Pretoria (Figs. 5.3 and 5.5). Maps of the area showed it as agricultural land. Densely populated (urbanised) settlement areas, and towards the outskirts, farmland which is being used for communal livestock grazing and growing maize characterise the region.

The villages included in the study were Mandela Village (Phase 1), Mahube Village (Lusaka), Extension 5 (Stanza Bopape), Extension 6, Extension 2 and RDP.

MAMELODI

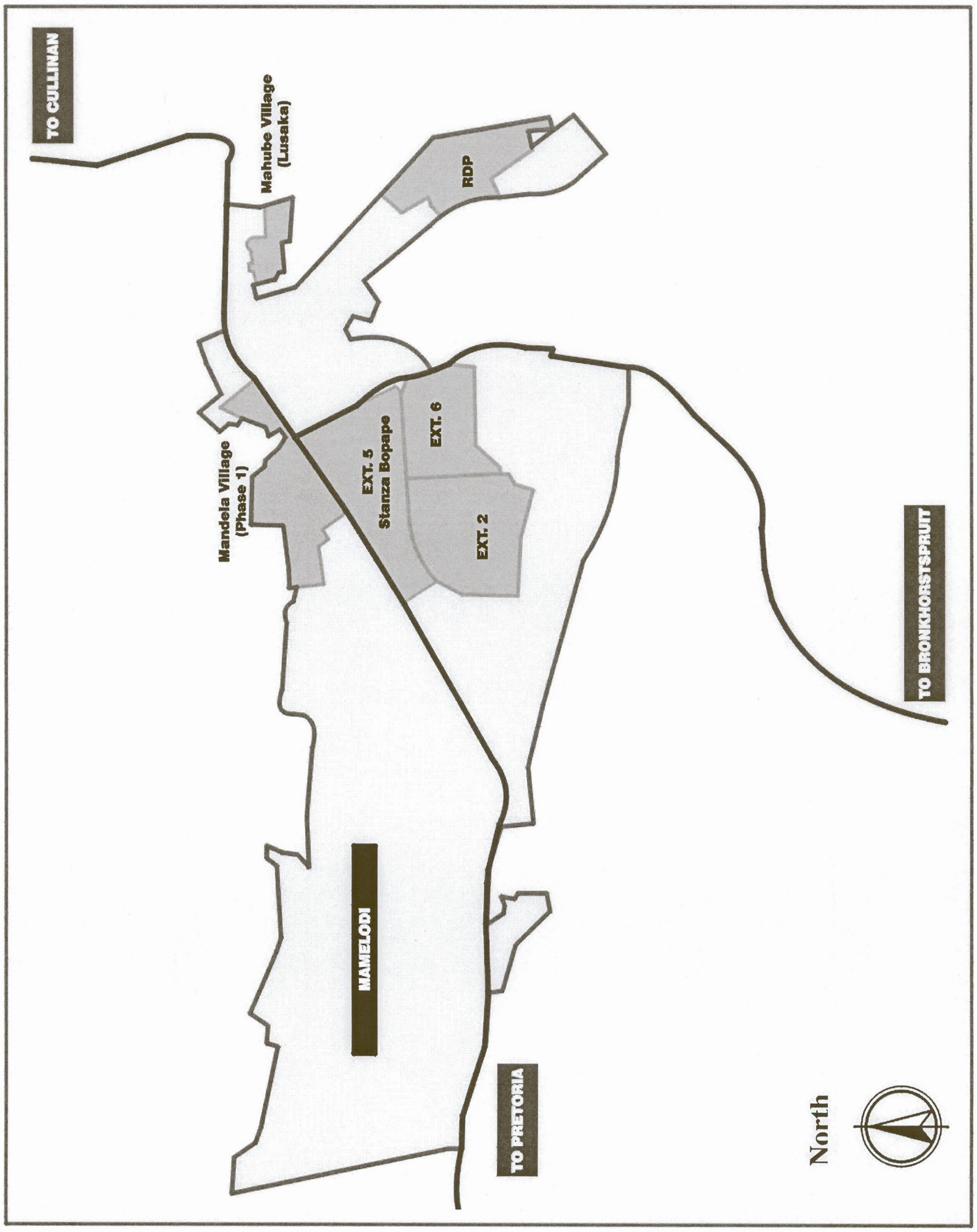


Fig. 5.5 **Area map of Mamelodi**

The community is mainly Zulu and Setswana speaking. Many people are unemployed or self-employed. The level of income is low, often substantially lower than the income of more permanently settled people living nearby. Informal government in the area often results in more efficient crime control than in other urban areas. Crime elements were still present because of local power struggles, forced evictions in the past, and confrontation with authorities such as the police.

5.2 **Materials and methods:** Semi-structured interviews guided by the standard questionnaires (Appendix A) for the VNAs were followed as described in Chapter 6. After completion of the questionnaire, the dogs were examined with the owner holding his or her own dogs. Special attention was given to any abnormalities and diseases encountered in these dogs. The examination consisted of observing the dog's posture and movements, the way it interacted with the owner, noting the body condition, amount of hair cover and condition of the coat, looking at the mucous membranes, eyes and perineal area, and examination for external parasites. The same procedures were followed during the examination of dogs and collection and processing of the samples as described in Chapter 2 (Fig. 5.6).

A workshop to plan the Jericho VNA, held at the Medical University of Southern Africa (MEDUNSA) two weeks before the VNA, included leaders from the community. The workshop addressed the analysis of the problem, objectives and strategies implemented to achieve the goals set for the VNA in Jericho. Following the workshop, a meeting was held with the community prior to the actual appraisal to involve the farmer's association, to inform the community about the appraisal, and to arrange for assistance with mediation, translation and guidance through the area with the community members during the VNA. The Jericho VNA was conducted during the period 11 - 14 March 1997.

