EPIDEMIOLOGICAL STUDIES ON THE HEALTH AND WELFARE OF THE ETHIOPIAN DONKEY, WITH PARTICULAR REFERENCE TO PARASITIC DISEASE

BY

MULUGETA ADAKO GETACHEW

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ProQuest LLC.
789 East Eisenhower Parkway
P.O. Box 1346
Ann Arbor, MI 48106 – 1346

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DECLARATION

I hereby declare that the work presented in this thesis is original and has not been submitted for another degree. The work is carried out by the author, except where collaboration and assistance with others has been acknowledged.

Signature.....

DEDICATION

To my mother, Alemitu Mulisa, my father, Mulugeta Adako

and my brother, Eticha Chala.

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ABBREVIATIONS

AHS	African horse sickness
ATNESA	Animal Traction Net Work for Eastern and Southern Africa
C	Degrees Celsius
CTA	Technical Centre for Agricultural and Rural Co-operation
DHWP	Donkey healthcare and welfare project
DNA	Deoxyribonucleic acid
DVM	Doctor of Veterinary Medicine
EAV	Equine arteritis virus
EHV	Equine herpes virus
EIA	Equine infectious anaemia
EIV	Equine influenza virus
EPG	Eggs per gram of faeces
ETB	Ethiopian birr (currency)
FAO	Food and Agriculture Organization
IAR	Institute of Agricultural Research
ILCA	International Livestock Centre for Africa
IDPT	International Donkey Protection Trust
ILPH	International League for the Protection of Horses

KG	Kilogram
LPG	Larvae per gram of faeces
MAFF	Ministry of Agriculture and Fishery Development
MASL	Meter above sea level
MG	Milligram
ML	Millilitre
MM	Millimetre
RPM	Revolution per minutes
VEE	Venezuela equine encephalitis
WAAVP	World Association for the Advancement of Veterinary Parasitology
WFA	World Farriery Association

SUMMARY

There is a perception that donkeys do not get ill. Previous experience in Ethiopia indicates that this is partly due to the fact that donkey owners do not recognise signs of disease and, even if the donkeys are sick, there is little chance that the donkey will be treated. Common injuries such as harness galls are not considered as a problem by donkey owners, mostly due to ignorance, lack of understanding and the ubiquitous nature of the problems. Information available on different aspects of donkeys health in Ethiopia is minimal in contrast to the important role they play in society and the country's economy. A survey conducted to determine the major health and management problems of working donkeys in Ethiopia is considered in this thesis.

Chapter 1 is a general introduction and review of donkeys with respect to their origin, domestication, geographical spread, number, distribution and their importance. Health and management problems of working donkeys are also reviewed from available information.

Chapter 2 is a general description of the materials and methods and includes description of the study areas and study animals, clinical examinations, data collection, management and analysis, post mortem worm recovery and other laboratory techniques.

Chapter 3 reports the results of a survey of the principal health and management problems of working donkeys at four project sites in Ethiopia during the period 1995-1997. According to this study a number of health problems were identified. Helminthosis was found to be a health problem of considerable magnitude

at all project sites. Of 2935 donkeys examined only one donkey was negative and the rest were found to harbour ova and/or larvae of large and small strongyles, ascarids, lung worm, pin worms, strongyloides, fluke, cestodes, stomach worm and bots. In total, 9493 donkeys of both sexes and ranging in age from two weeks to 30 years and over were examined and more than 40,000 clinical conditions were treated. Of these clinical conditions, wounds and sores due to poor harnesses and badly designed implements accounted for 43.7%, foot problems 14%, ectoparasites 13.5%, accidental wounds 6.6%, eye infections 5.4%, abscesses 3.0%, respiratory problems 2.7%, mud fever 2.6%, emaciation 2.6%, lameness 2.4%, urogenital problems 2.0%, tumours 0.9% and gastrointestinal problems 0.5%. A very common feature observed during this study was that the majority of donkeys were suffering from multiple health problems.

Chapter 4 describes the results of the investigation of the prevalence and population composition of internal parasites of working donkeys at the four project sites. The study revealed a 99% prevalence of infection by gastrointestinal parasites, with a high infection rate. Over 54% of the donkeys had faecal worm egg counts of more than 1000 epg. A total of 42 different species of parasites consisting of 35 nematodes, 3 trematodes, 1 cestode and 3 arthropod larvae were identified. Seventeen species of cyathostominae (small strongyles) and 7 species of Strongylinae (large strongyles) were identified. Other parasites identified include *Habronema muscae*, *Draschia megastoma*, *T. Axei*, *Strongyloides westeri*, *Anoplocephala perfoliata*, *Parascaris equorum*, *Fasciola hepatica*, *Fasciola gigantica*, *Gastrodiscus aegyptiacus*, *Dictyocaulus arnfieldi*, *Oxyuris equi*, *Probstmayria vivipara*,

Gasterophilus intestinalis, *Gasterophilus nasalis*, *Rhinoestrus purpureus* and *Setaria equina*. The results obtained revealed the presence of a range of parasitic species, which are representative of the important pathogenic parasites, found in equidae.

Chapter 5 presents the results of a field trial on the efficacy and safety of the different ivermectin formulations (Eqvalan, MSD-Agvet and Ivomec, MSD-Agvet) administered by different routes to donkeys for the treatment of gastrointestinal and pulmonary helminths in Ethiopia. All formulations of ivermectin were found to be 100% effective against large and small strongyles, as well as *T. axei,* up to eight weeks post treatment regardless of the routes of administration. There was no statistically significant difference between treatment efficacies. Fatalities and other severe adverse reactions were not encountered in this study, although transient swelling at the injection sites in two donkeys and ventral oedema in one donkey were observed in the group receiving subcutaneous administration. In view of the demonstrated efficacy of injectable ivermectin solution when administered orally, the ease of administration and absence of adverse reactions in donkeys, it is suggested that the injectable formulation is suitable for oral administration where economic hardship may be a consideration. Further work on the pharmacokinetics and bioavailability of the injectable form when used orally in donkeys is necessary. The establishment of appropriate dosage for donkeys is also important.

Chapter 6 is a general discussion and conclusion with proposals for further detailed studies of the diseases and other aspects of working donkeys. The chapter also discusses the possible reasons for neglect and abuse of donkeys. It concludes that the professionals, development agencies and governments should recognise donkey-

use as an appropriate and affordable technology for people with minimum resources. Moreover, the apparent ubiquitous association of donkey-use with underdevelopment and low status, both in traditional attitudes towards donkeys and institutional neglect, must be to be changed.

CHAPTER 1

GENERAL INTRODUCTION AND LITERATURE REVIEW

1.1. INTRODUCTION

In many countries, equine population statistics are estimates and extrapolations, and at the international level, data from many countries are seldom reported accurately, even though significant numbers of equids are known to exist (FAO, 1989). Most of the data on the equine population are collected by the Food and Agriculture Organization (FAO) and are based on estimates submitted by national agricultural ministries (Fielding, 1991; FAO, 1994; Starkey et al., 1997). According to Starkey et al. (1997), estimating the donkey population is very difficult, because donkey owners are seldom registered and substantial donkey populations occur in remote rural areas where it is difficult or impractical to survey them accurately. Moreover, in many parts of the world people are not proud of the presence of large numbers of donkeys (Starkey et al., 1997). The number of equids by type, continent and stage of country development is shown in table 1.1. As can be seen, 81% of all equids, 98% of all donkeys, 97% of all mules and 66% of all horses are found in developing countries. Moreover, 35.3% of the world equine population is made up of donkeys.

Table 1.1 Number of donkeys, mules and horses in the world ('000).

	Donkeys		Mules		Horses		Total	
	Number	%	Number	%	Number	%	Number	%
World	44030		15462		65292		124784	
Asia	21735	49.4	5903	38.2	17119	26.2	44757	35.9
Africa	13353	30.4	2289	14.8	3655	5.6	19297	15.5
Latin America and Caribbean	7574	17.2	6857	44.3	22653	34.7	37084	29.7
Others[1]	1368	3	412	2.7	21865	33.5	23645	18.9
Developed	1103	2.5	427	2.8	22042	33.8	23572	18.9
Developing	42927	97.5	15035	97.2	43250	66.2	101212	81.1

[1] Includes Europe, Oceania, USA, Canada and former USSR. (Sources: adapted from FAO, 1994; Starkey et al., 1997, Fielding, 1991 and 1997).

The earliest FAO estimate of the world donkey population is from 1961 when there were an estimated 37 million donkeys. Since then, the world donkey population has increased steadily and today it is estimated to be about 44 million (Figure 1.1), an increase of approximately 18.9%. According to Fielding et al. (1998), over the period 1979-1994 the increase in the agricultural human population was 11.3%. This indicates that, in global terms, the world donkey population is being maintained and perhaps growing in importance. These figures also suggest that there are over 124 million equids in the world, with over 1 billion people directly dependent upon them (Prentis, 1994).

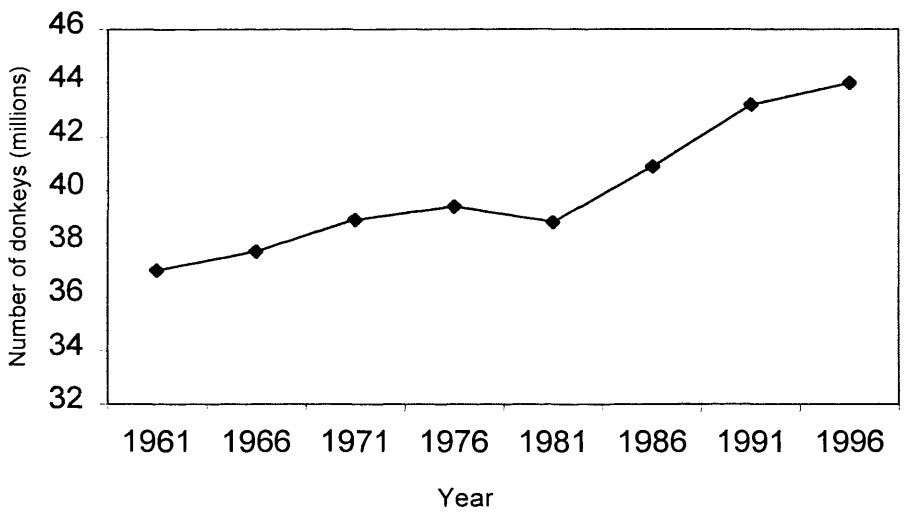

Fig.1.1 Estimate of the world donkey population, 1961-1996.

(Sources: adapted from FAO (1994); Starkey et al. (1997) and Fielding et al. (1998))

Donkeys provide valuable service in many parts of the world. They are mostly used for transport, tillage and other agricultural activities. Despite the increased use of fossil fuel, animals appear to be a continued source of assistance and one which plays a significant role in the economy of most developing countries (Ebenezer, 1991). It is important to realise that the great majority of donkeys in the world, over 97%, are kept specifically for work (Wilson, 1990; Ebenezer, 1991; Iversen, 1991; Prentis, 1994; Starkey, 1994a; Starkey et al., 1997; Fernando, 1997; Fielding et al., 1998).

In Ethiopia, donkeys have been used as beasts of burden for a long time and still render their services as pack animals throughout the country. This is mainly in rural and peri-urban areas where modern means of transportation are absent, unaffordable or unsuitable (Wilson, 1990, 1991; Feseha et al., 1991; Feseha, 1991, 1997; Alemu et al., 1997; Howe et al., 1997). Studies by Sisay (1997) have indicated that donkeys are still used even where modern transport is available in cities and towns. Donkeys have been found to provide pack services carrying over fifteen kinds of commodity weighing 60-100kg and covering distances of 15-30 km for durations up to 4-5hours (Feseha et al., 1997). According to Wilson (1978 and 1991), the annual average contribution of donkeys to the Northern Ethiopian salt trade from 1971 to 1974 was substantial and is shown in table 1.2.

Table 1.2 Annual average contribution (1971-1974) of donkeys, mules and camels to the Northern Ethiopian salt trade.

Parameters	Donkeys	Mules	Camels
Total values of excise (ETB)	60680	172093	198952
Contribution of excise duty (%)	14	40	46
Number of Journeys per year	80907	114729	66317
Salt transported (tones)	3981	8834	5949

Sources: Adapted from Wilson, 1978 and 1991.

Donkeys transported 49 kg of salt with an excise duty of ETB 0.75 per animal per trip. During these three Ethiopian years, revenue from donkeys averaged ETB 60680 (US$1=6.3ETB). Donkeys contributed 14% and mules 40% of excise duty. It is important to note that without donkeys there would be no mules and, therefore, the real contribution of donkeys should be considered to be in excess of 50%.

Donkeys as draught power, for tillage purposes and other agricultural activities are not popular in most parts of the country. The use of donkeys for agricultural operations is minimal and low utilization of donkeys is seen in this sector (Feseha et al., 1997). However, in some regions, particularly in the rift valley areas, donkeys are used to pull carts to transport different commodities and for tillage purposes, in association with oxen (Dilnesaw et al., 199; Feseha et al., 1997; Zelalem et al., 1997).

Contrary to the size of the donkey population in Ethiopia and the service they provide to society and the national economy, the attention given to these animals, both by society and government, is of the lowest order. They are perhaps, the most

neglected animals among livestock. Available literature suggests that few attempts have been made to study the different aspects of donkeys in Ethiopia.

1.2 ORIGIN, DOMESTICATION AND GEOGRAPHICAL SPREAD OF THE DONKEY.

The domestic donkey (*Equus asinus)* belongs to the genus *Equus* and the family *Equidae*, which include the wild asses of Africa and Asia as well as the species of horses (*Equus caballus*), and zebra (*Equus burchelli)* (Simpson, 1945; Cole et al., 1980; Nowak, 1991).

The precise wild progenitor of the domestic donkey is disputed (Blench, 1997). However, the ancestors of the present domestic donkeys are thought to be wild asses of Africa (*Equus asinus africanus*- Nubian wild ass, *Equus asinus somaliensis*- Somalia wild ass) and Asia (Onager, Kiang, Mongolian, Syrian and Kulan wild asses) (Grove, 1974, 1986; Cole et al., 1980; Haltenorth et al., 1980). Ducos (1970) found archaeological evidence of an extinct population of wild asses that lived in Syria and Palestine some 12,000-10,000 years ago and it was hypothesised that this population might have been ancestral to modern donkeys, perhaps in addition to the North African wild asses. The most commonly held theory for the origin of the present domestic donkey, however, is the Nubian wild ass (*Equus asinus africanus*) (Epstein, 1971, 1984; Haltenorth et al., 1980; Wilson 1990; Fernando 1997; Fielding et al., 1998). According to Haltenorth et al. (1980), there are similarities between local forms of the modern donkey and the phenotype of the African wild asses.

The original motive for domesticating the donkey is unknown. It is not certain that it would necessarily reflect its common usage today as transport for goods and people (Blench, 1997). Donkeys are believed to have been domesticated from the African wild asses around 5,000 BC in North Africa (Epstein, 1971, 1984; Cole et al., 1980; Haltenorth, 1980). Other evidence however, suggests that the wild ass of Africa (*Equus asinus africanus*) might have been present in western Asia some 10,000 years ago and that a separate centre of domestication could have existed in that region (Ducos 1970, 1975; Clutton-Brock, 1978). Cole et al. (1990), Wilson (1990), Bokonyi (1991) and Clutton-Brock (1992), however, have suggested that domestication took place in the Nile valley in upper Egypt, in what is now Northern Sudan, at some time before 3,400 BC. Evidence which supports this theory was given by Clutton-Brock (1992) in which the skeletons of three donkeys were found in an Egyptian tomb dated to 4,500-4,000 BC.

Since its domestication the donkey has spread to different parts of the world. In about 3,000 BC domesticated donkeys from Africa were taken into Asia and become common throughout India and Pakistan by about 2,000 BC (Fielding et al., 1998) and later in Greece and Italy (Camac, 1997). With the Roman army, they travelled throughout the Roman Empire as pack animals and then came to England with the Roman invasion of Britain (Camac, 1997). The trade route from the Pacific Ocean to the Mediterranean sea contributed to the spread of donkeys throughout Asia, Europe, and America (Haltenorth et al., 1980; Groves, 1986; Camac, 1997).

The wild ass, *Equus asinus africanus*, is indigenous to the African continent, spread from the Atlas mountains eastward to Nubia (North Sudan), down the Red sea

and probably as far as the border of Northern Kenya (Haltenorth et al., 1980; Grove, 1986). Winkler (1938) identified the wild ass in the rock-art of the eastern desert in Egypt at about 4,000-3,500 BC.

Despite its status in Egypt, the donkey is found only rarely in rock paintings and engravings of central Sahara (Blench, 1997). Similarly, perhaps more surprisingly, there appears to be no representation of donkeys in the horn of Africa (Phillipson, 1993). Generally, there are few archaeological records of the donkey and historical sources on the spread are rare (Blench, 1997). In part, the absence of donkeys in both written records and rock art may be related to their lowly status. While the painters of rock art in the Sahara focused on high prestige horses and later camels, they omitted the donkey because of its low status or because the spread of donkey was slow and scattered, and its importance only increasing with the evolution of long distance trade (Blench, 1997).

1.3 NUMBER AND DISTRIBUTION OF DONKEYS IN THE WORLD AND ETHIOPIA

The great majority of donkeys in the world, over 97%, are found in developing countries (Starkey et al., 1997). Almost half of the world donkey population is found in Asia, over one quarter in Africa and the rest mainly in Latin America (Table 1.1). Furthermore, the donkey population is not evenly distributed around the world with most donkeys occurring in semi-arid and mountainous areas. Countries with the largest donkey population are shown in table 1.3.

Table 1.3 Countries with the largest number of donkey population in the world.

Countries	Number of donkeys ('000)	Percentage of the wold
China	10923	24.8
Ethiopia	5000	11.4
Pakistan	3901	8.9
Mexico	3250	7.4
Egypt	1690	3.8
India	1600	3.6
Iran	1400	3.2
Brazil	1370	3.1
Afghanistan	1160	2.6
Nigeria	1000	2.3
Morocco	880	2.0

Source: adapted from Starkey and Starkey, 1997

Ethiopia has long had a large donkey population, increasing from 3 million in 1949 to 5 million in 1996 (Starkey et al., 1997). This is equivalent to 11.4% of the world and 37.4% of the African donkey population (Tables 1.1 and 1.3). It is now not only the biggest in Africa, but also the second largest in the world after China (Table 1.3).

Although they are found in almost all ecological zones of the country, the majority are located in the highland regions (Admassie et al., 1983; Feseha et al., 1997) where 90% of the people live (Admassie et al., 1983; Gizaw 1987; Feseha et al.,

1997). The areas of Shewa, Gonder, Tigray, Gojam, Wello and Arsi have the largest donkey populations in the country (Feseha et al., 1991). However, according to the present regional classification of Ethiopia, 97% of the donkey population is found in three regions: 44% in Oromia, 34% in Amhara and 19% in Tigray (Central Statistics, 1995), with the density of donkeys being highest in Tigray, Arsi and Shewa (Table 1.4). It is difficult, at present, to suggest the critical minimum donkey density per unit of population. However, according to FAO (1989), there were 27 donkeys per 100 people in Ethiopia, placing the country amongst the first twenty with sizable densities in the world. There are more donkeys than either horses or mules per human in all regions, except Arsi, Ilubabor, and Sidamo (Wilson, 1991).

Table 1.4 Donkey population and densities in the different regions of Ethiopia.

Zones	Donkey population ('000)	Highland areas ('000km^2)	Density of donkeys (number/km^2)
Arsi	363	24.6	14.8
Bale	125	34.5	3.6
Gamo Gofa	12	20.9	0.6
Gojam	394	58.1	6.8
Gondar	491	54.9	8.9
Hararghe	226	59.8	3.8
Ilubabor	16	15.3	1.0
Kefa	43	32.6	1.3
Shewa	956	72.6	13.2
Sidamo	125	54.1	2.3
Tigray	468	19.0	24.6
Welega	159	44.2	3.6
Wello	390	38.5	10.1

Sources: adapted from Admassie et al. (1983) and Feseha et al. (1997).

1.4 THE IMPORTANCE OF DONKEYS, PAST AND PRESENT

Records of domestic donkeys began in Egypt in the 4th millennium BC with the clear representation of working donkeys by the middle of the next millennium (Epstein, 1971). There are pictures of donkeys in the tombs of the Egyptian Pharaohs and 82 biblical references to the importance of donkeys (Fernando, 1997). There are also records that show ancient Romans and Ethiopians using donkeys for pack transport and agriculture (Fernando, 1997). Others suggest that donkeys have been employed as working animals for over 5,000 years (Wilson, 1990; Starkey, 1997). Mules, derived from donkeys, were important in military campaigns from 2,000 BC until and including the First World War (Starkey, 1995a). During the last century it is reported that donkeys were used to pull lawn mowers on the lawns of prosperous houses and the rubbish carts of the local council, in the United Kingdom. Moreover, they were also used for delivering milk and carrying laundry (Camac, 1997).

1.4.1 Donkeys as pack animals

Since the time of its earliest domestication, the donkey has been used for carrying loads and for riding. Paintings from Egypt 4,000 years ago show a man walking with loaded donkeys (Clutton-Brock, 1992). At about 4,000-3,500 BC, there were written records of large number of donkeys, many of which apparently used for portage (Kitchen, 1993). There has been a long tradition of using donkeys as pack animals in the circum-Saharan regions and parts of East and West Africa (Ebenezer, 1991; Starkey, 1994a; Fernando, 1997). In the late 19th century one record described donkey caravans of 200 to 300 animals and occasionally as many as 700 donkeys were used in

the trade of tobacco in Nigeria (Ogunmremi, 1982). This form of transport, for which donkeys are particularly suited, has been used since before the invention of the wheel (Fernando, 1997); that it has survived to the present days emphasises its value (Fielding et al., 1988). Their use for packing is commonly the first development stage after sole dependence on humans head and back transport (Starkey, 1997; Dijkman et al., 1997).

Packing is particularly appropriate in mountainous areas, where there are no roads and rugged and rough terrain is often inaccessible by motorised means of transportation. The low level of development of the road transport network is a key feature in many parts of developing countries (Wilson, 1990; Feseha et al., 1991; Starkey, 1994; Fielding et al., 1998), where pack transport, even today, is a popular way of transporting various materials. The common loads being pack-transported by donkeys are agricultural produce and materials, water, fuel wood, building materials and animal feeds (Fielding, 1988; Ramachandran, 1991; Wilson, 1991; Crossley, 1991; Iversen, 1991; Ramachandran et al., 1991; De Aluja et al., 1991, 1994; Dawson et al., 1993; Starkey, 1987, 1994a, 1995a, 1995b, 1997; Feseha et al., 1997; Starkey et al., 1997; Blench, 1997; Fernando, 1997; Fielding et al., 1998).

1.4.2 The use of donkeys as draught animals

Draught power includes pulling carts, wagons, sledges, cultivation implements and the beam of static engines (Fielding et al., 1998). The use of donkeys as draught animals is widely distributed, particularly in Africa, Asia, Middle East and Latin America (Wilson, 1990; Starkey, 1994b, 1997; Fernando, 1997).

