Review on Bovine Schistosomiasis with Due Emphasis on Its Epidemiology

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SUMMARY
Schistosomiasis is caused by different species of parasitic worms, called schistosomes. It is a Neglected Tropical Disease (NTD) of profound medical and veterinary importance. As many as 10 different species of schistosomes have been reported to naturally infect cattle; six have received particular attention mainly because of their recognized veterinary significance. The geographical distribution of schistosoma species infecting cattle are mainly determined by the distribution of their respective intermediate host snails, level of infection and the frequency of water contacts. Epidemiological studies conducted on bovine schistosomiasis are suggestive of the endemicity of the disease in Ethiopia particularly in the area with large permanent water bodies and marsh pasture areas of the country. Most infections in endemic areas occur at a subclinical level. However, it has been established that high level of prevalence of subclinical infections cause significant losses due to long-term effects on animal growth and productivity and increased susceptibility to other diseases. Snail hosts favor intensive transmission of Schistosomiasis and the infection rate of the disease are mainly affected by host related factors, anthropogenic/ human factors like poorly designed irrigation projects, management and seasonal factors. Diagnosis is based primarily on the clinico-pathological picture, parasitological techniques and post mortem findings. The most effective way to control cattle schistosomiasis in endemic areas is to prevent contact between the animals and the parasite. Awareness creation about the disease, destruction of the snail intermediate host population at their breeding sites, either by chemical or biological methods may be considered as a recommendation to prevent the occurrence of bovine schistosomiasis.
Keywords: Bovine, Epidemiology, Risk factors

1. INTRODUCTION

In both developed and developing country, livestock plays vital roles in generating income to farmers, creating job opportunities, ensuring food security. In addition, they also contribute to asset, social, cultural and environmental values, and sustain livelihoods. In its different agro-ecological zones and suitable environmental conditions, Ethiopia is a home for many livestock species and suitable for livestock production (Solomon *et al*., 2003; Tilahun and Schmidt 2012). Ethiopia is recognized for its vast wealth of livestock; in Africa. However, the economic benefit derived from the livestock sector does not commensurate with the potential due to a number of complex and inter-related factors of which widespread diseases occurrences, poor genetic potential of local breeds and inefficiency of livestock development services are the major ones (Jabbar *et al*., 2007; Negassa *et al.,* 2011).

Ethiopian livestock hosts a number of bacterial, viral and parasitic diseases. Schistosomiasis is one of the most prevalent parasitic diseases of bovine species reported from many parts of the world including Ethiopia. Schistosomiasis is a snail borne trematode infection of man, animal and wild animals caused by genus schistosoma and occurring in different parts of tropical and subtropical countries. Schistosomes are dioecious (unisexual) worms, which is an exception among the trematodes. The mature female is more slender than the male and normally carried in ventral groove, the gynaecophoric canal which is formed by ventrally flexed lateral out growths of the male body (Bont, 1995).

The geographical distribution of bovine schistosomiasis has been determined primarily by the distribution of snail intermediate host particularly *Bulinus* species which are important for the occurrence of disease in bovine species. *Schistosoma bovis* is a species' whose final hosts are bovines, ovines, caprines and whose secondary hosts are small wild ruminants. They are distributed throughout Africa, South West Asia and Mediterranean, Europe. (Urquhart *et al*, 2003).

The epidemiological situation of schistosomiasis must not however, be regarded as static. The increasing use of irrigation in agriculture and fish breeding facilitate to increase number of snails which carry *Schistosoma* and as a consequence the human and animal incidence of schistosomiasis is increases. Moreover, level of infection, the frequency of water contacts and increasing cattle mobility through trading or rental increased the possibility of spreading the disease or infection sources (Islam *et al.,* 2011).

In Ethiopia, epidemiological studies conducted on bovine schistosomiasis are suggestive of the endemicity of the disease particularly in the area with large permanent water bodies and marshy pasture areas of the country. *Bulinus, Indoplanorbis, Glanorbi*d snail intermediate hosts are transmitting schistosomes to cattle (Solomon, 1985). Snail hosts favor intensive transmission of schistosomiasis, and the disease act as important pathogen in Africa and Asia (Vanwyk, *et al*, 1974). Cattle become infected through skin penetration and the oral route. The type of watering facilities used by domestic stock; is therefore a crucial factor in the maintenance and transmission of the infection.

