ADDIS ABABA UNIVERSITY
FACULTY OF VETERINARY MEDICINE

RUMINANT FASCIOLOSIS: STUDIES ON THE CLINICAL OCCURRENCE, COPROLOGY, MALACOLOGY AND ABATTOIR SURVEY IN DEBRE BIRHAN AND SURROUNDING AREAS.

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A thesis submitted to Faculty of Veterinary Medicine, Addis Ababa University in partial fulfillment of the requirements for the Degree of Master of Science in Tropical Veterinary Medicine.

BY
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Board of Examiners: Signature

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LIST OF ABBREVIATIONS

p.p.m	parts per million
μm	micrometer
ml	milliliter
Kg	Kilogram
^{0}C	degree Celsius
WHO	World Health Organization
CTA	Center for Tropical Agriculture
CACC	Central Agricultural Censes Commission
AST	Aspartate Aminotransferase
GIS	Geographic Information System
GGT	Gamma Glutamyl Transferase
GLDH	Glutamate Dehydrogenase
FVM	Faculty of Veterinary Medicine
AAU	Addis Ababa University
DVM	Doctor of Veterinary Medicine
ELISA	Enzyme Linked Immuno Sorbent Assay
FEC	Fluke Egg Count
FhES	*Fasciola hepatica* Excretory-Secretory
Hlth	Health
ILCA	International Livestock Center for Africa
ARARI	Amhara Region Agricultural Research Institute
STATA	Stastical analysis
lat.	Latitude
long.	Longitude
DN	Data not available
NR	Not recommended
Cm	Centimeter
AL-IPB	Aklilu Lemma Institute of Pathobiology
Spp.	Species

m.a.s.l	meters above sea level
pp.	Page
mln	million
bln	billion
SC	Subcutaneous
Br.	Birr
Yrs.	years
m	meter
O	Oral
PCV	Packed cell volume
E	East
N	North

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ABSTRACT.

A study on ruminant fasciolosis in Debre Berhan and surrounding Peasant Associations was conducted from September 2005 to February 2006. The town of Debre Berhan and surrounding five Peasant Associations /PA's/ within 15 km radius namely; Chole, Genat, Zanjera, Wushawushign and Faji kebele were included in these study period. The study consisted of a questionnaire survey, clinical examination, studies on the prevalence of fasciolosis in cattle and sheep as well as snail population dynamics and infection rates. During the study period cross sectional surveys, coprological examination on animals and evaluation of the liver fluke disease with reference to sex, breed, age, body condition score and season were performed. At the same time studies were conducted in Debre Berhan municipal abattoir, private hotels and restaurants to evaluate the level of liver fluke disease damage in slaughtered animals. The methodology and procedures used in the studies consisted questionnaire survey, coprology, abattoir survey and malacology. Out of the 246 faecal samples collected from cattle and 384 from sheep 158 (64.23%) and 208 (54.17%) were found positive for fasciolosis respectively. Results of the coprological examinations also indicated that the prevalence of the disease significantly varied among the study locations and species of animals. The highest infection rate in cattle was found in Wushawushign (77.5%) and the lowest (53.7%) in Faji kebeles. On the other hand the prevalence of ovine fasciolosis was highest in Genet Giorgis (61.80%) than other kebeles while the lowest prevalence of ovine fasciolosis were recorded in Wushawushign kebele though statistically not significant (P>0.05). Results of the malacological study showed that the major species identified were *Lymnaea natalensis, L. truncatula, Bulinus trancatus, B. forscalii, Biomphilaria pfefferi, Bivalvia, Ancylus and other small Planorbids.* From the findings of this study the most abundant snail was *Bulinus* accounting (55.60%) followed by *Lymnaed* species. Snail population dynamics and their cercariae shedding pattern was higher in late rain season than in the dry season. *L. natalensis* was encountered for the first time in this area. These snails were recovered from Angolela River at a distance of about 15 kms on Debre Berhan-Mendida-Jihur road located at an altitude 2621 m.a.s.l. Of the 223 bovine and 292 ovine cases presented to the Debre Birhan Veterinary Clinic 38.56% and 28.77% were coprologically positive for *Fasciola* infection, respectively. The drugs most commonly used for the treatment of fasciolosis in the clinic were tricalbendazole and albendazole. Analysis of the findings among different age groups also indicated the existence of significant difference in prevalence of fasciolosis both in cattle and sheep ($P<0.05$). Sheep with poor body condition were more affected by the disease than sheep with good body condition ($P>0.05$), while stastically no significant difference was noted in cattle. The primary objectives of this study were to assess the magnitude of fascioliasis in ruminants in the study area; identify the species of snails incriminated as intermediate hosts and examine snail infection rates.

Key Words: - Ruminant fasciolosis, prevalence, coprology, abattoir survey, malacology, Debre Berhan.

1. INTRODUCTION

Fasciolosis is an economically important disease of domestic livestock, in particular cattle and sheep, and occasionally man. The disease is caused by Digenean trematodes of the genus *Fasciola*, commonly referred to as liver flukes. The two species most commonly implicated, as the aetiological agents of fasciolosis are *Fasciola hepatica* and *F. gigantica*. *F. hepatica* has a worldwide distribution but predominates in temperate zones while *F. gigantica* is found on most continents, primarily in tropical regions (Stuart, 1998).

Infection of domestic ruminants with *F. hepatica* (temperate liver fluke) and *F. gigantica* (tropical liver fluke) cause significant economic loss estimated at over US$ 2000 million per annum to the agricultural sector worldwide with over 600 million animal infected (Boray, 1985; Hillyer and Apt, 1997). In addition, fasciolosis is now recognized as an emerging human disease: WHO has recently estimated 2.4 million people are infected with *fasciola,* and a further 180 million at risk of infection (Anon, 1995). High prevalence of human fasciolosis has been reported in Bolivia and Peru where fasciolosis is regarded as an important human health problem (Anon, 1995; Hillyer and Apt, 1997). In tropical regions, fasciolosis is considered the single most important heliminth infection of cattle (Fabiyi, 1987) with prevalence rate of 30-90% in Africa (Schillhorn van Veen, 1980).

Ethiopia has a high livestock population, but productivity is low as a result of diseases, malnutrition and other management problems. Fasciolosis is one of the major parasitic diseases contributing to loss in productivity (Scott and Goll, 1977). Fasciolosis caused by *F. hepatica* and *F. gigantica*, is one of the most prevalent helminth infections of ruminants in different parts of the world including Ethiopia. It causes significant morbidity and mortality (Okewole, *et al.*, 2000; WHO, 1995).

The prevalence and economic significance of fasciolosis in Ethiopia has been reported by several workers (Yilma, 1983; Getachew, 1984; Roman, 1987; Abebe, 1988; Fekadu, 1988; Girmay, 1988; Wondwosen, 1990; Zerfu, 1991; Zewdu, 1991; Rahmeto1992) (Table1). In resent years, small-scale traditional irrigation scheme are expanding in many parts of Ethiopia.

It is anticipated that implementation of irrigated agriculture will create favorable habitat for fluke-transmitting snail vectors and thereby influence the life cycle progression occurrence of fasciolosis (Michael, 2004).

These parasites cause widespread mortality and morbidity in cattle, sheep and goats throughout the world (Blood and Radostits, 1989). Both *Fasciola hepatica* and *F. gigantica* are found in Ethiopia and are transmitted by *Lymnaea truncatula* and *L. natalensis*, respectively (Graber, 1978). Various reports indicate that it is a serious problem of livestock production in Ethiopia causing considerable economic losses. A rough estimate of the economic loss due to decreased productivity caused by bovine fascioliasis is about 350 million Birr (Bahru and Ephraim, 1979). Ngategize *et al.*, (1993) also estimated an annual economic loss of 48.4 million Birr due to ovine fascioliasis in the Ethiopian Highlands. (Brook *et al.*, 1985) carried out an investigation on the epidemiology of ovine helminthosis in four ecological regions and found that fasciolosis was highly prevalent in Debre Berhan area.

The primary objectives of this study were:

- To determine the prevalence of ruminant Fasciolosis, identify the fluke species involved.
- To identify the snail species incriminated as intermediate hosts and examine the level of infestation and cercarial shedding patterns.
- Based on the findings to recommend appropriate control and prevention measures.

2. LITERATURE REVIEW

2.1 Etiology

Fasciola (Fig.1) is a large fluke, flattened dorsoventrally, grey or grey- pink in colour, shaped rather like a leaf, with a conical projection at the anterior end, wide ' shoulders' and a tapering body ending in an obtuse tail. *Fasciola hepatica* is about 30 mm long while *F. gigantica* is up to 75mm long. Each has two suckers, one (the anterior sucker) in the center of the conical projection and one (the ventral sucker) on the ventral surface close up to the conical projection. The mouth is in the center of the anterior sucker and, anterior to the ventral sucker, there is a genital pore through which eggs are laid. Eggs (Fig.2) are 130-150 microns in length and have an operculum at one end. Male and female sexual organs are included within the body (Hall, 1977). *F. hepatica* may reach a size of 2-3 cm by 1.3 cm. It is leaf shaped, broader anteriorly than posteriorly, with an anterior cone-shaped projection, which is followed by a pair of broad "shoulders". It is grayish-brown in colour, changing to grey when preserved. The internal organs are branched while the cuticle is covered in spines. *F. gigantica* is significantly larger in size measuring 7.5 cm by 1.2 cm and the shoulders are not prominent.

The egg of *F. hepatica* measures 150μm by 90μm in size and also very similar in shape to that of *F. gigantica* (Soulsby, 1982). The egg of the latter is larger in size (200μm x 100 μm) (Dunn, 1978). *Fasciola* eggs should be distinguished from the eggs of other flukes, especially from the large eggs of *Paramphistomum*. *Fasciola* eggs has a yellowish brown shell with an indistinct operculum and embryonic cells whereas *Paramphistomum* egg has transparent shell, distinct operculum with embryonic clear cells, and possess a small knob at their posterior end (Soulsby, 1982).

a) Fasciola hepatica b) Fasciola gigantica

Figure 1. Adult *F. hepatica and F. gigantica*

(Source: - http://www.merckvetmanual.com/mvm/index.jsp.)

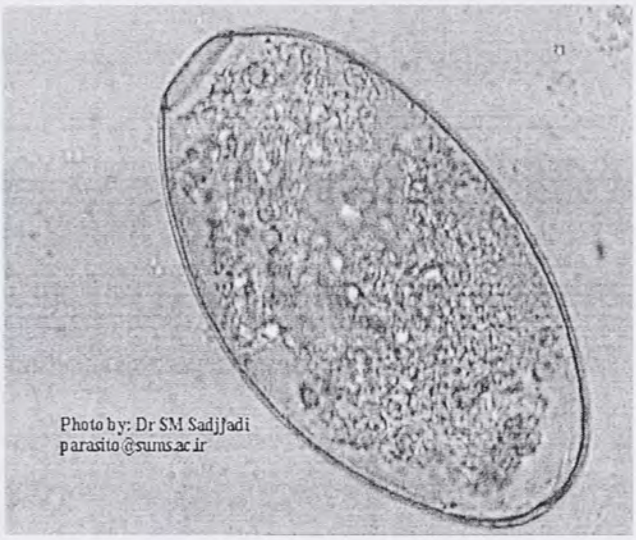


Figure 2. Egg of *Fasciola* (http://biodidac.bio.uottawa.ca)

According to Dunn (1978) and Soulsby (1982), the taxonomic classification of the organisms that cause fasciolosis is presented as follows:

Phylum: - Platyhelminthes,

Class: - Trematoda,

Subclass: - *Digenea*,

Suborder: - *Distomata*,

Family: - *Fasciolidea*,

Genus: - *Fasciola*,

Species: - *Fasciola hepatica* and *Fasciola gigantica.*

Morphology:

F. hepatica leaf-shaped worms of variable size up to 3cm long and 1.5cm wide. They are greyish, and the wide, darker, marginal zone of vitellaria is easily seen grossly. The cuticle is covered with backwardly directed spines, which wear off with age, but are always visible microscopically in the hollow of the shoulders and on the anterior cone. The flukes are easily recognized grossly and the only confusion likely is with *F. gigantica.*

F. gigantica very similar to *F. hepatica* but larger. It is not, though, as spectacularly large as the name would suggest, and is maximally 7.5cm long by 1.2cm wide, with much variation. It differs from *F. hepatica* in being more evenly leaf-shaped, with scarcely perceptible shoulders, in the parallel sides of the body, the short anterior cone, and the more profusely branched gut caeca. These are only relative differential points, it is true, but the gross appearance of the long, straight- sided *F. gigantica* is nevertheless quite characteristic and the only difficulties arise in areas where *F. hepatica – F. gigantica* hybrids are suspected. The egg is similar to that of *F. hepatica*, but is larger up to 197 μm by 104 μm (Dunn, 1978).

2. 2. Host range

2.2.1. Intermediate Host

The important *Lymnaea* species of snails involved in the transmission of fascioliasis vary in their geographical distribution in the world. The habitat requirements of the intermediate hosts of the two most important liver flukes differ slightly. The intermediate hosts for *F.hepatica* are amphibious snails that live close to the edge of slow moving or stagnant water whereas those transmitting *F. gigantica* live in deeper water and close to being true aquatic snails in their behavior. They can, however, adapt to an amphibious existence in adverse conditions (Hansen and Perry, 1994). Liver fluke is absent in areas where conditions are unsuitable for the development of suitable intermediate host snails. *Lymnaea spp*. Snails involved in the transmission *of F. hepatica* are mud living and amphibious, living on environmental niche which is subject to flooding and desiccation (Over, 1982).

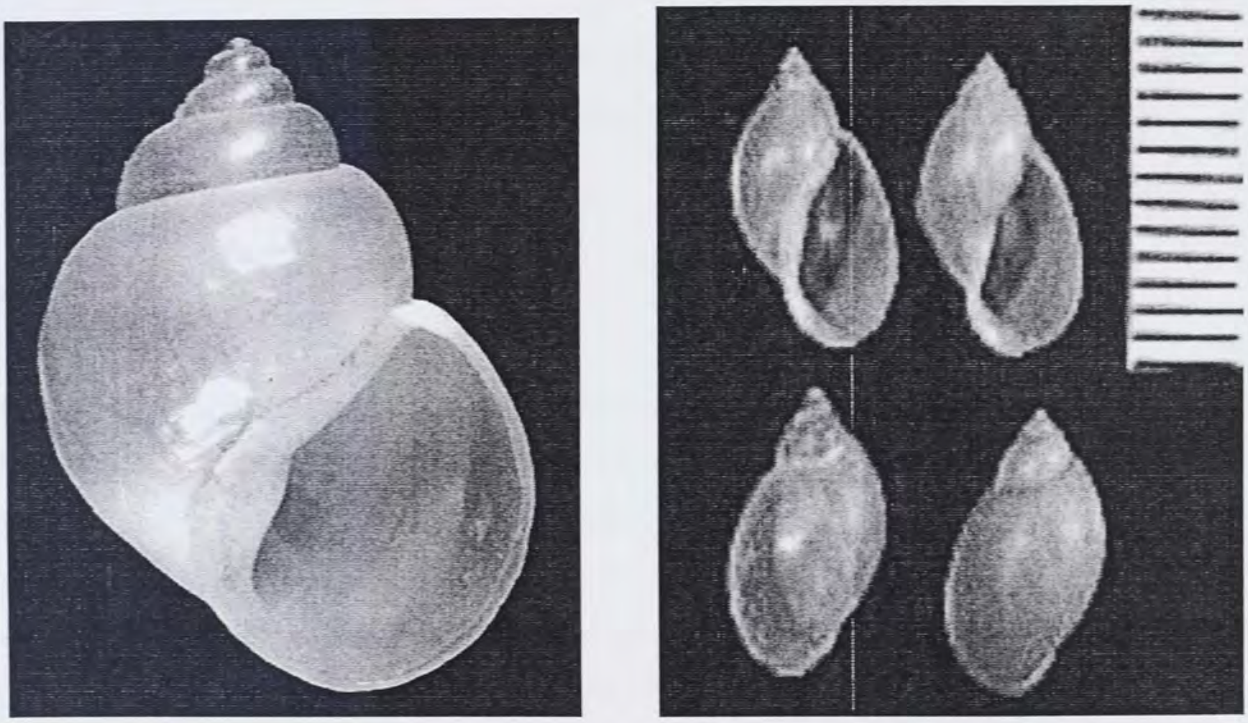


Figure3. *Lymnaea snails often parasitised by trematodes*

Source: - http://www.steve.gb.com/image/rants/lymnaea.jpg.

