STUDIES ON RICE FIELDS SNAILS AND URINARY SCHISTOSOMIASIS AMONG RICE FARMERS IN KURA LOCAL GOVERNMENT AREA, KANO STATE, NIGERIA.

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A DISSERTATION SUBMITTED TO THE SCHOOL OF POSTGRADUATE STUDIES, AHMADU BELLO UNIVERSITY, ZARIA IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF MASTER OF SCIENCE (M.Sc) DEGREE IN ZOOLOGY.

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NIGERIA.

DECEMBER, 2016.

DECLARATION

I declare that the work in this dissertation entitled "STUDIES ON RICE FIELDS SNAILS AND URINARY SCHISTOSOMIASIS AMONG RICE FARMERS IN KURA LOCAL GOVERNMENT AREA, KANO STATE, NIGERIA" has been carried out by me in the Department of Zoology, Ahmadu Bello University Zaria, Nigeria. The information derived from literature has been duly acknowledged in the text and in a list of references provided. No part of this work was previously presented for another Diploma or Degree at any institution.

Aisha Salihu JIBRIL _____ _____

Signature **Date**

CERTIFICATION

This dissertation entitled "**STUDIES ON RICE FIELDS SNAILS AND URINARY SCHISTOSOMIASIS AMONG RICE FARMERS IN KURA LOCAL GOVERNMENT AREA, KANO STATE, NIGERIA"** by Aisha Salihu, JIBRIL meets the regulations governing the award of the degree of Master of Science (M.Sc.) in Zoology of the Ahmadu Bello University Zaria, and is approved for its contribution to knowledge and literary presentation.

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DEDICATION

To Almighty Allah for His infinite mercy and to my beloved husband AbdulRahman Mohammed Manzuma.

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ABSTRACT

Ecological and parasitological studies were conducted in four agrarian districts (Butalawa, Dalili, Kosawa, Sarkin Kura) of Kura Local Government Area of Kano State, Nigeria to determine species composition, abundance and natural infection of molluscs by parasitic trematodes in rice field ecosystems; as well as the prevalence and intensity of urinary schistosomiasis among rice farmers. Manual prospections for molluscs diversity were conducted and physicochemical conditions of their microhabitats in rice fields were determined *in situ* using HANNA (HI98129) multiparameter metre. A total of 1959 specimens of five species of molluscs were obtained from the rice fields, which included 39(1.99%) *Bellamya crawshayi*, 307(15.67%) *Biomphalaria pfeifferi*, 548(27.97%) *Bulinusglobosus*, 95(4.85%) *Lymnaeanatalensis*, and 970(49.52%) *Melanoidesmaculata*.Only four (0.73%), of the *B.globosus* shed cercariae of trematode, giving snail infection rate of 0.20%.*Bellamyacrawshayi* and *L.natalensis* occurred at low percentages and were found only in two of the four districts; but *B. pfeifferi*, *B. globosus* and *M. maculata* occu rred in all the four districts. Physicochemical conditions of the rice fields where the molluscs species occurred in water were pH (8.24-9.70), TDS (30.00-39.00ppm), EC (64-77µs/cm) and temperature (24.00-27.50^{o}**C**). The species specific physicochemical conditions of molluscs' micro habitats did not differ significantly ($P>0.05$). District specific physicochemical parameters of rice fields' water differ significantly ($P<0.05$) amongst the four districts. Very high positive and significant ($r = 0.99$; $P<0.05$) correlation existed among the abundance of and both pH and temperature of rice fields' water in Dalili district ; and among *B. pfeifferi* abundance and temperature of rice fields' water in Kosawa district. An overall prevalence of urinary schistosomiasis of 211/420 (50.24%) was obtained in rice farmers in the study area; this ranged from 44/105 (41.90%) at Butalawa district to 63/105 (60%) at Sarkin Kura district. Prevalence of

urinary schistosomiasis in the female rice farmers was 48/111 (43.24%), and was 163/309(52.75%) in the male rice farmers. Intensities of urinary schistosomiasis ranged significantly ($P<0.05$) from 5.02(eggs per 10mL urine) in Butalawa district to 51.84 (eggs per 10mL urine) in Dalili district. Male rice farmers had significantly ($P<0.05$) higher intensities of infection than their female counterpart at both Dalili and Sarkin Kura, but gender based differences in intensities were not significant ($P>0.05$) at both Butalawa and Kosawa districts. A large majority (77.25%) of the rice farmers examined had light intensity of infection with 0-30eggs per 10mL urine. Acquisition of urinary schistosomiasis by the rice farmers was positively ($OR>1$) but insignificantly (Lower CI < 1) associated with the male gender. Rice farmers that were 10 years of age and younger had the highest prevalence of 78.05% while those aged 41years and older were not infected by *Schistosoma haematobium*. Prevalence of urinary schistosomiasis in the rice farmers declined significantly ($P<0.05$) with increasing age (declining from 78.05% in those aged 1-10years, to 19.35% in 31-40years group and nil in those aged 41years and older). Such epidemiologic risk factors as male gender, swimming and washing water contact activities, drinking from stream water, urination and or defaecation on rice farms, non-use of protective wears and lack of disease awareness were associated with the prevalence and transmission of urinary schistosomiasis among the rice farmers.

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ABBREVIATIONS

ANOVA	Analysis of variance
EC	Electrical Conductivity
pH	Potential of hydrogen ion
TDS	Total Dissolved Solids
TEMP	Temperature
OR	Odds Ratio

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background of the Study

Urinary schistosomiasis is a chronic human debilitating disease, caused by infection with the trematode *Schistosoma haematobium* (Ahmad *et al.*,2014).*Schistosoma haematobium* was first described by a German Pathologist, Theodore Maximilian Bilharz in 1851 during an autopsy on an Egyptian patient; and the common name for all forms of schistosomiasis is 'bilharziasis' in honour of his discovery (Okpala, 2010).Schistosome infections caused mainly by*Schistosoma haematobium* were estimated to occur in Africa, accounting for more than 97% of the number of infections worldwide (Steinmann*et al.*, 2006). Nigeria is one of the countries highly endemic for urinary schistosomiasis, where the disease has been unsystematically reported and large areas remain where the disease status is unknown (Anosike *et al.*, 2001).While at least 258 million requires preventive treatment forschistosomiasis in 2014, more than 61.6million people were treated for schistosomiasis in 2014 (WHO, 2016). The transmission of Schistosomiasis has been reported for 78 countries, treatment is required in only 52 endemic countries with moderate to high transmissions (WHO, 2016).

The disease is characterized by haematuria in 50% of cases, inflammation of the bladder, increased frequency of passing urine (micturation) and reduced bladder capacity sometimes leading to death (Usaini *et al*., 2015).The urethral lumen becomes greatly closed, penis or scrotum may develop obstruction and fistulae may tear through the skin (Usaini *etal*., 2015).The intermediate hosts of schistosomes in Africa are freshwater pulmonate snails, which belong to the Planorbidae family. The *snail* hosts belong to two genera, namely *Biomphalaria,* hostfor *S. mansoni,* and *Bulinus*, host for *S. haematobium* and *S. intercalatum* (Ngele*et al*.,

2012).Freshwater snails act as intermediate hosts, after being infected by schistosome "miracidia"(larvae thatemerge by the hatching of eggs found in human excreta or urine, deposited in the water), following developmental stages in the snails, cercariae are produced which are released into the body of water frequented by humans. As a result of contact with these cerceriae during water-based activities, the cerceriae penetrates the skin of the susceptible human hosts. The disease may cause damage to various tissues (the bladder, liver or the intestines) depending on the species. There are 16 different known species of *Schistosoma*, of which five are infective to man *S. mansoni, S. haematobium, S. intercalatum,S. japonicum* and *S. mekongi.* The species differ according to their snail intermediate hosts, egg morphology,final location of the adult worms in the human body, resulting symptoms, and their geographical distribution (Boelee and Madsen,2006).

The most common forms of the disease in Africa are: intestinal schistosomiasis, which is caused by*S. mansoni;* and urinary schistosomiasis, which is caused by *S. haematobium.*In sub-Saharan Africa, approximately 393 million people are at risk of infection from *S. mansoni,* ofwhich 54 million are infected. Those numbers for *S. haematobium* are estimated to be as high as436 million at risk, of which 112 million are infected (Van der Werf *et al.*,2003). Schistosomiasis is widespread, ranking second to malaria in term of socio-economic and public health significance in tropical and sub-tropical areas (Usaini *et al.,* 2015). Up to 60.99% of rice farmers had urinary schistosomiasis in a focal survey within Kaduna State, Nigeria (Oguike, 2015).

The transmission of schistosomiasis is associated with water development projects such as dams for irrigation systems and fishing, as the snail intermediate hosts of the parasites breed in them and they encourage human water contact (Jeffrey *et al*., 2004)

Kura Local Government lies in the Sudan Savanna vegetation zone isthe most extensively irrigated Local Government Area in Kano State, Nigeria due to the introduction of irrigation system in the area. As an agricultural town Kura is known for the production of food and vegetable crops both during dry and rainy season. The dry seasons mostly start from October and ends in April, while the rainy season begins from May and ends in September; with an average annual rainfall of 134.4mm. The inhabitantsof the Local Government Area are 80% farmers who are engaged in mixed farming in both the seasons. Some of the crops produced in the area are rice, wheat, maize, millet, Guinea-corn, beans and tomatoes, of which rice is highly cultivated than other crops. Thus with the population of this community who are mostly farmers, this is a risk factor of schistosomiasis, which is commonly known as TSARGIYA in this community.Various forms of water contact activities such as swimming, playing,farming, laundryand bathing have been found to enhance the transmission of schistosomiasis (Ahmad *et al*., 2014). These activities were amongst those reported to be responsible for the transmission of the disease at RuwanSanyi dam site at Malumfashi in Northern Nigeria (Ahmad *et al*., 2014). In this study, boys of less than 21 years of age were found to account for more than 79% of the infected individuals (Bichi *et al* ., 2003). Also many such cases were reported in areas at close proximity to contaminated waters among this age group in some parts of Kano State Nigeria (Abdullahi, 2009; Ekpo *et al.,* 2010).