Fig. 5.6 **Collecting a blood sample from a dog in Jericho (Courtesy R C Krecek)**

Following another workshop held at Onderstepoort, Zuurbekom was visited twice prior to the actual appraisal to involve the farmer's association during the planning stages, to inform the community about the appraisal. The Zuurbekom VNA was conducted during the period 19 - 23 January 1998.

After the customary planning workshop held at Onderstepoort, an initial community meeting was held on Sunday 24 January 1999 to introduce the concept to the community in Mamelodi, attended by residents of the informal settlement areas and stockowners. The local authorities [i.e. councillors and the South African Civics Association (SANCA)] were also included in the meeting to involve all the stakeholders and role-players and to assist with translation. Members of the community acted as guides through the study area for the duration of the project, which occurred over the period 25 - 29 January 1999.

5.3 **Results:** The number of thin blood smears, thick blood smears, blood filters, adhesive tape swabs and faecal flotations for the three study areas are in Table 5.1.

Table 5.1 **Number of blood smears, blood filters, adhesive tape swabs and faecal specimens examined from dogs in Jericho, Zuurbekom and Mamelodi**

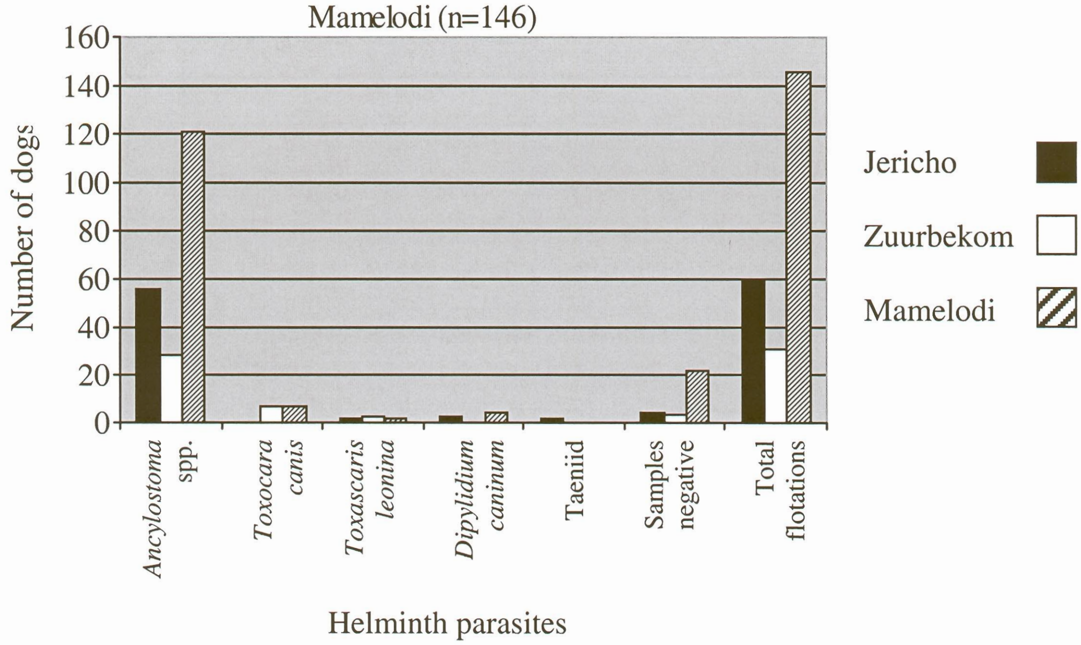
Study area	Jericho	Zuurbekom	Mamelodi
Thin blood smears	53	33	138
Thick blood smears	53	33	138
Blood filters	53	33	138
Adhesive tape swabs	67	38	173
Faecal specimens	60	31	146

Babesia canis was identified in one blood sample from Mamelodi, and taeniid eggs were identified in three adhesive tape swabs from Zuurbekom.

The results of the faecal examinations of dogs from Jericho, Zuurbekom and Mamelodi are shown in Fig. 5.7.

In the three study areas discussed in this chapter, the only significant statistical correlation found between the data categories was between the ESS of families that owned dogs in Mamelodi and dog condition score (P=0,0124).

Fig. 5.7 Helminth parasites identified in faecal flotations of dogs from Jericho (n=60), Zuurbekom (n=31) and Mamelodi (n=146)



5.4 **Discussion:** Blood samples were not collected from clinically sick dogs with anaemia, and the blood samples collected were all venous blood, which could explain the low number of samples positive for *Babesia*. With the exception of the one blood sample that contained *B. canis* (which represents 0.4 %), none of the of the 224 blood samples revealed haemoprotozoa or microfilariae.

The high incidence (93%) of *Ancylostoma* spp. using the faecal flotation technique indicated that hookworm was widespread in the Jericho area. The number of dogs infected with hookworms may have even been higher because of the possibility of false negatives as a result of small sample size, insufficient amount of faecal material obtained in some samples or delays in actual sample testing. This, however, could not be validated by actual comparison to necropsy intestinal samples, because few animals died during this study. A 93% *Ancylostoma* spp. infected dog population does pose a community health risk. Infective third-stage larvae, which develop from eggs, are a source of infection in this area. The larvae can penetrate human skin.

Comparatively *Ancylostoma* spp. eggs (93%) were the most common nematode of faecal samples in dogs from Zuurbekom. These high levels may be attributed to good rains during the two previous rainy seasons, and that most dogs roam the area due to unfenced properties. A common problem reported by the Zuurbekom residents was stray dogs that come from the surrounding urban areas. These dogs may contribute further to widespread transmission of *Ancylostoma*.

A. caninum eggs were found in 83% of faecal samples that were collected in Mamelodi. Most dogs seemed to be in a reasonably good condition, and the effects of parasitism from *A. caninum* were not clinically apparent.