The following are the most important species of *Lymnaea* involved in the transmission of *F. hepatica*.

- *L. truncatula*: Europe, Asia, much of Africa, and northern America, this is the most important and widespread species in the epidemiology of the fluke.
- *L. tomentosa*: Australia and New Zealand.
- *L. humilis*: North America
- *L. columella*: USA, Central America, Australia, New Zealand.
- *L. bulimoides*: Southern USA and Caribbean.
- *L. viator*: South America
- *L. diaphena*: South America

With increased study in many parts of the world one is becoming more aware of the advance of *L. truncatula* to a status approaching super species (Dunn, 1978). In Ethiopia the results of the malacological survey demonstrated the existence of *Lymnaea natalensis, Lymnaea truncatula, Biomphalaria pfeifferi* and *Bulinus* species around Kemissie (Ameni *et al*., 2001).

Site: The adults are found in the Bile ducts and the immature flukes in the liver parenchyma. Occasionally, aberrant flukes become encapsulated in other organs such as the lung (Urquhart, *et al*., 1996).

Distribution

F. hepatica: has a cosmopolitan distribution but the distribution of *F. gigantica* is more limited, being restricted to the tropics and have been recorded in Africa, the Middle East, Eastern Europe and South and Eastern Asia. Although a number of texts suggest the presence of *F.gigantica* in the southern United States and Hawaii (Soulsby, 1982; Radostits *et al*., 1994; Urquhart *et al*., 1996). Worldwide; in much of Africa and in Far East *F. hepatica* is replaced by *F. gigantica* in some other areas and in Indo-Pakistan; both species are present in almost equal incidences, though the localities differ, *F. hepatica* preferring higher and cooler regions (Dunn, 1978). *L. truncatula* is the most common intermediate host for *F. hepatica* in different part of the world (Njau *et al*., 1989) and in Ethiopia (Graber, 1974).

F. gigantica Found in most continents but does not occur in Western Europe (Urquhart *et al.*, 1996).

Lymnaea species: most important in the transmission of *F.gigantica*

L.auricularia: worldwide

L.rufescense: in Indian subcontinent

L.rubiginosa: in Malaysia

L.natalensis: African snail host

The snail intermediate hosts of *Fasciola* species in Ethiopia are principally two. These are *L. truncatula*, which is the intermediate host of *Fasciola hepatica*, and *L. natalensis*, which is the intermediate host of *F. gigantica*. *Lymnaea natalensis* is widely distributed in lowlands (Kolla): in irrigation canals and pockets of water with vegetation. *Lymnaea truncatula* is usually encountered in medium altitudes (Woina Dega) and highlands (Dega). The snails are usually found in small ponds, slow moving rivers and shallow streams (Kifle, 1989).

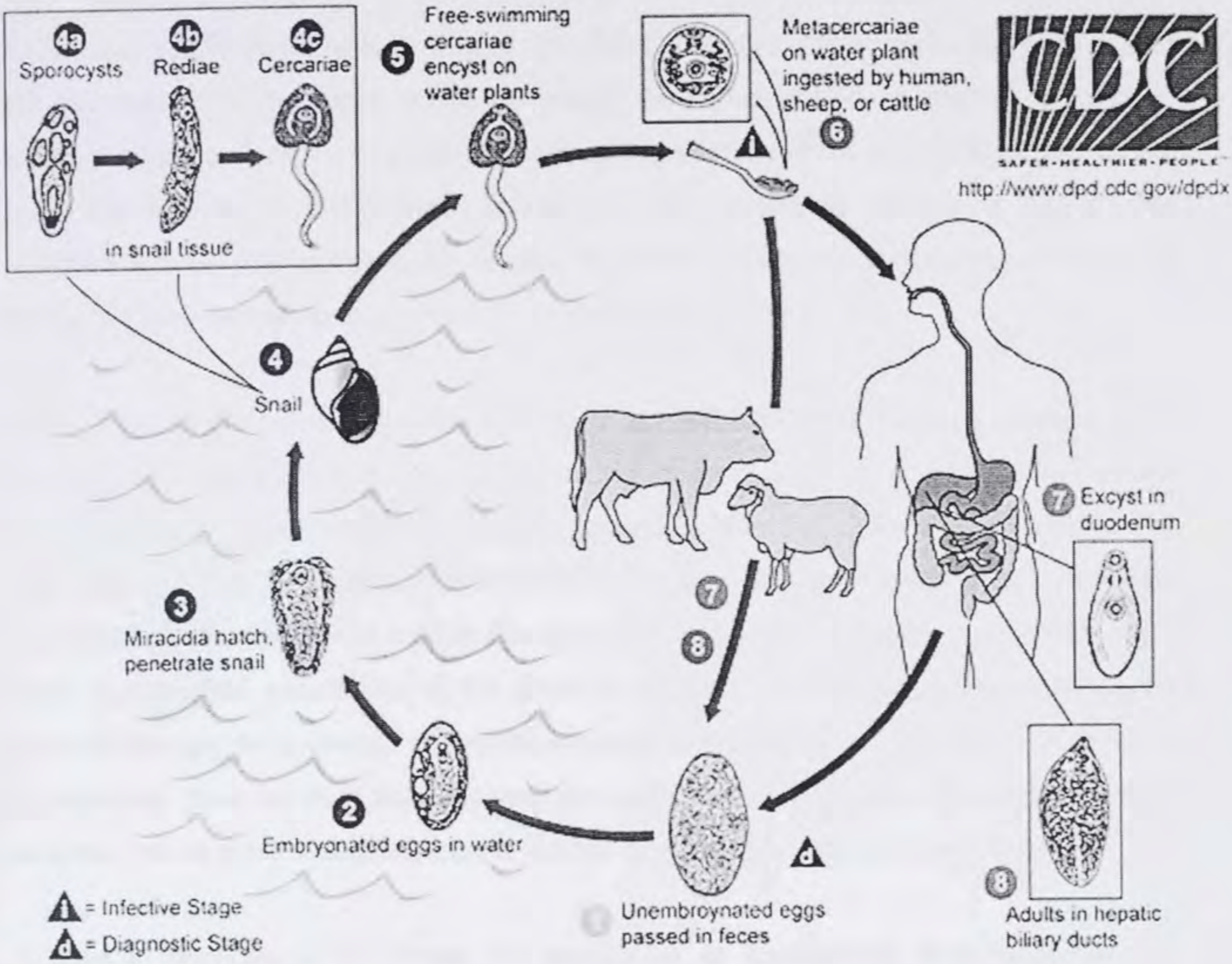
2.2.2. Final hosts

Infection of the final host occurs by ingestion of encysted metacercariae on herbage, or less commonly by ingestion of suspended metacercariae in drinking water. Once ingested, the young flukes encyst in the small intestine, penetrate the gut wall and traverse the abdominal cavity to reach the liver capsule and the liver tissue. The immature flukes migrate in the liver parenchyma for 6-8 weeks before entering a bile duct where they mature and commence egg production (Hansen and Perry, 1994).

Fasciola hepatica occurs in the bile ducts of the sheep, goat, cattle, other ruminants, pig, hare, rabbit, beaver, coypu, elephant, horse, dog, cat, kangaroo and man. In the unusual hosts, such as man and the horse, the fluke may be found in the lungs, under the skin or in other locations. The fluke is cosmopolitan in its distribution and is the cause of fascioliasis (liver fluke disease, liver rot), especially in sheep and cattle (Soulsby, 1982). Hosts for *F. hepatica* are most mammals including man, sheep and cattle being most important. For *F. gigantica* affects a wide range of domestic animals and is found in lowland areas replacing *F. hepatica* (Urquhart *et al.*, 1996).

2.3 Life cycle.

Figure 4. Life cycle of *Fasciola*, Source: http:// www.dpd.cdc.gov / dpdx / HTML / Fasciolosis.htm



Immature eggs are discharged in the biliary ducts and in the stool (1). Eggs become embrionated in water (2); Eggs release miracidia (3), which invade a suitable snail intermediate host (4), including many species of the genus *Lymnae*. In the snail the parasites undergo several developmental stages sporocysts (4a), rediae (4b), and cercariae (4c), the cercariae are released from the snail (5), and encyst as metacercariae on aquatic vegetation or other surfaces. Mammals acquire the infection by eating metacercariae. Human can become infected by eating vegetables / as salad /.

The life cycle follows the typical trematode pattern. The eggs embryonate in about 14-17 days at 22°C, but the process is much affected by moisture and other environmental factors (Ollerenshaw, 1966). Hatching only occurs on exposure to light, probably due to release of a "hatching enzyme" which attacks the opercular cement. The life cycle of a hatched miracidium is only about twenty- four hours (Boray, 1969).

F. hepatica and *F. gigintica* have similar life cycles. The adult flukes inhibit the bile ducts of the final host (cattle, buffaloes, sheep, and goats). The hermaphroditic parasite produces eggs, which are expelled with the bile into the intestine and shed in the faeces. The eggs embryonate and hatch in water or wet pastures, releasing a free- swimming miracidium. The ciliated miracidia actively seek and penetrate suitable intermediate hosts and undergo several stages of development by asexual multiplication (Hansen and Perry, 1994).

Eggs passed in the faeces of mammalian hosts develop and hatch releasing motile ciliated miracidia. This takes nine days at optimal temperatures of 22-26 ^{0}C and little development occurs below 10^{0}C (Urquhart *et al.*, 1996). Eggs laid by the adult parasite in the bile ducts of their hosts pass into the duodenum with the bile. The eggs then leave the host through faeces. The liberated miracidium has a short life span and must locate a suitable snail within three hours if successful penetration of the latter is to occur. In infected snails, development proceeds through the sporocyst and redial stages to the final stage in the intermediate hosts, the cercariae, these are shed from the snail as motile forms which attach themselves to firm surfaces, such as grass blades, and encyst there to form the infective metacercariae.

It takes a minimum of 6-7 weeks for completion of development from miracidium to metacercariae, although under unfavorable circumstances a period of several months is required. Infection of a snail with one miracidium can produce over 600 metacercariae (Smyth, 1994; Urquhart *et al.*, 1996). Metacercariae ingested by the final host excyst in the small intestine, migrate through the gut wall, cross the peritoneum and penetrate the liver capsule. The young flukes tunnel through the parenchyma for 6-8 weeks. Then enter the small bile ducts where they migrate to the larger ducts and occasionally the gall bladder. The prepatent period is 10-12 weeks and for *F. gigantica* is 13-16 weeks (Georgi, 1985; Urquhart *et al.*, 1996).

The minimum prepatent period of *Fasciola* is about 8 weeks and minimum of 5 months is required for the complete life cycle (Dunn, 1978). Depending on the species of the fluke, the cercariae will take one of three paths. (1) The cercariae may directly penetrate the skin of the definitive host. (2) The cercariae may attach to vegetation, loss its tail, secrete a thick cyst wall around itself, and thus develop into a metacercaria. The vegetation with the attached, encysted metacercaria will be ingested by the definitive host. (3) The cercariae may lose its tail, penetrate the second intermediate host, secrete a thick cyst wall around itself and develop into a metacercaria within the second intermediate host (Hendrix, 1998).

2. 4. Epidemiology

The principal factors, which determine the incidence of fascioliasis, are the presence of susceptible intermediate host snail, sufficient moisture, and suitable temperature (above $10^{o}C$) for the reproduction of the snails, the development of miracidia and the compilation of the larval development in the snails. The epidemiology of the disease also depends on a wide variety of topographical, biological and farm management factors. Depending on the climatic conditions the seasonal occurrence of fascioliasis varies from country to country but in general the occurrence of the disease can be predicted from meterological data and the required schedule for epidemiological control determined (Gaafar *et al.*, 1985).

Fascioliasis is a cosmopolitan disease its occurrence being dependent on the presence of biotypes suitable for the parasite as well as the snail intermediate host (Hall, 1977, Schillhorn, Van Veen, 1980). *F. gigantica* is widely distributed in tropical and subtropical areas of Africa and Asia while *F. hepatica* is widely spread in temperate areas and also in the high lands of the tropics (Over, 1982). Both species are encountered in many countries of Africa (Hall, 1977). Graber, 1975; Yilma and Malone, 1998, indicated that in Ethiopia *F. hepatica* is wide spread in areas with altitude above 1800 to 2000 meter above sea level while *F. gigantica* appears to be the most common species in areas below 1200m.a.s.l. Both species co-exist in areas with altitude ranging between 1200 to 1800m.a.s.l. The liver flukes have a versatile survival strategy; certain stages of the parasites and their intermediate hosts have a relatively well-developed ability to persist through adverse weather conditions such as drought and freezing. Thus persistence of infection from one season to the next may occur by several mechanisms: as adult flukes in mammalian hosts, as eggs on pasture, as larvae developing in snails and as metacercariae encysted on herbage (Hansen and Perry, 1994). *F.hepatica* is a temperate species and it is found in Southern America, Northern America, Europe and Australia and Africa, but found in the highlands of Ethiopia and Kenya (Yilma and Malone, 1998).

There are three main factors influencing the production of the large numbers of metacercariae necessary for outbreaks of fascioliasis.

2.4.1 Availability of suitable snail habitats:

L. truncatula prefers wet mud to free water, and permanent habitats include the banks of ditches or streams and the edges of small ponds. Following heavy rainfall or flooding, temporary habitats may be provided by hoof marks, wheel ruts or rain pond, Fields with clumps of rushes are often suspect sites. Though a slightly acidic pH environment is optimal for *L. truncatula*, excessively acid pH levels are detrimental, such occur in peat bogs, and areas of sphagnum moss (Urquhart *et al.*, 1996).

Intermediate hosts for *F. gigantica* are tropical aquatic snails, which thrive in clear stagnant or slow-moving water with high oxygen content and abundant aquatic vegetation. Such ecological situations are typically found at the fingers of rivers and lakes when water levels are stable and in irrigated fields throughout the humid tropics.

Snails, which are intermediate hosts of *F. gigantica and F. hepatica,* are typically found in tropical and temperate regions, respectively (Kendall, 1954).

2.4.2 Temperature:

A mean day/night temperature of 10 °C or above is necessary both for snails to breed and for the development of *F. hepatica* within the snail, and all activity ceases at 5 °C. This is also the minimum range for the development and hatching of *F. hepatica* eggs. However, it is only when temperatures rise to 15 °C and are maintained above that level, that a significant multiplication of snails and fluke larval stages ensures (Urquhart *et al.*, 1996). Temperature has a threshold effect only below 9 °C emergence is entirely inhibited, and as the snails cannot survive for long at 26 °C, this is the upper limiting temperature (Smyth, 1994).

Temperature is an important factor affecting the rate of development of snails and of the stages of the parasite outside the final host. The optimum temperature range for development of the snail is 15-26 °C. No development and no reproductive activity takes place at temperatures below 10 °C, but snails may survive adverse conditions for months buried in the mud. The interaction between moisture and temperature determines the survival and reproduction rate of the snails and the parasites (Hanson and Perry, 1994). At temperature below 10 °C eggs passed out in the faeces remain dormant until ambient temperatures are higher before hatching. Breeding of the snails and development of flukes in infected snails are also arrested at similar temperature (Hunter, 1994).

