STUDIES ON PREVALENCE AND THE IMPORTANCE OF CATTLE LEECH INFESTATION IN NGORONGORO DISTRICT, TANZANIA

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ABSTRACT

Leech infestations are not common in humans and animals, but occur through infested water by drinking or taking bath. It is endemic in rural areas because of inadequate use of safe and clean water. Extent of the problem in Tanzania is not well known because it is a neglected disease, therefore there is little documentation on the leech infestation. Cross-sectional study was conducted in April and May 2015 to determine prevalence and importance of cattle leech infestations in three villages (Endulen, Olpiro and Esere) of Endulen ward in Ngorongoro district, Tanzania. Specific objectives were to assess pastoralists knowledge, attitude and practices on leech infestation in cattle, to determine prevalence of leech in cattle and to determine presence/absence and identify leech species in study area. Study involved examination of cattle for leech infestation, inspection of water bodies for leech presence and questionnaire using interviews administered to household heads or any member of household in absence of the head. A total of 384 cattle were purposively and randomly selected and examined for leech infestation in mouth and nostrils. Water bodies were purposively selected and surveyed for leech detection. Fifteen minutes were spent on each water body. Collected leeches were preserved in 10% formalin solution for later identification. Data were entered into SPSS and analysed by Chi-square. Result showed prevalence of leech infestation in cattle was zero per cent. Leeches identified as belonging to order Arynchobdellida. Questionnaire survey showed that there is a significant local knowledge on leeches. Study was conducted during rainy season, there is high possibility that leeches were swept away through running water and hence no leech was detected on cattle. It is recommended that, more studies should be done during dry and wet seasons to establish true prevalence and importance of leech infestation in cattle in Ngorongoro District, Tanzania.

DECLARATION

I, ZAINAB IDD NYAMSINGWA, do hereby declare to the Senate of Sokoine University of Agriculture that this dissertation is my own original work done within the period of registration and that it has neither been submitted nor being concurrently submitted for a degree award at any other institution.

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The above declaration is confirmed by:

_____ _____

Prof. R.S.Silayo Date

Supervisor

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LIST OF ABBREVIATIONS AND ACRONYMS

FAO	Food and Agriculture Organization
NBS	National Bureau of Statistics
NCAA	Ngorongoro Conservation Area Authority
SPSS	Statistical Package for Social Sciences
Ta	Acclimation Temperature

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background Information

Tanzania has an estimated population of 21.3 million cattle and ranks third in Africa after Ethiopia and Sudan (currently Sudan and South Sudan, (NBS, 2011). Despite having a large cattle population, the contribution of the sector is relatively low partly due to a number of cattle diseases (Kurwijila*et al*., 2012). Water-borne diseases are among the diseases which reduce the productivity of the cattle sector at large. The well-known water-borne diseases are fasciolosis, paramphistomosis and schistosomosis (Fromsa*et al*., 2011; Nzalawahe*et al*., 2014).

Leech infestation also known as Hirudiniasis, is a neglected water-associated disease, which is increasingly becoming an important cause of cattle ill-health leading to yet undetermined magnitude of socio-economic losses (Silayo*et al*., 2013). It is reported to be common in rural areas of Africa and Asia (Sarathi, 2011; Behcet*et al*., 2011; Moghaddar, 2011; Bahmani*et al*., 2012b).

Risk of hirudiniasis is related to time spent in contact with infested water sources. It has been reported that animals are usually infested with leeches through the mouth during drinking water, after which the leeches attach themselves on the throat below the tongueor nostrils (Mukhopadhyay*et al*., 2009; Bahmani*et al*., 2013a; Dagnaw and Mekonnen, 2016). The mentioned clinical manifestations create confusion in diagnosis. Leech infestation leads to a number of clinical signs/symptoms such as anaemia, inflammations, respiratory distress and hematemesis (Bahmani*et al*., 2013a-b; 2014b-c). Leech infestation has been reported to cause deaths in cattle and lead to economic losses to

farmers and the cattle sector at large (Bahmani*et al*., 2012a; 2013d). Despite of being parasites themselves, some leech species serve as vectors for transmitting some bacteria, viruses and parasites of some lethal disease like AIDS, Hepatisis B, Toxoplasmosis and non-pathogenic stercorarian trypanosomes of fish (Apakupakul*et al*., 1999; Martin, 2001; Phillips *et al*., 2010; Bahmani*et al*., 2012b).

Leeches are widespread in aquatic (marine and freshwater) and terrestrial environment worldwide where they parasitize animals and humans. Terrestrial leeches are occasional ecto-parasites while aquatic leeches are endo-parasites where parasitism may be extended depending on the site of feeding. (Cundall *et al.*, 1986; Martin, 2001; Chow *et al*., 2005; Saha*et al*., 2005; Philips *et al*., 2010). Water-borne leeches are commonly found in lakes, ponds, springs, small streams, floating plants and pools while terrestrial leeches live in tropical rain forest, where they can be found on stones, shrubs and leaves (Mandal and Nandi, 2008; Eguale*et al*., 2010; Bahmani*et al*., 2013b; Bahmani and Mahmoud, 2014a).

Common aquatic and terrestrial leeches which parasitize cattle include *Limnatisnilotica*, *Myxobdellaafricana, Haemadispazeylanica*and *H. picta* respectively (Connior and Trauth, 2010; Bahmani*et al.*, 2012b; 2013 a-b; Ghazvinian*et al*., 2014).*Myxobdella* species are commonly found in South East Asia and Africa while *Praobdella* species are limited to Africa (Phillips *et al*., 2010). However, some leech species are parasites of turtles, frogs, snails and earthworm and feed on them (Bahmani and Mahmoud, 2014a). Non-blood sucking leeches play crucial role in soil mineral balance, recycling benthos of the lakes, streams and specifically eutrophic or polluted water and can be used as environmental stress indicator (Apakupakul*et al*., 1999). Leech infestation in humans and animals is not common but it occurs occasionally (Bahmani*et al*., 2012a). However, leech infestation in human have been extensively reported in a number of countries including

Iran, India, and Hong Kong (Chow *et al*., 2005; Mukhopadhyay*et al*., 2009; Rafeey and Moghaddam, 2012; Bahmani*et al*., 2013 d). In East Africa, leech infestation in human has been reported in Kenya, Tanzania and Ethiopia (Cundall*et al*., 1986; Kruger *et al*., 2004; Mekonnen, 2013). In one district of Tanzania (Mbulu), it was found that 50% of the children less than 12 years of age were anaemic, Kruger*et al*., (2004) reported a case of leech attack in an adolescent girl.

Despite the fact that leeches cause a number of complications some species such as *Hirudinariaglanulosa, Hirudodecora, Hirudonipponia*and*Hirudoverbena*are useful (Nikhat and Fazil, 2014), Historically, since 19th century, some species of leeches have been used for medical purposes such as bloodletting and surgery. Medicinal leeches are spread throughout Europe (Merila and Mattias, 2002; Ghazvinian*et al*., 2014).

