A SURVEY OF PARASITIC HELMINTHS IN HORSES FROM COMMUNAL FARMS IN THE NORTHEASTERN FREE STATE PROVINCE OF SOUTH AFRICA

BY

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DECLARATION

I, **Flatha Euginia Sarah Masangane**, hereby declare that this thesis is my original work and has not been presented for a degree in any other university

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This thesis has been submitted for a M.Sc. degree in Zoology (Parasitology) with our approval as University supervisors

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DEDICATION

This thesis is dedicated to my little boy, Siyabonga and my family (mother, two young sisters and young brother) for the love and support they always gave me, and above all to our Almighty GOD for the strength He has given me through difficult times of my studies and life.

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ABSTRACT

A survey of helminthes occurring in horses at Kestell in the northeastern region of the Free State Province was conducted for a period of ten months (June 2002-March 2003). The aim was to determine the factors influencing helminth parasites infections and to record the ticks of veterinary importance in horses in the northeastern Free State. Blood, fecal samples and ticks were collected from 24 horses on the same farms every month for a period of ten months. The age of horses was between five months and seven years. Collection was done from both males and females. Fecal samples were collected from horses for identification of helminthes, blood was collected to perform packed cell volume and ticks were collected for identification and recordings. McMaster, coprological and Visser sieve techniques were used for egg counts. A total of three helminth species and a protozoan were recovered. Dominating species were strongyle; with egg per gram (EPG) values ranging between 0 and 4400. An R test showed that there was significant difference between age ($p = 0.0218$), seasonality ($p < 0.0001$) and physical conditions ($p < 0.0001$) in the prevalence of strongyle. This means that the younger horses had higher infestation levels; colder months had lower infestation rates and the better the physical condition of the horse the lower the infestation. It also showed that there is a strong linear relationship between packed cell volume (PCV) and ($r = -0.23465$; p- value = 0.0004).

Larval identification was done through preparation of fecal cultures. Small strongyle larvae made up more than 80% of larval cultures in all samples cultured. Blood samples were collected to conduct a PCV test. The readings were found to be normal ranging between 24 and 44. *Rhipicephalus evertsi*

evertsi was were the only two tick species collected from the horses. A questionnaire survey was concurrently carried out to determine the influence of socio-economic factors on the management of horses, which may favour helminth infestation in these species. From the owners interviewed 35.8% were pensioners and unemployed. A total of 67% of horse owners utilize their horses everyday for transport, but the frequency range from once or twice a week. Only 39% of owners use herbal or natural product or drugs to treat their animals, whereas 23% use commercial products. Horses belonging to 90% of the owners were given lucern hay all year round, a few owners fed their horses on mealies and other utilized the veld to feed their horses. The disease conditions reported were worms, ticks, eye lesion, hoof problems, skin problem and infectious diseases. 45% of owners asked their friends or neighbours who had knowledge of horses for advice when their animals became sick and 30% treat the animals themselves. 19% reported that they did nothing and 6% took their animals to the state veterinarian. Approximately 3% made use of animal health inspectors, private veterinarians and traditional healers. Many owners (87%) allowed their horses to roam free during the day and about 84% of owners kept their horses in kraals or small camps during the night.

The information gathered from this study provides the first documentation study on helminthes of veterinary importance in horses in the northeastern Free State.

CHAPTER 1

INTRODUCTION AND LITERATURE REVIEW

1.1 Helminth parasites of horses

Equids are host to more than 75 species of helminths belonging to 28 genera of nematodes, five species of trematodes and four species of cestodes (Krecek *et al.*, 1994a and 1987; Lichtenfels, 1975). The poor nutrition and heavy work to which horses are subjected to, coupled with common grazing are ideal conditions for the proliferation of internal parasites. Almost all animals are infected with a range of parasites and a single parasitic infection is rare. Many parasites infecting equids also infect other species of livestock and cross-infection is common (Eysker and Pandey, 1989).

Numerous studies on horses and ponies have reported that strongyle infections might result in alteration in the host's blood composition (Murphy and Love, 1997). These included changes in the oesinophil count; erythrocyte count and serum protein levels in horses and ponies that harbour large helminth burdens. All these effects appear to be ambiguous indicators of strongyle infection as it is difficult to determine with certainty which group (for example, the large or small strongyle) or which species are responsible for specific alteration in the blood chemistry (Matthee *et al.*, 2000).

1.1.1 Phylum Nematoda

Nematodes are roundworms which make up large assemblage of relatively simple structured organism with a widespread distribution. Species which live in the intestine are generally larger, and those in the tissue attain relatively enormous length (Smyth, 1994). Adult worms living in the lumen of the intestine produce eggs that pass into the environment. There the eggs hatch and develop into infective larvae and horses ingest the larvae as they graze. Once inside the gastrointestinal tract of the horse, the larvae penetrate the large intestine and become encysted. It is this process that can cause disease (Williams, 1999).

1.1.1.1 Examples of nematode species that infect horses

In natural infections the strongylid burden comprises a mixture of several genera and species and they are conveniently divided into two subfamilies based on their morphological and migratory characteristics (Giles *et al.*, 1985). The so-called 'large strongyles' (subfamily Strongylinae) are characterized by lengthy migration of their larvae within the abdominal cavity, the long prepatent period and the attachment and 'plug feeding' of the adults on the caecal and colonic mucosae (Giles *et al.*, 1985).

The 'small strongyles' or the cyathostomes (subfamily Cyathostominae) comprise a group of over 40 species that are morphologically and biologically similar. These species have in fact been grouped into convenient practice for clinicians, often still under the all-embracing genus *Trichonema*. Cyathostome (trichoneme) larvae undergo only a local migration in the gut wall and have a shorter prepatent period (Round, 1969), although this may be prolonged by hypobiosis (Ogbourne, 1978). The bulk of adult cyathostomes are only superficially attached to the colonic mucosa and do not ingest blood (Giles *et al.*, 1985).

The studies conducted in South Africa on helminths of different zebra species have contributed greatly to the knowledge and indicate that some strongyle species are host specific and restricted to one host, whereas others are less specific (Krecek *et al.*, 1987 and 1994b, Scialdo-Krecek, 1983; Scialdo-Krecek *et al.,* 1983). However, these studies also emphasize the need for extensive research regarding the abundance, prevalence, and site distribution of helminth parasites in equids and the influence that the external environment may have on both the worm species composition and abundance in this host (Matthee *et al.*, 2000).

Over the past years, there has been an increased interest in the role of small strongyles in disease production in horses. It was previously held that small strongyles were of low pathogenicity to horses; however, it is now accepted that these parasites often result in severe disease (Williams, 1999).

Over the past twenty years or so, the prevalence of cyathostome appears to have increased rapidly. In recent surveys the cyathostomes have accounted for up to 100% of pasture larval counts (Herd and Gabel 1990; Herd, 1986). Although a healthy horse may carry large numbers of small strongyles with no obvious deleterious effect on its health, infestations by these parasites, especially the larval stages, are being increasingly recognized as an important cause of disease (Mair, 1994).

The amount of information available on small strongyle species of equids and the relationship between these hosts, the parasites and their environment is limited in Africa. Considering that there are 51 African countries and working equids inhabit most, this paucity of information reflects the limited knowledge currently available (Matthee *et al.*, 2000). Cyathostomes, and the disease they cause as larval cyathostomosis, are a group of parasites that inhabit the colon and cecum of horses. Up to 40 different species of small strongyles have been identified and they represent the most common parasites of horses on pasture.

The most widely recognized disease associated with cyathostome infection is diarrhoea. In two separate studies of diarrhoea in adults horses, cyathostome associated disease was the most common diagnosis (Love *et al.*, 1992). The syndrome most commonly associated with infections by cyathostomes is caused by the mass emergence of previously inhabited fourth stage larvae through the ceacal and colonic mucosae, and is referred to as acute larval cyathostomiasis. This disease is characterized by an acute onset of diarrhoea that becomes chronic, accompanied by rapid weight loss, subcutaneous oedema and sometimes death (Reilly *et al.*, 1993; Giles *et al.*, 1985; Mirck, 1977; Blackwell, 1973). Horses are usually affected in late winter or early spring, and are mostly adults less than five years old. Typical pathological findings include neurophilia, hypoalbuminaemia, hyperbetaglobulinaemia and the presence of numerous fourth or early fifth stage larvae in the faeces. Larval cyathostomiasis has also been recorded as a cause of recurrent bouts of diarrhoea in aged ponies. Other clinical symptoms associated with cyathostome infection include colic and chronic weight loss (Ogbourne, 1978).

Experimental infections have produced pyrexia, tachycardia, delayed shedding of winter coats and loose abnormal faeces (Tiunov, 1951). Infection is characterized by changes in serum protein chemistry in the fifth or sixth week post infection. The pathogenesis of cyathostome infections of horses has been reviewed by Ogbourne, (1978). Research activity on the small strongyles of horses is high because: (1) a disease syndrome in which larval stages emerging from the wall of intestine, colon and ceacum may cause severe colitis or death of horses in more frequently recognized (Mair, 1994; van Loon *et al.*, 1995; Mansmann, 1997); (2) resistance to anthelmintics has been reported widely (Herd and Coles, 1995; Ihler, 1995; Gawor, 1995) and (3) prospects for biological control appear to be promising using nematode- trapping fungi (Larsen *et al.*, 1996; Bird and Herd, 1995).

Parascaris equorum the roundworm is located in the small intestine of horses, is white in colour and up to 30cm long with three prominent lips. The principal source of infection for young foals is contamination of pasture paddock or stall with eggs from foals of the previous year. Adult worms in heavy infections can cause bile duct and intestinal obstructions and occasionally gut perforation. Damage is more pronounced in foals. Acute parascariasis is also accompanied by severe enteritis resulting in alternating constipation and foul smelling diarrhoea (Kaufmann, 1996). According to Soulsby (1982) and Kaufmann (1996) patent infection of *Parascaris* is occasionally found in mature horses, but they are of little clinical consequences.

Parasitic worms of the family Strongylidae are ubiquitous in the grazing horse population and responsible for a wide range of clinical symtoms. In the competitive world of parasites, worms of the *Strongyloides* genus occupy a special niche where their survival is strictly connected with the presence of suitable hosts in the same ecosystem. These nematodes with unusual adaptation properties gave rise to relationships between two ecosystems such as the external environment and mammalian organisms and became relatively independent from both ecosystems. These parasites need external maturation to settle into other individuals (Ziomko and Yvore, 1996).

Members of the genus *Strongylus* are blood-sucking parasites of the colon and caecum of equines, and often referred to as palisade worms. The development and transmission of three species have been investigated in some detail (Reinemeyer, 1986). When the infective larvae are ingested with food of the host, the third and fourth stages undertake curious migration in the tissues before returning to the gut where they mature (Anderson, 1992). *Strongylus* species cause the greatest losses from helminths in horses and *Strongylus vulgaris* is the most important species. The prevalence of infection approaches 100% in foals, but the pathogenesis seen in any one host is directly related to the intensity of infection (Marqhuardt & Demaree, 1985). According to Reinemeyer (1986), small strongyle ova usually comprise over 95% of the strongylid ova in a horse fecal sample. Cyathostome larvae, however, if present in large numbers, can be much more important, both in their long term effects on body weight and in causing the sudden onset of diarrhea (Reinemeyer, 1986).

Control of roundworms in horses presents some interesting problems because of peculiarities of pathogenesis in some species, different times of acquisition of other species, and interactions among populations of parasites. The organisms are cosmopolitan. Gastrointestinal helminths, mainly nematodes, are a major cause of disease in animals (Holmes, 1987). They cause great loss to livestock and their control requires frequent use of anthelmintics (Gray, 1987). In Africa the use of anthelmintics is generally limited by their relative high prices; in addition anthelmintic drugs are often diluted or stock under-dosed (Shillhorn Van Veen, 1986). Such practices can lead to drug resistant strains of helminths and this is indeed becoming a widespread problem (Borgsteede *et al.*, 1991).