T. canis eggs were found in (19%) of samples from Zuurbekom. The higher incidence of *T. canis* compared to its absence in the Jericho VNA is probably a result of the larger proportion of the dog population being pups or sub-adults. Holland et al. (1991) reported that young dogs are predisposed to infection with *T. canis*. Therefore, in this area close contact with dogs and poor personal hygiene may lead to visceral larva migrans.

The incidence of *T. canis* was lower in Mamelodi (4%) than in Zuurbekom (19%), although the majority of dogs were younger than three years old. Roaming dogs were quite common in the area, which could contribute to higher levels of infection. This is reflected by the high occurrence of *A. caninum* (83%) in Mamelodi.

Only one faecal sample from the 64 collected in Jericho contained ascarid eggs, viz. the eggs of *T. leonina*. Ascarid females are quite proficient egg producers, and the faecal flotation technique seems very efficient in demonstrating the presence of infection with ascarids. Their relatively low incidence, and the apparent absence of *T. canis* at this study area is a positive finding from a community health point of view.

Only two faecal samples from 31 from Zuurbekom showed the presence of *T. leonina* eggs. Unlike *Toxocara*, this parasite has no host age preference. *T. leonina* may also act as a zoonosis (Verster, 1986), and the 6% incidence of toxascarosis in the area may be significant. One faecal sample (1%) from Mamelodi contained eggs of *T. leonina*.

D. caninum eggs were present in only two faecal samples from Jericho although fleas (e.g., *C. canis, C. felis*), the intermediate host of this tapeworm, were not uncommon in the area. Considering the insensitivity of the faecal flotation and adhesive tape swab techniques in diagnosing infection with this parasite (as demonstrated under section 4.1.3), one can assume that a larger number of dogs was infected with *D. caninum*.

No *D. caninum* eggs were seen in faecal flotations of dogs from Zuurbekom.

Only four faecal samples from Mamelodi showed presence of *D. caninum* eggs, but they were absent in all the adhesive tape swabs. It seems that false negative tests in the live animal do occur, as excretion of ripe proglottids is an irregular event, depending on the number of tapeworms present in the intestine. Fleas were seen on dogs during examination and the number of dogs harbouring *D. caninum* should be higher than that diagnosed in this VNA.

Taeniid eggs were present in one faecal sample from Jericho. Interestingly, the adhesive tape swabs of the same dog tested negative, although the swab technique is regarded as more sensitive for diagnosing the presence of *Taenia* spp. in the live animal. None of the faecal samples of dogs from Zuurbekom and Mamelodi contained taeniid eggs.

Taeniid eggs were found on three of 21 adhesive tape swabs of dogs from Zuurbekom. This implies that one in every seven dogs was infected with tapeworms. As the eggs of *Taenia* spp. and *Echinococcus* spp. can not be differentiated microscopically (Reinecke, 1983), these three positive samples may have serious implications, should they be *Echinococcus* eggs. This small tapeworm of canids is an important zoonosis, and the eggs may infect humans even on contact with mucous membranes. The tissue cysts that develop from the eggs are very invasive and difficult to treat successfully. Advanced cystic echinococcosis (CE) is the type of infection diagnosed more commonly in Africa (Macpherson and Wachira, 1997; Reinecke, 1983), as opposed to alveolar echinococcosis (AE) in Europe and Asia, and is treated by surgical removal. This form of treatment is expensive, and the rupture of a viable cyst results in recurrence. The prevalence of *E. granulosus* in dogs is significantly affected by local practices involving slaughter of livestock, and human behaviour in relation to the dog is a major factor influencing the intensity of transmission of CE to humans (Macpherson and Wachira, 1997). If these eggs were from *Taenia* spp., the infection of three of 21 dogs is not important, except if the dogs acquired the infection from beef or pork, which implies that the meat supply in the communities may be unfit for human consumption. This also means that the dogs may contaminate the grazing which would lead to cysticercosis in the livestock. The effect of these tapeworms on the dog's health is not significant, as they seldom show clinical disease. The current understanding of the prevalence of echinococcosis in South Africa is 1 - 2% in Pretoria (Macpherson and Wachira, 1997) and 0.9% in South Africa in general (Verster, 1979).

The significant correlation between the ESS of families that owned dogs in Mamelodi and dog condition score indicates that the owners who could afford it offered more and a better quality food to their dogs.

Recommendations for dog-owners in Jericho, Zuurbekom and Mamelodi:

Again the large number of dogs showing eggs of *Ancylostoma* spp. and *T. canis* in faecal flotations supports the urgency of regular removal of dog faeces from the environment as a cost-effective, practical method of worm control in these communities. Dogs, especially young pups, and pregnant and nursing bitches ought to be dewormed. The pups should be raised in an enclosed area with a concrete floor that must be cleaned thoroughly every day.

Perhaps public education in the communities of Jericho, Zuurbekom and Mamelodi could receive a higher profile to create an awareness of the effects of these helminths on their animals, and the implications they have on human health. An effort must be made to prevent all contact between human skin (especially children) and dog excreta or contaminated soil. Small children should not be allowed to play in areas where dogs defaecate, and prevented from eating soil. The people ought to make a habit of washing their hands and vegetables before eating, especially in Mamelodi, where the occurrence of *Toxocara* is higher compared to Jericho and Zuurbekom. For this reason, pest control (e.g., mice, flies, etc.) must also be practised particularly in Mamelodi.

Veterinary services are more accessible in Mamelodi and Zuurbekom than in Jericho. The Pretoria SPCA is involved in the Mamelodi area, and they too could become more engaged in the extension process regarding zoonoses as part of their services to the community. There are veterinarians in Silverton, Meyers Park and Lynnwood (i.e., 5 - 10 km outside Mamelodi). Most of the roads are tarred, and public telephone and transport systems enable the animal owners to have better access to information and veterinary services than in other areas.