1.2 Problem Statement and Justification

Leech infestation is an emerging and neglected problem which is becoming a serious cause of ill-health in cattle. Since domestic and wild animals sometimes share same grazing places, it is highly probable that cattle can also be infested. There is little documented information on the extent of the problem especially in Tanzania. Establishing prevalence of leech infestation will highlight on extent of problem in the study area. Provision of information to the pastoralists community in the study area and the public in general about the prevalence of the disease can provide basis on general knowledge concerning leech infestation, clinical signs, treatments and hence help to reduce economic losses to the communities. This study, therefore, aimed to determine knowledge, attitude and practices of pastoralists on leech infestation, establishing prevalence of leech infestation in cattle and also identification of leech species in Ngorongoro district. The

information from the findings is expected to enable the practitioners and policy makers to map out prevention protocol against leech infestations.

1.3 Research Objectives

1.3.1 General objective

To determine prevalence and importance of cattle leech infestation in Ngorongoro district and support control strategies that may be used to improve animal health and hence livelihood of the pastoralists.

1.3.2 Specific objectives

i. To determine pastoralistsknowledge, attitudes and practices related to cattle leech infestation in Ngorongoro District.
ii. To determine prevalence of cattle leech attacks in Ngorongoro District.
iii. To determine leech presence/absence andleech species in water bodies in Ngorongoro district.

1.3.3 Research questions

i. What are pastoralists knowledge, attitudes and practices related to cattle leech attacks in Ngorongoro District?
ii. What is the prevalence of cattle leech infestation in Ngorongoro District?
iii. Can leech species be found and identified in water bodies in Ngorongoro district?

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Leech Distribution

Leeches are hermaphroditic invertebrate parasites in the Phylum Annelida and Family Hirudinea. They are divided into two types namely Aquatic and Land/terrestrial leeches (Garca*et al*., 2011; Bahmani*et al*., 2012b; 2013c-d; Bahmani and Mahmoud, 2014a).

Aquatic leeches are more life threatening than terrestrial leeches as they are more likely to cause anaemia that may require blood transfusion. However, aquatic leeches have world-wide distribution and dwell entirely in freshwater (Sket and Trontelj, 2008; Garca*et al*., 2011; Bahmani*et al*., 2014c). Land/Terrestrial leeches are commonly found in tropical areas such as South-East, Asia, South America (Behcet*et al*., 2011; Bahmani*et al*., 2014c). Leeches are globally distributed to all continents except Antarctica. Leeches live longer in high humidity and can be affected with temperature and food supply during growth period (Sket and Trontelj, 2008; Kendall, 2012). Leeches can be found living in marine, estuarine, moult terrestrial and freshwater ecosystem (Yamauchi *et al*., 2008). Leeches are also scarce in wetland vegetation such as free floating, submerged and aerial emerging leaves vegetation (Mandal and Nandi, 2008).

2.2 Leech Classification

Leeches are invertebrates belonging to the Phylum Annelida and class Hirudinea (Appendix 1). They have 34 segments which are however not discernible internally. In total there are about 650 leech species (Martin, 2001; Mekonnen, 2013; Raele *et al*.,2015).The members of sub-class Euhirudinea are known to

be true leeches with anterior and posterior suckers. It is further divided into two orders Rynchobdellida and Arhynchobdellida.

Order Arhynchobdellida the true leeches which use pharynx for feeding are further divided into two suborders which are Hirudiniformes and Erpobdelliformes.Hirudiniformes species are mostly parasitic on vertebrates while some are predator of some invertebrates and sporadically scavengers. However, Erpobdelliformesleeches are solely predator species or amphibious in lifestyle and swallow their prey as whole using muscular pharynx (Sket and Trontelj, 2008). The Suborder Hirudiformes contains the Family Hirudinidae while the Suborder Erpobdelliformes contains the Family Erpobdellidae.

Furthermore, Order Rynchobdellida contains leech species known to possess proboscis for feeding and are divided into two families named as Glossiphoniidae and Piscicolidae. Family Glossiphoniidaeleeches are known to feed on invertebrates and vertebrates and some are predatory whereas Piscicolidae are parasites primarily of fish and are the only marine leeches (Sket and Trontelj, 2008).

From order Rynchobdellida, family Glossiphoniidae is divided into three sub-families which are Haementeriinae, Theromyzinae and Glossiphoniinae while family Piscicolidae is divided into Piscicolidae sub-family and followed with Genus and species.Family Hirudinidae from order Arhynchobdellida does not possess sub-family but family Erpobdellida is divided into two sub-families named as Erpobdellinae and Trochetinae which is then followed with Genus and Species (Apakupakul*et al*., 1999; Ahmed and Rehemo, 2014; Kovalenko and Utevsky, 2015).

2.3 Leech Morphology

Leeches are cylindrical flattened invertebrates with 34 external segments. They vary in colour, some being brown, dark green, and black, sometimes with brown, orange and red striped lines on the body (Martin, 2001; Garca*et al*., 2011; Bahmani*et al*., 2012a; Bahmani*et al*., 2013b). These segmented worms have anterior and posterior suckers. Posterior suckers are used for locomotion and attachment while anterior suckers are used for sucking blood and they contain three or two jaws with sharp teeth which make Y and V incision respectively in the flesh of the host (Bahmani*et al*., 2012a; Mekonnen, 2013; Ghazvinian*et al*., 2014; Bahmani*et al*., 2014b; Dagnaw and Mekonnen, 2016).Terrestrial leeches have strong and powerful jaws to attach to the host skin while aquatic leeches have weak jaws which enable them to only pierce into soft tissue (Forouzan*et al*., 2012; Bahmani *et al*., 2012b; Bahmani*et al*., 2013b). Leeches possess heart shaped denticles, with teeth arranged into two rows on muscular jaws with saliva pores between neighbouring denticles. Number and size of denticles differs between the genera (Martin, 2001; Bahmani*et al*., 2013b; Kovalenko and Utevsky, 2015; Dagnaw and Mekonnen, 2016).

2.4 Leech Life Cycle

Leech life cycle involves egg, young leech and adult stages (Figure 1). Leeches are hermaphrodites which reproduce by reciprocal fertilization by which two individuals meet line up with anterior part of each opposite to the posterior part of the other and then each leech shoots a spermatophore into clitellar region of the other from where the sperm finds its way to the female parts. After copulation, eggs are laid between two days to several months depending on the species and meanwhile clitellum becomes ready to secrete cocoon which is filled with nutritive albumen produced by clitellar glands (Ahmed and Rehemo, 2014).

Environmental habitation on development of fertilized eggs in cocoon varies within the leech species (Phillips and Siddall, 2009; Ghazvinian*et al*., 2014; Ogello*et al*., 2016). For example, aquatic leeches prefer to fix in submerged objects or vegetation while others attach to hosts like fish (Kendall, 2012; Ahmed and Rehemo, 2014). Terrestrial leech species attach to the damp soil beneath stones, while others attach to the ventral surface of the parents. Most leeches require 1-2 years to complete their life cycle but this highly relates to feeding habitats and for example in temperate countries breeding occur in spring or summer while maturity occurs the following year (Barnes *et al.,* 2004).