1.2 Statement of the Research Problem.

- Ecology of snails in rice field habitats is poorly understood in Nigeria despite the association of specific gastropod hosts of *Schistosoma* species with these habitats (Oguike, 2015).

- Local rice production has received governmental impetus in Nigeria but the potential health risk and disease burden associated with rice farming are largely ignored.
- Schistosomiasis is strongly associated with agrarian occupation but its prevalence and intensity amongst rice farmers in Nigeria are poorly investigated (Anosike *et al.*,2006; Etim *et al*., 2012; Oguike, 2015).

1.3 Justification

- The Nigerian rice revolution can only succeed with healthy rice farmers and when the health challenges of productive farmers are assessed, appreciated and adequately tackled especially with the elimination of schistosomiasis risks.
- Assessment of urinary schistosomiasis prevalence and intensity among rice farmers and snails' occurrence and infectivity with *Schistosoma* are important indices of water contact risks (Opisa *et al.*,2011).
- Integrated schistosomiasis control is attainable through the strengthening of disease surveillance by monitoring of potential snail habitats and human cases (Li *et al.,* 2007).

1.4 Aim of the Study

To conduct a malacological survey of rice fields and parasitological screening of rice farmers for urinary schistosomiasis.

1.5 Objectives of the study

To determine:

i. Species composition, abundance and distribution of snail species in rice fields in Kura Local Government Area.

ii. The rate of cerceriae infection in snail species in rice fields in Kura Local Government Area.

iii. Physicochemical parameters of rice fields water in relation to snail occurrence in Kura Local Government Area.

iv. Distribution, prevalence and intensity of urinary schistosomiasis among rice farmers in some districts in Kura Local Government Area.

1.6Research Hypotheses

i. Snail species are neither present, abundant nor distributed in rice fields in Kura Local Government Area.

ii. Snail species are not infected by cerceriae in rice fields in Kura Local Government Area.

iii. Physico-chemical parameters of rice field water have no significant relationship with snail occurrence in Kura Local Government Area.

iv. Distribution, prevalence and intensity of urinary schistosomiasis among rice farmers in districts inKura Local Govermnent Area are low.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Schistosomiasis

2.2 History of Urinary Schistosomiasis

Schistosomiasis, caused by a trematode helminth, is present in different parts of the world and variously distributed. The causative agent has however only relatively been identified but the symptoms of the disease have been recognised a very long time ago. The most obvious sign of urinary schistosomiasis is blood in urine. This attracted the attention of ancient Egyptians who described the disease as 'a-a-a' disease (Okpala,2010). *Schistosoma haematobium* was the first to be described by a German Pathologist, Theodore Maximilian Bilharz in 1851 during an autopsy on an Egyptian patient and the popular name for all forms of schistosomiasis is 'bilharziasis' in honour of his discovery. Until 1906 it was assumed that *Schistosoma mansoni* was represented by the two species *Schistosoma haematobium* and *Schistosoma japonicum*. It had however been noted by Sir Patrick Manson, a physician to the Seamen's Hospital in Greenwich that the eggs passed in the urine from schistosomiasis patients were all terminally spined while only those found in the faeces had the lateral spines (Okpala, 2010). He then speculated that possibly there are two species of bilharzia, one with lateral spined ova depositing its eggs in the rectum only, the other haunting the rectum and bladder differently. The presence of the two types of spined eggs, and of two clinical forms of the disease, the vesical and the intestinal, caused considerable confusion until Sambon, in 1907 demonstrated the existence of two species, *Schistosoma haematobium* and *Schistosoma mansoni*. He named the worm that produced eggs with lateral

spine*Schistosoma mansoni*. The observations of Sambon and others were confirmed by the experimental work of Leiper in 1915 and later by other investigators (Okpala, 2010). Concurrently with the work carried out by Bilharz in Egypt, other scientists and physicians were also becoming aware of this disease, particularly in Japan where in 1847, four years before Bilharz described his new trematode, Yoshinao Fujii, a physician working in Numakuma County, reported the occurrence of *Schistosoma japonicum* in district of Kawanami (Okpala,2010). He also noted that the disease was most severe in Katayama district but was also found in other several nearby areas notably Ikariyama District and that it was called 'Katayama' disease. So the first description of Oriental schistosomiasis or 'katayama' disease was made by Fujii 1847. Between 1890 and 1904 Yamagiwa, Kurimoto and Fujinami found the eggs in various organs of human beings at autopsy, and Fujinami 1904 found the eggs in the faeces of patients afflicted with 'katayama' disease (Okpala, 2010).

Schistosomiasis is common worldwide, causing 56% of known cases of calcifications in the bladder known as bladder stone, calcified eggs of schistosomes have been found in Egyptian mummies dating from 1200 to 1000 BC (Usaini *et al.*, 2015).The distribution of schistosomes in man is governed by the existence of suitable intermediate molluscan host. Schistosomiasis is a water-borne parasitic disease thataffects 200 million people and more than 750 millionpeople are at risk (Steinmann *et al.,* 2006).The World Health Organization (Bolaji *et al.,* 2015) considers it as a significant public health problem inmuch of Africa. WHO estimates that worldwide, 180 million people live in endemic areas and 90 million are infected with the parasites. Most of these live in Sub-Saharan Africa. About 70 million persons suffer from terminal haematuria, 18 million from associated bladder wall pathology, and 10 million from hydronephrosis (an accumulation of urine in the kidney due to obstruction of the ureter). It is also estimated that

150,000 people die each year from resultant renal failure and an unknown but significant number from bladder and other genitourinary cancers. The overall mortality rate is estimated to be at least2 per 1,000 infected patients per year (Bolaji *et al*., 2015).In many places,there is a higher incidence of infection in young boys and women. This occurs because of increased contact with water compared to other population groups in cultures where women typically fetch water for household use and young boys often play in or near water.In some regions where men are primarily freshwater fishermen or farmers using irrigation farming, they have higher rates of schistosomiasis. These differential rates of transmission depend on cultural practices. It is important to consider them when planning treatment, prevention, and control strategies (Bolaji *et al.,* 2014).

Schistosoma haematobium co-exists with *Schistosoma mansoni* and the distribution of the two species is somewhat confusing. *Schistosoma haematobium* is highly endemic in the Nile Valley, present from Morocco to Egypt on the Mediterranean Coast, in Ethiopia and in the Sudan where it co-exists with *Schistosoma mansoni*. In West Africa, it is more widely disseminated than *Schistosoma mansoni*, occurring in Senegal, Guinea, Sierra-Leone, Liberia, Ghana, Nigeria, Chad, the Central African Republic, the Congo Republic, Gabon and Angola; also widely distributed in the countries in East Africa, including Madagascar and the Islands of Mauritius (Okpala, 2010). *Schistosoma mansoni* is prevalent in the Nile Delta in Egypt, in Sudan, Ethiopia, Libya, Central Africa and East Africa. In West Africa, it is present in Nigeria, Ghana, the Cameroon, Chad, Central African Republic, the Congo and Gabon. It is found in Venezuala, the Guianas, Eastern Brazil, Dominican Republic and Puerto Rico. The distribution of *Schistosoma japonicum* is confined to the Far East- Formosa, Celebes and several Islands of Philippines (Okpala, 2010).

The pattern of distribution of schistosomiasis is changing in two opposite directions: the increase of irrigation systems favours its spread and control schemes block its transmission. Water development projects in Africa are essential but often associated with an increase in water-borne diseases such as schistosomiasis. New fresh-water habitats for snail intermediate hosts of schistosomes may be created by construction of dams and irrigation projects. Greater opportunities for water contact lead to increase of both urinary and intestinal schistosomiasis as has been observed in villages along the shores of the Volta (Ghana), Kariba (Zimbabwe), Kainji (Nigeria) and Nasser (Egypt and Sudan) lakes.Humans are the major reservoirs of human schistosomes causing schistosomiasis. Apart from the role of humans as the major reservoirs of infection, other mammals have been incriminated as not less than 38 mammals have been found to be naturally infected by *S. mansoni*. A review of the situation in Brazil showed that at least 15 specimens of mammals, mostly rodents, werenaturally infected by *S. mansoni*. Since 1962, natural *S. mansoni* infections have been found in cattle in Brazil, Sudan and Venezuela. Although experimental infections with *S. haematobium* have been achieved in large primates and most recently in hamsters, there is no evidence of natural infection in other mammals (Okpala, 2010).

2.3 Distribution of Schistosomiasis

Schistosomiasis is widely distributed in the world.The areas affected are the Americas (Brazil, Venezuela and Suriname aswell as several Caribbean Islands),the Eastern Mediterranean (Islamic Republic of Iran, Iraq, Saudi Arabia, Syrian Arab Republic and Yemen), Eastern Asia (Cambodia, China, Indonesia, Japan, People's Democratic Republic of China, the Philippines) and some parts of Africa. (Ying- Si Lai *et al.*, 2015) literature search identified *Schistosoma*

haematobium and *Schistosoma mansoni*surveys done in, respectively, 9318 and 9140 unique locations. Infection risk decreased from 2000 onwards, yet estimates suggest that 163 million to 172 million (95% Bayesian credible interval, 155 million to 172 million; 18.5%, 17.6-19.5) of the sub-Saharan African population was infected in 2012. Mozambique had the highest prevalence of schistosomiasis in school-aged children (52.8%, 95% credible interval 48.7-57.8). Low-risk countries (prevalence among school-aged children lower than 10%) included Burundi, Equatorial Guinea, Eritea and Rwanda (Ying- Si Lai *et al.,* 2015). Like many other parasitic helminths, the distribution and intensity of schistosome infections are variable by locality. This is particularly true with this parasite, mainly due to the strictly limited ecological conditions for habitats of vector snails and conditions of habitats inrelation to annual rainfalls, unexpected drought, irrigation projects and industrial activities (Okpala, 2010). *Schistosoma haematobium* is found in 53 countries in the Middle East and Africa, including the Island of Madagascar and Mauritius (Okpala, 2010). There is also an ill-defined focus of *S. haematobium* in India (Okpala, 2010). Intestinal schistosomiasis occurs in 45 countries including the Arabian Peninsula, Egypt, Sudan, Sub-Saharan Africa, Brazil, some Caribbean Islands, Suriname and Venezuela.The global distribution of schistosomiasis has changed significantly in the past 50 years, with control successes achieved in Asia, the Americas, North Africa and Middle East. Schistosomiasis has been eradicated from Japan, transmission has been stopped in Tunisia and very low in Morocco, the Philippines, Saudi Arabia and Venezuela (Okpala, 2010).