The resettled farmers of Zuurbekom have a farmer's association with regular contact with the Agricultural Extension Services and State Veterinary Services in the area. They are also visited regularly by the Booysens SPCA, and there are private veterinary practices in Soweto and Lenasia to consult. The infrastructure is growing. The main access roads have tarred surfaces, and the dirt roads are graded frequently.

As a resettlement area, the residents also have access to various government and parastatal organisations already active in the area. These all provide opportunities for the education of animal owners and provision of veterinary services.

Jericho is a farming community, and the infrastructure of the surrounding villages is not well developed. An animal health technician, actively involved in the area, works closely with the local farmer's association and plays a leading role in extension and providing veterinary assistance in the community. The University of Pretoria also visits the area occasionally. The closest veterinary clinic, however, is at Maboloko, situated approximately 10 km south of Jericho. The main road through Jericho is tarred, and there are public telephones, and although veterinary services may not always be available, the residents of the community always have access to information.

Chapter 6 Socio-economic questionnaires completed with the assistance of dog-owners in Boksburg, Jericho, Zuurbekom and Mamelodi

6.1 **Introduction:** In modern times, the domestic dog is found in all human communities. The attitude and human interrelation with the domestic dog varies within different population groups due to differing cultural approaches (Gallant, 1998). According to Gallant, certain parts of the society, with a high level of appreciation and care for their own dogs, despise the dogs kept in other communities. The reason for this may be prejudices, as the general feeling among residents of high-income communities often see the crossbred dogs more commonly found in resource-limited communities as "inferior" (personal observation). The main purpose of the questionnaire was to determine the relationship between the dog and its owner, and evaluate the social position and importance of dogs in the communities.

6.2 **Materials and methods:** A questionnaire was formulated (Appendix A) and implemented as a semi-structured interview during the Veterinary Needs Appraisals (VNAs) (Mettrick, 1993). The dog-owners were guided through the questions verbally, with the assistance of an interpreter where and when necessary. The approach was similar to a checklist, rather than a questionnaire. The researcher was personally involved in completion of the questionnaire in order to ensure that the questions were correctly understood (Fig. 6.1). This helped to eliminate the possible constraints of illiteracy, and to provide complete information with regard to the factors that influence the dog's health, level of parasitism, environment, and the owner's economic situation. The questions were asked and steps were taken to assure that each question was properly understood. The questions were preferably simplified and explained rather than giving examples and a choice of answers to keep the answers unbiased. Some of the answers could be written down by careful observation of the environment, for example, questions relating to property boundaries, type of food offered to the dogs, shelter, bedding, restraint, etc.

Fig. 6.1 **The author (right) completing a questionnaire with a dog-owner in Jericho, North-West Province (Courtesy R C Krecek)**

Questionnaires were completed for all the owners of the dogs sampled in the VNAs. The Boksburg section of the study was conducted in two parts: firstly, the townships and informal settlements around Boksburg were visited and samples collected from the live dogs, and secondly, samples were collected from stray dogs, unwanted puppies and abused dogs that were euthanased by the local SPCA. Questionnaires were completed during visits to the communities in Boksburg when the live dogs were sampled, because on these occasions there was contact with the dog-owners. The samples collected in Bloemfontein were from SPCA euthanased dogs only, and the only information available was the suburb of origin. For the Bloemfontein study, therefore, no questionnaires were completed.

The ESS is a tool developed by McCrindle et al. (1994) for the measurement of the economic status of community members, the assessment of which was applied using certain criteria (Table 6.1). McCrindle et al. applied the abbreviation ESSCORE, but for this study ESS was used to conform to the abbreviation used for BCS.

Table 6.1 **Economic Situation Score (ESS) Method (after McCrindle et al., 1994)**

ESS	Dwelling	Description
1	Lean-to or hut	Roof held down with stones, walls corrugated iron, mud, wooden or thatch, floors mud or manure, open cooking fire
2	One- or two-roomed	Walls mud with thatch or corrugated iron or concrete blocks, cement floors, no gutters or ceiling
3	Three- to four-roomed	Walls plastered or painted, ceilings, gutters and drainpipes, electricity or gas, electrical or coal stoves
4	Five- or more-roomed	Face brick or plastered and painted walls, electricity or gas, stove, refrigerator, TV and/or music centre
5	Two or three bedrooms	Separate kitchen, lounge, bathroom, piped water to house, own borehole, electricity or gas, TV and video recorder, wall-to-wall carpets

6.3 **Results:** The questionnaire information was linked with the individual dog information for the four study areas (Boksburg, Jericho, Zuurbekom and Mamelodi) and considered in the final data analyses. The helminthology results are discussed separately under each of the study areas (Chapters 3 - 5). The research team visited 27 villages in these four study areas (Boksburg, Jericho, Zuurbekom and Mamelodi). A total of 446 dog-owners were interviewed, of whom 10 (2.2%) were retired and 290 (65%) were unemployed. These figures do not include contract and "piece" workers.

Of all the dog-owners interviewed, 66% owned three dogs or less, and 83% owned five dogs or less. One owned 17 dogs. Sixty-six to seventy-four percent of all dogs were roaming freely a large part of the time.

The most common reason given for owning a dog was for security purposes (Fig. 6.2), which created the impression that a lack of security was a big problem in the resource-limited communities. The dogs were therefore expected to work, rather than just be around for the enjoyment of the owners and their families.