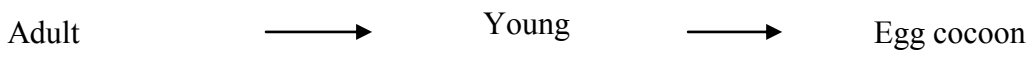

Figure 1: Leech life cycle (www.freshwaterlife.org).

2.5 Leech Ecology

Aquatic leeches are world-wide in distribution and are commonly found in freshwater bodies like lakes, ponds, rivers, springs, pools and small streams and can be found in tropical and sub-tropical countries (Behcet *et al*., 2011; Sarathi,2011: Bahmani *et al*., 2012 a-b; 2013 a-b; 2013d; Bahmani and Mahmoud, 2014a). Leech infestation commonly occurs by drinking infested water sources and contaminated water (Martin, 2001; Eguale*et al*., 2010; Sarathi, 2011; Bahmani*et al*., 2013d;Rajati *et al*., 2014).

2.6 Leech Feeding

Anterior sucker is responsible for sucking blood since it contains teeth and jaws. Moreover, the saliva of leech contains a number of compounds which serve as an anaesthetic to producing insensibility to the host which allows leech to suck blood without host interruption. They also secrete a vasodilator compound which dilates blood

vessels and hirudin, a complex protein which is highly anticoagulant to facilitate flow of blood from host (Phillips and Siddall, 2009; Kaya *et al*., 2011; Garca*et al*., 2011; Bahmani*et al*., 2013d;Ghazvinian*et al*., 2014; Bahmani and Mahmoud, 2014a).

Leeches can consume as much as 150 millilitres of blood up to 48 hours and usually ingest estimated amount of blood ten (10) times their own weight and stay a year after last meal (Mukhapadhyay*et al*., 2009; Mekonnen, 2013). Furthermore, there are leeches which do not feed on blood but feed on insects, snails and aquatic worms (Kendall, 2012; Bahmani and Mahmoud, 2014a). *Hirudinida*species have proboscis and pharynx for feeding which depend on development and presence of muscular jaws (Apakupakul *et al*., 1999; Sket and Trontelj, 2008).

Leeches prefer a significant warmer temperature $24.3^{\pm}9^{\circ}C$ than their acclimate temperature (Ta) $21^{\circ}C$ to reduce energy expenditure during feed processing. Cooler temperature $12.8\ ^{\pm}9^{\circ}C$ than the ambient temperature is preferable to unfading leeches (Martin, 2001; Petersen *et al*., 2011; Kovalenko and Utevsky, 2015). Different leech species have been reported to feed on cattle in different countries. These include *Limnatisnilotica, Hirudiria granulosa, Macrobdeladiploteria* and *Macrobd elladecora* (Connior and Trauth, 2010; Gaudry *et al*., 2010; Zhang *et al*., 2014).

2.7 Prevalence of Leeches

Parasitic infestation with leeches occurs through contaminated water environment (Bahmani*et al*., 2013d; Bahmani*et al*., 2014c). Infestations occur by drinking infested water, or taking bath in stagnant water either streams, ponds or lakes (Sarathi, 2011). Leeches are the elements of manifesting zoonotic disease (Bahmani and Mahmoud, 2014a). Hirudiniasis is not common to humans and animals but it is frequently more

endemic in rural wherethe use of safe/clean water is a problem. Most of the reported cases are from developing countries(Behcet*et al*., 2011; Garca*et al*., 2011; Sarathi, 2011; Bahmani*et al*., 2012a).

However, there are several reports on leech infestation in animals such as camel, cattle, hen, dog, donkey, goat, and sheep from Iraq, Iran and Libya (Bahmani*et al*., 2013d; Negm-Idin*et al*., 2013; Bahmani and Mahmoud, 2014 a).

Leech infestations in humans were reported from Kenya, Tanzania, Turkey and Ethiopia (Cundall*et al*., 1986; Kruger *et al*., 2004; Behcet*et al*., 2011; Mekonnen, 2013). Prevalence and intensity of leech infestation increases during hot and dry season. Prevalence fluctuation and leech infestation is associated with variation in leech intensity and quantity of contaminated/infested water in streams, ponds and lakes where animals drink. For instance, prevalence of leech infestation was high 98.6% compared to that of goat 72.26% in certain farm in Libya (Negm-Idin*et al*., 2013).

2.8 Pathogenic Effects of Leeches

Leech infestation (Hirudiniasis) in cattle causes serious complications like inflammation, severe bleeding and haematemesis leading to anemia and death in severe cases (Bahmani*et al*., 2013a-b; Bahmani and Mahmoud, 2014a; Bahmani*et al*., 2014b). Other effects include dyspnea manifested by neck extending, mouth breathing and snoring, anorexia, dysphagia, restlessness, abnormal cough and weight loss (Eguale*et al*., 2010; Bahmani*et al*., 2012b; 2014 b).

2.9 Diagnosis of leech infestation

Diagnosis is usually based on observation of clinical signs and examination for presence of the parasites when the cattle rest after or before grazing to observe if cattle drools saliva with blood. Common predilection sites of aquatic leeches are mucosal membranes nostrils and mouth (Egualeet *al*., 2010; Bahmanie*t al*., 2010; Garcae*t al*., 2011).

2.10 Treatment of Leech Infestation

Applications of traditional medicinal plants, chemicals, manual removal of the parasites, and water treatment are among control methods against leech infestations (Egualee*t al*., 2010). Hirudiniasis can be treated by medicinal plants such as ginger (*Zinjiberofficinale*), nicotine (*Nicotinatabacum*) garlic (*Allium sativum*L.)and yarrow (*Achilleamille**folium*L) (Bahmani *et al*., 2010; Forouzane*t al*., 2012; Bahmanie*t al.*, 2013a-b; Bahmanie*t al.*, 2014c; Bahmani and Mahmoud, 2014 a). Medicinal plants have been found to be more efficient than commercial products since they are readily available, less toxic and have no side effects (Bahmani and Mahmoud, 2014a). Application of salt, alcohol, insect repellent, a flame, vinegar, anaesthesia or a lit cigarette is among common techniques used to safely remove leeches from a host (Tubtimone*t al*., 2014).

2.11 Control of Leech Infestation

Provision of safe and clean water for drinking is best strategy for prevention of leech infestation in man and his domesticated animals. Local people especially in endemic areas are advised to use safe, clean or filtered/sieved water for human and animal consumption as well as avoiding areas with leeches (Kruger *et al*., 2004; Behcete*t al*., 2011; Shirzadeh and Golmohamedi, 2012). During breeding seasons in spring and summer leech infestation can be controlled by not taking cattle to the infested water (Barnes *et al*., 2004).

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 Study Area and Study Population

The studies were carried out in Ngorongoro which is a pastoral area with seasonal water supply from dwindling ponds known to be an important place for leech infestation. There are unpublished reports (Silayo, personal communication) on leech infestations in buffaloes (*Synceruss caffer*) in Ngorongoro.

The study was carried out in Endulen ward which is located at 3^{o} 11' 0" South, 35^{0} 10'0''East.All three villages in Endulen ward which are Endulen, Esere and Olpiro were incorporated in the study. Endulen ward was chosen because of having large number of cattle compared to other wards. According to 2013 livestock census the ward had a total cattle population of 40 154 (Itanisa, 2013).