Human schistosomiasis is the most prevalent of the water borne diseases, with a very great risk tothe health of rural populations (Biu *et al*.,2009). Schistosomiasis is common worldwide, causing 56% of known cases of calcifications in the bladder known as bladder stone. The disease affects more than 200 million people worldwide (8% of the world population) and as many as

500-600 million people have been exposed to schistosomiasis of all kinds, being more common in Africa, Asia and South America (Robert and Cirillo, 2002).

However, environmental changes linked to water resources development, increasing population and population migrations has led to the introduction and spread of the disease to previously low or non-endemic areas, particularly sub-Saharan Africa (Okpala, 2010). It is well documented that the construction of man-made lakes in areas endemic for schistosomiasis frequently leads to increase in level of this disease in the human population. Development of water resources and their management can increase schistosomiasis transmission (Duwa and Oyeyi, 2009).An analysis, based on African studies, showed that there is a risk ratio of 2.4 and 2.6 for urinary schistosomiasis (caused by *S. hematobium*) and intestinal schistosomiasis (caused by *S.mansoni*) respectively, among persons living adjacent to dam reservoir (Duwa and Oyeyi, 2009).Bilhariziasis is one of the most important diseases and is evident in about 75% of tropical developing countries, schools and residents in rural and irrigated Agricultural areas are estimated to be infected while between 500 and 600 million people are at risk (Usaini *et al*., 2015). Over 200 million people are currently estimated to be infected.

There are a number of less important species of schistosomes infecting man. *Schistosoma intercalatum* is endemic in parts of Zaire, Gabon, Cameroon, with small foci in Central African Republic, Chad, Nigeria and Burkina Faso (Okpala, 2010). *Schistosoma malayensis* was recently reported in Malaysia. In addition, a number of animal species accidentally infect man to cause zoonotic infections. These include *S. bovis* infecting cattle, sheep and goats in Africa, parts of Southern Europe and Middle East; *S. matthei* infecting cattle, sheep and goats in Central and Southern Africa; *S. margrebowiei* infecting antelope, buffalo and water buck in Southern and

Central Africa; *S. curassoni* infecting domestic ruminants in West Africa and *S. rodhaini* infecting rodents and carnivores in parts of Africa (Okpala, 2010).

2.4 Schistosomiasis in Nigeria

In Nigeria, both urinary and intestinal schistosomiasis caused by S. haematobium and S.mansoni, respectively are prevalent (Bolaji *et al*., 2015). Students are often vulnerable to infection, presenting clinical symptom like haematuria, suprapubic pain, dysuria, obstructive uropathy, kidney failure and elevated risk of bladder cancer. The mortality rate due to non-functioning kidney and haematemesis from S. haematobium has been estimated and it was over 150,000 per year, thus indicating that urinary schistosomiasis has become a grave public health problem in sub-Saharan African and second to malaria in term of morbidity and mortality (Bolaji *et al*., 2015). Until recently, schistosomiasis was not considered a public health problem in Nigeria for two reasons. Firstly, schistosomiasis was restricted to rural communities where hygiene is inadequate, where poverty prevails, where malnutrition and infection with other parasites are common (Okpala, 2010).

Secondly, it is a disease common to school aged children in whom the disease remains silent or mildly asymptomatic for many years. According to the legend Blair (1956), the Fulani tribe migrants of Northern Nigeria, transmitted schistosomiasis from the Upper Nile Basin. The disease, therefore has a long history in Nigeria. It is essentially an infection of rural agricultural communities where rural lifestyle and behaviour encourage the contamination of inland water with human excreta and urine. To this end, most previous studies on schistosomiasis in Nigeria

were concentrated in rural areas (Arinola, 1995).The distribution of *Schistosoma haematobium* was described as being almost universal in the North, and patchy elsewhere. *Schistosoma haematobium* is probably endemic in the Northern Region, and some areas are marked particularly by heavy infection rates. These areas include Katsina, Kano, Zaria, Kaduna, Birnin Kebbi and Argungu. Infection of man by both *S. mansoni* and *S. haematobium* is wide-spread in two of the former regions of Nigeria – West and North, and less in the East. Other parts of the Northern region from which high or fairly high infection rates have been reported are Plateau area, Yola, Biu area, Maiduguri, Potiskum area, the Wulgo area of Lake Chad Basin, the Riverine area along the Niger from Wawa to Pategi and Bida. Akogun and Obadiah (1996) also reported that schistosomiasis is common in Nigeria and is especially associated withwater related activities. In its geographical distribution in Nigeria, urogenital schistosomiasis is regarded as a disease mainly of the semi and dry savannah region, especially areas where there are irrigation schemes (Akogun and Obadiah, 1996). In Nigeria, the earliest known report of high prevalence of haematuria relates to the dry North (Donges, 1967). There were some reports on the epidemiology in the city area of Ibadan (Akinkugbe, 1962) Investigations indicate that the disease may be increasing in prevalence and importance particularly in the remote poorly accessible rural communities (Okpala, 2010). Various studies have been carried out to show prevalence and intensity of schistosomiasis in various States; Niger - Benue basin of Kogi state a prevelance and intensity studies was carried, a total of 1,104 samples were collected and analyzed, 206 were infected with the parasite, overall geometric mean intensity of 118.2 eggs/10ml urine was recorded, prevalence of infection was significantly higher in males (19.4%) than in females (16.5%) but there was no significant difference ($p > 0.05$) in intensity of infection between the two sexes. In this study children of 10-14 years with prevalence of (22.7%)

contributed more to the transmission of the disease in the Niger-Benue basin than those of age group > 20 years with prevalence (20.8%) (Ejima and Odaibo, 2010).

In another study on *Schistosoma haematobium* among school children in Ajase – Ipo, Kwara state, Nigeria out of 150 individuals investigated, 88 (58.7%) were found infected, which was slightly higher in males (62.0%) than females (54.9%) (Bolaji *et al*., 2015). Furthermore,in Sarkawa fishing community in Yauri, Kebbi State, urinary schistosomiasis was analyzed among 198 school age children out of which 90 pupils were positive for*Schistosoma haematobium* giving a prevalence of (45.45%) (Rikoto and Danladi, 2013). In another study in Ebonyi State, Nigeria, Ivoke *et al*. (2015) reported that 375 (46.18%) of 812 children in rural communities carried the infection.

Dams and irrigation projects which are wide-spread in Nigeria, electric power, water emanating from the water- flow creates suitable environment for snail breeding and industrial developments have contributed significantly to the spread of schistosomiasis. Ironically, these otherwise beneficial development activities favour increased transmission of water based diseases. Migrants, workers, and herdsmen, who represent a significant number of people in endemic areas, are both carriers and target for infection. Thus, schistosomiasis will be very much a concern for some time in Nigeria.

2.5Schistosomiasis in KanoState

The distribution and intensity of schistosomiasis are variable by locality, mainly due to the strictly limited ecological conditions for the habitat of the vector snails and changing conditions of habitat in relation to annual rainfalls, unexpected drought, irrigation schemes and other water development projects (Okpala, 2010). A study was carried out in July 2005 to August 2007 on

comprehensive mapping of urinary schistosomiasis using Geographic Information Systems (GIS) in Kano State, Nigeria to integrate the demographic, parasitologic and site location data of 132 towns / villages, in the 44 Local Government Areas of Kano State. A total of 6600 urine samples were examined for *S. haematobium*infection, 2820(42.7%) were positive out of the 44 Local Government Areas of Kano State and was presented in Table 2.1(Abdullahi *et al.*,2009).

Table2.1 The Distribution of Urinary schistosomiasis by Local Government area, Kano State, Nigeria (Abdullahi *et al*., 2009)

L.G.A	Number Examined	Number Positive	Percentage%
Ajingi	150	66	44.00
Albasu	150	58	38.66
Bagwai	150	80	53.33
Bebeji	150	77	51.33
Bichi	150	74	49.33
Bunkure	150	70	46.66
Dala	150	58	38.66
Danbatta	150	81	54.00
Dankudu	150	61	40.66
D/Tofa	150	27	18.00
Doguwa	150	58	38.66
Fagge	150	49	32.66
Gabasawa	150	72	48.00
Garko	150	82	54.66
G/Malam	150	75	50.00
Gaya	150	73	48.66
Gezawa	150	77	51.33
Gele	150	47	31.33
Gwarzo	150	60	40.00
Kabo	150	65	43.33
Karaye	150	44	29.33
Kibiya	150	50	33.33
Kiru	150	57	38.00
KMC	150	56	37.33
Kombotso	150	46	30.66
Kunchi	150	64	42.66

Kura	150	96	64.00
Madobi	150	65	43.33
Makoda	150	71	47.33
Minjibir	150	81	54.00
Nasarawa	150	58	38.66
Rano	150	68	45.33
R/Gado	150	60	40.00
Rogo	150	66	44.00

Table2.1 Cont'd: The Distribution of Urinary schistosomiasis by Local Government Area, Kano State, Nigeria (Abdullahi *et al*., 2009)

L.G.A	Number Examined	Number Positive	Percentage%
Shanono	150	70	46.66
Sumaila	150	60	40.00
Takai	150	81	54.00
Taroni	150	45	30.00
Tofa	150	48	32.00
Tsanyawa	150	76	50.66
T/wada	150	35	23.33
Ungogo	150	55	36.66
Warawa	150	75	50.00
Wudil	150	83	55.33
Total	6600	2820	42.72

2.6Life cycle of Schistosoma haematobium

Adult worms live in blood vessels around either the intestines or the urinary bladder.Together, male and female worms produce between 50 and several hundred eggs per day that are passed out in the urine. Miracidia, emerge from the eggs if they reach water. For the next 6-12 hours, they are able to penetrate into the intermediate host, a snail, which has to be of one of a limited number of species suitable for the specific type of schistosome. After a period of multiplication of 4-7 weeks in the snail, the next larval stage, the cercariae, emerges. They are now able to infect humans (or other animals). A single miracidium can develop into as many as 100 000cercariae. Up to 48 hours after leaving the snail, the cercariae are capable of penetrating through the skin of the definitive host and transform into schistosomula that migrate through the lungs and liver where they mature. After 6-12 weeks, they pair and move via blood vessels to their final position, where they begin to produce eggs. An average couple will produce eggs for 2-5 years, but have been known to live for up to 30 years (Hornstein *et al.,* 1990).