2.4.3 Moisture:

Fasciola species require moisture for transmission, proliferation and survival; miracidia need wet surfaces to fined snail hosts; snails need moisture to develop; cercariae do not normally emerge from snails unless there has been recent rainfall, transmission will be limited to the wet season, unless land is irrigated or there are permanent water courses. When precipitation exceeds potential evapotransparation resulting in increased water in the environment. Favour both the intermediate-host and intermediate stages. Fluke eggs will not develop while in the faecal mass. Moisture in necessary to break up the mass and even the presence of soil may reduce the rate of development of the egg (Rowcliffe and Ollerenshaw, 1960).

The ideal moisture conditions for snail breeding and development of *F. hepatica* within snails are provided when rainfall exceeds transpiration, and field saturation is attained. Such conditions are also essential for the development of fluke eggs, for miracidia searching for snails and for the dispersal of cercariae being shed from the snails (Urquhart *et al.*, 1996). Moisture is the critical factor determining the presence and extent of snail habitats, which serve as transmission foci for liver flukes (Hanson and Perry, 1994).

2.4.4 Oxygen tension

No development of egg will take place if present in a concentrated faecal suspension, although eggs will survive for more than twice as long in aerobic conditions as in anaerobic conditions. Eggs kept in cultures without faeces show little variation in mortality, but those in aerobic conditions hatch in one-fifth of the time taken those at a lower oxygen tension (Rowcliffe and Ollerenshaw, 1960). Boray (1969) observed that during the summer months in Australia the development of eggs is delayed and the hatching rate is lower in stagnant pools with a lot of organic matter compared with habitats moderate water movement.

2.4.5 pH

Eggs incubated at 27°C will develop and hatch within a pH range of 4.2 to 9.0, but above pH 8.0 development is prolonged (Rowcliffe and Ollerenshaw, 1960).

Table 1. Summary of the prevalence of fasciolosis in different parts of Ethiopia on the basis of coproscopy and abattoir examination.

Place	Prevalence %		Species	References
	Fecal	Abattoir		
Jimma	-	57.58	Bovine	Moges (2003)
Gondar	-	43.1 40.6	Bovine Ovine	Mezgebu (2003)
Assela	32.9	31.8	Ovine	Dinka (1996)
Debre Berhan	80	88.57	Bovine	Dagne (1994)
Awassa	-	30.43	Bovine	Hailu (1995)
E.Gojjam	50.56	-	Bovine	Beyazn (1995)
Tigray	-	26.9	Bovine	Takele (1995)
Nekemte	18.99 12.42	22.72 15.56	Bovine Ovine	Wassie (1995)
Bale	34.6	49.	Bovine	Abduljebar (1994)
Zeway	-	56.6 38.9	Bovine Ovine	Adem (1994)
W.Shoa	26.22	81.6 84	Bovine Ovine	Yadeta (1994)
Kombolcha	45.26	53.5	Bovine	Mulugeta (1993)
Wolliso	-	27.1	Bovine	Rahmeto (1992)
Soddo	15.77	47	Bovine	Abdul (1992)
Chillalo	60.2	-	Bovine	Zerfu (1991)
Assela	32	53.72	Bovine	Wondwosen (1990)
Dembidolo	-	77.8	Bovine	Abera (1994)
Kallu	15.77	-	Bovine	Girmay (1988)
Bahir Dar	60.2	-	Bovine	Fekadu (1988)
Nekemte	32	-	Bovine	Abebe (1988)
Gondar	-	75.1	Bovine	Roman (1987)

2. 5. Economic significance

Fasciolosis causes important economic losses in most regions of the world where cattle and sheep are raised (Radostits, 2001). Fasciolosis is still the disease of the great economical importance. According to some estimates every year about 600 mln of domestic animals became infected worldwide; only in the USA alone the economical losses are determined at over $ 2 bln. Moreover, during the last decade the human fasciolosis was stated as an emerging food-born zoonosis in some parts of the world. Reports estimate that as many as 2.4 to 17 mln people are infected. It is worth mentioning that the numbers of reported clinical cases and of infected people identified during epidemiological surveys have been increasing since1980. Economic effects of fasciolosis in livestock can range from sudden death as a result of massive infection to sub clinical infections, which produce marked economic effects. Ovine fasciolosis can result in significant blood losses with all associated consequences. In sheep and cattle, the reduction of weight gain and other adverse effects depend on the parasite burden. Infection has also deleterious effect on milk quantity and quality; it causes lower fertility rates in cattle and sheep (Machnicka, 2000). Various reports indicate that it is a serious problem of livestock production in Ethiopia causing considerable economic losses.

The annual loss due to endoparasitism including fasciolosis in Ethiopia is estimated at 700 million Birr (Mulugeta *et al.*, 1989). The economic significance of fascioliasis is considerable. It brings death, loss of carcass weight, reduced milk yield, condemnation of affected livers, decline in reproductive performance, predispose animals to other diseases and additional cost due to treatment expense (Olsen, 1974). The direct impact of *Fasciola* are liver lesions, reduction in feed utilization efficiency, deprivation of the animal of digested nutrients, and reduced feed intake through loss of appetite and discomfort leading to reduced feeding time. The economic implications are, however, best assessed at the output and input levels. The effects include reduced growth rates, reduced production of meat, milk and wool, reduced reproductive efficiency and mortality. A rough estimate of economic loss due to decreased productivity alone (excluding mortality losses) due to bovine fasciolosis is estimated at 300 million Birr (Bahiru and Ephraim, 1979). Fascioliasis is estimated to cause 40 to 70% of the total sheep mortality in the highlands (Njau *et al.*, 1988, Gryseels, 1988). (Getachew, 1984) found prevalence of 51% in an abattoir study covering one year in Addis Ababa. *Fasciola* infected livers are damaged and not palatable and so most livers are condemned at slaughter causing monetary losses to the owners, Loss of livers by condemnation due to fascioliasis alone was estimated at 631,320 Birr.

Fascioliasis is considered to be one of the major constraints to sheep production in the Ethiopian Highlands (ILCA, 1991). It is one of the major diseases that cause huge direct & indirect losses. Financial losses due to ovine fascioliasis alone was estimated at 48.8 million Ethiopian Birr per year of which 46.5%, 48.8% and 4.7% were due to mortality, productivity (weight loss and reproductive wastage) and liver condemnation, respectively. Reduced reproductive efficiency manifests it self through reduced pubertal development, extended lambing interval, reduced weight and number of weaned offspring per ewe and subsequent effect on the age and sex structure, and genetic improvement of the flock (Ngategize *et al.*, 1993).

Table 2. Financial losses due to fascioliasis in different parts of Ethiopia

Annual Losses (Eth. Birr)	Place of Abattoir	References
112,775.54	Awassa	Hailu (1995)
100,707.00	Nekemte	Wassie (1995)
376,019.70	Dire Dawa	Daniel (1995)
178,933.36	Debre Berhan	Tesfaye (1995)
180,942.48	Bahir Dar	Yohanes (1994)
109,601.24	Robe	Abduljebar (1994)
266,741.37	Kombolcha	Mulugeta (1993)
142,128.00	Soddo	Abdul (1992)
488,789.00	Jimma	Zewdu (1991)
92,153.60	Bahir Dar	Fekadu (1988)
67,667.40	Nekemte	Abebe (1988)
497,752.56	Gondar	Roman (1987)
631,320.00	Addis Ababa	Getachew (1984)
560,678.58	Debre-Zeit	Yilma (1983)

2. 6. Public health importance

Fasciola hepatica may be acquired by man, but not directly from cattle. A person must ingest the metacercariae in order be income infected (Levine, 1978). Sporadic human cases of fascioliasis occur through out the world. In Europe cases are associated primarily with the eating of watercress contaminated with metacercariae (Soulsby, 1982). In man, fascioliasis occurs as a result of eating infected vegetation and is not a serious condition (Dunn, 1978). The overall incidence of infection in man is less than 1%. The vertebrate host acquires infection by ingesting the metacercariae with water plants or in drinking water. The degree of pathogen city of *F. hepatica* to man depends on many factors, particularly the number of worms present and the organs infected. Mechanical and toxic damage are characteristic (Elmer and Glenn, 1982).

2. 7. Pathogenesis

Fasciolosis in ruminants ranges in severity from a devastating highly fatal disease into an asymptomatic infection in cattle. The severity of pathological manifestations usually depends on the number of metacercariae ingested over a period of time and the relative susceptibility of the animal. In sheep, acute fasciolosis occurs seasonally and is manifested by anaemia and sudden death. Deaths can occur within 6 weeks of infection. Cases of chronic fasciolosis occur in all seasons and the clinical signs may include anaemia, reduced weight gain, decreased milk production, unthrift ness, submandibular oedema and possibly death in sheep. In contrast, even heavily infected cattle may show no obvious clinical signs, but some production losses may be evident (Hanson and Perry, 1994).

Chronic fascioliasis characterized by progressive loss of condition and development of anemia and hypoalbuminaemia & emaciation, pallor of the mucous membrane, submandibular oedema and ascites (Urquhart *et al.*, 1996).
The migration through the intestinal wall appears to be non-damaging the host but the penetration of the liver capsule by a large number of young flukes results in an inflammatory response of the capsule (perihepatitis). This causes severe destruction of liver tissue (Hansen

and Perry, 1994). No appreciable damage is done during passage through the Intestinal wall or the peritoneal cavity, the principal lesions occurring in the liver, in either the parenchyma or the bile ducts. Essentially the disease entity can be divided in to acute form and a chronic form (Soulsby, 1982).

Acute *hepatic* fascioliosis occurs 5-6 weeks after ingestion of large number of metacercariae and is due to the sudden invasion of the liver by masses of young flukes. Sufficient parenchyma may be destroyed to cause acute hepatic insufficiency and to this may be added the effect of hemorrhage in to the peritoneal cavity by the movement of the young flukes in the parenchyma. There is hypoalbuminemia due to reduced albumin synthesis and plasma volume expansion caused by liver damage (Radostits *et al.*, 1994).

Chronic fasciolosis develops slowly and is due to the activity of the adult flukes in the bile ducts. These cause cholangitis, biliary obstruction, destruction of hepatic tissue and fibrosis, and anemia. The cause of anemia in chronic fascioliasis is the blood sucking activity of the adult flukes and continuous drain on iron reserves that this imposes. But recent work suggests that a substance produced by the worms may contribute to the development of anemia. Hypoalbuminemia is more marked in the chronic disease and is due mainly to the increased protein plasma leakage into the gut. It is more severe in sheep with anorexia or in those on a low plane of nutrition.

Chronic infection has been shown to limit growth rate and feed conversion in growing heifers and to reduce growth rate in beef cattle. Fascioliosis also increases the susceptibility of the animal to other diseases and reduced fertility and body growth (Radostits *et al.*, 1994). In cattle, calcification of the fibrotic lesions may eventually develop, forming complete casts of the bile duct and blocking it. They protrude markedly from the surface and are difficult to cut with a knife (Soulsby, 1982).

In cattle progressive cirrhosis of the bile ducts with eventual fibrosis of the liver. The bile ducts thicken & stand out prominently. They become filled with calcarious castes. The coat is raff and infected animals lose physical conditions. Damaged and dead liver tissue provides an ideal medium for the growth of the bacillus *Clostridium novyi* with production of a toxin that kills sheep suddenly by the acute condition known as "black disease" (Olsen, 1974).

2. 8. Clinical signs

Fasciolosis causes a wide range of clinical symptoms, depending on the number of metacercariae ingested but none of the symptoms is pathognomonic. Chronic fasciolosis is the most common form in cattle, sheep and other hosts. The symptoms of chronic fasciolosis are generally associated with hepatic fibrosis and hyperplastic cholangitis. Anaemia, oedema (bottle jaw), digestive disturbances (constipation, diarrhea) and c achexia d evelop g radually. Acute fasciolosis is less common than the chronic disease and occurs mainly in sheep. It is basically a hepatitis caused by the simultaneous migration of large numbers of immature flukes (Kaufman, 1996).

2.8.1 Small ruminants

In acute cases, in sheep, the animal dies suddenly, bloodstained froth appears at the nostrils & blood discharge from the anus. In chronic cases the first signs are seen at a time when young worms, burrowing through the liver parenchyma, have reached a fair size. The sheep is off colour and this is followed by an increasing anaemia. The a ppetite diminishes, the mucous membranes become pale and oedema develops. It may appear in the intermandibular space "bottle Jaw". The skin becomes dry and doughy to the touch. The wool is dry and brittle, falling out in patches. The debility, emaciation and general depression increase and there may occasionally be diarrhea or constipation and slight fever some times death may occur (Dunn, 1978; Soulsby, 1982).

2.8.2 Cattle

The most characteristic signs are digestive disturbances. Constipation is marked and the faeces are passed with difficulty, being hard and brittle. Diarrhea is seen only in the extreme stages. Emaciation increases rapidly, while dullness and weakness soon lead to prostration, especially in calves (Soulsby, 1982). After 6-8 weeks of migration in the liver tissue the young flukes enter the bile ducts. Their blood sucking activities irritate the lining of the ducts, resulting in an inflammatory response and the associated blood loss results in anaemia. Considerable thickening of the bile duct walls occurs with the result that these protrude markedly from the surface of the liver. In cattle the ducts often become calcified giving rise to the name "pipe-stem liver". The inflammatory effect is not limited to the bile ducts. Irritation of the ducts and obstruction of the bile flow may cause severe fibrosis of the liver (Hansen and Perry, 1994).
In heavy infections, where anaemia and hypoalbuminaemia are severe, submandibular oedema frequently occurs. In cows the main effects are reduction in milk yield and quality, particularly of the solids not fat component (Urquhart *et al.*, 1996).

2.8.3 Humans

The presence of adult *F. hepatica* in the bile ducts causes a variety of symptoms: malaise, intermittent fever, weight loss, pain under the right costal margin and often pruritis with eosinophilia. Urticaria with dermatographia may be seen, as may mild jaundice and anaemia. Adult *F. hepatica* can be found in aberrant sites such as the lungs and subcutaneously (Soulsby, 1982).

The following clinical periods can be distinguished: incubation phase (from the ingestion of metacercariae to the appearance of the first symptoms); invasive or acute phase (fluke migration up to the bile ducts); latent phase (maturation of the parasites and start of oviposition); and obstructive or chronic phase. In case of invasive or acute phase the symptomatology is due mainly to the mechanical destruction of the liver tissue and the abdominal peritoneum by the migrating larvae causing localized or generalized toxic and allergic reactions (Facey and Marsden, 1960) lasting 2-4 months. The acute phase may be prolonged and overlap onto a latent or an obstructive phase. The major symptoms of this phase are:

- *Fever:* this is usually the first symptom, generally low or moderate but may reach 40 °C, and in heavily infected cases as high as 42 °C; it may be remittent, intermittent or irregular with higher temperature in the evening; in some cases a low, recurrent fever lasting for as long as 4 to 18 months occurs.
- *Abdominal pain:* from mild to excruciating, some times vague, it may be generalized at the outset but is usually localized in the right hypochondrium or below the xyphoid.
- Gastrointestinal disturbances: loss of appetite, abdominal flatulence, nausea and diarrhoea are common, whereas vomiting and constipation are infrequent.
- *Urticaria:* a distinctive feature in the early stage of the fluke invasion and may be accompanied with bouts of bronchial asthma.
- *Respiratory symptoms:* cough, dyspnoea, haemoptysis and chest pain occur occasionally, but in some cases are the first manifestations of infection.

The following signs may appear on physical examination: Hepatomegaly, splenomegaly, ascites, anaemia, chest signs, and jaundice (Chen and Mott, 1990).

2.9 Diagnosis

Diagnosis primarily based on clinical signs, seasonal occurrence, prevailing weather patterns, and a previous history of fascioliasis on the farm or the identification of snail habitats. And also routine haematological tests and examination of faeces for fluke eggs are useful. The second is the detection of antibodies against components of flukes, the ELISA and the passive haemagglutination test being the most reliable (Urquhart *et al.*, 1996). *F. hepatica* eggs are large (up to 150μm) and operculate, and contain a cluster of yolk cells. Eggs of *F. gigantica* are like those of *F. hepatica* but larger (more than 150μm).