1.4.2.1 Donkeys for pulling carts

Although appropriate implements and harnesses have not been developed, donkeys have been used for carting in many parts of the world, particularly in Asia, Africa and Latin America (Starkey, 1994b). In most developing countries and despite the progress in road developments in some countries like India, China and Mexico, the animal-drawn carts still play a substantial role in rural and urban transport (Starkey, 1994b, Ramachandran, 1991; Upadhyay, 1991). The use of carts enables the donkey to transport more than it carries on its back (Starkey, 1997). Donkey carts are used to transport various materials such as agricultural produce, animal feeds, water, fuel wood, building materials, sick animals and people, which is similar to those materials transported by pack transport (Starkey, 1987, 1994b; 1997; Wilson, 1990; De Aluja et al., 1991; 1994; Sims et al., 1991; Upadhyay, 1991; Kumwenda et al., 1991; Bobobee et al., 1997; Buchenua et al., 1997; Dilnesaw et al., 1997; Feseha et al., 1997; Naunyango et al., 1997; Fielding et al., 1998). However, carts are more suitable for relatively flat, open terrain and localities with roads or broad paths.

1.4.2.2 Donkeys for tillage and other agricultural activities

While most donkeys undertake transport work, they can also be usefully employed for tillage operations and other agricultural activities. Even though they are not as strong as the oxen or horse, unless hitched together, with appropriate implements and harnessing material, even a single donkey can be used for light tillage or weeding and seeding (Starkey, 1987, 1994b, 1997; Fielding et al., 1998). A single donkey weighing 120-180 kg is capable of pulling a draft force/load of about 200-300N (20-30kg force)

for several hours. This represents about 12-25% of the body weight of a donkey. Highest work outputs are achieved with loads of about 15% of body weight (Betker, 1991; Prasad et al., 1991; Smith, 1991; Sims et al., 1994).

In some parts of the world, including many African countries, donkeys are increasingly used for field operations (Starkey, 1997). In some areas in Gambia and Namibia, donkeys have replaced oxen as the main draught animal. While the oxen are stronger, donkeys are better at surviving drought conditions (Starkey, 1994a, 1995a). The increased use of donkeys for tillage in Zimbabwe has been recorded over the last five years due to the reduction of the cattle population by 50% because of the recurrent drought (Ndlova et al., 1997). Similarly, since 1994, donkeys have become very popular in the west of Sudan for their draught power, particularly for tillage purposes, as oxen and camels have been depleted by the severe drought across the Sahel (Wylam, 1991). This is a trend evident throughout the world (Starkey, 1987, 1994b, 1995a, 1997; Croxton, 1993; Pearson et al., 1995; Andonova, 1997; Canacco, 1997; Fernando, 1997).

1.4.3 Donkeys as riding animals

There are many indications that donkeys have been used for riding (Clutton-Brock, 1992; Starkey, 1994a; Fielding et al., 1998). Some types of donkey have been bred tall and long-legged specifically for riding purposes (Wilson, 1978). Nowadays, riding donkeys is not very popular although in some countries it is normal for adult men and women to ride donkeys; but it is children who are the most likely to ride donkeys (Wilson, 1990; De Aluja et al., 1991; Feseha, 1991; Starkey, 1994a, 1997; Fernando, 1997; Mwakitwange et al., 1997; Mwenya et al., 1997 Fielding et al., 1998).

Donkeys are ridden in the same way as horses, although in some countries, especially those around the Mediterranean, the rider sits on the croup where the back is flattest and therefore more comfortable (Fielding et al., 1998). A healthy and properly managed adult donkey can comfortably carry the weight of an average person, 65-70kg (Starkey, 1997; Fielding et al., 1998).

1.4.4 Donkeys in the human food chain

Most of the time donkeys are not involved in the human food chain. However, wild asses have been hunted near to extinction for their meat and eating donkey meat was common in many Eurasian pastoral systems (Blench, 1997). Even though Islam prohibits the consumption of donkey meat and many Christian and traditionalist groups refuse to eat it, the extent to which donkeys are eaten is probably greatly underestimated. Also, because of its ambiguous status, the trade in donkeys for their meat remains poorly documented (Blench, 1997). However, it should be noted that the low regard for donkey meat is not universal (Fernando, 1997). Lesotho for instance, is one of the countries where donkeys are culled for meat when they are considered too old to work (Fernando, 1997), a feature also true in some areas in parts of West Africa (Blench, 1997). There is a thriving trade in donkeys in Nigeria, reaching southern markets for their meat, an occurrence probably replicated along the West African coast (RIM, 1992). In Mexico, where the use of donkeys for field work has decreased due to the introduction of modern agricultural systems, they are bred for meat; donkey, horse and mule meat is exported to various countries in Europe and Japan. Moreover, it is also processed as a protein supplement for animal feed (De Aluja et al., 1991). The Kamba people of Kenya are recorded as actually fattening donkeys for consumption

and some other cultivators close to the Massai people also eat donkey meat (Epstein, 1971; Twerda et al., 1997; Fielding et al., 1998). In some parts of Europe such as France and Italy, donkeys are prized for their meat where it is included in products such as salami (Wilson, 1990; Starkey, 1997; Fielding et al., 1998). Some parts of Southern Ghana (Canacco, 1997), Ecuador, Israel and South Africa (Svendsen, 1991) are also among the countries in which donkey meat is consumed.

Donkeys have supplied milk for human consumption (Epstein, 1971; Blench, 1997; Twerda et al., 1997). According to Camac (1997), a herd of donkeys called 'milch asses' in London, Britain, were milked in the street to produce asses' milk for the children of well-to-do families during the last century. In some African countries donkey milk is used for medicinal purposes (Fielding et al., 1998). A recent study conducted by Mutharia (1995) revealed that the Massai pastoralists in Kenya use fresh donkey milk for pneumonia and severe coughing.

1.4.5 Other uses of donkeys

In some countries donkeys assist with other operations such as raising water from wells, and milling. In Egypt, donkeys are used to turn irrigation wheels and, in Mozambique, to turn clay-mixing devices (Wilson, 1990; Starkey 1994b; Fernando, 1997). There are also some reports in which donkeys have been used during wars for carrying ammunition, war hardware and other logistic materials (Starkey, 1994a; Feseha et al., 1997). Their small hard hooves are ideal for threshing cereal and for compacting earth during pond and dam construction (Fielding et al., 1998). Because of the nature of their diet and their digestive efficiency (Cuddeford et al., 1995), the manure of the donkey tends to be relatively fibrous and of poor fertilizer value.

However, it is still a useful source of organic matter for the soil and, moreover, it is also used as a fuel and as a binder in the making of building bricks made of soil (Fielding et al., 1998).

In developed and industrialized countries donkeys are kept specifically for recreation purposes, breeding, shows or as a companionship and for guarding sheep (Starkey, 1997). Because of their size and likeable docile nature, donkeys are also used as an aid to stimulate and exercise mentally and physically handicapped people, particularly children (Svendsen, 1997b). However, from the worldwide perspective, the numbers involved in these specialized applications are small (Starkey, 1997).

1.5 HEALTH AND MANAGEMENT PROBLEMS OF WORKING DONKEYS

It is natural for many people in developed countries to assume that the care of equids, in general, and donkeys in particular, in developing countries where there is such strong interdependence, is commensurate with the contribution and worth of the animal. This is seldom the case and care is almost non-existent for donkeys (Svendsen, 1991; Green, 1994). Many reports suggest that there is a belief that donkeys do not get sick and hence do not need treatment (Bakkoury et al., 1991; De Aluja et al., 1991; Pradhan, et al., 1991; Sims et al., 1991; Upadhyay, 1991; Svendsen, 1991; Starkey, 1995a; Feseha et al., 1997; Itepu, 1997; Twerda et al., 1997; Wells et al., 1997). Management and care for donkeys seems to many people to be unnecessary as donkeys are one of the few domesticated animals that appear to do rather well with minimum management (Pearson et al., 1997b) and appear to be less affected or resistant or tolerant to most of the diseases that affect other animals, notably trypanosomiasis

(Connor, 1994) and African Horse Sickness (Barrowman, 1991; Coetzer et al., 1994 and Brown et al., 1990). However, it has been shown that donkeys are potentially susceptible to almost all diseases that affect other equids even though the degree of susceptibility varies (Howell, 1963; Uppal et al., 1991; De Wall et al., 1994; Pandey, 1994; Wells et al., 1997).

Except in a very few special cases, little that would be termed 'management' in the modern sense is practised. In general, the problems of working donkeys are often more acute in areas where modern life and technology impinge upon the traditional life style (Prentis, 1994). The majority of problems of working donkeys are due to mis-management, neglect and cruelty from ignorance (Belemlih, 1991; De Aluja et al., 1991; Feseha et al., 1991; Jones, 1991; Pradhan et al., 1991; Svendsen, 1991; MacGregor, 1994; Starkey, 1995a) and hence man himself is the major problem (Freeland, 1991). The major reasons for mis-management, ill-treatment or poor treatment of donkeys are many fold, among these, the poor economy of the country, lack of education and training, lack of materials, equipment, essential basic drugs and professional advises and basic lack of understanding by the people of the potential productivity of their animals given the correct care (MacGregor, 1994). It seems that deliberate maltreatment is rare and health problems are more likely to be due to ignorance and the ubiquitous nature of disease results in the animals' owners becoming indifferent or being unaware that anything is wrong (Dorman, 1994).

1.5.1 Saddlery and harnessing problems

One of the major causes of economic loss, suffering and ultimate death of working equids, in general, and donkeys in particular, is badly designed and ill fitting saddles and harnesses (Bubar, 1994; Starkey, 1994b). The saddlery and harness problems are purely due to a lack of understanding of the animals' needs and lack of education and training of the owners. Experience of the charity organizations has shown that there seems to be no end to the need for topical treatments of wounds or sores caused mainly by poor and ill fitting saddlery and harnesses. These lesions and associated problems could continue indefinitely unless positive steps are taken to change the attitude of the donkey owners (Dorman, 1994; MacGregor; Starkey, 1994a; Taylor, 1994).

Cases of saddle galls or back sores are very common (Svendsen, 1991; De Aluja et al., 1991, 1994; Starkey, 1997; Feseha, 1997). This is caused by the total lack of any type of saddle or padding for protecting the back of the donkey from loads (Starkey, 1994a; Feseha et al., 1997) or from the traditional way of loading whereby the load is put horizontally on the back without any padding, thus producing excessive and uneven pressure and friction against the vertebral column (Yilma et al., 1991; De Aluja et al., 1994). In one observation made in Ethiopia, 34% of 2020 donkeys examined were found to have saddle galls of different degrees of severity and it was noted that saddle galls were second only to parasitism in prevalence (Yilma, et al., 1991). Similarly, of 1400 donkeys examined in Mexico, 40% were found with saddle galls (Rodriguez-Maldonado, 1991).

The manufacture of harnesses is often improvised using pieces of cords, discarded bicycle or car tyres and turns of nylon ropes and wires. Deep sores under the girth straps, the tail, neck and any point where the harness or equipment is in contact

with the skin are very common findings in almost all countries (Bakkoury et al., 1991; Canacoo, 1991; Svendsen, 1991; De Aluja et al., 1994; Starkey, 1994b; Feseha et al., 1997; Fielding et al., 1998).

Restraining donkeys to prevent them roaming too far is common, particularly during the cropping seasons, in market places, local flourmills and watering areas. This restraining is done either by hobbling or tethering them. Often the tethering or hobbling materials used are very thin and made of nylon ropes or wires leading to deep cuts on the legs (Starkey, 1997; Getachew and Feseha, 1997; Fielding et al., 1998). It is common to see donkeys with bands of white hair around their legs resulting from tethering or hobbling wounds that have caused damage to the pigment producing cells (melanocytes) in the area. Moreover, tethering or hobbling jennies is very dangerous, as in most countries jacks are rarely castrated. As the jenny has no freedom of movement when she is rejecting the advances of the jack, self-inflicted injuries are very common (Getachew and Feseha, 1997; Starkey, 1997; Fielding et al., 1998).

As draught animals, donkeys are badly harnessed often with the majority of the force acting on the neck instead of the chest. Due to the lack of appropriate equipment for donkeys, they are forced to pull heavy equipment that has been designed for oxen or horses (Kumwenda et al., 1991; Svendsen, 1991; Starkey, 1994b). The donkeys are often subjected to loads of two thirds of their body weight and it is common to see donkeys struggling with clumsy, overloaded carts (Svendsen, 1991; Starkey, 1994a).

Apart from work-related health problems, wounds caused by predators, fighting because castration is not widely practiced, abuse from the man, car accidents and horn

gores are cited as common problems in many countries (Canacoo, 1991; Rodriguez-Maldonado, 1991; De Aluja et al., 1994; Getachew and Feseha, 1997; Feseha et al., 1997).

1.5.2 Nutrition and feeding of working donkeys

In rural areas donkeys seem to be able to maintain a reasonable condition for most of the year if allowed to graze good pasture (Pearson et al., 1997a). However, weight changes can be considerable in areas where the quantity and quality of grazing is poor during the dry seasons and in areas where donkeys are over-worked, which is the case in many countries particularly in sub-Saharan Africa and Latin America (De Aluja et al., 1994; Pearson et al., 1997b).

Meeting the energy requirement for maintenance, locomotion and work from available feed can be difficult during the dry season when feed is very scarce (Smith, 1991). Numerous observations made in Africa, Asia and Latin America, have suggested that in almost all cases, donkeys are left to graze or forage for themselves. Feeding of donkeys is entirely based on grazing communal owned grasslands as well as road sides or rocky hillsides where grass growth is stunted and the availability and type of grasses varies seasonally (Bakkoury et al., 1991; Mohammed, 1991; Ramachandran, 1991; Pradhan, 1991; Mkufya et al., 1994; Feseha et al., 1997; Twerda et al., 1997).

Unlike other farm animals which often have access to supplementary feed, donkeys seem to survive due to their tremendous capacity to utilize feeds of low quality (Tisserand, 1991; Upadhyay, 1991; Bakkoury et al., 1991; Feseha et al., 1997).

There is little awareness of the need to feed, adequately, working donkeys. Concentrate feed is often thought to be too expensive to feed to donkeys. Work done by Smith (1991) demonstrated that oxen fed on the type of feed available in the tropics could not increase their consumption of feed to match the energy spent whilst working. If this is the case for oxen for which supplementary feeds are provided, one can easily imagine that a similar situation exists for donkeys. Good feeding does not just benefit working donkeys: good body condition is associated with being better able to resist disease challenge, longevity and higher reproduction rates.

1.5.3 Housing

The essential features of housing animals are to provide a healthy environment and to give protection from adverse weather conditions (Sainsbury, 1997). However, working donkeys are not usually privileged with such conditions. At night they are generally kept in kraals or enclosures which have no protection against adverse weather conditions (De Aluja et al., 1994; Itepu, 1997; Twerda et al., 1997; Wells et al., 1997) but do provide protection from night predators such as hyenas and wolves, and theft. Other owners who do not have the means for providing shelters, keep their donkeys outside hobbled to tree trunks (Mohammed, 1991 and Twerda et al., 1997).

During the day-time when the donkeys are not working, they are not usually herded, rather left to graze or maybe hobbled or tethered during the cropping seasons (Starkey, 1994a; Pearson et al., 1997b; Twerda et al., 1997; Fielding et al., 1998). In areas where there are no natural shelters, such as trees, particularly during the dry season, it is a common feature to see donkeys, constantly tormented by flies, gathered

together in open fields in an attempt to minimize fly irritation (Mohammed, 1991; Getachew and Feseha, 1997).

1.5.4 Foot care and farriery in working donkeys

The value of working animals relates directly to their ability to move. The well-known saying, 'no foot no horse' is equally applicable to donkeys. It is widely held that working donkeys walking on hard surfaces do not need much of foot care (Lopez et al., 1994; Fowler, 1995). Indeed, overgrown hoof is not common in working donkeys. Furthermore, the diet they are exposed to is not of good quality reducing the likelihood of foot problems (William, 1986; Mkufya, 1994; Fowler, 1995). Unfortunately, basic foot care and farriery are practically non existent except where charity organizations such as the International Donkey Protection Trust (IDPT), The International League for the Protection of Horses (ILPH), World Farriery Association (WFA) and the Brook Hospital for Animals provide assistance for donkey owners (Svendsen, 1991; De Aluja et al., 1994; Green, 1994; MacGregore, 1994; Mkufya, 1994; Taylor, 1994). Various types of foot abnormalities do exist as uneven wearing of the hoof can lead to uneven conformation of the hoof, contracted heels, contracted tendons, angular deviations and twisted feet. Keratoma, thrush, foot abscesses, bruised soles, penetrating wounds of the hoof, hoof cracks and coronitis have all been reported (Bakkoury, 1991; Svendsen, 1991; Rodriguez-Maldonado, 1991; De Aluja et al., 1994; Lopez et al., 1994; Makufya, 1994; Getachew and Feseha, 1997).

In some countries, shoes for donkeys are found but are made of scraps of metal and rubber, and they are attached with carpenters' nails being driven from either distal or plantar aspects of the hoof (Green, 1994). Poor technique, primitive tools, lack of

knowledge and understanding and lack of suitable materials worsen the condition, resulting in severe foot and limbs injuries and abnormalities. Most commonly, a long toe-low heel imbalance is the result and sensitive tissue penetration and sole bruising are very common (Green, 1994; MacGregor, 1994).

1.6 DISEASES OF THE DONKEY

1.6.1 Parasites of working donkeys

With regard to parasitism, most studies report the occurrence of parasites from relatively small numbers of animals and with reference to a narrow range of parasites (Pandey et al., 1994). Helminthology, however, is one area that has been investigated more thoroughly than other health problems. Compared to horses, however, the information on donkeys is rather limited and related mainly to African countries (Sewell, 1991; Pandey et al., 1994). Studies have shown that there is an overall similarity in the type of parasite affecting horses and donkeys and there is also similarity in the species of parasites, particularly helminths, present in a wide range of climatic zones. (Sewell, 1991). This contrasts markedly with the situation in ruminants in which there is a clear difference in the genera of the helminths which predominate in areas where the main season for acquiring the infection is cool, with temperature 15-20 ^{o}C as against those where the eqivalant season is warmer (Hammond et al., 1990; Sewell, 1991).

1.6.1.1 Helminths of donkeys

According to Lichtenfels (1975), equids are hosts to 75 species of helminths belonging to 28 genera of nematodes, five species of trematodes and four species of cestodes.

Small strongyles (*Cyathostomes*), large strongyles, *Parascaris equorum, Habronema* species, *Oxyuris equi* have been reported from many African countries and also from the USA and UK (Pandey, 1980a, 1980b, 1980c, 1983; Pandey et al., 1988, 1990, 1991, 1992a, 1992b, 1993; Malan et al., 1982; Tolliver et al., 1985; Eysker et al., 1989; Feseha et al., 1991; Sewell, 1991; Yilma et al., 1991; Mukhwana, 1994; Svendsen, 1994; Trawford, 1997). Due to the complex taxonomy and difficulties in the identification of *cyathostomes,* very few workers have identified these parasites to the species level (Pandey et al., 1994). Work done by Eysker et al. (1989) in Zimbabwe revealed 11 species of cythostomes in donkeys. Some parasites such as *Trichostrongylus axei*, *Probstmayria vivipara*, *Strongyloides* and *Setaria* species are less frequently reported (Graber, 1970; Pandey, 1980a, 1980b, 1980c, 1983; Feseha et al., 1991; Yilma et al., 1991). These may have been overlooked due to their size and their predilection sites. Some helminth parasites are reported even more rarely such as *Onchocerca raillieti* (El Sammani et al., 1983), *Dictyocaulus arnfieldi* (Pandey, 1980a; Khallaayoune, 1991; Mukhwana, 1994; Feseha et al., 1991; Yilma et al., 1991), cestodes and trematodes (Graber, 1970; Vercruysse et al., 1986; Feseha et al., 1991; 1997; Yilma et al., 1991; Pandey, 1993). The general trend in most countries is for polyparasitism involving a large number of species (Pandey, 1994 et al; Svendsen, 1997a).

Apart from food deficiency, parasites are the major contributors to the short life span of donkeys in Africa, Asia and Latin America (Pandey et al, 1994; Feseha ,

1997; Svendsen, 1997a). The control of parasitic infection may well be the key to the well-being of working donkeys and it has been shown that a strategic worming programme can not only increase the general health of the donkey, allowing it to maximize utility of the sparse food allocated to it, but also lead to improved body condition and increase the life span (Bliss et al., 1985; Yilma et al., 1989; Feseha et al., 1991; Khallaayoune, 1991; Svendsen, 1997a).

1.6.1.2 Arthropods and other ectoparasites

Although there are many ectoparasites that infest donkeys, information on their occurrence and importance is rare (Pandey et al., 1994). *Gasterophilus* larvae are frequently reported arthropods in donkeys (Pandey et al., 1994). Even though six species of *Gasterophilus* are known (Zumpt, 1965), *Gasterophilus intestinalis* and *Gasterophilus nasalis* are the one most commonly reported (Graber, 1973; Hilali et al., 1987; Khallaayoune, 1991; Feseha et al., 1991, 1997; Pandey et al., 1988, 1990, 1992b). The nostril fly, *Rhinoestrus* species has been identified in Senegal (Kaboret et al., 1986).

Mange mites, occasionally *Psoroptes equi* (Abu Samara et al., 1987), *Sarcoptes equi* (Gabaj et al., 1992), lice, *Haematopinus asini and Damalinia equi* (El Gawad et al., 1987; Feseha, 1997), ticks (McCarti et al., 1987; Sahibi et al., 1994; Feseha et al., 1993, Feseha, 1997) have been reported in donkeys.

Habronema species are frequently reported in different countries, but cutaneous habronemiasis seems to be rare (Mohammed et al., 1990; Sims et al., 1991). Similarly, ticks and flies are known to occur in donkeys but again there are hardly any recent publications available on this subject (Pandey et al., 1994): one report from the

East Cape of South Africa identified ticks and mange mites as a major cause of skin problems (Wells et al,. 1997).

1.6.1.3 Protozoa

As with ectoparasites, publications or reports on parasitic protozoa of equids, in general, and donkeys in particular, are rare (Pandey et al., 1994).

1.6.1.3.1 Trypanosomes and trypanosomiasis

Published information on the epidemiology and economic importance of equine trypanosomiasis is scanty or non existent for most countries (Barrowman, 1991). The main reason suggested for this is that although a national equine population may be large, the number affected are generally owned singly or in small numbers, so that the overall importance of infection is not as easily measurable as it would be in a herd. Also, these animals are often owned by subsistence farmers or nomads whose problems are less likely to be identified or reported (Barrowman, 1991; Wells, 1984). However, it has been shown that equids including donkeys can be infected with various trypanosome species. Common trypanosome species identified infecting donkeys are *Trypanosoma brucei, Trypanosoma congolense, Trypanosoma evansi, Trypanosoma vivax* and *Trypanosoma equiperdum* (Boyet et al., 1972; Leach et al., 1981; Soulsby, 1982; Wells, 1984; Jurasek, 1986; Stephen, 1986; Barrowman, 1991; Feseha et al., 1993; Snow et al., 1996).

Donkeys are considered to be resistant to trypanosome infections and the infection is reported to be mild, asymptomatic and usually results in self-refractory or

chronic form. Donkeys are thought to play an epidemiological role as an important reservoir of infections (Leach et al., 1981; Wells, 1984; Stephen, 1986; Barrowman, 1991; Onovirian et al., 1991). However, work done by Sowe et al. (1990), Smith (1991), Feseha et al. (1993), De Wall et al. (1994), Mattioli et al. (1994), Sahibi et al. (1994) and Kebede (1995) has shown that donkeys can potentially be susceptible to trypanosomiasis in their own right.

It is important to realize that obvious disease and death are not the only consequences of trypanosomiasis or other diseases in general. In cattle, productivity in terms of work, reproduction and milk output can be significantly reduced even in animals that show little apparent sign of the disease (Murray and Gray, 1984; Trail et al., 1985). Exposure of infected donkeys to increased work-load, lower nutrition and gastrointestinal parasite burden, which are all known to be major health and management problems, will have an unfavorable influence on the performance and materially reduce the duration of working life. Unfortunately, there has been no work done concerning the economic effect of trypanosome infection in working donkeys (Barrowman, 1991).