The invasion, migration andmaturation of the parasite induce acute schistosomiasis. Acute urinary schistosomiasismay lead to fever, dysuria and haematuria.If not treated, symptoms of chronic schistosomiasis may emerge after 5-15 years (Girma and Mohamed, 2003).

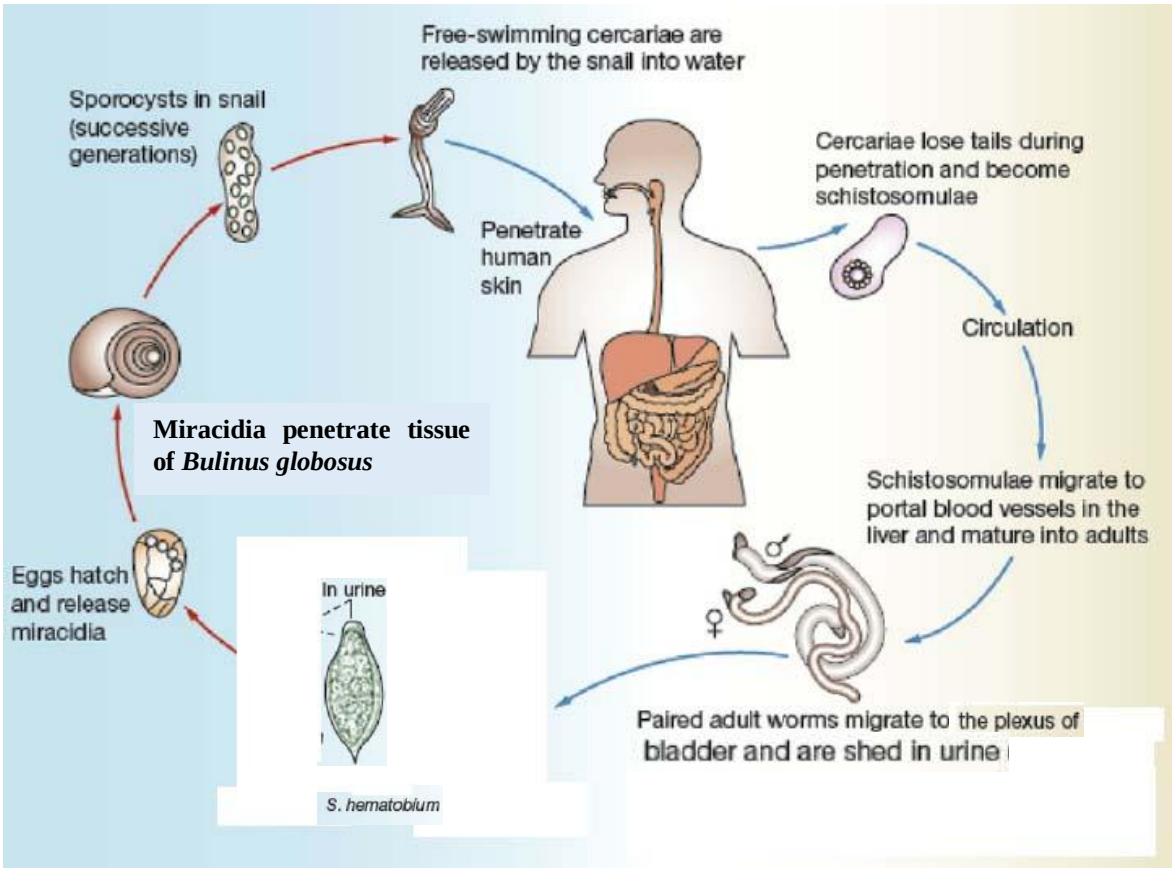


Figure 2.1 Life cycle of *Schistosoma haematobium*

Source: (GhislaineandPaul, 2007)

2.7 Pathogenesis of Urinary Schistosomiasis

The severity and manifestation of schistosomiasis is dependent on the duration andintensity of infection, the location of egg deposition, and concurrent infection. The different species of schistosomecausing schistosomiasis in man have their target organs. For example *Schistosoma haematobium*has its target organ as the urinary bladder, ureters and kidneys where it induces histopathological bilharziasis and epididymo-testicular bilharziasis in children (Edington and Giles, 1979). In individuals from endemic areas, initial infection goes unnoticed. But in visitors to endemic areas, initial infections with schistosomes commonly results in acute febrile illness (Katayama fever or acute schistosomiasis),(Doherty *et al*.,1996); which is a manifestation of the immune response to the developing schistosomes and eggs.In sites of cercarial invasion of the skin in schistosome infested water there could beintense pruritic papules, particularly on the feet and lower legs, referred to as cercarial dermatitis or "Swimmers' itch" (Mulvihill and Burneth, 1990).

The invaded cercariae are transported to and develop into adult stage in the mesenteric venules. The adult flukes are protected from host immune reactions by acquiring host antigens.(Mulvihill and Burneth, 1990).The clinical presentation in the invasive and acute stages of *S. heamatobium* infection issimilar to *S.mansoni* infection. In the established stage when the eggs penetrate through the wall of the bladder, there will be bleeding which can be found in the urine (haematuria). Eggs trapped in the wall of the bladder and in surrounding tissues cause inflammatory reactions with the formation of granulomata. Many of the eggs die and become calcified eventually producing what are known as "*Sandy patches"* in the bladder. Following prolonged untreated infection and a marked cellular immune response, the ureter may become obstructed and the bladder wall thickened leading toabnormal bladder function, urinary tract infection and eventually obstructive renal disease with kidney damage. (Beaver *et al.*, 1984).

2.8 Clinical Features

It is the eggs of *Schistosomaheamatobium* in the tissues that stimulate host inflammatory response whichcause pathological changes in the bladder and ureters.Some important clinical signs and symptomshave been described in association with urinary and intestinal schistosomiasis. These include albuminuria, haematuria, appendicitis and schistosomal ulceration of the urinary bladder (WHO,1993).

In women, urogenital schistosomiasis may present with genital lesions, vaginal bleeding, pain during sexual intercourse and nodules in the vulva. In men, urogenital schistosomiasis can induce pathology of the seminal vesicles, prostate glands and other organs. This disease may also have other long-term irreversible consequences, including infertility (WHO, 2016). Up to 80% of children infected with *S.haematobium* have dysuria, frequency of urination and haematuria. Along with the local effects of granuloma formation in the urinary bladder, obstruction of the

lower end of the ureter results in hydrourether and hydronephrosis which can be seen in 25-50%of infected children. As infection progresses, bladder granuloma undergoes fibrosis which results in typical sandy patchesvisible on cystoscopy. In many endemic areas, an association between squamous cell carcinoma of the bladder and *S.haematobium*infection can be observed (Beaver *etal.*,1984).

2.9Public Health Importance of Urinary Schistosomiasis

Schistosomiasis is one of the most wide-spread of all human parasitic diseases, ranking second only to malaria in terms of its socio-economic and public health importance in tropical and subtropical areas (Abubakar *et al*., 2015). It is also the most prevalent of the water-borne diseases andone of the greatest risks to health in rural farming areas of developing countries (Ahmad *et al*., 2014). As a main rural, often occupational disease, schistosomiasis principally affects people who are unable to avoid contact with water, either safe water for drinking, washing and bathing. As a result of low level ofresistance and intensive water contact when playing and swimming, children aged between 10 and 15 years are the most heavily infected (Ugbomoiko *et al*., 2010). Increased population migrations help to spread the disease, and schistosomiasis is now occurring increasingly in peri-urban areas. Although most people in areas of endemicity have light infections with no symptoms, the effects of schistosomiasis on health and economy are serious. Women performing domestic chores in infested water, such as washing clothes, are also at risk. Inadequate hygiene and contact with infected water make children especially vulnerable to infection. Migration to urban areas and population movements are introducing the disease to new areas. Increasing population size and the corresponding needs for power and water often result in development schemes, and environmental modifications

whichfacilitate transmission(WHO, 2016). In several areas (e.g. North-eastern Brazil, Egypt, Sudan),the working ability of the rural inhabitants, many man-hours and attendance to school by school children are severely reduced as a result of the weakness and lethargycaused by the disease (Okpala, 2010).The economic and health effects of schistosomiasis are considerable and the disease disables more than it kills. In children, schistosomiasis can cause anaemia, stunting and a reduced ability to learn, although the effects are usually reversible with treatment. Chronic schistosomiasis may affect people's ability to work and in some cases can result in death.The number of deaths due to schistosomiasis is difficult to estimate because of hidden pathologies such as liver and kidney failure and bladder cancer. Estimates therefore vary widely between 20,000 and 200,000 deaths per year (WHO, 2016).

2.10Diagnosis of Urinary Schistosomiasis

Diagnosis of urinary schistosmiasis is based on:

A. Clinical signs and symptoms

B. History of living in an endemic area

C. Serological tests

D. Finding the characteristic eggs.

During the acute stage and in chronic cases in which eggs cannot be found, serologicaltests are very useful. Serological tests that are applied for diagnosis of *S.mansoni*infection can be used for the diagnosis *S.haematobium* as well. The most common and conclusive means of diagnosis is microscopic finding of eggs with terminal spinein urine and occasionally in faeces. In long standing infections eggs may not be seen in the urine; the method then used is bladder mucosal biopsy (Clive, 2012).