This is confirmed by finding of the eggs in the faeces. They must be distinguished from the eggs of other flukes, especially the large eggs of *Paramphistomes*. The *Fasciola* egg has a yellow shell with an indistinct operculum. The *Paramphistomum* eggs have transparent shells and distinct opercula, their embryonic cells are clear and there is frequently a small knob at the posterior pole, while the eggs themselves are often larger than those of the liver fluke (Soulsby, 1982). *Fasciola* eggs are found in the faeces, though a negative finding does not mean an animal is fluke free. In many cases, it is only a response to antifluke drugs that suggests a presumptive diagnosis in retrospect. Adult fluke may be found in the liver on post-mortem examination (Gray, 1995).

Fascioliosis can be diagnosed by Fluke Egg Count (FEC), Liver Enzymes, Hematology, Serology and post mortem examination (Urquhart *et al*., 1996).

Fluke Egg Count (FEC): This is the standard method of diagnosis of the presence of adult flukes (chronic disease) and is not suitable for diagnosis of acute disease due to immature flukes.

Liver Enzymes: Diagnosis can be aided by plasma concentrations of gamma glutamyl transferase (GGT), which are increased with bile duct damage (Stuart, 1997). Elevation of liver enzyme levels (aspartate aminotransferase, AST and glutamate dehydrogenase, GLDH) can be useful for the diagnosis of acute fluke disease as early as two to three weeks post-infection. While raised L-gamma glutamyl transferase (GGT) levels can indicate chronic disease once adult flukes are present in the biliary tree (Urquhart *et al*., 1996). Elevated plasma GLDH or GGT levels are sensitive indicators of the disease in its acute and sub-acute or chronic phase respectively and can be used for the field diagnosis of acute fascioliasis and for identifying the effective removal of the parasite from the host (Gaafar *et al*., 1985).
Change in serum GLDH and GGT levels during the course of experimentally induced Infections with *F. hepatica* are in accordance with previous studies, which indicate that serum activities of liver enzymes are sensitive indicators of liver damage in sheep (http://www.sac.ac.uk/vet/External/MonthlyReport/Current.asp.).

Hematology: Demonstration of peripheral eosinophilia can be particularly useful in adult cattle and has recently been used as an early indicator of fasciolosis in dairy herds where metabolic disease was initially suspected. All of these tests may also be used to investigate suspected anthelmintic resistance by submitting samples pre- and post-treatment (normally 3 weeks after treatment).

Serology: Various serological techniques on blood samples, including ELISA, can be used to detect antibodies of *F. hepatica* with high level of specificity (Urquhart *et al.*, 1996). More recent techniques such as genetic characterization using PCR have been applied on isolates of fasciola from different species and geographical locations (Huang *et al.*, 2004). The ELISA test with excretory-secretory (ES) products as antigens has been proved to be a sensitive, specific and an early method of detection of *F. hepatica* infection in cattle and sheep (Santiago and Hillyer, 1988; Sinclair and Wassell, 1988).

Post mortem examination of fresh carcasses is the best method of diagnosis if liver fluke is suspected, as untreated animals provide the most accurate indication of the level of challenge. Measurement of flukes recovered will also give an indication of the age of flukes and the period of challenge. Post-mortem examination will also demonstrate any lesions resulting from concurrent diseases such as black disease or parasite gastroenteritis (Urquhart *et al.*, 1996).

2.10 Treatment

The older drugs such as carbon tetrachloride, hexachlorethane and hexachlorophene are still used in some countries. One of the choice drugs is triclabendazole, which removes all developing stages over one week old. Other drugs are rafoxanide, closantel and nitroxynil, which will remove flukes over four weeks old (Urquhart *et al.*, 1996). Out breaks of chronic fasciolosis can be successfully treated with a single dose of any of a range of drugs (rafoxanide, nitroxynil, brotianide, closantel, oxyclozanide and triclabendazole). Albendazole and netobimin are also effective against adult flukes albeit at increased dosage rates (Urquhart *et al.*, 1996). For bovine fascioliasis there is only one drug, namely triclabendazole, which will remove the early parenchymal stages. Albendazole is also effective at an increased dosage rate. In lactating cows, where the milk is used for human consumption, the above drugs are either banned or have extended withdrawal periods in most countries. An exception is oxyclozanide, which is licensed for use in lactating animals in many countries and has milk-withholding time of up to 3 days (Urquhart *et al*., 1996).

Efficacy of Triclabendazole on immature flukes brought a dramatic change in treated animals observed by an increased PCV and subsequent recovery of affected sheep. Between 90 and 100% efficacy of Triclabendazole against immature and mature flukes (Markos, 2000). Closantel, Hexachlorophene, Nitroxynil, Oxyclozantel, Rafoxanide, are important drugs (CTA, 1989).

Table 3.Anthelmintics for the treatment of liver flukes

Generic Name	Route of Administration	Dose date (mg/ Kg)		Minimum age of fluke in Weeks efficiency > 90%	
		Sheep	Cattle	Sheep	Cattle
Hexachlorophene*	O	15	20	12	<20
Hexachloroethane	O	250-300	300	12	12
Trichloroethane	O	20	20	12	>12
Bithionol	O	75	30	>12	>12
Hexachloroparaxylene	O	150	130	12	12
Bromophenophos	O	16	12	12	>12
Clioxanide*	O	20	NR	12	NR
Oxyclozanide*	O	15	13-16	12	>14
Niclofolan*	O	4	3	12	>12
	SC	NR	0.8	NR	<12
Nitoxynil	SC	10	19	8	10
Brotianide*	O	5.6	NR	12	NR
Rafoxanide*	O	7.5	7.5	6	12
	SC	NR	3	NR	12
Closantel	O	7.5-10	NR	8-6	NR
Diamphenetide	O	80-120	100	1day- 6 wks	1day-7 wks
Albendazole	O	4.75	10	>12	>12
Triclabendazole	O	10	12	1	1
Clorsulon	O	-	7	-	8
	SC	-	2	-	>12

O = Oral SC = Subcutaneous NR = Not Recommended

* = Also effective against Paramphistomes (see Table above).

Source: (Hanson and Perry, 1994).

2.11 Forecasting the occurrence of fasciolosis

Geographic information systems (GIS) can be used to complement conventional ecological monitoring and modeling techniques, and provide a means to portray complex relationships in the ecology of disease. GIS permits computer database management, storage and manipulation of special data, including standard maps, aerial photographs, satellite images, climate zones and ground survey maps. The relative importance of fasciolosis and the abundance of its snail intermediate host in different agro climatic regions are dynamic features influenced by local climatic thermal and moisture regime and soil type. The forecast model showed that varying degrees of *F. hepatica* risk occur in all areas of Ethiopia except in the arid northeast and east of the country. The highest risk areas were localized in the western humid zone. *F. gigantica* endemic-areas occur in the entire western zone of the country with localized foci in the south and east. High risk of *F. gigantica* infection was indicated only at a small focus along the Blue Nile River (Yilma and Malone, 1998).

The life cycle of the liver fluke and the prevalence of Fasciolosis is dependent on climate. This has led to the development of Forecasting systems, based on meteorological data, which estimate the likely timing and severity of the disease. In several western European countries, these forecasts are used as the bases for annual control programmes. Two different formulae have been developed. One estimates "ground surface wetness", which is the critical factor affecting the summer infection of snails. The other technique used is a "wet day" forecast. This compares the prevalence of Fasciolosis over a number of years with the number of rain-days during the summers of these years (Urquhart *et al.*, 1996). Climatic forecast models developed in Europe, the United States and elsewhere indicate that a 100 fold difference in *F. hepatica* burdens can occur in different years owing to the effect of climatic variation alone on snail host population, intermolluscan asexual multiplication, and survival of fluke eggs persistence of metacercariae on pasture.

The GIS forecast model developed in Ethiopia revealed that there are distinct regional differences in *F. hepatica* seasonal cercariae-shedding, fluke transmission pattern. In the western humid region, conditions are shown to be suitable for up to 6 months of transmission per year (May-November). Western sites like Gore and Jimma were considered to be high *F. hepatica* risk areas where transmission of the tropical species, *F.gigantica*, may also occur in August-September. In southern Ethiopia, *F. hepatica* transmission is bimodal, resembling the regional r ain p attern. In t he n orth-central a nd c entral h ighlands *F. h epatica* t ransmission i s confused to the heavy summer rain months (Yilma and Malone, 1998).

Geographic information system (GIS) can be used to define the epidemiology and distribution of fasciolosis. As compared to more ephemeral vectors such as mosquitoes, snails tend to be present year after year in same habitat and population generation time is relatively long. The unique biology and live cycle strategy of *Fasciola* make it amenable to effective use of GIS control model in several respects. High environmental sensitivity and the focal nature of transmission typically result in animals in fluke enzootic region (Ollerenshaw, 1966).

2.12. Control of ruminant fasciolosis

Effective control of trematode infections is based on strategically applied chemotherapy. Improvements in current farm management can reduce the chances of infections by limiting the contact between intermediate and final hosts. Furthermore, direct action may be taken to reduce or eliminate intermediate host populations. The use of one or more of these measures in an integrated strategy should be based on sound economic assessments of the diseases and the relative merits of control options. Some animal husbandry systems such as zero grazing (cut and carry) and tethering of animals may minimize the risk of trematode diseases (Hansen and Perry, 1994).

Control of fascioliosis may be approached in two ways, by reducing populations of intermediate hosts or using anthelmintics (Urquhart *et al.*, 1996). The control of *F. hepatica* in sheep and cattle is achieved through a combination of the control of the snail intermediate host and the treatment of infected animals (Soulsby, 1982).

Disruption of the life cycle of the parasite by controlling the snail intermediate hosts using molluscicides, applications of management tactics to avoid contact between susceptible livestock and Infective metacercariae and elimination of the parasite by chemotherapy are among the most commonly used control methods for fascioliosis. Routine anthelmintic treatment of animals at seasons when heavy infections of adult flukes accumulate in the host is recommended using a drug effective against adult and immature flukes. This should prevent serious losses in production, but for optimal benefit should be accompanied by snail control (Urquhart *et al.*, 1996).

Control measures for *Fasciola* ideally should involve removal of flukes in affected animals, reduction of the intermediate host snail population, and prevention of access of livestock to snail- infested pasture (Stuart, 1997).

2.12.1. Parasite Control

Seasonal strategic application of effective anthelmintics specific for trematodes, as well timed prophylactic and curative treatments, play an important role in the control of liver fluke infections. Strategic treatments have been developed for several regions of the world based on meteorological data with sound epidemiological information in order to improve the timing, and thereby the efficiency, of treatments. The basic principles of strategic anthelmintic application (treatment/prophylaxis) are:

I. Curative treatment about one to two months after the expected peak infection of the hosts. A curative effect can be achieved by one treatment to remove the residual fluke burden acquired from metacercariae, which had survived on the herbage.

II. Prophylactic treatment of ruminants towards the end of a period of ecologically reduced activity of the parasites and the intermediate hosts The most important prerequisite for efficient chemotherapy and chemoprophylaxis is a prior knowledge of the epidemiology of the disease based mainly on meteorological data and seasonal surveys in hosts (Hansen and Perry, 1994).

The prophylactic use of flukicides is aimed at:

a) Reducing pasture contamination by fluke eggs at a time most suitable for their development.

b) Removing fluke populations: at a time of heavy burdens or at a period of nutritional and pregnancy stress to the animal. Application of the drug should be before and after the rain season. In relation to the snail dynamics (Urquhart *et al.*, 1996).

More recently, a number of compounds such as oxycloznide, diamphenethide (not active in cattle), rafoxanide, nitroxynil, albendazole, and clorsulon have become available. Some of these (diamphenethide, 100mg/ kg; nitroxynil, 15mg/kg; closantel, 10 mg/kg; triclabendazole, 10 mg/kg; clorsulon, 7 mg/kg) are active against immature flukes. The selection of a fascialicide should be based on the disease situation, host animal, and local environmental conditions and regulations (McKellar, 1998).

2.12.2 Vector Control

Reduction of snail populations; Eradication of host snails from the environment may be extremely difficult, some times impossible in low-lying, wet areas with a temperate climate. Multiplication of snails is extremely rapid and incomplete eradication achieves only a temporary reduction in their population (Blood *et al.*, 1989). Before any scheme of snail control is undertaken a survey of the area for snail habitats should be made to determine whether these are localized or widespread among those control measures some are listed as follows:

2.12.2.1 Using commercial molluscicides

- Baylucide, effective at 0.3 p.p.m (parts per million).
- Copper pentachlorophenate, effective at 10 p.p.m.
- Copper sulphate, effective at 5.15 p.p.m.
- Frescon (Shell), effective at 0.1 p.p.m.

Control of snail intermediate hosts using commercial molluscicides, such as copper sulphate is most widely used and although more efficient molluscicides. Good control is possible by adding molluscicides, such as N-trityl morpholing, to the water habitat of snail, but there are many environmental objections to the use of molluscicides in water or irrigation channels (Urquhart *et al.*, 1996, Reinecke, 1983).

2.12.2.2 Using traditional (natural) products

The discovery of molluscicidal properties of Endod (*Phytolacca dodecandra*) led to extensive subsequent studies, which revealed Endod to be the best plant derived molluscicide (Legesse *et al.*, 1987). (Aklilu, 1984) reported that sun dried berries of this plant suspended in water at all concentration of 10-20 p.p.m killed *Schistsoma* and *Fasciola* transmitting snails in 24 hours. *L. natalensis* were highly susceptible to Endod at an early age and as the age increased susceptibility decreased (Tadesse and Getachew, 2002). Endod being a widely grown, relatively nontoxic natural product requiring minimal technological inputs and handling is more reliable in control of fascioliasis than commercial molluscicides. (Tadesse and Getachew, 2002).

2.12.2.3 Environmental manipulation (management of snail habitat)

- To prevent snail habitats from developing by regular clearing of drainage channel in vegetation, which provides suitable sites for snail development. Good drainage and the building of dams at appropriate sites in marshy and low-lying areas may reduce the snail problem.
- Keep livestock away from pastures contaminated with metacercariae.
- Vegetation clearing from and around watering sites.
- Planting of trees around the edges of swampy areas will have a long term drying effect, and they will be, in themselves, valuable.
- Establish proper watering facilities to prevent animals from drinking from lakes, ponds and streams (Hanson and Perry, 1994).
- Farm management maximum rotational control mixed or separates grazing.

2.12.2.4 Integrated approach

Efficient control of fascioliosis requires a well planned and executed, integrated control programme designed for each farm, area, country or region. The available strategies, which can be used individually or in combination (Hansen and Perry, 1994).

Different control measures have been recommended for ruminant Fascioliasis. The most feasible and sustainable control measure is a combination of selective chemotherapy and selective vector control based on vector-host relation. Since practically it is impossible to treat all water bodies, it is advisable to select main watering sites, threat them at a specific time, within integration of parasite control.

2.13 Immunity and immunization

Natural differences in host susceptibility to infection with *F. hepatica* are seen. Thus some animals, such as cattle and pigs, have a moderate to high degree of resistance to primary infection while others, such as sheep, are highly susceptible to infection with *F. hepatica*. Similarly, sheep do not normally develop a protective immune response to reinfection while cattle develop the ability to eliminate primary infections and develop protection against reinfection with *F. hepatica* (Van Tiggle, 1978).

The ability of cattle to develop protection against reinfection with *F.hepatica* suggested that immunization might be feasible. (Nansen, 1975) was able to immunize calves with irradiated metacercariae of *F. hepatica*. Six-to seven-month old calves were immunized with three doses of irradiated metacercariae and, after grazing infected pastures, there was a marked decrease in faecal egg counts and 71% reduction in the number of fluke recovered from immunized calves as compared to unimmunized animals. In general, the inability to immunize sheep against infection with *F. hepatica* reflects their inability to develop a protective immune response. Sheep do not acquire resistance to reinfection following initial infection with either non-irradiated or irradiated metacercariae (Boray, 1969).