Age, sex, breed, season, immunity, anthropogenic/ human, farming system and environmental factors are also playing the role for the prevalence and occurrence of schistosomiasis infection rate in animals. The young parasites cause some damage during migration, but the principal lesions and pathology are associated with passage of the spined eggs through the tissue of the gut lumen of intestine and other organs, and blood sucking habit of the helminthes worm (Soulsby, 1982).

Praziquantel is highly effective for the treatment of bovine schistosomiasis. Treatment of schistosomiasis helps in reversing acute or early chronic disease, preventing complications associated with chronic infection and preventing neuroschistosomiasis. The most effective way to control cattle schistosomiasis in endemic areas is to prevent contact between the animals and the parasite (Richer, 2003).

Since schistosomes of veterinary concern have received relatively little attention, detailed information on epidemiological data and various factors, which influence the host parasite relationship, appropriate prevention and control methods of bovine schistosomiasis in Ethiopia as well as in the world, are generally limited. Thus, the present review was carried out with the objective of to review on bovine schistosomiasis with due emphasis on its epidemiology; prevention and control strategies.

2. LITERATURE REVIEW

2.1. Etiology

Schistosomiasis (blood fluke disease or bilharzosis) is an infection due to the genus schistsoma. Adult Schistosomes are obligate parasite of the blood vascular system of vertebrates. Schistosomes are dioecious (unisexual) worms, which is an exception among the trematodes. The mature female is more slender than the male and normally carried in ventral groove, the gynaecophoric canal which is formed by ventrally flexed lateral out growths of the male body (Bont, 1995). A total of 19 different species are described worldwide (Bont 1995). They can be differentiated through their morphological features, life cycle, host specificity or enzyme; and DNA and behavioral characteristics (Rollinson and Southgate, 1987). Out of 10 species reported to naturally infect cattle, six have received particular attention mainly because of their recognized veterinary significance. Some of the species are *S. metheei*, S. *bovis, S. cunasoni*, *S. spindale, S. indicum,* and *S. nasale* (Hira and Patel, 1981).

2.2. Peculiar feature of Schistosoma species

Blood flukes do not resemble most other fluke species. Instead of being flat and with an oval shape, they look very much like "normal" worms. Also unlike most other flukes *Schistosoma* is not hermaphroditic but **bisexual,** and males and females show a different form (sexual dimorphism). Males are about 10 to 20 mm long and 1 to 2 mm thick, whereas females are 20 to 30 mm long and <1 mm thick, i.e. significantly longer and thinner than males. The oral and ventral **suckers** are rather small. Each male has a special structure along its body, the gynaecophoric canal, where the adult female resides permanently. In fact it seems that females cannot mature in absence of the males (Figure 1). As in other flukes the digestive system of *Schistosoma* is blind, i.e. it has no anus but ends in a blind branch, the **cecum.** *Schistosoma* **eggs** have species-specific sizes (130-300x40-90 micrometers) and are oval to spindle-shaped, with or without spines (Kahn, 2011).

2.3. Epidemiology

Schistosomiasis is closely associated with large permanent water bodies such as ponds, lakes and marshy pastures. A key determinant in the epidemiology of this infection is the relative abundance of the intermediate hosts and their ability to develop and survive in the environment. Contamination of water with schistosome eggs results when animal defecate in the water while drinking or if manure is used for feeding fish in ponds. Cattle become infected through skin penetration and the oral route. The type of watering facilities used by domestic stock is therefore a crucial factor in the maintenance and transmission of the infection (Pruss-Ustun *et al*., 2004). The geographical distribution of bovine schistosomiasis has been determined primarily by the distribution of snail intermediate host particularly *Bulinus* species which are important for the occurrence of disease in bovine species. *Schistosoma bovis* in central, eastern and west Africa, the Mediterranean area and the Middle East; *S. mattheei* in central, southern and eastern Africa; *S. intercalatum* in central Africa; S. *japonicum* in the Far East (a species infecting humans but which may also cause schistosomiasis in ruminants and other host species), *S. nasalis* is found in the veins of the nasal mucosa of livestock in the Indian subcontinent (Urquhart *et al.*, 2003). For this reason, the epidemiological situation of schistosomiasis must not however, be regarded as static, rather depending on the presence of intermediate snail hosts, their level of infection, and the frequency of water contacts (Kahn, 2011).