Other parasitic protozoa reported in donkeys include Babesia. *Babesia equi* and *Babesia caballi* are reported in working donkeys in Africa (Nafie et al., 1982; Selim et al., 1983; Jurasak, 1986; Feseha et al., 1993; De Wall et al., 1994; Sahibi et al., 1994). *Eimeria leukarti* (Chineme et al., 1979; Karanja et al., 1993) and *Klossiella equi*, the only known coccidian parasites of equine urinary tract (Karanja et al., 1995) have also been reported in donkeys.

1.6.2 Viral, Bacterial and Fungal diseases of donkeys.

There are 37 documented clinical syndromes of viral infection attributable to 14 taxonomic viral groups in equidae (Ramachandran, 1991). A number of bacterial and fungal infections have also been reported affecting horses world-wide (Rossdale et al 1980; Blood et al., 1989; Edelsten et al., 1990; Love and Mair et al., 1998). However, information on donkeys is extremely rare.

Horses used for recreation or as investments are usually valuable animals, often moved over long distances to different geographical areas for selective breeding and training. This practice exposes horses to infection much more than the traditional practices of the peasant farmer who rarely take his animals much beyond his property (Gibbs, 1981). It is this combination of wealthy ownership, large financial investment and internal exposure to infection that has resulted in considerable information being generated on the role of microbial infections as a cause of diseases in race and riding horses (Gibbs, 1981). In contrast, the peasant who rarely owns more than one or two equids can seldom afford veterinary services, so information on microbial diseases of equids in general, and donkeys in particular, in developing countries, is non-existent, being limited to the major epidemic diseases such as African Horse Sickness, Venezuela Equine Encephalitis and Anthrax (Howell, 1963; Gibbs, 1981; Sims, 1991). However, donkeys can potentially be infected by many viral, bacterial and fungal agents (Howell, 1963; Gibbs, 1981; Uppal et al., 1987, 1988, 1991; Edelsten et al., 1990; Sims, 1991; Yilma et al., 1991). Moreover, this is supported by serological, bacteriological and fungal investigation at The Donkey Sanctuary (Fowler, 1986; Crane, 1997a), seroepidemiological survey of donkeys in South Africa (Paweska et al.,

1997) and from the region of Nigeria (Adeyefa et al., 1996) and the work done by Uppal (1991), Ramachandran (1991) and McCollum et al. (1995).

Common viral infections reported in donkeys include African Horse Sickness (Howell, 1963; Gibbs, 1981; Ramachandran, 1991; House, 1993; Coetzer et al., 1994; Adeyefa et al., 1995), Equine Influenza (Gibbs, 1981; Uppal et al., 1987, 1988; Ramachandran, 1991; Adeyefa et al., 1995), Venezuela Equine Encephalitis (VEE) (Gibbs, 1981; Sims et al., 1991), Equine Infectious Anaemia (EIA) (Sims et al., 1991; Ramachandran, 1991) and Equine Arteritis Virus (EAV) (McCollum et al., 1995 ; Paweska et al., 1997).

African Horse Sickness causes diseases in horses, mules and donkeys with up to 95% mortality among susceptible animals (Howell, 1963; Brown et al., 1990). Epidemics of African Horse Sickness have been recorded in South Africa from as early as 1780 (Theiler, 1921) and evidence of endemic infections exists for most of Africa, South of Sahara (Reid, 1961, Gibbs, 1981; House, 1993; FAO, 1994; Adeyefa et al., 1995), particularly in Egypt and Ethiopia. According to Brown et al. (1990), it is the mild form of African horse sickness (AHS), which is an influenza like syndrome followed by total recovery, that is frequently seen in donkeys, mules and zebras. Although some workers suggest that donkeys appear to have some natural resistance to the development of the severe form of the disease (Brown et al., 1990) or are less sensitive to AHS (Gibbs, 1981, Reid; 1961; Sims, 1991), in an epidemic affecting the Middle East in the 1959-1961 over 300,000 horses, donkeys and mules died. Higher death rates were also recorded in epidemics involving South African donkeys (*Equus*

asinus somalicus) than in the nomadic species (*Equus asinus africanus*), prevalent in North Africa in 1944 (Alexander, 1948).

Venezuela Equine Encephalitis (VEE) has been reported to be fatal to donkeys. In one epidemic in Colombia in 1967, 27,000 donkeys and 40,000 horses and mules died of the disease (Gibbs, 1981).

A new variant of Equine Influenza Virus (A/equi-2) was isolated during an epidemic in North and Central India in 1987. During this period it was documented that donkeys were most severely affected resulting in higher mortality compared to horses and mules in some regions of the country (Ramachandran, 1991; Uppal, 1991). Cases of Equine Influenza in donkeys have also been reported in Mexico (Rodrogouez-maldonando, 1991) and Nigeria (Adeyefa et al., 1995).

Equine Infectious Anaemia, though reported in donkeys, is thought to result in asymptomatic infection (Ramachandran, 1991).

Even though, equine rabies is uncommon (Ramachandran, 1991), the number of species of mammals in which rabies has been recorded has grown steadily as diagnostic methods have improved and wider field studies conducted. It now seems likely that all mammals are susceptible (Crick, 1981). There are few reports concerning equine rabies, particularly in donkeys. In Europe, rabies in horses, mules and donkeys accounted for 0.3 to 0.5% of the total number of domestic mammals affected in 1979-1988. The mean number of confirmed cases per country reported in horses, mules and donkeys was 74, 9 and 0.6, respectively. Almost all mule and donkey cases were from Turkey (Ramachandran, 1991). There are also other reports of

rabies cases in donkeys from Ethiopia (Feseha, 1997) and a lethal form of rabies transmitted by vampire bats from Mexico (Sims, 1991). According to Badiali et al. (1968), a donkey strain of rabies virus was found to be non-pathogenic to rodents and dogs.

Other viral infections reported affecting donkeys include donkey pox virus from the USA (Ramachandran, 1991): Equine Arteritis Virus (EAV) in South Africa (McCollum et al., 1995; Pawesk et al., 1997); Equine Viral Rhinopneumonitis caused by EHV-1 in Mexico (Sims et al., 1991) and in UK causing most of the respiratory problems (Fowler, 1986); Asinine Herpes Virus (AHV-2) causing conjunctivitis in donkey foals and Asinine Herpes Virus (AHV-5) causing coital exanthema of donkeys (Ramachandran, 1991). According to Ramachandran (1991), the Asinine Herpes Virus (AHV-5) was found to be antigenically distinct from other Equine Herpes Viruses. Also, though, not in the case of domestic donkeys, Equine Herpes Virus (EHV-1) have been reported causing abortion in Grevy's zebras (*Equus grevy*) and onager (*Equus hemionus)* (Ramachnadran, 1991).

Common bacterial and fungal diseases known to infect horses include anthrax, strangles, tetanus, glanders, dermatophilosis, salmonellosis, brucellosis, leptospirosis, ulcerative lymphangitis, ringworm (dermatomycosis), epizootic lymphangitis in tropical and subtropical areas (Rossdale et al., 1980; Mansmann et al., 1982; Blood et al., 1989; Edelsten et al., 1990; Love and Mair et al., 1998). Anthrax, strangles, tetanus, glanders, ulcerative lymphangitis, epizootic lymphangitis and ringworm are rarely reported in donkeys (Edelsten et al., 1990; Sims et al., 1991; Uppal, 1991; Yilma et al., 1991; Feseha, 1997; Fielding et al., 1998).

Even though the above mentioned viral, bacterial and fungal diseases are described in donkeys, reports do not go further than being simple descriptive accounts and there are no epidemiological studies in the literature and the economic importance of the diseases is unknown.

1.6.3 Skin tumours in donkeys

Skin tumours of horses have been studied by several workers (Jacson, 1936; Moulton, 1961; Rangland et al., 1970; Cotchin, 1977; McMullan, 1982; Trenfield, 1985). According to these studies and others (Sundberg et al., 1977; Pascoe, 1981; McConaghy et al., 1994), the sarcoid is found to be the most common and highly prevalent affecting the skin of horses. Sarcoid is a locally aggressive and invasive fibropapilloma of equidae (Jacson, 1936; Rangland et al., 1970; Howarth, 1990) which is thought to be caused by a papillomavirus similar to bovine papillomavirus (Trenfield et al., 1985; Angelos et al., 1991; Reid et al., 1994b).

Although several studies have been conducted in horses, the information available in donkeys is rare and there are no published data available as to the common skin tumours affecting donkeys worldwide in general, and in tropical and sub-tropical countries in particular. Several reports, though, have indicated that among skin tumours of donkeys, sarcoid is the most common (Rodriguez-Maldonado, 1991; Yilma et al., 1991; Reid et al., 1994a; Crane, 1997b and Feseha, 1997).

Work done by Yilma et al. (1991) demonstrated that 33 (3%) of 1090 clinically examined working donkeys had sarcoid. The only work done in detail on donkey sarcoid was conducted by Reid et al. (1994a) in the UK. According to epidemiological observations made by Reid et al. (1994a) on a large donkey population (over 4000),

the prevalence of sarcoid was 4.4% and the disease frequently occurred in young animals between 2 and 5 years of age. Moreover, the study demonstrated that male/geldings are more frequently affected than females and the common predilection sites of the lesions are the paragenital region, head, ventral abdominal and limbs. However, multiple sites may be involved. Cases of the periocular and ocular sarcoid are the most serious, often leading to blindness. Out of 80 cases of donkeys with sarcoid, 15% had periocular lesions according to Reid et al. (1994a). A further investigation into the molecular biology of sarcoid from donkeys has identified papillomavirus DNA, homologous to bovine papillomavirus, BPV-1 and BPV-2. Moreover, it also revealed that the disease in donkeys is similar to that in horses (Reid et al., 1994b; Nasir et al., 1997).

1.7. CONCLUSION

The lack of published material on donkey health and welfare is an obvious constraint to the development of healthcare programmes for working donkeys. In many instances, strategies are devised simply by extrapolating from studies performed on the distinct, albeit, closely related, species, the horse. These may be far from justified.

Given the paucity of information specifically dedicated to diseases of the donkey, the studies described in the following chapters were designed to begin to address this issue, at least for the Ethiopian donkey.

1.8. OBJECTIVES OF THE STUDY

The objectives of this study there fore were two fold:

(i) General objective. To identify the major health and management problems of working donkeys at four project sites in Ethiopia and to suggest focus for future studies.

(ii) Specific objectives. Based on some of the results from the general objectives, specific studies were conducted in the area of parasitology. These specific objectives were:

a. Assessing the prevalence and level of infection of donkeys by gastrointestinal parasites.

b. Identifying the gastrointestinal parasitic population.

c. Evaluating the efficacy and safety of the currently used anthelmintic, ivermectin, administered through different routes against gastrointestinal and pulmonary helminths.

CHAPTER 2

GENERAL MATERIALS AND METHODS

2.1 STUDY AREAS AND DONKEY POPULATION

Studies conducted and reported in this thesis were carried out in areas where the Donkey Healthcare and Welfare Project (DHWP) in Ethiopia operates, under the auspices of the International Donkey Protection Trust (IDPT). These areas are located in different climatic zones with varying donkey populations (Table 2.1). Donkeys of all age groups and sexes, brought for the treatment at each of the project working sites, were considered eligible for inclusion in this study.

Table 2.1 Climatic data and donkey populations of the study areas in Ethiopia.

Areas	Altitude range (masl)*	Annual rainfall (mm)	Average daily temperature (°C)	Donkey population
Ada	1800	800	19	20437
Akaki	1700-2100	1000-1300	18-20	9000
Bereh	2300-3000	3000	15	12265
Boset	1200-2000	550-700	28-34	34726

* Meters above sea level

2.2 CLINICAL EXAMINATION AND DATA COLLECTION

The project has one mobile clinic, which functioned five days per week. All necessary and possible treatments were provided for donkeys and mules and every clinical

condition was recorded. During each visit to the project sites, donkey owners were registered and randomly selected from the record sheet and further systematic clinical examinations were performed on their donkeys for the presence of disease. Clinical examination included, body condition scoring (Svendsen, 1994), recording of skin conditions and their causes, foot problems and disorders, eyes problems, respiratory and urogenital problems, gastrointestinal problems, and identifying the presence of ectoparasites and collecting or recovering them (Appendix I). Beside the clinical examinations, simultaneous questioning of the owners were performed. This included: whether the animal was sick before and had received treatment; whether the animal had the identified problem(s) before, and for how long; whether his or her mature female donkey had given birth, if so, how many time and how many foals had died, and whether the donkey aborted and how many times. All clinically observed and diagnosed conditions and information obtained through the owners' interview were recorded in the prepared data record sheet.

2.3 LABORATORY SAMPLE PROCESSING

2.3.1 Faecal worm egg counts

Faecal samples were collected directly from the rectum of the donkeys of all ages, sexes and different body conditions into an air tight jar. The samples were transported to the laboratory and stored at 4°C until examination. Faecal worm egg counts using the modified MacMaster technique were performed within 48 hours (MAFF, 1984). Briefly, the protocol was as follows:

1. 3 grams of faeces in 42 ml of water were shaken in a small bottle until all the faecal material was broken down.

2. The mixture was poured through a wire mesh screen with an aperture of 0.15 mm and the strained fluid caught in a bowl, discarding the debris left on the screen.
3. The strained fluid was well mixed and a sample of it is centrifuged for two minutes at 1500 rpm and the supernatant was discarded.
4. The tube was agitated until the sediment was loosened and formed a homogenous sludge at the bottom of the tube and then filled with saturated salt solution to the same level as before.
5. The contents were mixed thoroughly and immediately a sufficient amount of the fluid was withdrawn with a Pasteur pipette and carefully allowed to run into each chamber of the counting slide.
6. The eggs in the two chambers were counted and the number of eggs per gram of faeces was obtained by multiplying the total eggs in the two chambers by 50 (3g of faece yielded 45 ml of suspension and 0.3 ml were examined).

2.3.2 Simple and rapid qualitative method to recover fluke eggs

1. 20-30 gams of faeces were washed through a wire mesh screen with an aperture of 0.15 mm with a forced jet of tap water and the filtrate was collected into a 250ml beaker.
2. 10 ml of the sample was centrifuged for 2 minutes at 1500 rpm and the supernatant was discarded. This procedure was repeated 3 to 4 times until the content of the tube was fairly clear.
3. The content was agitated and poured into a 90 mm petridish and examined for fluke eggs under a dissecting microscope, using a pair of 10x eye pieces and 32 mm objective.

2.3.3 Ova culture, differential larval count and identification

The faecal samples directly collected from the rectum were cultured in an incubator at 27°C for seven days (MAFF, 1984). The Baermann technique (MAFF, 1984) was used for larvae recovery. The protocol was as follows:

1. 10 grams of faeces was placed in a petridish with a loose-fitting top and left for 7 days in an incubator running at 27°C, stirring daily to inhibit fungal growth and for aeration.
2. The sample was spread on a circular filter paper, 170 mm in diameter, and placed in a wire mesh screen (0.15 mm aperture) of the Baermann apparatus and left to stand over night.
3. 6 ml of the sample was collected, well agitated and 0.15 ml of the sample was taken by Pasteur pipette to a microscope slide, covered with a 38x22 mm cover slide and systematically examined under a compound microscope (32x).
4. The number of larvae per gram was calculated as 4L where L is the number of larvae counted in 0.15 ml.

The larvae were identified to their specific genera and/or species according to the key description given by Russell (1948), Duncan (1979) and Georgi and Georgi (1990).

2.3.4 Post mortem worm recovery and identification

A complete examination of the contents and mucosal lining of each portion of the gastrointestinal tracts was conducted to recover mature adult worms. The portions of the gastrointestinal tracts examined for parasites were stomach, small intestine,

caecum, colon and rectum. The abdominal cavity and organs located therein were also examined. The aliquot sampling procedures of Drudge et al. (1963) and Lyons et al. (1983) were employed on each portion of the gastrointestinal tract contents and rinsed to recover and estimate the number of small strongyles and other small parasites. The contents and rinses of each portion were measured volumetrically, thoroughly mixed and sampled by the removal of 20% of the original content. Subsequently, the samples were thoroughly mixed and sub sampled in 200ml aliquot, which comprises 4% of the original total content and preserved in 10% formalin. After washings on a 60 mesh sieve (0.2mm), residues were carefully examined by dilution in water in a petridish under a dissecting microscope (30x). The remaining samples from each portion and the mucosal linings were examined for large strongyles and other large parasites. The worms were cleared in lacto-phenol solution and identification of the small strongyles and other small parasites was performed under a compound microscope (100x or 400x) and the large strongyles under the dissecting microscope (30x). The presence of the species of small strongyles and other small parasites such as *Trichostrongylus axei* and *Probstmayria vivipara* was determined by identifying all of the specimens from the subsamples. The parasite collections were identified to species according to Lichtenfels (1975) and the arthropod larvae according to Zumpt (1965).

2.4. DATA MANAGEMENT AND ANALYSIS

All field and laboratory data of the study animals were recorded on predesigned data record sheet and transferred to computer files using the database management system, dBase III Plus, version 1.0 software programme (Ashton-Tate, 1980 USA). Graphs and descriptive statistics were performed using data analysis tools in Microsoft Excel 97.

Other statistical analysis were done using Statistix Analytical Software, Version 4.0, 1992. Details of statistical analysis and modules used for specific studies are described in the material and method section of their respective chapters.

CHAPTER 3

THE PRINCIPAL HEALTH PROBLEMS OF WORKING DONKEYS IN ETHIOPIA

3.1 INTRODUCTION

The donkey is one of the most important domestic animals, contributing to many social and economic sectors (Fielding, 1987; Wilson, 1991; Clutton-Brock, 1992; Starkey, 1994a; Blench, 1997; Fernando, 1997; Svendsen, 1997b). They are often described as the poor man's horse, a situation well reflected in the animal-energy agriculture of Ethiopia.

Despite the large number of donkeys and the valuable service they provide, the attention given to health and welfare policy related to the donkey is minimal. In particular, research and development of the different aspects of veterinary care for donkeys is poorly developed. The Donkey Healthcare and Welfare Project (DHWP) in Ethiopia is part of the International Donkey Protection Trust (IDPT) established in 1987 by an agreement between the Faculty of Veterinary Medicine, Addis Ababa University and the IDPT, based in the UK. The common health, management and welfare problems of donkeys and mules in Ethiopia are the subject of study by the project and, starting in 1994, the project has used a mobile clinic to identify and treat health problems of donkeys and mules. Since its inception, specific studies undertaken by Feseha et al. (1991, 1993) and Yilma et al. (1991), have documented some of the health problems of donkeys and have identified gastrointestinal parasites as a major concern. The objective of this chapter is to describe the principal health problems of working donkeys in four different project working sites, thereby providing a focus for future policy with regard to donkey health and welfare in Ethiopia.

3.2 MATERIALS AND METHODS

3.2.1 Study areas and animals

The study areas covered by the Donkey Healthcare and Welfare Project were Ada, Akaki, Bereh and Boset as described in Chapter Two. The total donkey population covered by the project is estimated to be approximately 76,000 donkeys. Donkeys of all ages and sexes brought for treatment during the team's visit to each site were considered eligible for inclusion in this study.

3.2.2 Clinical and clinico-pathological examinations

Systematic clinical examinations were carried out in order to identify the presence of any disease, as described in Chapter Two. All clinically observed signs, diagnosed conditions and information obtained through the owners' interview were recorded in a standard data sheet. (Appendix II) During the clinical examination, donkeys were assessed for ectoparasites or signs of their presence. These included ticks, lice, mites, flies and fleas. The presence of mixed infestations was also recorded. An attempt was made to identify the parasites by laboratory means according to (Sloss and Kemp, 1978; Georgi and Georgi, 1990).

Faecal samples were collected directly from the rectum of donkeys of all ages, sex, and different body condition before treatment in order to determine the prevalence and level of infection by gastrointestinal and pulmonary helminths. Faecal worm egg counts using the modified McMaster technique (MAFF, 1984) were performed as described in Chapter Two.

3.3 RESULTS

During the period 1995-1997, over 20,000 donkeys belonging to more than 10,000 owners were presented for different health problems. In total, 9493 donkeys of both sexes and ranging in age from 2 weeks to over 30 years were examined and more than 40,000 clinical conditions were treated. The body condition of the donkeys was generally poor with 99% having body condition score of less than 3 and 1% with a score of 3. Eleven percent were in a very poor condition with a body condition score of 1.

The study revealed a number of health problems at all project sites. Common clinical conditions encountered are shown in figure 3.1.

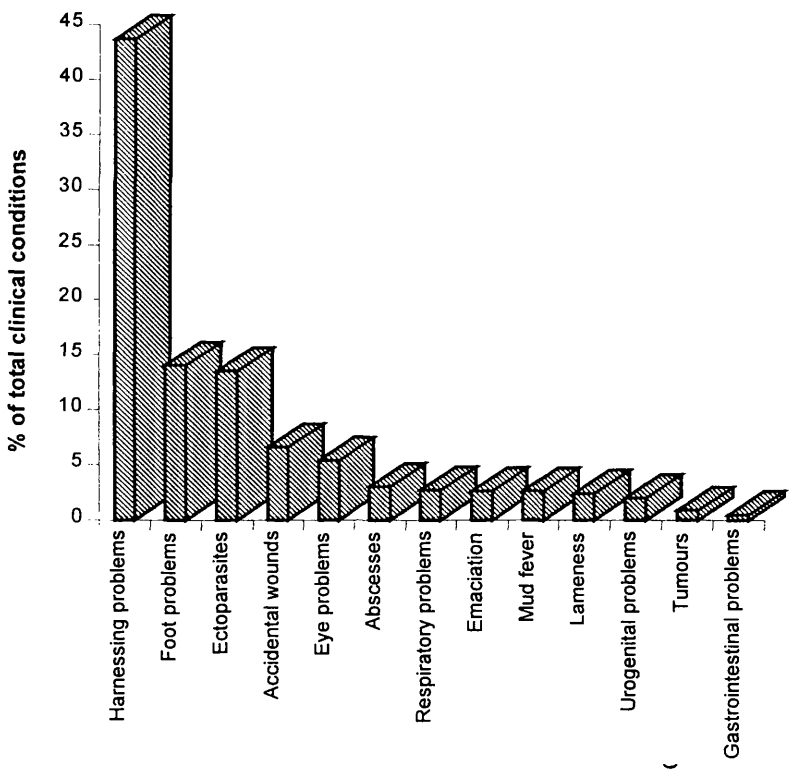

Figure 3.1 Common clinical conditions encountered in 9493 clinically examined working donkeys at all project sites, Ethiopia.

3.3.1 Gastrointestinal and pulmonary helminths

Helminthosis was found to be highly prevalent at all project sites. Of 2935 donkeys examined only one donkey was negative for helminths and the rest were found to harbour ova and/or larvae of large and small strongyles, ascarids, strongyloides, pinworms, lung worms, fluke, cestodes, stomach worms and bots. Gastrointestinal parasites were not only highly prevalent, but also had a high infection rate with more than 54% of the donkeys having a faecal worm egg count greater than 1000 epg.

3.3.2 Ectoparasites

The result of the ectoparasite survey revealed that ticks and lice were the major external parasites of donkeys (Table 3.1). *Amblyoma, Rhipicephalus, Boophilus and Hyalomma* species were among the highly prevalent tick species. The lice species identified were *Haematopinus asini* and *Damalinia equi*. In general, young donkeys less than three years of age and old donkeys of poor condition were the ones which suffered from lice infestation. Mixed lice and ticks infestation was a common feature. Mange mites were not a major problem in working donkeys, with a prevalence of only 0.3% (Table 3.1). *Psoroptes equi* and *Sarcoptes equi* were the only identified mites, 93% being *Psoroptes equi*. Flies were another common ectoparasite frequently observed annoying and feeding on donkeys. Common flies identified are shown in table 3.2. Eighty percent of the donkeys were infested with bot fly eggs.