Protection with radiation-attenuated vaccines has been successfully induced against fasciolosis in cattle and rats but generally not in mice, rabbits or sheep. Vaccination of cattle against *F. hepatica* with 3 to 3.5 Krad γ-irradiated metacercariae has been highly successful (Dargie *et al.*, 1974; Nansen, 1975).

3. MATERIALS AND METHODS

3.1. Study area

The study was conducted at Debre Berhan and its surrounding Peasant Association (PA's). Debre Berhan, a town of northern Shewa Administrative Zone of the Amhara National Regional State situated at 130 Km northeastern of Addis Ababa. The town Debre Berhan lies at lat.$09^0 31^{/}$ N. and long. $39^0 28^{/}$ E. With an altitude 2780m.a.s.l this area is mountainous with large plain grazing land, dissected by rivers and steams. The town and 5 peasant Associations (PA's) namely Genet, Chole, Zanjera, Wushawushign and Faji which are situated around Debre Berhan within a radius of 15 Km were the study sites. This area comprises large plain grazing land with extensive type of management system.

The mean annual temperature of Debre Berhan is 12.9^0c where the minimum and maximum temperatures are 6.1^0c and 19.9^0c respectively. The average annual rainfall is 905.4mm and the relative humidity is 62.3 % (Source: ARARI, Debre Berhan branch Agricultural Research Institute). The study area has the largest sheep and cattle, which provide source of income and security. They are grazed on private and communal pastures.

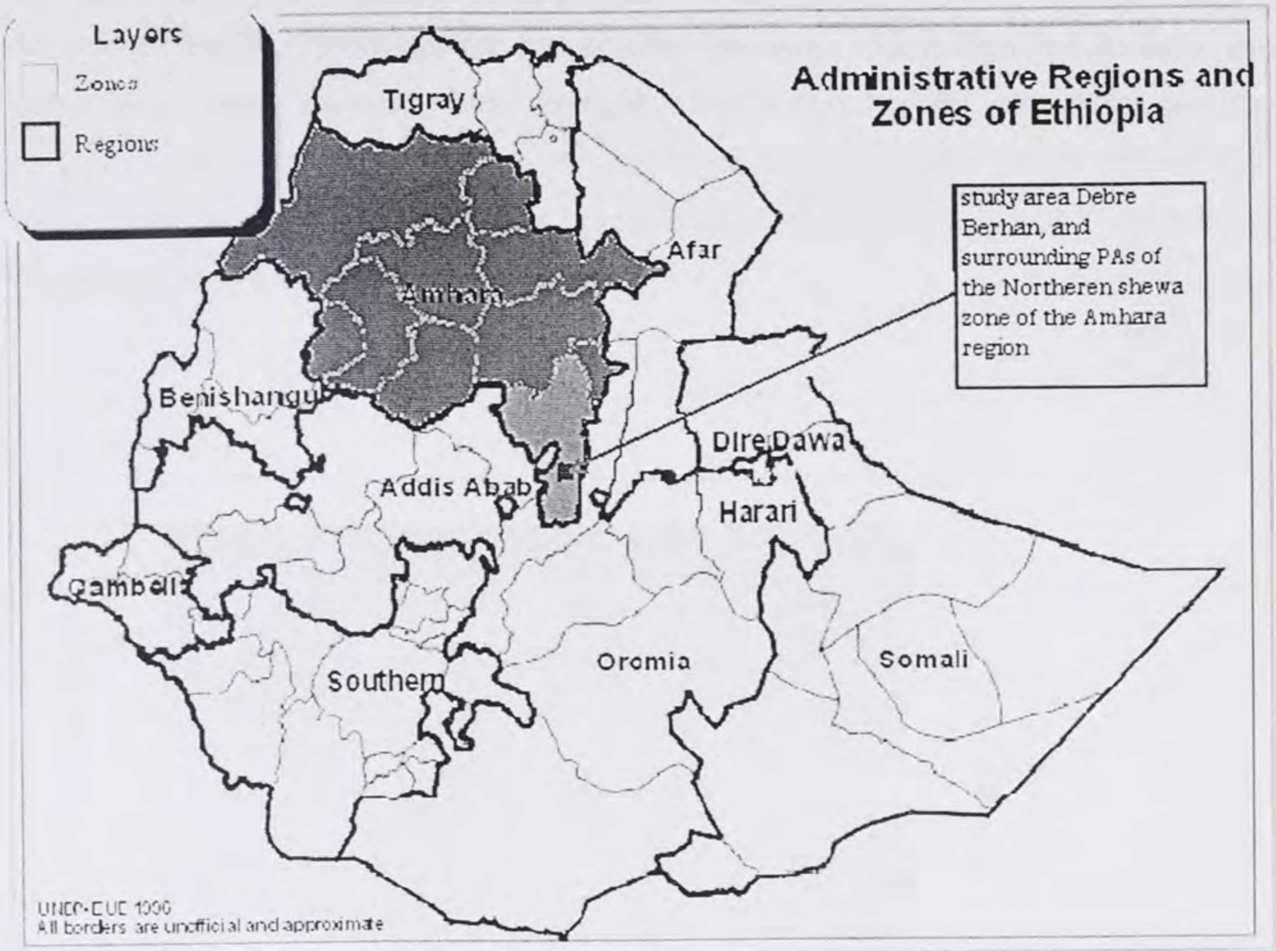


Figure.5. Map of the study area.

Meteorological data

Data on the climatic conditions of the study areas were obtained from ARARI (Amhara Region Agricultural Research Institute) at Debre Berhan branch office meteorogical station. The analysis and calculations focused on the mean monthly maximum and minimum temperature and the monthly and annual rainfall; a twenty-year data (1985-2004) were used. Figure6 shows distribution of the minimum and maximum temperatures and the average monthly rainfall; relative humidity for Debre Berhan and surrounding. The distribution of rainfall and the range of monthly temperature (maximum and minimum) were normal for the areas except that in July and August there were significant increases in the amount of rainfall recorded. Mean relative humidity varied from 62.9-88.9% in the wet Months (June-September) and 44.4-68.6% in the dry months (December –May).from the available data, Debre Berhan areas apparently have throughout the year well spread rainfall, the minimum temperature 1.7°C in November and the maximum 21.6°C in July. In the literature, the minimum temperature of above 10°C and the maximum temperature below 30°C are favorable for parasite development and hatching.

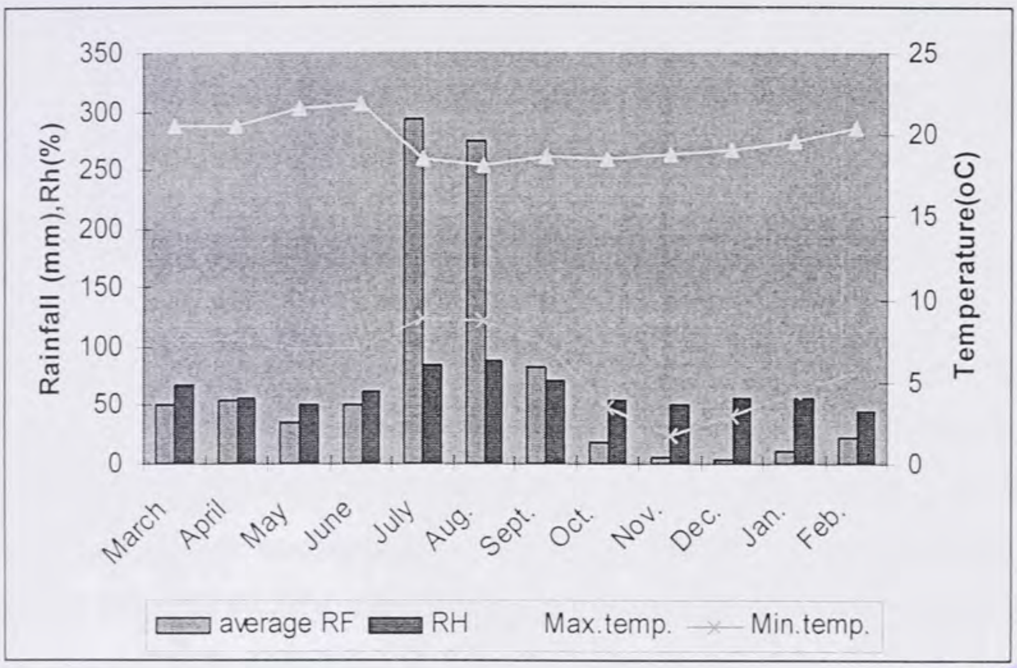


Figure 6. Meteorological data of the study area, a 20year average (1985-2004).

3.2. Study population

The study population comprises of indigenous /local/and cross/ breeds of cattle and sheep of different age and sex category found under the extensive grazing system. Statistical report on Livestock and Farm Implements for Amhara Region indicates that, there are 89,257 cattle and 118,081 sheep in Baso Worena district and 2984 cattle and 5915 sheep in Debre Berhan town. (Annex 12).

3. 3. Study design

3.3.1. Type of study and sample size determination

The study, which was conducted from September 2005 to April 2006, was cross sectional, with simple random sampling technique, the desired sample size for the study was calculated using the formula described by Thrusfield, M. (1995).

$$N = \frac{1.96^2 P\ exp\ (1 - P\ exp)}{d^2}$$

WHERE:

N = required sample size

P exp = expected prevalence,

d = desired absolute precision

1.96 = z-value for the 95% confidence level

With 95% confidence interval and at 5% absolute precision and based on previous studies conducted in Debre Berhan and Ambo areas in the Ethiopian highlands prevalence of 52.4 % of ovine fasciolosis was considered (Ngategize *et al*., 1993). Similarly Dagne (1994), based on faecal and abattoir examination for bovine fasciolosis in Debre Berhan reported prevalence rates of 80% and 88.57% respectively. On the bases of the above results a total sample size of 384 samples from sheep and 246 from cattle was determined.

3.3.2. Questionnaire survey

Questionnaire survey was conducted to evaluate the impact of the disease and the potential risk factors associated with it. Data on each sampled animal was collected using a pre-tested format (Annex 9). These include age, breed, sex, previous history of fascioliosis, and other relevant information related to fascioliasis. Information was collected on the husbandry system, housing system; feeding, disease problems and other management practices related to fascioliasis for possible understanding on the magnitude and distribution of the disease. In addition, a drug usage practice in the study area was compiled to evaluate the positive and negative contribution to the control of fascioliosis.

3.3.3. Coprology

Prevalence of fasciolosis was determined cross sectionally from September 2005 to April 2006 in the selected kebeles /peasant Associations/ which are found around Debre Berhan town. Through coproscopic examinations prevalence of infection was calculated according to the formula given by Thrusfeild (1995).

Faecal samples for parasitological examination were collected directly from the rectum of each animal, using disposable plastic gloves and placed in clean screw capped universal (sampling) bottle and each sample was clearly labeled with animal identification, date and place of collection. Samples were preserved with 5% formalin solution to avoid the eggs developing and hatching. The time of collection of faecal samples was uniformly maintained throughout the study period to avoid possible diurnal variations in fluke egg out put (Roy and Sunkhla, 1971). In the laboratory, coproscopic examinations were performed to detect the presence of *Fasciola* eggs using the standard sedimentation technique as described by (Hanson and Perry, 1994) (Annex 1).

3.3.4. Abattoir survey

Examination of livers for *Fasciola* was done with the liver removal from the abdominal cavity soon after slaughter. The livers of all the slaughtered animals were examined by inspection, palpation and systematic incision to recover immature and adult *Fasciola* flukes. Those livers condemned as unfit for human consumption due to fascioliosis during post mortem examination were registered and representative samples taken to the laboratory to count the fluke burden and the intensity of pathological lesions. Fluke recovery and count was done using the techniques described by (Hanson and Perry, 1994) (Annex 5). Pathological categorization of affected livers was determined by using an approach given by Ogunrinade, (1982) (Annex 6).

3.3.5. Malacological study

The study on the intermediate host snails for fasciolosis was conducted in different sites including low-lying swamps, water lodged areas and slow flowing streams. Snail sample collections were done by hand picking using a disposable plastic hand gloves and some times scooping method was also used. Snails were collected from grazing and watering sites seven times during the study period at monthly intervals from September to March 2006. Surface snail abundance or population density was estimated with the aid of a hand searching technique within a 30-minute time. The mollusks collected were placed in plastic bags /containers/ with fresh algae, aquatic vegetation and aerated water. The samples were transported to the laboratory for identification.

3.3.5.1. Identification of snail species

Aquatic Lymnaid snails, which act as intermediate hosts for *F. hepatica* and *F. gigantica* can be identified fairly easily as compared to other freshwater snails. The opening of the Lymnaid snails is on the right when the snail is held with the spires pointing away from the viewer. When the apex of the spire is facing the viewer the spires turn clockwise (Hansen and Perry, 1994).

Live snail samples were submitted to Aklilu Lemma Institute of Pathobiology, Addis Ababa University, where identification was done. Identification of snail intermediate hosts was made on the bases of shell morphology using a standard key (Frandsen and McCullough, 1980). During identification assisted by experts and experienced senior laboratory technicians from the above mentioned institute. Number of snails gained in a specified place within a specified time were counted, identified and recorded (Annex 3).

3.3.5.2 Examination of snails for cercarial shedding

For examination of snail for cercarial shedding freshly collected snail were used. The snail species incriminated as intermediate hosts were examined using the methods described by Frandsen and Christensen. (1984). Ten to twelve such petridishes were placed on a tray and exposed to artificial light for 2-3 hours. At the end of the exposure period the water from each vial containing exposed snails was examined using low power stereomicroscope. The procedures were repeated for another 2-3 hours; if no cercariae of *Fasciola* were recovered before recording as negative. The cercariae of *Fasciola* shed were identified based on the key given by (Frandsen and Christensen. 1984).

3.3.6 Statistical analysis

The row data, generated from this study were entered into Microsoft Excel database organized and arranged using the Excel spread sheet computer programme and were imported to be analyzed by appropriate soft wares. Other attribute data that were imported into the database system includes information on the localities, age, sex, breed, body condition of sampled animals and laboratory results. In addition to that degrees of liver injury were entered for abattoir data analysis. Chi square ($\chi 2$) statistics was used to determine the significance of the variations in infection prevalence between age, sex, breed, BCS, and localities (kebele/PA's). Statistical analysis was done using Stata computer programme (Intercooled Stata 7). Differences between groups, coprological results and snail infestation rate were tested. A 95% confidence interval and 5% significance level was used to determine whether there are significant differences in the parameters measured between the infected and non-infected groups.

4. RESULTS

4.1 Questionnaire Survey result

Studding results of the questionnaire survey indicates that sheep are the most predominant species of livestock in the study area. It accounts 31% of the total population of the livestock. We have also tried to know type of the management system in northern Shewa administrative zone of Amhara Region. Among those Livestock owners in Debre Berhan and surrounding kebele administrative localities respondents 99% were used extensive management system. And crop-livestock (Mixed farming) was the dominant type of farming practice in the area. Herd composition of cattle in the study are comprises mainly animals with age group 1.5-5 years of age category with (56%) and followed by younger animals with age group less than 5 years of age (31%) the rest being old animals aging above 5 years (12%). on the other hand (19%) of respondents of this questionnaire survey have sheep with < 0.6 year of age; (29%) of respondents have sheep with an age 0.6-1 year and (52%) have sheep with age > 1 Year.

About (90%) of the respondents agreed with the presence of animal health problem in their production system. And most of them tried to mention some main livestock diseases in order of their importance. The first number one disease internal parasite, specially fluke infection followed by foot-rot, pasteurollosis, black leg, pneumonia, septicemia, sheep pox, coenurosis. The respondents mentioned that it affect the livestock production by (mortality, loss of body weight gain, general weakness, loss of power in traction, loss of milk production and organ condemnation at slaughter). (100%) it is a wasting disease, which is known as locally by the name "wodoma", we tried to know about the meaning of this nomenclature, but most of them mentioned that the word wodoma means a plant which grown in the pond and riversides. And they believe that, when animals eat, this plant they might get fasciolosis.