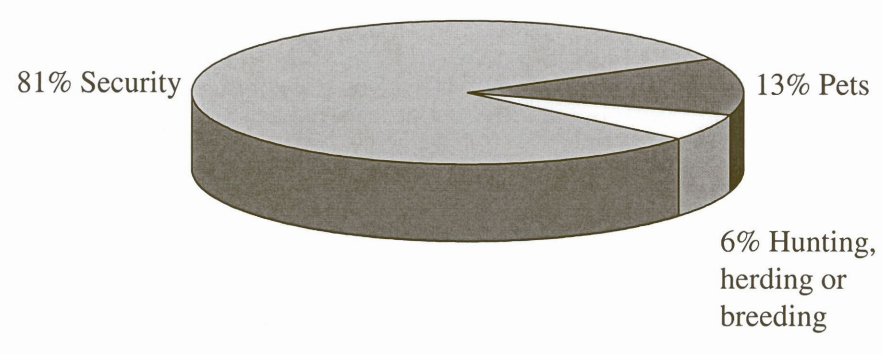


Fig. 6.2 **Reasons for owning dogs in the resource-limited communities of Boksburg, Jericho, Zuurbekom and Mamelodi**

Various combinations of food were given on the basis of "when available", and occasional supplementation regarded as leftovers included bones, fat and meat broth, etc. Some owners also added milk or food scraps to the base diet of porridge. Meat was given to the dogs in various forms, e.g., mince, butchers' sawdust, slaughter scraps, etc. The basic diets fed to the dogs are in Fig. 6.3.

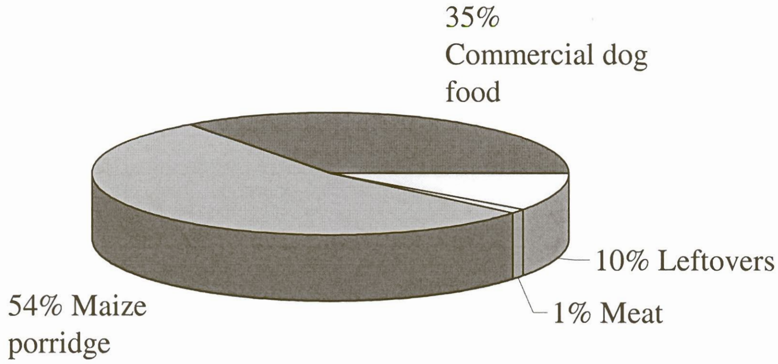


Fig. 6.3 **Basic diet of dogs in the resource-limited communities of Boksburg, Jericho, Zuurbekom and Mamelodi**

Most owners didn't practice any form of internal parasite control (Fig. 6.4). Only 18% reported deworming their dogs at some stage during these animals' lives.

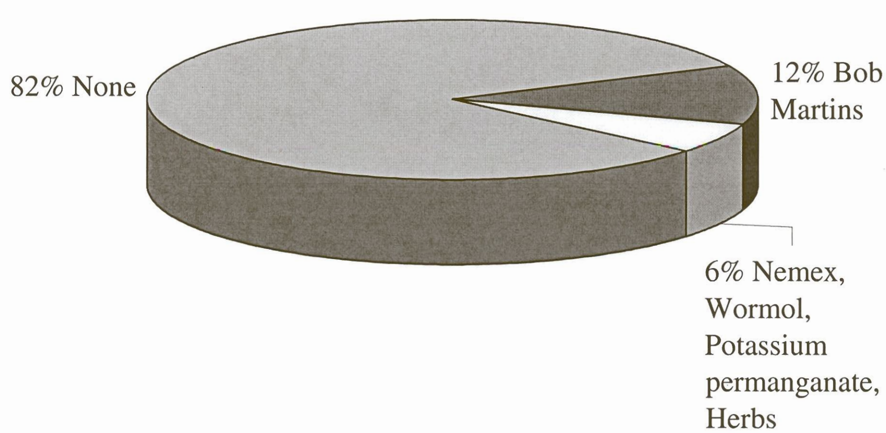


Fig. 6.4 **Deworming remedies reported used for dogs by owners in the resource-limited communities of Boksburg, Jericho, Zuurbekom and Mamelodi**

Standard veterinary procedures were not normally performed on the dogs (Fig. 6.5), but the owners would certainly consider it if there was a veterinarian in the vicinity, and if they could afford it. Of all the dogs sampled, 88% had never been given any form of veterinary attention. Some dogs had been vaccinated and this was done during one of the government's rabies vaccination campaigns. Dogs with docked tails had had this procedure done by their owners.

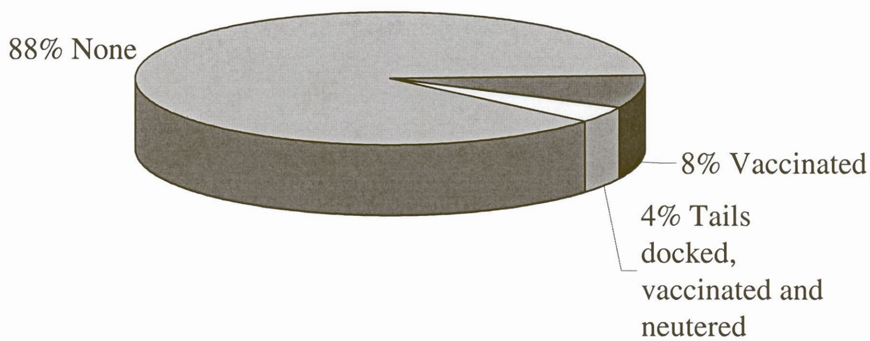


Fig. 6.5 **Veterinary procedures in addition to deworming carried out on dogs in the resource-limited communities of Boksburg, Jericho, Zuurbekom and Mamelodi**

Most dog-owners adopted a policy of "wait and see" when asked what their actions would be should their dogs become ill. Many said they would not do anything specific but just let the disease run its course (Fig. 6.6).

