Sudan University of Science and Technology
College of Graduate Studies

Prevalence and Risk Factors of Sheep Paramphistomiasis, Fascioliasis and Schistosomiasis in the White Nile State, Sudan

نسبة الاصابة وعوامل الخطر لمرض البارامفستوما, مرض الفاشيولا ومرض الشيستوسوما في الضان فى ولاية النيل الأبيض- السودان

A Thesis Submitted to the College of Graduate Studies in Partial Fulfillment of the Requirements for the Degree of Master of Preventive Veterinary Medicine (MPVM)

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Dedication

To:

My parents
My brother and sister,
My colleagues and friends and
all those who were in touch
during this work.

Azza

Acknowledgments

I thank God who helped me in completing this work and gave me a chance to be a researcher and I wish success in future studies. I am grateful to Professor Abdelhamid Ahmed Mohamed Elfadil who fully supervised the study and provided all guidance and advice necessary for completing the work in its present form .I am also grateful to co-advisor Dr.Abdalgader. Many thanks and appreciation to the staff of the Ministry of Animal Resources, White Nile State, Veterinary Research Laboratory , Rabak. Finally, my sincere gratitude to those who made significant contributions for completing this work.

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Abstract

A cross-sectional study was carried out on 156 sheep in Rabak, White Nile State, Sudan, during the period from March to June 2013. The objectives were to estimate the prevalence of paramphistomiasis, fascioliasis and schistomiasis in sheep and to investigate potential risk factors associated with each disease. The overall prevalence of sheep paramphistomiasis, fascioliasis and schistosomiasis in White Nile state (Rabak) was found to be 13.5%, 12.8% and 4.5% respectively when diagnosed by fecal sedimentation test.

In the current study, univariate analysis using the Chi- square, with a confidence interval of 95% at a *p-value* of ≤0.25 was used to identify potential risk factors associated with fecal sedimentation test-positivity for paramphistomiasis infection in sheep. Significant risk factors associated with fecal sedimentation positive in the univariate analysis were found to be: grazing type (*X2* =12.245, p = 0.00), water source (*X2* =3.691, p =.055), water bodies (*X2* =1.486, p = 0.223) and other diseases (*X2* = 4.699, p = 0.030).

Significant risk factors associated with being fecal sedimentation positive to fascioliasis in the univariate analysis were found to be :breed (*X2* = 6.757, p = 0.034), grazing type (*X2* =1.751 , p = 0.210),water source (*X2* =1.733 , p =1.88), snail presence (*X2* =1.405 , p = 0.23), water bodies (*X2* =1.405 , p = 0.23), vegetation (*X2* =1.405 , p = 0.23) and manure disposal (*X2* = 4.699, p = 0.030). Significant risk factors associated with being fecal sedimentation positive to schistosomiasis in the univariate analysis were found to be: breed (*X2* = 6.926, p =

0.031), grazing type (*X2* =6.0 , p = 0.014), water source (*X2* =4.608 , p =0.032), and knowledge of owner about disease (*X2* =1.841 , p = 0.175),

The multivariate analysis, using logistic regression, with a confidence interval of 95% and a *p- value* of ≤0.05 was used to assess the association between identified significant risk factors in the univariate analysis in combination towards a positive fecal sedimentation test status for paramphistomiasis. Fascioliasis and schistosomiasis in sheep. The analysis showed an association between being fecal sedimentation test positive status for paramphistomiasis in sheep and grazing type (Exp (B) = 10.3) and water source (Exp (B) = .561). For fascioliasis, the analysis showed an association between being positive status for fascioliasis in sheep and breed (Exp (B) = 3.1). As for schistosomiasis the analysis showed an association between being positive status for schistosomiasis in sheep and breed (Exp (B) = .03), grazing type (Exp (B) = .764), and water source (Exp (B) = 13).

ملخص الدراسة

أجريت دراسة مقطعية علي 156 راس من الضأن في ولاية النيل الابيض (ربك), خلال الفترة التي امتدت من مارس الي يونيو 2013 والهدف منها هو تقدير معدل انتشارمرض دودة الكرش 'مرض ابو كبيده ومرض الشيستيسوما والتحقق من عوامل الخطر المرتبطة بانتشار تلك الامراض وكانت نسبة المرض13.5% '.12.8% و4.5% بالترتيب. وقد اختبرت باختبار ترسيب البراز. تم العثور على عوامل الخطر المهمة المرتبطة بمرض دودة الكرش(p-value of ≤0. 25)باستخدام مربع كاي للتحليل باختبار ترسيب البراز في التحليل وحيد المتغير حيث كانت العوامل هي:

نوع المرعي.(*X2* =12.245 , p = 0.00) ,مصدر ماء الشرب,(*X2* =3.691 , p =.055) وجود البرك (*X2* =1.486 , p = 0.223)والاصابة بالأمراض الأخرى .(*X2* = 4.699, p = 0.030)و تم العثور علي عوامل الخطر المهمة المرتبطة بمرض ابو كبيدة(p-value of ≤0. 25) باستخدام مربع كاي للتحليل باختبار ترسيب البراز في التحليل وحيد المتغير حيث كانت العوامل هي:

السلالة ,(*X2* = 6.757, p = 0.034),نوع المرعي(*X2* =1.751 , p = 0.210) ,

,مصدر ماء الشرب (*X2* =1.733 , p =1.88),وجود البرك (*X2* =1.405 , p = 0.23)

الحشائش ,(*X2* =1.405 , p = 0.23) ,ازالة الروث (*X2* = 4.699, p = 0.030)

اصابة بالأمراض اخري Exp (B) = 2.17, p =)كما تم العثور علي عوامل الخطر الايجابية الهامة المرتبطة بمرض الشيستيسوما≤0. 25 p-value of باستخدام مربع كاي للتحليل باختبار ترسيب البراز في التحليل وحيد المتغير حيث كانت العوامل هي:

السلالة(*X2* = 6.926, p = 0.031), نوع المرعي,(*X2* =6.0 , p = 0.014)

مصدر ماء الشرب ,(*X2* =4.608 , p =0.032), و معرفة المالك بالمرض = p , 1.841= *X2*) (0.175),

باستخدام تحليل الانحدار اللوجستي $p\text{- value of} \leq 0.05$ اظهر وجود ارتباط ايجابي بين مرض دودة الكرش المشخص باختبار ترسيب البراز ونوع المرعي(Exp (B) = 10.3) و مصدر مياه الشرب Exp (B) = .561)(ولمرض ابو كبيدة اظهر التحليل وجود ارتباط بين المرض و السلالة :

Exp (B) = 3.1). ولمرض الشيتيسوما اظهر التحليل وجود ارتباط بين المرض و السلالة

Exp (B) = .03), نوع المرعي (Exp (B) = .764) ومصدر ماء الشرب.(Exp (B) = 13)

Introduction

1. Background:

Amphistomes (rumen fluke), Fasciola (liver fluke) and Schistosoma (blood fluke) are the most important trematode affecting cattle, sheep and goats (Soulsby, 1982). Gastro-intestinal nematode parasitic infection are a major constraint to the sheep industry and cause production losses , increased costs of management and treatment and even mortality in severe cases (Yagoob *et al*., 2013).

Fasciola, *Schistosoma* and *Paramphistoma* spp. are snail-borne trematode capable of causing acute and chronic disease in ruminant .They have a wide geographical distribution in subtropical and tropical areas, where the infection leads to economic losses related to mortality and low productivity (Howell *et al*., 2012). Paramphistomosis has been a neglected trematode infectious disease in ruminants, but has recently emerged as an important cause of productivity loss (Eslami *etal*, 2012). There is little evidence regarding the pathogenesis of adult flukes to their hosts, but severe damage to the mucosa of the rumen was provoked in heavy infection in experimentally infected cattle (Bokaie *et al*., 2011).

A high number of immature worms in the duodenum may affect production, since these parasites causing a lower feed conversion, a loss of weight and/or a decrease in milk production, which are responsible for the economic losses, morbidity and mortality (Rolfe *et al*., 1991).Gastrointestinal parasites are a major constraint to health and productivity in grazing livestock production systems .Various species of Paramphistomum cause a disease called *Paramphistomosis*. These parasites wander in the duodenal mucosa resulting in severe erosions. In heavy infection, they cause enteritis characterized by oedema, haemorrhages and ulceration whereas adult flukes in the fore–stomach are well tolerated (Ghosh *et al*., 2013).

It has been estimated that more than 500 million ruminant worldwide are at risk due to parasitic infection. Death due to immature paramphistomes is very high and may be as high as 80-90% in domesticated ruminants (Juyal *et al*., 2003; ILHA *et al*., 2005).*Paramphistomum cervi* is considered to be one of the most important species of paramphistomes since they are cattle parasites with cosmopolitan distribution. The harm caused by the infection in bovine affects production.

2. **Synonyms:**

2.1 Synonyms of *Paramphistoma*:

Paramphistoma Amphistomiasis

2.2 Synonyms of *Fasciola*:

Fasciola liver fluke

2.3 Synonyms of *Schistosoma*:

Schistosomabilharzia snail fever

3. History:

3.1 History of Paramphistomosis:

Although the pathogenicity of the parasites is controversial, amphistomes can cause both chronic production losses and acute mortality in cattle (Sanabria and Romero 2008). Amphistomes infect cattle worldwide, but the most severe effects occur in the tropics (Horak 1971). In addition, in the context of the natural history of parasite transmission, amphistomes can render *Bulinus* spp. more susceptible to infection with *Schistosoma bovis* and *S. haematobium*, parasites of bovid and people, respectively.

Amphistomiasis is caused by various species of rumen fluke, of which the most important in Africa is thought to be *Paramphistomum microbothrium* but owing to unresolved taxonomic issues, precise identification of this species is often problematic.Paramphistomosis is largely a disease of young animals less than two years of age, because repeated infections of low intensity generally produce an almost complete immunity. Adult *Paramphistomes* are the main parasites in the rumen and reticulum of sheep, goats, cattle, and water buffaloes; the pathological effects of infection are almost entirely caused by the immature stages within the first part of the small intestine (Shaheen *et al*., 2013).

3.2 History of Fascioliasis:

Snail-borne diseases cause severe economic losses in Africa (Abunna *et al*., 2010).Fasciolisasis iscaused by the liver flukes *Fasciola gigantica* and *F. hepatica*. Indeed *fasciolisasis* is a key trematode disease of ruminants worldwide and it shows the most widespread distribution of any vector-borne parasitic disease. *Fasciola gigantica* is the most important liver fluke in most areas of sub-Saharan Africa (Wamae *et al*. 1998), including Uganda (Ogambo *et al*., 1972).

3.3 History of Schistosomiasis:

Schistosoma (also known as bilharzia, bilharziasis or snail fever) is caused by several species of trematode belonging to the *genus Schistosoma*. Snails serve as the intermediary agent between mammalian hosts. Individuals within developing countries who cannot afford or obtain proper water and sanitation facilities are often exposed to water contaminated by the infected snails. (Singh *et al.,*2004).

4. Background biology:

Each of the parasites requires an aquatic Mollusca host and shares a common mode of transmission, which means there are many similarities, yet subtle differences exist which broadly determine the endemicity of disease associated with freshwater habitats around the world.

5. Life cycles and transmission:

The life cycles of each of the parasites provide important ecological cues, for example, defining transmission break points or thresholds that have to be satisfied for diseases to first establish and progress towards natural endemicity.

5.1Life cycles of *Paramphistoma spp*.

Paramphistomum have an indirect life cycle with fresh water snails as the intermediate hosts, e.g. of the genus *Bulinus, Planorbis, Stagnicola,* etc. These snails are found in permanent and temporary watercourses, irrigation channels, swamps, dam edges and depressions, they are normally found attached to vegetation in these habitats (*NSW DPI 2007*).

Adult flukes in the stomach lay eggs that are shed outside with the feces. About 2 weeks later miracidia hatch out of the eggs. They swim in the water bodies until they find a suitable snail. They penetrate into the snail and continue development to sporocysts and rediae, which can multiply asexually producing daughter rediae. Each redia produces several cercariae, the next developmental stage. Out of a single miracidium up to 30 cercariae can develop. Cercariae abandon the snail, swim around and attach to the vegetation where they encyst and become metacercariae. Metacercariae are infective forfinal hosts that feed on infested vegetation.

Livestock ingests metacercariae while grazing in contaminated pastures. Once in the small intestine the young flukes leave the cysts, attach to the intestinal mucosa and continue development. They feed on the tissues of the gut wall. Later on they detach from the gut's wall and migrate to the rumen, where they complete development to adult flukes and start producing eggs. After ingestion by the final host it takes 2 to 4 months for metacercariae to complete development and start laying eggs (pre-patent period) .

5.2Life cycles of*Fasciola spp*:

The life cycle of *Fasciola,* comprise four phases, all of which markedly influenced by the characteristic of the environment and\or human activities.

(**Phase 1**) The definitive host harbours the fluke adult stage in the large biliary passages and gallbladder ,egg reaching the external milieu by way of bile and intestine ;the definitive host is infected by ingestion of metacercaria ;metacercaria excyst in the small intestine within an hour after ingestion ,penetrate the hosts intestine wall, and appearing the abdominal cavity by about 2 hour after ingestion; most reach the liver within 6 days after excystment; in the liver they migrate for 5 to 6 weeks ,preferentially feeding directly on liver tissue; the eventually penetrate into the bile ducts where they become sexually mature ;the prepatent period is about 2 monthsin sheep and cattle, varies according to the host and also the number of the adult flukes in the liver ,so that the greater the fluke number ,the longer the time to mature and to initiate egg laying

(Phase 2) the transit between definitive mammal host and intermediate snail host include the long resistance phase of the egg and short active phase of miracidium ;eggs shed with mammal faeces will only continue their development if they reach freshwater of appropriate physio-chemical characteristics ;if the climatic condition

are suitable (15-25 c),the miacidia develop and hatch in about 9 to 21 days; the miracidium hatch under light stimulation and swims rapidly until it contacts an appropriate aquatic or snail host.

(**Phase3**) The development at intermediate host level includes miracidium peneterate into the snail ,sporocyst ,radial generation ,production of cercariae and shedding of the latter into water ;up to 4 redial generation have been found ,although3 generation are usually produced after monomiracidial infection; the radial generation follow the same development pattern in different lymnaeid species; cercaria develop within 6-7 weeks at 20-25 c.

(Phase 4) the transit between the intermediate snail host and definitive mammal host include the short swimming phase of cercaria and long definitive host (Mas Coma,2004).both *F,hepatica* and *F.gigantica* are transmitted by the snails of the family Lymnaesidae. Infection with fasciolosis is usually associated with grazing wet land and drinking from the snail infesting watering places (Dechase et al., 2012). There are many ecological factors affecting snail population include temperature, light, PH, vegetation depth of water, current of the water, chemical composition of the soil and snail population competition. The most important intermediate hosts of F.gigantica in Sudan is L.natalensis ,L.aurcularia. The life cycle of this trematode, involve snail as an intermediate hosts (Mihreteab et al., 2010).

5.3 Life cycles of *Schistosoma spp*:

Mature Schistosomes inhabit the mesenteric veins and during the period of egg laying, the female worm enters the small blood vessels of the gut wall where the eggs are deposited. The deposited eggs attach to the intima of the blood vessels using the spine to avoid being swept away by the blood current, when laden with eggs; the vessels eventually rupture so that the eggs penetrate the vessel wall and migrate to the intestinal lumen(Smith, 1993).This migration takes several days to weeks, during which time non-embryonated eggs develop. On their way to the intestinal lumen, about half of the eggs are carried away with the blood stream and get trapped in the liver, spleen and other organs such as the lungs (Urquhart *et al.*, 1996). The eggs that reach the rumen are passed in faeces and hatch within minutes of coming in contact with water .The released miracidia penetrates an appropriate snail intermediate host of which *Bulinusspp*. is particularly important in the transmission of bovine Schistosomiasis. (Wright *et al*., 1979).

Intramolluscan development takes about five weeks and it occurs without the redial forms. It involves asexual multiplication of daughter sporocysts resulting in the emergence of numerous infective cercariae from the snail.

Infection of ruminants by cercariae is usually accomplished by active penetration of the skin, although it has been shown that per-oral infection while drinking cercariae contaminated water may also be of importance (Kassuku *et al* ., 1986). After penetrating the skin or mucosa, the cercariae shed their tail and transform to schistosomule that migrate via the vascular system through the heart and lungs to the systemic circulation. Schistosome mature in the hepatic portal veins, mate and migrate to the mesenteric veins where egg production starts, after 6 to 7 weeks of infection (Urquhart *et al*., 1996). Female Schistosoma worms lay only one egg at a

time and a pair of worms produces about 100 to 300 eggs daily. The eggs of *schistosoma* measure about 132 to 247 by 38 to 60 mm. they have no operculum but are spinal-shaped and have a lateral or terminal spine, depending on species (Soulsby, 1982).

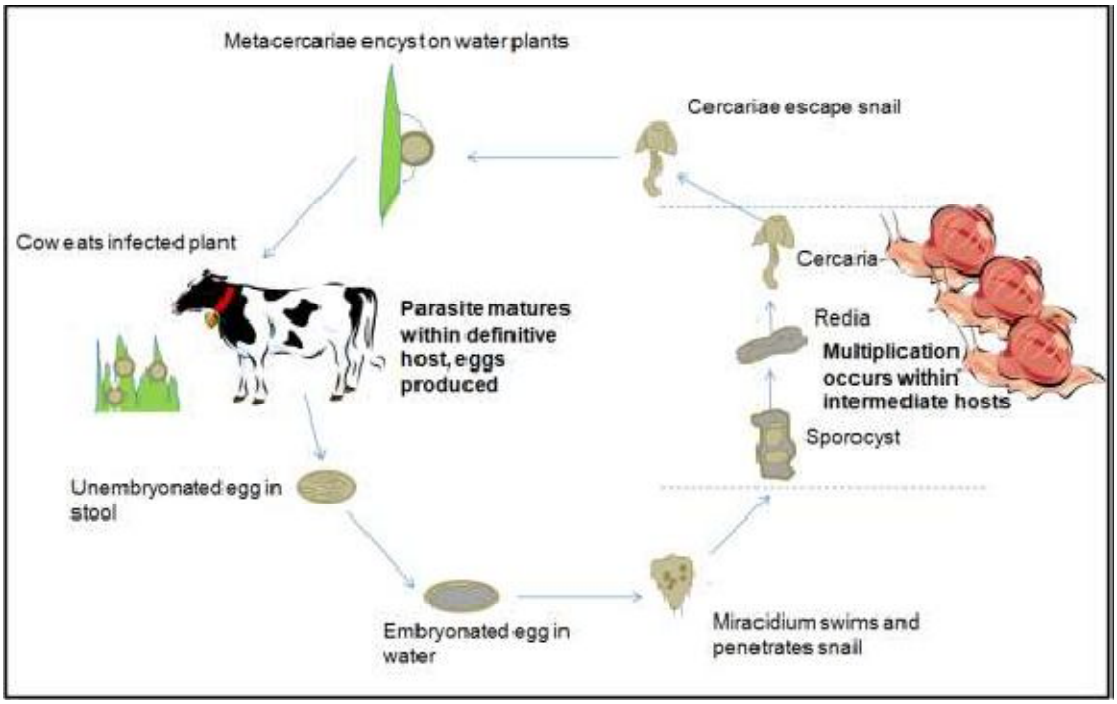

Figure1: Generalised lifecycle for *Fasciola* and *amphistome and schistosoma* species. (Torgerson and Claxton 1999).

6. The definitive host range:

Both *Fasciola* spp. and amphistomes have the potential to infect many different definitive hosts. However, they have evolved to survive best in certain preferred hosts. *Fasciola gigantica* is adapted to domestic cattle, with a longer adult survival time, higher levels of egg shedding and high infectivity compared to sheep and goats (Hammond and Sewell 1974). However, wild ruminants can also be affected and could act as a reservoir in certain situation. Evidence suggests that the infection could survive in wildlife in the absence of domestic cattle .*Fasciola*

hepatica shows a preference for sheep, in that it survives for many years and immunity develops slowly. Amphistomes can infect many different hosts, but appear to survive best, and grow to their largest size, in cattle compared to sheep and goats (Sanabria and Romero 2008). Adult amphistomes often survive for many years in cattle.

7.Justification:

Trematodes are parasites inhabiting various vertebrate body organs such as the bile duct or the stomach of ruminants, where oxygen supply is scarce and intermittent. Liver fluke disease hits agricultural animals such as cattle and sheep, and has a worldwide distribution often resulting in large economic losses. *Fasciola* and *schistosoma* besides being an animal pathogen, is also a major human pathogen.

Paramphistomaiasisis an important neglected disease and it is a public health problem in Africa, especially in rural communities. In Sudan,*Paramphistoma, Fasciola and Schistosoma*causemajor infectious diseases, where sheep, cattle and goats drink from water bodies infested with snails. Determination of the prevalence of these diseases is very important in order to explore the size of the problem which helps to control these diseases, are thought to be associated with the presence or absence of intermediate snail habitats in the grazing areas of the animals. The development of sustainable strategies for controlling water borne infection is a priority. Strategic use of anthelmintic, enhancement of host resistance by genetic improvement or by the use of vaccines, biological control and better herd management all have a role to play in sustainable control of these diseases.