The increasing use of irrigation in agriculture and fish breeding facilitate to increase number of snails which carry *Schistosome* and as a consequence the human and animal incidence of schistosomiasis is increased.

In areas where conditions are favorable, prevalence of infections in cattle may be 40%–70% and commonly higher. Although this parasite occur in many tropical and subtropical areas, the disease is important in livestock mainly in Eastern Asia., Africa and India (Sewell and Brocklebsy, 1990). It's estimated that at least 165 million animals infected (De Bont and Vercruysse, 1997).

2.3.1. Risk factors for infection

2.3.1.1. Host related risk factors

Age

Infection rate increased with the increase of age and peak infection occurred at the maturity of age (Bedarkar *et al*. 2000). This might be due to a long exposure time because older animals move long distances in search of scarce pastures and water thereby increasing their chances of infection as well as becoming infected at overcrowded watering holes. On the other hand, the very young calf do not graze extensively as the older do, so they get less infection of cercariae unlike adult animals. Kassaw (2007) and Nagi *et al*., (1999) also reported that the increased contact time with schistosoma infested habitat increases the rate and endemicity of schistosomiasis.

Sex

Differences in susceptibility to infection between sexes have been observed by various workers. The observed disparity may not solely due to difference in susceptibility but may also depend on a sex-related variation in behavior that results in differences in exposure (Magona and Musisi, 2002). The reason seems to be related to social practice of keeping females under better management and feeding condition for milk production and breeding whether males are generally let lose to graze freely in pasture and infrequently used for draught purpose and also more stressed. Males are also fed relatively poor diet which increases the susceptibility to parasitic infection (Houdijk and Athana, 2003).

Breed

Alemseged *et al.,* (2010) reported as local breeds are more affected by schistosomiasis than cross breeds. This difference in prevalence of the disease does not appear to be due to the difference in susceptibility but due to the difference in exposure. Cross breeds are mostly kept for dairy or fattening purpose and they are mostly housed and supplementing good feed and clean water which reduce their access to the cercariae. However, the local once are mostly managed extensively to graze freely and get access to infective stage of the parasite.

Immunity

Cattle residing in endemic areas show a typical pattern in faecal egg counts. The faecal egg excretion usually starts between 4 and 8 months of life, counts increase rapidly to reach a maximum around the age of 6–15 months and then decrease markedly by the age of 18 months (De Bont and Vercruysse, 1997). In older animals, faecal egg counts remain low, tissue egg counts seem to follow the pattern of the faecal egg counts, while worm burden tends to increase with the age of the host (Majid *et al.*, 1980) cited by (vercruysse & Gabriel, 2005).

This suggests the development of an acquired immunity, which mainly acts through a reduction of the fecundity of the female worm, expressed as reduced faecal, and tissue egg counts, with few effects on worm burden. However, evidence is accumulating that with increasing duration of exposure to continuous challenge, cattle also become less susceptible to reinfection. Examination of naturally infected animals has shown that partial protection against reinfection also occurs, and acquired resistance to schistosomes is of major importance in the regulation of infection intensity in the field (Kahn, 2011)

According to some authors, the strength of the immunological response of the host which results in reduced worm fecundity could be related to the intensity of the primary infection, i.e. low levels of infection failing to stimulate the host response (vercruysse & Gabriel, 2005). The suppression in egg production is probably induced by serum-born factors, since adult worms from cattle with naturally acquired immunity to *S. bovi*s, surgically transplanted into non-immune animals, produced large number of eggs again (Bushura *et al.,* 1982, Bushura *et al.,* 1994). Reductions in worm burden and egg counts could also be induced in non-immune calves, which received serum from immune donors (Bushura *et al.,* 1994).

A few studies reported on heterologous resistance. Calves previously exposed to infection with the human schistosomes *S. mansoni* and *S. haematobium* were partially protected against *S. mattheei* and *S. bovis*, and it was believed that this type of heterologous resistance might be of considerable importance in protecting cattle from the more serious effects of schistosomiasis (De Bont and Vercruysse, 1997).