About (90%) of the respondents mentioned that GIP is the first important disease in the area. About 87% of the respondents indicated that the presence of disease with signs of emaciation, diarrhea and sub-mandibular oedema "bottle jaw". (94%) of them responded about the presence of this disease during the studding period (September-March) and the remains told us the occurrence of the disease two years ago. About the occurrence the disease (83%) of the livestock owners believed that the existence of the disease through out the year, 15% answered it is occurred once in a year and 2% of them say once in two years. Concerning the seasonality of the disease 62% say in dry season; 16% in wet season; others 21% answered that it is occurred without seasonal variation and 1% of the respondents say I do not know.

44% of the respondents believe that liver fluke disease affects all, and 56% of them says portion of the heard. Concerning the age group of an animal 42% of respondents indicated that the disease will affect all age groups without differentiation, 48% believes that it will affect adult animals, while 10% of respondents answers the fluke will affect highly younger once. About the disease mortality 92% of respondents say that it is a killer disease. Among respondents 2% have loss of cattle, and on the other hand 18% of respondents have lost 1-3 of sheep during the period of last one year (2004-2005). Concerning the effect of the disease on milk output and body weight gain 94% reported that, it has high effect on the production.

About the source of the disease and ways of transmission 75% of respondents answered that they know very well. Most of them mentioned that source of infection are watering and or/grazing/ feeding on swampy/marshy/ areas, along rivers sides. When an animals get sick 71% of respondents took to the governmental veterinary clinic/animal heath posts/. Others treat at home by themselves or by assistance of other local/ traditional healing practioners/. 60% of the sources of animal drugs are from the surrounding veterinary clinics/animal health posts/. While 32% of them bought from private veterinary drug shops and others from open markets and drug smugglers. Mainly themselves 62% and only 38% by veterinary personnel did administration of drugs. Only 48% of the respondents deliver the appropriate amount of doses of the drugs. 92% of them give the bolus with water but the rest are giving with feed.

4.2 Clinical findings

Of the total 223 cattle and 292 sheep presented to Debre Berhan Veterinary Clinic animals were diagnosed by clinical signs and coproscopically for parasite infestation (Annexes 10 and 11). Out of these 86 (38.56%) cattle and 84 (28.77%) sheep were found positive for fasciolosis. The main clinical signs observed in animals were emaciation, loss of appetite, ascities and submandibular oedema.

4.3 Coprology

A total of 630 faecal samples were examined out of which 246 were from cattle and 384 from sheep. The prevalence rates in cattle and sheep were 64.23% and 54.17 %, respectively (Tables 4 and 5). In addition, the highest prevalence of bovine fasciolosis (77.5 %) was recorded in Wushawushign PA and (61.80%) of ovine fasciolosis in Zanjera PA of Basso Worena woreda/district/. In both cattle and sheep there were statistically not significant in infection between cattle and sheep ($P > 0.05$). In cattle, prevalence of fasciolosis was noted to decrease in older animals.

Table 4. Prevalence of bovine fasciolosis in Debre Berhan and surrounding PA's

Studty site Kebele (PA)	Total examined	No. (%) positive	95% CL
Debre berhan	44	25 (56.82%)	32.55-60.03%
Faji	54	29 (53.70%)	39.96-67.44%
Genet	53	34 (61.15%)	49.66-76.26%
Chole	15	9 (60 %)	31.92-88.08%
Zanjera	40	30 (75 %)	60.97-89.02%
Wushawushign	40	31 (77.5%)	63.97-91.02%
	246	158(64.23%)	58.19-70.26%

Pearson chi2 = 8.8583 $p = 0.115$ ($p > 0.05$)

Results of the coprological examination of animals from different kebeles/localities/ showed variation in infestation rates. The prevalence of fasciolosis in cattle was higher in Wushawushign kebele (77.5%), an area that is found on Ankober road, than the lowest prevalence rate in Faji kebele with (53.70%) thought statistically not significant (p>0.05) (Table 4).

Table 5. Prevalence of ovine fasciolosis in Debre Berhan and surrounding PA's

Study site Kebele (PA)	Total examined	No. (%) positive	95% CL
Debre Berhan	14	7 (50.00%)	20.04-79.95%
Faji	67	39 (58.21%)	46.08-70.33%
Genet	89	55 (61.80%)	51.50-72.09%
Chole	15	8 (53.33%)	24.73-81.93%
Zanjera	62	34 (54.84%)	42.09-67.58%
Wushawushign	137	65 (47.45%)	38.97-55.91%
	384	208 (54.17%)	49.16-59.17%

Pearson chi2 = 5.1350 $p = 0.400$ ($p > 0.05$)

On the other hand the prevalence of ovine fasciolosis showed higher in Genet Giorgis kebele administration (61.80%) than other administrative kebeles, but the lowest prevalence of ovine fasciolosis were recorded in Wushawushign kebele though statistically not significant (P>0.05) (Table 5).

Table 6. Prevalence of fasciolosis by sex

Species	Sex	Total examined	No. (%) positive	95% confidence interval
Cattle	Male	117	67 (57.26%)	48.17-66.36%
	Female	129	91 (72.22%)	62.57-78.52%
	Total	246	158 (64.23%)	58.20-70.26%
Sheep	Male	171	94 (54.97%)	47.44-62.50%
	Female	213	114 (53.52%)	46.77-62.50%
	Total	384	208 (51.17%)	49.16-59.17%

For cattle Pearson chi2 = 4.3003 $P = 0.038$ ($P < 0.05$)
For sheep Pearson chi2 = 0.0803 $P = 0.777$ ($P > 0.05$)

Sex wise male and female cattle were compared, rates of infestation between them showed that male have (57.26%) and female (72.22%) analysis of this results were statistically significant differences (chi2 = 4.3003, p< 0.05). but in sheep the statistical analysis for male and female (54.97%) & (53.52%) respectively showed (chi2 = 0.0803, p > 0.05) (Table 6).

Table7. Prevalence of fasciolosis by breed

Species	Type of breed	Total examined	No. (%) positive	95%CL
Cattle	Local	136	85 (62.50%)	54.26-70-74%
	Cross	110	73 (66.36%)	57.39-75.33%
Sheep	Local	297	158 (53.20%)	47.49-58.90%
	Cross	87	50 (57.47%)	46.87-68.07%
	Total	630	366 (58.09%)	54.30-62.02%

For cattle Pearson chi2 = 1.2809 P = 0.258 (P > 0.05)
For sheep Pearson chi2 = 0.3233 P = 0.570 (P > 0.05).

Analysis of the prevalence rates based on breed to both species showed that statistically not significant (p>0.05). For cattle and sheep the highest infestation rate were recorded in cross breed (66.36% & 57.47%) than local zebu breed with prevalence rate (62.50% & 53.20%) respectively (for cattle and sheep) (Table 7).

Table 8. Prevalence of fasciolosis based on body condition

Species	body condition Score	No. of Samples	*Fasciola* infection No.Positive (%)	95% CI
Cattle	Poor	142	96 (67.61%)	59.81-75.39%
	Good	104	62 (59.62%)	50.02-69.20%
	Subtotal	246	158 (64.23%)	58.45-70.52%
Sheep	poor	228	127 (55.70%)	49.20-62.19%
	Good	156	81 (51.92%)	43.99-59.85%
	Subtotal	384	208 (54.17%)	49.16-59.17%
	Total	630	366 (58.09%)	54.23-61.95%

For cattle Pearson chi2 =1.6682 P = 0.197 (P>0.05)
For sheep Pearson chi2 = 0.7089 P = 0.400 (P> 0.05)

In both species of animals analysis of the prevalence of the disease based on body condition shows that in animals with poor body condition the prevalence of the disease was higher for cattle (67.61%) and for sheep (55.70%) than animals with good body condition which was not statistically significant (p>0.05).

Table 9. Prevalence of bovine fasciolosis by age

Age group	Total examined	No. (%) positive	95% confidence interval
< 1.5	42	30 (71.43%)	57.18-85.67%
1.5-5	114	85 (74.56%)	66.44-82.67%
>5 yr.	90	43 (46.67%)	37.25-70.25%
Total	246	158 (64.23%)	58.19-70.25%

Pearson chi2 = 19.2642 P = 0.001 (P<0.05)

Table10. Prevalence of ovine fasciolosis by age

Age group	Total examined	No. (%) positive	95% confidence interval
<0.6	73	40 (54.79%)	43.10-66.48%
0.6-1	77	54 (70.13%)	59.67-80.58%
>1 yr.	234	114 (48.72%)	42.16-59.17%
Total	384	208 (54.17%)	49.16-59.17%

Pearson chi2 (2) = 10.7133 Pr = 0.005 (P<0.05)

Analysis of the prevalence rates based on age showed that there was statistically significant difference (Chi^2 = 19.2642) for cattle and (Chi^2 = 10.7133) for sheep and (p<0.05) to both species. Highest rate in cattle of age group 1.5-5years old (74.56%) followed by younger with age group less than 1.5 years (71.43%) and least in older aged animals above 5 years of age (46.67%).in sheep the highest were also in medium level age group 0.6-1 year (70.13%) followed youngest age (<0.6 year) (54.79%) and least in age group >1 year (48.72%) (Table 9, 10) The differences were statistically significant (P<0.05).

Table 11. Prevalence of bovine fasciolosis by season

Season	Total examined	No. (%) Positive	95% confidence interval
Late rainy	123	84(68.29%)	59.95-76.63%
Dry	123	74(60.16%)	51.38-68.93%
Total	246	158(64.23%)	58.19-70.25%

Pearson chi2 (1) = 86.2434   P = 0.001 (P< 0.05)

Table12. Prevalence of ovine fasciolosis by season

Season	Total examined	No. (%) positive	95% confidence interval
Late rainy	193	88(46.00%)	38.50-52.68%
Dry	191	87(45.55%)	38.42-52.67%
Total	348	175(45.57%)	40.56-50.57%

Pearson chi2 =187.0   P = 0.001 (P <0.05)

In the study area the seasonal prevalence rate of bovine and ovine fasciolosis revealed high rates during late rainy season (September to November) than in the dry season. Recorded prevalence rate of late rainy season were (68.29% for cattle & 46% for sheep) and in dry season 60% for cattle & 45.55% for sheep) and the difference to both species were statistically significant (p<0.05) (Tables 11 and 12).

4.4 Abattoir study

During these study period In Debre Berhan Municipal Abattoir from September 2005 up to the end of May 2006 totally 1726 animals were slaughtered and out of these 1443 (83.60%) livers were condemned by fasciolosis (Figure 7), post mortem examination in abattoir reveled that fasciolosis in the study area exceeds more than 83.60%.

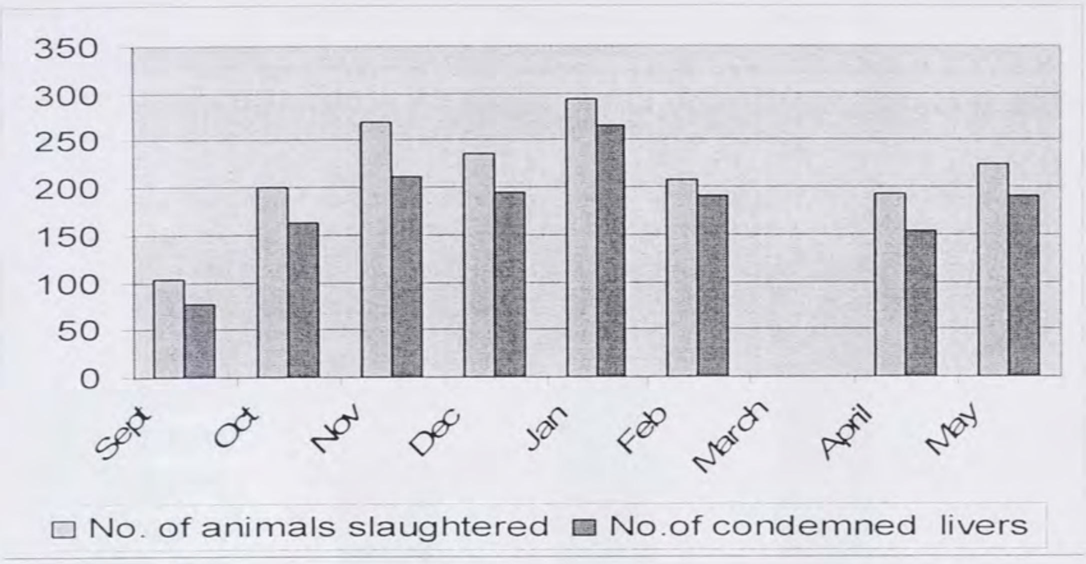


Figure 7 Number of animals slaughtered and condemned livers.

Those animals, which are severely affected, had least fluke count. There is no significant association between fluke burden and intensity of hepatic lesion. At these time 162 randomly selected *Fasciola* positive cattle livers were inspected. Out of these 40 (24.69%) were lightly, 71(43.83%) moderately and 51 (31.48%) severely affected (Figure 8)

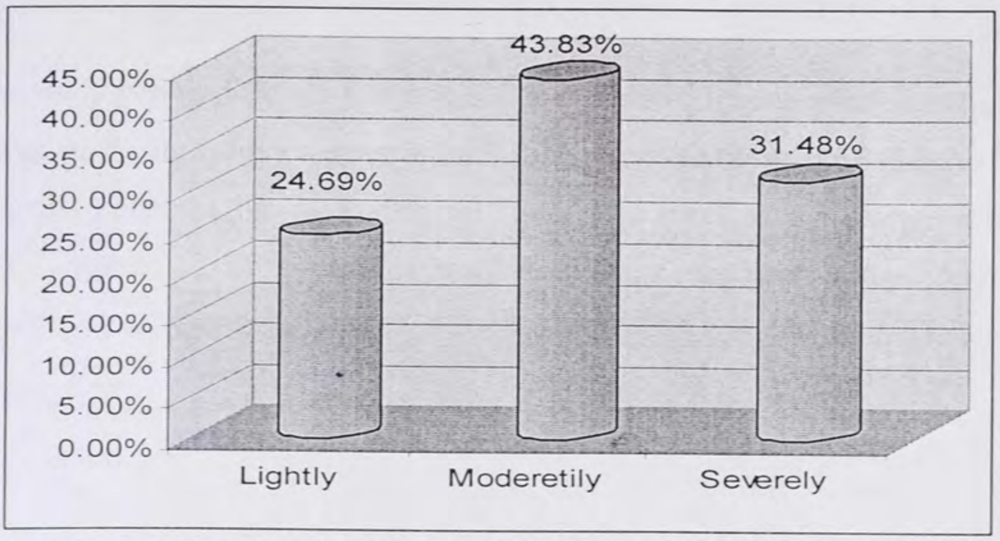


Figure 8 Liver damage in infected cattle slaughtered in Debre Berhan municipal abattoir

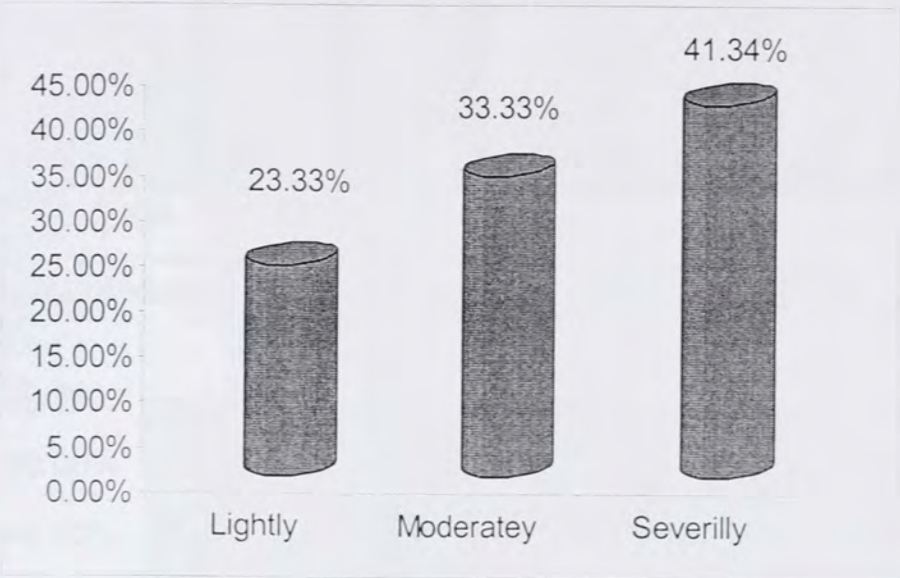


Figure 9. Liver damage in sheep slaughtered in Debre Berhan town

In the municipal abattoir only cattle's are slaughtered, so examinations of sheep livers were done in private hotels and restaurants in Debre Berhan town. During pathological categorization among those 150 infected sheep livers were 23.33% lightly, 33.33% moderately and 41.34% severely affected (Figure. 9).