Climatically, Endulen is dry area with mostly seasonal water supply. It has an annual temperature of 17.6°C and average annual rainfall of 886 mm. There is much more rainfall in the cool season than in warm season.

3.2 Study Design

Cross sectional study design was used, where data collection was carried out in April and May 2015.

3.3 Sample Size

Sample size was calculated according to the formula by Kothari (2004), whereby;

$n= z^2 *P (1- P) / d^2$, where;

n = required sample size

d = tolerable error of estimation (type 1 error = 0.05)

z = standard normal deviate for a 5% confidence level (1.96)

p = assumed prevalence (50%). So,

$n = (1.96)^2 * 0.5(1- 0.5) / (0.05)^2$

n = 384

This sample total was divided among three study villages giving 128 as required sample size per village. From each village 16 households were randomly selected by picking the first and third households and skip the second one to reach required households. Animals were purposively selected,those which manifest clinical signs such as drooling saliva with blood. In absence of animals with mentioned condition, then eight animals were randomly selected by allowing the animals to pass through the line and pick every sixth animal to reach eight animals in each household.

For the questionnaire study, one respondent was selected from each selected households from which cattle were sampled. This was household head or any member of the house in absence of the head.

3.4 Survey of Leeches in Water Bodies in Study Area

Water bodies, such as ponds, streams and springs in study area were purposively selected as guided by the village head. Survey for leeches was based on searching under the stones at the shore (where the flow of water was not high) and also on top of the fine grass inside the water.Fifteen minutes were spent on each water body. Collected leeches were preserved in buffered formalin 10% solution for later morphological modification (Klemm, 1972).

3.5 Questionnaire

Assessment of knowledge, practice and attitude related to leech infestation in cattle among pastoralists was carried out using semi-structured questionnaire which was administered face to face interviews. Social-demographic characteristics which were sought out included education level, type of cattle kept, number of cattle owned, pastoralists knowledge about leeches, clinical signs and management of leech infestations, leech infested areas and long term leech management mechanism.

3.6 Detection of Leech Infestation in Cattle

Examination for leeches in cattle was done by examining predilection sites like oral cavity and nostrils (Egualeet *al*., 2010; Garcaet *al*., 2011; Forouzanet *al*., 2012). Each animal was cast down and was visually inspected in the mouth and nostrils for evidence of infestation (Figure 2).

Figure 2: A cow being inspected for leeches in the mouth and nostrils

3.7 Data Analysis

Data was cleaned, edited and coded before the analysis and data was analysed by using Statistical Package for Social Studies (SPSS) version 16. Descriptive and inferential statistics were done. Unfortunately, frequencies was intended to be used to compute prevalence of leech infestation and proportions were compared by chi-square test, where by level of significance (α) was set at 0.05. Further, prevalence of leech attack were obtained by total number of cattle infested / total number of cattle in examined herd (household) within Endulen ward multiply by 100 to get a percentage.

CHAPTER FOUR

4.0 RESULTS

4.1 Prevalence of Cattle Leech Infestation in Ngorongoro District

A total of 128 cattle were examined in each of the three villages for the presence of leech and no cattle were found to be infested. This means that at the time of the study, prevalence of leech infestation in cattle was zero per cent (0%).

4.2 Water Bodies Surveyed in Study Area

In the course of survey for leeches in water bodies, leeches were found on top of fine grass inside the water in Endange – Rashid stream at Olpiro, (Appendix 1), while in Enjoro pond at Esere, leeches were recovered from the shore of the pond (Appendix 2). Larvae and young leeches were also collected from under stones in Leteu pond (Appendix 3), whereas larvae were recovered under stone from the shore of the Engini pond at Endulen village (Appendix 4). Leeches were found and collected from Oldogom stream (Appendix 5) under stones at the shore where the flow of water was slow. Pastoralist use local sieve to filter water for cattle in Endulen (Appendix6). All leeches collected from field were identified as belonging to order Arhynchobdellida. Identification to genus and species levels could not be achieved because of the method of preservation (Formalin 10% instead of 70% alcohol) which made the specimens brittle (Soulsby, 1982).

4.3 Socio- Demographic Characteristics of the Respondents

4.3.1 Age

Result from the study shows that mean age of respondents was 29.5 years while 18 and 52 years were minimum and maximum ages respectively. On the other hand (33.3%) of the respondents were aged from 46 years and above whereas (31.2%) were at category of 25

years and below. Furthermore, (22.9%) and (12.5%) were aged 26-35 years and 36-46 years respectively (Table 1).

4.3.2 Sex

Table 1 show that the vast majority (70.8%) of respondents were male.

4.3.3 Respondents duration of stay in a particular village

Results in Table 1 show that (54.2%) of the respondents had stayed in their respective village for 21 years or more compared to (16.7%) each who had stayed for 11-20 years and 6-10 years. This can be compared with (12.5%) that had stayed for $\leq$ 5 years in their respective villages.

4.3.4 Education level

Table 1 shows that slightly more than half (54.2%) of the respondents had no formal education in contrast to (37.5%) who had completed primary education and relatively small proportion (6.2%) and (2.1%) who had completed secondary and adult education respectively.

4.3.5 Type of cattle kept

Table 1 shows that vast majority (96.7%) of the respondents were keeping indigenous cattle while very few remaining (2.1%) kept both exotic and indigenous cattle.

4.3.6 Number of cattle owned

The number of cattle owned by respondents ranged from 150 to 493 (Table 1). The majority (93.8%) of the respondents reported owning $\leq$ 200 cattle while very few (4.2% and 2.1%) reported owning between 201– 400 and $\geq$400 cattle, respectively.

Table 1: Socio--demographic characteristics of the respondents (n=48)

Respondents Profile	Categories	Frequency	Percentage
Age	≤ 25	15	31.2
	26-35	11	22.9
	36-45	6	12.5
	≥46	16	33.3
Sex	Male	34	70.8
	Female	14	29.2
Duration of stay (Years)	≤5	6	12.5
	6-10	8	16.7
	11-20	8	16.7
	≥21	26	54.2
Education level	None	26	54.2
	Adult education	1	2.1
	Primary	18	37.5
	Secondary	3	6.2
Types of cattle	Indigenous	46	96.7
	Exotic	1	2.1
	Both	1	2.1
Number of cattle	≤ 200	45	93.8
	201-400	2	4.2
	≥ 401	1	2.1

4.4 Pastoralist Knowledge about Leeches

Three quarters (75%) of the respondents indicated they had knowledge on leech infestations (Table 2). A cross-tabulation of knowledge status and respondents profile was done. Results show that, (30.6%) of the respondents who answered YES to the question whether they had knowledge about leech infestation were below 25 years whereas (41.7%) of respondents who answered NO were above 45 years and above. Furthermore, statistical analysis using the χ^2 revealed that there was no statistically significant

difference (p = 0.837) between age groups in knowledge about leech infestations. Also, Chi-square test revealed that there was no statistically significant difference (p = 0.271) between males and females on knowledge about leech infestations. Table 2 shows that level of education of the respondents was not found to influence their knowledge about leech infestations (p = 0.600).