1.1.2 Phylum Platyhelminthes

1.1.2.1 Class Trematoda

Trematodes occur in a wide range of host environments, the majority of the species are endoparasitic but some are ectoparasitic. The larval stages may occur in invertebrate (especially molluscs) hosts and vertebrate hosts but the majority of adult stages occur in or on vertebrates. Specimens range in length from 1mm to 75mm and are usually grey or creamy white in colour, but many acquire a characteristic coloration due to the assimilation of food materials from the host. The mouth and reproductive apertures are typically anterior. The digestive system is well developed and food material consists of intestinal debris, blood, mucus or other tissue exudates depending on the host environment (Smyth, 1994).

1.1.2.1.1 Example of trematode species that infect horses

Fasciola hepatica remains one of the most important helminths of livestock in many countries of the world although it does not match the collective significance of nematodes. Its tropical counterpart is *Fasciola gigantica*. There are effective strategies for the control of fasciolasis, based largely on the drug fasciolicide (Fairweather and Boray, 1999).

The infection of livestock by *Fasciola* species causes worldwide economic impact, estimated at over three billion US dollars per year. In many parts of the tropics fasciolosis is the most prevalent helminth infection, with rates of 30-90% in Africa and 25-90% in Indonesia (Mulcay & Dalton, 1998). Fasciolosis is associated with poor rate of weight gain in animals and the disease is caused by the migrating immature parasites eliciting hepatic tissue damage and inflammatory responses (El-Ghaysh *et al.*, 1999).

Fasciolosis is an important cosmopolitan disease of certain herbivorous, domestic and wild animals caused by the trematode *F. hepatica*. The mammalian host is infected by ingesting encysted metacercariae, which then invade and develop in the livers of their hosts to cause great losses (Ngategize *et al.*, 1993).

Gastrodiscus aegyptiacus is located in the colon and small intestine of equines. Heavy infections of this intestinal fluke are accompanied by diarrhoea, anaemia, oedema, emaciation and marked weakness. Adults have a relatively low level of pathogenicity. A high number of immature flukes can cause severe problems (Kaufmann, 1996). Previous infection and the age of the host afford some protection against reinfection, and acute disease is, therefore, usually seen only in young animals (Soulsby, 1982).

The long-term commercial outlook for the current chemical treatment programme, based on triclabendazole (Fasinex) appears weak because of a number of problems, such as environmental issues concerning residues arising from long-term veterinary drug treatment (El-Ghaysh *et al.*, 1999).

1.1.2.2 Class Cestoda

Cestodes belong to the group of parasites called tapeworms. Typically, they have scolex or "head" and a flattened strobila or "body". Various structural differences separate the species of tapeworms. One of the most obvious ones is the flaps or lappets found on the scolex. The scolex, equipped with four suckers, is used for attachment to the organ (usually intestine) that the tapeworm parasitizes. A strobila is composed of a ribbon of individual segments or proglottids. Each proglottid contains various body systems including reproductive organs. The most posterior proglottids become gravid or literally filled with eggs and then separate, passing out with feces (Lyons *et al.*, 1997).

Tapeworms have no mouthparts and cannot actively ingest food. Nutrients are absorbed through the body wall of the proglottids. The life cycle includes the definitive host (horse) in which they mature and intermediate host (oribatid mite) in which immature stages are found. Horses, as they graze or eat other feed, accidentally ingest oribatid mites infected with immature or cysticercoid stages. Inside the horse cysticercoids develop to adult tapeworms after about two months. Tapeworm eggs within gravid proglottids, pass in horse feces and are eaten by free-living soil or oribatid mites. Within the mites, cysticercoid stages develop after two to four months. Horses then eat infected mites and the tapeworm cycle continues (Lyons *et al.*, 1997).

Diagnosis of infections of tapeworms in live horses is difficult. Detection of their eggs in horse feces is not reliable by standard techniques for determining presence of eggs of other internal parasites, such as nematodes. Therefore, not finding the tapeworm eggs in feces does not mean that these parasites are actually absent in a horse. Tapeworm eggs are angular and vary in appearance, depending on the view presented. The eggs have hyaline-like thickened walls and contain an embryo with six hooklets (hexacanth). Tapeworm infection can sometimes be verified by finding specimens in the feces after a horse has been treated with a drug activity against these parasites (Lyons *et al.*, 1997).

1.1.2.2.1 Examples of cestodes species that infect horses

Anocephala species is located in the small intestine of horses and donkeys. It is the largest tapeworm of equines. It can become up to 8cm long and 2cm wide and has a typical tapeworm structure. High numbers of *Anocephala magna* can cause catarrhal or hemorrhagic enteritis (Kaufmann, 1996).

Anocephala perfoliata is a cestode of the family Anoplocephalidae. It has an indirect life cycle via pasture dwelling orbatid mites. Grazing horses ingest mites containing infective cysticercoids of the parasites. The parasites attach by means of suckers situated on the scolex to the intestinal mucosa of the ileocaecal junction. It matures into an adult after 6 to 10 weeks and attains a final size of only 5 to 8cm in length. Adult parasites shed gravid proglottids that break up during passage through the horse's large intestine, which can take in excess of 48 hours. Coprological diagnosis of *A. perfoliata* is highly specific, due to the eggs' characteristic appearance, but feces of infected horses contain small numbers of tapeworm eggs, resulting in poor sensitivity (Proudman and Trees, 1999).

Although *Anocephala perfoliata* was previously regarded to be relatively harmless, infection of equines in recent reports have suggested its potential pathogenicity in the horses, because the parasite can cause significant gastrointestinal disease or even death (Proudman and Edwards, 1993; Owen *et al.*, 1989; Beroza, 1983 and Barclay *et al.*, 1982). An increasing prevalence of the tapeworm has been attributed by some authors to changes in climatic factors that directly influence the propagation of the orbatid mite, intermediate host of the cestode (Geering and Johnson, 1990), and also to the widespread use of ivermectin in equine anthelmintic programmes (Edwards, 1986), promoting higher tapeworm burdens through lack of competition from other gastrointestinal parasites (Meana *et al.*, 1998).

Until recently, the equine tapeworm was difficult to diagnose and considered being of questionable pathogenicity. The equine tapeworm *A. perfoliata* was considered for many years to be an accidental finding in the intestinal tracts of horses at postmortem examination, and rarely associated with clinical disease. A number of studies have documented the prevalence of *A. perfoliata* in different countries throughout the world. More than 50% of thoroughbreds examined in central Kentucky, United States of America the last several years were infected with *A. perfoliata.* It does not appear to be an acquired or age resistance to this parasite in horses of all ages, including older ones, can be infected. Reported prevalence varies from 14% to 18% (Kaufmann, 1996).

Detrimental effects are usually difficult to attribute directly to tapeworms. More implications of problems associated with *A. perfoliata* have been suggested than with the *Anoplocephala magna* and *Paranoplocephala mammillana*. The normal site of attachment of *A. perfoliata* is around the ileocecal valve. Large numbers may directly or indirectly cause reduction of this opening. There may be ulceration, inflammation, and formation of a diphtheritic membrane where the parasites are attached. Various other pathologic effects reported are perforation, intussusception (prolapse) of the terminal ileum and cecum, and hypertrophy/ hyperplasia (thickening) of the ilea walls. These effects seem to be more prevalent in weanling, yearling and adolescent thoroughbreds, which have been studied more than other breeds. Intussusception of the small intestine and cecum can be corrected surgically and prognosis is good if done promptly. Clinical signs for which *A. perfoliata* should be considered, as a possible cause are colic, poor growth, and unthriftiness. *Anoplocephala magna* have been associated with enteritis (Lyons *et al.*, 1997).

Treatment for tapeworms is a dilemma at this time because no drugs are labeled for their removal. However, pyrantel pamoate, on the market for removal of nematodes, has activity on *A. perfoliata.* This drug is commonly used because of its activity against *A. perfoliata.* At the therapeutic dose rate (6.6mg base/kg), it is somewhat less active than the double dose rate (13.2mg base/kg). Even though a 20X margin of safety of the 6.6mg base/kg dose rate has been established, safety of higher dose rates has not been defined in breeding animals. Therefore, use of higher than the therapeutic dose rate of pyrantel pamoate is not recommended, particularly in pregnant animals. Limited data indicated at least some activity of the low dose rate (2.64mg/kg) of pyrantel tartrate on *A. perfoliata* (Lyons *et al.*, 1997).

Gongylonema pulchrum the gulletworm, is located in the mucosa of the oesophagus of horses, donkeys and ruminants. *Gongylonema pulchrum* lies embedded in the oesophageal mucosa in a zigzag fashion and reaches

145cm in length. Eggs are passed in the feces and hatch after being eaten by dung beetles in which the larvae develop to the infective stage. Infection of the horse occurs by eating the infected beetles. *Gongylonema pulchrum* is of little clinical importance (Kaufmann, 1996).

1.2 Ticks as parasites of veterinary importance for horses

Ticks are of considerable veterinary medical and economic importance as vectors of infectious disease of man and animals throughout the world, especially in Africa. Although different species of ticks and tick-bourne disease occur in various ecological regions, their impact on animal production is similar in nature and importance. They are responsible for severe losses either by tick worry, blood loss, damage to hides and udders and injection of toxins or through mortality or debility by the diseases transmitted (Hlatshwayo, 2000).

1.2.1 Phylum Arthropoda

Most ticks of importance from the veterinary point of view belong to the family Ixodidae. They have a hard dorsal shield or scutum covering the entire upper surface of the male and a relatively small scutum is just behind the head or capitulum of the female, nymph or larva. This scutum bears a patterns which is characteristics for each species of tick. Sometimes it is uniform in colour and the pattern is made up only of the pits, grooves and minute punctuations on it but in some ticks a colour pattern is also present. The rest of the body wall is leathery in appearance and extremely expandable, enabling the tick to take in a large volume of blood during each of the three periods in its life that it feeds. Its mouthparts, which are adapted for piercing and sucking, are visible from above in all stages. Two eyes are sometimes, but not always, present.

When present they are situated anteriodorsally, one on each side of the scutum (Hlatshwayo, 2000).

1.2.1.1 Examples of tick species that infect horses

The common name of *Rhipicephalus evertsi evertsi*) is the red-legged tick. The adults feed readily on cattle, horses, sheep and goats. They have also been recorded from many wild herbivores but only rarely from carnivores. The larvae and nymphae usually feed on the same host range as the adults and in addition, frequently infest wild hares. The most favorite site of attachment in adults is under the tail, and round the anus. Sometimes they attach on the groin. The larvae and nymphae usually attach deep down in the external ear canal, rarely elsewhere (Howell *et al.*, 1978).

The life cycle of *R. evertsi evertsi* depend on two hosts. The adults feed for about four to six days, sometimes longer, the female becoming bluish with a brownish tinge as she engorges. In summer she starts to lay eggs five days after dropping from the host and produces up to 7000 eggs, which hatch after approximately a month. During winter a month may lapse before she even begins laying and the eggs take up to two months to hatch. The larval-nymphal feeding period in the ear lasts about 10 to 14 days and the nymphae subsequently take three to four weeks to develop into adults. Unfed larvae can withstand starvation for seven months and adults for over a year. Red-legged ticks are most active in summer and some specimens can be found all through the year (Howell *et al.*, 1978).

The red-legged tick is probably the most common vector in southern Africa of *Babesia equi*, causing biliary fever in horses and other equines.

At a certain stage it was also thought to be an important carrier of *Babesia bigemina*, causing redwater of cattle, but recent work has created doubt about this idea and its position is being reinvestigated (Howell *et al.*, 1978).

Boophilus microplus is known as the blue tick and its adults are small, inconspicuous with a short mouth. The engorged females are bluish-brown and can be seen attached to most of the body. The smaller females are brownish-yellow in colour. *Boophilus microplus* has a one-host life cycle, in which moulting from larva to nymph and nymph to adult takes place on the host. The time spent on the host, from the attachment of the unfed larva until the detachment of the engorged female, is approximately three weeks. Because of this short life cycle the tick is able to pass through several generations in one year. *Boophilus microplus* occurs throughout the year. In Australia and southern Africa, low winter temperatures synchronize egg development and hatching, so that the highest number of larvae is usually present on the pasture after the warmer weather of spring. 'Waves' of larvae then occur through the summer and into cool months of May and June (Coetzer and Erasmus, 1994).