2.2.1.2. Seasonal risk factors

Schistosome infection rate in cattle increases during rainy season. The highest infection rate in rainy season could be due to abundance of snails and their rapid multiplication and dispersion. Furthermore, dispersion of fecal matter occurs due to rain splashes. These factors may enhance the infection of snails by miracidia and cercarial contamination to adjacent areas through water. During this time conditions on the lands are suitable for the survival of the intermediate hosts and they become heavily infected with the schistosome larval stages. So, cattle are prone to get the infection of schistosomes (Soulsby, 1982). But in dry season infection rate of the schistosome parasite is low because of harsh dry conditions and less chances of infection due to unavailability of snail intermediate hosts as the water sources are scarce in this season (Kahn, 2011)

2.2.1.3. Management risk factors

Infection rate reported to be low in intensive farming system where animals are mainly stall fed. This might be due to the better management practices and sanitation. Belayneh and Tadesse (2014) highlighted the fact that proper management practices and policy change towards urban husbandry can minimize the schistosomiasis prevalence. They also reported that when cattle are slaughtered through back yard system and consequently the stomach and other intestinal contents including blood and washed materials are dumped into the nearby water bodies' prevalence of the disease also increases.

In the semi-intensive system of rearing where animals grazing in the fields have more risks of getting contact with water and subsequently with the infective stage, cercaria. Moreover, increasing cattle mobility through trading and or rental potentially increases the possibility of spreading the disease or infection sources (Kahn, 2011)

In addition to management risk factors, cattle schistosomiasis is dependent on environmental factors such as moisture, rain fall, temperature, presence of water bodies (stagnant, swampy, and marshy) and snail intermediate hosts. Husbandry practice such as grazing system, keeping animals whether they are kept all together and / or separately, feeding (contaminated pasture with larva) and drinking areas (Mersha *et al*., 2012).

2.3.1.4. Anthropogenic/human factors

Construction of water schemes to meet the power and agricultural requirements for development have lead to increasing rates of transmission of schistosomiasis (Chitsulo *et al.,* 2000). The impact of prolonged available surface water in newly developed irrigation areas is a predisposing factor for water and vector-borne diseases. Areas that are periodically affected by schistosomiasis are exposed to continued year round attack due to suitable environment for snails' survival (Behailu and Haile, 2002).

A major factor associated with the increase of schistosomiasis is water development projects, particularly manmade lakes (hydroelectric power) and irrigation schemes (agriculture), which can lead to shifts in snail vector populations (Patz *et al*., 2000; WHO, 2002). On the other hand, water stagnation and weed growing due to inadequate water management sustain the life of the snails to complete the life cycle of schistosomes (Boeele and Madsen, 2006). Many surface irrigation systems in Africa create favorable snail-breeding conditions that facilitate the transmission of schistosomiasis (WHO, 2004). Irrigation schemes are dynamic agro-ecosystems that can transport snails a long way along the canals and where local events can either provide habitat-friendly conditions or inhibit snail populations (Dale and Polasky, 2007).

Generally, the variability within irrigated areas, the canal type, the distance of sites from the canal, the composition and density of aquatic vegetation (Khallaayoune, 1998a), the season (WHO, 2007), specific local conditions such as water stagnation, water depth and shading (Dale and Polasky, 2007) and water flow velocities and the location of breeding sites affect the presence and density of snails among sites. Low-flow velocities and locations found at the starting point of low-order canals are favorable to get aeration of the water and food availability for snails (Boelee and Madsen, 2006).

2.4. Transmission

Schistosomes live in the mesenteric and hepatic veins of the host (except for *S. nasale*, which lives in the nasal veins), where they feed on blood and produce eggs with a characteristic terminal or lateral spine. Eggs passed in the feces must be deposited in water, hatch and release miracidia, which invade suitable water snails and develop through primary and secondary sporocysts to become cercariae (Fraser *et al*., 1991)

When fully mature, the cercariae leave the snail and swim freely in the water, where they remain viable for several hours. Ruminants are usually infected with cercariae by penetration of the skin, although infection may be acquired orally while animals are drinking. During penetration, cercariae develop into schistosomula, which are transported via the lymph and blood to their predilection sites. The prepatent period varies according to the species but is generally 45–70 days. The increased host range of the hybrid parasites and changes in host distribution seen in Africa may have a direct impact on transmission of these schistosomes. Laboratory hybrids have been observed to acquire enhanced characteristics such as infectivity, fecundity, and growth rates (Kahn, 2011).