Testing the viability of eggs is important in determining the stages of infection. Viability may be determined by direct examination of the eggs to observe for flame cell action in the miracidia, by inducing eggs to hatch or by examining a preparation stainedwith trypan blue(Laikemariam *etal.*,2005).

Efficient methods for the concentration of eggs in urine for epidemiologicalwork include sedimentation by centrifugation; filtration through millipore filters hadalso been adopted by many workers (Salih, 1979; Saladin *et al*., 1980; Ivoke*et al*., 2015). In most developing countries in tropical Africa today where schistosomiasis and other important parasitic diseases are endemic, poor economyhas resulted in drastic cuts in the funding of scientific research (Okpala, 2010).The consequent chronic shortage of foreign exchange has made it very difficult for scientists in these countries to procure the necessary equipment all of which are imported from foreign countries. There is, therefore need for the development of alternative procedure that will be simple, and cheaper but will also give comparable and reliable results (Asaolu and Ofoezie, 1988-1990; Okpala, 2010).

2.11 Treatment and Control of Schistosomiasis

The treatment of schistosomiasis depends on the stage of infection and clinicalpresentation.Treatment of schistosomiasis is targeted at several aspects of the life-cycle of the schistosome parasites.The control of schistosomiasis is based on large-scale treatment of at-risk population groups; access to safe water; improved sanitation; hygiene education and snail control.The WHO strategy for schistosomiasis control focuses on reducing disease through periodic, targeted treatment with praziquantel (WHO, 2016). This involves regular treatment of all risk groups of people. In a few countries, where there is low transmission, the elimination of

the disease should be aimed for (WHO, 2016).Drug treatment is still the principal method of control and the drug of choice for schistosomiasis is praziquantel. Asingle oral dose of 40 mg/Kg body weight is generally sufficient to give cure rates of between 60-90% and reduction of 90-95% in the average number of eggs excreted. Alternativesinclude oxamniquine used exclusively to treat intestinal schistosomiasis in Africa and South America and metrifonate effective for the treatment of urinary schistosomiasis. However,metrifonate has been lately withdrawn from the market (Beaver *et al.,* 1984). However, the degree of recovery from the infection depends on the extent of thedamage caused by the infection. If extensive fibrosis has occurred this cannot bereversed and there is a permanent damage. According to WHO (1998), until 1970treatment of schistosomiasis was nearly as dangerous as the disease itself. Praziquantel is effective in the treatment of all forms ofschistosomiasis with virtually no side effects. On the other hand, Global 2000, statedthat the following groups of people should not take praziquantel - anybody whoalways reacts to the drug, a seriously sick person, pregnant women, children underfour years and breast- feeding mothers (Okpala, 2010). In some cases there may be mildreactions to praziquantel, which include headache, tiredness, dizziness and loss of appetite. The drugshould not be taken on an empty stomach.

The lack of epidemiological data and basic information regarding prevention of the disease in rural communities with high risk groups hindered the control efforts (Houmsou *et al.*, 2012).

2.12 Distribution of Snail Intermediate Hosts ofSchistosomes

The planorbid snails, *Bulinus* species, act as the intermediate hosts of*Schistosoma haematobium* (Thomas, 1973). Cowper (1963) observed two distinct strains of *S. haematobium* in West Africa, one transmitted by only *Bulinus truncatus*and the other transmitted by *B. globosus. Bulinus globosus* is the common representative of the genus *Bulinus* in Nigeria and the vector of the

majority strain of *S.haematobium*. *Bulinus* has also been incriminated as the intermediate host of *S.intercalatum* (Thomas, 1973).

(Betterton et al., 1988) studied human infections near dam sites and the distribution and habitat preferences of snail intermediate hosts and found 5 species with *Bulinus senegalensis* being the most widely spread. Ndifon and Ukoli (1989) carried out snail investigation in South Western Nigeria and recorded that *B. globosus,* as the most widely distributed followed by *Biomphalariapfeifferi*. *Bulinus forskalii* was among the snail intermediate hosts of schistosomes during an investigation of the Lake Chad Basin of Borno State, Nigeria (Lambo, 1982). *Bulinussenegalensis* was reported as the intermediate host of *Schistosoma haematobium* in Chad irrigation scheme in Borno State and near Benin City in Edo state, Nigeria (Ukoli, 1984). Studies on ecology of gastropod fauna of some minor tributaries of river Benue in Makurdi, Nigeria, encountered *Bulinus truncatus* as one of the four snail species encountered which is recognized as the intermediate host for schistosomiasis in Nigeria (Omudu and Achagh, 2005). A study carried out at Jakara dam in Wasai town of Minjibir L.G.A. of Kano state, Nigeria found *Bulinus globosus* intermediate host of schistosomiasis as the most abundant species of snail during the research work (Duwa and Oyeyi, 2009).Ngele *et al*., (2012) carried out a study on the intermediate hosts of schistosomiasis in Bende L.G.A., Abia State Nigeria and identified *Bulinus spp*as the most widespread species.

2.13 Physiology and Adaption of Snails

Snails use water and vegetables for food, shelter and as substrates for laying their eggs. Absence of all or any of these factors adversely affects the existence of snails. Spoel *et al*., (1979) observed that at low temperature of about 14℃ and a high photoperiod, the egg-mass production

of snails ceases while at pH of 6.0, egg-laying and hatching are maximal. Hodasi (1978) experimented on the effect of dryness and aestivation on growth, reproduction and mortality of snails. He recorded that the reproduction potential was reduced and the young snails withstood desiccation better than adult ones. After the aestivating period, there was no significant difference in their size, but during the aestivation, the snails stopped feeding and entered a stage of dormancy by fixing their shell apertures to the mud surface or wall of the container. Fish ponds, increasingly constructed in Brazil and other countries in the tropics for the purpose of supplying proteins to increasing populations, have been identified as another potential source of schistosomiasis infection, especially if they are not properly maintained (Ferguson and Ruiz-Tieben, 1971).

2.14 Control of Snail Intermediate Hosts

The incidence of all trematode infections of both medical and veterinaryimportance can be checked by effective control of their snail intermediate hosts. The various control measures applied include use of molluscicides, alteration of the aquatic environment and biological control. To achieve an effective control programme, knowledge of the aestivating period, the infective period and the habitat of the snail hosts are important (Jobin, 1978).

2.14.1 Application of Molluscicides

There are various chemicals used in snail control. Use of chemicals may be successful for snail control but it also has a number of disadvantages, such as cost, and very importantly, the toxicity of the chemicals which may also kill non-target aquatic organisms such as fish which the affected population may rely on. Some plants andtheir extracts are used in controlling snail hosts due to their molluscicidal activities. Singh and Agarwal (1988) reported on the effectiveness of

the latex of dicotyledonus plants, in the order Euphorbiales, in snail control. The water extract of *Tetrapleura tetraptera* was found to be very active as a molluscicide in control of schistosomiasis and fascioliasis (Adewunmi, 1984). Agaceta *et al*., (1981) recorded seven local plants including *Croton tiglium, Entada phaseoloides, Nicotiana tabacum,Coryza balsamifera, Citrus mitis, Jatropha curcas,* and *Menispermas coclus* as having strong molluscicidal activity when used at concentration of 100-500 ppm.

Also the methanolic extract of *Detarium microcapum* has molluscicidal activities; causing 55-98% snail mortality (Panda and Kela, 1997). Other methods, such as thegrowth of certain plants on the sides of water ways have been introduced. The berries of endod (*Phytolacca decandra*) have been reported as naturally molluscicidal when they fall into water body. Osuala and Okwuosa (1993) reported that the stem back extract of neem plant, A*zadirachta indica,* caused a 100% mortality on *Bulinus, Biomphalaria and Lymnaea* species.The current molluscicide of choice is niclosamide, which is available in a paste form. It is generally mixed with water and sprayed on snail habitat areas. At low concentration, it is highly toxic to snail and their egg masses (Okpala, 2010). For practical use, a concentration of 0.6 – 1mg/L is recommended with an exposure time of 8 hours. The compound is safe to handle and after dilution, it is nontoxic to water plants and crops. However, it is very toxic to fish. Fish killed by the molluscide can be safely eaten. Other chemicals used include Bayluscide, sodium pentachlorphenate, acerolsein,coppersulphate and manganese sulphate (Yescoth and Hanson, 1976).

2.14.2 Alteration of the aquatic environment

This includes altering the flow of the water, clearance of vegetation anddrainage at certain times of the year. Disadvantages of these methods include damage to fish population, and creating suitable environment for other disease vectors, such as *Simulium*,to breed (WHO, 1993)

2.14.3 Biological control

This can be achieved by introducing competitor snail species, such as *Marisa cornuarietis*,which compete with *Biomphalaria* snails for food and eat their eggs (Okpala, 2010).Also snail eating fishes can be introduced into the water (Spoel *et al.*, 1979). (Perez *et al.*, 1991) reported that the snail, *Thiara granifera* competed with *Biomphalariaglabrata* for space. A field trial in a Brazilian lake indicated that *Tilapia melanopleura* was a predator of *Biomphalaria glabrata* (Okpala, 2010). In Bahia, the local fish, apaiar (*Anthronatusocelatus),* was used for snail control. Several other fish species such as *Tilapia rendalli*and the cichlid, *Sargochromis codringtoni* have been found to be effective predators of snail intermediate hosts (Perez *et al.*, 1991).

2.14.4 Reduction of snail habitats

Snails need vegetation for food, shelter and as a substrate for their eggs. The removal of vegetation in irrigation ditches and canals could reduce the population of snails. However, to clear vegetation manually, one usually has to get into the water, which is dangerous, while mechanical clearance is very expensive (Okpala, 2010). The clearing of canals may also help in the control of other diseases, including malaria, and may improve the effective useof irrigation water (Okpala, 2010). A disadvantage of this method is the need for frequent repetition. Where sufficient resources are available, canals can be lined with cement to prevent or reduce the growth of vegetation. People can also remove plants from places where children swim or where

clothes or dishes are washed. Under certainconditions, the plant-eating Chinese grass carp-fish, *Ctenopharyngodon idella,* maybe suitable for the biological control of aquatic plants (Istifanus, 1988).