1.3 Problems Facing Horse Owners

Horses were domesticated for reasons fundamentally different from those of pigs, cattle, goats and sheep; these were primarily domesticated to create additional sources of protein. The horse family was not domesticated until other uses for animals had been discovered and accepted and, although equids were originally and in some cases still are used for food, they have mainly been draught and transport animals throughout history. Horses appear to have been first domesticated in Eastern Europe, in the Ukraine, about 5500 years ago. The evidence for this is the large number of horse bones (60 % of all animal bones) at Ukraine sites. Equines provide work as saddle and pack animals, as pullers of carts, as draught animals for cultivation, as prime movers for lifting water from wells and for minor industrial purposes. Most equines are used in the immediate locality but some are used for long distance transport (Clutton-Brock, 1978).

Most farmers face the problem of internal parasites and ectoparasites because they have little knowledge about them. There is very little knowledge about the management system under which the horses are kept in South Africa or about the impact of the helminth infections on the horses (Svendsen, 1997).

1.3.1 Control of helminth parasites

Control of internal parasites of equids has had a variety of classes of antiparasitic compounds for approximately the last 60 years (Lyons *et al.*, 1999). First to appear on the market were diphenylamides (phenothiazine) in the 1940s, followed by piperazines in the 1950s and benzimidazole (e.g. Thiabendazole), organophosphates (trichloroform and dichlorvos), imidothiazole (levamisole) and pyrimidines (e.g. pyrental tartrate and pyrental parmoate) in 1960s and 1970s. The first macrocyclic lactane marketed was ivermectine in 1983 and the second was moxidectine in the 1990s. These latter compounds are active on parasitic arthropods and nematodes and are commonly called endectocides. Prevalence data on endoparasites from equine population, particularly data that might reflect the impact of chemotherapy on parasite population, are difficult to obtain (Lyons *et al.*, 2000).

1.3.2 Managing ecto-parasites (ticks) on horses

Ticks are bloodsucking organisms that attach to human or animal hosts at specific times during their cycle to obtain a blood meal. When full they drop off and remain hidden in thatch and overgrowth until it is time to feed again. Ticks are most commonly found in overgrown, brushy areas, which provide the shelter and humid conditions that ticks need. These areas also harbor the small mice and the other mammals that are important intermediate hosts during tick development. Avoidance of "ticky" areas, use of protectants and keeping horses in mowed pastures where the vegetation dries out quickly and allows penetration of sunlight will reduce problems with ticks (Townsend, 1998).

1.3.3 Management of horses

As most horses are not kept for meat and milk production but as transport animals they do in fact, require less in the way of management than if their functions were more complex. Some supplementary feeding may be provided and it veterinary services are available these are often in urban centers where equines are gathered for transport purposes, here may receive considerable medical care. Equines indeed usually figure as the largest group of animals treated at veterinary centers (Townsend, 1998).

1.3.3.1 Management systems

The total number of horses in Africa is estimated to be 500 000, compared to 50 million worldwide. Most horses in Africa are used for recreation rather than work. South Africa has 280 000 horses, chiefly pure-bred (Anon, 1997).

In Africa, working domestic equids are most often used in rural and resource-limited communities. These communities embrace a wide range of farming and management system in which the control of disease agent, such as cyathostomes, has not yet been well tested. For example, for many of these owners the use of anthelmintics is constrained by both the cost and their availability. The agricultural co-operatives or other sources where such products are available are often long distances away and therefore inaccessible. Such a situation calls for alternative strategies for nematode control, which are cost effective, appropriate and acceptable to owners. In Africa, there is only one available report anthelmintic resistance in horses and that is in South Africa (Krecek, R.C. and Guthrie, A.J, 1999).

1.3.3.2 Alternative approaches to control

Because of financial constraints of owners, lack of availability of anthelmintics and the occurrence of anthelmintic resistance, alternative methods of controlling helminth parasites of equids are needed. The alternative strategies are fecal removal, biological control including nematode-trapping fungi and selective chemotherapy (Krecek, R.C. and Guthrie, A.J, 1999).

a. Fecal removal

A human activity, namely the mechanical control practice of fecal removal or collecting dung to use as fuel, building material and for composing, acts to interrupt the life cycle of parasites. The pasture hygiene approach was designed for horses kept under intensive conditions in USA and UK where constant re-infection problems occurred (Herd, 1993). Twice weekly removal of excessive feces provided superior cyathostome and ascarid control as well as well as a 100 % increase in grazing area, and freedom from dung-related problems. The cost of pasture sweeping or vacuuming may thus be offset by improved worm and colic control, slower selection for anthelmintic resistance, and by the increase grazing area due to the elimination of ungrazed roughs around fecal deposits. This approach was of particular value in controlling the unique problems of weanling and yearling horses under intensive grazing conditions (Herd and Gabel, 1990; Herd, 1986).

b. Nematode-trapping fungi

Biological control implies situations when man attempts to use naturally occurring antagonists to lower a pest population which would otherwise causes losses of plant and animal production (Gronvold *et al.*, 1996). In practice, biological control has no direct application to internal animal parasites, when in their parasitic stage. However, the parasitic stages may be indirectly regulated by biological control of the free-living larval stages on pasture (Gronvold *et al.*, 1996).

Numerous examples of organisms, which exploit free-living stages of parasites as a source of food, are found in nature. Such examples are important to study in that they may prove to be a potential form of biological control (Gronvold *et al.*, 1996). Sayre and Starr (1988) list some biological control agents of helminths as invertebrates, dung bettles, earthworms, microarthropds (such as macrochelid mites), microorganism, bacteria and fungi. The most promising is fungi, which exhibit antinematodes properties. Fungi with these properties have been recognized for some time and consist of a variety of species. The most important group of nematophagous fungi includes nematode-trapping (predacious) fungi and endoparasitic fungi. Other fungi antematode properties either invade nematode egg or produce metabolites toxic to nematodes (Barron, 1977).

Persmark (1997) discusses predacious and endoparasitic fungi and stated that they are found in all environments throughout the world, but are particularly abundant in rich agricultural soils. Under laboratory conditions, where these fungi are grown as a monoculture on standardized, nutrient-poor media and are provided with a nematode prey that cannot escape, results can be very successful with nematode larvae captured and destroyed within a matter of hours. However this type of work provides little relevant information, as how these fungi would perform as practical biological control agents against parasitic nematodes larvae under field conditions. The parasite control efficacy of each fungus should be considered and evaluated within the livestock production systems being considered (Krecek, R.C. and Guthrie, A.J, 1999).

One proposed application is to incorporate nematophagous fungi into feed blocks. These blocks could provide a means of low-cost nutrient supplementation, can be manufactured using simple technology, and those manufactured in the developing world often-incorporate surplus plant by-products as the nutrient source. Such fungal blocks could prove to be a particularly important control option in the tropic and subtropics where anthelmintics are not widely available, the value of animal (horses) is less than the value of the treatment, an the shelf life of the feed blocks is six months or more (Waller, 1997).

c. Selective chemotherapy

Selective chemotherapy refers to the judicious use of anthelmintics by applying criteria in deciding to give a dose of remedy. A comparison between the effects of conventional and selective antiparasitic treatments on nematode parasites of horses from two management systems in South Africa (Krecek *et al.*, 1994a) revealed that selective treatment resulted in considerable saving and advantage of the avoidance of further anthelmintic resistance development. Duncan and Love (1991) were the first to report on this alternative strategy of controlling strongyles in horses in the UK. The large size of the horse (such as 400 kg) and the relative high cost of the anthelmintic encourage this approach among horse owners (Krecek, R.C. and Guthrie, A.J, 1999).

1.4 Socio-economic factors

A socio-economic aspect of animal disease in southern Africa is a topic under review in South Africa (Krecek *et al.*, 1995). Changes, which are taking place in the country, demand a revised approach to meet broad national development requirements in terms of socio-economics (Krecek *et al.*, 1995).

According to Krecek *et al* (1995) socio-economic factors have a strong influence on the distribution, dynamics and significance of animal diseases, particularly in developing countries where there are wide differences in the socio-economic status of their inhabitants. Socio-economic factors operate at different levels of resolution, between which their importance often varies; the most important of these resolutions are households, community and nation.

In order to examine the socio-economic consequences of animal diseases, it is necessary to briefly examine the definitions and the context of this area of investigation. The prefix socio- refers to whole societies or to individuals. Sociology includes the customs, traditions and patterns of historical development and institution that have evolved within societies. These include the type of government or legal system, regulations of property ownership, education arrangements, veterinary or medical arrangements and family structures. Sociology looks at the nature and behavior of social groups and how are they similar and how they differ from each other. Branches of Sociology examine diverse groups within a society. Socio-economic status usually relates to levels of education, income or occupation (Krecek *et al*., 1995).

Socio-economic factors are generally taken to mean the non-physical properties or characteristics of human environments, which can greatly influence the natural environments. In broad terms we refer to the economic status of human populations and all the other characteristics which can be influenced by that, such as level of education, access to resources, including capital, land and services. In addition to the economic status anthropological characteristics may also influence attitudes to education, attitudes toward technology adaptations, attitudes towards land tenure and many of these characteristics enhance or diminish the effect of economic factors exerting their greatest influence in the more impoverished communities (Krecek *et al*., 1995).

Krecek *et* al (1995) micro-epidemiology provides the socio-economic and socio-cultural factors that affect the distribution and importance of parasitic diseases and their method of control where health education and community involvement are essential features of the programme. The occurrence and prevalence of parasitic infections in a given locality are reflections of a complex interaction between the environment and the host species that are present. The ability to monitor the impact of diseases depends upon setting up facilities that are available. Throughout the world this varies from one extreme, the extensive grazing practices of nomadic or transhumanant people, to intensive and non-intensive systems in developed areas.

CHAPTER 2

OBJECTIVES

2.1 Rationale

Helminth infections are of considerable economic importance in livestock production. These infections not only cause clinical disease and mortalities but also cause production losses such as reduced weight gain. They also cause economic losses through condemnation of the whole carcass or specific organs at slaughter. The economic loss due to parasitic infections in South Africa is very high, and this is because of the wide range of parasites in the country. There is very little knowledge about the management system under which they are kept in South Africa or about the impact of the helminth infections on the horses (Svendsen, 1997).

Several factors such as limited resource, unavailability of relevant information and veterinary services and the misconceptions that helminths are not important because they can not be seen in animal, compared to ectoparasites such as ticks (Wells *et al.*, 1998b, Starkey, 1995) all contribute to an apparent lack of internal parasite awareness and consequently their control in horses. Most of what is known about the effect of helminth species on equids (Murphy and Love, 1997) and the value of alternative control methods (Waller, 1999) is based on studies on horses in developed countries.

This study investigates the current prevalence and socio-economic factors influencing the helminth infections of horses at Kestell in the north eastern region of the Free State Province South Africa. This information will help the government planners and researchers and will shed light on the most important helminth parasites encountered around Kestell. The availability of such information will be crucial in understanding disease patterns and for effective control and disease management programmes. Using known and established methods like the McMaster, Visser sieve and Centrifugation techniques it was possible to determine the various helminth species of horses in this region. The major objective of this study was to determine helminth parasites of veterinary importance in horses. Data collected will form the basis in the development of appropriate control strategies against internal helminths of economic importance in horses at Kestell in the north eastern region of the Free State Province.

2.2. General objectives

To determine factors influencing helminth infection and to record ticks of veterinary importance in horses at Kestell in the north eastern region of the Free State Province.

2.3 Specific objectives

- To determine the prevalence of helminths in horses at Kestell in the north eastern Free State Province.
- To record ticks of veterinary importance in horses at Kestell in the north eastern Free State Province.
- To determine the socio-economic factors influencing helminth management in horses (Questionnaire survey).