Table 3.1 Common ectoparasites recovered from 9493 donkeys at all project sites, Ethiopia.

Ectoparasites	No. Positive	% positive	% of total cases
Ticks	3358	35.4	61.4
Lice	2083	21.9	38.1
Mange mites	29	0.31	0.53

Table 3.2 Common fly species identified annoying and feeding on donkeys at all project sites, Ethiopia.

	Study sites			
Fly species	Ada	Akaki	Bereh	Boset
Musca domestica	+++	+++	+++	+++
Musca Autumnalis	+++	+++	+++	+++
Stomoxys calcitrans	+++	+++	+++	+++
Tabanids	NS	NS	+++	NS
Hippobosca	NS	NS	NS	+++
Bot flies	+++	+++	++	+++

Key: +++= Very common, ++= Common, NS= Not seen.

3.3.3 Skin conditions

Wounds due to lack of saddle or use of improper padding, improper harness and harnessing materials, and accidents were by far the most common skin problem identified (Figures 3.1, 3.2 and Appendix II). Hyena bites, donkey bites, horn gores, trauma, or abuse and car accidents were common accidental wounds. Of 2670 clinical conditions of accidentally acquired wounds, donkey bites and hyena bites accounted for 55.1% and 32.4%, respectively. (Appendix II) Single or multiple external abscesses, mainly resulting from harnessing injuries and accidental wounds, were very common. Of 9493 donkeys examined, 1269 (13.4%) were found with abscesses of varying degrees of severity. The equine sarcoid was found to be the most common skin tumour. Of 9493 donkeys clinically examined 320 (3.4%) and 25 (0.3%) were found to be positive for sarcoid and warts, respectively.

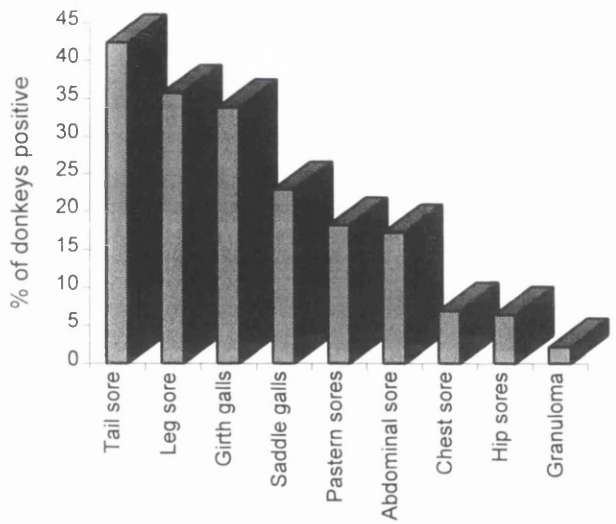

Figure 3.2 Common wounds and sores encountered in 9493 clinically examined working donkeys at all project sites, Ethiopia.

3.3.4 Foot problems and disorders.

Even though hoof overgrowth was not a major finding, examination of donkey feet revealed a number of problems and disorders often not considered as problems by the owners. Common foot disorders are displayed in figure 3.3. Of 5661 clinical conditions of foot problem, twisted feet associated with either long toe or heel, curved hoof, hoof cracks, or contracted tendons accounted for 46.4% (Appendix II).

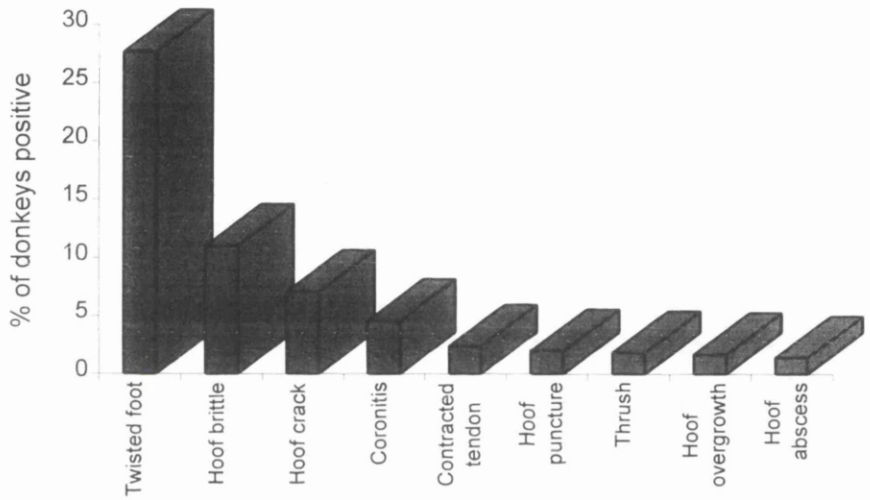

Fig.3.3 Common foot problems encountered in 9493 clinically examined working donkeys at all project sites, Ethiopia.

3.3.5 Eye problems.

Examination of the eyes of the donkeys revealed a number of pathological lesions (Table 3.3). Canthus wounds due to fly strike and lesions similar to habronemiasis were common, leading to blepharitis, blepharoedema and conjunctivitis. Large and dense corneal scars impairing the vision, and blindness, mostly caused by trauma, were observed.

Table 3.3 Common pathological lesions of eyes observed in 9493 clinically examined donkeys at all project sites, Ethiopia.

Pathological lesions	Number	% of total cases
Canthus wounds	820	37.2
Conjunctivitis	396	18.0
Blepharitis	270	12.2
Blepharoedema	251	11.4
Corneal ulcer	188	8.5
Corneal opacity/oedema	137	6.2
Blindness	90	4.1
Neoplasm	54	2.4

3.3.6 Respiratory problems.

Respiratory problems most often characterised by a dry and hacking cough for a prolonged period of time was observed. Of 9493 clinically examined donkeys, 1093 (12 %) were found to have either upper and/or lower respiratory tract problems of varying degrees of severity. Dry coughing, coughing with nasal discharge, coughing associated with head and neck lymph node enlargements and associated abnormal lung sounds were among the observed clinical signs (Appendix II). Drenching pneumonia was another common respiratory problem caused by incorrect drenching of donkeys by the owners with traditional herbal medicine.

3.3.7 Gastrointestinal problems.

Colic, bloat, impaction, rectal prolapse and dysphagia were among the gastrointestinal problems observed. Of 9493 examined donkeys, 190 (2%) were found with gastrointestinal problems (Appendix II).

3.3.8 Urogenital problems

Abortion and foetal mortality were found to be the common reproductive problems among working donkeys. Information obtained on the reproductive history of 1179 mature female donkeys is summarised in table 3.4. Of the total clinical conditions observed 2% were urogenital problems (Figure 3.1). Other urogenital problems such as urethral obstruction, orchitis, paraphimosis and dystocia were among the encountered problems.

Table 3.4 Some reproductive problems observed in mature female donkeys during the period 1995 -1997 at all project sites, Ethiopia.

Cases	Number of donkeys (n= 1179)
Number of donkeys aborted	354
Number of abortions recorded	558
Total foals born	2998
Number of foals died	438
Abortion rate	30.0
Foal mortality rate	14.6

3.4 DISCUSSION

This study has described the different health and management problems of working donkeys at four project sites in Ethiopia. The high infection rates by gastrointestinal helminths at all project sites were probably the reflection of absence of anthelmintic therapy. At all project sites similar parasites were identified despite some differences in their respective prevalence, which may probably be attributed to the effect of differences in climate. The results are consistent with the findings of Feseha et al. (1991), Yilma et al. (1991), Svendsen

(1991,1994), Mukhwana (1994), Pandey et al. (1994) and Selim et al. (1994). Studies conducted by Bliss et al. (1985), Feseha et al. (1991) and Khallaayoune (1991) suggested that improvement in body condition could be achieved following anthelmintic treatment. However, given the prevalence of polyparasitism, the recommendation of appropriate strategic anthelmintic treatment may need to be tailored to specific sites.

Even though ticks, lice and flies were common ectoparasites at all project sites, tick infestation rate varied. The highest infestation rate was recorded in Boset, one of the lowland areas. Although some studies (Feseha et al., 1993; Sahibi and Bakkoury, 1994) have suggested that the degree of tick infestation in donkeys is lower than in cattle, the present observation has shown that donkeys can be infested with large burdens. Studies by Feseha et al. (1993), Sahibi and Bakkoury (1994) and McCart et al. (1987) have demonstrated donkeys with piroplasmosis. With such a high prevalence of ticks in the present study, the risk of piroplasmosis and other tick-borne diseases cannot be ruled out. Severe lice infestations characterised by skin irritation, often causing self inflicted trauma with extensive alopecia, was very common. Similar results were reported by El Gawwad et al. (1987). Although a mixed infestation was most commonly seen, the blood sucking louse (*H. asini*) was the more common finding. This parasite causes anaemia, general debility and weight loss (Johnston, 1994, Urquhart et al., 1996; Trawford, 1997), which was a feature observed in most of the donkeys. The high prevalence of lice infestation in the young donkeys may suggest an age related immunity. The other important ectoparasites were flies. The horse and stable flies are known to be blood sucking insects (Sweeney, 1976; Soulsby, 1982; Urquhart et al., 1996). Apart from their nuisance and blood sucking effects, these insects are also known to transmit diseases such as trypanosomiasis, anaplasmosis, Equine Infectious Anaemia, stomach worms and onchocerciasis (Soulsby, 1982; Hussein and Sammani, 1985; Tarry, 1994). The low prevalence of mange mites may indicate that the donkeys are resistant to these ectoparasites,

because there were horses infected with mange mites sharing the same pasture during this study. Similar results were reported by Trawford (1997) in UK donkeys, which he thought might be due to the wide spread use of ivermectin, an explanation that could not be applied to the present study. However, one recent report from East Cape of South Africa identified mange mites and ticks as a major skin problem (Wells, 1997).

Most of the skin lesions observed were caused by the lack of proper use of saddles or protection for the donkeys' back from the load, improper harness use and harnessing materials, and accidents. Saddle galls or back sores, girth galls, tail sores and leg sores were by far the major problems. Similar results were reported by Canacoo (1991), Pradhan et al. (1991), Rodriguez-Maldonado (1991), Sims and Maldonado (1991), Yilma et al. (1991), De Aluja et al. (1994) and Feseha et al. (1997) suggesting that these lesions are widely spread among working donkeys throughout the world. However, due to their location, tail sore and girth galls may be overlooked and are rarely reported in the literature. Common skin lesions observed around the legs in this study, produced by a thin cord usually used to hobble or tether the donkeys, is consistent with the results of De Aluja et al. (1994).

Wounds from donkey and hyena bites were reported by Rodriguez-Maldonado (1991) and Feseha (1997) which are consistent with the present results. Donkey bites caused by fighting between stallions or from the aggressive pre-coital activity between jenny and jack were common where the number of female donkeys were few and the stallions were not castrated. Canacoo (1991) and Tawdrous (1998) reported similar results. Horn gores from zebu cattle were often observed leading to ventral hernia, and abortion in pregnant jennies. Stabling and feeding donkeys together with cattle was one of the most common reasons for horn gores. Cases of horn gores were reported by Tawdrous (1998) in donkeys stabled and fed together with buffaloes.

The present finding of equine sarcoid is consistent with the results of Yilma et al. (1991) and Reid et al. (1994a).

As donkeys in Ethiopia are working animals, the hoof is continuously trimmed and the chance to overgrow is rare. However, as foot care and farriery is not well practiced in Ethiopia, uneven conformation of the foot, often twisted and associated with long toe and heel, curved hoof, hoof crack and contracted tendons, were the major foot disorders. Similar results were reported by Misk et al. (1985), Canacoo (1991), Lopez et al. (1991) and Rodriquez-Maldonado (1991). Although lameness was not a major problem, it was observed associated with coronitis, thrush, hoof puncture, hoof overgrowth, hoof abscesses, contracted tendons and injuries. Thrush was a common cause of lameness during the wet season, which was also reported by Feseha (1997).

Eye infections characterized by conjunctivitis, predisposed by trauma or systemic infections, were common. Primary conjunctivitis in horses associated with *Moraxella equi* and *Thelazia californiensis* (Gelatt, 1982) and the associated face sore of the periocular region (Johnston, 1994; Tarry, 1994) were observed causing blepharitis, blepharoedema and conjunctivitis in donkeys. Eyelid and nictitating membrane neoplasms, particularly sarcoids, were common problems. Similar results were reported by Reid et al. (1994a) and Getachew and Feseha (1997). Bacterial and viral origins of eye problems cannot be ruled out as they are frequently reported in horses (Mansmann et al., 1982; Johnston, 1994).

Respiratory problems characterized by a prolonged, dry and hacking cough, typical clinical sings of equine influenza in horses (Blood et al 1989) and raised temperature, mucopurulent nasal discharge and enlarged head and neck lymph nodes followed by abscessation and rupture, clinical signs of strangles in horse (Sweeney, 1996; and Newton et al., 1997) were frequently observed. The causative agent of strangles, *Streptococcus equi,* was isolated from camels in Ethiopia (Yigezu et al., 1997) but there is no information as to its

role in the donkeys. There are no references in the literature as to the causes of respiratory disease in working donkeys of Ethiopia. However, studies by Uppal (1991), Ramachandran (1991) and Paweska et al. (1997) have shown that a number of viral and bacterial infections are associated with diseases of the respiratory system in donkeys in other countries. Moreover, serological and bacteriological investigation at The Donkey Sanctuary (Fowler, 1986; Crane, 1997a) suggest that donkeys are susceptible to the spectrum of respiratory viral and bacterial pathogens as in other equids.

Even though gastrointestinal problems such as colic, impaction, bloat and rectal prolapse were commonly observed, the classic signs of colic in horses (Blood et al., 1989) were rarely seen. It is generally accepted the classic signs of colic in donkeys signifies that the condition is very severe and well advanced (Fowler, 1986; Crane, 1997). Bloat due to excessive ingestion of young green grasses was common during the wet season supporting a similar observation by Sims et al. (1991). Impaction due to the ingestion of excessive coarse, dry and high fibre feed such as the fine residue of 'teff' (*Eragositis abyssinica*) was frequently seen during the harvesting and threshing seasons. From the high prevalence of strongyles in working donkeys (Feseha et al., 1991; Yilma et al., Svendsen, 1994), particularly the migrating strongyle, *S. vulgaris*, the most pathogenic of all equine internal parasites (Duncan, 1973; Soulsby, 1982; Austin, 1994; Urquhart et al., 1996), it is impossible to exclude these as a cause of spasmodic colic in working donkeys.

Abortion and foal mortality were the major reproductive problems. As reported by Mitchell and Allen (1975), Rossdale and Ricketts (1980) and Julian (1992), physical stress, fight or trauma and nutritional deficiencies are known causes of abortion, foal mortality and dystocia in horses. Probably the same applies to working donkeys as these animals are highly stressed, poorly managed and suffering from a number of health problems. Infective causes of abortion, prenatal death and foal mortality, such as viral, bacterial and fungal origin were

reported from horses by Rossdale and Ricketts (1980) and Ramachandran (1991). However, there is no information available as to the cause of abortion or foal mortality in donkeys in Ethiopia and further study is needed.

The present study has shown that donkeys in Ethiopia suffer from multiple health problems. Apart from the gastrointestinal parasites, it is clear that harness and harnessing problems, foot problems, ectoparasites, respiratory problems, reproductive problems and eye infections require more attention and detailed studies are required to launch appropriate treatments and preventive measures. Very few attempts have been made to study the diseases of donkeys in Ethiopia and more research is needed before one can make better use of these animals and realize their potential. Moreover, the low priority and economic importance given to these animals by most governments, planners and scientists has to be changed.

CHAPTER 4

INTERNAL PARASITES OF WORKING DONKEYS IN ETHIOPIA.

4.1 INTRODUCTION

The prevalence and the type of internal parasites affecting equids, in general, and donkeys in particular have not been determined to a great extent in Ethiopia. Available information (Feseha, Mohammed and Yilma, 1991) suggested that gastrointestinal parasites are the major health problems of working donkeys. The present work was carried out to assess the prevalence and to determine the population of internal parasites of working donkeys in Ethiopia.

4.2 MATERIALS AND METHODS

4.2.1 Study areas and Animals

The study was carried out during the period from 1995 to 1997. The study areas were Ada, Akaki, Bereh and Boset, which are covered by the Donkey Healthcare and Welfare Project as described in Chapter Two. Donkeys of both sexes and ranging in age from 2 weeks to 30 years and over were included in this study. In total 2935 donkeys from the different project sites were examined to determine the general prevalence and intensity of parasitic infection. Two hundred and fifteen donkeys from two fasciola endemic areas, Akaki and Bereh, were examined to determine the prevalence of fluke in those areas. Seven donkeys died due to different reasons during the period 1995-1997, were necropsied and examined for gastrointestinal parasites, lungworm, fluke and other internal parasites.

4.2.2 Faecal worm egg count and identification.

Each month, between 50 and 100 donkeys were randomly selected from the herds of donkeys brought for treatment at the project sites and faecal samples were collected directly from the rectum. Faecal worm egg counts using the modified McMaster technique were performed as described in Chapter Two. Fresh faecal samples were immediately processed to recover the larvated eggs of lungworm, *Dictyocaulus arnfieldi.* A simple and rapid qualitative method, as described in Chapter Two, was used to recover fluke eggs. Eggs of strongyles, *Parascaris equorum, Anoplocephala species, Fasciola hepatica, Gastrodiscus species, Strongyloides westeri* and the larvated eggs of *D. arnfieldi* were identified by their morphological appearance according to Sloss and Kemp (1978) and Soulsby (1982).

4.2.3 Ova culture and larval identification

For ova culture, samples with high medium and low eggs per gram (epg) were randomly selected. For this purpose, 515 faecal samples were pooled into 103 sub samples, each sub sample consisting of 5 samples. The faecal samples were cultured in an incubator at 27°C for seven days (MAFF, 1984). The Baermann technique (MAFF, 1984), as described in Chapter Two, was used for larvae recovery. The larvae were identified to their specific genera and/or species according to the key description given by Russell (1948), Duncan (1974) and Georgi and Georgi (1990).

4.2.4 Post mortem worm recovery and identification

Post mortem examination of seven donkeys that died during the study was undertaken. A complete examination of the contents and the mucosal lining of each part of the gastrointestinal tract for mature adult worms was conducted. The aliquot sampling procedures of Drudge et al. (1963) and Lyons et al. (1983) for the stomach and intestinal contents and washings were employed to recover and to estimate the worm burdens of small strongyles and other small gastrointestinal parasites as described in Chapter Two. The abdominal cavity and organs located nearby were scrutinized for *Setaria* species, *S. edentatus* and *Fasciola* species. The nasal and paranasal sinuses, and lung tissues were examined for the presence of arthropod larvae and lungworm, respectively. The recovered small and large strongyles, and other large and small worms were identified to the species level according to Lichtenfels (1975) and the arthropod larvae according to Zumpt (1965). No attempts were made to recover the immature worms imbedded in the mucosa of the gastrointestinal tracts. However, the cranial mesenteric artery and its branches were thoroughly examined for the presence of *S. vulgaris* larvae.

4.3 RESULTS

The present study revealed 99% prevalence of gastrointestinal parasites, with high level of infection rates, more than 54% of the donkeys having faecal worm egg counts greater than 1000 epg (Figures 4.1 and 4.2).

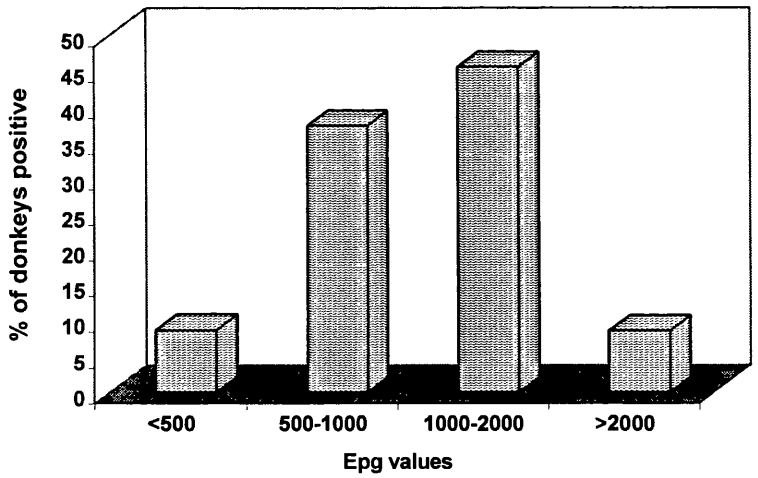

Figure 4.1. Level of strongyle infection rate as determined from faecal worm egg count of 2935 donkeys at all project sites, Ethiopia.

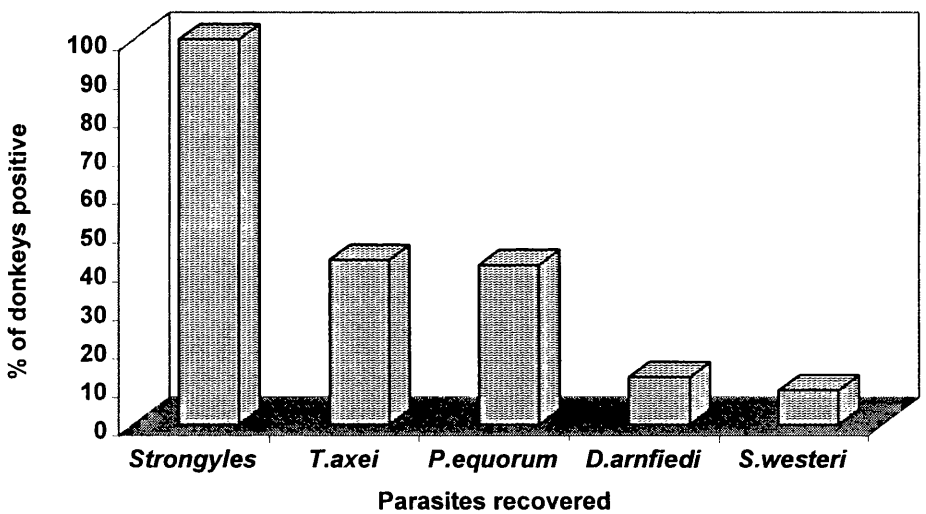

Figure 4.2 The prevalence of gastrointestinal and pulmonary helminths of 2935 donkeys examined at all project sites, Ethiopia.

80% of the donkeys were infested with *gasterophilus* eggs. The results of faecal examination from donkeys of the two fasciola endemic areas revealed 80% fasciola and 30% gastrodiscus infection.

The examination of ova and larvae recovered from ova culture enabled the identification of five genera and 12 species of helminth parasites (Tables 4.1and 4.2). A total of 42 species of parasites, consisting of 35 nematodes, 3 trematodes, 1 cestode, and 3 arthropod larvae were identified (Tables 4.2, 4.3, 4.4, 4.5 and 4.6). The majority of parasite species were recovered from the seven necropsied donkeys. Among the large strongyles, *S. vulgaris* was found to be the most prevalent parasite, recovered from 99% of ova culture (Table 4.2) and from all necropsied donkeys (Table 4.4). Moreover, larvae of *S. vulgaris* were recovered from the cranial mesenteric artery and its branches (Table 4.4). The 17 recovered and identified species of cyathostome from the seven necropsied donkeys are summarized in table 4.5.