2.5. Life Cycle

Schistosomes are dioecious (unisexual) worms, which are an exception among the trematodes and have an indirect life cycle, while water snail act as an intermediate host belong to the genera *Bullinus* and *planorbis* (Brown, 1980).

The adult females lay eggs in the capillaries of the intestinal wall. The egg masses form abscesses that finally burst and release the eggs into the gut, which are transported outside with the host's feces. Once outside and in contact with water the eggs release small swimming larvae, the miracidia, which find a suitable snail and penetrate into its body. Inside the snail miracidia develop further during 1 to 4 months through two generations of sporocysts to asexually produce dozens of cercariae. Mature infective cercariae leave the snail through its respiratory hole. A single snail can release up to 3'000 cercariae (Kahn, 2011).

Free-swimming cercariae actively search a final host. Their survival in the environment is limited to a few days. The infective stage for the disease is matured cercaria after they leave the snail invade the final host through the skin or mucus membranes penetration or are ingested with contaminated water when grazing in marshes, swamps, and otherwise humid vegetation. Ingested cercariae penetrate the rumen. Once inside the host's body they get into a blood vessel and start a species-specific migration (often passively transported with the blood) through various organs until they reach their preferred final locations where they complete development to adult flukes, copulate and start producing eggs. During this time they feed on red blood cells (Aiello, 1998).

Visceral Schistosomes mature in the hepatic portal veins, mate and migrate to the mesenteric veins where egg production starts (Bont, 1995). The female in the mesenteric vein insert her tail in to the venule. The eggs penetrate the venule endothelium aided by their spines and by proteolytic enzymes secreted by the unhatched miracidia (Urquhart*, et al*., 1987). Egg lay by the female worm penetrate the wall of the veins and migrate to the intestinal lumen or the nasal cavity. (*S. nasale*) of the host are retained inside the body and it is the retained eggs and their products that responsible for most morbidity from Schistosomiasis (Fekade *et al*., 1989).

2.6. Pathogenesis

When the cercariae are fully matured, they leave the snail and invade the final host through the skin or mucous membranes. After penetration cercariae develop in schistosomula, which are transported through the lymph and blood to their predilection sites (Jones *et al.*, 1997). The migration of the eggs may cause mechanical damage and lesions. Moreover, Schistosoma eggs trapped in the tissue elicit granulomatous reaction that is mounted to destruct the eggs. These granulomas consist of several cell types, mainly eosinophils, macrophages and lymphocytes (Olds and Mahamoud, 1980). In the chronic stages of the disease, the pathology is associated with collagen deposition and fibrosis, resulting in organ damage and dysfunction (Kogulan and Lucey, 2005).

The major disease syndromes associated with Schistosomes include dermatitis, acute and chronic Schistosomiasis (Macsween and Whaley, 1993). The intensity of lesions and signs depends on the duration of infection, number and location of eggs trapped in tissues, species of the parasite and with the immunity of the host to the parasite. At necropsy during the acute phase of the disease there is marked hemorrhagic lesions in the mucosa of the intestine, but as the disease progress the whole of intestine appears grayish, thickened and edematous due to confluence of the egg granulomata and the associated inflammatory changes, on sections of the liver there is also evidence of granulomata and of portal fibrosis provoked by eggs which have, inadvertently, been swept into small portal vessels (Urquhart *et al.,* 1996)

Generally, the pathologies of schistosoma infections are highly associated with the eggs and the intensity of the pathogenic effects depends on the duration of the infection and the number of Schistosomes present. Adult parasites in the vascular system can cause lesions. Cercaria induced skin lesions have been also described (Jones *et al*., 1997).