CHAPTER 3

MATERIALS AND METHODS

3.1 Description of the study area

The study was carried out between June 2002 and March 2003 in the north eastern Free State Province at Kestell (28°38' E; 28°20' S), which is located +/- 50 km, 28 km respectively, from the Qwa-Qwa Campus of the University of the Free State (Figure 1). The north eastern Free State is a predominantly hilly and mountainous area situated between latitudes 28° and 30° S, and 28° and 30° E. Geology of the north eastern Free State Province with its beautiful landscape consist of rocks of the Karoo super-group, namely, the Beaufort and Stormberg groups, with the soil types belonging to the Clovelly-Avalon, Katspruit, Kroonstad-Katspruit and Sterkspruit groups. Numerous dolerite dykes and occasional sills have intruded the Karoo formations and a few small dolerite diatremas have also been recorded in Qwa-Qwa, which contain sedimentary breccias (Kritzinger and Pieterse, 1987).

The north eastern Free State lies within the summer rainfall region of South Africa with more than 85 percent of the precipitation occurring during the period September to March, mainly in the form of thunderstorms. The temperature in the eastern Free State may be described as being cool to moderate warm. The average temperature during mid winter is 7.4°C and during mid-summer 17.9°C. The average daily minimum temperature during winter is 4.6°C and the average daily maximum temperature during summer is 29.9°C. Cold spells, i.e. temperatures less than 5°C occur fairly often throughout the year and usually, last several days at a time. Hot spells, i.e. temperatures in excess

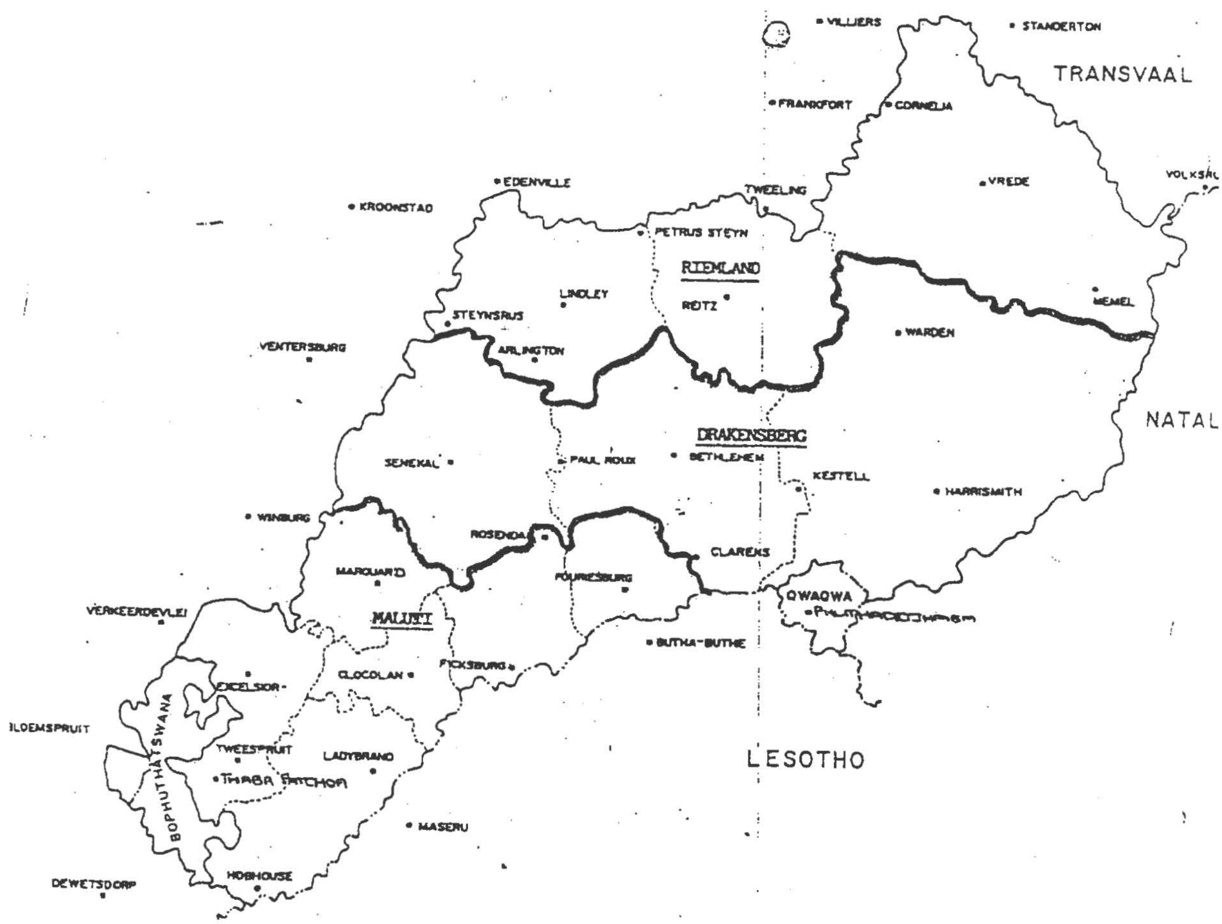

Figure 1: Map showing the location of the study site, Kestell in the north eastern Free State Province of South Africa.

of 35°C also occur for several days per year. During September and October temperatures are highly variable, while during April and May it is fairly stable (Kritzinger and Pieterse, 1987).

The north eastern Free State belongs to the grassland biome, and includes five vegetation types, namely, moist cool highveld, moist cold highveld, afro-montane and alti-montane grassveld (Moffett, 1997).

3.2 Collection of blood ticks and fecal samples

Blood, ticks and fecal samples were collected from horses (Plate 1) over a period of ten months (June 2002 to March 2003). The experimental animal physical conditions were assessed using body condition score method (Figure 2) by Henneke *et al* (1983). The system is based on the nine points scale with a score of one representing poor and nine representing extremely fat (Table 1). A total of at least 24 horses
were sampled every month at Kestell. Fecal samples were collected directly from the recta of the animals (Plate 2) and used for worm egg counts (EPG) and third stage larvae identification. Fecal egg counts was done according to McMaster (Reinecke, 1983), Visser sieve (Malan and Visser, 1983) and centrifugation/floatation (Beroza *et al.*, 1986) techniques. Larval identifications were done through the preparation of fecal cultures (Michael, 1999).

3.3 Fecal worm egg counts

It is important to understand that demonstration of parasite eggs or larvae in the feces provides evidence that animals are infected but often does not accurately indicate the degree of infection. Fecal samples were collected

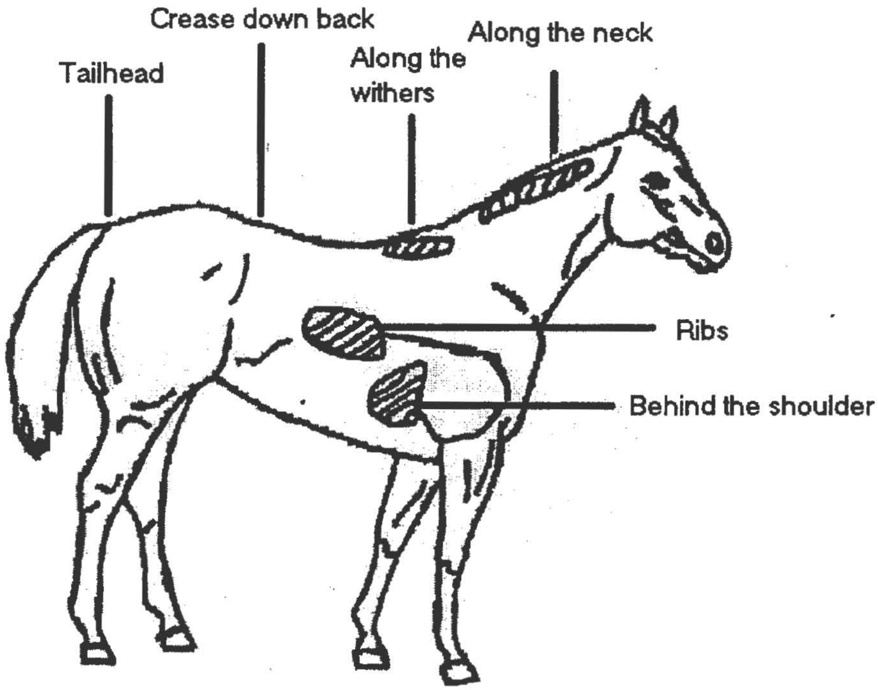

Figure 2: Diagram of areas palpated to estimate body fat and condition score.

Table 1: Description of individual condition scores of horses (Henneke *et al.*, 1983)

Score	**Description**
1 Poor	Animal extremely emaciated. Spinous processes, ribs, tailhead, tuber coxae and ischii projecting prominently. Bone structure of withers, shoulders and neck easily noticeable. No fatty tissue can be felt.
2 Very Thin	Animal emaciated. Slight fat covering over base of spinous processes, transverse processes of lumber vertebrae feel rounded. Spinous processes, ribs, tailhead, tuber coxae and ischii prominent. Withers, shoulders and neck structures faintly discernable.
3 Thin	Fat build up about halfway on spinous processes, transverse processes cannot be felt. Slight fat cover over ribs. Spinous processes and ribs easily discernable. Tailhead prominent, but individual vertebrae cannot be visual identified. Tuber coxae appear rounded, but easily discernable. Tuber ischii not distinguishable. Withers, shoulders and neck accentuated.
4 Moderately thin	Negative crease along back. Faint outline of ribs discernable. Tailhead prominence depends on conformation, fat can be felt around it. Tuber coxae not discernable. Withers, shoulders and neck not obviously thin.
5 Moderate	Back level. Ribs cannot be visually distinguished but can be easily felt. Fat around tailhead begging to feel spongy. Withers appear round over spinous processes. Shoulders and neck blend smoothly into body.
6 Moderately fleshy	May have slight crease down back. Fat over ribs feels spongy. Fat around tailhead feels soft. Fat begging to be deposited along the side of the withers, behind the shoulders and along the sides of the neck.

7 Fleshy	May have crease down back.. Individual ribs can be felt, but noticeable filling between ribs with fat. Fat around tailhead is soft. Fat deposited along withers, behind shoulders and along the neck.
8 Fat	Crease down back. Difficult to feel ribs. Fat around tailhead very soft. Area along withers filled with fat. Area behind shoulder filled with fat. Noticeable thickening of neck. Fat deposited along inner thighs.
9 Extremely fat	Obvious crease down back. Patchy fat appearing over ribs. Bulging fat around tailhead, along withers, behind shoulders and along neck. Fat along inner thighs may rub together. Flank filled with fat.

directly from the recta of the animals and placed in labelled containers (pill bags). Fecal worm egg counts were done using the McMaster, centrifugation/ flotation and Visser sieve techniques.

3.3.1 Mcmaster technique (Reinecke, 1983)

The procedure for performing this technique is summarized below:

(i) Fecal samples were collected directly from the recta of the animals and placed in separate labelled containers (pill bags).

(ii) 4g of fecal sample were weighed out on a weighing balance (Sartorius, South Africa).

(iii) 56ml of a 40% sugar solution was added to horse feces as a floatation medium.

(iv) The above mixture was then be blended with the aid of a commercial laboratory blender (Waring, South Africa).

(v) To break the foam that was formed from blending, a few drops of amyl alcohol was added.

(vi) The required number of chambers of a McMaster slide were then filled with the fecal mixture using pasteur pipettes (Elkay, South Africa).

(vii) Slides were allowed to stand for approximately 2 minutes so that the eggs could float to the surface of the floatation medium.

(vii) With the aid of light microscope (Nikon, Japan), the eggs were counted in the grid of each counting chamber at x400 magnification (eyepiece, x 10; objective, x 40)

3.3.2 Visser sieve techniques (Malan and Visser, 1983)

The procedure for performing this technique is summarized below:

(i) Fecal samples were collected directly from the recta of the animals and placed in individual labelled containers (pill bags).

(ii) 4g of fecal sample were weighed out on a weighing balance (Sartorius, South Africa).

(iii) A three-in-one filter (25 mm, 70 mm and 110 mm) was suspended in a filter stand over a large basin.

(iv) The fecal material was placed in the inner (110 mm) filter. A course spray of water at high pressure was directed at the feces, moving the fecal material from the inner (110 mm) filter to break up and wash the feces through the other 75 mm and 25 mm filters.

(v) Each filter retained coarser particles according to size, allowing the finer materials to pass through.

(vi) The inner filter (110 mm) was removed and hanged in the ring provided on the stand and washed again.