8. Objectives:

The objectives of this study were:

1/ To estimate the prevalence of *Paramphistomiasis* , *Fascioliasis* and *Schistosomiasis* in Rabak.

2/ To investigate the risk factors associated with these diseases.

Chapter One

Literature Review

1.1Classification:

1.1.1Classificationof *paramhistoma*

According to Zeder *(*1970*)paramphistoma* was classified as follows:

Kingdom: Animalia

Phylum: Platyhelminthes

Class: Trematoda

Subclass: Digenea

Order: Echinostomida

Family: Paramphistomatidae

Genus: paramphistomum

Cotylophoron

Calicophoron

Explanatum

Gigantocotyle

Ugandocycle

Type species*:* *P.cervi*

P.cotylophorum

P.microbothrium

P.gotoi

P.grande

P.hiberniae

P.ichikawai

P.epiclitum

1.1.2 Classification of *Fasciola*:

Kingdom: Animalia

Phylum: Platyhelminthes

Class: Trematoda

Order: Digenea

Family:Fasciolidae

Genus: Fasciola

Species*:* *Fasciola hepatica* and *Fasciola gigantica*

(Saira ,.2011).

1.1.3Classification of *Schistosoma*:

According Zeder *(*1790*),Schistosoma*was classified as follows:

Kingdom: Animalia

Phylum: Platyhelminthes

Class: Trematoda

Subclass: Digenea

Order: Strigeidida

Family: Schistosomatidae

Genus: Schistosoma

Type species:*Schistosoma bovis*

Schistosoma haematobium

Schistosoma indicum

Schistosoma japonicum

Schistosoma mansoni

1.2 Etiology

1.2.1EtiologyofParamphistomaiasis*:*

Amphistomiasis in farm and wild mammals is due to infection of paramphistomes, such of the following species are *paramphistomes* and*calicphoron*.

These are essentially rumen flukes, of which *Paramphistomum cervi* is the most notorious in terms of prevalence and pathogenicity. Infection occurs through ingestion of contaminated vegetables, in which the viable infective metacercaria are deposited from snails, which are the intermediate hosts(Chai *et al*.,2009) The immature flukes are responsible for destroying the mucosal walls of the alimentary tract on their way to growing into adults. It is by this fervent tissue obliteration that the clinical symptoms are manifested. The adult flukes, on the other hand, are quite harmless, as they merely prepare for reproduction (Brown *et al., 2005).*

1.2.2 Etiology of Fascioliasis*:*

Fasciolosis is an economically important disease of domestic livestock, in particular sheep and cattle. The disease is caused by digenean trematodes of the genus *Fasciola* , The etiological agents of *faciolosis* are *F.hepatica and F.gigantica* .*F.hepatica* has a worldwide distribution but predominates in temperate zones while *F.gigantica* is found on most continents . Several abattoir surveys conducted in various parts of Ethiopia have demonstrated the presence of Fasciolosis ,due to *F.hepatica* and*F.gigantica,* in ruminants (Kassaye *et al*.,2012).

Apart from its great veterinary importance throughout the worlds , fasciolosis is also a known zoonosis affecting a number of human population (Oyeduntan *et al*., 2008).

1.2.3 Etiology Schistosomiasis:

In endemic areas, *Schistosoma mattheei, S. bovis, S. curassoni, S. indicum and S. spindale* have been reported to naturally infect cattle. *Schistosoma* show morphological and physiological peculiarities that distinguish them from other trematodes (Smith, 1993). They have an elongate structure, but as for other trematodes, they possess oral and ventral suckers, the latter being larger and more muscular in the male than female. The male and female worms are separated and have to come together in the definitive host to mate thus enabling the female worm to produce eggs (Webster *et al*.,2005). The female worm lives in permanent copula with the male, the latter curving its body ventarally to form a canal in which it bears the long narrow body of the female.

1.3.1 Description of *Paramphistoma* worm:

The generic name (Greek: *para* meaning "similar" [to *Amphistoma*], amphi meaning "on both sides", and *stoma* for "mouth") is given due to the presence of an anterior oral sucker and a posterior larger ventral sucker in adult worms (Boray, 1959). The body is minute, measuring less than a centimetre. *Paramphistomum* are all hermaphrodite having both male and female reproductive systems in the posterior region of the body (Olsen, 1974).

1.3.2 Description of *Fasciola*:

Fasciola spp. are leaf-shaped, dorso-ventrally flattened helminthes. In many studies, gross morphology is used to differentiate the two species. *Fasciolagigantica* is typically longer at approximately 28-52 mm and has a narrower body whilst*F. hepatica* has more pronounced ‘shoulders’ and is considerably shorter at around 12-29 mm(Periago *et al*. 2006).

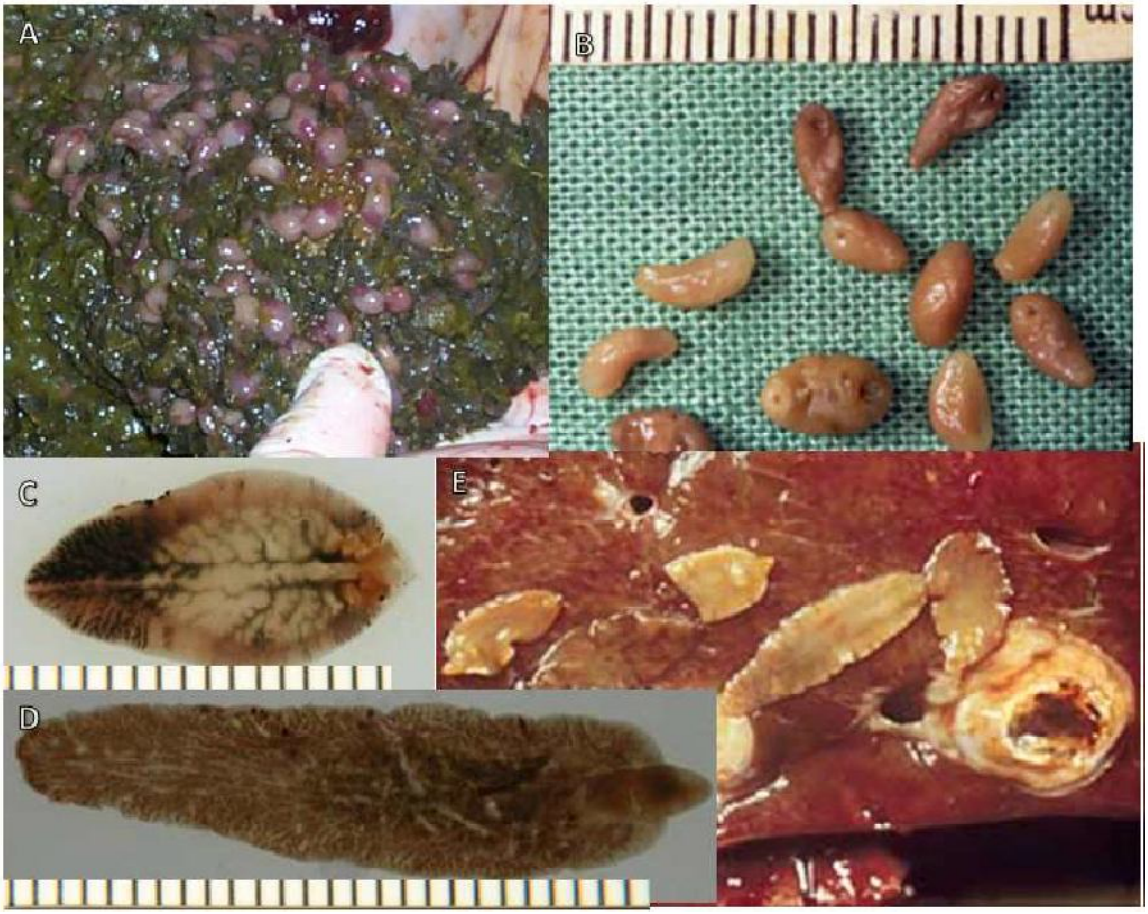

Figure 2: Gross appearance of the parasites. *Amphistomes* in rumen (A) and obtained from rumen (B). Gross external morphology of the *Fasciola spp. F. hepatica*(C) and *F. gigantica* (D). *F. hepatica* in the liver (E).(Periago *et al*. 2006).

1.3.3 Description of *Schistosoma* worm and egg:

The average length of adult male of *schistosoma* worm was (16.7±1.3mm) and it had two suckers (oral and ventral) anddistinct gynacophoric canal and 3-6 testicles situated behind.

The ventral sucker, and in all specimens showed male holding the threadlike female in gynacophoric canal .The egg was elongated spindle shaped with large terminal spine. The average size of the eggs was 266±11.6µm length and 58±3.7 µm width.

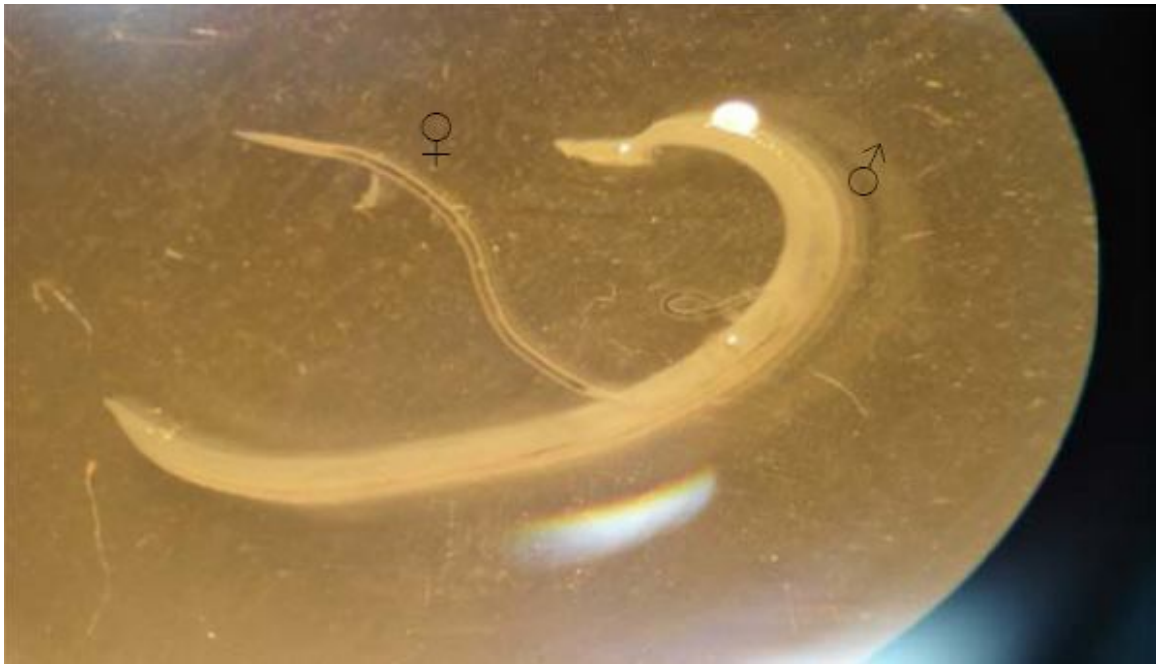

Figure3: Male and female *Schistosomabovis*. (Zangana et al ., 2012).

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1.4 Clinical signs

1.4.1 Clinical signs of paramphistomiasis:

Most livestock have only light stomach fluke infections. They show no signs of disease due to either adult fluke or small numbers of immature fluke. Heavy infections with the immature fluke may cause decreased appetite, restlessness and weight loss. Fluid, foul-smelling diarrhea, dehydration and death may result from these infections. Moderate infections with the immature fluke may cause reduced weight gains or milk production, or ill-thrift. Immature fluke live in the small intestine of ruminants where they attach themselves to the intestinal lining with powerful suckers. In large numbers, they destroy part of this lining and cause acute inflammation of the intestine. Death can occur in severe infections (Lioyd *et al.*, 2007).

Figure 4: Sheep scouring due to infection with stomach fluke.

(NSW DPI 2007).

1.4.2Clinical sign of Fascioliasis:

Acute Fascioliasis is common in sheep and goats while the chronic form is found mostly in cattle. Symptomof fascioliasis include anemia, emaciation and reproduction dysfunction in animals with the chronic form, While in acute Fascioliasis ,the animals usually show signs of anorexia ,dullness diarrhea , muscular atrophy , subcutaneous edema and impaired immune system . hepatic fasciolosis is often characterized by swollen liver (Ozung ,2011).

1.4.3 Clinical sign of Schistosomiasis:

In *Schistosoma*, diseased animals show unthriftness, loss of conditions, anorexia, intermittent diarrhea, mixed with blood, dehydration, sunken eyes, more over severe emaciation andthirst were also encountered. Systemic reactions was mildhowever, pale mucous membrane, polypnea and nasaldischarge were also seen. (Zangana*etal*, .2012).

1.5 Diagnosis:

Diagnosis is mostly done through coprology and immunological examination but other factors like clinical signs, biochemical and hematological profiles can be taken in to account. Coprological examination are not reliable in animals or in human. In spite of this, egg count is still commonly used, however, it is not useful until about 8-10 weeks post infection. Immunodiagnosis provides early detection of Fascioliasis with a month of infection (Saria, 2011).

1.5.1 Diagnosis of Paramphistomiasis:

Provisional diagnosis is usually made on the history and clinical signs of disease (anorexia, polydipsia and projectile diarrhea) and the presence immature paramphistomes in the fluid faces or at post mortem examination. Faecal examination for eggs at this stage is usually unrewarding as the disease is in the prepatent phase. Immature flukes are conical, pink in color and 1-5mm long. The fecal sedimentation technique, commonly used for *Fasciola* and *Schistosoma*. Diagnosis is the most accurate to identify eggs of paramphistomes in faeces. The eggs of *Paramphistoma* are oval and opercula, resembling that of *F. hepatica*; however, they are slightly larger and clear (transparent) rather than yellow in color. The addition of a contrast stain such as methylene blue may help to differentiate these two species of eggs. The adult flukes are pear-shaped and red in color, approximately 1cm long with a sucker at the tip of the cone and another sucker ventrally at the posterior-end (De Waal, 2010).

1.5.2 Diagnosis of Fascioliasis:

Diagnosis of Fascioliasis may consist of tentative and confirmatory procedures. A tentative diagnosis of this trematode may be established based on prior knowledge of epidemiology of the disease in a given environment, observation of clinical signs, and information on grazing history, seasonal occurrence of the disease, and identification of snail habitats. Confirmatory diagnosis however, is based on demonstration of these trematode eggs through standard examination of feces in the laboratory. Post mortem examination of infected animals, liver examination at slaughter or necropsy was found to be the most direct, reliable, and cost effective technique for diagnosis. There is other laboratory tests (enzymatic and/or serological procedures) used to qualify the infection mainly for research purposes (Dechasa *et al.*, 2012). To overcome this, efforts have been directed toward the immunological detection. A number of sensitive and specific

serological tests for diagnosis infection have been described in recent years acuminating in the commercial availability of ELISA kits. ELISA immunoassay method is a para clinic sensitive and accurate test, being used in most western laboratories to monitor the infection in sheep and cattle in endemic areas. These immunodiagnostic methods are widely used in human medicine. Molecular identification based on PCR gene specific primers and cloning of internal transcribed spacer and their sequence comparison was used. The phylogenetic diversity was also studied by using six microsatellite markers. The markers were popularly used in molecular systematics world in different organisms for determining species origin and classification, whereas microsatellites investigates genetic diversity present in an organism. The presence of diversity in the genome of an organism ensure its successful survival and makes it adaptable to the prevailing environment. The considerable variability present proposes interbreeding which is favorable for diversity (Saria, 2011).

1.5.3 Diagnosis of Schistosomiasis:

Parasitological diagnosis of *S. bovis* infection by demonstration of the parasite eggs in fecal sample is possible at 5-8 weeks post infection, depending on the level of the infection. The fecal egg excretion remains high during the 2 months following patency after which it declines to a few number of eggs per gram of feces .Definitive diagnosis of an active *S. bovis* infection can be made only by detecting eggs of the parasite in feces or biopsy specimen of the infected animal. The routine methods used for parasitological diagnosis include; fecal smear, filtration method, sedimentation method, rectal and liver biopsy and miracidial hatching test. The most commonly used method for detection of fecal egg excretion under field condition is the sedimentation method (Saeed*et al.*, 1984).

1.6 Post mortem:

1.6.1 Post mortem finding of Paramphistomiasis:

At post mortem examination for Paramphistomosis, there is a marked hemorrhagic enteritis with large numbers of the parasites on the mucosa or contents of the duodenum and upper ileum, subcutaneous edema, gelatinous fatty degeneration. Extensive catarrhal or hemorrhagic duodenitis or jejunitis with destruction of associated glands and lymph nodes are the main histopathological features. Young flukes may be found embedded in the duodenal mucosa. There is a marked fall in total plasma proteins due to increased leakage of plasma albumin (Kiusluka *et al.,* 1996).

1.6.2 Post mortem finding of Fascioliasis:

For *Fasciola* examination the liver is removed and examined, the liver is cut into thin slices (1 cm to 2cm thick) and immersed in 9% sodium chloride solution for 3 h at 37°C. The solution was then observed for the stage and for adult Fasciola parasites. The recovered flukes were preserved in 5% formalin solution (Akkari*etal*, .2011).

1.6.3 Post mortem finding of Schistosomiasis:

In *Schistosoma,* histopathological findings oftissues of infected sheep particularly lymph node, revealed lymphadenitis, while inmesentery cross section of adult parasites in lumen of vein associated withthrombophlebitis has been seen, Liver also showed minute granulomas around centralvein. The gross pathological lesions of mesentery represented bypresence of black dots or black streaks on serosa of intestine and mesentery, paleness, enlargement of mesenteric lymph node. Hepatomegaly also has been seen. Severe adhesion also have been seenbetween

mesentery, intestine and abdominal muscles. (Al-Kennany *et al.*,2009).At necropsy, *S. bovis* infection can be diagnosed by finding thousands of visible adult worms in the mesenteric vessels. Infected livers are diagnosed on the basis of the presence of macroscopic lesions of Schistosomiasis visible as white-gray foci under the liver capsule and within the substance of the liver .However, in certain instances few lesions may be present and may not be detected and hence crush smears made from those livers are necessary for demonstration of *S. bovis* eggs to confirm the diagnosis. In a living animal, however, the pathology of *S. bovis*is related to fecal egg excretion and this finding renders parasitological examination by finding eggs of the parasite in fecal samples an interesting alterative to biopsy specimens (Saeed *et al.*, 1984).

1.7 Treatment:

Most drugs licensed for the treatment of Fascioliasis are not effective against Paramphistomosis. Only a few drugs have been shown to have an efficacy against either the immature and/or mature flukes namely; niclosamide, oxyclozanide, rafoxinide and resorantel. However, since Paramphistomosis is seldom a significant economic problem in many temperate climates, these drugs are often not available and/or lienced for the treatment of paramphistomes. In Ireland, oxyclozanide is the only practical option for the treatment (De Wall, 2010).

Chemotherapy is widely acknowledged as the most important, rapid and cost effective method of reducing morbidity due to Schistosomainfections(Aradaib*etal* .,1993).the discovery of Praziquantel in the 1970s has been breakthrough for treatment of patients infected with Schistosoma.praziquentel is usually administered in a single oral dose .(Chin 2005)

1.8 Geographic distribution:

1.8.1Geographic distribution of *Paramphistoma*:

*Paramphistoma*is considered as worldwide in prevalence. It is most commonly found in tropical and subtropical region including Australia, Asia, Africa, Eastern Europe, and Russia. The most debilitating cases are reported in Europe from Bulgaria, Italy, France, and Poland and in Asia from Thailand, India, and China. The parasitic infection was first described from Punjab, India (Boray., 1959).Amphistomes similarly have a worldwide distribution. Several species are recognised and tend to be localised to certain areas, based on local conditions and the presence of the preferred vector. *Paramphistomum microbothrium* is highly prevalent in Africa, with reports of disease occurring in Kenya, Tanzania, Zimbabwe and South Africa (Dinnik *et al.*,1956).

1.8.2 Geographic distribution of *Fasciola*:

The two species of liver fluke are each adapted to specific climatic conditions and intermediate hosts that determine their global distribution. A cooler climate favours *F.hepatica* and *Lymneatruncatula*snail, *which* are more common in temperate regions of the world although they also occur in highland regions of Africa including Kenya (Kanyari *et al.* 2010), Ethiopia (Abunna *et al*. 2010) and Tanzania .*Fasciola gigantica* is the more common cause of fascioliasis in tropical regions, where conditions favour both the parasite and its host Nonetheless; there are areas where both parasites and snail species are present.