2.7. Clinical findings

The effects of schistosome infections of livestock are not easily recognized and the non-specific clinical signs are often overlooked by farmers. Infections may, however, result in severe clinical signs. The infections are often manifested by acute intestinal signs, 7-9 weeks after infection (the time when the females produce large numbers of eggs which penetrate the gut wall) (Kahn, 2011)

The principal clinical signs are associated with passage of the spined eggs through the tissue of the gut lumen. The young parasites cause some damage during migration, but most of the lesions are due to the irritation produced by the eggs of parasites in the intestine and other organs, and blood sucking habit of the helminthes worm. The helminthes worm may also enter the vesical veins and they may cause hematuria (Soulsby. 1982). In cattle the clinical sign exhibited are emaciation, marked diarrhea mixed with blood or mucous, dehydration, pallor of mucus membrane marked weight loss, decreased production and rough hair coat (Bont, 1995).

Signs associated with chronic hepatic disease may develop when eggs are washed back to the liver by the portal circulation during their penetration of the gut wall. The eggs become lodged in the liver and an intense immunological response results, followed by the formation of a granuloma. A large proportion of the liver may be destroyed and the liver function severely disturbed (Mersha *et al*., 2012)

2.8. Diagnosis

Diagnosis is based primarily on the clinico-pathological picture, seasonal occurrence, previous history of schistosomiasis in the area or the identification of snail habitats with a history of access to natural water bodies, demonstration of characteristic eggs based on the species in the feces, postmortem examination and hematological tests (Urquhart *et al.,* 1997).

Clinical signs

Cattle infected with *S. bovis* develop a syndrome characterized by weight loss, poor weight gain, diarrhoea, loss of appetite, roughness of the skin, and pale mucous membranes. These signs are usually observed by 6-7 weeks after exposure to the infective stage, the cercaria. The severity of these signs increases between the 7th and the 9th week, where the fecal egg counts are highest. However, the clinical signs of the disease are unreliable as other trematodes parasites may produce similar clinical signs (Kahn, 2011)

Postmortem findings

At necropsy, *S. bovis* infection can be diagnosed by finding thousands of visible adult worms in the mesenteric veins. 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 (Hendrix and Robinson, 2006). 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.

Parasitological techniques

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 eggs are characteristics in shape and size for each species. The Schistosomes eggs oval (as in *S. monsoni, S. haematobium*, *S. japonicum*) to spindle shaped (*S. bovis, S. mattheei*) containing a single spined protruding from the shell (Jones and Hunt, 1997).

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. In general when schistosomiasis is suspected, diagnosis is best confirmed by a detailed postmortem examination which reveal lesion and if mesentery is stretched, the presence of numerous Schistosomes in the veins (Urquhart, *et al*., 1987).

2.9. Economic and public health significance of the disease

In attempting to estimate the economic importance of schistosomiasis one is strongly confronted with a varied array of factors for most of which there are no adequate measurements, among these factors are geographical distribution, prevalence, intensity of infection, clinical gradients, morbidity and mortality, and transmission patterns, which are influenced by environmental conditions, the relative efficiency of intermediate hosts and agricultural practices (Wright, 2015).

Although few or no overt clinical signs may be recognized in the short term, high prevalence rates of chronic schistosome infections cause significant losses on a herd basis. These losses are due to less easily recognizable effects on growth and productivity, as well as increased susceptibility to other parasitic and bacterial diseases (De Bont & Vercruysse, 1998)

According to (Cauley *et al*., 1984) in addition to the high prevalence, outbreak of the disease and increased susceptibility to other parasitic and bacterial disease, the disease has an economic impact like production losses due to *S. bovis* that result from mortality, delayed growth, partial liver condemnation and poor future reproduction performance and sub-clinical infections cause significant losses due to long term effects on animal growth and productive capacity or milk yield and draft power

Over 200 million people are infected over at least in 75 countries with 500 million or more people exposed to infection. Schistosomiasis caused by *S. mansoni*, *S. haematobium* and *S. japonicum* is secondary only to malaria and affect approximately 200 million people in Africa, Asia, and South America (Bowman, 2003; Mohammad and Waqtola, 2006). Cercarial dermatitis or swimmer's itch is a condition caused when cercariae of blood flukes that normally parasitize aquatic birds and mammals penetrate the human skin, sensitizing the areas of attack and causing pustules and an itchy rash. Since humans are not suitable definitive hosts for these flukes, the cercariae do not normally enter the blood stream and mature instead, after penetrating the skin, they are destroyed by the victim's immune response. Allergenic material released from dead and dying cercariae produce a localized inflammatory reaction**.** Humans may become sensitized and develop pruritic macula papular, then vesicular skin lesions at the site of penetration. Skin lesions may be accompanied by a systemic febrile response that runs for 5 to 7 days and resolves spontaneously (Kahn, 2011)