Examination of the peritoneal cavity revealed *Setaria equina* in five out of seven donkeys necropsied. Three species of trematode, *Fasciola hepatica* and *Fasciola gigantica* from the liver and *Gastrodiscus aegyptiacus* from the caecum were recovered from one necropsied donkey. Moreover, examinations of the paranasal sinus and the lung tissue revealed arthropod larvae, *Rhinoestrus purpureus* and lungworm, *D. arnfieldi,* respectively (Table 4.6).

Table 4.1 Gastrointestinal and pulmonary helminths identified using ova from 2935 donkeys and ova culture from 515 donkeys at all project sites, Ethiopia.

	Egg identification	Larval identification
Parasites	(n=2935)	(n=515)
Cyathostomes	99%	99%
Large strongyles	*	99%**
T. axei	42.8%	91%
Lung worm	12.4%	-
Parascaris equorum	41.4%	-
Strongyloides westeri	8.9%	18
Anoplocephala species	0.51%	-

*Percentage of cyathostomes and large strongyles together was 99%.

***S. vulgaris* was the most prevalent among large strongyles.

Table 4.2 The prevalence and type of parasitic larvae recovered from ova culture at all project sites, Ethiopia.

	T.axei	S.vul	S.ed	*S.*eq	Cya	Gya	Pot	Oes	Tro	*S.*ws.
Number of positive pooled samples	94	102	1	10	102	24	5	32	13	18
Number of larvae recovered	3443	6787	16	124	6948	564	108	636	320	1224
Mean lpg	36.6	66.5	16	12.4	68.1	23.5	21.6	19.9	24.6	68.0
Standard deviation	25.2	27.4	-	6.4	28.4	33.6	6.0	14.1	13.2	28.2
% of positive pooled samples*	91.3	99	1	9.7	99	23.3	4.9	31.1	12.6	17.5
% of each larvae type from total larvae (20147)	17.2	34.1	0.1	0.6	34.5	2.7	0.5	3.2	1.6	5.5

Key: S. vul = *S. vulgaris,* S.ed = *S. edentatus,* S.eq = *S. equinus,* Cya = Cyathostomes, Gya = *Gyalocephalus*, Pot. = *Poteriostomum*, Oes = *Oesophagodontus*, Tro = *Triodontophorus*, S.ws = *S. westeri*

*515 faecal samples were pooled in 103 sub samples, each pooled sample consists of 5 faecal samples.

Table 4.3 Stomach worms and *Gasterophilus* larvae identified at necropsy of seven donkeys from Ada, Ethiopia.

Parasites	Location	Number of donkeys positive. (n=7)
Habronema muscae	Stomach	7
Draschia megastoma	Stomach	7
Trichostrongylus axei	Stomach	7
Gasterophilus intestinalis	Stomach and Rectum	7
Gasterophilus nasalis	Stomach and Rectum	7

Table 4.4 Species of large strongyles identified at necropsy of seven donkeys from Ada, Ethiopia.

Parasites	Location	Number of donkeys positive (n=7)
S. vulgaris	Colon and caecum	7
S. vulgaris larvae	Cranial mesenteric artery	7
S. edentatus	Colon	1
S. equinus	Caecum	1
Triodontophorus serratus	Colon	7
Triodontophorus brevicauda	Colon	6
Triodontophorus tenuicollis	Colon	4
Oesophagodontus robustus	Colon	3

Table 4.5 Species of cyathostomes identified at necropsy of seven donkeys from Ada, Ethiopia.

Cyathostome species	Location	Number of donkeys positive (n=7)
Cyathostomum labiatum	Colon and Caecum	7
Cyathostomum labratum	colon	6
Cyathostomum catinatum	Colon and Caecum	7
Cyathostomum tetracanthum	Colon and Caecum	7
Cyathostomum coronatum	Colon and Caecum	5
Cyathostomum montgomeryi	Caecum	1
Cylicocyclus auriculatus	Colon	7
Cylicocyclus nassatus	Colon	7
Cylicocyclus elongatus	Caecum	7
Cylicocyclus brevicapsulatus	Colon	6
Cylicostephanus longibursatus	Colon and Caecum	7
Cylicostephanus bidentatus	Colon	7
Cylicostephanus minutus	Colon and Caecum	6
Cylicostepahnus calicatus	Colon	3
Cylicodontophorus bicoronatus	Colon and Caecum	7
Poteriostomum ratzii	Colon	7
Gyalocephalus capitatus	Colon	7

Table 4.6 Other parasite species identified at necropsy of seven donkeys from Ada, Ethiopia.

Parasites	Location	Number of donkeys positive (n=7)
Anoplocephala perfoliata	Small intestine	1
Parascaris equorum	Small intestine	4
Fasciola hepatica	Liver	1
Fasciola gigantica	Liver	1
Gastrodiscus aegyptiacus	Caecum	1
Dictyocaulus arnfieldi	Lung	1
Oxyuris equi	Colon	1
Probstmayria vivipara	Colon	7
Setaria equina	Peritoneal cavity	6
Rhinoestrus purpureus	paranasal sinus	6

4.3 DISCUSSION

This chapter has described the prevalence and infection rate, and the type of gastrointestinal and other internal parasites recovered and identified from Ethiopian working donkeys. Even though the major criticism of the faecal worm egg count is the lack of information on the composition of parasitic infection because the eggs of various strongyle genera can not be differentiated (Soulsby, 1982, Drudge et al.,

1986), this method coupled with ova culture enabled the identification of a number of parasites. According to Lichtenfels (1975), equidae are the hosts of 75 species belonging to 28 genera of nematodes, 5 species in 2 genera of trematodes and 4 species in 3 genera of cestodes. Of these, 50% were identified in this study in working donkeys of Ethiopia.

Due to the complex taxonomy and difficulty in the identification of cyathostomes, few workers have identified these parasites to the species level in donkeys (Eysker et al., 1989; Graber, 1970; Pandey et al., 1991). The most comprehensive lists are from Zimbabwe (Eysker et al., 1989) where 11 species of cyathostomes were identified, compared to 17 species in the present work. The present findings of cyathostomes in donkeys accounted for 42% of the total cyathostomes known to infect equidae (Lichtenfels, 1975). Feseha et al. (1991) reported cyathostomes consisting of the genera *Cyathostomum, Cylicocyclus, Cylicodontophorus, Cylicostephanus, Gyalocephalus* and *Poteriostomum* from donkeys in Ethiopia. However, they were not identified to the species level.

The high prevalence of *Strongylus vulgaris* in this study is consistent with the results of Feseha et al. (1991) and other studies (Pandey et al., 1980b, 1989, 1991). Generally, it is thought that adult horses are resistant to *S. vulgaris* infection (Enigk, 1951; Duncan, 1975), but the present study and studies by English (1979) and Pandey (1980b, 1981, 1989) have identified heavily infected adult donkeys and horses, suggesting that they are susceptible to infection. Immunosuppression could be one possible explanation for infection in adult working donkeys, because the animals are often stressed and under nourished (Feseha et al., 1997, Svendsen, 1997b). The high prevalence of *S. vulgaris* coupled with the highly stressed and under nourished

donkeys in Ethiopia suggests the need for further investigation into the control of this pathogenic parasite (Duncan, 1973; Soulsby, 1982; Austin, 1994; Urquhart et al., 1996).

Stomach worms, *T. axei*, spirurids and the *Gasterophilus* larvae have been reported from donkeys in Ethiopia (Feseha et al., 1991). However, the present study is the first to report *Draschia megastoma* and to identify *Habronema muscae* and the two *Gasterophilus* larvae, *Gasterophilus intestinalis* and *Gasterophilus nasalis* to the species level in donkeys of Ethiopia. These species of parasites, however, were reported from donkeys by Scialdo et al. (1982), Hilali et al. (1987), Pandey et al. (1991, 1992a, 1992b, 1993) in other countries.

Studies by Russell (1948) and Drudge et al. (1986) have shown that the infection of *Strongyloides westeri* in foals as early as two weeks of age induces an immune response. This results in the disappearance of egg bearing females after a few months and self-cures are characteristic by the time the foals are six months olds. Similar results were observed in the present study although patent infections were observed up to one year of age.

The high faecal egg counts of *P. equorum* recovered from foals and younger donkeys of up to 3 years of age and the detection of patent infection with low faecal egg counts in adult donkeys is consistent with the findings of Russell (1948), Clayton and Duncan (1979). Clayton and Duncan (1979) demonstrated that age per se was the important factor in the development of resistance to *P. equorum* in horses.

The finding of fluke, *Gastrodiscus aegyptiacus*, is consistent with the results of Graber (1973) in horses and Feseha et al. (1991) in donkeys. Eventhough *G. aegyptiacus* is considered to cause no pathological conditions (Dunn, 1969), studies

by Bracegirdle (1973), Azzie (1975), Roberts et al. (1976) and Schandevyl and Sumbu (1987) have revealed that it is pathogenic in horses.

Both *Fasciola hepatica* and *Fasciola gigantica* were recovered from only one out of seven donkeys necropsied. Coproscopy, however, demonstrated a high prevalence of infection. This result does not indicate the true prevalence of fasciola infection in donkeys, because the faecal samples were taken only from fasciola endemic areas and further study has to be conducted to determine the true prevalence of this parasite. Pankhurst (1963), Pandey (1983) and Pandey et al. (1991) reported the infection of donkeys by *Fasciola hepatica* but not by *Fasciola gigantica.*

Cestode species *Anoplocephala perfoliata*, *Anoplocephala magna* and *Paranoplocephala mamillana* are commonly reported in equidae (Lyons et al., 1983; Drudge and Lyons, 1986; Urquhart et al., 1996). However, the prevalence of cestodes was very low and only *A. perfoliata* was recovered in the present study. The low prevalence of these parasites might be a reflection of the low prevalence of oribatid mites, the intermediate host, or the resistance of donkeys to cestodes. However, studies by Lyons et al. (1983) and Drudge and Lyons (1986) have shown that neither acquired nor age resistance to cestodes occurs in horses. On the other hand, it was found that discharge of gravid segments is sporadic in horses (Slocombe, 1979; Drudge and Lyons, 1986). This could be a reason for the frequent failure to demonstrate eggs by floatation technique and hence low prevalence.

The detection of larvated eggs of the lungworm, *Dictyocaulus arnfieldi,* without using a Baermann technique (MAFF, 1984) in the present work may be a reflection of the presence of large number of eggs in the faeces. No signs of respiratory problem were observed in these infected donkeys. Infection of donkeys by

D. arnfieldi has been reported by many workers (Thomas and Jones, 1960; Pankhurst 1963; Round, 1976; Nicholls et al., 1979; Pandey, 1980a; Lyons et al., 1985; Feseha et al., 1991; Yilma et al., 1991). Work done by Round (1976) has shown that patent infections are known to persist for up to five years. The donkey is said to be the natural host of equine lungworm, and a potential source of infection for horses (Lapage, 1968; Soulsby, 1982).

Observations made by Drudge and Lyons (1986) affirm that it is unusual for horses to be completely free from gastrointestinal parasites, particularly small strongyles. The present finding confirmed the same observation in working donkeys. The results obtained from the necropsied donkeys coupled with coproscopy have revealed the presence of a range of parasitic species, which are representative of the important pathogenic parasites found in equidae (Lichtenfels, 1975). The presence of polyparasitism with high prevalence and high infection rate is an indication that favorable environmental conditions for infection, survival and perpetuation of the parasites and/or the absence of anthelmintic therapy exist in working donkeys of Ethiopia.

CHAPTER 5

FIELD EVALUATION OF IVERMECTIN FORMULATIONS ADMINISTERED IN DIFFERENT ROUTES IN ETHIOPIAN WORKING DONKEYS

5.1 INTRODUCTION

Donkeys are economically important animals in Ethiopia. They have been used as beasts of burden for centuries and are valuable throughout the country. Despite their large number and their key role in the rural and agricultural life, the knowledge of the physiology, nutritional requirements, health problems and management systems of the donkey is limited and not readily available in the literature. Previous studies undertaken have indicated that gastrointestinal parasitism is a major problem of Ethiopian donkeys (Svendsen, 1986; Feseha et al., 1991; Yilma et al., 1991). This has been further confirmed by the work of the Donkey Healthcare and Welfare Project (DHWP), launched under the sponsorship of the International Donkey Protection Trust (IDPT) since September 1994. In the areas where the project operates, polyparasitism is prevalent and intensity rates high. The ubiquitous presence of parasites is considered to be one cause contributing to the short life span of Ethiopian donkeys, which is in the order of 9-13 years (Svendsen, 1986, 1994; Feseha, 1991) as compared to a possible 37-40 years in the UK (Svendsen, 1994).

The efficacy of the oral paste formulation (Eqvalan, MSD-Agvet) against gastrointestinal and pulmonary helminths of donkeys was found to be greater than 90% (Feseha et al., 1991). The oral paste formulation, although highly effective and convenient to use, is more expensive than the injectable formulation of ivermectin (Ivomec, MSD-

Agvet). Studies carried by Wescott et al. (1980), Klein and Torbert (1980), French et al. (1983), Anderson (1984), Karns and Luther (1984) and Hsu et al. (1989) indicated that the injectable formulation of ivermectin sometimes causes adverse reactions such as swelling at injection sites, ventral or facial oedema, urticaria or pruritus, stiffness and depression when given parenterally to equidae. Furthermore, the drug is not licensed for this route of administration to equidae. Latterly, the project has utilized the injectable formulation of ivermectin for cattle, administered orally, in treating donkeys against internal and external parasites. The field study described in this chapter was therefore undertaken to assess the efficacy and safety of paste and injectable formulations of ivermectin (Eqvalan paste, and Ivomec, respectively) and more importantly to compare the efficacy and safety of injectable ivermectin when administered orally and subcutaneously to working donkeys.

5.2. MATERIALS AND METHODS

5.2.1. Study areas animals

Forty donkeys of mixed age (6 months - 25 years) and sex originating from the same village of one of the project sites were used in this study. The animals were confirmed to be carrying naturally acquired infestations of internal parasites and had never been treated with antiparasitic agents in the time preceding the study period. The study was conducted from February 21, 1996 to April 15, 1996.

At the outset each animal was randomly allocated to one of four groups of 10 donkeys.

Group 1. Animals were treated orally with the injectable 1% w/v ivermectin (Ivomec, MSD-Agvet) at the recommend dose of 0.2mg per kg body weight.

Group 2. Animals were treated subcutaneously with the injectable 1% w/v ivermectin (Ivomec, MSD-Agvet) at the dose rate of 0.2mg per kg body weight

Group 3. Animals were treated with the oral paste formulation of 1.87% w/w ivermectin (Eqvalan, MSD-Agvet). It was administered orally at the dose rate of 0.20 mg/kg body weight.

Group 4 Animals were used as controls and were given normal saline orally.

The weight of the donkeys was estimated using the method developed by clinical staff at The Donkey Sanctuary, Devon, UK (Svendsen, 1994).

5.2.2. Sample Collection and Processing

Faecal samples were collected directly from the rectum of all donkeys before treatment, and one week, four weeks and eight weeks post treatment. The samples were processed at the Department of Pathology and Parasitology of the Faculty of Veterinary Medicine, University of Addis Ababa, Debre Zeit and stored at 4°C until examination. Faecal worm egg counts were performed within 48 hrs using the modified McMaster technique (MAFF, 1984). Ova culture was conducted for the identification of helminth parasites. For this purpose two pooled faecal samples (five samples in one pool) were used for each treatment group both before and after treatment. The faecal samples were cultured in an incubator at 27°C for seven days. Larvae were recovered by the Baermann technique (MAFF, 1984) and identified according to the methods of Russel (1948) and Duncan (1974).

5.2.3. Efficacy of the drug and statistical analysis

The anthelmintic efficacy was assessed by comparing the geometric mean eggs per gram of faeces (epg) before and after treatment for each treatment group (Duncan et. al, 1988). The efficacy of the two formulations and routes of administration, the differences in the number of larvae recovered, and the differences in the epg and lpg of the recovered parasites among the placebo-treated and the ivermectin-treated groups throughout the study period were, a priori, to be compared for significance at 5% level using one way analysis of variance (Siegel, 1992). Where appropriate, pairwise comparison of means was to be conducted using the Newman-Keuls multiple range test. However, the large number of zero values precluded the necessity and appropriateness of such analysis. Instead, Mann Whitney U tests were used to compare the three treatment groups with the placebo group.

5.3. RESULTS

The mean faecal worm egg counts (epg) and differential larval recovery from faecal cultures for the four treatment groups before and after treatment are shown in tables 5.1 and 5.2, respectively. Data collected on day 0 indicated that all treatment groups had donkeys with comparable burdens of strongyles and *T. axei* (Table 5.1) and no statistically significant differences were observed in mean epg among the treatment groups. The infection by *P. equorum, D. arnfieldi and S. westeri* were less uniform and not considered of sufficient significance to require or allow any comparison of the treatment regimes.

Coproculture study on the pooled faecal samples before treatment showed that 40.8% of the recovered eggs were small strongyles and 31.4% large strongyles (Table 5.2). *S. vulgaris* accounted for 28.9% of the large strongyles. There was no significant difference

($P<0.05$) in the number of larvae recovered among the treatment groups. The culture performed after treatment only showed the presence of small strongyles at eight weeks with no large strongyles or *T. axei* (Table 5.2).

Table 5.1 Mean faecal worm egg counts (epg) for the treatment groups before and after treatments, and the percentage efficacy of ivermectin formulations.

Sampling dates	Helminthes types	IAO	IAS	OP	Control
Day 0	*T.axei*	308(6)**	300(4)	163(4)	250(6)
	Strongyles	1055(10)	844(9)	890(10)	980(10)
	P.equorum	500(1)	250(2)	308(5)	400(5)
	D.arnfieldi	-	200	-	-
	S.westeri	-	800(1)	-	-
Week 1.	*T.axei*	0 (100%)+	0 (100%)	0 (100%)	250
	Strongyles	0 (100%)	0 (100%)	0 (100%)	1005
	P.equorum	0	0	0	400
	D.arnfieldi	-	0	-	-
	S.westeri	-	0	-	-
Week 4.	*T.axei*	0 (100%)	0 (100%)	0 (100%)	280
	Strongyles	0 (100%)	0 (100%)	0 (100%)	1150
	P.equorum	0	0	0	430
	D.arnfieldi	-	0	-	-
	S.westeri	-	0	-	-
Week 8.	*T.axei*	0 (100%)	0 (100%)	0 (100%)	310
	Strongyles	183 (82.7%)	191 (77.4%)	200 (77.5%)	1130
	P.equorum	100	0	0	310
	D.arnfieldi	-	0	-	-
	S.westeri	-	0	-	-

Keys: IAO - Injectable administered orally. IAS - Injectable administered subcutaneously. OP - Oral paste

** Numbers in parentheses at day 0 indicate number of positive cases.

+ Other numbers in parentheses indicate percentage efficacy.

Table 5.2 Mean faecal larval counts (lpg) of the treatment groups before and after treatment.

Sampling Dates	Helminth types	IAO	IAS	OP	Control	Total	(%)
Day 0.	L.strongyles[+]	100	128	108	160	496	(31.4)
	S.strongyles[++]	172	160	156	156	644	(40.8)
	T.axei	76	100	84	100	360	(22.9)
	Free living[**]	20	24	20	16	80	(5.1)
	Total	**368**	**412**	**368**	**432**	**1580**	-
Week 1.	L.strongyles	0	0	0	120	120	(31.1)
	S.strongyles	0	0	0	160	160	(45.9)
	T.axei	0	0	0	80	80	(20.8)
	Free living	0	0	0	24	24	(6.9)
	Total	**0**	**0**	**0**	**384**	**384**	-
Week 4.	L.strongyles	0	0	0	120	120	(26.5)
	S.strongyles	0	0	0	180	180	(39.8)
	T.axei	0	0	0	112	112	(24.8)
	Free living	0	0	0	40	40	(8.9)
	Total	**0**	**0**	**0**	**452**	**452**	-
Week 8.	L.strongyles	0	0	0	120	120	(23.7)
	S.strongyles	20	22	24	180	246	(48.6)
	T.axei	0	0	0	104	104	(20.6)
	Free living	4	12	0	20	36	(7.1)
	Total	**24**	**34**	**24**	**424**	**506**	-

Keys: IAO - Injectable administered orally. IAS - Injectable administered subcutaneously. OP - Oral paste.
[**] Free Living Larvae. [+] Large Strongyles [++] Small Strongyles

In general, ivermectin was found to be highly effective in all the treatment groups regardless of the route of administration and formulation. In the comparison of the different treatment groups over time the large number of zero values precluded the necessity or advisability of classical multi group comparison. Instead, Mann Whitney U tests were used to compare the groups with the placebo group, with each other and with time zero. The key findings were that for both ova and larvae of each parasite, (i) there was no significant

difference in efficacy in the three treatment groups at any time point (ii) at all time points each treatment group was significantly different from the placebo group and (iii) each of the treatment groups was significantly different at each post-treatment time point from the time zero values. Fatalities and other severe adverse reactions were not encountered in this study. However, some transient swellings at the injection sites in two donkeys and ventral oedema in one donkey were observed in the group receiving subcutaneous administration.

5.4 DISCUSSION

Faecal examinations revealed the presence of a range of parasitic ova. All donkeys were found to be positive for three or more parasitic species such as large and small strongyles, *T. axei* and *P. equorum.* This again confirms that helminthosis is a problem of considerable magnitude in working donkeys as reported by Feseha (1991), Feseha et al. (1991) and Yilma et al. (1991). The predominant parasitic species identified using ova culture was *S. vulgaris.* This parasite is the most pathogenic of all equine internal parasites (Duncan, 1973; Drudge and Lyons, 1977; Soulsby, 1982; Austin, 1994; Urquhart et al., 1996). The occurrence of relatively higher percentage of *S. vulgaris* in this study is consistent with the findings of Feseha et al. (1991) but lower than the results obtained in chapter 3.

This comparison of the two ivermectin formulations by different routes of administration demonstrated an efficacy of 100% for large strongyles, small strongyles and *T. axei.* Similar results were obtained by Torbert (1982) and French et al. (1983) in horses and ponies using a 2% micellar formulation and anecdotally in donkeys by Trawford (personal communication) with 1% injectable formulation of ivermectin. The study carried out by Lyons et al. (1980) and Bello and Norflet (1981) also indicated a similar efficacy of injectable ivermectin given parenterally and orally in horses.

There was no statistically significant difference in the efficacy of ivermectin among the three treatment groups receiving ivermectin at times up to eight weeks post treatment. Although no statistically significant difference in efficacy was observed, the lower efficacy observed eight weeks post treatment is probably due to the different prepatent period of some parasites caused by reinfection (Martin et al., 1985). The general conclusion is that ivermectin is effective up to eight weeks post treatment as has been observed in horses and ponies (Lyons et al., 1980; Bello and Norflet, 1981; Yazwinski et al., 1982; French et al., 1983; Herd, 1990).

The results obtained by French et al. (1983) in which the egg counts from ponies and horses treated orally with micellar formulation of ivermectin were greater than in those treated by the parenteral route eight weeks post treatment does not concur with the results obtained in this study. Moreover, the lower efficacy against adult and larval stages of cyathostomes, using oral administration of injectable ivermectin, obtained by Yazwinski et al. (1982) was not observed, at least in the case of adult cyathostomes.

Taking into consideration that the efficacy of oral administration of the injectable solutions is equal to the other two formulations, the ease of administration with a slightly modified 10-20 ml regular syringe, the price advantage over the paste formulation and the absence of fatalities or severe adverse reactions, the injectable formulation would appear to be suitable for use via oral administration. The finding in this study as well as those of others (Lyons et al., 1980; Dipietro, 1992) underlines that the efficacy of ivermectin is generally the same regardless of the route of administration (orally, intramuscularly or subcutaneously) provided that dosage is adequate. However, oral administration of injectable ivermectin has the advantage that injection sites reactions are avoided and the risk of anaphylactic shock and other adverse reactions are reduced.