Half of the respondents who answered YES to question whether they had knowledge about leech infestation were those who had stayed in their respective village for more than 20 years. On the other hand (16.7%) respondents who answered NO to the question whether they had no knowledge about leech infestation, are those who stayed in their respective village for less than 20 years (p = 0.569).

Majority of respondents (91.7%) who kept 200 or less cattle, had knowledge about leech infestation compare of (8.3%) who kept more than 200 cattle. Therefore, number of cattle kept had no influence on the knowledge about leech infestation (p = 0.587). Table 2 also shows that, type of cattle kept do not influence knowledge about leech infestation (p = 0.560).

Table 2: Cross tabulation of knowledge status and respondents profiles

	Categories	knowledge on leech infestations				χ^2	Sig.
		Yes		No			
		N=36	%	N=12	%		
Age	≤ 25	11	30.6	4	33.3	0.851	0.837
	26-35	9	25	2	16.7		
	36-45	5	13.9	1	8.3		
	≥46	11	30.6	5	41.7		
Sex	Male	27	75	7	58.3	1.210	0.270
	Female	9	25	5	41.7		
Education	None	18	50	8	66.7	1.869	0.600
	Adult education	1	2.8	0	0		
	Primary	14	38.9	4	33.3		
	Secondary	3	8.3	0	0		
Stay duration	1-5 years	4	11.1	2	16.7	2.017	0.569
	6-10 years	7	19.4	1	8.3		
	11-20 years	7	19.4	1	8.3		
	> 20 years	18	50.0	8	66.7		
No. of cattle	≤ 200	33	91.7	12	100	1.067	0.587
	201-400	2	5.6	0	0		
	≥ 401	1	2.8	0	0		
Types of cattle	Indigenous	35	94.4	12	100	0.340	0.560
	Exotic	1	2.8	0	0		
	Both	1	2.8	0	0		

4.4.1 Clinical signs and management of leech infestations

Table 3 shows that majority (81.2%) of the respondents indicated they were aware of the clinical signs of leech infestation in cattle including drooling saliva with blood, abnormal cough and loss of appetite, when compared to (18.8%) who indicated they were unaware. On the other hand, almost all (93.8%) of the respondents reported removing leeches from their cattle manually while (4.2%) indicated they use tobacco to remove leeches from the nose and (2.1%) reported not attempting to remove leeches at all.

Table 3: Knowlegde on clinical signs and management of leech infestations

Variable	Category	n	%
Signs of leech	Aware	39	81.2
	Unaware	9	18.8
Immediate management	Manual removal	45	93.8
	Tobacco	2	4.2
	Not to remove leech	1	2.1

4.4.2 Long term managements of leech infestations

Table 4 indicates that changing cattle drinking locations was the most commonly (37.5%) used approach followed by sieving water for cattle (22.5%). Ponds and dam constructions were least mentioned (5% and 2.5%, respectively). On the other hand, more than a quarter (27.5%) of the respondents used no strategy while only (15%) mentioned removal of leech from cattle as their control strategy.

Table 4: Prevention strategies of leech infestations in cattle

Strategy	Response		Percent of cases
	n	%	
Changing cattle water drinking locations	15	34.1	37.5
Sieving cattle drinking water	9	20.5	22.5
Dam construction	1	2.3	2.5
Ponds construction	2	4.5	5
Removal of leech from cattle	6	13.6	15
None	11	25	27.5
Total	**44**	**100**	**110**

4.4.3 Pastoralist perception on problem of leech infestations in cattle

Table 5 indicates that most (93.8%) of respondents, believed leech infestation in cattle is of no importance while (6.2%) of respondents believed leech infestation is important.

Table 5: Respondents perception on problem of leech infestations in cattle

Variable	Category	n	%
Problem perception	Important	3	6.2
	Not important	45	93.8
Total		48	100

4.4.4 Common inspected body parts forleech detection

Respondents were asked to mention common sites of leech infestations on the animal and multiple response analysis was conducted. The results presented in (Table 6) show that the mouth was the most common (84.6%) site inspected for leech attack followed by whole body (10.3%), and hairs (7.7%) while nose and eye were the least inspected (5.1% and 2.6%), respectively.

Table 6: Leech inspected areas

Inspected areas	Responses		Percent of cases
	n	%	
Mouth	33	76.7	84.6
Nose	2	4.7	5.1
Hairs	3	7	7.7
Whole body	4	9.3	10.3
Eye	1	2.3	2.6
Total	**43**	**100**	**110.3**

4.4.5 Cattle drinking places

Respondents were asked to mention places where they take their cattle to drink water and multiple responses were conducted to identify water sources which are used mostly. (Table 7) shows that Oldogom stream was repeatedly mentioned (17.2%) followed by Simajek cattle trough (12.2%). Olpiro pond was mentioned (9.1%) of respondents

compared to (7.1%) Naasira pond.Other ponds were rarely mentioned (6.1 - 1.0%). In this study it was found that, the three villages share Oldogom stream meaning that, there is a high possibility that leeches will pass from one village to another. It was also observed that, most of the pastoralists use Simajek cattle trough (Figure 3) to water their cattle because of sieved water which is safe/clean for cattle. This indicates that, pastoralists are aware of the problem and take as many precautions as possible to prevent their cattle from leech infestation which include the use of local sieve for filtering water, avoid contaminated/infested water sources, hence minimize chances of leech infestation in their cattle.

Figure 3: Simajek cattle trough in Olpiro village

Table 7: Cattle drinking places

Drinking place	Responses		Percent of cases
	n	%	
Oldogom stream	17	17.2	36.2
Simajek spring	12	12.1	25.5
Olpiro	9	9.1	19.1
Naasira	7	7.1	14.9
Mutani	6	6.1	12.8
Leteu	6	6.1	12.8
Almoramu	6	6.1	12.8
Mjeeni	5	5.1	10.6
Endarere	5	5.1	10.6
Engina	4	4.0	8.5
Alaitole	4	4.0	8.5
Endamagha	4	4.0	8.5
Esere	3	3.0	6.4
Engeshei	3	3.0	6.4
Enjoro	2	2.0	4.3
Rimotiok	1	1.0	2.1
Mgororoni	1	1.0	2.1
Msamaby	1	1.0	2.1
Nungengi	1	1.0	2.1
Ngiribari	1	1.0	2.1
Endange-Rashid	1	1.0	2.1
Total	**99**	**100**	**210.6**

4.4.6 Respondents ideas on how to reduce leech attack in cattle

Multiple response analysis was conducted to understand which methods pastoralists apply to reduce leech infestation in cattle in Ngorongoro District. Table 8 shows that majority (68.9%) of respondents mentioned use of tobacco as herbal medicines whereas (8.9%) mentioned the cooperation between the researchers /practitioners and the pastoralist. Furthermore, (6.7%) of respondents mentioned introduction of crab to water sources while other strategies mentioned were water sieving, using rain water and change of

drinking place(2.2 – 4.4%). Therefore, respondents were aware on how to reduce the problem of leech infestations. Pastoralists believe that crab eats leeches, thus villagers collect crabs from the water sources within the village and introduce crabs to every infested water sources. Samples of the mentioned crabs collected from the study area and brought to SUA for identification were determined on morphological grounds to belong to class Malacostraca, Order Decapods (Hickman *et al*., 2001).