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 Study Area

The study was conducted in Kura Local Government Area of Kano State, Nigeria. Kura local Government Area is among the 44 Local Government Areas of Kano State Nigeria and is located in the southern part of the state along the dual carriage way Zaria – Kano Road, at a distance of about 35km from Kano, the State capital. It is located on latitude 11^0 46'17″N and longitude 8^0 25'49″E (Fig 3.1) and covers an area of about 206km^2 with human population of about 144,601 at the 2006 census (NPC, 2006). Kura Local Government Area shares common boundaries with Garun Malan Local Government Area, atthe West; Madobi Local Government Area, at the North; Dawakin Kudu Local Government Area, at the East and Bunkure Local Government Area at the South. Kura Local Government lies in the Sudan savanna vegetation belt and is the most extensively irrigated Local Government in the state due to the introduction of irrigation system in the area. As an agricultural town, Kura was known for the production of food stuffs and vegetable crops both during dry season and rainy season. The dry season mostly start from October to April, while the rainy season begins from April to September with an average annual rainfall of 134.4mm. The people of local Government are 80% farmers who are engaged in mixed farming in both the seasons. Some of the crops produced in the area are rice, wheat, maize, millet, Guinea-corn, beans, tomatoes, of which rice is highly cultivated than other crops.

Kura has a total of 10 districts out of which four were used for this study namely, Butalawa, Dalili, Kosawa, and Sarkinkura (Figure 3.1).

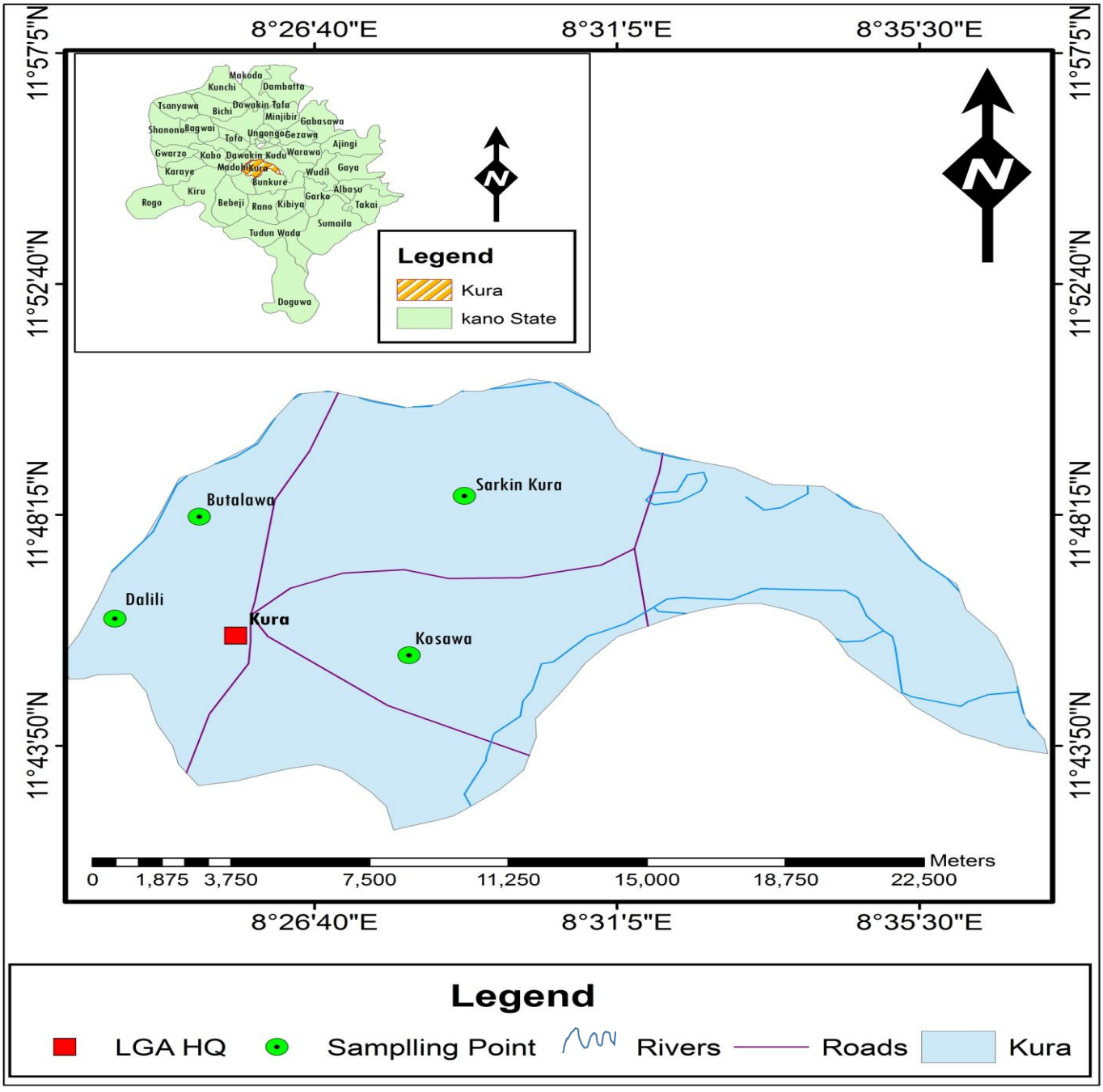


Figure:3.1.Map of Kura L.G.A. Showing the Study Area.

Source: Modified From Administrative Map of Kano State.

3.2 Sample Size Determination:

The estimated number of individuals sampled for urinary schistosomiasis in this study was obtained using Fisher's sampling formula (Fisher, 1935) which is $N=\frac{Z^2PQ}{d^2}$

Where;

N = Sample size

Z = the critical value of standard normal distribution (1.96 at 95% confidence interval)

P= estimated prevalence of *Schistosoma haematobium* infection

Q=1-P

d =absolute precision or sampling error tolerated=5%

The minimum calculated sample size for this study was 288 using a prevalence rate of 25% (Ahmad *et al.*, 2014) but a total of 420 individuals were sampled.

3.3Study Population:

The study population was composed of 420 rice farmers. The study population was categorized into six age groups as follows, 1-10; 11-20; 21-30; 31-40; 41-50; 50 years and above of age.

3.4 Administration of Questionnaires:

A structured questionnaire was administered to each farmer to obtain personal data such as name, district, age, sex, risk factors for schistosomiasis, disease awareness, snail perception and sources of drinking water.

3.5 Sample Collection:

3.5.1 Urine collection.

Urine samples werecollected from consented rice farmers in some districts in Kura Local Government in Kano State. Sterilized and well labeled 15ml sample bottles weredistributed to the farmers for urine collection. The farmers were instructed to collect their urine as recommended by WHO (1999). That is, the urine samples must be mid-stream and were collected between10am and 2pm which coincided with the peak rhythm of eggs release by the parasite.

3.5.2 Snails collection.

Systematic sampling technique was used to select three rice farms in each district and searched for mollusc species. An estimated area of $20\,m^2$ (4m x 5m) per rice farm was thoroughly examined for available mollusc species using a scooper with hands protected in gloves and placed in labeled containers.

3.5.3 Physicochemical parameters.

Physicochemical parameters such as temperature, pH, Total dissolved solids and electrical conductivity of water in the rice farms were also determined in-situ using HANNA HI 98129 meter, and this was done simultaneously as the snail samples were collected the physicochemical parameters of where it colonized was taken using the HANNA HI 98129 meter.

3.6 Laboratory Analysis of Samples:

Following the collection of urine samples, 5 ml of 10% formal saline was added into the sample (Cheesbrough,1999), in order to prevent eggs of the parasite from hatching to release miracidiae.

The urine samples wasthen placed in a cold box containing ice and transported to the Parasitology and Entomology Research laboratory, Department of Biological Sciences Ahmadu Bello University Zaria where analysis was conducted. Each urine sample was transferred into a 15ml centrifuge tube and centrifuged in a centrifuge machine (Heraeus Labofuge 300) at a speed of 1000 revolution per minute for 2 minutes (Cheesbrough, 2009). The supernatant was decanted leaving the residual concentrate. The concentrate in the centrifuge tube was well tapped with finger to ensure more distribution of the available eggs in the concentrate, about 0.2ml of the concentrate was transferred to a slideand observed under the total magnification of ×100 and ×400. The egg of *Schistosoma* species was identified according to the pictorial keys of Soulsby (1982) and counted. The total number of eggs counted per 0.2mL was estimated against the final sedimented volume and expressed as number of ova per 10mL urine sample. Molluscs collected were transported in moist plastic container to the laboratory, placed singly in Petri dishes containing distilled water and exposed to tungsten filament bulb (60W) for several hours (3-6 hours) to stimulate cercarial emergence. The snails were identified; using the pictorial keys of Mandahl-Barth (1962), using their morphological differences, counted and recorded.

3.7 Data Analyses:

Analysis of variance was used to test for significance in the variation of physicochemical parameter across studied districts of Kura Local Government Area of Kano state, Nigeria. Pearson correlation analysis was used to establish relationship between physicochemical parameters and snails abundance. Odds ratio was calculated for each risk factor investigated to determine association with urinary schistosomiasis in the farmers. Chi square test was used to determine significant differences in age- specific prevalence of the disease. Unpaired student t-

test and Chi- square (χ^2) were used to test for significant difference in sex-specific prevalence of urinary schistosomiasis.

CHAPTER FOUR

4.0 RESULTS

4.1 Species Composition, Abundance, Distribution of Molluscs Species

The diversity and relative abundance of molluscs species collected from rice fields in four districts within Kura Local Government Area of Kano State, Nigeria are shown on Table 4.1. Five species of molluscs were encountered which included *Bellamyacrawshayi* (Smith) (Plate 4.1), *Biomphalaria pfeifferi*(Krauss) (Plate 4.2), *Bulinus globosus*(Morelet) (Plate 4.3), *Lymnaea natalensis* (Krauss) (Plate 4.4) and *Melanoides maculata* (Bruguiere) (Plate 4.5). A total of 1959 specimens of the five species of molluscs were collected from the ricefields. These ranged in distribution from 279(14.24%) specimens obtained in Butalawa district to 692(35.32%) specimens obtained in Sarkin Kura district. While *B.crawshayi*and *L. natalensis*were each encounterd in only two of the four districts where both species had the least abundance of number (1.99%) and number (4.85%) respectively, the other three molluscs species were each encountered in all the four districts with abundances ranging from 15.67% for *B.pfeifferi* to 49.52% for *M.maculata.* Kosawa district had the least diversity of three species of molluscs being devoid of *B.crawshayi*and *L.natalensis*. Both Butalawa and Dalili each had a diversity of four species of molluscs; each being devoid of *L. natalensis* and *B. crawshayi* respectively. All the five species of molluscs were encountered in Sarkinkura district (Table 4.1).