(vii) Water supply was shut off and the contents of the middle and the outer filters were drained into glass jars labelled 70 mm and 25 mm respectively

(viii) Each filter was gently rinsed with a small volume of water ensuring that the volume in the glass jars did not exceed 60 ml.

(ix) Four teaspoons of sugar was added to the jar labeled 25 mm.

(x) The contents in the bottle marked 25 mm was stirred to dissolve the sugar.

(xi) Using a pipette, all three chambers of a McMaster slide were filled with aliquots from the washings of the 25 mm sieve.

(xii) The modified McMaster slide was filled with the aliquots from the 70 mm sieve.

(xiii) The slides were then allowed to stand for a few minutes at room temperature.

(xiv) The slides were examined using a standard light microscope at x 400 magnifications (eyepiece, x 10; objective, x 40).

3.3.3 A centrifugation/ flotation (Beroza *et al*., 1986)

The procedure for preparing a centrifugation/ flotation technique

(i) Fecal sample were collected directly from the recta of the animals and placed in a separate labeled containers (pill bags).

(ii) Approximately 40 g of feces were placed in a beaker.

(iii) Mixed vigorously with 5 to 10 ml of tap water to a pasty consistency.

(iv) The resulting mixture was then strained through a coarse sieve and the liquid collected in two 10 ml centrifuge tubes.

(v) Both tubes were then spun at 1200 g for 10 minutes, the supernatant from both tubes was discarded and the fecal plugs were resuspended in tap water.

(vi) Both tubes were spun again for 10 minutes at 1200 g and the supernatant from tubes was discarded.

(vii) The fecal plugs were resuspened in separated sucrose (prepared by dissolving 450 g granulated sugar in 350 ml warm water and spun at 1200 g for 10 minutes.

(viii) On the removal from the centrifuge the tubes were filled to the brim with saturated sucrose solution and a coverslip applied to the top

(ix) After the tubes were allowed to stand for two hours, the coverslips, with any attached tapeworm eggs were placed on a microscope slide.

(x) The slides were then examined using a standard light microscope at x 400 magnifications (eyepiece, x 10; objective, x 40).

3.4 **Fecal cultures from horses** (Michael, 1999).

The procedure for preparing fecal cultures is summarized below:

(i) A 2 cm thick wooden stick was placed in the center of a fruit jar.

(ii) A mixture of feces and vermiculite at an approximate volume ratio of 1:1.5 was added into the jar.

(iii) The mixture was pressed down with a second stick until the layer of feces is 7 cm thick.

(iv) The inside of the jar and the compacted fecal mixture was moistened with water without soaking the contents.

(v) The lid on the culture bottle was then lightly screwed on.

(iv) Cultures were incubated in a moist incubator (Labotec, South Africa) at 27° C for 8 days.

(vii) Larvae migrating on the surface of the culture bottles were harvested by moistening the inner walls of the culture bottles and collecting them in a clean beaker.

(viii) The cultures were harvested from the upper surface of the bottle containing feces/ vermiculite mixture.

3.4.1. **Preparation of larvae for identification** (Michael, 1999).

(i) A small aliquot of larvae harvested from fecal culture was transferred into a microscope slide using a Pasteur pipette, a drop of iodine added and covered

(ii) The larvae were identified using larval identification key (Table 2)

Table 2: Larval identification in feces of horses

a. Length: 290- 850μm b. Body/ tail ration:1.5/1 c. Intestinal cells: 0-8 triangular d. Has sheath e. Tail long and whip-shaped f. Thicked: 14-18μm g. Well developed, clearly visible oesophagus	Small strongyle
• Length: 800-1000μm • Body/tail: 2/1 • Intestinal cells: 16-32 • No sheath	Large strongyle

3.5 Blood sample collection and PCV determination (Michael, 1999).

(i) Experimental animals were restrained and pressure was applied by means of a rubber band, which was held securely around the animal's neck to make the jugular vein bulge to facilitate introduction of the needle.

(ii) An 18G1.5 needle (Precision Glide, Europe) was used to collect blood in sterile ethylenediamine tetra-acetic (EDTA)-coated vacutainer tubes (Becton Dickinson Vacutainer System, United Kingdom).

(iii) When sufficient blood is collected the vacutainers were gently tilted back and forth for a few minutes to allow mixing with the anticoagulant.

(iv) In the laboratory, two capillary tubes (micro hematocrit tubes, Wertheim) were filled with blood samples and sealed on one end with clay.

(v) Blood-filled hematocrit tubes were centrifuged in a micro hematocrit centrifuge (Taiwan) for 10 minutes to separate the plasma from the red blood cells.

(vi) The packed cell volume (PCV), which is a measure of the percentage of red blood cells, was then measured using a micro hematocrit reader (Taiwan) (Michael, 1999).

3.6 Questionnaire survey

The study was conducted in Qwaqwa and Kestell in the north eastern Free State Province South Africa. The survey questionnaire was divided into five sections dealing with (demography) employment status of the farmers, (health) horse diseases, (nutrition) horse feeds, (breeding) horses multiplication and (management) where animals are kept. These sections involve multiple-choice answers.

A total of 31 questionnaire were distributed to the farmers. Different villages (Thibella, Phomolong, Moeding, Matswakeng and Malekunutu) in Qwaqwa were visited. The aim of distributing the questionnaires was to determine the socio-economic factors influencing the helminth management in horses. The farmers were questioned verbally and the answers were recorded on the questionnaire forms (Appendix 1).

3.7 Data presentation and analysis

The data was analyzed statistically using the appropriate analysis of variance techniques. All statistical data was done on the software Program Statistical Analysis System (SAS). The R-square test distribution was used in testing the hypothesis of independence between different variables of classification.

CHAPTER 4

RESULTS

4.1 Helminth distribution, diversity and abundance in horses

Between June 2002 and March 2003 a total of three helminth species and one protozoan species were recovered from 24 horses at Kestell in the north eastern Free State (Table 3). The main species recovered was strongyle with egg per gram (EPG) ranging between 0 and 4400. Horses of ages ranging from 5 months to 7 years of both sexes were sampled (Table 4). Their physical conditions are presented in Table 5.

Identification of helminth species was done by examination of only eggs and third stage larvae, and their classification was done to the genus level. The results of the larval identifications correlated with those of the egg count and identification. Blood was collected for packed cell volume (PCV), which determines anemia. The normal values range between 24 and 44 for domestic horses and the results were found to range between 24 and 44 (Table 6).

The effect of age, sex and physical conditions was investigated. Based on 5% significance level all except sex had significant effect on strongyle. The R test showed that there is significant difference between age ($p=0.0218$), months ($P<0,0001$) and physical conditions ($p<0,0001$) in the prevalence of strongyle. This means the younger the horse had higher infestation levels colder the months had a low infestation and the better the physical condition of the horse the lower the infestation. It also showed that there is a strong negative linear relationship between packed cell volume (PCV) and strongyle ($r = -0.23465$; p- value = 0, 0004).

Table 3: Helminth species with their egg per gram (EPG) ranges recovered from 24 horses at Kestell

Helminth species	**EPG values ranges**	
	Farm 1	**Farm 2**
Strongyle	0- 4400	50- 3450
Parascaris eqourum	0- 1350	0
Oxyuris equi	0- 1750	0
Eimeria spp	0- 100	0
Total number of horses sampled per month for a period of 10 months	12	12

Table 4: Comparison of horse ages between two study areas in Kestell

AGE OF HORSES	PERCENTAGES	
	Farm 1	Farm 2
5 months	17 %	-
7 months	8 %	17 %
8 months	8 %	-
9 months	17 %	-
1 year	17 %	-
2 years	-	17 %
3 years	8 %	33 %
4 years	8 %	8 %
5 years	8 %	8 %
7 years	-	8%

Keys
-: horses of this age were not found on the farm

Table 5: Physical conditions of horses from two study areas in Kestell

Physical Condition Scores	PERCENTAGES	
	Farm 1	Farm 2
2 (Very thin)	25 %	8 %
3 (Thin)	50 %	42 %
4 (Moderately thin)	16 %	50 %
Total number of horses sampled per month for a period of 10 months	12	12

Table 6: Packed cell volume (PCV) values of horses from two farms in Kestell.

Months and year	Farm 1	Farm 2
	PCV	PCV
June 2002	24	28
July 2002	32	25
August 2002	33	32
September 2002	32	28
October 2002	33	29
November 2002	32	29
December 2002	31	30
January 2003	30	26
February 2003	44	28
March 2003	28	32
Total number of horses sampled per month for 10 months	12	12

4.2 Seasonal dynamics of helminth species isolated from horses

The average EPG's of strongyle in both the farms (Figure 3 and Figure 4) showed the same seasonal pattern. At both the farms strongyle has reached a peak in summer month (January) and low EPG's were recorded during colder months (July). However, other helminths like *Parascaris equorum*, *Oxyuris equi* and protozoan *Eimeria* were stable throughout the year (Figure 3). *Parascaris equorum*, *Oxyuris equi* and *Eimeria* were only isolated from Farm 1.

4.2 Larval cultures

Small strongyle larvae made up more than 80 % of the larval culture in all samples cultured. On both the farms higher small strongyle percentages were found. The larvae were only identified as large or small strongyle.

4.4 Seasonal dynamics of ticks isolated from horses in Kestell

Ticks were also collected from 24 horses for a period of ten months. A total of 824 ticks were collected from Farm 1 and 1061 ticks were collected from Farm 2 over a period of ten months. *Rhipichephalus evertsi evertsi* was identified from horses. The infestation rate of horses with ticks ranged from at least five ticks on one horse to more than hundred ticks. The dominating species was found to be *Rhipichephalus.* Ticks of the species *Rhipichephalus* were located mainly in the ears and anal region. During infestations high level of intensity they were also be found in the perineal region, on the fore head, and in the mane. The seasonal distribution for *Rhipicehalus* in Farm1 and Farm 2 are shown in Figure 5 and Figure 6 respectively.

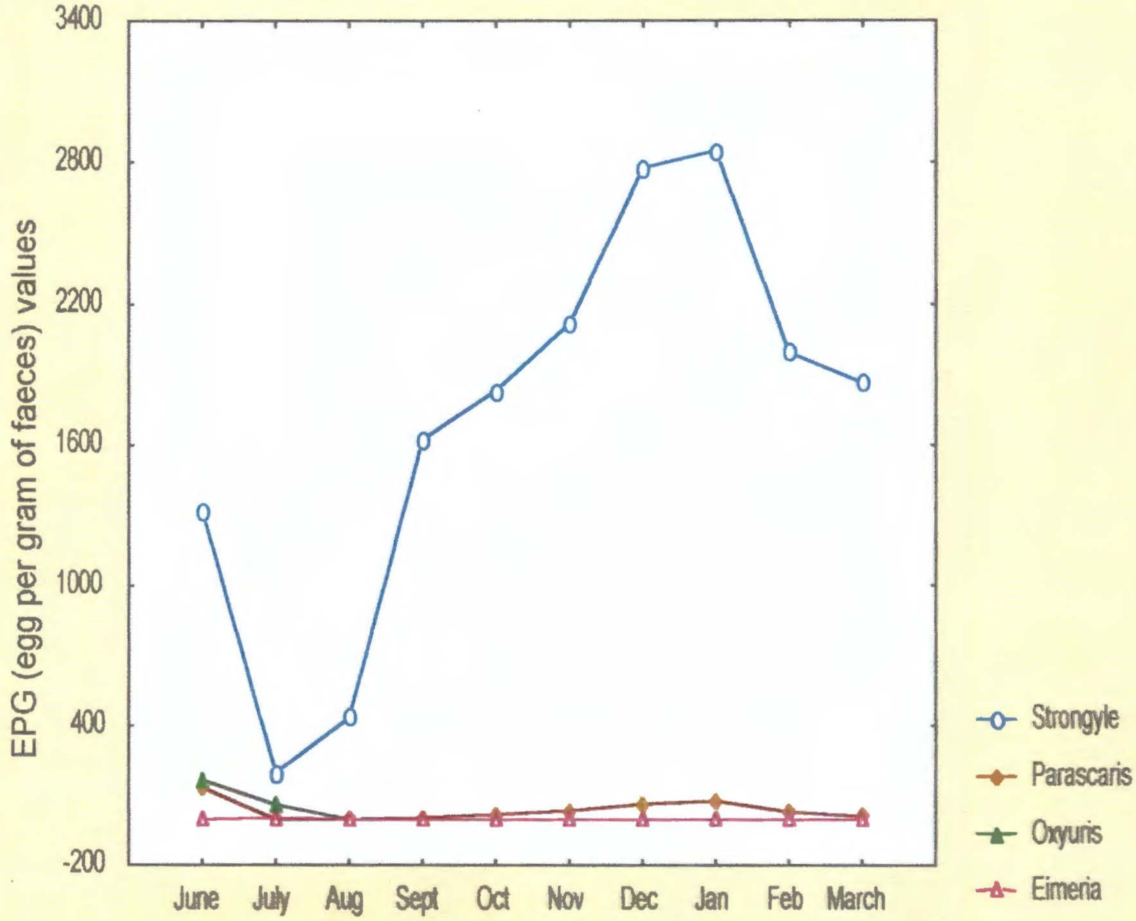

Figure 3: EPG values of helminthic species of horses in Kestell (Farm 1)