Furthermore, (2.2%) respondents called for cooperation between the researchers/practitio ners andthe pastoralist to work on the problem of leech infestation in cattle and come up with the solutions.An important observation during survey of water bodies in study area was finding of presence of a bird commonly called Hamer kop (*Scopus umbreta*) (Figure 4) which fed on crabs. Because crabs were viewed positively by pastoralists in connection with the fight against leeches, the Hamer kop was viewed negatively by villagers.

Figure 4: Hamer kop bird (http:en.m.wikipedia.org/wiki/hamerkop)

Table 8: Reduction strategies on leech attacks in cattle

Reduction strategies	Responses		Percent of cases
	n	%	
Use of tobacco as herbal medicine	31	68.9	75.6
Cooperation between veterinarians and pastoralists	4	8.9	9.8
Crabs	3	6.7	7.3
Poisons	2	4.4	9.4
Sieve	2	4.4	9.4
Use of rainy water	1	2.2	2.4
Change drinking place	1	2.2	2.4
Research should be done	1	2.2	2.4
Total			
	45	**100**	**109.8**

CHAPTER FIVE

5.0 DISCUSSION

5.1 Cattle Leech Infestation

The present study has revealed that, no leech infestation could be detected in sampled cattle. This does not mean that leech infestation is not a problem in study area, since leech were detected and collected from different water bodies in study area. Rather, none detection could be the result of effective preventative measures implemented as well as the time of study being not season where leech attacks are likely to occur.

A number of preventative measures implemented by pastoralist to protect their cattle were observed to include water filtration (Simajek cattle trough), use of rain water sources and introduction of biological control (Crab). Livestock keepers intimated that they introduced crabs as important allies in control of leeches from water bodies although the crabs themselves were also fed upon by certain birds identified as Hamer kop.Leech infestation is season-dependent and is endemic mostly during hot/dry season, where there is dwindling of water pools accessible for cattle to drink (Silayo*et al.*, 2013; Negm-eldin*et al*., 2013). Leeches are likely to be swept away with running water. Pastoralists prefer to use temporary fast moving water bodies formed by rain water.

5.2 Survey of water bodies for leeches

Survey of water bodies for presence of leech revealed a considerable presence of leeches in various locations within the water bodies including on top of fine grass inside the water at Endange –Rashid stream, Olpiro stream and in between stones at Leteu stream and Engini pond at Endulen. Leeches are commonly found in stream, ponds, lakes (Mandal and Nandi, 2008; Bahmani*et al.*, 2012a-b). Leeches collected from different water sources

were preserved in 10% buffered formalin solution. Unfortunately, the use of above mentioned preservative instead of 70% of alcohol lead to difficulties in morphological identification of specimen. However, leeches were belonging to order Arhynchobdellida after observing the presence of three jaws which make Y mark(Mekonnen, 2013).

5.3 Leech Feeding

Despite the fact that, leeches are invertebrate and vertebrate parasites known to feed on blood from humans, livestock and wildlife they also feed on snails, frogs, fishes, turtles, amphibians and earthworms (Sket and Trontelj, 2008; Bahmani and Mahmood, 2014a).

During the study at Esere village in Endange-Rashid stream where leeches were collected, snails were also observed to be present. It is wellknown that, leeches can survive a year after the last meal (blood). Therefore, leeches feed on cattle mostly during the water scarce dry season. Consequently, there is a great possibility that leeches also fed on snails after blood sucking (Mekonnen, 2013).

5.4 Socio-Demographic Characteristics of Respondents

5.4.1 Age and sex

Results showed that, most of sampled respondents who were aged 45years and above reported to have no knowledge about leech infestation, as well as those who were 25 years and below were highly sampled and reported to have knowledge about leech infestations. Therefore, it indicates that respondents among mentioned ages were highly engaged in animal husbandry compared to others. However, majority of males respondent have great chance of being sampled due to the fact that, cattle husbandry investments demands drudgery, physical energy and rather it discourages women (Mlekwa, 1996). This might have been influenced by the fact that Maasai are typical patriarchic society

and so males had greater chance of being sampled than females (Gneezy*et al.*, 2009; Akangara and Ongonga, 2013).

5.4.2 Respondent duration of stay in a particular village

Respondents who had stayed in their respective villages more than 20 years, reported to have knowledge about leech infestation. Maasai are semi-nomadic pastoralists who live under communal land management system. They usually migrate for feed, pastures, and also for mineral salts for cattle. Being in respective village for long period of time, make respondents to have better knowledge concerning environments, cattle diseases, and how to control them especially leech infestation and in which season infestation is endemic (May, 2003).

5.4.3 Education level

The present findings show that, there was no correlation between education level and knowledge about leech infestation. Therefore, it would seem that, formal education that was introduced to the pastoralist societies still remains dormant, since it has not been indigenous educational practice, Therefore, the economic, cultural and physical factors combine to deny education to Maasai and pastoralist community as whole (Mlekwa, 1996).

Historically, formal education has being avoided among pastoralists society due to mobile life style and it is irrelevant to pastoralists practice. Among pastoralist, few receive formal education and women receive less than men (May, 2003; Gneezy*et al*., 2006). This is due to general thinking capacity that a boy returns investments home whereas a girl expected to leave home to marry and bring in bride wealth and women tend to be seen less capable. Among setbacks in educational developments in pastoralists communities

includes, long distance to and from school without food, less effort for women education, teachers are not prepared to teach pastoralists areas and negative attitude toward schooling. However, parents prefer their children remain with values, norms, customs of their culture since formal education change children to modern society (Mlekwa, 1996).

5.4.4 Type of cattle kept and number of cattle

The questionnaire study shows that, indigenous cattle are highly preferred by pastoralists. They have ability to survive and reproduce in any geographical locations including fluctuating feed supply, high/low temperature and local diseases like leech infestations. However, they have mechanism to manage with feed scarcity. Moreover, there is a need to conserve genetic diversity for future use (De Lange, 2006).

5.4.5 Pastoralists knowledge about leech

From the questionnaire findings, it shows that leech infestations is season-dependent, it is endemic during dry and hot season June and July, where there are dwindling water pools (Silayo*et al*., 2013; Negm-eldin*et al*., 2013). During rainy season, leeches are being swept away with running water and reduce chances of leech infestation and hence zero prevalence.

Majority of respondents were well knowledgeable about leech infestations in many aspects such as clinical signs as well as prevention and control. Mentioned clinical manifestation of leech infestations included loss of condition, loss of appetite, abnormal coughing, and drooling saliva with blood. Furthermore, preventative and control measures implemented by the pastoralists include use of local sieve at home, use of filtered water (Simajek cattle trough) and introduction of crabs as biological control. Leech infestation

was treated by using tobacco as herbal medicine and manual removal of leech from the infested cattle (Ogello*et al*., 2016).

5. 5 Prevalence of Leech

In study area prevalence of leech infestation was found to be zero%. Despite that, leeches were detected and collected from different water bodies in study area. Leech infestation is season-dependent, and this discrepancy was likely due to study being conducted during rainy season, where leeches were being swept away by fast moving running water.