1.8.3 Geographic distribution of *Schistosoma:*

Schistosoma is found throughout Africa and South America, especially in Brazil, Venezuela and Guyana. It also lives on several Caribbean islands such as Puerto Rico, St. Lucia, mar-Tinique, and Guadeloupe. It is thought that species may have been brought to the western hemisphere during the African slave trade when a number of susceptible snail hosts may have been introduced, possibly in the casks of drinking water that were brought with the slaves.

The current geographic distribution of *S. haematobium*covers Sub-Saharan Africa, the Middle East and the Arabic peninsula, with a total of 54 affected countries (WHO, 2012).

1.9.1 Epidemiology of Paramphistomiasis*:*

Flooding, caused by heavy rains, results in the dispersal of snails from permanent water masses, such as lakes and ponds. Paramphistoma eggs, deposited in these areas by grazing animals, hatch and infect the snails. Outbreaks of disease generally occur in the drier months of the year when the receding water uncovers herbage contaminated with encysted metacercariae in these areas. In the UK, it has been suggested that dispersal of snails by flooding events and changes in farm-management practices may be responsible for the apparent emergence of the parasite (Foster *et al., 2008*). Previous infection and the age of the host animal afford some protection against re-infection. Acute disease is usually seen in young animal less than two years of age, older (adult) animals often continue to harbor , Sheep appear susceptible throughout their lives and multiple infections only result in partial immunity to reinfection.(De Waal, 2010).

1.9.2 Epidemiology of Fascioliasis*:*

The worldwide losses in animal productivity due to fascioliasiswere estimated at US $200 million per annum, to rural agricultural communities and commercial producers, with over 600 million animals infected .In developed counties, the incidence ofF. *hepatica* can reach up to 77%. In tropical countries, fascioliasisis considered the single most important helminthes infection of cattle, with reported prevalence of 30-90% (Spithill*et al*., 1999). The prevalence of fascioliasis in many parts of Africa has been determined mainly at slaughter. However, estimation of economic loss due tofascioliasis at national or regional level is limited by lack of accurate estimation of the prevalence of disease (Phiri *et al*., 2005).

1.9.3 Epidemiology ofSchistosomiasis*:*

Most of the research work done on some of the major bovine *Schistosoma* species, *S. bovis*, *S. spindle*, *S. nasale* and *S. mattheei* indicate that Schistosomiasis represent a subclinical form characterized by high prevalence of moderate worm burdens in the population (Lawrence, 1976) , (Kassuku *et al.*,1986) reported heavy infection levels of *S.bovis* on some Tanzanian farms. In earlier studies (McCauley *et al.*, 1983) observe a high level of mortality in Sudanese cattle due to Schistosomiasis .

1.10 Prevention and control:

Where rumen flukes are endemic, preventive measures are a must to reduce the snail populations, the contamination of pastures with infective stages, or the access of livestock to highly infested pastures. Vector snails are aquatic and live in water (e.g. streams, lakes, pools, swamps, marshes, irrigation channels, ditches, ponds, water holes, waterlogging, etc.) and are enormously prolific. Whatever measures help keeping the pastures dry have to be encouraged, either to reduce the snail population, or to shorten survival of encysted metacercariae, e.g.:

- Ensuring an adequate drainage
- Building watering points on solid ground, without puddles
- Make unavoidable ditches or channels less attractive to the snails: making the borders steeper and/or cover them with concrete, eliminate the surrounding vegetation, drying them completely out periodically, etc.
- Avoid even very small water points that support the snails, e.g. hardened footprints (of shoes or car tires).
- If permanent humid environments cannot be eliminated, they have to be fenced to prevent livestock from grazing there.
- Keeping livestock healthy and well fed diminishes the harm caused by flukes.
- Biological control of theseflukes (i.e. using their natural enemies) is so far not feasible.

1.11 Fluke control:

Like other diseases of livestock, there are various methods of disease management at individual- and herd-levels. Possible options for control of *Fasciola spp*. are reviewed by (Robert ,2011). Currently, anthelmintic are the only method used in most tropical regions .Oxyclozanide and albendazole are two anthelmintic that have reasonable (although not complete) efficacy against adult flukes and in controlling the chronic form of disease However, their efficacy against acute fascioliasis is poor as they are ineffective against immature fluke. Careful consideration of local economic and animal management conditions is required when designing a control programme, and for small-scale farming, grazing management may provide the best control option if good information is available (Keyyu *et al.*. 2008).

Previous study:

Worldwide:

A retrospective study was carried out over a 10- to 12-year period to analyse the changes in prevalence of natural fascioliasis and Paramphistomosis among cattle and snails in central France, and to determine the causes which had induced these changes. The prevalence of natural fascioliasis in cattle increased from 1990 to 1993 (13.6% to 25.2%) and diminished afterwards up to 1999 (at 12.6%). Those of natural Paramphistomosis showed a progressive increase between 1990 and 1999 (from 5.2 to 44.7%). The prevalence of natural infections and the numbers of free redial counted in the snails (*Lymnaea truncatula)* infected with F. hepatica did not show any significant variations over time. By contrast, the prevalence of natural Paramphistomosis in snails significantly increased from 1996 to 2000 and remained afterwards in the same range of values (3.7–5.3%), while the number of

free redialsignificantly increased up to 2006 (from a mean of 6.5 to 13.8 redial per infected snail, respectively) (Magea *et al., 2002*).

A total of 2628faecal samples (651 cattle, 1608 buffaloes, 213 sheep and 156 goats) were collected randomly from different village(s)/area(s) of the district of Punjab and adjoining areas in Jammu (J&K) during the period of July 2004 toJune 2005. The samples were screened microscopically for paramphistomes eggs by sedimentation methods. Out of the total, 167 fecal samples (122 buffaloes, 22 cattle, 14 sheep and 9 goats) were found positive for paramphistomes eggs with an incidence rate of 6.35 percent. The highest incidence was found in buffaloes followed by sheep, goats and cattle. District-wise incidence rate was observed to be highest in Gurdaspur followed by Amritsar, Kapurthala and Jammu (Shabeh *et al* 2006).

In another study therumen of 100 slaughtered animals viz. sheep (n=14), goats (n=42), cattle (n=34) and buffalo (n=10) were examined to determine the prevalence of adult *Paramphistomum cervi* during January 2007 in Tehsil Jatoi, District Muzaffar Garh, Pakistan. Overall prevalence was found to be 22% (22/100) and species wise prevalence was 28.57% (4/14) in sheep, 23.80% (10/42) in goats, 17.64% (6/34) in cattle and 20% (2/10) in buffaloes, the difference between the species being non-significant.*(* Raza *et al* 2009).

Epidemiological studies were undertaken at slaughterhouses, livestock farms, and veterinary hospitals and on household buffaloes under different management and climatic conditions in four different districts of the Punjabprovince. Infection rate was 7.83%, 12.33%, 7.17% and 4.25% respectively in the cattle at the slaughterhouse, livestock farm, and veterinary hospital and at household cattle. Overall the highest prevalence in terms of season, 26% and 14.50%, was recorded during autumn at livestock farms and slaughtered cattle followed by 9.75%

veterinary hospitals during summer and the lowest (2.5%) in household cattle was recorded during winter. *(*Khan *et al.*,2008).

A cross sectional study was carried out from October 2010 to March 2011 at Andassa Livestock Research Center, North-West Ethiopia. The objective was to determine the prevalence of cattle fluke's infection. Faecal samples were collected from a total of 384 cattle, cross breed (n= 39) and Fogera breed (n=345) of all age groups and sex. Sedimentation technique was employed for the recovery of fluke eggs from freshly collected fecal sample. The results indicated that the overall prevalence of bovine fluke's infection was 60.42%. In this study, the highest prevalence was recorded from Paramphistomosis (45.83%) followed by Fascioliasis (23.96%), and Schistosomiasis (9.89%) (Yenenehe*t al.*,2012*).*

To investigate the Epidemiology of *Paramphistomum* infection in cattle, faecal samples from 360 cattle were collected from individual areas of the Sirajgonj district from March 2009 to April 2010. One hundred and ninety one animals (53.1%) were infected with single or multiple species of *Paramphistomum*. Age of animals significantly ($P<0.05$) influenced the prevalence of Paramphistomosis. Older animals suffered (60.3%) more than growing (44.4%) and young (54.0%) ones. Older animals were 1.94 times more susceptible than growing animals. Furthermore, females were more (59.5%; 1.79 times) susceptible to *Paramphistomum spp*. than males (45%). Breed has also significant ($p<0.05$) effect. The prevalence of Paramphistomosis was higher ($p<0.05$) in crossbred (61.8%) animals than that of local (49.2%) cattle. *(*Paul *etal.*,2011*).*

In an attempt to establish an ideal method for mass production of *Calicophoron microbothrium* metacercariae, a study was carried out to compare the shedding capacities of *Bulinus tropicus* naturally and experimentally infected with *C. microbothrium.* A total of 906 F1 *B. tropicus* between 4 and 5 weeks old were each experimentally infected with two *C. microbothrium* miracidia and monitored for 12

weeks. The infected snails were fed on dried lettuce and fish flakes and were kept in one plastic aquaria housed in a snail room where temperature, light and humidity were controlled. Seventy-four percent of the experimentally infected snails died during the prepatent period and of the remaining, only 13.2 % developed patent infection, while 12.5 % were refractory. Snail growth rate was poor and the average shedding rate was 20 cercariae per snail per day (Mavenyengwai *et al.*, 2006).

In another study, the analysis of infection by *Paramphistomidae* trematodewas conducted in two agricultural regions with different knowledge on these parasitoids. Faecal and blood samples were collected from 374 cattle in Salto (NW Uruguay) where there is a lack of information about Paramphistomosis. A total of 429 cattle from Galicia, the percentage of cattle passing Paramphistomidae-eggs by faeces was 7% (95% Confidence Interval 5, 10). A significantly higher prevalence of Paramphistomiasis in the Hereford Angus cattle (OR = 3.5) was recorded (Sanchís *et al.*, 2013).

A cross-sectional study in Ethiopia was proved to be 28.6 % (329/1152) of which 154 (40.1 %) were in cattle, 111 (28.9 %) were in sheep and 64 (16.7 %) were in goats. The mean worm burdens of *Paramphistomum* were proved to be 270.46 ± 471.947, 222.96 ± 521.850 and 73.31± 281.612, in cattle, sheep and goats, respectively. Highest prevalence of Paramphistomiasis was registered in highland shoats, 30.2% (116/384) compared with those originated from lowland, 15.4 % (59/384). In the current study, the prevalence was proved to be higher in adult shoats than young shoats with prevalence of 30.5 % (117/384) in adult and 15.1% (58/384) in young shoats. Infection was known to be highest in poor body conditioned animals (76.3 %), followed by medium (23.9 %) and good (6.9 %)

body conditioned animals. A statistically significant difference ($p<0.05$) of paramphistomosis prevalence was observed on the basis of species, body condition, different age groups and agro climatic zones (origins) of shoats. The high level of Paramphistomosis in cattle, sheep and goats in the present study represents high rate ofinfection and immense economic losses to the country, Ethiopia (Melaku.,*et al*2012).

A cross-sectional study was conducted to determine the prevalence of fascioliasis in small ruminants slaughtered at Modjo Modern Export Abattoir (MMEA), central Ethiopia. A total of 1000 animals (500 sheep and 500 goats; 250 animals each from 4origins) were examined for the presence of *Fasciola*sp. Species, age and origin of animals was taken into consideration. Liver incision, observation and species identification on the basis of size and morphology of adult worm were applied. An overall prevalence of 3.2% was registered. The prevalence was 5.6 and 0.8% sheep and goats, respectively. It was 1.25% in young and 4.5% in adult by age groups. The prevalence of 7.6, 0.8, 2.4 and 2.0% was observed in animals from Arsi, Borana, Jinka and Yabello in respective origin. Significant difference ($P<0.05$) was observed in occurrences of *Fasciola* between animals species and age as well as among origin of the animals. *(*Kifle *et al.*,2011*).*

A total of 768 cattle were randomly selected among those animals slaughtered at Adwa municipal abattoir in Ethiopia to determine the prevalence and the economic loss due to liver condemnation. Following post-mortem examination, 248 (32.3%) cattle were positive for fascioliasis. According to the intensity of pathological lesions, 84 (33.8%) constituted severely affected livers; the rest, 81 (32.7%), 55 (22.2%) and 28 (11.3%) were moderately affected, lightly affected and undifferentiated, respectively. The number of fluke recovered in moderately

affected livers was higher (Mean = 91) than that of either severely (Mean = 60) or lightly (Mean= 38) affected livers. There was a statistically significant association ($P<0.05$) between the different levels of intensity of pathological lesion and fascioliasis prevalence. Species identification revealed that *Fasciola hepatica* was more prevalent (13.9%) as compared to *Fasciola gigantica* (7.7%); certain proportion of animals (6.0%) harbored mixed infection and others unidentified immature fluke (4.7%). Statistically significant variation was observed in the prevalence of fascioliasis among animals with poor, medium and good body conditions ($P<0.05$). (Bekele *et al.*,2010).

A retrospective study was carried out based on the existent registrations of fascioliasis found in the bovine slaughterhouse of Ilam province during 3 successive years. In the year of (2007-2008), 8.48% of the sacrificed animals were infested. The year of (2008-2009) 6.03% and the third years (2009-2010) 11.09%. Inthe (2007-2010).It was found that high prevalence of fascioliasis in animals slaughtered in the province, rising more than one third of the total, with significant differences in proportions ($P<0.01$) among the three years. Post mortem, findings were sub-capsular hematomas, venous congestion and fibrous peritonitis. The economic losses were considerable. (Khosravi*et al.*,2012).

A case control study was investigated in riverine buffalo calves of the Murrah breed for *Fasciola gigantic* infection. The clinical course of the primary experimental was investigated. Nine male calves aged 12–15 months were randomly assigned to two groups of five (Group I) and four (Group II) animals. Each animal in Group I, was orally infected with 1000 metacercariae (mc) of *F. gigantica*, whereas Group II animals did not receive any infection dose and served as uninfected controls. No clinical signs of fascioliasiswere observed until the sixth

week post-infection (PI). Group I animals, however, developed recognized symptoms of acute fascioliasis, comprising apyrexic inappetance, anemia, poor weight gain, diarrhea and sub-mandibular and facial edema, respectively, from 5, 6, 8, 16 and 17 weeks PI. The signs were intermittent in nature and of variable duration. The prepatent period was of 92–97 days (mean 95.2 ± 3.1). One of the five infected animals died on day 147 PI. At necropsy, 36.8 ± 11.0% of the infection dose was recovered as adult fluke population. The gross lesions were primarily biliary in nature. Group II, the uninfected controls, throughout the study period of 165 days PI, did not show any symptom and were negative for *F. gigantica*. The study demonstrated that the onset of adverse effects of *F. gigantica* on the growth and health of the infected host was mainly noted during late prepotency much before coprological prediction and diagnosis. The significance of preventive therapy against fascioliasis during prepotencyhas been stressed in endemic areas. *(*Yadav*et al.*,1999).

In another study,asurvey of economic loss and the prevalence of fascioliasis in ovine species were conducted in Menz Lalo Midir district, Amhara National Regional State, during the period of September 2010 to June 2011. The objectives of this study were assessing the financial loss, determining prevalence. The total of number of study animals were 810 sheep from eight Kebeles (Tamawenze, Seklaye, Tayate, Saga, Wegere, Kilerbo, Toll, and Angetla) of Menz Lalo Midir district selected on lottery system. Prevalence was determined by fecal sample examinations (Begashaw and Chanie 2012).

Across-sectional study was conducted to investigate diversity and prevalence of helminthes parasites of livers of sheep and goats in the district of Quetta between August 2001 and March 2002. *Fasciola hepatica, F. gigantica* and *Paramphistomum explanatum* were recorded. Overall trematodiasis was 23.75% in

sheep and 27.90% in goats. Mixed infection of *F. hepatica* and *F. gigantica* was higher (12.26 and 20.93% in sheep and goats, respectively) compared with infection with parasites alone, or in mixed combination with *P. explanatum.* An increase in prevalence and intensity of parasites was seen during and after the rainy season. Presence of *F. gigantica* strongly suggests that animal transport influences epidemiological findings (Ahmed and Nawaz2005).

In another study, the occurrence of Schistosomiasiswas detected by fecal examination and abattoir survey and histopathological study was done during a period from 2006 to 2007 in Iraq. *Schistosomabovis* was identified with prevalence rate 11.37% by fecal examination where as 1.6% by abattoir survey. The Infections was more prevalent in age 1-3 years (15.9%). The histopathological findings reveal characteristic lesions in blood vessels and some tissues including thrombosis in venues and mesenteric vein and minute granuloma around the eggs in portal area and fatty necrosis in the liver, cystic structure of some mucosal glands of the intestine containing eggs, with infiltration of mononuclear inflammatory cells in different tissues. *(*Zangana *et al.*,2012*).*

In another study the prevalence of helminthes of sheep in relation to age, sex, nutritional status, management system and flock size was studied at Tangail district, Bangladesh from July to December 2010 by fecal examination. A total of 190 sheep were examined of which 154 (81.1%) were positive for one or more species of helminthes parasites. Seven species of helminthes were identified, of them three species were trematode, namely, *Fasciola gigantica* (8.4%), *Paramphistomum* spp. (44.2%) and *Schistosoma indicum* (3.7%); four species were nematodes, namely, *Bunostomum* spp (19.0%), *Trichuris* spp. (2.1%), *Strongyles* (62.6%) and *Strongyloides* spp. (9.5%). No cestodes were identified. Prevalence of helminthes was significantly ($p<0.01$) higher in young sheep aged

>1-2 year (92.7%) than adult aged > 2 years (83.3%) and lamb aged ≤ 1 year (63.6%). Higher prevalence was recorded in female than in male sheep. In relation to nutritional status and flock size, prevalence of helminthes were significantly ($p<0.01$) higher in poor health and large flock sized animals. *(*Sangma *et al* 2012).

A cross-sectional study was conducted commencing October 2010 to January 2011 in Fogera Woreda, South Gondar Zone of Amhararegion, NorthwesternEthiopian order to determine the prevalence of bovine Schistosomiasis. Simple random sampling was used to select the study animals and coprological examination using sedimentation technique was applied for the recovery of *schistosoma* eggs from freshly collected fecal samples. Out of 167 fecal samples examined 17 (10.17%) were found positive for Schistosomiasis. There was no statistically significant difference observed P=1.506, df=2, p>0.05) among the three peasant associations visited even thoughWagetera showed higher prevalence 8(14.5%) than the other two Peasant associations. Similarly, though 10(12.05%) male and 7(8.33%) female cattle were found positive there was statistically significant difference observed between the two sexes (P=0.53, df=1, p>0.05). Never the less ,there were statistically significant differences appreciated among the three age categories (P=2.31, df=2, p<0.05).Cattle having less than 2 years, 2-5years and greater than 5 years old had 8(14%), 6(10.9%). (Chanie,2011).

A study was carried out to determine heterologous Schistosome infections and behavior of the blood flukes, in domestic animals in endemic areas in India. In the present work, 7 Barbary goats, 2-3 month-old, were infected simultaneously with 2000 cercariae of *Schistosoma incognitum* and 2000 that of *S.spindale,* while one goat with 3 000 cercariae of *S.incognitum* and 1000 of S. spindale by a newly developed polythene -pinna method. The fluke recovery was time dependent with

highest recovery (44.92%) on 233 DPI and lowest (0.7%) on 387 DPI. *S. spindale* was the dominant species over *S. incognitum* with a species ratio of 1:0.82 to 1:0.2 and was capable to remove the latter completely on 605 DPI where only male S. spindale (505 number) persisted. (Gupta *et al.*, 2006*)*

The pathological response of sheep to two dose levels (400 or 10,000 cercariae) of *Schistosoma bovis*was evaluated 24 weeks after infection. The results confirmed that a single low or high dose causes lesions in the liver and intestine, and that the lungs, lymph nodes, pancreas and abomasum are affected in sheep given a single high dose. In addition, the study showed that pathological changes (mainly a granulomatous inflammatory reaction) were induced not only by eggs but also by adult worms, and that their severity was in general related to the dose of *S. bovis*. Hoeppli reaction product, observed on the surface of adult Schistosoma in some parasitic granulomas, showed no immune reaction for IgG, IgA or IgM. (Ferreras-Estrada *et al*,. 1998).