There is a need to establish optimum or sufficient ivermectin dosage rates for donkeys independently. This is important as the difference in anthelmintic metabolism between the different species of equids or routes of administration may result in under or over dosing, and be particularly true for donkeys in which the pattern of use of almost all drugs is extrapolated from that of horses.

CHAPTER 6

GENERAL DISCUSSION AND CONCLUSION

This thesis has described the major health and management problems of working donkeys, based on a preliminary survey at four project sites of the International Donkey Protection Trust in Ethiopia. The study revealed that the donkeys suffer from multiple health problems.

Gastrointestinal parasites were found to be major health problem, as reported by Feseha et al. (1991), Yilma et al. (1991) and Svendsen (1994). It has been documented that parasitism is a common factor leading to ill health, suffering and the early demise of donkeys throughout the world (Svendsen, 1991). The study showed not only a high prevalence and rate of infection, but also revealed the presence of a range of parasitic species, representative of the important pathogenic parasites found in equidae (Lichtenfels, 1975). The presence of polyparasitism with high levels of infection is an indication that favorable environmental conditions for infection, survival and perpetuation of the parasites and/or the absence of anthelmintic therapy exist in the working donkeys of Ethiopia. The donkeys in Ethiopia, as in many other countries (Svendsen, 1991, 1994, 1997b), are subject to poor nutrition and their resistance is further lowered due to the stress of heavy workloads. However, although the exact impact of parasites on the health and performance of working donkeys is not known pathological effects of these parasitic infections do occur (Pandey et al., 1994). This and other studies (Bliss et al., 1985; Yilma et al., 1991; Feseha et al., 1991) indicate that strategic anthelmintic treatment of donkeys not only can reduce worm burden but also lead to improved body condition. However, given the presence of polyparasitism, the application of appropriate anthelmintic treatments should be based on a sound and complete knowledge of the epidemiology of endoparasitism in donkeys in Ethiopia.

Second to gastrointestinal parasites, wounds and sores due to absence or the ill-fitting saddles and harnesses and badly designed implements were the major causes of economic loss and suffering of working donkeys. The main causes of these problems were found to be due to mis-management by owners stemming from neglect or ignorance. The long-term solution to this problem probably lies in educating and encouraging the farmers to adopt preventive measures. The main reasons for mis-management, ill-treatment or poor treatment are many fold, but the poor economy of the country, lack of education and training, lack of materials, equipment, essential drugs and professional advice are all likely contributors.

The absence of basic foot care and farriery in Ethiopia seems to predispose the donkeys to foot abnormalities. Uneven wearing of the hoof, which leads to uneven conformation, is widely distributed. This problem develops slowly and is only recognized at its severe stage when permanent damage may have been done. This incipient and ubiquitous finding may be why owners do not recognize the problem early. A well shod and well balanced foot must be the objective in foot care as this will allow the animal to work in comfort and at maximum efficiency. This can only be achieved through the use of a professional farrier and when the owner understands the potential productivity of their animals given the correct care. Education and training are the key issue and, indeed, may be the only way to resolve such problems.

Respiratory and reproductive problems and eye infection were other major areas of concern in working donkeys. The identification of most of these problems was based on clinical observation and confirms the existence of such problems in working donkeys of Ethiopia, despite the fact that little information and few reports previously

existed. Moreover, these studies provide base line information for further detailed studies.

The economic impact of diseases on productivity of ruminants has been determined for some of the major diseases that affect livestock in the tropics (Murray and Gray, 1984). However, virtually no information is available on the economic impact of any donkey diseases. The lack of such information will undoubtedly have hindered development of policy decision on disease control and prevention of such diseases in donkeys.

Despite the fact that the donkeys play a significant role in farming systems and the livelihoods of a large number of farmers, research and development into the different aspects of donkeys has been minimal, an issue identified by several people writing about or working on promoting the case of donkeys (Svendsen, 1991; Starkey, 1994a). There is no government policy or legislation on donkey use and welfare and no attention is given to promotion of the subject in Ethiopia. There is no international or national research institution dedicated to working on disease and productivity of the donkey. In effect, development institutions and governments have marginalized the extremely valuable resource of small scale farmers and traders.

Generally, the health, management and welfare problems can be controlled and the increased use of the donkey can be enhanced:

(i) through a proper veterinary care; the epidemiology of the different diseases and their effect on productivity, performance of donkeys, and economic losses must be studied. Increased investigation into the development of proper harnesses and appropriate implements is critically important.

(ii) when a reasonable equine promotion policy is set up to facilitate equine production and to promote the welfare issue of these animals.

(iii) when the donkey is seen by the whole community as an animal for collective benefit, and not just for the individual who owns the animal.

(iv) when a better awareness of its utility and its possibility as an economic force is considered by people concerned with developmental programmes and

(v) through better communication, education and technology transfer at sustainable level among different countries.

Properly managed, and with appropriate support and promotion there can be no reason why the value of the donkey will not only continue but will be enhanced, for the benefit of all developing countries. There can be no doubt that the long relationship of man with the donkey that has existed since the first records of domestication will continue into through the next millenium. It is our responsibility to see that the relationship is one based on a partnership rather than exploitation.

References

Abu Samra, M.T., Abbas, B. and Ibrahim, K.E.E. (1987) Five cases of psoroptic manage in the domestic donkey (*Equus asinus*) and treatment with ivermectin. *Equine Veterinary Journal,* **19**, 143-44.

Adeyefa, C.A., Hamblin, C. (1995) Continuing prevalence of African horse sickness in Nigeria. *Revue de Elevage Medicine Veterinaire Pays Tropicaux*, **1**, 31-33

Admassie, Y., Abebe, M., Ezra, M. and Gay, J. (1983) Ethiopian high lands reclaimation study: report on sociological survey and sociological considerations in preparing a development strategy. Institute of Development Research Working Paper No.4. University of Addis Ababa, Ethiopia.

Aganga, A.A. and Maphorisa, K. (1994) Characteristics and uses of donkeys in Botswana. In: P. Starkey, E. Mwenya and J. Stares (eds). Improving animal traction technology. *Proceedings of The First Workshop of Animal Traction Network for Eastern and Southern Africa,* 18-23 January, 1992. Lusaka, Zambia. pp. 146-149.

Alemu, G., Azage, T. and Alemu, Y. (1997) Research needs on donkeys' management and utilization in Ethiopia. Paper presented for Animal Traction Network in Eastern and Southern Africa (ATNESA) workshop on improving donkey utilization and management. 5-9 May, 1997. Debre Zeit, Ethiopia (In press).

Alexander, R.A. (1948) The 1944 epizootic of horse sickness in the Middle East. *Onderstepoort Journal of Veterinary Science,* **23**, 77-92.

Anderson, R.R. (1984) The use of ivermectin in horses: research and clinical observation. *Compendium and Continuing Education for Practicing Veterinarian.* 6, s516-s521.

Andonova, S. (1997) An economic analysis of the benefits of donkeys utilization in Bulgaria. Paper presented for Animal Traction Network in Eastern and Southern Africa (ATNESA) workshop on improving donkey utilization and management. 5-9 May, 1997. Debre Zeit, Ethiopia (In press).

Austin, S..M. (1994) Large strongyles in horses. *Compandium and continuing education for practicing veterinrian*, **16**, 650-656.

Azzie, M.A.J. (1975) Pathological infection of thoroughbred horses with *Gastrodiscus aegyptiacus*. *Journal of South African Veterinary Association*, **46**, 77-78.

Badiali. L. and Abou-Youssef, M. (1968) Abbortive or sub-lethal rabies: a study of rabies strain of equine origin. *Veterinary Italiana,* **14**, 807-822.

Bakkoury, M. and Belemlih, A. (1991) Some aspects of the use of equines in an urban areas in Mexico. In: D. Fielding and R.A. Pearson (eds). Donkeys, mules and horses in tropical agricultural development. *Proceedings of a Colloquium*, 3-6 September, 1990. Edinburgh, Scotland. pp. 26-27.

Barrowman, P.R. (1991) Equine trypanosomiasis. In: D. Fielding and R.A. Pearson (eds). Donkeys, mules and horses in tropical agricultural development. *Proceedings of a Colloquium*, 3-6 September, 1990. Edinburgh, Scotland. pp. 106-112.

Belemlih, A. (1991) SPA/SPANA's education programme in Morocco. In: D. Fielding and R.A. Pearson (eds). Donkeys, mules and horses in tropical agricultural development. *Proceedings of a Colloquium*, 3-6 September, 1990. Edinburgh, Scotland. pp. 319-321.

Bello, T.R. and Norflet, C.M. (1981) Clinical antiparasitic efficacy of ivermectin against equine parasites. *Journal of Equine Veterinary Science*, **1**, 14-17.

Betker, J. and Kutzbach, H.D. (1991) The role of donkeys in agricultural mechanization in Niger: potential and limitations. In: D. Fielding and R.A. Pearson (eds). Donkeys, mules and horses in tropical agricultural development. *Proceedings of a Colloquium*, 3-6 September, 1990. Edinburgh, Scotland. pp. 223-230.

Blench, R. (1997) The history and spread of donkeys in Africa. Paper presented for Animal Traction Network in Eastern and Southern Africa (ATNESA) workshop on improving donkey utilization and management. 5-9 May, 1997. Debre Zeit, Ethiopia (In press).

Bliss, D.H., Svendsen, E.D., Georgoulakis, I.E., Grosomanidis, S., Taylor, F. and Jordan, W. (1985) Strategic use of anthelmintics in working donyes in Mediterranean climatic conditions. *Veterinary Record,* **117**, 613-614.

Blood, D.C. and Radostits, O.M. (1989) Veterinary medicine: a text book of cattle, sheep, pigs, goats and horses (7^{th} ed). Baillier Tindal, London.

Bobobee, E.Y.H. and Dibbits, H.J. (1997) The potential and limitation of donkey traction in Ghana. Paper presented for Animal Traction Network in Eastern and Southern Africa (ATNESA) workshop on improving donkey utilization and management. 5-9 May, 1997. Debre Zeit, Ethiopia (In press).

Bokonyi, S. (1991) The earliest occurrence of domestic asses in Italy. In: R.H. Meadow and H.P. Uerpmann (eds). Equids in the Ancient World, pp. 178-216.

Borwick, R. (1981) The book of the donkeys. Pelham Books Ltd, London.

Boyet, W.P., Mackenzie, P.K.I., Pilson, R.D. and Leavis, H. (1972) The importance of the donkey (*Equus asinus*) as a source of food and reservoir of trypanosomes for *Glossina morsitans*. *West Rhodesia Science News,* **6**, 18-20.

Bracegirdle, J.R. (1973) A case of *Gastrodiscus aegyptiacus* in a horse in Ethiopia. *Veterinary Record*, **93**, 561-562.

Brown, C.C. and Dardiri, A.H. (1990) African Horse Sickness: a continuing menace. *Journal of American Veterinary Medical Association,* **196**, 2019-2021.

Buber, A.J. (1994) ILPH working together for equines saddlery and harnessprogramme. In: M. Bakkoury and R.A. Prentis (eds). Working equines. *Proceedings of The Second International Colloquium,* 20-22 April, 1994. Rabat, Morocco. pp. 171-174.

Buchenua, M. Lawrence, P. and Becker, K. (1997) Improving the working efficiency and welfare of donkeys in the South Western region of Niger. Paper presented for Animal Traction Network in Eastern and Southern Africa (ATNESA) workshop on improving donkey utilization and management. 5-9 May, 1997. Debre Zeit, Ethiopia (In press).

Camac, R. (1997) Introduction and origin of the donkey. In: E.D. Svendsen (ed). The Professional Handbook of The Donkey. Whittet Books Limited, London. UK. pp.9-18.

Canacco, E.A. (1991) Management of donkeys: a South Ghana experience. In: D. Fielding and R.A. Pearson (eds). Donkeys, mules and horses in tropical agricultural development. *Proceedings of a Colloquium*, 3-6 September, 1990. Edinburgh, Scotland. pp. 189-193.

Canacco, E.A. (1997) Utilisation of donkeys in Southern Ghana. Paper presented for Animal Traction Network in Eastern and Southern Africa (ATNESA) workshop on improving donkey utilization and management. 5-9 May, 1997. Debre Zeit, Ethiopia (In press).

Central Statistic Authority (1995) Number and percentage distribution of horses, asses, mules and camels used for draught purposes by types and regions for private holdings. Statistical Bulletin No. 132. Addis Aaba, Ethiopia.

Chineme, C.N., Tulpule, S.S. and Jamdar, M.N. (1979) Enteritis associated with *Eimeria leuckarti* infection in donkeys. *Veterinary Record,* **105**, 126.

Clayton, H.M. and Duncan, J.L. (1979) The development of immunity to *Parascaris equorum* infection in the foal. *Research in Veterinary Science*, **26**, 383-384.

Clutton-Brock, J. (1992) Horse power: a history of the horse and the donkey in human societies. Harvard University press. Cambridge and Massachusetts. 192p.

Coetzer, J.L.W. and Erasmus, B.J. (1994) African horse sickness. In: J.A.W. Coetzer, G.R. Thomson and R.C. Tustin (eds). Infectious Diseases of Livestock with Special Reference to South Africa. Vol I. Oxford University Press. Cape Town, South Africa. pp. 460-475.

Cole, H.H. and Garrett, W.N. (1980) The biology and use of domestic animals (2^{nd} ed). W.H. Feeman company, Sanfrancisco, pp. 16-17.

Connor, R.J. (1994) African animal trypanosomiasis. In: J.A.W. Coetzer, G.R. Thomson and R.C. Tustin (eds). Infectious Diseases of Livestock with Special Reference to South Africa. Vol I. Oxford University Press. Cape Town, South Africa. pp. 165-207.

Cotchin, E. (1977) A general survey of tumours in the horse. *Equine Veterinary Journal,* **9**, 16-21.

Crane, M. (1997a) Medical. In: E.D. Svendsen (ed). The Professional Handbook of The Donkey (3^{rd} ed). Whittet Book Limited, London. pp. 19-36.

Crane, M. (1997b) Surgey. In E.D. Svendsen (ed). The Professional Handbook of The Donkey (3rd ed). Whittet Book Limited, London. pp. 43-51.

Crick, J. (1981) Rabies. In: E.P.J. Gibbs (ed). Virus diseases of food animals, vol. II. Academic Press. London and New York. pp. 469-516.

Crossley, P. (1991) Transport for rural development in Ethiopia. In: D. Fielding and R.A. Pearson (eds). Donkeys, mules and horses in tropical agricultural development. *Proceedings of a Colloquium*, 3-6 September, 1990. Edinburgh, Scotland. pp. 48-61.

Animal Croxton, S. (1993) traction in action aid. Rural development Agency (RDA). Intermediate technology development groups. Kiwezi, Ikanga, Kenya. 50p.

Cuddeford, D., Pearson, R.A. Archibald, R.F. and Muirhead. R.H. (1995) Digestibility and gastrointestinal transit time of diets containing different proportion of alfalfa and oats straw given to thoroughbreds, shetlandponies, highland ponies and donkeys. *Animal Science,* **61**, 407-417.

Dawson, J. and Barwell, I. (1993) Roads are not enough: new perspectives on rural transport planning in developing countries. Intermediate Technology Publications. London, UK.

De Aluja, A.S., Chavira, H. and Lopez, A. (1994) The use of Equids in Mexican agriculture. In: M. Bakkoury and R.A. Prentis(eds). Working equines. *Proceedings of The Second International Colloquiu,* 20-22 April, 1994. Rabat, Morocco. pp. 281-288.

De Aluja, A.S. and Lopez, F. (1991) Donkeys in Mexico. In: D. Fielding and R.A. Pearson (eds). Donkeys, mules and horses in tropical agricultural development. *Proceedings of a Colloquium*, 3-6 September, 1990. Edinburgh, Scotland. pp. 1-7.

De Wall, D.T. and Van Heerden, J. (1994) Equine babesiosis. In: J.A.W. Coetzer, G.R. Thomson and R.C. Tustin (eds). Infectious Diseases of Livestock with Special Reference to South Africa. Vol I. Oxford University Press. Cape Town, South Africa. pp. 293-304.

Dijkman, J.T. and Sims, B.G. (1997) From beast of burden to pick-up truck: changes and challenges for the utilization of equines in Bolivia. Paper presented for Animal Traction Network in Eastern and Southern Africa (ATNESA) workshop on improving donkey utilization and management. 5-9 May, 1997. Debre Zeit, Ethiopia (In press).

Dilnesaw, A., Mengistu, G., Zelalem, B. Firew, K. and Bekele, M. (1997) Improved transportation with donkey carts in Ethiopia. Paper presented for Animal Traction Network in Eastern and Southern Africa (ATNESA) workshop on improving donkey utilization and management. 5-9 May, 1997. Debre Zeit, Ethiopia (In press).

Dipietro, J.A. (1992) Daily anthelmintic therapy in horses. *Compendium and Continuing Education for Practicing Veterinarian,* **14**, 651-654.

Dorman, A. (1994) Educational means and measures. In: M. Bakkoury and R.A. Prentis (eds). Working equines. *Proceedings of The Second International Colloquium,* 20-22 April, 1994. Rabat, Morocco. pp. 323-326.

Drudge, J.H. and Lyons, E.T. (1977) Pathology of infections with internal parasites of horses. *The Blue Book for Veterinarian,* **27**, 267-275.

Drudge, J.H. and Lyons, E.T. (1986) Interna parasites of equids with emphasis on treatment and control. Somerville, NJ: Hoechst-Rousssel Agri-Vet Company. 26p.

Drudge, J.H., Szanto, J., Wyant, Z.N. and Elam, G. (1963) Critical tests of thiabendazole as anthelmintic in horse. *American Journal of Veterinary Research*, **24**, 1217-1222.

Ducos, P. (1970) The oriental institute excavations at Merebeit, Syria: preliminary report on the 1965 campaign, part IV. *Journal of Near East Stud,* **29**, 173-189.

Ducos, P. (1975) A new find of an equid metatarsal bone from Tellmurei Bit in Syria and its relevance to the identification of Equids from the early Holocene of the Levant. *Journal of Archeological Science* **2**, 71-73.

Duncan, J.L. (1973) The life cycle, pathogenesis and epidemiology of *S. vulgaris* in the horse. *Equine Veterinary Journal*, **5**, 20-25.

Duncan, J.L. (1974) Field studies on the epidemiology of mixed strogyle infection in horses. *Veterinary Record,* **94**, 337-345.

Duncan, J.L. (1975) Immunity to S*trongylus vulgaris* in the horse. *Equine Veterinary Journal*, **7**, 192-197.

Duncan, J.L., Arundel, J.H., Malczewski, A. and Slocombe, J.O.D. (1988) World Association for the Advancement of Veterinary Parasitology (WAAVP). Guide lines for evaluating the efficacy of equine anthelmintic. *Veterinary Parasitology,* **30**, 57-72.

Dunn, A.M. (1969) Veterinary Helminthology. Williams Heinemann, London.

Ebenezer, J.S. (1991) Human and animal power for rural areas. In: D. Fielding and R.A. Pearson (eds). Donkeys, mules and horses in tropical agricultural development. *Proceedings of a colloquium*, 3-6 September, 1990. Edinburgh, Scotland. pp. 240-244.

Edelsten, R.M., Gourlay, R.M., Lawson, G.H.K., Morrow, A.N. and Ramachandran, S. (1990) Diseases caused by bacteria. In: M.M.H. Sewell and D.W. Brocklesby (eds). Handbook on Animal Diseases in The Tropics (4th ed). Baillier Tindal. London. pp. 33-103.

El Gawwad, A.M.A., Derhalli, F.S. and Nassar, A.M. (1987) A morphological study on lice attacking the donkey, *Equua asinus* in Egypt. *Journal of the Egyptian Veterinary Medical Association,* **47**, 321-332.

El Sammani, S.E. and Hussein, H.S. (1983) *Onchocerca rallieti*: adult location and skin distribution of microfilaria in Sudanese donkeys. *Journal of Helminthology,* **57**, 355-360.

English, A.W. (1979) The epidemiology of equine strongylosis in Southern Queensland. 3. Seasonal variation in arterial population of *Strongylus vulgaris* and the prevalence of some helminthes. *Australian Veterinary Journal*, **55**, 310-314.

Enigk, K. (1951) Weitere untersuchugen zur biologie von *Strongylus vulgaris* (nematodes) im Wirtstiere. *Zeitschrift fur Tropenmedizin und Parsitologiei*, **2**, 523-535.

Epstein, H. (1971) The origin of the domestic animals of Africa. African Publishing Corporation. New York, USA.

Epstein, H. (1984) Asses, Mules and Onager. In: I.L. Mason (ed). Evolution of domesticated animals. Longman pub. London, UK. pp. 174-184.

Eysker, M. and Pandey, V.S. (1989) Small strongyle infection in donkeys from the high veld in Zimbabwe. *Veterinary Parasitology,* **30,** 345-349.

FAO (1989) Food and Agriculture Organization Production Yearbook, Vol.42. Rome, Italy.

FAO (1994) Food and Agriculture Organization Production Yearbook, vol. 48. Rome Italy.

Fernando, P. (1997) Donkeys and development: socio-economic issues in the use and management of donkeys. Paper presented for Animal Traction Network in Eastern and Southern Africa (ATNESA) workshop on improving donkey utilization and management. 5-9, May 1997. Debre Zeit, Ethiopia (In press).

Feseha, G. (1991) Use of equines in Ethiopia. In: *Proceedings of Institute of Agricultural research (IAR) No. 4.* Fourth livestock improvement conference, 13-15 November, 1991. Addis Ababa, Ethiopia. pp. 51-58.

Feseha, G. (1997) Disease and health problems of donkeys abroad. In: D.E. Svendsen (ed). The Professional Handbook of The Donkey, (3rd ed). Whittet Books Lmt, UK. pp. 207-226.

Feseha, G., Alemu, G., Friew, K., Abule, I. And Ketema, Y. (1997) An overview of donkey utilization and management in Ethiopia. Paper presented for Animal Traction Network in Eastern and Southern Africa (ATNESA) workshop on improving donkey utilization and management. 5-9 May, 1997. Debre Zeit, Ethiopia (In press).

Feseha, G., Mohammed, A. and Yilma, J.M. (1991) Vermicular endoparasitism in donkeys of Debre Zeit and Menagesha, Ethiopia: strategic treatment with ivermectin and Fenbendazole. In: D. Fielding and R.A. Pearson (eds). Donkeys, mules and horses in tropical agricultural development. *Proceedings of a colloquium*, 3-6 September, 1990. Edinburgh, Scotland. pp. 156-166.

Feseha, G. and Nuria, Y. (1993) Endoparasitism and management problems of donkeys (abstract). Word Association for the Advancement of Veterinary Parasitology. 14th International conference on understanding and control of parasitic diseases of animals. 8-13 August, 1993. Cambridge, UK. pp. 41.

Fielding, D. (1987) Donkey power in African rural transport. *World Animals Review*, **63**, 23-30.

Fielding, D. (1988) Pack transport with donkeys. *Appropriate Technology Journal* ***15***, 11-13. Intermediate Technology Publications. London, UK.

Fielding, D. (1991) The number and distribution of equines in the wold. In: D. Fielding and R.A. Pearson (eds). Donkeys, mules and horses in tropical agricultural development. *Proceedings of a colloquium*, 3-6 September, 1990. Edinburgh, Scotland. pp. 62-66.

Fielding, D. and Krause, P. (1998) Donkeys. Tropical Agricultural Series, CTA Publications. Nezerland. 119p.