4.2 The rate of cercariae infection in snail species in rice fields of Kura Local Government Area

Table 4.2 shows the infection rates of five molluscs species obtained from rice fields. Only four of the 548 specimens of *Bulinus globosus*were infected, giving a specific infection rate of 0.73%. The other four species of molluscs did not shed cercariae, out of a total 1959 molluscs specimens

Districts	*Bellamya crawshayi*	*Biomphalaria pfeifferi*	*Bulinus globosus*	*Lymnaea natalensis*	*Melanoides maculata*	Total (%)

examined, only four (0.20%) shed cercariae (Table 4.2).

Table 4.1Molluscs diversity and abundance in rice fields in some districts in Kura Local Government Area, Kano State, Nigeria.

Butalawa	08	91	73	00	107	279 (14.24)
Dalili	00	100	175	93	301	669 (34.15)
Kosawa	00	56	60	00	203	319 (16.28)
Sarkinkura	31	60	240	02	359	692 (35.32)
Total (%)	39 (1.99)	307 (15.67)	548 (27.97)	95 (4.85)	970 (49.5)	19590)



Plate I*Bellamya crawshayi*



Plate II*Biomphalaria pfeifferi*



Plate III*Bulinus globosus*



Plate IV*Lymnaea natalensis*



Plate V*Melanoides maculata*

Table 4.2 Cercaria Infection Rates of the Snail species in rice fields in Kura Local Government Area, Kano State, Nigeria.

Mollusc species	Number examined	Number infected	Infection rate (%)
Bellamya crawshayi	39	0	0.00
Biomphalaria pfeifferi	307	0	0.00
Bulinus globosus	548	4	0.73
Lymnaea natalensis	95	0	0.00
Melanoides maculata	970	0	0.00
Total	1955	4	0.20

4.3 Physicochemical Parameters of Rice Field Water and Associated Mollusc Species in Rice Fields Kura Local Government Area

The range, mean and standard deviation of the water parameters of rice fields where each of the five species of molluscs were encountered are shown in Table 4.3. Water pH of the rice fields was alkaline and ranged from 8.24 to 9.70. The least mean water pH was 8.63 where *B. crawshayi* was encountered, while the highest mean water pH was 9.00 where *L. natalensis*occurred. The pH of water supportive of the occurrence of the five species of molluscs in the rice fields did not differ significantly (P=0.76; i.e P>0.05). The total dissolved solids (TDS) in water of the rice fields ranged from 30.00ppm to 39.00ppm. The least mean TDS of the rice fields' water was 30.80ppm where the trio of *B.pfeifferi*, *B.globosus*and *M. maculata* occurred, while the highest mean water TDS was 33.25ppm where *L.natalensis*was encountered. The total dissolved solids of water supportive of the occurrence of the five species of mollusc in the rice fields ranged between 64.00µs/cm and 77.00µs/cm. The least mean EC of water in the rice fields was 67.75µs/cm where *L. natalensis*occurred, while the highest mean EC of water was 68.83µs/cm where the trio of *B.pfeifferi*, *B.globosus* and *M.maculata* occurred.The EC of water supportive of the occurrence of the five species of mollusc in the ricefields did not differ significantly (P=0.98; i.e. P > 0.05).Water temperature in the rice fields ranged between 24.00^{o}C and 27.50^{o}C. The least mean water temperature in the rice fields was 25.50^{o}C where *B. pfeifferi*, *B. globosus* and *M. maculata* occurred while the highest mean water temperature in the rice fields was 26.75^{o}C where *L. natalensis* was encountered. The water temperature supportive of the occurrence of the five species of mollusc in the rice fields did not differ significantly (P=0.20; i.e. P>0.05) (Table 4.3).

Table 4.3Range (Mean ± Standard Deviation) of water parameters of rice fields in Kura Local Government Area, Kano State,Nigeria.

	Water parameter			
Mollusc species	pH	TDS(ppm)	EC(µs/cm)	Temperature(^{o}C)
Bellamya crawshayi	©8.47 -8.86 ¥ (8.63 ± 0.20^{a})	31.00 -33.00 (32.33 ± 1.15^{a})	67.00 -69.00 (68.30 ± 1.15^{a})	26.50 -26.70 (26.60 ± 0.10^{a})
Biomphalaria pfeifferi	8.24 -9.70 (8.77 ± 0.38^{a})	30.0 -39.00 (30.80± 2.67^{a})	64.00 -77.00 (68.83 ± 3.88^{a})	24.00 -27.50 (25.50 ± 1.24^{a})
Bulinus globosus	8.24 -9.70 (8.77 ± 0.38^{a})	30.00 -39.00 (30.8 ± 2.67^{a})	64.00 -77.00 (68.83 ± 3.88^{a})	24.00 -27.50 (25.5 ± 1.24^{a})
Lymnaea natalensis	8.47 -9.70 (9.00 ± 0.55^{a})	33.00 -34.00 (33.25 ± 0.50^{a})	66.00 -69.00 (67.75 ± 1.50^{a})	26.30 -27.50 (26.75 ± 0.53^{a})
Melanoides maculata	8.24 -9.70 (8.77 ± 0.38^{a})	30.00 -39.00 (30.80 ±2.67^{a})	64.00 -77.00 (68.83 ± 3.88^{a})	24.00 -27.50 (25.50 ± 1.24^{a})
P value	0.76^{ns}	0.38^{ns}	0.98^{ns}	0.20^{ns}

Mean with the same superscript letter within the same column are not significantly different (P>0.05)

Legend

© Range

¥ Mean ± standard deviation

Variations in the physicochemical parameters of rice field water among the four districts of Kura Local Government Area of Kano State, Nigeria are shown in Table 4.4. The mean pH of rice fields' water ranged from 8.49 at Butalawa to 9.19 at Dalili. Water pH was significantly ($P > 0.05$) different amongst the three other districts. The total dissolved solids (TDS) of rice fields' water ranged significantly ($P < 0.05$) from 30.67ppm at Butalawa to 37.00ppm at Kosawa. There was no significant difference ($P > 0.05$) between the TDS of rice fields' at Dalili and Sarkin Kura. The electrical conductivity (EC) of rice fields' water ranged significantly ($P < 0.05$) from 65.33µs/cm at Butalawa to 74.00µs/cm at Kosawa. There was no significant difference ($P>0.05$) among electrical conductivity of rice fields water at Butalawa, Dalili and SarkinKura. Water temperature in the rice fields ranged significantly ($P<0.05$) from 24.20**ºC**at Kosawa to 26.77**ºC**at Dalili. There was no significant difference ($P>0.05$) between the temperature of rice fields water at Dalili and SarkinKura (Table 4.4).

Tables 4.5a, 4.5b, 4.5c, 4.5d and 4.5e, show the correlation coefficient (r) matrix and associated probability (p) values of the association of physicochemical parameters of molluscs habitats in rice fields and abundance of mollusc species in each of the four districts investigated in this study. In Dalili district, there was insignificant ($P>0.05$) high positive correlatin ($r = 0.87$-0.94) amongst the abundance of three species of mollusc (*L.natalensis, B.globosus, M.maculata*) and both pH and temperature of rice fields' water . However, very high positive and significant ($r = 0.99$; $P = 0.018$; $P = 0.04$) correlation existed amongst the abundance of *B.pfeifferi* and both pH and temperature of rice fields' water showed high negative ($r = -0.66$ to -0.97) but not significant ($P>0.05$) correlation with the abundance of *L.natalensis, B.pfeifferi, B.globosus* and *M.maculata* (Table 4.5a). In Sarkin Kura district, insignificant ($P>0.05$) high positive correlation existed

among pH (r = 0.77-0.97), TDS(r = 0.55-0.86), EC (r 0.55-0.86), temperature (r = 0.55-0.86) and the abundances of

Table 4.4 District specific physicochemical parameters (Means ± Standard Deviation) of rice fields' water in Kura LocalGovernment Area,Kano state, Nigeria.

District	pH	TDS(ppm)	EC(Ms/cm)	Temperature(0c)	Snails abundance
Butalawa	8.49 ± 0.24^{b}	30.67 ± 1.15^{c}	65.33 ± 2.31^{b}	24.57 ± 0.06^{b}	279
Dalili	9.19 ± 0.51^{a}	33.30 ± 0.58^{b}	67.33 ± 1.53^{b}	26.77 ± 0.64^{a}	669
Kosawa	8.79 ± 0.16^{b}	37.00 ± 2.00^{a}	74.00 ± 2.52^{a}	24.20 ± 0.20^{a}	319
Sarkin Kura	8.63 ± 0.20^{b}	32.33 ± 1.15^{b}	68.33 ± 1.15^{b}	26.60 ± 0.10^{a}	692
P value	0.03*	0.00**	0.00**	0.00**	

Means with the same superscript letter along same column are not significantly different ($p>0.05$)

Legend

pH- Potential of hydrogen ion
TDS- Total Dissolved Solids
EC- Electrical Conductivity
SD- Standard Deviation
P value- Probability value
**-Highly Significant
* - Significant

Table 4.5a: Correlation matrix of the association of physicochemical parameters ofmolluscs in Dalili study district