Previous study:

In Sudan:

A case control study was carried out to determine the pathogenic effects of experimental *Schistosoma bovis* infection in Sudanese sheep and goats by a variety of clinical, parasitological, physiological and histopathological techniques; uninfected animals of each species were used as controls. Infected animals of both species lost or failed to gain weight and developed a hemorrhagic diarrhea, in appetence, marked anemia, hypoalbuminaemia, hyperglobulinaemia and their severity was generally related to faecal egg counts. Red cell breakdown and albumin catabolism were much higher in infected than in control animals of the same species. Although all the animals were infected with the same number of cercariae, both the number of worms reaching maturity and the tissue egg counts tended to be higher in sheep than in goats. On the other hand, goats had significantly higher faecal egg counts than sheep and it is suggested that this was the reason for the generally more severe disease in the former species. (Saeed *et al*, .1984)

Each of two desert sheep was infected with 1500 cercariae of *Schistosomamansoni* of northern Sudan. Signs of infection were anorexia, soft faeces, progressive weakness and loss of wool. The sheep were killed 254 and 269 days after infection .The post mortem finding were heavy infiltration of the lamina propria with inflammatory cells, numerous ova in the sub mucosa ,hyperplasia of lymphoid tissue ,edema of the mesenteric lymph nodes , and focal pulmonary edema and congestion . There were egg granulomas,focal necrosis ,schistosomal pigment

,fatty change ,depletion of glycogen and reduction in the activity of adenosine triphosphatase,succinic tetrazolium reductase and glucose-6-phosphatase in the liver .In one sheep 1330 cercariae penetrated and 700 matured to produce males and females in a 5:2 ratio. In the other sheep, about one third of the cercariae penetrated and matured .The ratio of males to females was 3:1. (S.E.I. Adam and M.Magzoub 1976).

Sheep are partially susceptible to*Schistosoma mansoni* infection. However, development of worms is slow and they are reduced in size. No anemia is produced in the infected animals, but a moderate degree of eosinophilia occurs at a late stage. The peculiar pathological lesions observed in the liver of ruminants is recorded and a simple technique suitable for perfusion of adult Schistosome worms in large animals is described. (Saeed and Nelson 1974).

In the Sudan, a study the prevalencewas designed to compare information on parasitic diseases occurrence in nomadic cattle herds in Abyei area. Collection of data from the veterinary records, Veterinary drug centres, questionnaire and external parasites, faecal and blood samples from animals were carried out for one year. The clinical records showed that, parasitic diseases constitute a major problem, and formed 53% of the total diseases recorded in the clinical records. Veterinary drug centers records also revealed that, within parasitic drugs, anthelmintic drugs were the most used in high quantities constituting 48%, then blood parasites as 37% and external parasites drugs which were 15%. During the wet season, many cattle herds were found in a restricted area sharing the available water and pasture. Cattle parasitic diseases were surveyed at four administrative

units in the study area at Muglad, Mayram, Abyei and Dibab. Faecal samples, blood smear, ticks and biting flies were collected. The results of this survey, floatation and sedimentation methods,showed that: Paramphistomum sp. constituted 11.25%, *Fasciola gigantica* 5.00% ,*Schistosoma bovis*, 1.50%, *Oesophagustomum spp.* 2.50%, *Moniezia sp.* 0.63% and *Eimeria spp.* 4.38%. Theoccurrence of internal parasites was found higher during the wet season (Gad Alkareem*et al*., 2012).

Chapter Two

Materials and Methods

2.1 Study Area:

Study was conducted on Rabak slaughter house, (The capital of White Nile State of Sudan)White Nile State has strategic location, it lies in the South of North Sudan, (Latitude: 13° 16' 27" N and Longitude: 32° 26' 59" E), population of the state is estimated at 1.73 millions of inhabitants (NBHS, 2009),

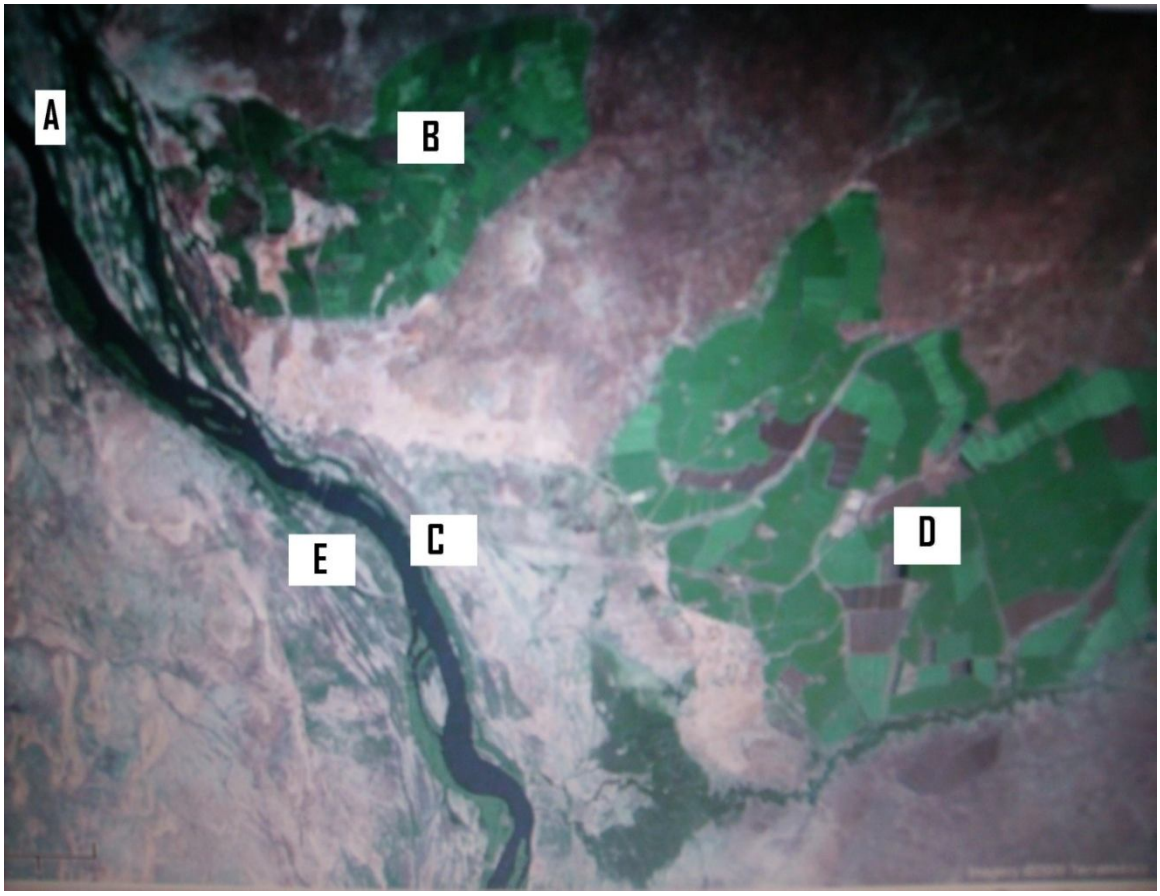

Figure 5: Satallite picture for the study area, A: Gezira Abba, B:Asalaia Suger company, C: Rabak Town, D: Kenana Suger company, E: Kosti Town.(Mukhtar *et al* 2010).

2.2 Study Design:

The study design was a cross sectional study, which provides snapshot information on occurrence of a disease (Martin *et al*., 1988). A Cross-sectional studywas conducted at Rabak abattoir on three selected days .These dayswas selected were Saturday, Monday and Tuesday. The animals in these days selected by systematic random sampling method. Among each group of five animals selected one animal was examined.

2.3 Sample size:

The expected prevalence of sheep Paramphistomosis, fascioliasis and Schistosomiasis was done according to the method described by (Gad AL Kareem*etal*, 2012).

Sample size was calculated according to the formula by(Martin *et al.*1988).

$$n = \frac{4\,P^{X}Q}{L^{2}}$$

Where:

N≡ Sample Size P≡ Expected prevalence = 0.04

Q ≡ 1- P = 0.96 L≡ Allowable error

$$\frac{4*11*89*10.000}{100*100*25} = 156 \text{ animal}$$

2.4 Sampling Method:

A simple random sampling method was conducted and carried out to select individual animals. (Martin *et al*., 1988).

2.5 Questionnaire:

A questionnaire, was completed by the animals owner or manager through an interview to identify possible independent variables (potential risk factors) associated with the presence of the diseases in sheep .

2.6 Individual risk factors:

Potential individual risk factors and their categories were as follow:

sex (male, female) , age (adult(>1) , young(≤1)), breed (sulimy, garage and cross), bodycondition (good ,poor),

2.7 Management risk factors:

Management risk factors include: grazing type(indoor, outdoor), source of animals(kordofan ,white Nile) , water source(tap , canal ,river), snail presence (yes , no), water bodies (yes , no), vegetation (yes , no), knowledge of owner about disease (yes , no), manure disposal (yes , no), and other diseases (positive , negative).

2.8 Animals and sample collection:

Survey of Paramphistomiasis, Fascioliasis and Schistosomiasis inslaughterhouse:

Fecal samples (approximately 10 gram) were collected directly from the rectum of the animal in a clean plastic container after labeling with specific identification number; each sample was transported to Rabak veterinary researchlaboratory. With the date, the number of the animal and the age recorded. After collection, the feces were stored at four^{0}C until the test was performed within 48h.

2.9 Diagnostic technique:

2.9.1 Faecal Examination:

Faecal samples were examined by sedimentation technique for the presence of fluke eggs using the method described by Urquhart *et al.*, (1988). Briefly, 10 gm of feaces was weighed, mixed in 200 ml water in a measuring cup and filtered 3 times through a tea sieve. The filtrate was allowed to stand for 10 min after which the sediment was collected in a test tube and centrifuged at 700 rpm for 3 min. After centrifugation, the supernatant was decanted and a drop of the sediment was tested microscopically. Trematode eggs were identified on the basis of morphology (Soulsby, 1982).

2.10Analysis of the results:

Results of the study were analyzed using statistical package of social science (SPSS). First, Descriptive statistical analysis was displayedin frequency distribution and cross tabulation tables.Univariate analysis using the chi-square for qualitativedata. P-value of 0.25 was considered as significant association and the risk factor was then selected to enter the multivariate analysis. Multivariate analysis: Forward or backward stepwise logistic regression wasused toanalyses the data and to investigate association between a potential risk factor and the prevalence of the three diseases. A p-value of 0.05 indicated significant association between the diseases Paramphistomosis, fascioliasis and Schistosomiasis and the risk factor.

Figure6:Eggs of *Paramphistomum* (p) and*Fasciolahepatica*(f) (wall ,2012).

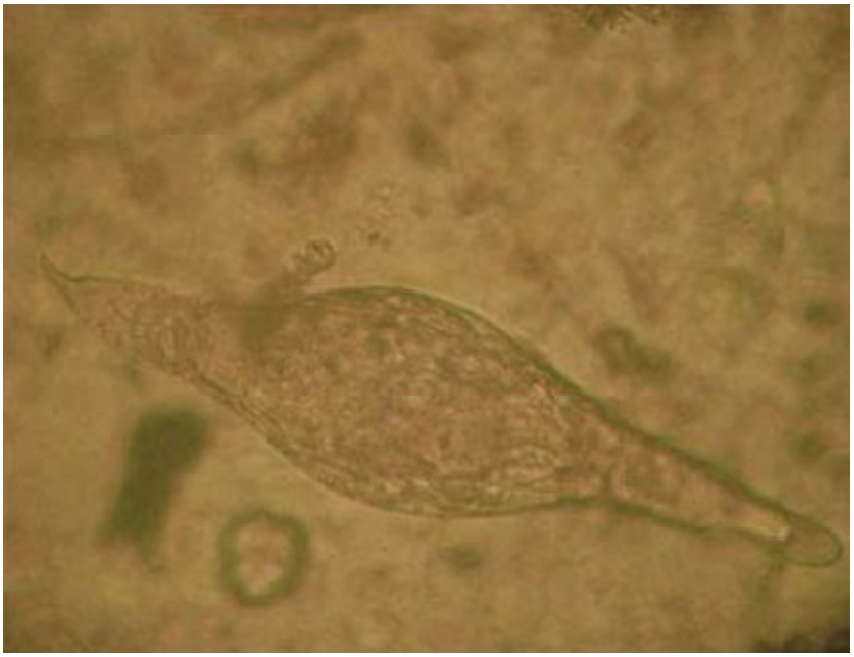

Figure 7: The egg of *S.bovis* (Zangana, 2012).

Chapter Three

Results

3. Descriptivestatisticalanalysisfrequency, cross tabulation and association betweenParamphistomum and potential risk factor:

3.1 Results:

Of the total 156 sheep inspected, 21 (13.5%) animals were positive, and the rest were negative forParamphistomiasis (table 3.1.1). the overall prevalence of sheepParamphistomosis in Rabak was 13.5%.

Table 3.1.1: Distribution ofParamphistomiasis infection among 156sheep examined by fecal sedimentation test in Rabakslaughterhouse:

	Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**
Valid				
-ve	135	86.5	86.5	86.5
+ve	21	13.5	13.5	100.0
Total	**156**	**100.0**	**100.0**	

3.2 Sex of animals:

The results of this study showed the distribution of 156 sheep examined for Paramphistomiasis according to sex. Total number of male examined was 42 (26.9%) animals, while the total number of female examined was114 (73.1%) (Table3.1.2). Among males, 7 animals were found infected. Rate of infection

within males was 16.6%. While among females, 14 animalswere found infected. The rate of infection within females was 12.2% (table 3.1.3).

The Chi- square test showed no significant association between *Paramphistomum*infection and sex of animal (p-value = 0.477), (Table3.1.4).

3.3 Age of animals:

One hundred fifty sex sheep of various ages were examined in this study. The result shows the age distribution of sheep, 65 (41.7%)of thesheep were less than or equal one year (young) and 91 (58.3%) of sheep were more thanone year (old), (Table 3.1.2). Among young animals,7 animals were found infected. Rate of infection within young animals was 10.7%. However, among adults 14 animals was found infected. Rate of infection within adults was 15.3% (Table 3.1.3).

The Chi- square test showed no significant association betweenParamphistomuminfection and age of animal (p-value = 0.638), (Table3.1.4).

3.4 Breed:

The results of study showed distribution of Paramphistomosis infection in Rabak slaughterhouse according to breeds. Total number of Sulimy breed was 76 (48.7%) animal. Among these 76 animals, 11 animals were found infected. The rate of infection was 14.4%. Total number of Garage breed examined was 49 (31.4%). Among these, there was 7 infections. The rate of infection was 14.2%. And Total number of cross breed examined was 31(19.9%).Among these, there was 3 infections. The rate of infection was 9.6%, (Table 3.1.3).

The Chi- square test showed no significant association between the infection and breed (p-value = 0.788), (Table 3.1.4).

3.5 Body condition:

The body condition of animals and the presence of infection were investigated. 115 (73.7%) of sheep were found to be in good condition, while 41 (26.3%) of sheep were found to be in poor condition (Table 3.1.2). Among good condition, animals 15was found infected. The rate of infection within good animals was 13%. However,6 animals was found infected among poor condition animals. The rate of infection within poor animals was 14.6 % (Table 3.1.3).

The Chi- square test showed nosignificant association between the infection and body condition (p-value = 0.798), (Table 3.1.4).

3.6 Grazing:

The results of study showed distribution of Paramphistomosis infection in Rabak slaughter house according to grazing. Total number of indoor grazing was 10 (6.4%) animals. Among these 10 animals, 5 were found infected. The rate of infection was 50%. Total number of outdoor grazing examined was 146 (93.6%). Among these, there was 16 infection. The rate of infection was 11% (Table 3.1.3).

The Chi- square test showed a significant association between the infection and grazing (p-value = 0.000), (Table 3.1.4).

3.7 Source of animals:

Of the total 156 cattle inspected, 142(91%) animal was from north Kordofan Among these 142 animals 19 sheep was found infected, while 14 animals (9%) were from the south white nil. Among these 14 animals, 2 animals were found infected .The rate of infection inKordofan was 13.3. And the rate of infection in south White Nile was 14.2, (Table3.1.3).

The Chi-square results showed that there is no significant association between the infection and source of animal (p-value = 0.92), (Table 3.1.4).

3.8 Water source:

The results of study showed distribution of Paramphistomosis infection in Rabak slaughterhouse according to water source. Total number of animals drinking from taps was 23 (14.7%) animals. Among these 23 animals, 6 were found infected. The rate of infection was 26%. Total number of animal drinking from canal examined was 133 (85.3%). Among these 133 animals, there was 15 infections. The rate of infection was 11.2%. (Table3.1.3).

The Chi- square test showed a significant association between the infection andwater source (p-value 0.05), (Table 3.1.4).

3.9 Snails Presence:

The results of study showed distribution of Paramphistomiasis infection in Rabak slaughterhouse according to presence of snails. Total number of animals with no presence of snails examined were 9 (5.8%) animals. while the total number of animals with presence of snails examined were 147 (94.2%) (table3.1.3).Among these with no presence of snails 2 animals found infected .The rate of infection with no presence of snails was (22.2%).Among these with presence of snails 19 animals found infected .The rate of infection with presence of snails was (12.9%) ,(Table 3.1.3).

The Chi- square test showed nosignificant association between the infection and presence of snails (p-value = 0.42), (Table 3.1.4).

3.10 Presence of water bodies:

The results of study showed distribution of Paramphistomosis infection in Rabak slaughter house according to presence of water bodies .Total number of animals with no presence of water bodies examined were 9 (5.8%) animals. while the total number of animals with presence of water bodies examined were 147 (94.2%) animals(table 3.1.3).Among these with no presence of water bodies 0 animal found infected .The rate of infection with no presence of water bodies was (0%).Among these with presence of water bodies 21 animals found infected .The rate of infection with presence of water bodies was (13.4%) ,(Table 3.1.3).

The Chi- square test showed no significant association between the infection and presenceof water bodies (p-value = 0.22), (Table 3.1.4).

3.11: Vegetation:

The results of study showed distribution of Paramphistomosis infection in Rabak slaughterhouse according to vegetation. Total number of animals

withno vegetation were 9 (5, 8%) animals. while the Total number of

animals with vegetation examined were 147 (94.2%) animals (Table 3.1.2).Among these with no vegetation 2 animals found infected .The rate of infection with no vegetation was (22.2%).Among these with vegetation 19 animals found infected .The rate of infection with vegetation was (12.9%),(Table 3.1.3).

The Chi- square test showed no significant association between the infection and vegetation (p-value = 0.42), (Table 3.1.4).

3.12 Manure disposal:

The results of study showed distribution of Paramphistomosis infection in Rabak slaughterhouse according to manure disposal. Total number of animals Withno manuredisposal examined were 139 (89.7%) animals, while the total number of animalswith manuredisposal examined were 17(10.3%) animals (Table3.1.2).Among these with no manure disposal 20 animals found infected .The rate of infection with no manuredisposal was (14.3%).Among these manure disposal 1 animalfound infected .the rate of infectionwith manure disposal was (5.8%), (Table 3.1.3).

The Chi- square test showed no significant association between the infection and manure disposal. (P-value = 0.33), (Table 3.1.4).

3.13 Knowledge about disease:

The results of study showed distribution of Paramphistomosis infection in Rabak slaughterhouse according to knowledge about disease. Total number of animals withno knowledge of owner about disease examined were 137 (87.8%) animals. while the total number of animalswith knowledge of owner about disease examined were 19 (12.2%) animals (Table3.1.2).Among these no knowledge of owners about disease 19 animalsfound infected .the rate of infection with no knowledge of owner about disease was (13.8%).Among these with knowledge of owner about disease 2 animals found infected .The rate of knowledge of owner about disease infection with knowledge of owners about disease was (10.5%), (Table 3.1.3).

The Chi- square test showed no significant association between the infection and knowledge about disease (p-value = 0.68), (Table 3.1.4).

3.14 Other diseases:

The results of study showed distribution of Paramphistomosis infection in Rabak slaughterhouse according to infection of animals with other diseases. Total number of animals with negative other diseases examined were143 (91.7%) animals. while the total number of animals with positive to other diseases examined were13 (8.3%) animals (Table3.1.2).Among thesenegativeto other diseases examined 17 animals found infected .the rate of infection innegativeto other diseases examined was(11.8%) .Among thesepositiveto other diseases4 animals were found infected .The rate of infection withpositiveto other diseases was (23.5%), (Table 3.1.3).

The Chi- square test showed nosignificant association between the infection andother diseases (p-value = 0.13), (Table 3.1.4).