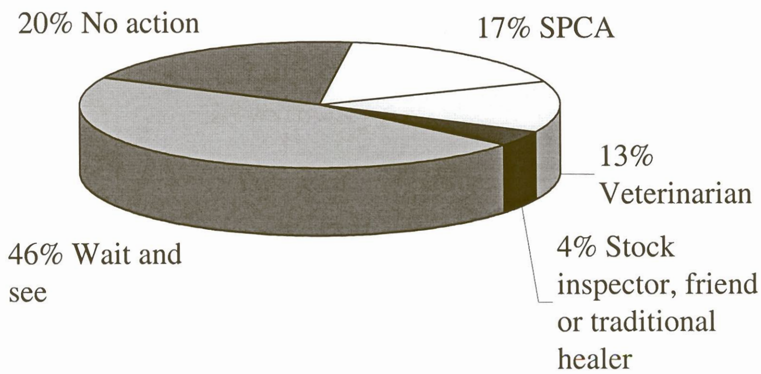


Fig. 6.6 **Veterinary actions in case of illness of dogs in the resource-limited communities of Boksburg, Jericho, Zuurbekom and Mamelodi**

Economic Situation Scores (McCrindle et al., 1994) were not done in Jericho and Zuurbekom. Jericho is a rural community with a communal land farming system, and wealth within the community is measured traditionally in terms of cattle numbers. The municipal structure is based on the traditional tribal system as mentioned in Chapter 5. Although water and electricity was lacking in some of the smaller surrounding villages, the overall living standard of the community seemed rather well developed, but this was difficult to express in western terms. Zuurbekom was a formal settlement area for smallholders. In this study area it was difficult to assess the economic situation, as most of the homes previously belonged to affluent farmers before the government's farmer resettlement programme took over the land. Many of the new houses were built as part of the government housing project, and therefore it did not indicate the true economic situation. The Mamelodi study area reflected more or less the same general economic situation as Boksburg. Both are urban informal settlement areas, large sections of which consist of corrugated iron shacks with or without property borders, narrow, often eroded dirt roads and little or no municipal services. An ESS assessment was conducted (Fig. 6.7) on the dog-owning families in the Mamelodi study area only. The larger proportion of families was classified as ESS2.

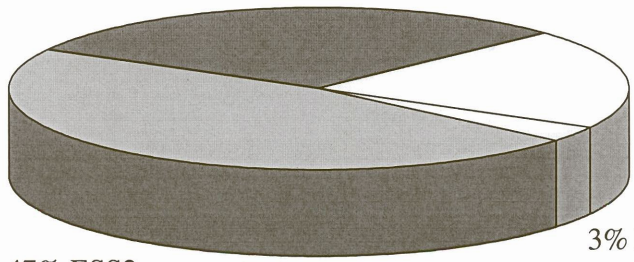


Fig. 6.7 **Economic Situation Scores (ESS) of dog-owners in Mamelodi**

6.4 **Discussion:** While many of the dogs were in reasonably good condition (score 3), 43% were lower than 3, which is probably not attributed to quantity but rather quality of the food given to them to eat. Less than 50% were offered protein as primary nutrition, and most diets only consisted of maize-based carbohydrates. With the effects of parasitism (Chapters 3 and 5) added, and in particular where large numbers of *A. caninum* are present, this may lead to protein, vitamin (particularly B12) and mineral (i.e., sodium) deficiencies. This could result in stunted growth, sub-optimal body condition, increased susceptibility to diseases as well as nutritional and hormonal imbalance (Nelson and Couto, 1998; Roitt, 1997).

One hundred and eighty-four of all the 436 dog-owners (42.2%) in the study removed dog faeces from the environment. This is significant because this is probably the step of helminth parasite control which can have the most impact on worm levels in the environment (R C Krecek, personal communication, 1999; Herd, 1986). In these study areas where dogs roam freely there is a high level of transmission. Deworming together with faecal removal is a strategy that reduces worm levels significantly in other hosts such as donkeys (S Matthee, personal communication, 1999).

Helminth parasite levels in dogs of which the owners said they dewormed their dogs regularly (18%) were no different when compared with helminth parasite levels in dogs of owners who did not deworm their animals (Fig. 6.4). Clearly their deworming strategies were ineffective. With good management (regular removal of dog faeces, restricted movement, improved hygiene, etc.), deworming may not be necessary at all. Parasite control, if applied with appropriate knowledge and understanding (correct diagnosis together with effective dewormer, regular deworming of pups and young dogs, deworming of pregnant and lactating bitches and sick animals) can be cost-effective.

On the topic of animal health care, a "no intervention" or "wait-and-see" approach will not be in the animal's best interest. Although some degree of resistance to parasites by hosts develops in time (Miller, 1968), most cases of helminthosis don't just go away. The lack of veterinary care is even more serious in households where there is more than one dog, as reinfection and cross-infection continue to take place. The dog-owners may argue that they cannot afford the cost of deworming their dogs, but that doesn't justify having large numbers of dogs. Feeding an extra dog for a year costs more than two dogs' deworming for a year. The same argument applies to the topic of restricting the dogs' movements.

Parasitism in dogs in these communities is even more alarming if one thinks of the accumulation of infective stages of helminths in the environment and the threat they pose to the human population (Holland et al., 1991). Most of the helminths encountered in these study areas were zoonotic, and the women and children were particularly at risk, as they were the ones who came into more regular contact with the infective environment and infected dogs.

Chapter 7 Conclusions

The aims of this study were met. The occurrence of helminth parasite infections in dogs from resource-limited communities of Boksburg, Bloemfontein, Jericho, Zuurbekom and Mamelodi were determined and discussed in Chapters 3 - 5. The relative zoonotic potential of each of these species is dependent on whether it is possible to infect humans, how likely it is to infect humans and the numbers of infective stages of these parasites in the environment with which humans may come into contact and become infected. As an example, *T. canis*, which is able to infect humans, will probably come into contact with humans if their dogs harbour egg-producing females. Owners become infected if they handle contaminated soil and place their contaminated hands in their mouths (i.e. eating, etc.). The health status and extent of veterinary care was discussed in Chapter 6, and recommendations for parasite control were discussed throughout this document.