Fowler, J.N. (1986) Medical. In: E.D. Svendsen (ed). The Professional Handbook of The Donkey. Sovereign Printing Group. UK. pp. 91-99.

Fowler, J.N. (1995) Common conditions of donkeys in temperate climates. *Veterinary Annual,* **35**, 86-95.

Freeland, G.G. (1991) Donkeys, mules and horses in tropical agricultural development. In: D. Fielding and R.A. Pearson (eds). Donkeys, mules and horses in tropical agricultural development. *Proceedings of a colloquium*, 3-6 September, 1990. Edinburgh, Scotland. pp. 322-324.

French, D.D., Torbert, B.J., Champman, M.R., Klein, T.R. and Pierce, R.J. (1983) Comparison of the antiparasitic activity of micellar formulation of ivermectin given parenterally and per os. *Veterinary Medicine and Small Animal Clinic,* **78**, 1778-1780.

Gabaj, M.M., Beesley, W.N. and Awan, M.A. (1992) A survey of mites on farm animals in Libya. *Annals of Tropical Medicine and Parasitology,* **86**, 537-542.

Gelatt, K.N. (1987) The eye. In: A. Mansmann, E.S. MacAllister and P.W. Pratt (eds). Equine medicine and suregry (3rd ed). American veterinary publications. California, USA. pp. 399-432.

Georgi, J.R. and Georgi, M.E. (1990) Parasitology for veterinarains (5th ed). W.B. Saunders Company. Pholadelphia and London.

Getachew, M. and Feseha, G. (1997) Common health problems of working donkeys of Ethiopia. Paper presented for Animal Traction Network in Eastern and Southern Africa (ATNESA) workshop on improving donkey utilization and management. 5-9 May, 1997. Debre Zeit, Ethiopia (In press).

Gibbs, E.P.J. (1981) Virus diseases of horses. In: E.P.J. Gibbs (ed). Virus diseases of food animals, Vol. I. Academic Press. London and New York. pp. 217-230.

Gizaw, N. (1987) Policy and strategy options towards rapid development of Ethiopian livestock industry. *Proceedings of The first Livestock Improvement Conference,* 21-22 June, 1986. Addis Ababa, Ethiopia.

Gonzalez, D.J., Velazquez, B.L., Espinoza, O.A. and Arriaga, J.C. (1994) Draught animals in smallholder (Campesino) farming systems in the highland of central Mexico. *Draught Animal News,* **21**, 7-10.

Graber, M. (1970) Helminthes et helminthiasis des equids (anes et chevaux) de la republique du Tchad. *Revue d Elevage et de Medicine Veterinaire des Pays tropicaux,* **23**, 207-222.

Graber, M. (1973) Helminthes and helminthiasis of domesticated animals in Ethiopia. Institu de Elevage de Medicine Veterinaire des Pays Tropicaux. Maison-Alfort, France.

Green, L. (1994) The practice of farriery in a few less developed countries. In: M. Bakkoury and R.A. Prentis (eds). Working equines. *Proceedings of The Second International Colloquium,* 20-22 April, 1994. Rabat, Morocco. pp.169-170.

Groves, C.P. (1974) Horses, asses and zebras in the wild. Ralph Curtis Books. Hollywood and Florida, USA. 192p.

Groves, C.P. (1986) Taxonomy: distribution and adaptation of recent Equids. In: R.H. Meadow and H.P. Uerpmann (eds). Equids in the Ancient World. pp. 11-51.

Haltenorth, T. and Diller, H. (1980). A field guide to the mammals of Africa including Madagascar. Collins. London, USA.

Hammond, J.A. and Sewell, M.M.H. (1990) Disease caused by helminths. In : M.M.H. Sewell and D.W. Brocklesby (eds). Handbook on Animal Diseases in The Tropics (4^{th} ed) Bailliere Tindal, London. pp. 105-159.

Herd, R.P. (1990) The changing world of worms: the rise of the cyathostomes and the decline of *S. vulgaris. Compendium and Continuing Education for Practicing Veterinarian*, **12**, 732-736.

Hilali, M., Derhalli, F.S. and Baraka, A. (1987) Incidence and monthly prevalence of *Gasterophilus* species larvae (Diptera: Gasterophilidae) in donkeys (*Equus asinus)* in Egypt. *Veterinary Parasitology*, **30**, 111-113.

House, J.A. (1993) African Horse Sickness. *Veterinary Clinics of North America Equine Practice,* **9**, 355-364.

Howarth, S. (1990) Sarcoids: the story so far. The Veterinary Annual, 30th issue. London, Butterworth. pp. 145-154.

Howe, J. and Garba, R. (1997) Farm-level transport and animal dependency in Kaffcho zone, Ethiopia. Paper presented for Animal Traction Network in Eastern and Southern Africa (ATNESA) workshop on improving donkey utilization and management. 5-9 May, 1997. Debre Zeit, Ethiopia (In press).

Howell, P.G. (1963) African Horse Sickness: emerging diseases of Animals. FAO Agricultural Studies No. 61. Rome, Italy.

Hsu, W.H., Wellborn, S.G. and Schaffer, C.B. (1989) The safety of ivermectin. *Compendium and Continuing Education for Practicing Veterinarian*, **11**, 584-589.

Hussein, H.S. and Sammani, S.E. (1985) *Onchocerca raillieti* prevalence and pathology in Sudanese donkey. *Journal of Comparative Pathology*, **95**, 345-351.

Itepu, F. (1991) Donkeys: An alternative source of draft animal power for rural women in Kavngo, Namibia. Paper presented for Animal Traction Network in Eastern and Southern Africa (ATNESA) workshop on improving donkey utilization and management. 5-9 May, 1997. Debre Zeit, Ethiopia (In press).

Iversen, E. (1991) Equine based transport. In: D. Fielding and R.A. Pearson (eds). Donkeys, mules and horses in tropical agricultural development. *Proceedings of a colloquium*, 3-6 September, 1990. Edinburgh, Scotland. pp. 245-250.

Jackson, C. (1936) The incidence and pathology of tumours of domesticated animals in South Africa. *Onderstepoort Journal of Veterinary Science,* **6**, 378-385.

Johnston, A.M. (1994) Equine medical disorders (2nd ed). Black Well Scientific Publications. London, UK.

Jones, P. (1991) Overcoming ignorance about donkeys in Zambia: a case study. In: D. Fielding and R.A. Pearson (eds). Donkeys, mules and horses in tropical agricultural development. *Proceedings of a colloquium*, 3-6 September, 1990. Edinburgh, Scotland. pp. 311-318.

Julian, A.F. ((1992) Equine abortion in Newzland between 1974 and 1990. *Surveillance*, **19**, 24-25.

Jurasek, V. (1986) Results of the laboratory examination of parasites in the animals of Mozambique. IV. Horse and donkeys. *Folia Veterinaria,* **30**, 111-113.

Kaboret, Y., Pangui, L.J. and Vercruysse, J. (1986) Note sur la gastrophilose des anes au Burkina Faso. *Revue de Elevage et de Medicine Veterinaire des Pays Tropcaux,* **39**, 211-212.

Karanja, D.N.R., Nigatia, T.A. and Wandera, J.G. (1993) *Eimeria leukarti* infection in Kenyan donkeys. *Bulletin of Animal Health and Production in Africa,* **41**, 111-115.

Karanja, D.N.R., Nigatia, T.A. and Wandera, J.G. (1995) Donkey klossielosis in Kenya. *Veterinary Parasitology*, **59**, 1-5.

Karns, P.A. and Lther, D.C. (1984) A survey of adverse effects associated with ivermectin use in Louisiana. *Journal of American Veterinary Medical Association,* **185**, 782-783.

Kebede, K. (1995) A preliminary survey of donkey trypanosomiasis and assessment of pack cell volume at different altitudes in North Omo administrative region, Ethiopia. DVM Thesis. Addis Ababa University, Ethiopia.

Khallaayoune, K. (1991) Benefit of a strategic deworming programme in working donkeys in Morocco. In: D. Fielding and R.A. Pearson (eds). Donkeys, mules and horses in tropical agricultural development. *Proceedings of a colloquium*, 3-6 September, 1990. Edinburgh, Scotland. pp. 174-180.

Kiriama, L.L. (1997) Utilisation of donkeys in the northern part of Tanzania: prospects and problems. Paper presented for Animal Traction Network in Eastern and Southern Africa (ATNESA) workshop on improving donkey utilization and management. 5-9 May, 1997. Debre Zeit, Ethiopia (In press).

Kitchen, K.A. (1993) The land of punt. In: T. Shaw, P. Sinclair, B. Andah and A. Okpoko (eds). The archeology of Africa: Food, Metals and Towns. London, Routledge.

Klein, T.R. and Torbert, B.J. (1980) Efficacy of ivermectin (22, 23, Dihydroavermectin B_1) against gastrointestinal parasites in ponies. *American Journal of Veterinary Research*, **41**, 1747-1750.

Kumwenda, K. and Mateyo, C. (1991) The potential and utilization of donkeys in Malawi. In: D. Fielding and R.A. Pearson (eds). Donkeys, mules and horses in tropical agricultural development. *Proceedings of a colloquium*, 3-6 September, 1990. Edinburgh, Scotland. pp. 28-32.

Lapage, G. (1968) Veterinary parasitology (2nd ed). Oliver and boyd. Edinburgh and London, UK.

Leach, T.M. and Robert, C.J. (1981) Present status of chemotherapy and chemoprophylaxis of animal trypanosomiasis in eastern hemisphere. *Pharmacology and Therapeutics,* **13**, 91-147.

Lichtenfels, J.R. (1975) Helminths of domestic equids. Illustrated keys to genera and species with emphesis on North American forms. *Proceedings of The Helminthological Society of Washington* (special issue), **42**, 1-92.

Lopez, A., Chavira, H. and Granillo, A. (1994) Foot and hoof disorders in the under priviledged equids in Mexico. In: M. Bakkoury and R.A. Prentis (eds). Working equines. *Proceedings of The Second International Collquium*, April 20-22, 1994. Rabbat, Morocco. pp. 57-64.

Love, S.J. and Mair, T.S. (1998) Infectious diseases and parasitology. In: T. Mair, S., Love, J. Schumacher and E.A. Watson (eds). Equine Medicine, Surgery and Reproduction. WB Saunders Company Limited. London, UK. pp. 398-418.

Lyons, E.T., Drudge, J.H. and Tolliver, S.C. (1980) Antiparasitic activity of ivermectin in critical tests in equids. *American Journal of Veterinary Research,* **12**, 2069-2072.

Lyons, E.T., Tolliver, S.C., Dridge, J.H., Swerczek, T.W. and Crowe, M.W. (1983) Parasites in Kentucky thoroughbreds at necropsy: Emphasis on stomach worms and tape worms. *American Journal of Veterinary Research*, **44**, 839-844.

Lyons, E.T., Tolliver, S.C., Dridge, J.H., Swerczek, T.W. and Crowe, M.W. (1985) Lung worm (*Dictyocaulus arnfieldi*): prevalence in live equids in Kentucky. *American Journal of Veterinary Research*, **46**, 921-923.

Lyons, E.T., Tolliver, S.C., Dridge, J.H., Swerczek, T.W. and Crowe, M.W. (1987) Common internal parasites found in stomach, large intestine and cranial mesenteric artery of thoroughbreds in Kentucky at necropsy (1985 to 1986). *American Journal of Veterinary Research*, **48**, 268-273.

MacGregor, M.C. (1994) ILPH working together for equines programme. In: M. Bakkoury and R.A. Prentis(eds). Working equines. *Proceedings of The Second International Colloquium,* 20-22 April, 1994. Rabat, Morocco. pp. 175-178.

MAFF (1984) Manual of Veterinary Investigation Laboratory Techniques. Reference book 390, Vol. 2. London UK.

Malan, F.S., Reinecke, R.K. and Scialdo-Krecek, R.C. (1982) Anthelmintic efficacy of fembendazole in donkeys assessed by the modified non-parametric method. *Journal of South African Vetrinary Association*, **53**, 185-188.

Maldonando, S.J. and Sims, B.G. (1991) Donkeys and other equines in Mexican Agriculture. In: D. Fielding and R.A. Pearson (eds). Donkeys, mules and horses in tropical agricultural development. *Proceedings of a colloquium*, 3-6 September, 1990. Edinburgh, Scotland. pp. 8-12.

Mansmann, R.A. and McAllister, E.S. (1982) Equine medicine and Surgery (3rd ed). American Veterinary Publications, California, USA.

Martin, P.J., Anderson, N. and Jarret, R.G. (1985) Resistance to benzimidazole anthelmintics in field strain of *Ostertagia and Nematodirus* in sheep. *Australian Veterinary Journal*, **62**, 38-43.

Mattioli, R.C., Zinsstag, J. and Pfister, K. (1994) Frequency of trypanosomiasis and gastrointestinal parasites in draught donkeys in the Gambia in relation to animal husbandry. *Tropical Animal Health and Production,* **26,** 102-108.

McCarti, B.M., Hinter, A.G., Pogrom, R.G. and Bourne, A.S. (1987) Tick infestation on livestock in Yemen Arab Republic and their potential as vector of livestock diseases. *Tropical Animal Health and Production,* **19**, 21-23.

McCollum, W.H., Timoney, P.J. and Tenglesen, L.A. (1995) Clinical, virological and serological responses of donkeys to intranasal inoculation with the KY-84 strain of equine arteritis virus. *Journal of Comparative Pathology,* **2**, 207-211.

McConaghy, F.F., Davis, R.F. and Hodgson, E.R. (1994) Equine sarcoid: a present therapeutic challenge. *Compendium on Continuing Education for the Practicing Veterinarian,* **16**, 1022-1031.

McMullan, W.C. (1982) Equine medicine and surgery (3rd ed), Vol. 2. Santa Barbara, American Veterinary Publications. Santa Barbara, USA.

Micthchell, D. and Allen, W.R. (1975) Observation on reproductive performance in the yearling mare. *Journal of Reproductive Fertility (suppl)*, **23**, 531.

Misk, N.A. and Nigam, J.M. (1985) Unusual traumatic foot abnormalities in Egyptian donkeys. *Equine practice*, **7**, 15-20.

Mkufya, S.O. (1994) The draught animal project. In: M. Bakkoury and R.A. Prentis (eds). Working equines. *Proceedings of The Second International Colloquium,* 22-24 April, 1994. Rabat, Morocco. pp. 315-322.

Mohammed, A. (1991) Management and breeding aspects of donkeys around Awassa, Ethiopia. In: D. Fielding and R.A. Pearson (eds). Donkeys, mules and horses in tropical agricultural development. *Proceedings of a colloquium*, 3-6 September, 1990. Edinburgh, Scotland. pp. 185-188.

Mohammed, F.H., Abusamra, M.T., Iibrahim, K.E. and Idris, S.O. (1990) Cutaneous habronemiasis in horses and donkeys. *Revue Elevage Medicine Veterinaire des Pays Tropicaux,* **42**, 535-540.

Monnier, J. (1965) Contribution a l etude de la traction bovine au Senegal. *Machinisme agricole tropicale,* **10**, 3-25.

Moulton, J.E. (1961) Tumours of domestic animals. University of California Press. Berkley and Los Angeles, USA.

Mukhwana, E.J. (1994) Helminth parasites of donkeys (*Equus asinus*), Burchell's zebras (*Equus burchelli*) and camels (*Camelus dromedarius*) in a selected areas of Northern Kenya. In: M. Bakkoury and R.A. Prentis (eds). Working equines. *Proceedings of The Second International Colloquium,* 22-24 April, 1994. Rabat, Morocco. pp. 45-50.

Murray, M. and Gray, A.R. (1984) The current situation on animal trypanosomiasis in Africa. *Preventive Veterinary Medicine*, **2**, 23-30.

Mutharia, L. (1995) Oloyian Kalani Group Ranch: a participatory assessment of pastoral resources and their utilization in selected areas of Kajiado district. Intermediate Technology. Nairobi, Kenya. 71p.

Muvirimi, F. (1997) Current practice and characterization of farmers using draught animals in semi-arid Zimbabwe: intervention to improve the productivity of draught animals. In: Improving the Productivity of Draught Animals in Sub-Saharan Africa. *Proceedings of The Workshop,* 25-27 December, 1997. Harare, Zimbabwe (In press).

Mwakitwange, G., Haule, S., Massung, M. and Sizay, M. (1997) The status and potential of donkeys in the southern highlands of Zimbabwe. Paper presented for Animal traction Network in Eastern and Southern Africa (ATNESA) workshop on improving donkey utilization and management. 5-9 May, 1997. Debre Zeit, Ethiopia (In press).

Mwenya, E. and Keib G. (1997) History and utilization of donkeys in Namibia. Paper presented for Animal Traction Network in Eastern and Southern Africa (ATNESA) workshop on improving donkey utilization and management. 5-9 May, 1997. Debre Zeit, Ethiopia (In press).

Nafie, T., El Allawy, T., Motellib, A.A. and El Amroussi, S. (1982) Effect of induced equine piroplasmosis on some blood constituents. *Assiut Veterinary Medical Journal,* **9**, 123-128.

Nasir, L., McFarlane, S.T., Torrintegui, B.O. and Reid, S.W.J. (1997) Screening for bovine papilloma virus in peripheral blood cells of donkeys with and without sarcoids. *Research in Veterinary Science,* **63**, 289-290.

Naunyango, S., Haufiku, M. and Rigourd, C. (1997) Donkey traction: the experience of North Central Namibia. Paper presented for Animal Traction Network in Eastern and Southern Africa (ATNESA) workshop on improving donkey utilization and management. 5-9 May, 1997. Debre Zeit, Ethiopia (In press).

Ndlova, L.R., Bwakura,T. and Topps, J.H. (1997) The role of donkeys in the crop related activities in integrated crop-livestock systems in semi-arid areas of Zimbabwe. Paper presented for Animal Traction Network in Eastern and Southern Africa (ATNESA) workshop on improving donkey utilization and management. 5-9 May, 1997. Debre Zeit, Ethiopia (In press).

Newton, J.R., Wood, J.L.N., Dunn, K.A. DeBrauwere, M.N. and Chanter, N. (1997) Naturally occurring persistent and asymptomatic infection of guttural pouches of horses with *Streptococcus equi*. *Veterinary record*, **140**, 84-90.

Nicholls. J.M., Clayton, H.M., Duncan, J.L. and Buntain, B. (1979) Lung worms (*Dictyocaulus arnfieldi*) infection in donkeys. *Veterinary Record*, **104**, 567-570

Nowak, R.M. (1991) Walker's mammals of the world (5th ed). Vol. II. Johns Hopkins University Press. Baltimore, London UK pp. 1303-1319.

Ogunmremi, G.O. (1982) Counting the camel: the economics of transportation in pre industrial Nigeria. NOK Publishers international. New York.

Onoviran, O. and Odeyemi, P.S. (1991) Trypanosomiasis in donkeys in Nigeria. In: D. Fielding and R.A. Pearson (eds). Donkeys, mules and horses in tropical agricultural development. *Proceedings of a colloquium*, 3-6 September, 1990. Edinburgh, Scotland. pp. 113

Pandey, V.S. (1980a) Epidemiological observation on lung worm, *Dictyocaulus arnfieldi*, in donkeys from Morocco. *Journal of Helminthology,* **54**, 275-279.

Pandey, V.S. (1980b) Hydatidosis in donkeys in Morocco. *Annals of Tropical Medicine and Parasitology,* **74**, 519-521.

Pandey, V.S. (1980c) Seasonal prevalence of *Strongylus vulgaris* in anterior mesenteric artery of the donkey in Morocco. *Veterinary Parasitology,* **7**, 357-362.

Pandey, V.S. (1981) Epidemiology of *Strongylus vulgaris* infection of horse in Morocco. *Tropical Animal Health and Production*, **13**, 119-121.

Pandey, V.S. (1983) Observation on *Fasciola hepatica* in donkey from Morocco. *Annals of Tropical Medicine and Parasitology,* **77**, 159-162.

Pandey, V.S. and Cabaret, J. (1993) Stomach parasites of donkeys in Morocco: habitat and interspecific interaction. *Veterinary Parasitology,* **49**, 331-337.

Pandey, V.S. and Eysker, M. (1988) Parasites in donkeys of the highveld of Zimbabwe. *The Veterinary Quarterly,* **10**, 246-248.

Pandey, V.S. and Eysker, M. (1989) *Strongylus vulgaris* in donkeys (*Equus asinus)* from the highveld of Zimbabwe. *Veterinary Parasitology,* **32**, 173-179.

Pandey, V.S. and Eysker, M. (1990) Internal parasites of donkeys from the highveld of Zimbabwe. *Zimbabwe Veterinary Journal,* **21**, 27-32.

Pandey, V.S. and Eysker, M. (1991) Internal parasites of equines in Zimbabwe. In: D. fielding and R.A. Pearson (eds). Donkeys, mules and horses in tropical agricultural development. *Proceedings of a colloquium*, 3-6 September, 1990. Edinburgh, Scotland. pp. 163-173.

Pandey, V.S., Khallaayoune, K., Ouhelli, H. and Kakkak, A. (1994) Parasites of donkeys in Africa. In: M. Bakkoury and R.A. Prentis (eds). Working equines. *Proceedings of The Second International Colloquium,* 22-24 April, 1994. Rabat, Morocco. pp. 35-44.

Pandey, V.S., Ouhelli, H. and Verhulst, A. (1992a) Epidemiological observations on stomach worms of donkeys in Morocco. *Veterinary Research Communications,* **16,** 273-279.

Pandey, V.S., Ouhelli, H. and Verhulst, A. (1992b) Epidemiological observation on *Gasterophilus intestinalis* and *Gasterophilus nasalis* in donkeys from Morocco. *Veterinary Parasitology:* **41**, 285-292.

Pankhurst, J. W. (1963) Liver flukes in donkeys. *Veterinary Record*, **75**, 434.

Pascoe, R.R. (1981) Clinical survey of tumours and tumour-like lesions in horses in South East Queensland. *Equine Veterinary Journal*, **13**, 235-239.

Paweska, J.T., Binns, M.M., Woods, P.S.A. and Chirnside, E.D. (1997) A survey of antibodies to equine arteritis virus in donkeys, mules and zebras using virus neutralization (VU) and enzyme linked immunosorbet assay (ELIZA). *Equine Veterinary Education,* **29**, 40-43.

Pearson, R.A., Lawrence, P.R. and Jansen, H.G.P. (1990) Animal traction in Niger: prospect for the future. International Livestock Centre for Africa (ILCA). Niamey, Niger.

Pearson, R.A., Nengomasha, E. and Krecek, R. (1997a) Improving the management of donkeys in Africa: issues, experience and opportunities. Paper presented for Animal Traction Network in Eastern and Southern Africa (ATNESA) workshop on improving donkey utilization and management. 5-9 May, 1997. Debre Zeit, Ethiopia (In press).

Pearson, R.A., Nengomasha, E. and Krecek, R. (199b7) The challenges in using donkeys for work in Africa. Paper presented for Animal Traction Network in Eastern and Southern Africa (ATNESA) workshop on improving donkey utilization and management. 5-9 May, 1997. Debre Zeit, Ethiopia (In press).

Pearson, R.A., Nengomasha, E. and Krecek, R.C. (1995) The challenges in using donkeys for work in Africa. Paper presented at the workshop on meeting the challenge of animal traction. 4-8 December, 1995. Karen, Kenya (In press).

Phillipson, O.W. (1993) The antiquity of cultivation and herding in Ethiopia. In: T. Shaw, P. Sinclair, B. Andah and A. Okpoko (eds). The Archeology of Africa: Food, Metals and Towns. London, Routledge.