However, with use of anti-leech measures put in a place to prevent leech infestation such as the use of filtered water (Simajek cattle trough), use of local sieve at home and introduction of crab as biological control. Leech infestation is highly endemic during dry/hot season (June- July) where there is dwindling of water pools for cattle to drink (Negm-ldin*et al*., 2013; Silayo*et al*., 2013).

CHAPTER SIX

6.0 Limitation of the Study

i. Although leeches were expected to be more prevalent during rainy season, study had to be conducted during dry season (June and July) due to logistics limitations. This is the probably the reason why zero prevalence of leech was found in cattle.

ii. Due to scarcity of pastures during dry season, pastoralists normally take cattle for grazing early in morning and return late afternoon. This posed a difficult in getting un-grazed animals for leech examination.

iii. The studies did not include post mortem examination of cattle at slaughtered houses/slabs and meat inspection records were not sought. This could have improved the chances of detection of leech infestation of cattle at the study area.

CHAPTER SEVEN

7. 0 CONCLUSIONS AND RECOMMENDATIONS

7. 1 Conclusions

From the present study it can be concluded that, cattle leech infestations could not be detected in study area within Ngorongoro District. The risk is present as evidenced by detection of leeches within water bodies inspected. Pastoralists in study area have good knowledge on risk of leech infestation enabling them to device preventative measures likely instrumental in reducing prevalence of leech infestation. The main objective of the study was to determine the prevalence of leech attacks in cattle which was evaluated. However, prevalence was zero%, since the study was conducted during rainy season. On other hand, the problem was well taken care of, by using filtered water (Simajek cattle trough), changing places for watering cattle and introduction of crabs as biological control. Chi- square through cross tabulation shows that, pastoralists profile was found not to have statistical significance on knowledge about leech infestation whereas type cattle kept found to have statistical significance on knowledge about leech infestations.

7.2 Recommendations

The study was conducted in rainy season contributing to no detection of leech infestation. For true estimate of the prevalence of leech infestation in Ngorongoro District, it is recommended more studies be carried out to include especially dry season when cattle are at great risk of being infested through drinking unsafe/ contaminated water from dwindling pools in which leeches reside. However, the water filtration (Simajek cattle trough) to prevent leech infestation as found in the study area is commendable and can be recommended to be applied in other areas of Tanzania, where cattle leech infestation is prevalent. In fact filtering water into trough helps to prevent cattle to defecate or urinate

in watering places. It is effective way to of preventing other water-borne parasitic disease such as fasciolosis and schistosomiasis

Despite the high knowledge on leech infestation found among pastoralists in study area, it's recommended that more education on leeches be imparted on pastoralists in study area to ensure further reduction in risk of leech infestation.

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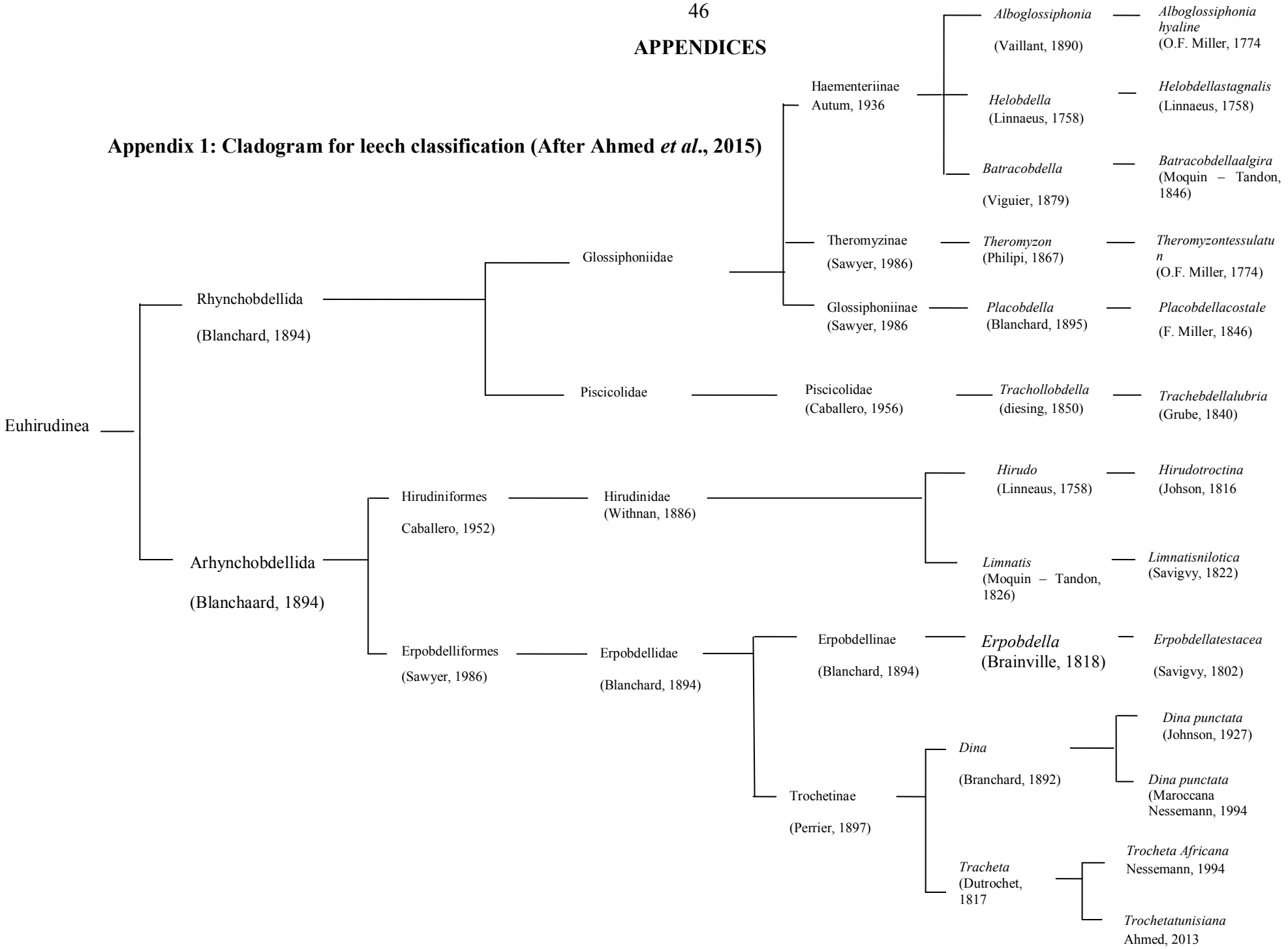
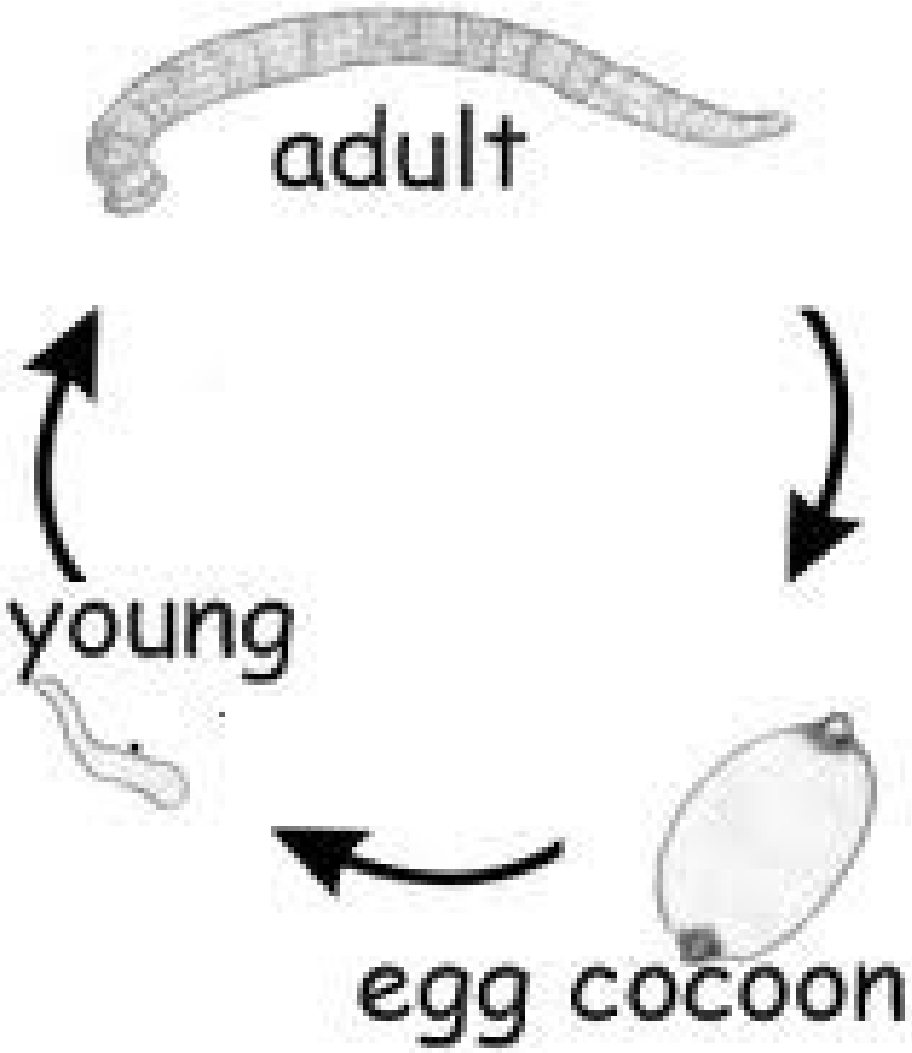
APPENDICES