Table 3.1.2: Summary of frequency distribution of 156 sheep from Rabak slaughterhouse examined for Paramphistomiasis by fecal sedimentation test according to potential risk factors:

Risk Factors	Frequency	Relative Frequency%	Cumulative Frequency%
Sex			
Female	114	73.1	73.1
Male	42	26.9	100.0
Age(years)			
Young(≤1)	65	41.7	41.7
Old(>1)	91	58.3	100.0
Breed			
Sulimy	76	48.7	48.7
Garag	49	31.4	80.1
Cross	31	19.9	100.0
Body condition			
Poor	41	26.3	26.3
Good	115	73.7	100.0
Grazing type			
Indoor	10	6.4	6.4
Outdoor	146	93.6	100.0
Source			
North Kordofan	142	91	91
South White Nile	14	9	100.0
Water source			
Tap	23	14.7	14.7
Canal	133	85.3	100.0

Table 3.1.2 continued:

Risk Factors	Frequency	Relative Frequency %	Cumulative Frequency %
Snails presence			
No	9	5.8	5.8
Yes	147	94.2	100.0
Water bodies			
No	9	5.8	5.8
Yes	147	94.2	100.0
Vegetation			
No	9	5.8	5.8
Yes	147	94.2	100.0
Knowledge			
No	137	87.8	87.8
Yes	19	12.3	100.0
Manure disposal			
No	140	89.7	89.7
Yes	16	10.3	100.0
Other diseases			
-ve	143	91.7	91.7
+ve	13	8.3	100.0

Table 3.1.3: Summary of cross tabulation for the rate of Paramphistomiasis in each category of the potential risk factors in 156 sheep fromRabak slaughterhouse:

Risk factors	No. examined	No.affected (%)
Sex		
Female	114	14(12.2)
Male	42	7(16.6)
Age (years)		
Young(≤5)	65	7(10.7)
Old(>5)	91	14(15.3)
Breed		
Sulimy	76	11(14.4)
Garag	49	7(14.2)
Cross	31	3(9.6)
Body condition		
Poor	41	6(14.6)
Good	115	15(9.6)
Grazing type		
Indoor	10	5(50)
Outdoor	146	16(11)
Source		
North Kordofan	142	19(13.3)
South White Nile	14	2(14.2)
Water source		
Tap	23	6(26)
Canal	133	15(11.2)

Table 3.1.3 continued:

Risk factors	No. examined	No.affected (%)
Snails presence		
No	9	2(22.2)
Yes	147	19(12.9)
Water bodies		
No	9	0(0)
Yes	147	21(14.2)
Vegetation		
No	9	2(22.2)
Yes	147	19(12.9)
Knowledge		
No	137	19(13.8)
Yes	19	2(10.5)
Manure disposal		
No	139	20(14.3)
Yes	17	1(5.8)
Other diseases		
-ve	143	17(11.8)
+ve	13	4(30.7)

Table 3.1.4: Summary univariate analysis for the association between Paramphistomiasis and potential risk factors in 156 sheep examined at Rabak slaughterhouse using the Chi-square test:

Risk factors	No. examined	No. affected (%)	d.f	X^2value	p- value
Sex			1	.507	.477
Female	114	14(12.2)			
Male	42	7(16.6)			
Age(years)			1	.899	.638
Young(≤1)	65	7(10.7)			
Old(>1)	91	14(15.3)			
Breed			2	.476	.788
Sulimy	76	11(14.4)			
Garag	49	7(14.2)			
Cross	31	3(9.6)			
Body condition			1	.066	.798
Poor	41	6(14.6)			
Good	115	15(9.6)			
Grazing type			1	12.245	.000
Indoor	10	5(50)			
Outdoor	146	16(11)			
Source			1	.009	.925
North Kordofan	142	19(13.3)			
South White Nile	14	2(14.2)			
Water source			1	3.691	.055
Tap	23	6(26)			
Canal	133	15(11.2)			

Table 3.1.4 Continued:

Risk factors	No. examined	No.affected(%)	d.f	Chi-square value	p- value
Snails presence			1	.629	.428
No	9	2(22.2)			
Yes	147	19(12.9)			
Water bodies			1	1.486	.223
No	9	0(0)			
Yes	147	21(14.2)			
Vegetation			1	.629	.428
No	9	2(22.2)			
Yes	147	19(12.9)			
Knowledge			1	.180	.689
No	137	19(13.8)			
Yes	19	2(10.5)			
Manure disposal			1	.941	.332
No	139	20(14.3)			
Yes	17	1(5.8)			
Other diseases			1	4.019	.134
-ve	140	17(12.1)			
+ve	13	4(30.7)			

Table 3.1.5: Multivariate analysis for the association between Paramphistomiasis and potential risk factors in 156 sheep examined at Rabak slaughterhouse

Risk factors	No. examined	No.affected (%)	Exp(B)	p-value	95.0%C.I for Exp(B)	
					Low	High
Grazing type						
indoor	10	5(50)	10.3	.000	.795	132.7
outdoor	146	16(11)	Ref			
Water source						
Tap	23	6(26)	.561	.055	.067	4.680
Canal	133	15(11.2)	Ref			
Water bodies						
No	9	0(0)	.000	.223	.000	.
Yes	147	21(14.2)	Ref			
Other diseases						
-ve	140	17(12.1)	Ref	.134	.000	.
+ve	13	4(30.7)	1			

3.2 Descriptive statistical analysis frequency tables, cross tabulation and association tables between fascioliasis and risk factors:

3.2.1 Results:

Of the total 156 sheep inspected, 20 (12.8%) animals were positive, and the rest were negative for fascioliasis (Table .3.2.1).the overall prevalence of sheepfascioliasis in Rabak was12.8%

Table 3.2.1 Distribution offascioliasis infection among 156sheepexamined inRabakslaughterhouse:

	Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**
Valid				
-ve	136	87.2	87.2	87.2
+ve	20	12.8	12.8	100.0
Total	**156**	**100.0**	**100.0**	

3.2 Sex of animals: Among 42 males, 7 animals were found infected. Rate of infection within males was 16.6%. While among 114 females, 13 animalswere found infected. The rate of infection within females was 11.4% (Table 3.2.2).

The Chi- square test showed no significant association between Paramphistomum infection and sex of animal (p-value = 0.383), (Table 3.2.3).

3.3 Age of animals:

Among 65young animals,7 animals were found infected. Rate of infection within young animals was 10.7%. However, among 91 adults 13 animals were found infected. Rate of infection within adults was 14.2% (Table 3.2.2).

The Chi- square test showed no significant association between Paramphistomum infection and age of animal (p-value = 0.739), (Table 3.2.3).

3.4 Breed:

Among 76 sulimy, breed 15 animalswere found infected. The rate of infection was 19.7%. Among 49 Garage breed, 4 animals was found infections. The rate of infection was 8.1%. And Among 31 cross breed,one animal was found infected. The rate of infection was 3.2 %,(Table 3.2.2).

The Chi- square test showed asignificant association between the infection and breed (p-value = 0.034), (Table 3.2.3).

3.5 Body condition:

Among 115good condition animals 15was found infected. The rate of infection within good animals was 13%. However, 5 animals were found infected among 41 poor condition animals. The rate of infection within poor animals was 12.1 %,(Table 3.2.2).

The Chi- square test showed no significant association between the infection and body condition (p-value = 0.889), (Table 3.2.3).

3.6 Grazing:

Among 10 indoor grazing animals, zero animal were found infected. The rate of infection was 0%. Total number of examined was 146 (93.5%). Among 146 outdoor grazing animals, 20 animals were found infected. The rate of infection was 13.6%, (Table 3.2.2).

The Chi- square test showednosignificant association between the infection and grazing (p-value = 0.21), (Table 3.2.3).

3.7 Source of animals:

Among 142 animal was from north Kordofan 19 sheep was found infected, The rate of infection was 13.3%, Among 14 animals from the south White Nile, one animalwas found infected and the rate of infection was 7.1% ,(Table 3.2.2).

The Chi-square results showed that there is no significant association between the infection and source of animal (p-value = 0.50), (Table 3.2.3).

3.8 Water source:

Among 23 animals drinking from taps, one animalwas found infected. The rate of infection was 4.3%. Among 133 animals, drinking from canal there was 19 animalsfound infected. The rate of infection was 14.2%. (Table 3.2.2).

The Chi- square test showedno significant association between the infection andwater source (p-value 0.188), (Table 3.2.3).

3.9 Presence of snails:

Among 9animals with no presence of snails no animals found infected .The rate of infection was (0%).Among 147 with presence of snails20 animals found infected .The rate of infection was (13.6%). (Table 3.2.2).

The Chi- square test showed nosignificant association between the infection andpresence of snails (p-value = 0.23), (Table 3.2.3).

3.10 Presence of water bodies:

Among 9animal with no presence of water bodies 0 animal found infected .The rate of infection was (0%).Among 147 with presence of water bodies 20 animals found infected .The rate of infection with presence of water bodies was (13.6%),(Table 3.2.2).

The Chi- square test showed no significant association between the infection andpresence of water bodies (p-value = 0.23), (Table 3.2.3).

3.11: Vegetation:

Among the9 animals with no vegetation no animal was found infected .The rate of infection with no vegetation was (0%).Among 147 with vegetation 20 animals found infected .The rate of infection with vegetation was (13.6.%),(Table 3.2.2).

The Chi- square test showed no significant association between the infection and vegetation (p-value = 0.23), (Table 3.2.3).

3.12 Manure disposal:

Among 139 withno manuredisposal15 animals found infected .The rate of infection was (10.7%).Among 17 animals with manure disposal 5 animals found infected, the rate of infectionwith manure disposal was (29.4%). (Table 3.2.2).

The Chi- square test showed no significant association between the infection and manure disposal. (P-value = 0.03), (Table 3.2.3).

3.13 Knowledge about disease:

Among 137 animals with noknowledge of owners about disease 17 animalsfound infected, the rate of infection with noknowledge of owner about disease was (12.4%).Among 19 animals withknowledge of owner about disease 3 animals found infected .The rate of infection withknowledge of owners about disease was (17.6%),(Table 3.2.2).

The Chi- square test showed no significant association between the infection andknowledge about disease (p-value = 0.68), (Table 3.2.3).

3.14 Other diseases:

Among 143negativeto other diseases examined 19 animals found infected , the rate of infection innegativeto other diseases examined was (13.2%).Among 13 animals positiveto other diseases, 3animals were found infected .The rate of infection withpositiveto other diseases was (23%).(Table 3.2.2).

The Chi- square test showed nosignificant association between the infection andother diseases (p-value = 0.66), (Table 3.2.3).

Table 3.2.2: Summary of cross tabulation for the rate of fascioliasis in each category of the potential risk factors in 156 sheep from Rabak slaughterhouse:

Risk factors	No. examined	No. affected (%)
Sex		
Female	114	13(11.4)
Male	42	7(16.6)
Age (years)		
Young(≤1)	65	7(10.7)
Old(>1)	91	13(14.2)
Breed		
Sulimy	76	15(19.7)
Garag	49	4(8.1)
Cross	31	1(3.2)
Body condition		
Poor	41	5(12.1)
Good	115	15(9.6)
Grazing type		
indoor	10	0(0)
outdoor	146	20(13.6)
Source		
North Kordofan	142	19(13.3)
South White Nile	14	1(7.1)
Water source		
Tap	23	1(4.3)
Canal	133	19(14.2)

Table 3.2.2, continued:

Risk factors	No. examined	No. affected (%)
Snails presence		
No	9	0(0)
Yes	147	20(13.6)
Water bodies		
No	9	0(0)
Yes	147	20(13.6)
Vegetation		
No	9	0(0)
Yes	147	20(13.6)
Knowledge		
No	137	17(12.4)
Yes	19	3(15.7)
Manure disposal		
No	139	15(10.7)
Yes	17	5(29.4)
Other diseases		
-ve	140	19(12.1)
+ve	13	1(7.6)

Table 3.2.3: Summary univariate analysis for the association between fascioliasis and potential risk factors in 156 sheep examined at Rabak slaughterhouse using the Chi-square test:

Risk factors	No. examined	No. affected (%)	d.f	X^2 value	p- value
Sex			1	.761	.383
Female	114	13(11.4)			
Male	42	7(16.6)			
Age(years)			1	.604	.739
Young(≤1)	65	7(10.7)			
Old(>1)	91	13(14.2)			
Breed			2	6.757	.034
Sulimy	76	15(19.7)			
Garag	49	4(8.1)			
Cross	31	1(3.2)			
Body condition			1	.019	.889
Poor	41	5(12.1)			
Good	115	15(9.6)			
Grazing type			1	1.751	.210
Indoor	10	0(0)			
Outdoor	146	20(13.6)			
Source			1	.444	.505
Kordofan	142	19(13.3)			
White Nile	14	1(7.1)			
Water source			1	1.733	.188
Tap	23	1(4.3)			
Canal	133	19(14.2)			

Table 3.2.3 continued:

Risk factors	No. examined	No. affected (%)	d.f	Chi-square value	p- value
Snails presence			1	1.405	.236
No	9	0(0)			
Yes	147	20(13.6)			
Water bodies			1	1.405	.236
No	9	0(0)			
Yes	147	20(13.6)			
Vegetation			1	1.405	.236
No	9	0(0)			
Yes	147	20(13.6)			
Knowledge			1	.171	.680
No	137	17(12.4)			
Yes	19	3(15.7)			
Manure disposal			1	4.699	.030
No	139	15(10.7)			
Yes	17	5(29.4)			
Other diseases			1	.818	.664
-ve	140	19(12.1)			
+ve	13	1(7.6)			

Table 3.2.4: Multivariate analysis for the association between fascioliasis and potential risk factors in 156 sheep examined at Rabak slaughterhouse

Risk factors	No. examined	No. affected (%)	Exp(B)	p-value	95.0%C.I for Exp(B)	
					Low	High
Breed						
Sulimy	76	15(19.7)	6		.740	49.6
Garag	49	4(8.1)	3.1	.034	.319	30.5
Cross	31	1(3.2)	Ref			
Grazing type				.21		
Indoor	10	0(0)	Ref			
Outdoor	146	20(13.6)	.000		.000	
Water source						
Tap	23	1 (4.3)	Ref	.188		
Canal	133	19(14.2)	.472		.055	4.050
Snails presence						
No	9	0(0)	Ref			.
Yes	147	20(13.6)	.000		.000	
				.236		
Water bodies						
No	9	0(0)	Ref		.000	
Yes	147	20(13.6)	.000	.236		

Table 3.2.4 continued:

Risk factors	No. examined	No. affected (%)	Exp(B)	p-value	95.0%C.I for Exp(B)	
					Low	High
Manure disposal						
No	139	15(10.7)	.425	.030	.125	1.44
Yes	17	5(29.4)	Ref			

3.3 Descriptivestatisticalanalysis frequency tables, cross tabulation and association tables between Schistosomiasis and risk factors:

3.3.1 Results:

Of the total 156 sheep inspected, 7 (4.5%) animals were positive, and the rest were negative for fascioliasis (Table .3.3.1).the overall prevalence of sheepSchistosomiasis in Rabak was4.5%

Table 3.3.1 Distribution ofSchistosomiasis infection among 156sheepexamined inRabakslaughterhouse:

	Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**
Valid				
-ve	149	95.5	95.5	95.5
+ve	7	4.5	4.5	100.0
Total	**156**	**100.0**	**100.0**	

3.2 Sex of animals: Among 42 males, one animal was found infected. Rate of infection within males was 2.3%. While among 114 females, 6 animals were found infected. The rate of infection within females was 5.2% (Table 3.3.2).

The Chi- square test showed no significant association between Schistosomiasis and sex of animal (p-value = 0.44), (Table 3.3.3).

3.3 Age of animals:

Among 65 young animals,three animals were found infected. Rate of infection within young animals was 4.6%. However, among 91 adults 4 animals was found infected. Rate of infection within adults was 4.3% (Table 3.3.2).

The Chi- square test showed no significant association between Schistosomiasisinfection and age of animal (p-value = 0.97), (Table 3.3.3).

3.4 Breed:

Among 76 sulimy breed one animalswere found infected. The rate of infection was 1.3%. Among 49 Garage breed, 2 animals was found infections. The rate of infection was 4%. And Among 31 cross breed,4 animals was found infections. The rate of infection was 12.9 %,(Table 3.3.2).

The Chi- square test showed asignificant association between the infection and breed (p-value = 0.031), (Table 3.3.3).

3.5 Body condition:

Among 115 good condition animals 5 animals was found infected. The rate of infection within good animals was 4.3%. However,2 animals was found infected among 41 poor condition animals. The rate of infection within poor animals was 4.8 %,(Table 3.3.2).

The Chi- square test showed no significant association between the infection and body condition (p-value = 0.88), (Table 3.3.3).

3.6 Grazing:

Among 10 indoor grazing animals, 2 animals were found infected. The rate of infection was 20%. Among 146 outdoor grazing animals,5 animals was found infection. The rate of infection was 3.4%, (Table 3.3.2).

The Chi- square test showedasignificant association between the infection and grazing (p-value = 0.01), (Table 3.3.3).

3.7 Source of animals:

Among 142 animal was from north Kordofan 6 sheep was found infected, The rate of infection was 4.2%, Among 14 animals from the south white nil, one animal was found infected And the rate of infection was 7.1% ,(Table 3.3.2).

The Chi-square results showed that there is no significant association between the infection and source of animal (p-value = 0.61), (Table 3.3.3).

3.8 Water source:

Among 23 animals drinking from taps, 3 animals were found infected. The rate of infection was 13%. Among 133 animals, drinking from canal there was 4 was found infections. The rate of infection was 3%. (Table 3.3.2).

The Chi- square test showed a significant association between the infection and water source (p-value 0.03), (Table 3.3.3).

3.9 Presence of snails:

Among 9 animals with no presence of snails one animals was found infected .The rate of infection was (11.1%).Among 147 with presence of snails 6 animals found infected .The rate of infection was (4%).(Table 3.3.2).

The Chi- square test showed no significant association between the infection and presence of snails (p-value = 0.32), (Table 3.3.3).

3.10 Presence of water bodies:

Among 9 animal with no presence of water bodies one animal was found infected .The rate of infection was (11.1%).Among 147 with presence of water

bodies 6 animals found infected .The rate of infection with presence of water bodies was (4%),(Table 3.3.2).

The Chi- square test showed no significant association between the infection andpresence of water bodies (p-value = 0.32), (Table 3.3.3).

3.11: Vegetation:

Among these 9 animal with no vegetation one animal was found infected .The rate of infection with no vegetation was (11.1%).Among 147 with vegetation 6 animals found infected .The rate of infection with vegetation was (4%),(Table 3.3.2).

The Chi- square test showed no significant association between the infection and vegetation (p-value = 0.32), (Table 3.3.3).

3.12 Manure disposal:

Among 139 with nomanure disposal 6 animals found infected.The rate of infection was (2.1%).Among 17 animals withmanure disposal one animal wasfound infected .the rate of infection withmanure disposal was (5.8%).(Table 3.3.2).

The Chi- square test showed no significant association between the infection and manure disposal. (P-value = 0.76), (Table 3.3.3).

3.13 Knowledge about disease:

Among 137 animals with noknowledge of owners about disease 5 animalsfound infected .the rate of infection with noknowledge of owner about disease was (3.6%).Among 19 animals withknowledge of owner about disease

2animals found infected .The rate of knowledge of owner about disease infection with knowledge of owners about disease was (10.5%),(Table 3.3.2).

The Chi- square test showed no significant association between the infection and knowledge about disease (p-value = 0.17), (Table 3.3.3).

3.14 Other diseases:

Among 143 negative to other diseases examined 6 animals found infected, the rate of infection in negative to other diseases examined was (4.1%). Among 13 animals positive to other diseases one animal was found infected .The rate of infection with positive to other diseases was (5.2%), (Table 3.3.2).

The Chi- square test showed no significant association between the infection and presence of other diseases (p-value = 0.79), (Table 3.3.3).