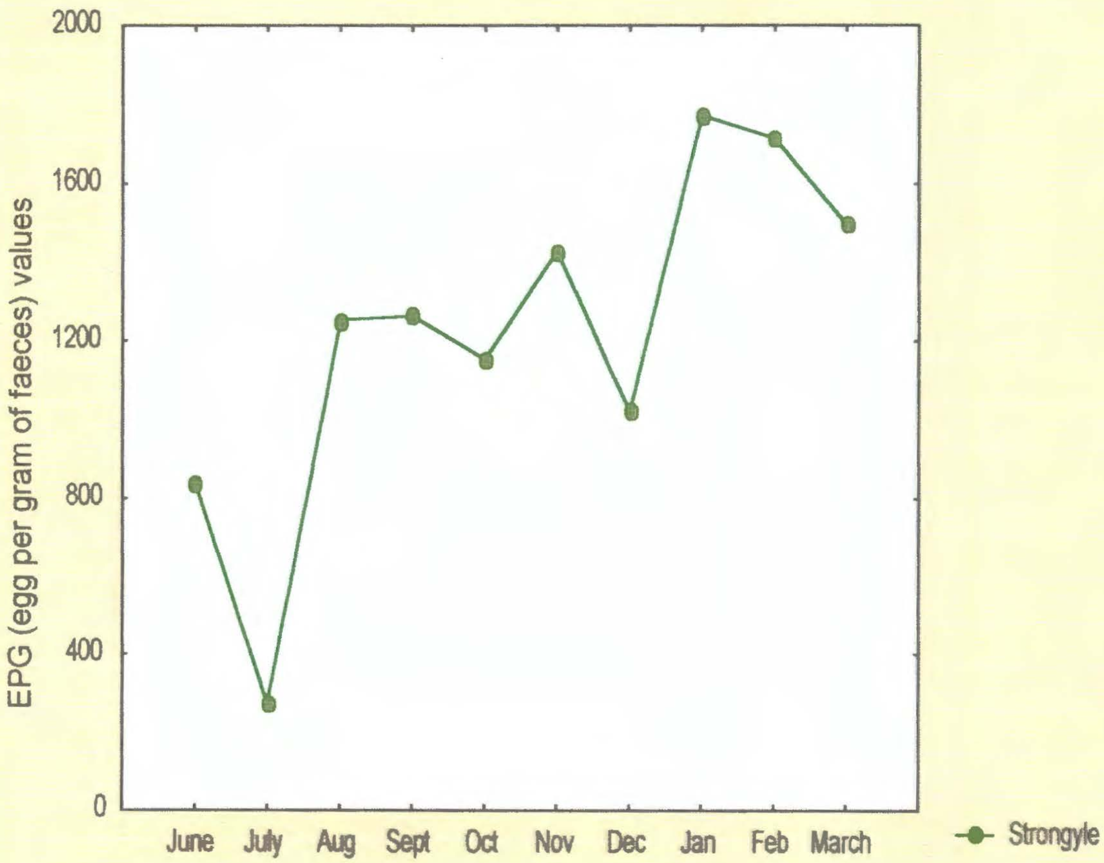

Figure 4: EPG values of helminthic species of horses in Kestell (Farm 2)

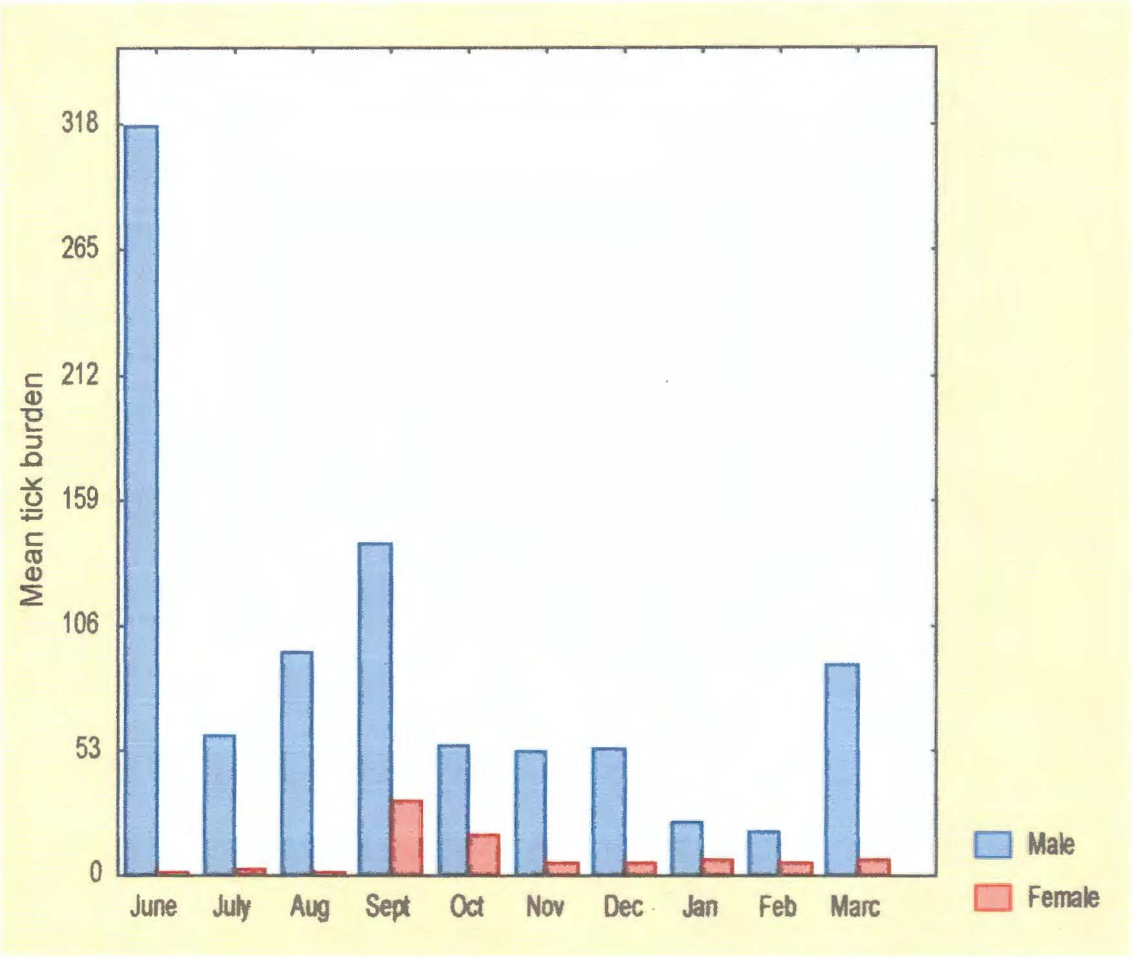

Figure 5: Mean monthly male and female *Rhipicephalus* burdens on horses on Farm 1

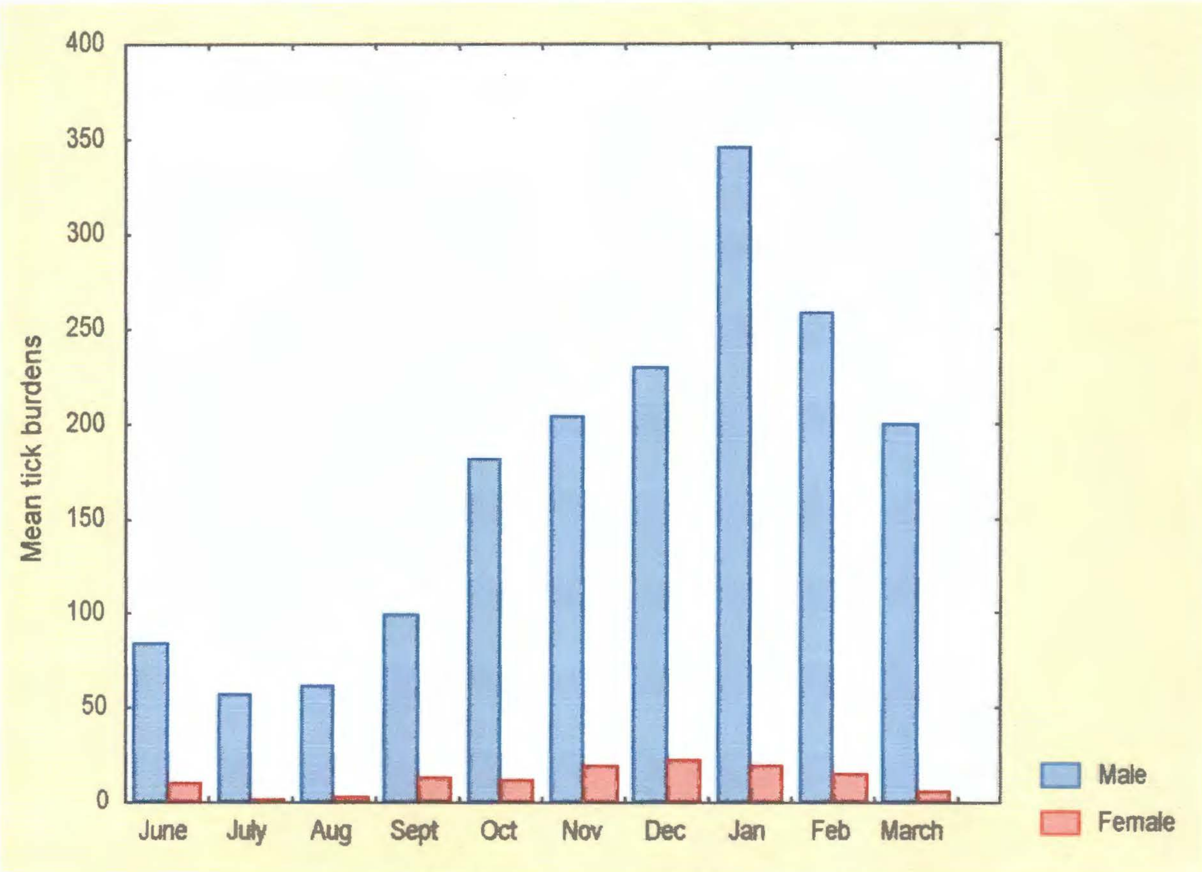

Figure 6: Mean monthly male and female *Rhipicephalus* burdens on horses on Farm 2

4.5 Questionnaire survey

Semi-structured interviews, based on discussions with relevant people in the community and a resultant problem conceptualization, were undertaken at 31 households in 11 villages of the north eastern region of the Free State Province.

Little is known regarding the keeping of animals in the north eastern Free State, South Africa. Therefore the attitudes of horse owners to control helminth parasites, and the extent to which veterinary practitioners are involved in providing advice on parasite control of horses was researched. The replies to our questionnaire indicated that there is low level of awareness on the need for helminth control.

Between February 2001 and November 2002 31 participants were interviewed; 96.8% of the owners were male and 3.2% were female. Their home language was Southern Sotho.

Besides the horses other domesticated animals included donkeys (0.3%), mules (0.6%), cattle (16.7%), dogs (2.2%), goats (6.6%), sheep (8.6%), chickens (8.5%), ducks (0.9%) and geese (0.2%) (Figure 7).