Pradhan, S.M.S., Mahato, S.N. and Joshi, B.R. (1991) Equines in Nepal. In: D. Fielding and R.A. Pearson (eds). Donkeys, mules and horses in tropical agricultural development. *Proceedings of a colloquium*, 3-6 September, 1990. Edinburgh, Scotland. pp. 22-25.

Prasad, V.L., Marovanidze, K. and Nyathi, P. (1991) The use of donkeys as draught animals relative to bovines in the communal farming sectors of Zimbabwe. In: D. Fielding and R.A. Pearson (eds). Donkeys, mules and horses in tropical agricultural development. *Proceedings of a colloquium*, 3-6 September, 1990. Edinburgh, Scotland. pp. 231-239.

Prentis, R.A. (1994) Issues for working equines: key note address. In: M. Bakkoury and R.A. Prentis (eds). Working equines. *Proceedings of The Second International Colloquium,* 22-24 April, 1994. Rabat, Morocco. pp. 9-16.

Ragland, W.L., Keown, G.H. and Spencer G.R. (1970) Equine sarcoid. *Equine Veterinary Journal,* **2**, 2-11.

Ramachandran, S. (1991) Viral condition of equids. In: D. Fielding and R.A. Pearson (eds). Donkeys, mules and horses in tropical agricultural development. *Proceedings of a colloquium*, 3-6 September, 1990. Edinburgh, Scotland. pp. 114-125.

Ramachandran, S. and Srinivas, R.P. (1991) The contribution of donkeys and pony to the economy of rural and urban low-income group in Karnataka state, South India. In: D. Fielding and R.A. Pearson (eds). Donkeys, mules and horses in tropical agricultural development. *Proceedings of a colloquium*, 3-6 September, 1990. Edinburgh, Scotland. pp. 20-21.

Reid, N.R. (1961) African Horse Sickness. *British Veterinary Journal*, **118**, 137-142.

Reid, S.W.J., Fowler, J.N. and Smith, K.T. (1991) Detection of papilloma viral DNA in the sarcoid of the donkey. In: D. Fielding and R.A. Pearson (eds). Donkeys, mules and horses in tropical agricultural development. *Proceedings of a colloquium*, 3-6 September, 1990. Edinburgh, Scotland. pp. 135-137.

Reid, S.W.J., Gettinby, G. Fowler, J.N. and Ikin, P. (1994a) Epidemiological observation on sarcoids in a population of donkeys (*Equus Asinus). Veterinary Record,* **134**, 207-211.

Reid, S.W.J., Smith, K.T. and Jarret, W.F.H. (1994b) Detection, cloning and Characterization of papilloma viral DNA presents in sarcoid tumours of *Equus asinus. Veterinary Record*, **135**, 430-432.

RIM, (1992) Nigerian national livestock resources survey report by Resource Inventory and Management limited (RIM). Abuja, Nigeria. 130p.

Roberts, H.M. Adams, J.W.E. and Danks, B.C. (1976) *Gastrodiscus aegyptiacus*: a therapeutic trial. *Rhodesian Veterinary Journal*, **6**, 73-76.

Rodriguez-maldonado, G. (1991) The principal problems in working donkeys in Mexico (abstract). In: D. Fielding and R.A. Pearson (eds). Donkeys, mules and horses in tropical agricultural development. *Proceedings of a colloquium*, 3-6 September, 1990. Edinburgh, Scotland. pp. 138-139.

Rossdale, P.D. and Ricketts, S.W. (1980) Equine stud farm medicine (2nd ed). Baillier Tindal. London UK.

Round, M.C. (1976) Lungworm infection (*Dictyocaulus arnfieldi*) of horses and donkeys. *Veterinary Record*, **99**, 393-395.

Russel, A.F. (1948) The development of helminthiasis in thoroughbred foals. *Journal of Comparative Pathology*, **58**, 107-127.

Sahibi, H. and Bakkoury, M. (1994) Equine babesiosis in Morocco, prevalence and equine ticks. In: M. Bakkoury and R.A. Prentis (eds). Working equines. *Proceedings of The Second International Colloquium,* 22-24 April, 1994. Rabat, Morocco. pp. 65-74.

Sainsbury, D.W.B. (1997) Housing. In: E.D. Svendsen (ed). The Professional Handbook of The Donkey (3rd ed). Whittet Books Limited. London UK. pp. 106-124.

Schandevyl, P. and Sumbu, W. (1987) *Gastrodiscus aegyptiacus*: un essai clinique arec l'albendazole et le dichlorvos. *Revue de Medicine Veterinaire*, **138**, 23-26.

Scialdo, R.C., Reinecke, R.K. and de Vos, V. (1982) Seasonal incidence of helminthiasis in the Burchell's zebra. *Onderstepoort Journal of Veterinary Research*, **49**, 127-130.

Schmidt-Neilson, K. (1964) The donkey: physiological problems of heat and water. Desert animals. Clarendon press, Oxford, USA.

Selim, M.K., Abdel-gawad, A.F., Ragheb, M.M. and Abd el-Malek, M.H. (1994) Control of different strongyle worms in donkeys under the Egyptian environmental condition. In: M. Bakkoury and R.A. Prentis (eds). Working equines. *Proceedings of The Second International Colloquium,* 22-24 April, 1994. Rabat, Morocco. pp. 149-154.

Selim, M.K., Hosny, Z., El Ghawas, A. and Hafez, M.A.M. (1983) The pathogenic influence of splenectomy on the tissues of donkeys latently infected with *Babesia equi. Journal of The Egyptian Veterinary Medical Association,* **43**, 315-322.

Sewell, M.M.H. (1991) Uniformity and contrast of the helminth disease of equids. In: D. Fielding and R.A. Pearson (eds). Donkeys, mules and horses in tropical agricultural development. *Proceedings of a colloquium*, 3-6 September, 1990. Edinburgh, Scotland. pp. 141-150.

Sieber, N. (1997) The economic impact of pack donkeys in Makete, Tanzania. Paper presented for Animal Traction Network in Eastern and Southern Africa (ATNESA) workshop on improving donkey utilization and management. 5-9 May, 1997. Debre Zeit, Ethiopia (In press).

Siegel, J. (1992) Statistix: analytical software, version 4.0. 4080 Roscrea Drive, Tallahassee FL, USA.

Simpson, G.G. (1945) The principles of classification and classification of the mammals. *Bulletin of American Museum Natural History,* **85**, 1-350.

Sims, B.G., Arevalo, I. Doyle, P. and Twomlow, S. (1994) Development and evolution of equine powered tillage and seeding implement for semi-arid condition in Mexico. In: M. Bakkoury and R.A. Prentis (eds). Working equines. *Proceedings of The Second International Colloquium,* 22-24 April, 1994. Rabat, Morocco. pp. 249-266.

Sims, B.G., Maldonando, S.J. (1991) Donkeys and other equine in Mexican agriculture. In: D. Fielding and R.A. Pearson (eds). Donkeys, mules and horses in tropical agricultural development. *Proceedings of a colloquium*, 3-6 September, 1990. Edinburgh, Scotland. pp. 8-12.

Sisay, Z. and Tilahun, F. (1997) The role of pack donkeys in the major grain market (Yehil Berenda) of Addis Ababa, Ethiopia. Paper presented for Animal Traction Network in Eastern and Southern Africa (ATNESA) workshop on improving donkey utilization and management. 5-9,May, 1997. Debre Zeit, Ethiopia (In press).

Slocombe, J.O.D. (1979) Prevalence and treatment of tape worms in horses. *Canadian Veterinary Journal*, **20**, 136-140.

Sloss, M.W. and Kemp, R. (1978) Veterinary clinical parasitology (5th ed). IOWA State University Press. Ames, Iowa.

Smith, A.J. (1991) The working equine: what we can learn from research with other animals used for draught purposes? In: D. Fielding and R.A. Pearson (eds). Donkeys, mules and horses in tropical agricultural development. *Proceedings of a colloquium*, 3-6 September, 1990. Edinburgh, Scotland. pp. 211-219.

Snow, W.F., Wacher, T.J. and Rawlings, P. (1996) Observation on the prevalence of trypanosomiasis in small ruminants, equines and cattle in relation to tsetse challenge in the Gambia. *Veterinary Parasitology,* **66**, 1-11.

Soulsby, E.J.L. (1982) Helminths, arthropods and protozoa of domesticated animals (7th ed). Baillier Tindall. London, UK.

Sowe, J., Gai, B., Sumberg, J. and Gilbert, E. (1990) Animal traction for agricultural development. In: D. Fielding and A. Faye (eds). *Proceedings of The Third Workshop of the West African Animal Traction Net Work.* 7-12 July, 1988. Wageningen, Netherlands. pp. 315-321.

Starkey, p. (1987) Brief donkey work. *Ceres,* **20**, 37-40.

Starkey, P. (1994a) Donkey utilisation in Sub-Saharan Africa: receny changes and apparent needs. In: M. Bakkoury and R.A. Prentis (eds). Working equines. *Proceedings of The Second International Colloquium,* 22-24 April, 1994. Rabat, Morocco. pp. 289-302.

Starkey, P. (1994b) Improving animal traction technology. In: P. Starkey, E. Mwenya and J. Stares (eds). *Proceedings of The First Workshop of the Animal Traction Net Work for Eastern and Southern Africa (ATNESA),* 18-23 January, 1992. Lusaka, Zambia.

Starkey, P. (1995a) The donkey in South Africa: myths and misconceptions. In: P. Starkey (ed). Animal power in South Africa- empowering rural communities. Development Bank of South Africa, Gauteng, South Africa. 160p.

Starkey, P. (1995b) Animal power in South Africa: empowering rural communities. Development Bank of South Africa, Gauteng, South Africa. 160p.

Starkey, P. (1997) Donkey work. In: E.D. Svendsen (ed). The Professional Handbook of The Donkey. Whittet Books Limited. London, UK. pp. 183-206.

Starkey, P. and Starkey, M. (1997) Regional and world trends in donkey population. Paper presented for Animal Traction Network in Eastern and Southern Africa (ATNESA) workshop on improving donkey utilization and management. 5-9 May, 1997. Debre Zeit, Ethiopia (In press).

Stephen, L.E. (1986) Trypanosomiasis: a veterinary perspective. Pergamon press. Oxford, UK.

Sundberg, J.P., Burnstein, T., and Page, E.H. (1977) Neoplasms of equidae. *Journal of The American Veterinary Medical Association,* **170**, 150-152.

Svendsen, E.D. (1986) Donkeys abroad. In: E.D. Svendsen (ed). The Professional Handbook of The Donkey (1st ed). Sovereign Printing Groups. UK. pp. 233-245.

Svendsen, E.D. (1991) Work to improve the condition of working donkeys and mules worldwide. In: D. Fielding and R.A. Pearson (eds). Donkeys, mules and horses in tropical agricultural development. *Proceedings of a colloquium*, 3-6 September, 1990. Edinburgh, Scotland. pp. 181-184.

Svendsen, E.D. (1994) The main types of parasites affecting donkeys' health in various parts of the world. In: M. Bakkoury and R.A. Prentis (eds). Working equines. *Proceedings of The Second International Colloquium,* 20-22 April, 1994. Rabat, Morocco. pp. 23-34.

Svendsen, E.D. (1997a) Parasites abroad. In: E.D. Svendsen (ed). The Professional Handbook of The Donkey (3rd ed). Whittet Books Limited. London, UK. pp. 227-238.

Svendsen, E.D. (1997b) Donkeys abroad. In: E.D. Svendsen (ed). The Professional Handbook of The Donkey (3rd ed). Whittet Books Limited. London, UK. pp. 166-182.

Sweeney, C.R. (1996) Strangles: *Streptococcus equi* infection in horses. *Equine Veterinary Education*, **8**, 368-369.

Tarry, D. (1994) Horse ectoparasite problem in Britain. *Equine Veterinary Education*, **6**, 319-320.

Tawdrous, E.N. (1998) Common injuries of working donkeys treated at Brooke Hospital for Animals. *Equine Veterinary Education*, **10**, 51-54.

Taylor, W. (1994) The Moroccan farrier training program. In: M. Bakkoury and R.A. Prentis (eds). Working equines. *Proceedings of The Second International Colloquium,* 20-22 April, 1994. Rabat, Morocco. pp. 327-330.

Theiler, A. (1921) African Horse Sickness (pestis equorum). *South African Department of Agricultural Science Bulletin.* No. 19.

Thomas, R.E. and Jone, L.P. (1960) Lung worm in burro. *Veterinary Record*, **55**, 38-40.

Tisserand, J.L., Faurie, F. and Toure, M. (1991) A comparative study of donkey and pony digestive physiology. In: D. Fielding and R.A. Pearson (eds). Donkeys, mules and horses in tropical agricultural development. *Proceedings of a colloquium*, 3-6 September, 1990. Edinburgh, Scotland. pp. 67-72.

Tolliver, S.C., Lyons, E.T. and Drudge, J.H. (1985) Species of small strongyles and other internal parassites recovered from donkeys at necropsy in Kentucky. *Proceedings of The Helminthological Society of Washington,* **52**, 260-265.

Torbert, B.J. (1982) Efficacy of injectable and oral formulation of ivermectin against gastrointestinal parasites in ponies. *American Journal of Veterinary research*, **43**, 1451.

Trail, J.C.M., Sones, K., Jibbo, J.M.C., Durkin, J., Light, D.E. and Murray, M. (1985) Productivity of boran cattle maintained by chemoprophylaxis under trypanosomiasis risk. ILCA Research Paper No.9. Addis Ababa, Ethiopia. 76p.

Trawford, A.F. (1997) Parasites in UK donkeys. In: E.D. Svendsen (ed). The Professional Handbook of The Donkey (3rd ed). Whittet Books Limited, London, UK. pp. 56-69.

Trenfield, K., Spradbrow, P.B. and Vanselow, B. (1985) Sequences of papilloma virus DNA in equine sarcoid. *Equine Veterinary Journal,* **17**, 449.

Twerda, M., Fielding, D. and Fielding, C. (1997) Role and management of donkeys in Samburu and Turkana pastoralist societies in Northern Kenya. *Tropical Animal Health and Production,* **29,** 48-54

Upadhyay, R.C. (1991) Equine power : the role and feature potential in India. In: D. Fielding and R.A. Pearson (eds). Donkeys, mules and horses in tropical agricultural development. *Proceedings of a colloquium*, 3-6 September, 1990. Edinburgh, Scotland. pp. 13-19.

Uppal, P.K. (1991) Control of the 1987 equine influenza epidemic in India and the present status of the disease. In: D. Fielding and R.A. Pearson (eds). Donkeys, mules and horses in tropical agricultural development. *Proceedings of a colloquium*, 3-6 September, 1990. Edinburgh, Scotland. pp. 126-132. .

Uppal, P.K. and Yadav, M.P. (1987) Out break of equine influenza in India. *Veterinary Record*, **122**, 569-570.

Uppal, P.K. and Yadav, M.P. (1988) Isolation of A/Equi-1 virus during the 1987 equine influenza epidemic in India. *Equine Veterinary Journal,* **21**, 364-366.

Urquhart, G.M., Armour, J., Duncan, J.L., Dunn, A.M. and Jennings, F.W. (1996) Veterinary Parsitology (2st ed). Black Well Science Ltd. Oxford and London, UK.

Vercrussey, J., Harrids, E.A., Kaboret, Y., Pangui, L.J. and Gibson, D.I. (1986) Gastrointestinal helmiths of donkeys in Burkina Faso. *Zeitschrift fur Parasitenkunde* **72**, 821-825.

Wells, E.A. (1984) Animal trypanosomiasis in South Africa. *Preventive Veterinary Medicine,* **2,** 31-41.

Wells, D. and Krecek, R.C. (1997) Socio-economic roles of donkeys in Hammanskraal, South Africa. Paper presented for Animal Traction Network in Eastern and Southern Africa (ATNESA) workshop on improving donkey utilization and management. 5-9 May, 1997. Debre Zeit, Ethiopia (In publication).

Wescott, R.B., Farrell, C.J. Gallina, A.M. and Foreyt, W.J. (1980) Efficacy of ivermectin B_{1a} for treatment of experimentally induced nematode infection in cattle. *American Journal of Veterinary Research,* **41**, 1326-1328.

William, S.T.F. (1986) The donkey foot and its care. In: E.D. Svendsen (ed). The Professional Handbook of The Donkey. Sovereign Printing Group. Uk.

Wilson, R.T. (1976) Some quantitative data on the Tigre salt trade from the early 19th century to the present day. Annals Instituto, University of the Orient. *Napoli,* **36**, 154-164.

Wilson, R.T. (1978) Studies on the livestock of Southern Darfur, Sudan. VI-Notes on equines. *Tropical Animal Health and Production,* **10**,183-189.

Wilson, R.T. (1987) Animals for work: non-draught use in Ethiopia. In: K. Beyene and L.M. Lambourine (eds). The Status of Livestock Pasture and Forage Research and Development in Ethiopia. Addis Ababa, Ethiopia. pp. 78-93.

Wilson, R.T. (1990) The Donkey. In: W.J.A. Payne (ed). An introduction to animal husbandry in the tropics (4th ed). Longman Scientific Technical. New York USA. pp. 581-603.

Wilson, R.T. (1991) Equines in Ethiopia. In: D. Fielding and R.A. Pearson (eds). Donkeys, mules and horses in tropical agricultural development. *Proceedings of a colloquium*, 3-6 September, 1990. Edinburgh, Scotland. pp. 33-47.

Winkler H.A. (1938) Rock drawings of Southern Upper Egypt. Egypt exploration society. London UK.

Wylam, C.B. (1991) Experience from donkey draught from West Sudan. In: D. Fielding and R.A. Pearson (eds). Donkeys, mules and horses in tropical agricultural development. *Proceedings of a colloquium*, 3-6 September, 1990. Edinburgh, Scotland. pp. 286-292.

Yazwinski, T.A., Hamm, P., Greeway, B.S. and Tilley, W. (1982) Antiparasitic effectiveness of ivermectin in horses. *American Journal of Veterinary Research*, **43**, 1092-1094.

Yigezu, L.M., Roger, F., Kiredjian, W. and Tariku, S. (1997) Isolation of *Streptococcus equi* (strangles agent) from Ethiopian camel. *Veterinary Record*, **140**, 608.

Yilma, J.M. Feseha, G. Svendsen, E.D. (1989) Epidemiology and control of helminthiasis of working donkeys in Ethiopia (abstract). World Association for The Advancement of Veterinary Parasitology. August 1989. Berlin. pp. 38.

Yilma, J.M. Feseha, G. Svendsen, E.D. and Mohammed, A. (1991) Health problems of working donkeys in Debre Zeit and Menagesha regions of Ethiopia. In: D. Fielding and R.A. Pearson (eds). Donkeys, mules and horses in tropical agricultural development. *Proceedings of a colloquium*, 3-6 September, 1990. Edinburgh, Scotland. pp. 151-155.

Yousef, M.K., Dill, D.B. and Mayes, M.G. (1970) Shifts in body fluids during dehydration in burro (*Equus asinus). Journal of Physiology,* **29**, 345-349.

Zelealem. B., Dilnesaw, A. and Mengistu, G. (1997) Local manufacturing and distribution of donkey carts in South Shewa, Ethiopia: lessons and problems. Paper presented for Animal Traction Network in Eastern and Southern Africa (ATNESA) workshop on improving donkey utilization and management. 5-9 May, 1997. Debre Zeit, Ethiopia (In press).

Zumpt, F. (1965) Myiasis in man and animals in the Old World. A Textbook of Physicians, Veterinarians and Zoologists. Butterworths and Co (publishers) LTD. London, UK.

Appendix I

Appendix I Daily data record sheet of different clinical conditions of donkeys and mules at all project sites, Ethiopia.

Name of project site_____

Date of examination_____

Serial No.	Owner name	No. of donkeys owned	No. of mules owned	Age	Sex	Body condition score	Skin conditions, their specific sites and causes
0001							
0002							
0003							

Serial No.	Foot problems and disorders	Pathological lesions of eyes and their possible causes	Respiratory problems	Urogenital problems	Gastrointestinal problems
0001					
0002					

Appendix I

Ectoparasite survey.

Serial No.	Tick species				Lice species		Mange mites		Bot eggs
0001									
0002									
0003									
0004									

Faecal worm egg/larval counts of gastrointestinal and pulmonary helminths.

Serial No.	Parasites identified and their faecal worm egg/larval counts						
	T. axei	Strongyles	Ascarids	Lung worm	Cestodes	*S. westeri*	Fluke
0001							
0002							

Appendix II Common clinical conditions observed and diagnosed in working donkeys at all project sites, Ethiopia.

Table 1. Number and percentage of common clinical conditions encountered in 9493 working donkeys at all project sites, Ethiopia, during the period 1995-1997.

Clinical conditions	Number	% from total conditions
Harnessing problems	17700	43.7
Foot problems and disorders	5661	14.0
Ectoparasites	5470	13.5
Accidental wounds	2670	6.6
Eye problems	2206	5.4
Abscesses	1269	3.1
Respiratory problems	1093	2.7
Emaciation	1071	2.6
Mud fever	1066	2.6
Lameness	960	2.4
Urogenital problems	819	2.0
Tumours	345	0.9
Gastrointestinal problems	345	0.5
Total clinical conditions	40520	100

Appendix II

Table 2. Common wounds and sores due to improper harnesses and harnessing materials, and inappropriate implements encountered in 9493 examined working donkeys at all project sites, Ethiopia.

Wounds/sores	Number	%	% from total wounds/ sores
Saddle galls (back sore)	2174	22.9	12.3
Tail sore	4022	42.4	22.7
Leg sore	3393	35.7	19.2
Girth galls	3208	33.8	18.1
Pastern sore	1801	19.0	10.2
Abdominal sore	1635	17.2	9.2
Chest sore	657	6.9	3.7
Hip sore	605	6.4	3.4
Granuloma	205	2.2	1.2
Total conditions	17700	-	100

Appendix II

Table 3. Common foot problems and disorders encountered in 9493 clinically examined working donkeys at all project sites, Ethiopia.

Foot problems/disorders	Number	%	% from total problems/disorders
Twisted hoof wall or toe	2625	27.7	46.4
Hoof brittle	1046	11.0	18.5
Hoof crack	671	7.1	11.9
Coronitis	434	4.6	7.7
Contracted tendon	225	2.4	4.0
Puncture wounds of hoof	189	2.0	3.3
Thrush	176	1.9	3.0
Hoof overgrowth	162	1.7	2.9
Hoof abscesses	133	1.4	2.3
Total conditions	5661	-	100

Table 4. Common accidental wounds encountered in 9493 examined donkeys at all project sites, Ethiopia.

Accidental wounds	Number	%	% from total accidental wounds
Donkey bites	1471	15.6	55.1
Hyena bites	866	9.1	32.4
Horn injuries	184	2.0	7.0
Trauma/abuse	149	1.6	5.6
Total conditions	2670	-	100

Appendix II

Table 5. Number and percentage of common clinical signs of respiratory problems in 9493 clinically examined working donkeys at all project sites, Ethiopia.

Clinical signs associated with respiratory problems	Number	%	% from total clinical signs
Prolonged dry coughing	696	7.3	63.7
Coughing with nasal discharge	232	2.4	21.2
Drenching pneumonia	126	1.3	11.5
Coughing associated with head and neck lymph node enlargement	39	0.4	3.6
Total conditions	1093	-	100

Table 6. Some gastrointestinal problems observed in 9493 clinically examined working donkeys at all project sites, Ethiopia.

Gastrointestinal problems	Number	%	% from total gastrointestinal problems
Rectal prolapse	64	0.7	33.7
Bloat	47	0.5	24.7
Impaction	42	0.4	22.1
Colic	27	0.3	14.2
Dysphagia	10	0.1	5.3
Total conditions	190	-	100