Table 3.3.2: Summary of cross tabulation for the rate of Schistosomiasis in each category of the potential risk factors in 156 sheep from Rabak slaughterhouse:

Risk factors	No. examined	No. affected (%)
Sex		
Female	114	6(5.2)
Male	42	1(2.3)
Age (years)		
Young(≤1)	65	3(4.6)
Old(>1)	91	4(14.2)
Breed		
Sulimy	76	1(1.3)
Garag	49	2(4)
Cross	31	4(12.9)
Body condition		
Poor	41	2(4.8)
Good	115	5(4.3)
Grazing type		
Indoor	10	2(20)
Outdoor	146	5(3.4)
Source		
North Kordofan	142	6(4.2)
South White Nile	14	1(7.1)
Water source		
Tap	23	3(13)
Canal	133	4(3)

Table 3.3.2 continued:

Risk factors	No. examined	No. affected (%)
Snails presence		
No	9	1(11.1)
Yes	147	6(4)
Water bodies		
No	9	1(11.1)
Yes	147	6(4)
Vegetation		
No	9	1(11.1)
Yes	147	6(4)
Knowledge		
No	137	5(3.6)
Yes	19	2(10.5)
Manure disposal		
No	139	6(4.3)
Yes	17	1(5.8)
Other diseases		
-ve	140	6(4.2)
+ve	13	1(7.6)

Table 3.3.3: Summary univariate analysis for the association between Schistosomiasis and potential risk factors in 156 sheep examined at Rabak slaughterhouse using the Chi-square test:

Risk factors	No. examined	No. affected (%)	d.f	X^2 value	p- value
Sex			1	.595	.441
Female	114	6(5.2)			
Male	42	1(2.3)			
Age(years)			1	.050	.975
Young(≤1)	65	3(4.6)			
Old(>1)	91	4(14.2)			
Breed			2	6.926	.031
Sulimy	76	1(1.3)			
Garag	49	2(4)			
Cross	31	4(12.9)			
Body condition			1	.020	.888
Poor	41	2(4.8)			
Good	115	5(4.3)			
Grazing type			1	6.00	.014
Indoor	10	2(20)			
Outdoor	146	5(3.4)			
Source			1	.253	.615
Kordofan	142	6(4.2)			
White Nile	14	1(7.1)			
Water source			1	4.608	.032
Tap	23	3(13)			
Canal	133	4(3)			

Table 3.3.3 continued:

Risk factors	No. examined	No. affected (%)	d.f	Chi-square value	p- value
Snails presence			1	.987	.323
No	9	1(11.1)			
Yes	147	6(4)			
Water bodies			1	.987	.323
No	9	1(11.1)			
Yes	147	6(4)			
Vegetation			1	.987	.323
No	9	1(11.1)			
Yes	147	6(4)			
Knowledge			1	1.841	.175
No	137	5(3.6)			
Yes	19	2(10.5)			
Manure disposal			1	.087	.768
No	139	6(4.3)			
Yes	17	1(5.8)			
Other diseases			1	.466	.792
-ve	140	6(4.2)			
+ve	13	1(7.6)			

Table 3.3.4: Multivariate analysis for the association between Schistosomiasis and potential risk factors in 156 sheep examined at Rabak slaughterhouse

Risk factors	No.inspected	No.affected (%)	Exp(B)	p-value	95.0%C.I for Exp(B)	
					Low	High
Breed						
Sulimy	76	1(1.3)	Ref	.031	.002	.539
Garag	49	2(4)	.02		.000	1.360
Cross	31	4(12.9)	.03			
Grazing type				.014		
indoor	10	0(0)	Ref			
outdoor	146	20(13.6)	.764		.020	16.26
Water source						
Tap	23	1 (4.3)	Ref			
Canal	133	19(14.2)	13	.032	.601	285.
Knowledge						
No	137	5(3.6)	Ref			.
Yes	19	2(10.5)	.10		.004	3.240
				.175		

Chapter Four

Discussion

Results of the present study have increased knowledge on the epidemiology of Paramphistomosis, fascioliasis and Schistosomiasis in sheep in Rabak slaughterhouse in White Nile State of the Sudan, investigated by using fecal sedimentation test and questionnaires. Even though there was some bias in the collection of information from the owners. Few studies have been conducted on Paramphistomosis, fascioliasis and schistomiasis in sheep in the Sudan, which, did not include investigations on the potential risk factors contributing to the occurrence and spread ofParamphistomosis,fascioliasis and schistomiasis among sheep populations.

Therefore, this study was conducted to estimate the infection rate of Paramphistomosis, fascioliasis and schistomiasis in sheep and to investigate potential risk factors associated with the occurrence of Paramphistomosis, fascioliasis and schistomiasis in White Nile State.

In this study, the overall infectionrate of egg of Paramphistomosis in sheep fecal samples collected from Rabak slaughterhouse in White Nil State were found to be 13.5% (21/156) by fecal sedimentation test.The results obtained from fecal sedimentation in the present study were higher than the prevalence reported by Shabeh *et al.*,(2006) in India who reported a sero prevalence of 6.6% (14/213) in sheep, by Sanchís*et al.,* (2013) in Spain who reported a prevalence of 7% (803/56), and by khan *et al.*, (2008) in India who reported a prevalence of 7.83% (2400/188).However the prevalence reported in thepresent study was lower than the prevalence reported in Bangladesh which was 72.9% (105/144) by Uddin *et al.,* (2006), in Ethiopia of 28.9% (111/384) by Melaku et *al* (2012), and in Pakistan which was 28.5 (4/ 14) by Raza *et al*(2009). This could be explained by the

differences in the tested sample size (n), practicing of traditional communal grazing and geographical regions.

The overall prevalence of fascioliasis in sheep obtained from fecal samples collected from Rabak slaughterhouse in White Nile State were found to be 12.8% (20/156). However, this findingwas higher than the prevalence reported by Koko *et al* (2003) in Sudan who reported a prevalence of 12.5% (36/287), by Kifle *et al* (2011) in Ethiopia who reported a prevalence of 5.6% (28/500), and by GadAlKareem et al (2012) in Sudan who reported a sero prevalence of 5% (8/160), While on the other hand, the prevalence of fascioliasis reported in this study was lower than the prevalence reported by Bekele *et al*.,(2010) in Ethiopia who reported a sero prevalence of 33.8% (248/768), by Yeneneh et *al*,. (2012) in Ethiopia who reported a prevalence of 23.9% (92/384), and by Fromsa *et al*., (2011) in Ethiopia whoreported aprevalence of 42.3% (44/198). This difference could be elaborated by the differences in the tested sample size (n), animal production systems and geographical regions.

The overall prevalence rate of egg of Schistosomiasis in sheep fecal samples collected from Rabak slaughterhouse in White Nile State were found to be 4.5% (7/156) by fecal sedimentation test. However, thisfinding was higher than the prevalence reported byGadAlKareem*et al.,* (2012) in Sudan who reported a prevalence of 1.25% (2/160), and by Sangma *et al.*,(2012) in Bengladish who reported aprevalence of 3.7% (7/190), While on the other hand, the prevalence of schistomiasis reported in this study was lower than the seroprevalence reported by Yeneneh *et al*., (2012) in Ethiopia who reported a prevalence of 9.89% (38/384), by Zangana *et al., (*2012) in Iraq who reported a prevalence of 11.37% (33/290), by Formosa *et al.,* (2011) in Ethiopia who reported a prevalence of 13.4%

(14/198)and by Chanie*et al*., (2011) in Ethiopia who reported a prevalence of 10.7% (17/167).

Knowledge of risk factor associated with paraphistomiasis, fascioliasis and Schistosomiasis in sheep is an important pre-requisite for the design and implementation of effective control strategies and for management programs that can lead to the control and eradication of the disease. Knowledge of these risk factors and their association and contributions to the occurrence and spreading of paraphistomiasis, fascioliasis and Schistosomiasis among sheep populationsand is a good aid for clinical diagnosis and for determining the epidemiology and patterns of the disease. Very few studies in the Sudan have addressed risk factors associated with positivity to paraphistomiasis,fascioliasis and Schistosomiasis in sheep.

In the current study, univariate analysis using Chi -square, with a confidence interval of 95% at a *p-value* of ≤0.25 was used to identify potential risk factors associated with fecal sedimentation test positivity for paraphistomiasis infection in sheep. Significant risk factors associated with being fecal sedimentation test positive in the univariate analysis were found to be Grazing type (*X2* =12.245, p = 0.00), Water source (*X2* =3.691, p =.055), Water bodies (*X2* =1.486, p = 0.223), and other diseases (*X2* = 4.699, p = 0.030).

The association of these risk factors withpositiveinfection by Paramphistomosis in sheep were investigated for the first time. In the current study, univariate analysis using Chi -square, with a confidence interval of 95% at a *p-value* of ≤0.25 was used to identify potential risk factors associated with fecal sedimentation test positivity for fascioliasis in sheep. Significant risk factors associated with being fecal sedimentation test positive in the univariate analysis were found to be breed (*X2* = 6.757, p = 0.034), grazing type (*X2* =1.751 , p = 0.210),water source (*X2* =1.733 , p =1.88), snail presence (*X2* =1.405 , p = 0.23),

water bodies (*X2* =1.405 , p = 0.23), vegetation (*X2* =1.405 , p = 0.23), and manure disposal (*X2* = 4.699, p = 0.030).

The significant association of breedwithfascioliasis in sheep is in agreement with the findings of Yenenehe*t al.*, (2012), whilst the significant associationof grazing type, water source, snail presence, water bodies, vegetation and manure disposal with fascioliasis-positivity in sheep are reported for the first time. In our study the significant association of breed as risk factor could be explained by the fact that local breed is known for its tolerance to parasitic diseases.

In the current study, univariate analysis using Chi -square, with a confidence interval of 95% at a *p-value* of ≤0.25 was used to identify potential risk factors associated with fecal sedimentation test positivity for schistomiasis infection in sheep. Significant risk factors associated with being fecal sedimentation test positive in the univariate analysis were found to be breed (*X2* = 6.926, p = 0.031), grazing type (*X2* =6.0, p = 0.014), water source (*X2* =4.608, p =0.032), and knowledgeof owner about disease (*X2* =1.841, p = 0.175).

The Significant association of grazing typewithSchistosomiasis-positivity in sheep is in agreement with the findings of Islam*et al* (2011), whilstthe significantassociation ofwater sourceand Knowledgeof owner about diseasewith Schistosomiasis in sheep are reportedfor the first time. In our study the Significant association of grazing type as risk factor could be explained by fact that animals in indoor grazing are mainly stall fed, and might be due to the better management practices and sanitation. Also in the outdoorsystem of rearing, where animals are grazing in the fields have more risks of getting contact with water and subsequently with the *Schistosoma spp*.

The multivariate analysis, using logistic regression, with a confidence interval of 95% and a p- valueof ≤0.05 was used to assess the association between

identified significant risk factors in the univariate analysis in the relation to the positive fecal sedimentation test statusfor Paramphistomosis in sheep. Potential risk factors which were regarded to be Significant with $p \leq 0.25$ in the univariate analysis were also entered into the multivariate analysis. This analysis showed an association between being fecal sedimentation test positive status for Paramphistomosis infection in sheep and grazing type (Exp (B) = 10.3.p =.000), and water source (Exp (B) = .561.p =.055).The positive association of these risk factor withpositive fecal sedimentation test for Paramphistomosis in sheep were investigated for the first time.

The multivariate analysis, using logistic regression, with a confidence interval of 95% and a p- valueof ≤0.05 was used to assess the association between identified significant risk factors in the univariate analysis in the relation to the positive fecal sedimentation test statusfor fascioliasis in sheep. However, some Potential risk factors which were regarded to be significant with $p \leq 0.25$ in the univariate analysiswere entered into the multivariate analysis. This analysis showed an association between being fecal sedimentation test positive status for fascioliasis infection in sheep and breed (Exp (B) = 3.1.p =.034).The positive association of these risk factor withpositive fecal sedimentation test for fascioliasis in sheep were reported for the first time.

The multivariate analysis, using logistic regression, with a confidence interval of 95% and a p- valueof ≤0.05 was used to assess the association between identified significant risk factors in the univariate analysis in the relation to the positive fecal sedimentation test forSchistosomiasis in sheep. However, some potential risk factors which were regarded to be significant with $p \leq 0.25$ in the univariate analysiswere entered into the multivariate analysis. This analysis showed an association between being fecal sedimentation test positive status for Schistosomiasis infection in sheep and breed (Exp (B) = .03.p =.03), grazing type

(Exp (B) = .764.p =.014), and water source (Exp (B) = 13.p =.032). The significantassociation of this risk factor withpositive fecal sedimentation test forSchistosomiasis in sheep were reported for the first time in our investigation.

Conclusion:

From the results of the study, it can be concluded that sheep paramhpistomiasis, schistosomiasis and fascioliasis according to fecal diagnosis is prevailing in Rabak of the White Nile state at high prevalence rate by fecal sedimentation test. The rate was 13.5% for *Paramphistoma*, 12.8% for *Fasciola* and 4.5% for *Schistosoma*.

Based on the results of our study, risk factors associated with these water borne disease in sheep in Rabak of the White Nile state are breed, grazing type ,body condition, water source, snail presence, water bodies, knowledge of owner about disease, manure disposal, sex, water source, vegetation, manure disposal and other disease diagnosed by fecal sedimentation test.

Recommendations:

The study shows the need for:

1- More studies on potential risk factors that enhance the spread and transmission of paramphistomiasis, fascioliasis and schistosomiasis in sheep in the Sudan.

2- Extension and communication programs should be started to enable sheep and other livestock owners to understand the importance of these diseases.

3- The socio-economic impact of these diseases in sheep and vaccination cost-benefit ratio should be investigated.

4- Importantly, a realistic integrated control and eradication program should immediately be launched as recommended by OIE.

5- The scheme of initiation of a regional network for surveillance, control and eradication of these important diseases in Africa is suggested. (Hansen et al., 1994).

Reference

Abunna, F; Asfaw, L; Megersa, B. and Regassa, A. (2010). 'Bovine fascioliasis Accessible at: www.pvj.com.pk .

S.E.I. Adam,M. AND Magzoub,M.(1973). Effect of Lucanthone hydrochloride on the hepatic lesions induced by a Sudan strain of *Schistosoma mansoni*. *J.comp.path. Ther*.83,pp:429-435.

Ahmed, S.; Nawaz , M. and Roomana, G.(2005). Diversity and Prevalence of Trematodes in Livers of Sheep and Goat in Quetta, Pakistan. *PakistanJournal ZooL, vol. 37(3), pp: 205-210.*

Akkari,H.;Gharbi,M. and Darghouth,A.(2011). Infestation of tracer lambs by Fasciola hepatica in Tunisia: determining periods for strategic anthelmintic treatments. École Nationale de Médecine Vétérinaire,30(3),pp:917-929.

Al-Kennany, E. R.; Al- Hamoo, R. N. and Al- Alaaf, E. Sh.(2009). Pathological study on sheep infected with *Schistosoma bovis*.Al- Anbar J. Vet. Sci., Vol.: 2 No. (2), ISSN: 1999- 6527

Aradaib, I.E, Abbas, B., Bushara, H.O. (1993).Evaluation of *Schistosoma bovis* adult worm extract for vaccination of calves. *Preventive Veterinary Medicine,* v. 16, p. 77-84,

Begashaw,S and Chanie,M (2012). Assessment of the economic impact and prevalence of ovine fasciolosis in Menz Lalo Midir district, north-east Ethiopia . *Vet World.* 5(5): 261-264

Bekele, M ;Tesfay, H ; and Getachew, Y (2010). Bovine Fasciolosis: Prevalence and its economic loss due to liver condemnation at Adwa Municipal Abattoir, North Ethiopia .*journal EJAST* 1(1) pp: 39-47.

Brown ,D.S .(2005). Fresh water snail of Africa and their medical importance. *Taylor and Francis* , pp:366-370.

Bokaie, S., Halajian, A. and Eslami, A. (2011). A survey on the bovine amphistomiasis in Mazanderan province, north of Iran. *Iranian journal of veterinary research*, vol.12, pp: 34-36 .

Boray, J. (1959). "Studies on intestinal amphistomosis in cattle". *The Australian Veterinary Journal*, 35 (6), pp:282–287.

Brown, D.S. (2005). Freshwater Snails Of Africa And Their Medical Importance (2 ed.). *Taylor & Francis Ltd*. pp:366–370.

Chai, J.Y. ; Shin, E.H. ; Lee, S.H. and Rim, H.J. (2009). "Foodborne intestinal flukes in Southeast Asia".*The Korean Journal of Parasitology,* 47, pp:69–102.

Chanie, M. (2011). Prevalence of Bovine Shistosomiasis in Fogera District, South Gondar Zone, Amhara National Regional State, Northwest Ethiopia. *Journal**Global Veterinaria*9 (5): 612-616

Chein , M. (2005). Use of praziquantel for clinical treatment and morbidity control of *schistosomia japonica* in china : a review of 30 years experience.j.actatropica ,96(2),pp:168-176.

De Waal, T. (2010). *Paramphistomum*- a brief review. *Irish* Vet. J. 63(5):313-315.

Dechase,T. ;Anteneh,W. and Dechase ,F.G.(2012).prevalence ,gross pathological lesions and economic losses of bovine fasciolosis at Jimma Municipal abattoir, Ethiopia. *Journal of veterinary medicine and animal health* ,4(1),pp:6-11.

Dinnik, J. A. and Dinnik, N. N. (1956). 'Observations on the succession of redial generations of*Fasciola gigantica* Cobbold in a snail host'. *Zeitschrift für Tropenmedizin und Parasitologie,vol.* 7(4), pp:397-419.

Eslami, A. ; Halajian, A. ; and Bokaie, S. (2012). A survey on the bovine amphistomiasis in Mazanderan province, north of Iran. *Iranian Journal of Veterinary Research* ,12 , pp:34.

Ferreras,M.;Garcia,M.;perez,C.;manga,G.;ramajo,M.;escudero,D.andmarin,j .(1998). Apathological study of experimental long-standing *Schistosoma bovis* infection in sheep.*journal comp pathol*,119(4),pp:84-479.

Foster, A.P. ; Otter, A. ; O'Sullivan, T. ; Cranwell, M.P. ; Twomey, D.F. ; Millar, M.F. and Taylor, M.A. (2008). Rumen fluke (paramphistomosis) in British cattle. Veterinary Record, 162, pp:528.

Gad Alkareem, I. ; Abdelgadir, A. and Elmalik, K. (2012). Study on prevalence of parasitic diseases in cattle in Abyei area Sudan**.** *Journal of Cell and Animal Biology*, 6(6), pp:88-98.

Gupta,J.(2006). Sheep production and management, New Delhi .*CBS Publisher and distributors*,pp:1-239.

Garedagi Yagoob, H.Hashemzadeh Farhang,A. Fattahi. (2013). Prevalence of abomasal nematodes in sheep slaughtered at Baneh town. *American Journal of Animal and Veterinary Sciences*, 8(3): 142-145

Ghosh,K.;Mony,T.;Jalal,M. and Islam ,M(2013). Study on paramphistomiosis in cattle at Sonatala Upazila,Bogra,Bangladesh.*journal of advances in parasitology* ,1(1),pp:4-5.

Hammond, J.A. and Sewell, M.M.H.(1974). Floatation on the Sellotape (demonstration).*JOURNAL OF Transactions of the Royal Society of Tropical Medicine and Hygiene*, PP :66, 547 .

Howll,A. ,Mugisha,L. and Davies, J. (2012). Bovine fasciolosis at increasing altitudes. Parasites and vectors, 5:196.

Hansen, J. and Perry, B. (1994). The Epidemiology, diagnosis and control of helminth parasites of ruminants. A hand book. International Laboratory for Research on Animal Disease (ILRAD), Nairobi, Kenya.

Horak, I. G. (1971).'Paramphistomosis of domestic ruminants'. *Advances in Parasitology,vol.* 9,pp: 33-72.

Ilha, M. R.; Loretti,A. and Reis,A.C. (2005).*Wasting* and mortality in beef cattle parasitized by eurytrema coelamaticum in the state of Parana, southern Brazil, *Vet. Parasitol*, 133, PP: 49-60.

Juyal, P.; Kasur, S. and Hassan, K. (2003). Epidemiological status of paramphistomiasis in domestic ruminants in Punjab. Parasitic Diseases. pp: 231-235.

Islam,K.(1975). Schistosomiasis in domestic ruminants in Bangladesh. *Tropical animal health and production* ,pp:244-248.

Keyyu, J.D., Kassuku, A.A., Kyvsgaard, N.C. and Monrad, J. (2008). 'ComparativeEfficacy Of Anthelmintics against *Fasciola gigantica* and *amphistomes* In naturally infected cattle in Kilolo District, Tanzania', *Tanzania Veterinary Journal*, 25(1), 40-47.

Kassuku,A. , Christensen,N. ,Monrad,J. and Knudsen,J.(1986). Epidemiological studies on schistosoma bovis in Iringa region, Tanzania. *Acta Tropica*, 43:153-163.

Khan, U. J. Tanveer, A. ; Maqbool, A. and Masood, S. (2008). Epidemiological studies of paramphistomosis in cattle.Veterinarski Arhiv, 78 (3), pp: 243-251.

Khosravi,A. and Babaahmady,E.(2012). Epidemiology of*Fasciola Hepatica* in Iran.Parasitology International ,VOL 4, PP:4 .

Kifle, D ;Hiko, A. (2011). Abattoir survey on the prevalence and monitory loss associated with fasciolosis. *International journal of livestock production* , vol.2(9),pp:138-141.

Kiusluka, L. and cambarage, D. (1996). Disease of small rummenant in Sub_Suhran Africa. Edited and buplished by vetaid center for tropical vetrenary medicine. pp:17.

Koko, W. S ; Abdalla, H. S ; Glal, M. (2003). Caprine fasciolosis in Gazera state, central Sudan .*journal of veterinary advances* 2(7), pp: 396-399

Le Roux, P. L. (1957). Parasitic diseases in livestock.*FAO Report no. 696*, pp: 1-47.

Lloyd J, Boray J, Love S (2007). Stomach fluke (paramphistomes) in ruminants. Primefact, 452. www.dpi.nsw.gov.au.

Magea, C. ; Bourgneb , H. ; Toullieub, J. ; Rondelaud, D. and Dreyfuss, G. (2002). *Fasciola hepatica* and *Paramphistomum daubneyi* changes in prevalences of natural infections in cattle and in Lymnaea truncatula from central France over the past 12 years **.**vet.res, 33 , pp:439-447.

Mas-Coma, S.; Bargues, M. D. and Valero, M. A.(2005). Fascioliasis and other plant borne trematode zoonoses. *Int. J. Parasitol* , 35, pp: 1255–1278.