Cercarial dermatitis occurs worldwide. In North America, ocean-related schistosome dermatitis (clam diggers itch) occurs on all Atlantic, Gulf, Pacific, and Hawaiian coasts. It is common in muddy flats off Cape Cod. A form of cutaneus larva migrants often called "swimmers itch" (cercarial dermatitis) occurs in man and Schistosomes which have a limited migration in human skin (Hendrix and Robinson, 2006). Migratory water fowl frequently harbour schistosomes (blood flukes) in their blood vasculature. These schistosomes produce eggs that pass in the bird's feces to the water environment. The eggs hatch, producing miracidia, which turn penetrate a aquatic snails with the snail, the miracidium undergo asexual reproduction and produce thousands of cercariae these cercariae exit the snail to penetrate the definitive host, the migratory water fowl (Hendrix and Robinson, 2006).

Humans serve as incidental hosts for these avian schistosomes. During the swimmer months, people swim or wade in the lakes, ponds, rivers and even ocean waters frequented by the wild birds. The cercariae released from the snails penetrate the skin of humans instead of the skin of the migratory birds (Urquhart, *et al*., 1987). Schistosome infection of animals can be a serious factor in human transmission at least in the case of one species *S. japonicum* (Hall, 1985).

2.10. Status of Bovine schistosomiasis in Ethiopia

In Ethiopia, bovine schistosomiasis is one of the major constraints of animal disease by causing mortality, low fertility, retarded growth, poor productivity (poor conversion rate), low milk yield and increased susceptibility to other parasitic or bacterial disease (Dargie, 1980). However, reports on animal schistosomes are very scanty and it has been considered as an occasional finding in slaughter house and postmortem examinations (Shibru, *et al*, 1989). According to (Solomon, 1985), *S. bovis* is the only species reported with localized distribution in ten out of fourteen administrative regions in the country. Detailed information on prevalence and intensity of infection of *S. bovis* in Ethiopia and various factors, which influence the host parasite relationship, are generally lacking.

But recently, epidemiological studies conducted on bovine schistosomiasis are suggestive of the endemicity of the disease particularly in the area with large permanent water bodies and marshy pasture areas of the country. *S. bovis* has a localized distribution, which is found commonly in northern, eastern, southwestern and central parts of Ethiopia. In Ethiopia, the prevalence and distribution of bovine schistosomiasis is not well known and three species of snail intermediate hosts are identified so far; *Bulinus abyssinicus, Bulinus africanus, Bulinus trancatus* transmit this parasite to cattle (Lo, 1973) and probably also to sheep. Studies conducted in different parts of Ethiopia that reports different level of prevalence are summarized in table 1.

2.11. Treatment

Praziquantel is highly effective for the treatment of bovine schistosomiasis. Treatment of schistosomiasis helps in reversing acute or early chronic disease, preventing complications associated with chronic infection and preventing neuroschistosomiasis. The goal of treatment is reduction of egg production via reduction of worm load: this reduces mortality and morbidity (Richer, 2003). Care has to be exercised in treating clinical cases of schistosomiasis since the dislodgement of the damaged flukes may result in emboli being formed and subsequent occlusion of major mesenteric and portal blood vessels with fatal consequences (Urquhart *et al.,* 1996)

2.12. Control and prevention

A pre-requisite for disease control/prevention is to screen factors facilitating identification of categories of animals that are at particular risk of developing an infection (Thrusfield, 1995). So, an in depth understanding of the epidemiology of schistosomiasis is required to develop control strategies. The most effective way to control cattle schistosomiasis in endemic areas is to prevent contact between the animals and the parasite. Unfortunately, this is not always possible in parts of the world where nomadic conditions of management prevail (Bont, 1995).