Appendix 1: Cladogram for leech classification (After Ahmed *et al*., 2015)



Appendix 2: Leech life cycle (www.freshwaterlife.org)



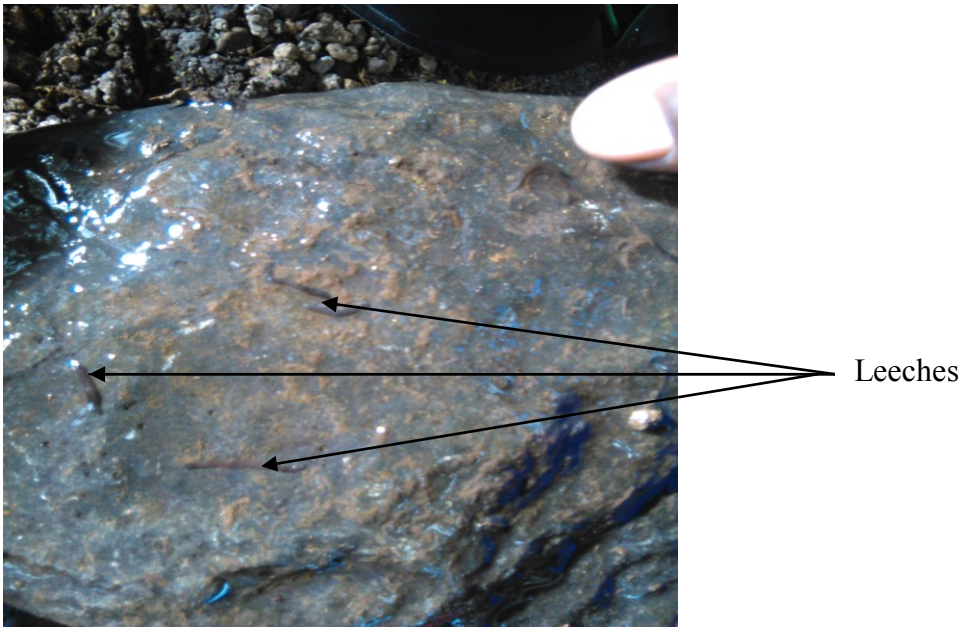
Appendix 3: Leech found on top of the fine grasses inside water at Endange-Rashid stream at Olpiro

Appendix 4: Leech recovered from Enjoro stream at Esere

Appendix 5: Larva recovered from Engine pond at Endulen

Appendix 6: Small leeches found under side of stone with larva at Leteu stream at Endulen

Appendix 7: Leeches collected under stone from Oldogom stream at Endulen



Appendix 8: Local sieve for home filtering water for cattle at Endulen

Appendix 9: Questionnaire

Questionnaire on Leeches in Ngorongoro.

Date: ……

District: NGORONGORO.

Ward: ENDULEN

Village no (1= Endulen, 2 = Esere , 3 = Olpiro)

1. Respondent No. …… Name……..
2. Age:

   (a) 0 – 25

   (b) 26 – 35

   (c) 36 – 45

   (d) Above 45 Gender: 1 = Male, 2 = Female

3. Position

   a) Male head

   b) Female head

   c) Other (specify) ……

4. Highest level of education

   a) No formal education

   b) Adult education

   c) Primary education

   d) Secondary education

   e) Tertiary education

   f) Others (specify) …..……

5. How long have you been in this area?

   (a) 0 – 5 years

   (b) 6 – 10 years

   (c) 11 – 20 years

   (d) > 20 years

6. Types of cattle kept:

   (a) Indigenous

   (b) Exotic

   (c) Both

7. How many cattle are you keeping?

   (a) 0 -200

   (b) 201- 400

   (c) 401- 600

   (d) > 601

8. Do you know about leeches? YES / NO

9. Do you know signs of leech infestation in cattle? YES / NO

10. How do you remove leech in cattle by

    (a) Salt (c) Manual removal with aid of rough leaf

    (b) Manual removal with aid of cloth (d) others (specify)

11. Which methods are you using to prevent cattle from leech infestation?

    (a) ……

    (b) ……

    (c) ……

    (d) ……

12. Have you ever inspected your cattle for presence of leeches? Yes / No

13. If yes, where did you inspect? Mention the place……..

14. Where do you take your cattle for drinking water?

    (a) ……..

    (b) ……..

    (c) …….

15. How do you consider problem of leech infestation in cattle?

    (a) Very important

    (b) Important

    (c) Present but not important

    (d) Not present

16. What do you think should be done to reduce the problem?

    (a) …….

    (b) ……

    (c) ……..

Additional comments on LEECHES:

……..……

……..……