4.5.1 Demography

Of 31 owners interviewed, 35.8% were pensioners and unemployed; 30% were employed and 20% own their business. The remaining owners, which are 15%, their main source of income was from farming.

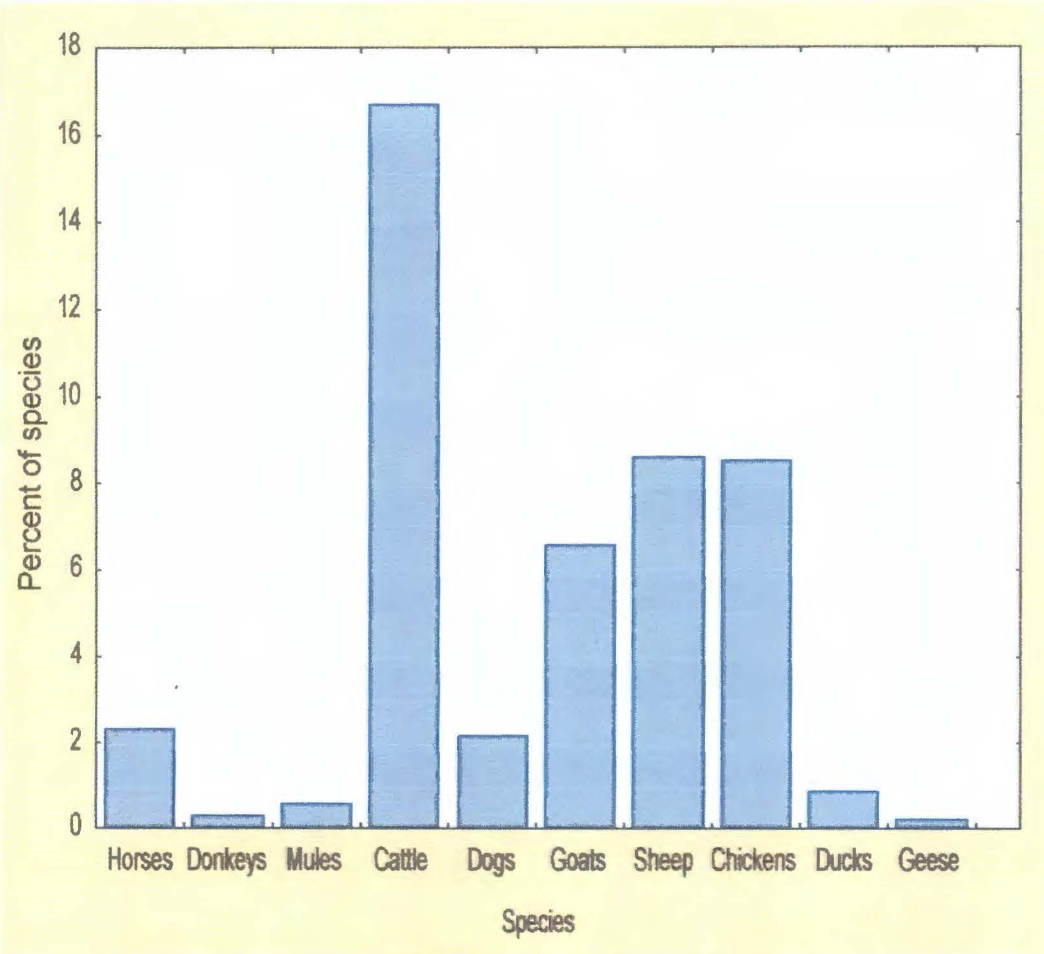

Figure 7: The proportion of domestic animals owned by farmers.

A total of 67% interviewees said that they utilize their horses for transport, but the frequency ranged from once a week (16. 11% of owners) to twice a week (6.5%).

A total of 9% of owners traveled short distances (between one and two kilometers) with their horses in one day. A further 6.5% owners traveled three to five km and eleven to twenty km in one day with their horses and 6.3% reported a distance of six to ten kilometers.

4.5.2 Management of sick animals.

A total of 45% of owners ask their friends or neighbors who had knowledge of horses when their animals become sick. A further 30% treated the animals themselves; 19% reported that they do nothing and 6% take their animals to the State veterinarian.

About 3% of owners made use of Animal Health Inspector, private veterinarian and traditional healers for medical help.

In line with the fact that many owners treat their animals themselves, 39% use the herbal or natural products or drugs to treat their animals and 23% use the commercial product purchased from shops. The costs of these health treatments were on average of R100 per month per owner. Other costs associated with the horses were fodder (costs range between R100 and R4000 per month per owner) and the health treatment (costs range between R100 and R2000 per month per owner).

The owners reported a variety of disease conditions (Figure 8). The most common conditions noted were ticks (83% of owners), worms (45%) and hoof problems (19.4%).

4.5.3 Nutrition of horses

Horses belonging to 90% of the owners were given Lucerne hay all year round. Further 6% of owners fed their horses on mealies and 4% of owners gave their animals concentrate commercial food. The veld in the village was utilized by 84% and 16% let their horses graze at roadside. During winter, 83.9% of owners reported the condition of their animals being poor and only 16.1% reported them being average. During summer 90.3% of owners reported the condition of their animals being good and only 9.7% their animals being excellent. All of horse owners (100%) reported the grazing condition in winter being poor and in summer being good.

4.5.4 Breeding of horses

Many owners initially obtained their horses by breeding (71%). Twenty nine percent of owners owned horses which they inherited. A horse could cost anything from R400 to R800 to buy, while most owners claimed that they could sell a horse for anything between R500 and R1000.

4.5.5 Management of horses

Many owners (87%) allowed their horses to roam free (along the road or in the veld) during the day. A further 13% of owners kept their horses in their back yard. Whereas 84 % of the owners kept their horses in a kraal

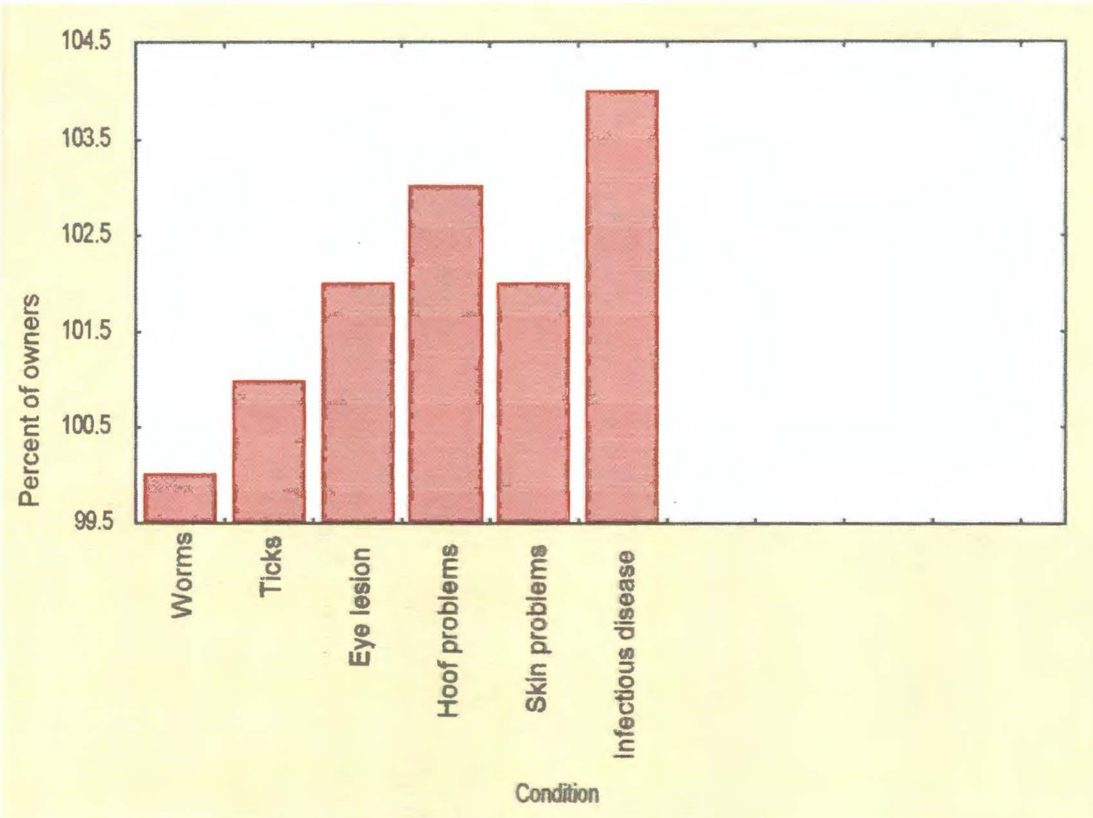

Figure 8: Parasites, veterinary problems and their frequency in horses as observed by farmers

or small camp during the night. The remaining percent of owners kept their horses tethered and some are roaming free (along the road or in the veld) during the night.

The majority of horse owners did not report on how their animals increase or decrease. Only 22.6 % reported on increase and the increase of numbers was in two ways: firstly by birth of fowls (19.4 % of owners) and secondly, by horses being bought (3.2 % of owners).

CHAPTER 5

DISCUSSION AND CONCLUSION

This study was conducted at Kestell in the northeastern Free State. The study area is an established site of University of the Free State Qwaqwa campus Parasitology Research Program.

5.1 Total fecal egg counts

Soulsby (1982) states that in horses 500 EPG suggests a mild infection, 800- 1000 a moderate infection and 1500- 2000 a severe infection. It would therefore appear that the horses in the study were severely infected with nematodes (4400 EPG). Egg counts are influenced by consistency of feces and by the total amount of feces passes per day.

5.2 Strongyle egg count

The strongyle eggs were the most abundant nematode eggs found with EPG values ranging between 0 and 4400. Since almost of the larval cultures contained over 80 % small strongyles, it would stand to reason that a high proportion of eggs in fecal egg counts were small strongyle eggs. Although more than 40 species of cyathostomes have been described in domesticated horses, less than 12 are abundant and common. Worldwide, only five species compose 80% to 90% of the total adult worm burden (Uhlinger, 1991). According to Reinemeyer (1986), small strongyle ova usually comprise over 95% of the strongylid ova in a horse fecal sample.

5.3 *Parascaris equorum* egg count

Parascaris was found in foals of three to nine months of age with EPG values ranging between 0 and 208. In horses a marked resistance of *Parascaris* becomes evident after six months of age (Soulsby,1982). Age immunity is not dependent on previous exposure to infections (Jacobs, 1986). According to Soulsby (1982) patent infections are of little clinical consequence. Researchers working on adult donkeys in Burkino Faso (Vercrysse *et al.*, 1986) reported a prevalence of *Parascaris* eggs of 23.5% and counts ranging from 100 to 500 EPG. It would therefore appear that, it is not uncommon to find *Parascaris* in adult donkeys which correlate with the study done in Kestell where *Parascaris* was observed in faols only.

5.4 *Oxyuris equi* egg count

Oxyuris eggs were found in female and foals with EPG values ranging between 0 and 375. This is possibly because of close association between females and foals in the herd. Horses frequently engage in mutual grooming sessions and this could play an important part in the transmission of *Oxyuris* egg between members of a herd. Male horses or jacks may be less exposed to infection with *Oxyuris* because they tend to be more solitary (Wells *et al.*, 1998b).

5.5 Larval cultures

Small strongyle larva made up the majority of larvae identified, although it was not possible to identify them to genus or species level. Fecal egg counts and culture of larvae are used to quantify and differentiate mixed infections of gastrointestinal helminths in horses. Accurate diagnosis of levels of mixed infection with gastrointestinal nematodes by larval culture and differentiation depends on a constant relationship between number of eggs present in initial fecal sample and the number of larvae recovered from culture, provided culture conditions remain similar (Michael, 1999).

5.6 Packed cell volume (PCV)

The normal packed cell volume (PCV) values ranging between 24 and 44 observed in this study might be due to low level of degree of infection with blood sucking helminths, which can influence the pathogenesis of gastrointestinal parasitic infection (Holmes, 1987).