Mavenyengwa, M. ; Mukaratirwa, S. ; Obwolom ; and Monrad, J. (2006). Observations on mass production of *Calicophoron microbothrium* metacercariae from experimentally and naturally infected *Bulinus tropicus***.** Onderstepoort Journal of Veterinary Research, 73, pp:95–100**.**

Melaku, S. and Addis, M. (2012). Prevalence and Intensity of Paramphistomum in Ruminants Slaughtered at Debre Zeit Industrial Abattoir, Ethiopia. *Global Veterinaria*, 8(3), pp:315-319.

Mihreteab,b. ; Haftom ,t. and Yahenew,g.(2010). Bovine fasciolosis: prevalence and its economic loss due to liver condemnation at Adwa municipal abattoir, north Ethiopia. *EJAST*, 1(1), pp:39-47.

McCauley ,E. , Majid,A. and Tayed,A. (1983). Economic evalution of the production impact of bovine schistosomosis and vaccination in the Sudan. *Prev. Vet.Med,2* ,pp:261-270.

Mukhtar,O.O.(2010). Studies on the epidemiology, immunodignosis and the chemotherapy of *fasciolagigantica* in the white Nile state, Sudan .University of Khartoum. Sudan

NBHS (2009), Sudan National Baseline Household Survey, North Sudan - Tabulation Report. Sudan Central Bureau of Statistics, Kosti department, White Nile state, Khartoum, Sudan

NSW DPI (2007). Stomach flukes (paramphistomes) in ruminants www.dpi.nsw.gov.au.

Ogambo-Ongoma, A. H. (1972) .'Fascioliasis survey in Uganda', *Bulletin of Epizootic Diseases of Africa*, VOL. 20(1), PP:35-41.

Olsen, O.W. (1974). Animal Parasites: Their Life Cycles and Ecology (3 ed.). Dover Publications, Inc., New York/University Park Press, Baltimore, US. pp: 273–276.

Oyeduntan ,A.;Adekunle,B. and Benjamin,O. (2008).seasonal prevalence of *Fasciola gigantica* infection among the sexes in nigerian cattle. *veterinary research* ,2(1),pp:12-14.

Ozung,P. ,Owa, P. and Oni, K. (2011). An assessment of the prevalence of Fascioliasis of ruminants in Ikom abattoir of Cross River State ,Nigeria . *Continental journal of veterinary science* 5(1), pp:1-5.

Paul, A. K. ; Talukder, M. ; Begum, K. and Rahman M. A.(2011). Epidemiological investigation of Paramphistomiasis in cattle at selected areas of Sirajgonj district of Bangladesh.

Periago, M. V., Valero, M. A., Panova, M. and Mas-Coma, S. (2006) 'Phenotypiccomparison of allopatric populations of*Fasciola hepatica* and Fasciola gigantic. *J.parasitology international 55*, pp: 249-260.

Phiri, A. M., Phiri, I. K, Sikasunge, C. S. and Monrad, J., (2005). Prevalence of fasciolosisin Zambian cattle observed at selected abattoirs with emphasis on age, sex andorigin. *J. Vet. Med*. B, 52,pp: 414-416.

Raza, M. A. ; Murtaza, S. ; Bachaya, H. A. and Hussain, A. (2009). Prevalence of*Paramphistomum cervi* in Ruminants Slaughtered in District Muzaffar Garh. Pakistan Vet. J., 29(4), pp: 214-215.

Robert,w. and tolan,j.(2011). Fascioliasis Due to *Fasciola hepatica* and *Fasciola gigantica* Infection: An Update on this neglected tropical disease .lab medicine,42, pp:107-116.

Rolfe, P.; Boray,J.;Nichols,P. AND Collins,G. (1991) .Epidemiology of paramphistomiasis in cattle. International. *J. Parasitol*, 21,PP: 813-819.

Melaku,S. and Addis, M. (2012). Prevalence and indencity of paramphistomum in Ruminants Slaughtered at Debre Zeit Industrial Abattoir, Ethiopia, Global Veterinaria 8 (3): 315-319, .

Saaed,A.;Hussein,M. and Taylor,M.(1984). The pathogenesis of experimental Schistosoma bovis infections in Sudanese sheep and goats.comp pathology,94(3),pp:85-371.

Saeed, A.A ; and Nelson, G. S.(1974). Experimental*Schistosoma mansoni* infection in sheep. *Journal of Tropical Animal Health and Production*. Vol 6(1). Pp:45-52

Sanabria,R.E.F. AND Romero,J.R. (2008). Review and update of paramphistomosis.*Helminthologia* ,45,PP: 64-68.

Sanchish, J. ; Sanchez ,R. ; Macchib, M.I. ; Pineiroa, P. ; Suareza, J.L. ; Cazapal, C. ; Maldinib, G. ; Venzalb, J.M. ; Silvaa, A. and Ariasa, M.S. (2013). Infection by Paramphistomidae trematodes in cattle from two agricultural regions in NW Uruguay and NW Spain. Veterinary Parasitology, 191, pp: 165–171.

Sangma, A ;Begum, N ; Roy, B. C ; and Gani, M. O (2012). Prevalence of helminth parasites in sheep (*Ovis aries*) in Tangail district, Bangladesh .

Shabih, H. and Juyal, P. (2006). Towards Epidemiology Of Paramphistomosis In Domestic Ruminants In Punjab. Indian *Journal of Animal Sciences*, 42 (4), PP: 272-282.

Shaheen H., Kadry M. Sadek and Eman K. Bazh (2013). Evaluation of oxyclozanide and niclosamide combination as alternative antiparamphistomal therapy in buffaloes. African Journal of Pharmacy pharmacology,7(30),pp:2157-2166.

Singh,A,;Singh,A. and Chaudhri,S.(2004). Visceral Schistosomiasis of domestic animals in India: Humoral immune status of infected cattle, sheep and goats against major polypeptide antigens of *Schistosoma indicum* and *S. spindale*.parasite immunal,26(4),pp:75-167.

Smith, A.; Dowd,A.;Heffernan,M. and Dalton,P.(1993).*Fasciola hepatica*:a secreted cathepsin L-like proteinase cleaves host immunoglobuline. *International journal of parasitology* ,23,pp:977-983.

Saira,M.,Maqbool,M. ,Zafar,Y. ,and Qayyum, M. (2011). Phenotypic analysis of adult *Fasciola spp*. From Potohar region of Punjab. *Pakistan j. Zool* ., vol. 43(6), pp:1069-1077.

Soulsby, E.J.L. (1982). Helminths, Arthropods and Protozoa of Domesticated Animals. Bailliere, Tindall, London, pp:809.

Spithill,T. W.; Smooker, P. M. and Copeman, D. B. (1999). '*Fasciola gigantica*: Epidemiology, control, immunology and molecular biology' in Dalton.Iranian Journal of Veterinary Research, Shiraz University, 12, PP: 34-52 .

Tolosa, T. and Tigre, W., (2007). The prevalence and economic significance of bovine fasciolosis at Jimma abattoir, Ethiopia. *The Internet Journal of Veterinary Medicine,* **3**(2).

Torgerson, P; Claxton, J. (1999). "Epidemiology and control In Dalton, JP. *Fasciolosis"*. Journal of Wallingford, Oxon, UK: CABI Pub. pp: 113–49.

Urquhart G M., Duncan J L., Armour J., Dunn A M., Jenning (1996).Veterinary Parasitology. Second Edition. Blacwell Scince, UK. 103-113.

Waal, T.D. (2011).paramphistomum a brief review. Irish Veterinary Journal, 63, pp:5.

Wamae, L. W; Hammond, J. A; Harrison, L. J. S. and Onyango-Abuje, J.A. (1998). 'Comparison of production losses caused by chronic *Fasciola gigantica* infection in yearling Friesian and Boran cattle'. *Tropical Animal Health and Production,*vol.30(1),pp: 23-30.

World Health Organization (WHO), (2012). Foodborne_trematode_infections fascioliasis. http://www.who.int/en.

Websert,B.;Tehuem,t. and Southgate,V.(2005). The interaction of *schistosoma* in Cameroon. Journal of helminthology ,79,pp:193-197.

Wright,K. (1979). An intracellular parasite in the intestinal phase. *J parasitol* 65:, pp:441-445.

Yadav ,S.;Sharma ,R.;Kalicharan,A.;Dass,R. and Verma,A.(1999). Primary experimental infection of riverine buffaloes with *Fasciola gigantica*.,82,PP:285-296.

Yagoob,G and Bahavarnia,S (2013). Seasonal prevalence of abomasal nematode in small ruminants slaughtered at Tabriz town,Iran . Life science journal ,10(5),pp:206-209.

Yeneneh, A. ; Kebede, H. ; Fentahun ,T. and Chanie ,M. (2012). Prevalence of cattle flukes infection at Andassa Livestock Research Center in north-west of Ethiopia.Veterinary Research Forum, 3(2), pp:85- 89.

Zangana, K. I; and Aziz, K. J (2012). Prevalence and pathological study of schistosomiasis in sheep in Akra/Dohuk province, northern Iraq. *Journal of Veterinary Sciences,* Vol. 26, pp:125-130

Zedar,. (1970). Chromosome Studies in *Paramphistomum Cervi .International Journal of Cytology,* V128 issue 2

Appendix 1

1: Frequency for distribution of 156 sheep examined by fecal sedimentation test at Rabak slaughterhouse paramphistomiasis, fascioliasis and schistosomiasis according to potential risk factors investigated:

Appendix 1.1: Age

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid				
Young	65	41.7	41.6	41.6
Old	91	58.3	58.3	100.0
Total	156	100.0	100.0	

Appendix 1.2: Sex

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid				
Female	114	73.1	73.1	73.1
Male	42	26.9	26.9	100.0
Total	156	100.0	100.0	

Appendix 1.3: Breed

	Frequency	Percent	Valid Percent	Cumulative Percent
Sulimy	76	48.7	48.7	48.7
Garage	49	31.4	31.4	80.1
Cross	31	19.9	19.9	100.0
Total	156	100.0	100.0	

Appendix 1.4: Body condition

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid				
Poor	41	26.3	26.3	26.3
Good	115	73.7	73.7	100.0
Total	156	100.0	100.0	

Appendix 1.5: Grazing

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid				
Indoor	10	6.4	6.4	6.4
Outdoor	146	93.6	93.6	100.0
Total	156	100.0	100.0	

Appendix 1.6: Source

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid				
North Kordufan	142	91	91	91
South W.N	14	9	9	100.0
Total	156	100.0	100.0	

Appendix 1.7: Water source

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid				
Tap	23	14.7	14.7	14.7
Canal	133	85.3	85.3	100.0
Total	156	100.0	100.0	

Appendix 1.8: Snail presence

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid				
No	9	5.8	5.8	5.8
Yes	147	94.2	94.2	100.0
Total	156	100.0	100.0	

Appendix 1.9: Water bodies

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid				
No	9	5.8	5.8	5.8
Yes	147	94.2	94.2	100.0
Total	156	100.0	100.0	

Appendix 1.10: Vegetation

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid				
No	9	5.8	5.8	5.8
Yes	147	94.2	94.2	100.0
Total	156	100.0	100.0	

Appendix 1.11: Manure disposal

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid				
No	140	89.7	89.7	89.7
Yes	16	10.3	10.3	100.0
Total	156	100.0	100.0	

Appendix 1.12:Knowledge

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid				
No	137	87.8	87.8	87.8
Yes	19	12.2	12.2	100.0
Total	156	100.0	100.0	

Appendix 1.13: Other diseases

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid				
Negative	143	91.7	91.7	91.7
Positive	13	8.3	8.3	100.0
Total	156	100.0	100.0	

Appendix 2

2: Cross-tabulation tables for distribution of 156 sheep paramphistomiasis examined at Rabak slaughterhouse according to potential risk factors investigated

Appendix 2.1: Distribution and prevalence of paramphistomiasis in 156 sheep examined at Rabak slaughterhouse according to age:

	Age of animal		**Total**
	Young	**Old**	
Fecal			135
-ve	58	76	135/156X100
Total %	58/65X100	76/91X100	86.5%
	89.2%	83.5%	
+ve	7	15	21
Total %	7/65X100	15/91X100	21/156X100
	10.7%	16.4%	13.5%
	65	91	156
Total %	100.0%	100.0%	100.0%

Appendix 2.2: Distribution and prevalence of paramphistomiasis in 156 sheep examined at Rabak slaughterhouse according to sex:

	Sex of animal		**Total**
	Female	**Male**	
Result **-ve**	100	35	135
Total **%**	100/114X100 87.7%	35/42X100 24.6%	135/156X100 86.5%
+ve	14	7	21
Total **%**	14/114X100 12.2%	7/42X100 16.6%	21/156X100 13.5%
Total %	114 100.0%	42 100.0%	156 100.0%

Appendix 2.3: Distribution and prevalence of paramphistomiasis in 156 sheep examined at Rabak slaughterhouse according to breed:

	Breed			**Total**
	sulimi	Garage	**cross**	
Fecal–ve	65	42	28	135
	65/76X100	42/49X100	28/31X100	135/156X100
Total %	85.5%	85.7%	90.3%	86.5%
+ve	11	7	3	21
	11/76X100	7/49X100	3/31X100	21/156X100
Total %	14.4%	14.2%	9.6%	13.5%
Total %	76	49	31	156
	100.0%	100.0%	100.0%	100.0%

Appendix 2.4: Distribution and prevalence of paramphistomiasis in 156 sheep examined at Rabak slaughterhouse according to body condition:

	Body condition		**Total**
	Boor	**Good**	
Fecal -ve	35	100	135
	35/41X100	100/115X100	135/156X100
Total %	85.3%	86.9%	86.5%
+ve	6	15	21
	6/41X100	15/115X100	21/156X100
Total %	14.6%	13.1%	13.5%
	41	115	156
Total %	100.0%	100.0%	100.0%

Appendix 2.5: Distribution and prevalence of paramphistomiasis in 156 sheep examined at Rabak slaughterhouse according to grazing:

	Grazing		Total
	indoor	Outdoor	
Fecal-ve	5	130	135
Total %	5/10X100	130/146X100	135/156X100
	5%	89%	86.5%
+ve	5	16	21
	5/10X100	16/146X100	21/156X100
Total %	5%	11%	13.5%
	10	146	156
Total %	100.0%	100.0%	100.0%

Appendix 2.6: Distribution and prevalence of paramphistomiasis in 156 sheep examined at Rabak slaughterhouse according to source:

	Source		Total
	North Kordofan	**South w.n**	
Fecal-ve	123	12	135
Total %	123/142X100	12/14X100	135/156X100
	86.6%	85.7%	86.5%
	19	2	21
	19/142X100	2/14X100	21/156X100
Total %	13.3%	14.3%	13.5%
	142	14	156
Total %	100.0%	100.0%	100.0%

Appendix 2.7: Distribution and prevalence of paramphistomiasis in 156 sheep examined at Rabak slaughterhouse according to water source:

	water Source		Total
	Tap	**canal**	
Fecal-ve	17	118	135
Total %	17/23X100	118/133X100	135/156X100
	73.9%	88.7%	86.5%
	6	15	21
	6/23X100	15/133X100	21/156X100
Total %	26.1%	11.3%	13.5%
	23	133	156
Total %	100.0%	100.0%	100.0%

Appendix 2.8: Distribution and prevalence of paramphistomiasis in 156 sheep examined at Rabak slaughterhouse according to snail presence:

	Snail presence		**Total**
	No	**Yes**	
Fecal	7	128	135
-ve	7/9X100	128/147X100	135/156X100
Total %	77.8%	87%	86.5%
+ve	2	19	21
	2/9X100	19/147X100	21/156X100
Total %	22.2%	13%	13.5%
	9	147	156
Total %	100.0%	100.0%	100.0%

Appendix 2.9: Distribution and prevalence of paramphistomiasis in 156 sheep examined at Rabak slaughterhouse according to water bodies:

	Water bodies		**Total**
	No	**Yes**	
Fecal -ve	9	126	135
	9/9X100	126/147X100	135/156X100
Total %	100%	85.7%	86.5%
+ve	0	21	21
	0/9X100	21/147X100	21/156X100
Total %	0%	14.3%	13.5%
	9	147	156
Total %			
	100.0%	100.0%	100.0%

Appendix 2.10: Distribution and prevalence of paramphistomiasis in 156 sheep examined at Rabak slaughterhouse according to vegetation:

	Vegetation		**Total**
	No	**Yes**	
Fecal -ve	7	128	135
	7/9X100	128/147X100	135/156X100
Total %	77.8%	87%	86.5%
+ve	2	19	21
	2/9X100	19/147X100	21/156X100
Total %	22.2%	13%	13.5%
	9	147	156
Total %	100.0%	100.0%	100.0%

Appendix 2.11: Distribution and prevalence of paramphistomiasis in 156 sheep examined at Rabak slaughterhouse according to manure disposal:

	Manure disposal		**Total**
	No	**Yes**	
Fecal-ve	119	16	135
	19/139x100	16/17x100	135/156X100
Total %	13.7%	94.1%	86.5%
+ve	20	1	21
	20/139x100	1/17x100	21/156X100
Total %	14.3%	5.9%	13.5%
	139	17	156
Total %	100.0%	100.0%	100.0%

Appendix 2.12: Distribution and prevalence of paramphistomiasis in 156 sheep examined at Rabak slaughterhouse according to knowledge:

	Knowledge		**Total**
	No	**Yes**	
Fecal -ve	118	17	135
	118/137X100	17/19X100	135/156X100
Total %	86.1%	89.4%	86.5%
+ve	19	2	21
	19/137X100	2/19X100	21/156X100
Total %	13.9%	10.6%	13.5%
	137	19	156
Total %			
	100.0%	100.0%	100.0%

Appendix 2.13:: Distribution and prevalence of paramphistomiasis in 156 sheep examined at Rabak slaughterhouse according to other diseases:

	Other diseases		**Total**
	Posative	Negative	
Fecal -ve	123	12	135
	123/140x100	12/16x100	135/156X100
Total %			86.5%
	87.9%	75%	
+ve	17	4	21
	17/140x100	4/16x100	21/156X100
Total %	12.1%	25%	13.5%
	140	16	156
Total %	100.0%	100.0%	100.0%

Appendix 3

3. Association between paramphistomiasis and potential risk factors using the Chi- square test:

Appendix 3.1: Association between paramphistomiasis and age:

	Value	**Df**	**Asymp.sig. (2-sided)**
Pearson chi- square	.899	1	.638
Continuity			
Likelihood Ratio	1.044	1	.593
No of valid Cases	156		

Appendix 3.2: Association between paramphistomiasis and sex:

	Value	**Df**	**Asymp.sig. (2-sided)**
Pearson chi- square	.507	1	.477
Continuity	.200	1	.655
Likelihood Ratio	.488	1	.485
No of valid Cases	156		

Appendix 3.3: Association between paramphistomiasis and breed

	Value	**Df**	**Asymp.sig. (2-sided)**
Pearson chi- square	.476	2	.788
Continuity			
Likelihood Ratio	.510	2	.775
No of valid Cases	156		

Appendix 3.4: Association between paramphistomiasis and body condition:

	Value	**Df**	**Asymp.sig. (2-sided)**
Pearson chi- square	.066	1	.798
Continuity	.000	1	1.00
Likelihood Ratio	.065	1	.799
No of valid Cases	156		

Appendix 3.5: Association between paramphistomiasis and grazing:

	Value	**Df**	**Asymp.sig. (2-sided)**
Pearson chi- square	12.245	1	.000
Continuity	9.123	1	.003
Likelihood Ratio	8.476	1	.004
No of valid Cases	156		

Appendix 3.6: Association between paramphistomiasis and source:

	Value	**Df**	**Asymp.sig. (2-sided)**
Pearson chi- square	.009	1	.925
Continuity	.000	1	1.000
Likelihood Ratio	.009	1	.925
No of valid Cases	156		

Appendix 3.7: Association between paramphistomiasis and water source:

	Value	**Df**	**Asymp.sig. (2-sided)**
Pearson chi- square	3.691	1	.055
Continuity	2.530	1	.112
Likelihood Ratio	3.149	1	.076
No of valid Cases	156		

Appendix 3.8: Association between paramphistomiasis and snail presence:

	Value	**Df**	**Asymp.sig. (2-sided)**
Pearson chi- square	.629	1	.428
Continuity	.084	1	.772
Likelihood Ratio	.547	1	.459
No of valid Cases	156		

Appendix 3.9: Association between paramphistomiasis and water bodies:

	Value	**Df**	**Asymp.sig. (2-sided)**
Pearson chi- square	1.486	1	.223
Continuity	.521	1	.474
Likelihood Ratio	2.687	1	.101
No of valid Cases	156		

Appendix 3.10: Association between paramphistomiasis and vegetation:

	Value	**Df**	**Asymp.sig. (2-sided)**
Pearson chi- square	.629	1	.428
Continuity	.084	1	.772
Likelihood Ratio	.547	1	.459
No of valid Cases	156		

Appendix 3.11: Association between paramphistomiasis and manure disposal:

	Value	**Df**	**Asymp.sig. (2-sided)**
Pearson chi- square	.941	1	.332
Continuity	.352	1	.553
Likelihood Ratio	1.131	1	.287
No of valid Cases	156		

Appendix 3.12: Association between paramphistomiasis and knowledge:

	Value	**Df**	**Asymp.sig. (2-sided)**
Pearson chi- square	.160	1	.689
Continuity	.002	1	.967
Likelihood Ratio	.170	1	.680
No of valid Cases	156		

Appendix 3.13: Association between paramphistomiasis and other disease:

	Value	**Df**	**Asymp.sig. (2-sided)**
Pearson chi- square	4.019	1	.134
Continuity			
Likelihood Ratio	3.679	1	.159
No of valid Cases	156		

Appendix 4

4: Cross-tabulation tables for distribution of 156 sheep fascioliasis examined at Rabak slaughterhouse according to potential risk factors investigated:

Appendix 4.1: Distribution and prevalence of fascioliasis in 156 cattle examined at Rabak slaughterhouse according to age:

	Age		**Total**
	young	**Old**	
Elisa -ve	58	78	136
	58/65X100	78/91X100	136/156X100
Total %	89.2%	85.7%	87.2%
+ve	7	13	20
	7/65X100	13/91X100	20/156X100
Total %	10.8%	14.3%	12.8%
Total %	65	91	156
	100.0%	100.0%	100.0%

Appendix 4.2: Distribution and prevalence of fascioliasis in 156 cattle examined at Rabak slaughterhouse according to sex:

	Sex		**Total**
	Female	**Male**	
Elisa -ve	101	35	136
	101/114X100	35/42X100	136/156X100
Total **%**	88.6%	83.3%	87.2%
+ve	13	7	20
	13/114X100	7/42X100	20/156X100
Total **%**	11.4%	16.7%	12.8%
	114	42	156
Total **%**	100.0%	100.0%	100.0%

Appendix 4.3: Distribution and prevalence of fascioliasis in 156 cattle examined at Rabak slaughterhouse according to breed:

	Breed			**Total**
	Sulimi	Garage	**Cross**	
Fecal–ve	61	45	30	136
	61/76X100	45/49X100	30/31X100	136/156X100
Total %	80.3%	91.8%	96.8%	87.2%
+ve	15	4	1	20
	15/76X100	4/49X100	1/31X100	20/156X100
Total %	19.7%	8.2%	3.2%	12.8%
Total %	76	49	31	156
	100.0%	100.0%	100.0%	100.0%

Appendix 4.4: Distribution and prevalence of fascioliasis in 156 cattle examined at Rabak slaughterhouse according to body condition:

	Body condition		**Total**
	Boor	**Good**	
Fecal -ve	36	100	136
	36/41X100	100/115X100	136/156X100
Total %	87.8%	86.9%	87.2%
+ve	5	15	20
	5/41X100	15/115X100	20/156X100
Total %	12.2%	13.1%	12.8%
	41	115	156
Total %	100.0%	100.0%	100.0%

Appendix 4.5: Distribution and prevalence of fascioliasis in 156 cattle examined at Rabak slaughterhouse according to grazing:

	Grazing		Total
	Indoor	Outdoor	
Fecal-ve	10	126	136
Total %	10/10X100	126/146X100	136/156X100
	100%	86.3%	87.2%
+ve	0	20	20
	0/10X100	20/146X100	20/156X100
Total %	0%	13.7%	12.8%
	10	146	156
Total %	100.0%	100.0%	100.0%

Appendix 4.6: Distribution and prevalence of fascioliasis in 156 cattle examined at Rabak slaughterhouse according to source:

	Source		Total
	North Kordofan	**South w.n**	
Fecal-ve	123	13	136
Total %	123/142X100	13/14X100	136/156X100
	86.6%	92.9%	87.2%
	19	1	20
	19/142X100	1/14X100	20/156X100
Total %	13.3%	7.1%	12.8%
	142	14	156
Total %	100.0%	100.0%	100.0%

Appendix 4.7: Distribution and prevalence of fascioliasis in 156 cattle examined at Rabak slaughterhouse according to water source:

	Water Source		Total
	Tap	**canal**	
Fecal-ve	22	114	136
Total %	22/23X100	114/133X100	136/156X100
	95.7%	85.7%	87.2%
	1	19	20
	1/23X100	19/133X100	20/156X100
Total %	4.3%	14.3%	12.8%
	23	133	156
Total %	100.0%	100.0%	100.0%

Appendix 4.8: Distribution and prevalence of fascioliasis in 156 cattle examined at Rabak slaughterhouse according to snail presence:

	Snail presence		**Total**
	No	**Yes**	
Fecal	9	127	136
-ve	9/9X100	127/147X100	136/156X100
Total %	100%	86.4%	87.2%
+ve	0	20	20
	0/9X100	20/147X100	20/156X100
Total %	0%	13.6%	12.8%
	9	147	156
Total %	100.0%	100.0%	100.0%

Appendix 4.9: Distribution and prevalence of fascioliasis in 156 cattle examined at Rabak slaughterhouse according to water bodies:

	Water bodies		**Total**
	No	**Yes**	
Fecal -ve	9	127	136
	9/9X100	127/147X100	136/156X100
Total %	100%	86.4%	87.2%
+ve	0	20	20
	0/9X100	20/147X100	20/156X100
Total %	0%	13.6%	12.8%
	9	147	156
Total %	100.0%	100.0%	100.0%

Appendix 4.10: Distribution and prevalence of fascioliasis in 156 cattle examined at Rabak slaughterhouse according to vegetation:

	Vegetation		**Total**
	No	**Yes**	
Fecal -ve	9	127	136
	9/9X100	127/147X100	136/156X100
Total %	100%	86.4%	87.2%
+ve	0	20	20
	0/9X100	20/147X100	20/156X100
Total %	0%	13.6%	12.8%
	9	147	156
Total %	100.0%	100.0%	100.0%

Appendix 4.11: Distribution and prevalence of fascioliasis in 156 cattle examined at Rabak slaughterhouse according to manure disposal:

	Manure disposal		**Total**
	No	**Yes**	
Fecal -ve	124	12	136
	124/139x100	12/17x100	136/156X100
Total %	89.2%	70.6%	87.2%
+ve	15	5	20
	15/139x100	5/17x100	20/156X100
Total %	10.8%	29.4%	12.8%
	139	17	156
Total %	100.0%	100.0%	100.0%

Appendix 4.12: Distribution and prevalence of fascioliasis in 156 cattle examined at Rabak slaughterhouse according to knowledge:

	Knowledge		**Total**
	No	**Yes**	
Fecal -ve	120	16	136
	120/137X100	16/19X100	136/156X100
Total %	87.6%	84.2%	87.2%
+ve	17	3	20
	17/137X100	3/19X100	20/156X100
Total %	12.4%	15.8%	12.8%
	137	19	156
Total %	100.0%	100.0%	100.0%

Appendix 4.13: Distribution and prevalence of fascioliasis in 156 cattle examined at Rabak slaughterhouse according to other disease:

	Other diseases		**Total**
	Posative	Negative	
Fecal -ve	121	15	136
	121/140x100	15/16x100	136/156X100
Total %	86.4%	93.7%	87.2%
+ve	19	1	20
	19/140x100	1/16x100	20/156X100
Total %	13.6%	6.3%	12.8%
	140	16	156
Total %	100.0%	100.0%	100.0%

Appendix 5

5. Association between fascioliasis infection and potential risk factors using the Chi- square test:

Appendix 5.1: Association between fascioliasis and age:

	Value	**Df**	**Asymp.sig. (2-sided)**
Pearson chi- square	.604	1	.739
Continuity			
Likelihood Ratio	.736	1	.692
No of valid Cases	156		

Appendix 5.2 : Association between fascioliasis and sex :

	Value	**Df**	**Asymp.sig. (2-sided)**
Pearson chi- square	.761	1	.383
Continuity	.363	1	547
Likelihood Ratio	.726	1	.394
No of valid Cases	156		

Appendix 5. 3: Association between fascioliasis and breed:

	Value	**Df**	**Asymp.sig. (2-sided)**
Pearson chi- square	6.757	2	.034
Continuity	.		
Likelihood Ratio	7.437	2	.024
No of valid Cases	156		

Appendix 5.4: Association between fascioliasis and body condition:

	Value	**Df**	**Asymp.sig. (2-sided)**
Pearson chi- square	.019	1	.899
Continuity	.000		1.000
Likelihood Ratio	.020	1	.899
No of valid Cases	156		

Appendix 5.5: Association between fascioliasis and grazing:

	Value	**Df**	**Asymp.sig. (2-sided)**
Pearson chi- square	1.571	1	.210
Continuity	.585	1	.444
Likelihood Ratio	2.843	1	.092
No of valid Cases	156		

Appendix 5.6: Association between fascioliasis and source:

	Value	**Df**	**Asymp.sig. (2-sided)**
Pearson chi- square	.444	1	.505
Continuity	.061	1	.805
Likelihood Ratio	.510	1	.475
No of valid Cases	156		

Appendix 5.7: Association between fascioliasis and water source:

	Value	**Df**	**Asymp.sig. (2-sided)**
Pearson chi- square	1.733	1	.188
Continuity	.958	1	.321
Likelihood Ratio	2.166	1	.141
No of valid Cases	156		

Appendix 5.8: Association between fascioliasis and snail presence:

	Value	**Df**	**Asymp.sig. (2-sided)**
Pearson chi- square	1.405	1	.236
Continuity	.451	1	.502
Likelihood Ratio	2.549	1	.110
No of valid Cases	156		

Appendix 5.9: Association between fascioliasis and water bodies:

	Value	**Df**	**Asymp.sig. (2-sided)**
Pearson chi- square	1.405	1	.236
Continuity	.451	1	.502
Likelihood Ratio	2.549	1	.110
No of valid Cases	156		

Appendix 5.10: Association between fascioliasis and vegetation:

	Value	**Df**	**Asymp.sig. (2-sided)**
Pearson chi- square	1.405	1	.236
Continuity	.451	1	.502
Likelihood Ratio	2.549	1	.110
No of valid Cases	156		

Appendix 5.11: Association between fascioliasis and manure disposal:

	Value	**Df**	**Asymp.sig. (2-sided)**
Pearson chi- square	4.699	1	.030
Continuity	3.181	1	.075
Likelihood Ratio	3.774	1	.052
No of valid Cases	156		

Appendix 5.12: Association between fascioliasis and knowledge:

	Value	**Df**	**Asymp.sig. (2-sided)**
Pearson chi- square	.171	1	.680
Continuity	.002	1	.963
Likelihood Ratio	.161	1	.687
No of valid Cases	156		

Appendix 5.13: Association between fascioliasis and other diseases:

	Value	**Df**	**Asymp.sig. (2-sided)**
Pearson chi- square	.818	1	.664
Continuity	.	.	.
Likelihood Ratio	1.243	1	.537
No of valid Cases	156		

Appendix 6

6 : Cross-tabulation tables for distribution of 156 sheep schistosomiasis examined at Rabak slaughterhouse according to potential risk factors investigated :

Appendix 6.1: Distribution and prevalence of schistosomiasis in 156 cattle examined at Rabak slaughterhouse according to age:

	Age		**Total**
	young	**Old**	
Elisa -ve	62	87	149
	62/65X100	87/91X100	149/156X100
Total %	95.4%	95.6%	95.5%
+ve	3	4	7
	3/65X100	13/91X100	7/156X100
Total %	4.6%	4.4%	4.5%
Total %	65	91	156
	100.0%	100.0%	100.0%

Appendix 6.2: Distribution and prevalence of schistosomiasis in 156 cattle examined at Rabak slaughterhouse according to sex:

	Sex		**Total**
	Female	**Male**	
Elisa -ve	108	41	149
	108/114X100	41/42X100	149/156X100
Total **%**	94.7%	97.6%	95.5%
+ve	6	1	7
	6/114X100	1/42X100	7/156X100
Total **%**	5.3%	2.4%	4.5%
	114	42	156
Total **%**	100.0%	100.0%	100.0%

Appendix 6.3: Distribution and prevalence of schistosomiasis in 156 cattle examined at Rabak slaughterhouse according to breed:

	Breed			**Total**
	Sulimi	Garage	**Cross**	
Fecal–ve	75	47	27	149
	75/76X100	47/49X100	27/31X100	149/156X100
Total %	98.7%	96%	87%	95.5%
+ve	1	2	4	7
	1/76X100	2/49X100	4/31X100	7/156X100
Total %	1.3%	4%	13%	4.5%
Total %	76	49	31	156
	100.0%	100.0%	100.0%	100.0%

Appendix 6.4: Distribution and prevalence of schistosomiasis in 156 cattle examined at Rabak slaughterhouse according to body condition:

	Body condition		**Total**
	Boor	**Good**	
Fecal -ve	39	110	149
	39/41X100	110/115X100	149/156X100
Total %	95.1%	95.7%	95.5%
+ve	2	5	7
	2/41X100	5/115X100	7/156X100
Total %	4.9%	4.3%	4.5%
	41	115	156
Total %	100.0%	100.0%	100.0%

Appendix 6.5: Distribution and prevalence of schistosomiasis in 156 cattle examined at Rabak slaughterhouse according to grazing:

	Grazing		Total
	Indoor	Outdoor	
Fecal-ve	8	141	149
Total %	8/10X100	141/146X100	149/156X100
	80%	96.6%	95.5%
+ve	2	5	7
	2/10X100	5/146X100	7/156X100
Total %	20%	3.4%	4.5%
	10	146	156
Total %	100.0%	100.0%	100.0%

Appendix 6.6: Distribution and prevalence of schistosomiasis in 156 cattle examined at Rabak slaughterhouse according to source:

	Source		Total
	North Kordofan	**South w.n**	
Fecal-ve	136	13	149
Total %	136/142X100	13/14X100	149/156X100
	95.8%	92.9%	95.5%
	6	1	7
	6/142X100	1/14X100	7/156X100
Total %	4.2%	7.1%	4.5%
	142	14	156
Total %	100.0%	100.0%	100.0%

Appendix 6.7: Distribution and prevalence of schistosomiasis in 156 cattle examined at Rabak slaughterhouse according to water source:

	Water Source		Total
	Tap	**Canal**	
Fecal-ve	20	129	149
Total %	20/23X100	129/133X100	149/156X100
	87%	97%	95.5%
	3	4	7
	3/23X100	4/133X100	7/156X100
Total %	13%	3%	4.5%
	23	133	156
Total %	100.0%	100.0%	100.0%

Appendix 6.8: Distribution and prevalence of schistosomiasis in 156 cattle examined at Rabak slaughterhouse according to snail presence:

	Snail presence		**Total**
	No	**Yes**	
Fecal	8	141	149
-ve	8/9X100	141/147X100	149/156X100
Total %	88.9%	96%	95.5%
+ve	1	6	7
	1/9X100	6/147X100	7/156X100
Total %	11.1%	4%	4.5%
	9	147	156
Total %	100.0%	100.0%	100.0%

Appendix 6.9: Distribution and prevalence of schistosomiasis in 156 cattle examined at Rabak slaughterhouse according to water bodies:

	Water bodies		**Total**
	No	**Yes**	
Fecal -ve	8	141	149
	8/9X100	141/147X100	149/156X100
Total %	88.9%	96%	95.5%
+ve	1	6	7
	1/9X100	6/147X100	7/156X100
Total %	11.1%	4%	4.5%
	9	147	156
Total %	100.0%	100.0%	100.0%

Appendix 6.10: Distribution and prevalence of schistosomiasis in 156 cattle examined at Rabak slaughterhouse according to vegetation:

	Vegetation		**Total**
	No	**Yes**	
Fecal -ve	8	141	149
	8/9X100	141/147X100	149/156X100
Total %	88.9%	96%	95.5%
+ve	1	6	7
	1/9X100	6/147X100	7/156X100
Total %	11.1%	4%	4.5%
	9	147	156
Total %	100.0%	100.0%	100.0%

Appendix 6.11: Distribution and prevalence of schistosomiasis in 156 cattle examined at Rabak slaughterhouse according to manure disposal:

	Manure disposal		**Total**
	No	**Yes**	
Fecal-ve	133	16	149
	133/139x100	16/17x100	149/156X100
Total %	95.7%	94.1%	95.5%
+ve	6	1	7
	6/139x100	1/17x100	7/156X100
Total %	4.3%	5.9%	4.5%
	139	17	156
Total %	100.0%	100.0%	100.0%

Appendix 6.12: Distribution and prevalence of schistosomiasis in 156 cattle examined at Rabak slaughterhouse according to knowledge:

	Knowledge		**Total**
	No	**Yes**	
Fecal -ve	132	17	149
	132/137X100	17/19X100	149/156X100
Total %	96.4%	89.5%	95.5%
+ve	5	2	7
	5/137X100	2/19X100	7/156X100
Total %	3.6%	10.5%	4.5%
	137	19	156
Total %	100.0%	100.0%	100.0%

Appendix 6.13: Distribution and prevalence of schistosomiasis in 156 cattle examined at Rabak slaughterhouse according to other disease:

	other diseases		**Total**
	Posative	Negative	
Fecal -ve	136	12	149
	136/143X100	12/13X100	149/156X100
Total %			95.5%
	97.2%	92.3%	
+ve	6	1	7
	6/143X100	1/13X100	7/156X100
Total %	2.8%	7.7%	4.5%
	143	13	156
Total %	100.0%	100.0%	100.0%

Appendix 7

Appendix 7: Association between schistosomiasis infection and potential risk factors using the Chi- square test:

Appendix 7.1: Association between schistosomiasis and age:

	Value	**Df**	**Asymp.sig. (2-sided)**
Pearson chi- square	.505	1	.975
Continuity			
Likelihood Ratio	.595	1	.954
No of valid Cases	156		

Appendix 7.2: Association between schistosomiasis and sex:

	Value	**Df**	**Asymp.sig. (2-sided)**
Pearson chi- square	.595	1	.441
Continuity	.112	1	.737
Likelihood Ratio	.673	1	.412
No of valid Cases	156		

Appendix 7.3: Association between schistosomiasis and breed:

	Value	**Df**	**Asymp.sig. (2-sided)**
Pearson chi- square	6.926	2	.031
Continuity	.		
Likelihood Ratio	5.934	2	.051
No of valid Cases	156		

Appendix 7.4: Association between schistosomiasis and body condition:

	Value	**Df**	**Asymp.sig. (2-sided)**
Pearson chi- square	.020	1	.888
Continuity	.000		1.000
Likelihood Ratio	.019	1	.889
No of valid Cases	156		

Appendix 7.5: Association between schistosomiasis and grazing:

	Value	**Df**	**Asymp.sig. (2-sided)**
Pearson chi- square	6.000	1	.014
Continuity	2.755	1	.097
Likelihood Ratio	3.580	1	.059
No of valid Cases	156		

Appendix 7.6: Association between schistosomiasis and source:

	Value	**Df**	**Asymp.sig. (2-sided)**
Pearson chi- square	.253	1	.615
Continuity	.000	1	1.000
Likelihood Ratio	.220	1	.639
No of valid Cases	156		

Appendix 7.7: Association between Schistosomiasis and water source:

	Value	**Df**	**Asymp.sig. (2-sided)**
Pearson chi- square	4.608	1	.032
Continuity	2.564	1	.109
Likelihood Ratio	3.414	1	.065
No of valid Cases	156		

Appendix 7.8: Association between schistosomiasis and snail presence:

	Value	**Df**	**Asymp.sig. (2-sided)**
Pearson chi- square	.978	1	.323
Continuity	.025	1	.873
Likelihood Ratio	.722	1	.396
No of valid Cases	156		

Appendix 7.9: Association between schistosomiasis and water bodies:

	Value	**Df**	**Asymp.sig. (2-sided)**
Pearson chi- square	.978	1	.323
Continuity	.025	1	.873
Likelihood Ratio	.722	1	.396
No of valid Cases	156		

Appendix 7.10: Association between schistosomiasis and vegetation:

	Value	**Df**	**Asymp.sig. (2-sided)**
Pearson chi- square	.978	1	.323
Continuity	.025	1	.873
Likelihood Ratio	.722	1	.396
No of valid Cases	156		

Appendix 7.11: Association between schistosomiasis and manure disposal:

	Value	**Df**	**Asymp.sig. (2-sided)**
Pearson chi- square	.087	1	.768
Continuity	.000	1	1.000
Likelihood Ratio	.080	1	.777
No of valid Cases	156		

Appendix 7.12: Association between schistosomiasis and knowledge:

	Value	**Df**	**Asymp.sig. (2-sided)**
Pearson chi- square	1.841	1	.175
Continuity	.586	1	.444
Likelihood Ratio	1.429	1	.232
No of valid Cases	156		

Appendix 7.13: Association between schistosomiasis and other diseases:

	Value	**Df**	**Asymp.sig. (2-sided)**
Pearson chi- square	.466	1	.792
Continuity	.	.	.
Likelihood Ratio	.548	1	.780
No of valid Cases	156		