4.5 Malacological study

During the study period different water bodies and possible transmission sites in the selected five biotopes of the study area were examined. The pH ranged from 7.03 to 8.26. From a total of 3027 snails collected the malacological study demonstrated the existence of *Lymnaea truncatula, L. natalensis, Biomphalaria pfeifferi, Bulunus truncates, Bulinus forscale, Physa, Bivalvia and Ancylus* species (Figur11).

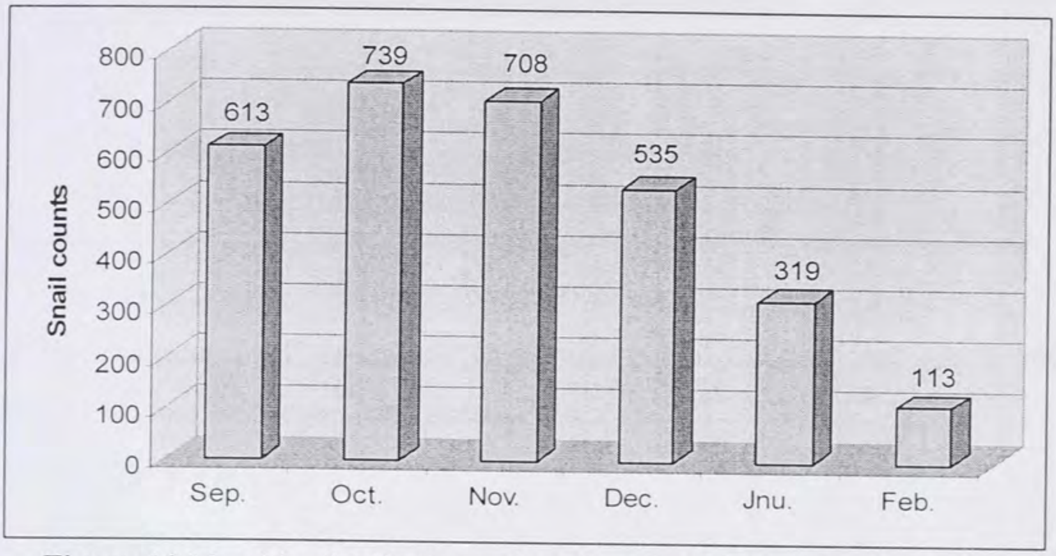


Figure 10 Monthly distributions of snails collected from the study area.

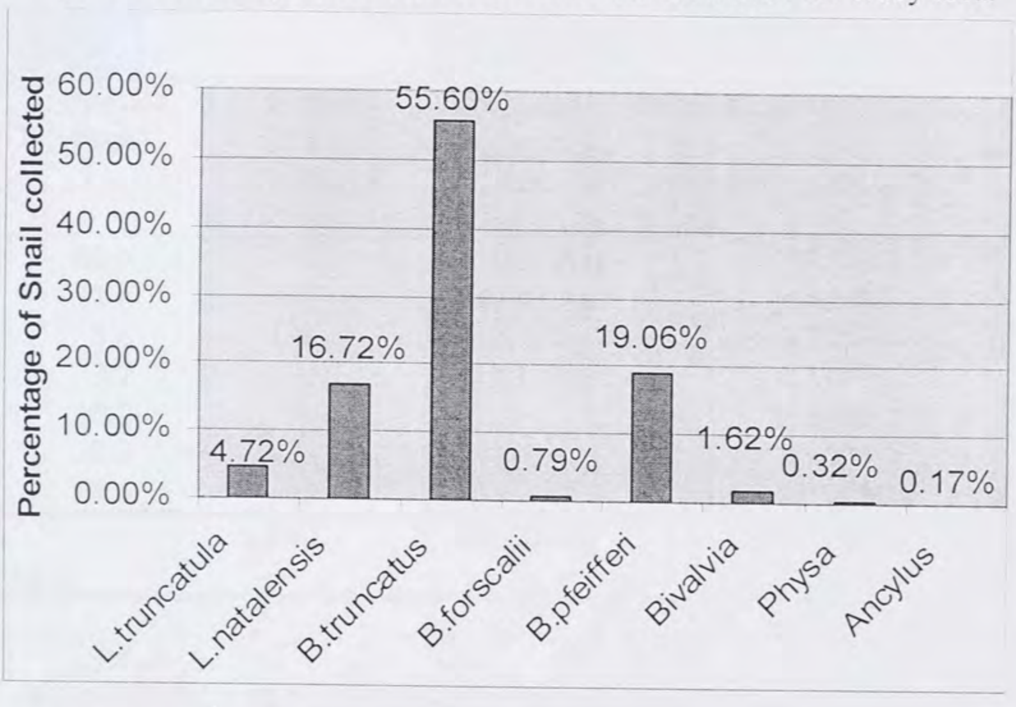


Figure 11 Snail species recorded from the study area.

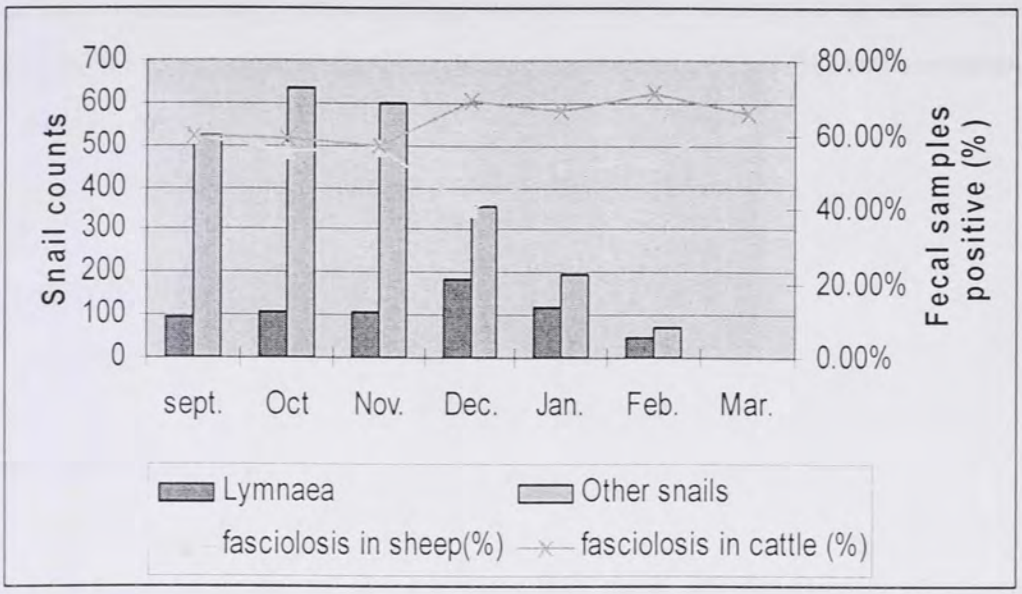


Figure 12 The distribution of fasciolosis in ruminants and the associated snail population dynamics in Debre Berhan and surrounding PA's

Table13 Lymnaed snails found within a limited period by hand and scoop collection

Months of year	rainfall (mm)	Number of snails collected	Number of snails releasing Cercariae: Of fasciola (%)	other trematodes(%).
September	83.6	93	15(16.13%)	7(7.52%)
October	18.4	106	10(9.43 %)	6(5.66%)
November	5.4	108	3(2.77%)	4(3.70%)
December	3.7	182	4(2.19%)	2(1.09%)
January	10.8	90	0	0(0.00%)
February	22.3	73	0	1(1.37%)
March	51.6	0	0	0(0.00%)
Total		652	32(4.90%)	20(3.07%)

Results of examination of Lymnaied snails for cercarial shedding shows that, out of those 652 snails 32 (4.90%) were positive for *Fasciola* cercariae and 20(3.07%) were releasing cercariae of others trematodes (Table 13).

5. DISCUSSION

5.1 Questionnaire survey

Analysis of the questionnaire survey indicates that sheep are the most predominant species of livestock in the study area accounting to 31% of the total population of the livestock. 99% of the livestock owners in Debre Berhan and surrounding practice extensive management system and crop-livestock (Mixed farming) were the dominant type of farming system in the area.
About (90%) of the respondents confirmed presence of animal health problems in which, the internal parasite, especially fluke infection is the major problem. About 87% of the respondents indicated that the presence of disease throughout the year with signs of emaciation, diarrhea and submandibular oedema "bottle jaw". The questionnaire survey reveals that Fasciolosis is the one of the major health problem of ruminants in the area.

5.2 Coprology

The results of coprological examination reveal that the prevalence of bovine fasciolosis in and around Debre Berhan was 64.63%, which is in agreement with previous studies by (Bahiru and Ephrem, 1979), On the other hand it is lower than values reported by Dagne, (1994) in the same area. Prevalence of bovine fasciolosis around Debre Berhan through coprological examination was 80%. This may be due to the expansion of animal health extension and veterinary services /the opening of animal health posts at kebele / Peasant association level/ and the intervention of near by private veterinary drug shops /pharmacies/, which enables the farmers to have more access for disease control and interventions. Concerning ovine

fasciolosis result of the present study from six localities it accounts to an average of 54.16%, which is in agreement with the previous studies by Ngategize *et al.*, (1993) in the same area.
In this survey, the highest prevalence of bovine fasciolosis (77.5 %) was recorded in Wushawushign PA followed by Zanjira (75%); Genet Giorgis (61.15%); Chole (60%); Debre Berhan (56.82%) and the lowest were in Faji kebele with the prevalence rate of (53.70%). On the other hand the highest prevalence of infection of ovine fasciolosis were recorded in Genet Giorgis (61.80%) followed by Faji (58.21%); Zanjira (54.84%); Chole (53.33%); Debre Berhan (50%); with the lowest (47.45%) in Wushawushign kebele /PA/ of Basso worena district. The prevalence of bovine and ovine fasciolosis was not statistically significant ($P>0.05$). Generally, the difference in the prevalence of fasciolosis is strongly associated with variation in the type of soil, geomorphology and the biotype suitability for the development of the intermediate host.

An attempt was made to examine the association of prevalence, with risk factors like sex, breed, age, species, body condition of animal and their geographical location.
A significant variation ($P<0.05$) in the prevalence of bovine and ovine fasciolosis in different

age groups was observed (Table9,10), a finding that agrees with works of Dwinger *et al.*, (1982). Low prevalence of bovine fasciolosis dominates in the younger group (1.5-5 years of age). This might be attributed to the fact that calves are not often grazed with older age groups, which reduces the chance of exposure. In different parts of Ethiopia, similar results indicating inverse correlation of prevalence and age of cattle were reported by Roman (1987), Rahmeto (1992), Dagne (1994). The highest infestation rates were observed in middle-aged animals with age group (1.5 -5 years) and the lowest prevalence rate also observed in older animals with age group (> 5 years). This might be due to acquired resistance to repeated infestation. Body condition of each sampled animal was made on subjective basis to observe the effect of fasciolosis in emaciated (malnourished) animals based on a standard body condition scoring matrix for sheep were adopted from Tompson and Meyer, (1986,1994) and for cattle were adapted from Nicholson and Butterworth, (1986) (Annex 7 & 8). Even statistically the effect of body condition on prevalence of fasciolosis was not significant (Table 8). Animals with poor body condition and nutrition may have higher risk for fasciolosis infection than those animals with good body condition.

5.3 Abattoir survey /slaughtered animal investigation/

A total of 1726animals were slaughtered during this study period In Debre Berhan Municipal Abattoir out of these 1443 (83.60%) livers were found infected with fasciolosis. Affected livers were classified into three groups depending on the severity of hepatic lesion based on criteria set by (Ogunrinade, 1982). Of the 162 randomly selected fasciola positive bovine livers 40 (24.69%) were lightly, 71(43.83%) moderately and 51 (31.48%) severely affected (Fig.8). On the other hand of the150 infected ovine livers 23.33% lightly, 33.33% moderately, and 41.34% were severely affected. Both fluke species, *F. hepatica* and *F. gigantica* were encountered in infected livers during post mortem inspection. Fluke counts conducted on 162 infected livers revealed mean fluke burden of 78 per liver, implying high fluke burden in the area. Throughout the study period, it was observed that more than three-fourth of the slaughtered animals were found infected by *Fasciola* spp. Soulsby, (1982) demonstrated that the p resence o f m ore t han 5 0 f lukes p er l iver i ndicates h igh p athogenesity. (Fekadu, 1 988; Rahmato, 1992); the result is also harmonious with the works of (Dwinger *et al*., 1982; Ross, 1968); and agrees with previous works done in different parts of our country by (Roman, 1987; Abebe, 1988; Wondwosen, 1990). This inverse c orrelation is attributed to the severe fibrosis, which makes difficult the movement of young flukes.

Lossos, (1986) has shown that beef cattle have relatively less flukes with severely affected livers suggesting that severe fibrosis impedes in the passage of immature flukes and acquired resistance resulted in the expulsion of flukes from the bile ducts. This could be associated with in severe fibrosis, calcification and cirrhosis, which hinder the further passage of the young/immature flukes/. This supports the idea that an acquired immunity (cattle) gradually develops; this limits the life span of the primary infection, slows the migration of the secondary infection and eventually reduces the number of flukes established (Urquhart, 1996). The extent of liver damage does greatly vary with different factors including stages of infestation or resistance of the host. The reason for the high fluke burden in this study may be due to the nature of the surrounding flood plain, which favors the presence of persistent transmission sites.

5.4 Malacological results

The malacological study focused on the snail species in association with those five biotypes, within 15 kms radius from the town of Debre Berhan. During this period a totally of 3027 snails were collected. The results of malacological investigation demonstrated the existence of *Lymnaea truncatula, Lymnaea natalensis, Biomphalaria pfeifferi, Bulinus truncates, Bulinus forscalii, Physa, Bivalvia, other small planorbids and Ancylus* species (Fig.11). From this study, observed that highly dominant snails were *Bulinus* species.

The snail survey during the study period demonstrated the presence of both *Lymnaea* species (*L. truncatla* and *L.natalensis)*, which are the intermediate hosts of *F.hepatica* and *F.gigantica* respectively. *L. natalensis* was collected from Angolela River at a distance of 10-13 km on DebreBerhan-Mendida-Jihur road. With elevation of 2621m.a.s.l. It is for the first time that this species was encountered at this altitude. Present finding agree with previous studding by Rahmeto, (1992) has reported the existence of both species of snails at elevation of 2070 m.a.s.l around Woliso.

Yilma and Malone, (1998) have also earlier reported at Fiche and Debre Berhan (elevation above 2800m) completion of an infection cycle required more than one year, a unique epidemiological feature of *F. hepatica* transmission in such areas. The occurrence of *F.gigantica* infection varied between 1455m.a.s.l (Negege, Southern region) and 2563m.a.s.l (Arjo, western regions). Less number of *L. truncatula* were collected, the reason behind is that this species of snail is mud or amphibious snail progressive drying of all habitats, with standing water. Population of *L. truncatula* steadily decreased from September until they disappeared by the last visit. At the end of September the topsoil completely dried out, although in the gully and flush areas collapse of the foliage grasses provided conditions where *Lymnaea* could persist longer.