Although most dogs (57%) examined were in a good condition (Condition Score 3 and higher), 43% of the dogs assessed were still regarded as "under condition". For some breeds such as greyhound or collie-type breeds a condition score of 2 may still be acceptable, but the dogs seen in this study were too thin. It was found during the statistical analyses that BCS is more closely related to diet than to infection with the adult stages of intestinal parasites and clinical disease, except in a few extreme cases. In fact, this study showed that intestinal parasite levels bear no direct relation to BCS, and any influence on BCS is probably secondary. Similarly, there was no connection between dog diet and total helminth parasite incidence. In Mamelodi there was general agreement between owner ESS and dog BCS, which suggest that owners who could afford it, provided more food of a better quality to their animals.

The presence and levels of parasitism of *A. caninum* were high in all the study areas (Table 7.1) and is a concern. In Bloemfontein, the prevalence of *A. caninum* was lower than elsewhere. The differences in micro- and macroclimates between Bloemfontein and Boksburg may explain this lower percentage in the former. The Free State is characterised by colder winters and a drier climate than Gauteng and may therefore not be as suitable for the presence of hookworm. *A. braziliense* was more or less equally represented in both areas, and may be more important as a cause of cutaneous larva migrans in the human population (Miller, 1971). On faecal examination, the prevalence of *Ancylostoma* spp. in the North-West Province and all the Gauteng study areas was found to be in excess of 75%, and 25% in Bloemfontein.

Table 7.1 **Faecal samples of dogs that contained eggs of *Ancylostoma caninum* in the five study areas**

Study area	Percentage (%)
Boksburg	77.4
Jericho	93.3
Zuurbekom	90.3
Mamelodi	82.9
Bloemfontein	25.4
Total	74.2

The common ascarids *T. canis* and *T. leonina* were present in both areas where necropsies were performed (Table 7.2). Both of these ascarids are zoonoses (Verster, 1986) and cause visceral larva migrans, especially in children and people who have contact with soil. Woodruff (1975) quoted that from a total of 800 soil samples from parks and public places in London, 24.4% contained eggs of *Toxocara* spp. Regular contact with *Toxocara* eggs, and if personal hygiene (or rather a lack thereof) permits, this poses a real potential for infection of *Toxocara* in man. Figures of occult human infection found after serological testing of patients in London (quoted by Woodruff, 1975) showed a four-fold increase of *Toxocara* infection in asthmatic patients, a four-fold increase in patients with chorio-retinitis and tumours of the retina and choroid, and a 13 times greater incidence in patients with hepatitis associated with eosinophilia, compared to age-matched controls. Figures quoted by Kinceková et al. (1996) indicated that 13.7% of healthy blood donors in Slovakia and 19% of humans tested in the Czech Republic were serologically positive.

The prevalence of *S. lupi* was similar in both Boksburg and Bloemfontein, which suggest that 13-14% of all dogs in resource-limited communities may be infected. No age predilection for infection with *S. lupi* could be demonstrated statistically, therefore dogs may already be at risk shortly after they reach weaning age. All the cases seen were subclinical, and there was no significant correlation with dog body condition score.

T. vulpis was absent from all the Bloemfontein necropsy samples, but 6% of dogs from Boksburg harboured whipworms. This contributes to our previous understanding of the distribution of this nematode, which has been reported from KwaZulu-Natal (Reinecke, 1983).

The presence of *D. caninum* and *J. pascualei* was also similar in the two necropsy sampling areas. The prevalence of these cestodes in Boksburg was 39% and 44% respectively, and in Bloemfontein 6% and 5%, respectively. However, there is no reliable, sensitive test available to diagnose infection in the live animal except for treating dogs with a cestocide or laxative and then doing coprological examinations for the recovery of the adult worms. Faecal flotation showed presence of *D. caninum* eggs in a small percentage of cases (6% and 5%, respectively), and adhesive tape swab results (3% in both areas) were unsatisfactory. It seems that for the moment, practitioners will have to rely on occasional reports made by concerned owners of proglottids in their dog's faeces, the presence of proglottids in the faecal samples examined in the clinic, or proglottids seen in the perineal region of the dogs. Only 8% of samples in live dogs were diagnosed positive in this study. This finding is based on a comparison with the actual prevalence from necropsies of dogs from these two areas.

Taenia spp. were higher in prevalence in Bloemfontein than in any of the other study areas. The adhesive tape swab technique was superior to any of the other methods used to diagnose parasitism of these cestodes in the live dog, and it was 88% accurate in this study. This agrees with the findings of Deplazes and Eckert (1988).

Table 7.2 **Comparative summary of the percentage of helminths recovered from dogs from Boksburg (n=69) and Bloemfontein (n=63) during necropsies**

	Boksburg (%)	Bloemfontein (%)
Total dogs	100	100
A. caninum	88	27
A. braziliense	20	19
T. canis	36	21
T. leonina	9	32
S. lupi	14	13
T. vulpis	6	0
D. caninum	39	44
J. pascualei	6	5
Taenia spp.	4	33

There was no significant seasonal influence on the total roundworm burdens of dogs in this study. However, significantly higher incidences of *D. caninum* were found in Boksburg in summer and in *A. caninum* in Bloemfontein in spring.

No significant differences could be demonstrated between anthelmintic treatments given to the dogs by their owners, and helminth eggs found on the faecal flotations. This implies that the worm remedies used were either ineffective, or wrongly applied.