Other methods of control include destruction of the snail intermediate host population at transmission sites, either by chemical or biological methods, or their removal by mechanical barriers or snail traps, ecological measures and management methods of controlling. From the current available chemical Bayluscide (Niclosamide) and copper sulfate are the choices for molluscicide. In addition to these, a native Ethiopia plant, *phytoplaca dodecandora*, locally known as "endod" is also an effective molluscicide (Shibru *et al*., 1989).

Biological control of blood flukes (i.e. using their natural enemies) is so far not feasible. However there are medicinal plants which are affective against external and internal parasites. Ecological measures against the snails that aim to render their habitat unsuitable for survival, such as drainage, removal of water weeds, and increased water flow, have also proved valuable. These measures not only help reduce the transmission of schistosomiasis but also help control other parasitic trematodes such as *Fasciola gigantica* and paramphistomes, which also have water snails as intermediate hosts and frequently are found in the same localities as schistosomes (Kahn, 2011). In human, the most effective way of controlling Schistosomiasis are the provision of sanitary facilities and piped water since; it reduces human contact with contaminated water (Mohammad and Waqtola, 2006).

3. Conclusion

Schistosomiasis is a chronic debilitating infection of humans and animals caused by different species of schistosomes. *S. bovis,* the agent of schistosomiasis in cattle is one of the major veterinary problems in many Mediterranean and African countries. Occurrence of bovine schistosomiasis is dependent on environmental factors such as moisture, rain fall, temperature, water bodies (stagnant, swampy and marshy) and snail intermediate hosts. Few epidemiological studies conducted on bovine schistosomiasis in Ethiopia indicate, the endemicity of the disease in the country. Although few or no overt clinical signs may be recognized in case of bovine schistosomiasis in the short term, high prevalence of chronic schistosome infections cause significant losses on a herd basis. Although the economic significance of the disease is mainly attributed to morbidity, mortality, liver condemnation, reduced productivity and poor subsequent reproductive performance, still there a limitation on detailed information of epidemiology; and various factors, which influence the host parasite relationship. Therefore, further study on the epidemiology of the disease like malacological and parasitological survey, and mapping high risk areas, destruction of the snail intermediate host population at their breeding sites, either by chemical or biological methods should be carried out for sound prevention and control of schistosomiasis.

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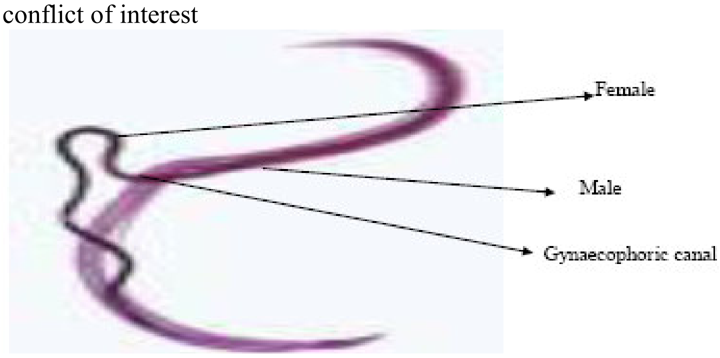

Figure 1. Mature Schistosome worm: female lying in the gynaecophoric canal of male.
Source: (Urquhart *et al*., 1987).

Table 1. Prevalence of Bovine schistosomiasis in different parts of Ethiopia.

Author/s name	Study area	Prevalence reported
Lemma, (1973)	Awassa	5.5%
Lo, (1973)	Gewene	1.5%
Solomon, (1985)	Bahirdar	33%
Haile, (1985)	Bahirdar	33%
Aemro, (1993)	Bahirdar	12.3%
Hailu, (1999)	Bahir Dar	34%
Mengistu *et al*.(2012)	Fogera district	10.17%
Ameni *et al*. (2001)	Kamissie	28%
Yelelet, (2004)	Bahirdar	17.4%
Almaz, (2007)	Bahirdar	10.93%
Solomon, (2008)	Bahirdar	28.14%
Zelalem, (2010).	Fogera district	12.5%
Alemseged *et al.* (2010)	Dembi district	27.13%
Mersha *et al.* (2011)	South Gondar	13.7%
Abebe *et al.*(2011)	Jimma Zone	13.46%
Mihrat and Samuel, (2015)	DabireTabor	7.6%