6. CONCLUSION AND RECOMMENDATIONS

In general, it can be concluded that fasciolosis is one of the major obstacle for livestock development in Ethiopia by inflicting remarkable direct and indirect losses at different parts of the country where its occurrence is closely linked to the presence of biotypes suitable for the development of snail intermediate host.

The present study indicates that bovine and ovine fasciolosis is widely distributed disease with high prevalence rate in the Debre Berhan region. The abattoir study demonstrated significant economic impact of the disease directly and indirectly affecting small ruminant productivity. Presences of both intermediate snail vectors (*L.truncatula and L. natalensis*) of the two *Fasciola* species (*F. hepatica and F. gigantica*) were recovered. The finding of the present work is also in agreement with earlier studies strongly suggesting that priority should be given to planning and setting a control programme.

Snails were most abundant in Angolela than other study sites. No significant variation was recorded in water pH (7.06-8.26) and temperature (19.5-20^{0}C) between the study sites, from the result we can conclude that snails can inhabit within different ranges of localities.

- Strategic use of antihelmintics should be performed to reduce pasture contamination with fluke eggs. Here proper year round study should be conducted so as to elaborate time of the year beneficial to apply antihelmintics.

- Further information on the epidemiology of the disease, the ecology and biology of intermediate host snail should be gathered.

- Integrated control approach using selected antihelmintic therapy and snail control should be conducted to reduce magnitude of the problem.

- Creating and further consolidation of farmer's awareness is necessary.

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8. ANNEXES

Annex 1. Sedimentation method

Sedimentation technique is a procedure which helps to assess the presence of trematode infections through repeated dilution of the faecal suspension, and sedimentation of the eggs (which are heavier than most of the faecal particles), the faeces in the sample are reduced and the eggs concentrated so that they are more easily observed. The process can be made very much easier if the faeces are initially sieved through a 150µm sieve. The procedure can be used to detect liver fluke (*Fasciola*) and *Paramphistomum* eggs (Hanson and Perry, 1994).

Procedure:

A) Weigh or measure approximately 3 g of faeces into container.
B) Pour 40-50 ml of tap water into container.
C) Mix (stir) thoroughly with a stirring device (fork, tongue blade).
D) Filter the faecal suspension through a tea strainer or double- layer of cheesecloth into another (container 2).
E) Pour the filtered material into a test tube.
F) Allow standing (sediment) for 5 minutes.
G) Remove (pipette, decant) the supernatant very carefully.
H) Resuspend the sediment in 5 ml of water.
I) Allow to sediment for 5 minutes.
J) Discard (pipette, decant) the supernatant very carefully.
K) Stain the sediment by adding one drop of methylene blue.
L) Transfer the sediment to a microslide.
M) Cover with a cover slip.
N) Examine under a microscope at a magnification 10 X 4 for trematode eggs.

Annex 2. Malacological study

Sites expected to be favorable for snail breeding were surveyed. These sites including low-lying swampy areas, water lodged areas, drainage ditches, slow flowing streams and moisture vegetation of which most of them are found around at the grazing lands. In the collection, snails visible to the naked eye and are floating on the surface of water and those on the moist mud were collected using a scoop or picked up by hand wearing gloves, transmission sites which are deep and full of vegetation were searched by using a scoop. The collected snail samples were brought from field water and algae and water vegetation. Identification of snails was made on the basis of shell morphology at the field and/ or in the laboratory of Aklilu Lemma Institute of Pathology, Addis Ababa University using a field guide to African Freshwater Snails. For cercarial shedding studies live snails collected from the field were exposed to light for specified periods of time.

Annex 3. Snail record sheet

Region…………………Zone……………….Wereda…………………Kebele………..
Altitude………………..

Date	Place /Locality/	No. of Snails collected	Species. identified	Infected lymnaea snails		Remark
				Number	%	

Annex 4. Record sheet for cross sectional study.

Region...
Zone………………………..…..
Woreda…………………………...
Kebele (PA)……………….……..
Date..

No	Owners name	address	A N I M A L					
			Species	Sex	Breed	Age	BCS	Faecal exam. result

Annex 5. Post mortem examination procedure for liver fluke

For more precise assessment of the liver fluke burden of an animal the liver can be examined post-mortem for its content of immature and adult fluke.

Equipments:

- A sharp knife
- A cutting board
- A medium size tray
- A wash bottle
- Petri dishes
- A laboratory counter

Procedure:

A) P lace the liver on a board and cut it into fine slices with a sharp knife.

B) After each cut is made apply pressure to the liver to squeeze out the flukes and wipe these off gently before making the next cut.

C) When the whole organ has sliced, place all of the material in a tray and cover with water.

D) R emove the pieces of liver, again squeezing each piece as it is removed from the water.

E) Pour water and flukes into a sieve and wash parasites until clean.

F) Pour into petri dishes and count the flukes present.

G) I f very large number of immature flukes are present, count by a dilution technique.

Annex 6. Pathological Categorization of affected livers:

According to Ogunrinade, 1982 they were classified into 3 groups;

Lightly affected - if the quarter of the liver is affected or if one bile duct is prominently enlarged on the ventral surface of the liver

Moderately affected – if half of the organ is affected or if two or three bile ducts are hyperplastic.

Severly affected – if the entire organ is involved or if the liver is cirrhotic and triangular in out line for the right lobe is atrophied.

Annex 7. Body condition scoring (BCS) of sheep.

Rank	Condition score type	Description	grouping
Condition Score 1	Very thin	Very thin Spine prominent and sharp	poor
Condition Score 2	Thin	Thin Spine prominent and smooth	
Condition Score 3	Average	Average Spine smooth and rounded	good
Condition Score 4	Fat	Fat Spine only detected as a line	
Condition Score 5	Very fat	Very fat Spine not detectable; fat dimple over spine	Very good

Adapted from Thompson and Meyer, 1986, 1994.

Body Condition scoring of sheep

James M. Thompson and H. Meyer

Department of Animal Sciences, Oregon State University

http://oregonstate.edu/dept/animal-sciences/bcs.htm

A body condition score estimates condition of muscling and fat development. Scoring is based on feeling the level of muscling and fat deposition over and around the vertebrae in the loin region. In addition to the central spinal column, loin vertebrae have a vertical bone protrusion (spinous process) and a short horizontal protrusion on each side (transverse process). Both of these protrusions are felt and used to assess an individual body condition score.

The systems used most widely are listed as follows based on a scale of 1 to 5. The five scores are:

Condition 1 (Emaciated)

Spinous processes are sharp and prominent. Loin eye muscle is shallow with no fat cover. Transverse processes are sharp; one can pass fingers under ends. It is possible to feel between each process.

Condition 2 (Thin)

Spinous processes are sharp and prominent. Loin eye muscle has little fat cover but is full. Transverse processes are smooth and slightly rounded. It is possible to pass fingers under the ends of the transverse processes with a little pressure.

Condition 3 (Average)

Spinous processes are smooth and rounded and one can feel individual processes only with pressure. Transverse processes are smooth and well covered, and firm pressure is needed to feel over the ends. Loin eye muscle is full with some fat cover.

Condition 4 (Fat)

Spinous processes can be detected only with pressure as a hard line. Transverse processes cannot be felt. Loin eye muscle is full with a thick fat cover.

Condition5 (Obese)

Spinous processes cannot be detected. There is a depression between fat where spine would normally be felt. Transverse processes cannot be detected. Loin eye muscle is very full with a very thick fat cover.

Annex 8. Description of Body condition score (BCS) of African Zebu cattle.

Score	Condition	Feature	Grouping
1	L-	Marked emaciation	Poor
2	L	Transverse processes projection prominently, Neutral spines apper sharply	
3	L+	Individual dorsal spines are pointed to the touch; hips, pins, tail-head and ribs are prominent. Transverse processes visible, usually individually.	
4	M-	Ribs, hips, and pins clearly visible. Muscle mass between hooks and pins slightly concave. Slightly more flesh above the transverse processes than in L+.	Good
5	M	Ribs usually visible, little fat cover, dorsal spines barely visible.	
6	M+	Animal smooth and well covered; dorsal spines cannot be seen, But are easily felt.	
7	F-	Animal smooth and well covered, but fat deposits are not marked. Dorsal spines can be felt with firm pressure, but feel rounded father than sharp.	Very good
8	F	Fat cover in critical areas can be easily seen and felt; transverse Processes cannot be seen or felt.	
9	F+	Heavy deposits of fat clearly visible on tail- hooks and pins fully covered and cannot be felt even with firm pressure. head, brisket, and cod; dorsal spines, ribs,	

Adapted from Nicholson, M.J and Butterworth, M.H, 1986.

Annex 9. Questionnaire survey format:

Respondent's name--

Code---

Village--

Date---

Status: Worker---

Owner---

Location: Region---

Zone---

District--

Village-------------------- --

Herd structure: upto1.5yrs. -------------- 1.5-5yrs. -------------Above5yrs--------------------

Type of production system:

Agricultural (Major crops)--------------------------
Pastoral--
Agro pastoral---
Sedentary---
Semi-sedentary--------------------------------------
Nomadic--

Type of management cattle: Free grazing-------------------------

Tether--------------------------------------

Stall-feeding-----------------------------

Have you observed the Presence of a disease with the following symptom?

Bottle jaw---

Diahirrea ---

Emaciation--

Is the disease wedoma /fasciolosis/ a major problem for you on this farm?

Yes----------- No--

Is it present now? --

What is its local name? --

Last time of its occurrence: Month---------------Year---------------Season-------------

How frequently does it occur?

Every year-------------------------------

Always there-----------------------------

Every---------------------------------year

When does it occur normally? In long rainy -----------------------------

In dry season------------------------------

In short rainyRainy------------------------

How dose it affect an animals?

The entire herd -----------------------------

Proportion----------------------------------

Singile one--------------------------------

In cattle which age group is highly affected ------------------------------

Less than 1.5yr----------------------------

Between1.5 & 5yrs-----------------------

Above 5 yrs--------------------------------

All age group------------------------------

In sheep which age group are highly affected?

Less than 0.6yr----------------------------

Between 0.6 & 1 yr-----------------------

Above 1 yr--------------------------------

All age group -----------------------------

Does it cause death? Yes----------------------No------------------------

If it causes death in cattle how many animals you loss in the past one year? -------

Number of deaths in each age group <1.5 yr----------------------------

1.5-5 years--------------------------------

Above5 years------------------------------

Number of deaths in sheep--

Up to 6months--------------------------------

0.6-1 yrs ----------------------------------

Above 1 yrs---------------------------------

Dose it have an effect on milk production and body weight gain? Yes---------No------------

What do you do when your animals get sick?

Treat at home ----------------------------------

Vet. Clinic-------------------------------------

Others (specify) -------------------------------

What is the local name for treatment? ---

Who is applying the treatment? You yourself---------------------------------

Vets. ---

Drug smugglers------------------------------

Do you us antihelmintics for the treatment? Yes--------------No-------------

If Yes, which antihelmintics are you commonly using to treat your animals? ----------------

----

What quantity of antihelmintics do you use to treat your cattle?

Correct amount---

In correct amount---

To treat your sheep? --

How much money do you pay to get a single mature oxen treated? -----------------------------

To a single mature sheep ---

How many times did each animal get vet. Treatment against Fascioliasis since last year?

One time only--

Two times---

Three times---

More than three times---

Do you have antihelminthics now in stock? --

If yes, can you show please? --

How do you use it? --

Annex 10. Coprological examination of cattle in Debre Berhan Veterinary Clinic.

Parasitic eggs found during coprological examination.										
	Fasciola	Strongyl	Trichuris	Ascaris	Paramph	Monezia	Coccidia	Dictyoca	Negative	Total
Sept	4	1	1	2	6	0	0	0	7	21
Oct	14	10	0	7	11	0	0	2	18	62
Nov	16	10	0	3	15	0	1	0	24	69
Dec	10	5	0	1	5	2	3	0	15	41
Jan	10	5	0	0	2	0	1	0	18	36
Feb	22	7	0	1	11	0	1	0	22	64
May	10	4	0	0	1	0	0	0	15	30
TOTAL	86	42	1	14	51	2	6	2	119	223

Annex 11. Coprological results of sheep examined in Debre Berhan Veterinary clinic.

Months	Fasciola.	Strongyl	Tricurise	Ascarise.	Paramph	Monesea	Coccidia	Dictioca	Negative	Total
September	0	2	0	0	0	0	0	1	0	3
October	10	13	7	3	2	1	0	2	18	56
November	32	41	7	0	3	5	0	23	26	137
December	23	10	1	0	1	0	0	1	5	41
January	8	1	0	0	2	1	1	0	4	17
February	7	2	1	0	4	0	0	0	7	21
May	4	6	1	0	0	1	0	0	5	17
TOTAL	84	75	17	3	12	8	1	27	65	292

Annex 12. Total livestock population in Basoworena district and in Debre Berhan town.

	LIVESTOCK POPULATION	
	In Baso worena District	In Debre Berhan town
Cattle	89,257	2,984
Sheep	118,081	5,912
Goats	41,973	117
Horses	6,148	169
Asses	25,837	211
Mules	469	DN
Camels	DN	DN
Poultry	97,207	5,190

9. CURRICULUM VITAE

1. Personal Details:

Full name:	Zerinhun Abegaz Yassin (D.V.M, Msc in Tropical Vet. Medicine)
Sex:	Male
Date of birth:	09/05/1965 G.C
Place of birth:	Town- Passomile, Province-Wollo, Region- Amhara, country-ETHIOPIA
Marital status:	Married

2. *Language Skills*:

Mother tongue	Amharic
Other Language	English & Russian

3. *Educational Back Ground:*

Year attended	Grade	Name of school/ Institution	Location	Qualification obtained
1977-1980	7-10	Haik secondary	Haik	-
1981-1982	11-12	W/ro Sihin senior Secondary School	Dessie	Diploma
1983-1984	12+2	Ambo junior College of agriculture	Ambo	Diploma
1989-1994	+6	Moldovian State Agriculture University	Republic of Moldovia	(DVM) Doctor of veterinary Medicine
2004-2006	+2	Addis Ababa university, Faculty of veterinary Medicine	Debre Zeit	Msc degree in Tropical veterinary Medicine.

4. Work Experience:

Period	Position	Place of work	Organization
1985-1988	Agricultural Development Agent	Gojam - Guagusa district - Pawe settlement area.	Ministry of Agriculture (M.O.A)
1995-1997	Veterinarian & head of wereda(district veterinary team)	Tenta district (South Wollo)	Ministry of Agriculture (M.O.A)
1998	Veterinarian & head of wereda(district veterinary team)	Wereillu district (South Wollo)	Ministry of Agriculture (M.O.A)
1999-2004	Veterinarian and District National Livestock Project coordinator	Ambassel district (South Wollo)	Ministry of Agriculture (M.O.A)

Seminar: Ruminant Fasciolosis: Review of the disease and its control measures. July 2005, Debre Zeit, Ethiopia.

Research work:

The Therapeutic efficiency of antihelmentics and immuno-stimulator polyoxidon-2 in case of gastrointestinal strongylosis in sheep. (DVM thesis, Moldovian State Agricultural University, June1994, Kishinov, Moldova Republic).

Ruminant Fasciolosis: Studies on the clinical occurrence, coprology, malacology and abattoir survey in Debre Berhan and surrounding areas. (Msc thesis, Addis Ababa University, Faculty of Veterinary Medicine, June 2006, Debre Zeit, Ethiopia).

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10. SIGNED DECLARATION SHEET

I, the undersigned, declare that this thesis is my original work and has not been presented for a degree in any university and that all sources of material used for the thesis have been duly acknowledged.

Name ZERIHUN ABEGAZ YASSIN

Signature ____________

Date of submission 23-06-2006

This thesis has been submitted for examination with my approval as an academic advisor.

Dr. Getachew Tilahun ____________

Ruminant Fasciolologsis;Studies On
The Clinical Occurrence Coprology,
Malacology& Abattoir Survey In
Debre Birhan &Surrounding Areas

Zerihun Abegaz