The high levels of parasitism found in dogs of the five study areas are alarming, not only from an animal health point of view, but also from a community health perspective. Many of the dog parasite species are zoonotic, and there is close contact between the people (especially children) and their animals, which could result in human infections. Most community members are not aware of this. There is a need in the communities for the promotion of knowledge of the dangers of these parasites, and to enable them to control helminths in their animals and the environment through appropriate extension and training.

General recommendations:

Anthelmintic treatment without supportive management strategies is only a short-term solution (Chandler, 1928). In resource-limited communities, helminth control by implementing a sound management policy through education (i.e., awareness and a change of habits if appropriate) will prove to be more practical and cost-effective, and should therefore be the principal route taken. The single most important action, particularly in multi-dog households, is to remove the source of contamination (i.e., dog faeces, to reduce parasite transmission in the environment, especially where roaming or vagrant dogs frequent the area).

In communities where regular municipal waste removal is lacking, the disposal of dog faeces may be a problem. The municipal authorities should also be educated, not only on the dangers of helminth zoonoses, but also on the effects that accumulation of their waste has on human health. Other alternatives to dispose of dog faeces should be investigated (e.g., throwing it into the pit of long-drop toilets, burying or burning).

The dog's everyday habits and what they eat may also have an impact on the levels of parasitism. Roaming dogs may become infected elsewhere and spread the infection in the normal home environment. Some dogs eat dung beetles, frogs, mice, lizards, uncooked chicken, abattoir scraps and carrion and become infected with helminth parasites such as *S. lupi*, ascarids or taeniids. Bitches, after having passed helminth infection to the pups via the milk and through the placenta, may become re-infected with *A. caninum* or *T. canis* when they lick their pups. Dogs may also be infected with taeniids or *D. caninum* after accidental ingestion of flies or fleas.

Deworming and flea control strategies should be aimed particularly at pups and sub-adult dogs, as well as stressed animals (pregnant and lactating bitches, and sick dogs), as they are more sensitive to the effects of parasitism. Personal (washing hands) and kitchen hygiene (washing fruit and vegetables) before eating should become a way of life, and will help with promoting the eating of clean food and a healthy community.

Preventing people from contact with dog faeces is also important. This implies that dogs should be kept away from public parks and playgrounds, people (especially children) should avoid areas where dogs frequently defaecate, and wear protective clothing (e.g., shoes, gardening gloves, etc.) when they are working in the soil.

Resource-limited communities have been living with helminth-infected dogs for centuries. It has probably never been a serious problem in traditional nomadic/pastoral hunter-gatherer communities where fewer animals had more space, as the reinfection rate of their domesticated animals was low. In modern society with its increasing population numbers and urbanisation, however, there is an ever increasing helminth challenge with increasing helminth levels, and consequently also an increased environmental contamination rate and a threat to public health as a result of zoonoses. As we move into the new millennium, it is unlikely that the human population will benefit and prosper without a thorough knowledge of internal parasites associated with their pets, the zoonotic capabilities of those parasites, as well as the management and therapeutic measures at their disposal to maintain animal- and ultimately also public health. Knowledgeable veterinarians and paraveterinary workers can only impart this knowledge, provided they have motivated community leaders committed to community health, education, development and prosperity.

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APPENDIX A: Socio-economic questionnaire used during semi-structured interviews with dog-owners of Boksburg, Jericho, Zuurbekom and Mamelodi

Village and code: Date: Examiner/Interviewer

1.	Owner identity: Surname:	First name:	Other name:	Occupation:
2.	Address: House number. and street name:	Suburb:	Town/village:	
3.	Number of dogs owned:	Other animal spp. owned:		
4.	Property boundaries:	Fenced	Walled	Can dog escape at all? Y/N
5.	Reason for keeping a dog: Hunting Sheep herding	Breeding Security	Racing Other	Pet/companion
6.	Shelter and bedding:	Shelter Y/N	Bedding Y/N	Kept indoors
7.	Restraint:	Tied up	Slip-wire	Total freedom
8.	Hygiene:	Faeces removed Y/N		Frequency
9.	Feeding: Primary:	What	When	How often
	Supplementary:	What	When	How often
10.	Water supply:	Source		
11.	Internal parasite control: Y/N Preparation used:	How often		
12.	External parasite control: Y/N Preparation used:	How often		
13.	Veterinary procedures:	Inoculations	Spay/castration	Tail docking
14.	Veterinary actions when dog becomes sick:	Ask veterinary advisor	Veterinarian	Traditional healer
	Wait and see	Treat self	Ask a friend	Other
15.	Nearest veterinarian	Distance:		
16.	Source of supplies, feed, remedies etc.			
17.	Nearest co - op:	Distance:		
18.	Rands spent on dogs per month:	Food	Remedies	Veterinary
19.	Do you make use of the Pretoria SPCA? Y/N	Do you make use of the private veterinarian in the area? Y/N		Veterinarian's name:
20.	Common health problems of dogs:			
21.	Are dogs a problem to livestock? Y/N			
22.	Is there a need for State Service to impound stray dogs? Y/N		ESScore:	
23.	Comments:			

Lab no.

Owner's name (if different)		Sex[1]	Age[2]	Breed	Size[3]	Purpose	C/S[4]	Obvious abnormality	Specimens[5]
	1.								
	2.								
	3.								
	4.								
	5.								
	6.								
	7.								
	8.								
	9.								
	10.								
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	13.								
	14.								
	15.								

Dogs/cats general remarks:

[1]M=male, F=female, S=spayed, N=neutered
[2]P=suckling pups, S=sub-adults (approx. up to 1 year old), A=adult, O=older than 8 years
[3]S=small, M=mediun, L=large
[4] Condition score where 1=anorexic and 5=grossly overfat
[5] B=blood, F=faeces, S=adhesive tape swab