5.7 Monthly and seasonal averages

The monthly average total fecal eggs counts were low throughout the year. This was also true of the strongyle egg counts. Strongyle burdens of horses tend to show a seasonal incidence, which is a reflection of the pasture burden of infective larvae (Soulsby, 1982). Soulsby 1982 demonstrated that mares in Great Britain showed a marked increase in strongyle egg output in late spring and early summer and it is also the case on Farm 1 at Kestell.

5.7.1 *Parascaris equorum* egg counts

Parascaris showed a peak in winter and also in summer (EPG value of about 237) but the cause of this is not known. Research on horses in Kentucky, USA, showed that the average number of adult *Parascaris* recovered at necropsy was greatest in spring, followed by winter, with the other two seasons yielding lower numbers (Lyons *et al.*, 2000). In this study it was found that there was a peak in summer and winter and in the other two seasons *Parascaris* was stable.

5.7.2 *Oxyuris equi* egg counts

Oxyuris egg counts were significantly higher in winter only with EPG of about 375 and it was stable in summer, autumn and lower in spring. The average number of *Oxyuris* specimens per horse recovered by Lyons *et al.*, 1990 in Central Kentucky in the United State of America was also higher in winter, second highest in autumn, thereafter spring and summer.

5.8 Ticks parasitizing horses

Rhipichephalus evertsi evertsi has a two-host life cycle. The larva to nymph moult occurs on one host and the tick passes through more than one generation per annum. All stages are present on hosts throughout the year, although their abundance may vary from season to season. The tick tolerates a wide rage of climatic conditions and is present throughout most of the eastern part of southern Africa. Adults of *R. e. evertsi* are easily controlled by localized application of acaricide to the perianal area. It is probably only on horses that a sufficient number of adults would ever be present to justify the costs of control. No specific control measures are usually taken against the immature stages (Coetzer *et al.,* 1994).

On Farm 1 the number of *Ripichephalus* reached a peak in June and in October 2002 the number was reduced until February 2003.

5.9 Condition scoring

Dietary energy intake has a marked effect on ovarian function in a number of species of horses (Hatez and Jainudeen, 1974). Body condition such as the amount of stored fat in an animal's body, is positively related to reproductive performance in cattle (Dunn and Kaltenbach, 1980; Croxton and Stollard, 1976; Whitman, 1975; Donaldson, 1969; Lamond,

1969) and sheep (Polliot and Kilkenny, 1976). Research into the relationship between body condition and reproduction in the equine is vague and often misconstrued (Henneke, 1981). To date, evaluation of body condition in horses has no consistent basis and comparison of research or management systems considering body condition and reproductive efficiency cannot be adequate evaluated (Henneke *et al.*, 1983).

The condition scoring system was based on visual appraisal and palpable fat cover at six areas of horse's body (Figure 2). During the winter months, the presence of a long, heavy hair coat complicated visual appraisal, and palpation of the animal was conducted to determine body condition more accurately. Some conformation differences made certain criteria within each score difficult to apply to specific animals. Some horses had more prominent withers and were flatter across the back than others. Therefore more emphasis was placed on fat cover over the ribs, behind the shoulders and around the tail head when evaluating horses with high withers and flat backs. However, when properly applied, the scoring system was independent of size or conformation of the horse (Henneke *et al.*, 1983).

Horses from both farms had physical conditions that ranged between score 1 & 2 (Table 1). The horses were extremely emaciated; spinous processes, ribs, tailhead, tuber coxae and ischii projecting prominently. The bone structure of withers, shoulders and neck were easily noticeable. No fatty tissue was felt. These conditions were observed during winter and were probably because grazing conditions was poor. During summer the grazing conditions were good and the condition score ranged between

2 & 3. Horses scoring from 4 to 9 were never observed probably due to poor management practices, including lack of good feed supplements and absence of anthelmintic treatment.

5.10 Questionnaire

The questionnaire was not well received by the horse owners in the structured interviews. Owners were suspicious when they were asked questions and answers were being written down. They were afraid and reported that the researchers will take or hurt their animals. When they realize that their animals would not be hurt or taken from them, their suspicious turned into interest.

Horses play a vital role in these resource- limited communities. The majority of the owners were pensioners and unemployed and the horses provide vital transport.

A large number of horse owners fed their horses with lucern hay and a small percentage gave their horses concentrated commercial food. The horse owners also use veld to feed their horses. Water was often supplied to the horses when they were still in the yards before they were hitched up to work or went to the veld. The owners reported that the conditions of grazing and horses during summer were good, whereas during winter the grazing conditions were poor.

The majority of horse owners bred their horses themselves in order to increase the number, whereas a small percent inherit them either from their family numbers or neighbors. The horse owners within the community had business minds; they could buy with a lesser amount and sell at a higher price.

Horses were usually left to roam free during the day, but during the most horses owners kept their horses in their back yards. The theft of horses in these areas is a major problem. The owners said they knew who was stealing the horses; they even organized groups themselves into that searched for their lost animals as the police would not do anything about their missing horses.

CHAPTER 6

CONCLUSION

The conditions for helminth research were unique in this study for two reason: firstly the horses had never received anthelmintic treatment of any sort, and secondly, because the horses were essentially allowed to roam free in herds, and not managed or grouped according to age or sex. The findings of this study therefore reflect the natural transmission and prevalence of helminths of horses in the study areas.

Horses of different age groups had slightly different helminth profiles. Young horses generally had a high prevalence of strongyle, *Parascaris* and *Oxyuris* eggs. They appeared not to have the opportunity to accumulate large numbers of protozoa *Eimeria.* As the horse became older their levels of *Parascaris* and *Oxyuris* decreased. The reason might be the animals developing age immunity towards the helminths.

Investigations on the helminth parasites in South Africa (Scialdo-Krecek, 1983; Scialdo-Krecek *et al.*, 1983) and Namibia (Scialdi-Krecek *et al.*, 1983) suggest that in arid environments, a smaller diversity of nematodes species is present in the host. In addition, Scialdo-Krecek *et al* (1983) found that there are higher numbers of strongyle in Burchell's zebra in the Kruger National Park (387-697 mm annual rainfall). The areas in which our horses originated have an annual rainfall of (700– 1340 mm annually), that may explain the diversity and abundance (EPG values of 4400) of strongylid parasites recovered from the horses in this area.

Parasitism is only one problem in the life of working equid; other problems are work, stress, inadequate nutrition and veterinary care. The problems with, and solution for effective and appropriate cyathostome control in equids are driven by their own unique factors. Veterinary services and agricultural co-operatives selling anthelmintics, are far away from the community

Even when anthelmintics are available, owners in these resource-limited communities can often not afford dewormers or do not consider them a priority when compared to other herd management issues, such as stock theft or visible disease agents such as ticks (Wells *et al.*, 1998a and Wells *et al.*, 1998b). Owners should be taught to use body condition scores together with appropriate management interventions (such as fecal removal) and this may result in more effective nematode control. There is a need to understand the owners' perceptions concerning the role of their animal health issues if we are to make appropriate recommendations and expect them to be adopted by communities. Our knowledge of the impact of helminths and disease agents on working equids should allow us to develop effective sustainable control strategies for these situations. Communities have indicated a need for further information on animal health, which has led to training programs for farmers, extension officers and other animal users in the sub region and elsewhere.

The condition scoring system is easy to apply and could be useful in experiments on the effects of nutrition and reproductive performance. Further the system can be very useful communication tool in managing mares to achieve maximum performance (Henneke *et al.,* 1983).

The questionnaire was the first in the north eastern Free State, South Africa to address the need for information concerning the socio-economic profile of horse owners living in resource-limited areas. Valuable insights into the role of the working horses in the community the management and the health of horses were gained. This will allow future workers in this area to plan their projects appropriately. It is clear from this project that horses perform a vital function in resource-limited communities.

Future research projects focusing on communal farmers could make a valuable contribution to the horses and their owners. Studies to assess the use, potential and constraints of horses in the other places of eastern Free State should be conducted. Information on basic horse management and health needs to be made available to extension officers and owners in these areas. Provision of basic veterinary services and the education of owners about the correct treatment of their horses is also a priority. In response to the shortage of horses, breeding programmes may be an appropriate step.

Future research also should concentrate more on identifying the genus present to species level. Although the adults of most species have been described and can be identified by a few experts, the morphological identification of most larval and egg stages of these parasites is impossible. The eggs are morphologically indistinguishable and larval stages are generally undescribed (Lichtenfels *et al.*, 1998).

The present study adds to the existing information on the prevalence, diversity and socio-economic factors influencing helminth parasites in horses in Africa and equids in general. The specific identities of these parasites will contribute to an understanding of their impact on the health status of horses as well as to an assessment of the extent of their adverse effects.

CHAPTER 7

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APPENDIX 1

SOCIO-ECONOMIC QUESTIONNAIRE **(Adopted from Wells *et al.*, 1998a)**

Name:…………………………………………………………………………

Address:………………………………………………………………………

……………………………………………………………………………………

Gender:…………………………..

Area:…………………………………………………………………………

Type of an area:………………………………………………………………

NB: MARK WITH AN "X " IN THE APPROPRIATE COLUMN

1. How many animals do you own?

Species	Total number
Horse	
Donkeys	
Mule	
Cattle	
Dogs	
Goats	
Sheep	
Chickens	
Others (Specify)	

A. Demography

1. What is your main income?

The work done by animals	
Own business	
Farming	
Employed full-time by someone	
Other (please specify)	

3 How often do you use your animals?

Once a week	
Two times	

Three times	
Four times	
Five times	
Every day	
Other (please describe)	

4 How far, on average, do you ride your horse in one day?

1-2 km per day	
3-5 km per day	
6-10 km per day	
11-20 km per day	
21-30 km per day	
More than 30 km per day	

B. Management of sick animals

1. If you have problems with your animals or if they become sick or are injured what do you do?

Ask a friend or a neighbor with knowledge	
Treat animals yourself	
Animal health inspector	
Traditional healer	
Private veterinarian	
State veterinarian	
Do nothing	
Other (please describe)	

2. Are any products or drugs used to treat the animals?

Yes	**No**

If yes, what type?

Herbal/Natural		**Commercial (bought from a shop)**	
Obtained from the veterinarian		**Other (please describe)**	

3. How much is spent per month on the animals?

Fodder	**R**
Health treatment	**R**
Implements	**R**
Total amount	**R**

4. Which disease conditions have the animals ever had?

Worms	
Ticks	
Wounds	
Eye lesion	
Hoof problems	
Skin problems	
Infectious disease	
Other (please specify)	

5. If your animals are not treated by veterinary/ or animal health inspector which of the following statement(s) could have influenced your decision

Veterinary costs (expensive)	
Veterinarian not available	
Health inspector not available	
Transport costs prohibiting	
Transport not available	
Do not have knowledge/ information about veterinarian/ or health inspector	
Other (please specify)	

C. Nutrition of horses

1. What do you feed your animals?

Concentrate commercial food	
Lucerne hay	
Other	
Mealies	
Other (please specify)	

2. Where does your animal graze?

Around the house	
At road side	
In the veld	
Other (please describe)	

3.What is the condition of your animals?

WINTER				SUMMER			
Poor		**Fair**		**Poor**		**Fair**	

Average		**Good**		**Average**		**Good**	
Excellent				**Excellent**			

3. What is the condition of grazing?

WINTER				SUMMER			
Poor		**Fair**		**Poor**		**Fair**	
Average		**Good**		**Average**		**Good**	
Excellent				**Excellent**			

D. Breeding of horses

1. Where did you obtain the animal/animals?

Bred the animals yourself	
Bought (describe from whom)	
Other (please describe)	

2. How much would a horse cost to buy; how much could you sell the horse for?

Buy	**R**	**Sell**	**R**

E. Management of horses

1. Where are animals kept?

	DURING THE DAY	**DURING THE NIGHT**
In your back yard		
In a kraal /small camp		
Tethered		
Roaming free		
Other (please describe)		

2. How has the number of horses that you own changed in the last year?

Births (number)		
Number of deaths due to	**Disease**	
	Old age	
	Other (describe)	
Slaughtered (number)		
Stolen/Disappeared (number)		
Bought (number)		
Other (please describe and give number)		

INTERVIEWED
BY……………………………………………………..