Dalili	*Bellamya crawshayi*	*Biomphalaria pfeifferi*	*Bulinus globosus*	EC	*Lymnaea natalensis*	*Melanoides maculate*	pH	TDS	Temp
B.crawshayi	NA								
B.pfeifferi	NA	1							
B.globosus	NA	0.9280	1						
EC	NA	0.7150	0.9240	1					
L.natalensis	NA	0.8594	0.9880	0.9720	1				
M.maculata	NA	0.8768	0.9928	0.9631	0.9994	1			
pH	NA	0.9996	0.9386	0.7353	0.8741	0.8906	1		
TDS	NA	0.6674	0.8968	0.9978	0.9432	0.9432	0.689	1	
Temp	NA	0.9980	0.9500	0.7583	0.8903	0.9058	0.994	0.7137	1

Legend

pH - Potential of hydrogen ion
TDS - Total Dissolved Solids
EC - Electrical Conductivity
Temp - Temperature
NA - Not Available

Table 4.5b: Correlation matrix of the association of physicochemical parameters of molluscs in Sarkinkura study district

Sarkin Kura	*Bellamya crawshayi*	*Biomphalaria pfeifferi*	*Bulinus globosus*	EC	*Lymnaea natalensis*	*Melanoides maculate*	pH	TDS	Temp
B.crawshayi	1								
B.pfeifferi	0.9762	1							
B.globosus	0.9870	0.9286	1						
EC	0.7370	0.8660	0.6186	1					
L.natalensis	0.7370	0.8660	0.6186	-1	1				
M.maculata	0.9723	0.8985	0.9973	-0.5587	0.5587	1			
pH	0.8996	0.9729	0.8176	0.9582	0.9582	0.7726	1		
TDS	0.7370	0.8660	0.6186	1	-1	0.5587	-0.9582	1	
Temp	0.7370	0.8660	0.6186	-1	1	0.5587	0.9582	-1	1

Legend

pH - Potential of hydrogen ion
TDS - Total Dissolved Solids
EC- Electrical Conductivity
Temp - Temperature

Table 4.5c: Correlation matrix of the association of physicochemical parameters of mollusc in Kosawa study district

Kosawa	*Bellamya crawshayi*	*Biomphalaria pfeifferi*	*Bulinus globosus*	EC	*Lymnaea natalensis*	*Melanoides maculata*	pH	TDS	Temp
B.crawshayi	NA								
B.pfeifferi	NA	1							
B.globosus	NA	0.8943	1						
EC	NA	-0.9833	-0.9608	1					
L.natalensis	NA	NA	NA	NA	NA				
M.maculata	NA	0.3036	0.6978	-0.4718	NA	1			
pH	NA	0.9076	0.6244	-0.8166	NA	-0.1237	1		
TDS	NA	-0.8943	-1	0.9608	NA	-0.6978	-0.6244	1	
Temp	NA	0.9982	0.8660	-0.9707	NA	0.2462	0.9313	-0.866	1

Legend

pH - Potential of hydrogen ion
TDS - Total Dissolved Solids
EC- Electrical Conductivity
Temp- Temperature
NA – Not Available

Table 4.5d: Correlation matrix of the association of physicochemical parameters of molluscs in Butalawa study district

Butalawa	*Bellamya crawshayi*	*Biomphalaria pfeifferi*	*Bulinus globosus*	EC	*Lymnaea natalensis*	*Melanoides maculata*	pH	TDS	Temp
B.crawshayi	1								
B.pfeifferi	0.4714	1							
B.globosus	0.9421	0.7399	1						
EC	-0.6363	-0.9803	-0.8581	1					
L.natalensis	NA	NA	NA	NA	NA				
M.maculata	0.9226	0.7751	0.9985	0.8846	NA	1			
pH	0.5636	0.9942	0.8080	-0.9959	NA	0.8386	1		
TDS	-0.3974(0.74)	-0.9966	-0.6821	0.9608	NA	-0.7206	-0.982	1	
Temp	0.8030(0.43)	0.9042	0.9563	-0.9563	NA	0.9707	0.9449	0.8660	1

Legend

pH - Potential of hydrogen ion
TDS - Total Dissolved Solids
EC- Electrical Conductivity
Temp- Temperature
NA – Not Available

Table 4.5e: Shows the correlation matrix of the association of physicochemical parameters of molluscs in all the study districts

Total	*Bellamya crawshayi*	*Biomphalaria pfeifferi*	*Bulinus globosus*	EC	*Lymnaea natalensis*	*Melanoides maculata*	pH	TDS	Temp
B.crawshayi	1								
B.pfeifferi	0.0566	1							
B.globosus	0.7129	0.3512	1						
EC	-0.2430	-0.5122	-0.0994	1					
L.natalensis	0.3327	0.4438	0.3830	0.0150	1				
M.maculata	0.4609	0.0907	0.8144	0.2475	0.3829	1			
pH	-0.2584	0.6669	0.3844	0.0029	0.9065	0.3879	1		
TDS	-0.3717	-0.4280	-0.1910	0.9747	0.0991	0.1514	0.1153	1	
Temp	0.3770	0.2324	0.8443	-0.0639	0.6358	0.8041	0.5382	-0.14	1

Legend

pH - Potential of hydrogen ion
TDS - Total Dissolved Solids
EC- Electrical Conductivity
Temp- Temperature

L.natalensis,B.crawshayi, B.pfeifferi, B.globosus and *M.maculata* (Table 4.5b). In Kosawa district, non-significantly (P>0.05) high positive correlation existed among water pH (r = 0.62-0.90) and abundance of *B.pfeifferi* and *B.globosus;* water TDS (r = 0.69- 0.89) and abundance of *B.pfeifferi* and *M.maculata;* water EC (r = 0.96-0.98) and abundances of *B.pfeifferi* and *B.globosus;* water temperature (r = 0.86) and abundance of *B.globosus* (Table 4.5). A significantly (P = 0.03) high positive correlation (r = 0.99) existed between the temperature of rice fields' water and abundance of *B.pfeifferi.* Non-significant (P>0.05) low positive correlation (r = 0.12-0.47) existed among the pH , EC and temperature of rice fields' water and the abundance of *M.maculata* in Kosawa district (Table 4.5c). In Butalawa district , insignificant (P>0.05) high positive correlation (r = 0.63-0.99) existed amongst the pH , TDS and EC of rice fields' water and abundances of *B.pfeifferi, B.globosus* and *M.maculata.* While non-significant (P>0.05) high positive correlation (r = 0.63-0.78) existed among the EC and temperature of rice fields' water and abundance of *B.crawshayi* in Butalawa district, non-significant (P>0.05) low to mild positive correlation (r = 0.39-0.56) existed among the pH and EC of rice fields' water and abundance of *B.crawshayi.* Similarly non-significant (P = 0.88) low positive correlation (r = 0.17) existed between the temperature of rice fields' water and abundance of *B.pfeifferi* in Butalawa district (Table 4.5d).

4.4 Distribution, Prevalence, and Intensity of Urinary Schistosomiasis among Rice Farmers in Kura Local Government Area

The distribution, sex related prevalence and intensity specific of urinary schistosomiasis among rice farmers in four districts of Kura Local Government Area in Kano State, Nigeria are shown in Table 4.6.The prevalence of urinary schistosomiasis in the female rice, farmers ranged from

Table 4.6: Distribution sex-related prevalence and mean intensity of urinary schistosomiasis among rice farmers insome districts of Kura Local Government Area, Kano state, Nigeria.

Districts	Female (F)		Male (M)		Total(M+F)		Mean intensity(eggs/10ml)		
	No. Examined	No.+ve(prev%)	No.Examined	No.+ve(prev%)	No.Examined	No.+ve(prev%)	Male	Female	Total
Butalawa	31	09(29.03)	74	35(47.30)	105	44(41.90)	05.31[c]	03.38[b]	05.02[d]
Dalili	21	09(42.86)	84	48(57.14)	105	57(54.29)	61.21[a]	01.89[b]	51.84[a]
Kosawa	44	22(50.00)	61	25(40.98)	105	47(44.76)	14.80[b]	18.05[a]	16.32[c]
SarkinKura	15	08(53.33)	90	55(61.11)	105	63(60.00)	37.42[a]	04.38[b]	33.22[b]
Total	111	48(43.24)	309	163(52.75)	420	211(50.24)	118.74	27.70	106.40
P value							0.03	0.00	0.00

Means with the same superscript letter along same column are not significantly different ($p>0.05$)

Legend

No. - Number

+ve - Positive

Prev - prevalence

9/31(29.03%) in Butalawa to 8/15(53.33%) in SarkinKura.The overall prevalence of the infection in female rice farmers was 48/111(43.24%).Amongst the male rice farmers, prevalence of urinary schistosomiasis ranged from 25/61(40.98%) in Kosawa to 55/90(61.11%) in SarkinKura. The overall prevalence of the infection in male rice farmers was 163/309(52.75%). The overall prevalence of urinary schistosomiasis in the study area was 211/420(50.24%) with prevalences ranging from 44/105(41.90%) to 63/105(60.00%) in the study areas. Themean overall intensity of *Schistosoma haematobium* was higher (118.74eggs/10mL of urine) in males rice farmers than (27.70eggs/10mL of urine) in female rice farmers. The intensities of schistosomiasis for male rice farmers ranged from 5.31 - 61.2eggs/10mL of urine between the districts and from 3.38 – 18.05eggs/10mL of urine for their female counterparts. The mean total intensity of the disease ranged from 5.02eggs/10mL urine in Butalawa districts to 51.84eggs/10mL urine in Dalili district Table (4.6).

Table 4.7 shows the epidemiologic association of urinary schistosomiasis with the genders of rice farmers in Kura Local Government Area of Kano State Nigeria. Acquisition of urinary schistosomiasis is positively (Odds Ratio > 1) but insignificantly (lower CI < 1) associated with male gender but not associated (OR < 1) with the female gender (Table 4.7).

In Table 4.8 is shown the distribution of urinary schistosomiasis among six age categories of rice farmers of both genders in Kura Local Government Area of Kano State, Nigeria. Prevalence of urinary schistosomiasis in female rice farmers ranged from 90.91% in those aged 1-10years to nil (0%) in those aged 41years and older.Prevalence of the disease in male rice farmers ranged from 76.06% in those aged 1-10 years to nil (0%) in those aged 41years and older. Rice farmers that were 10years of age and younger had the highest prevalence of 78.05% while those aged 41years and older were not infected.

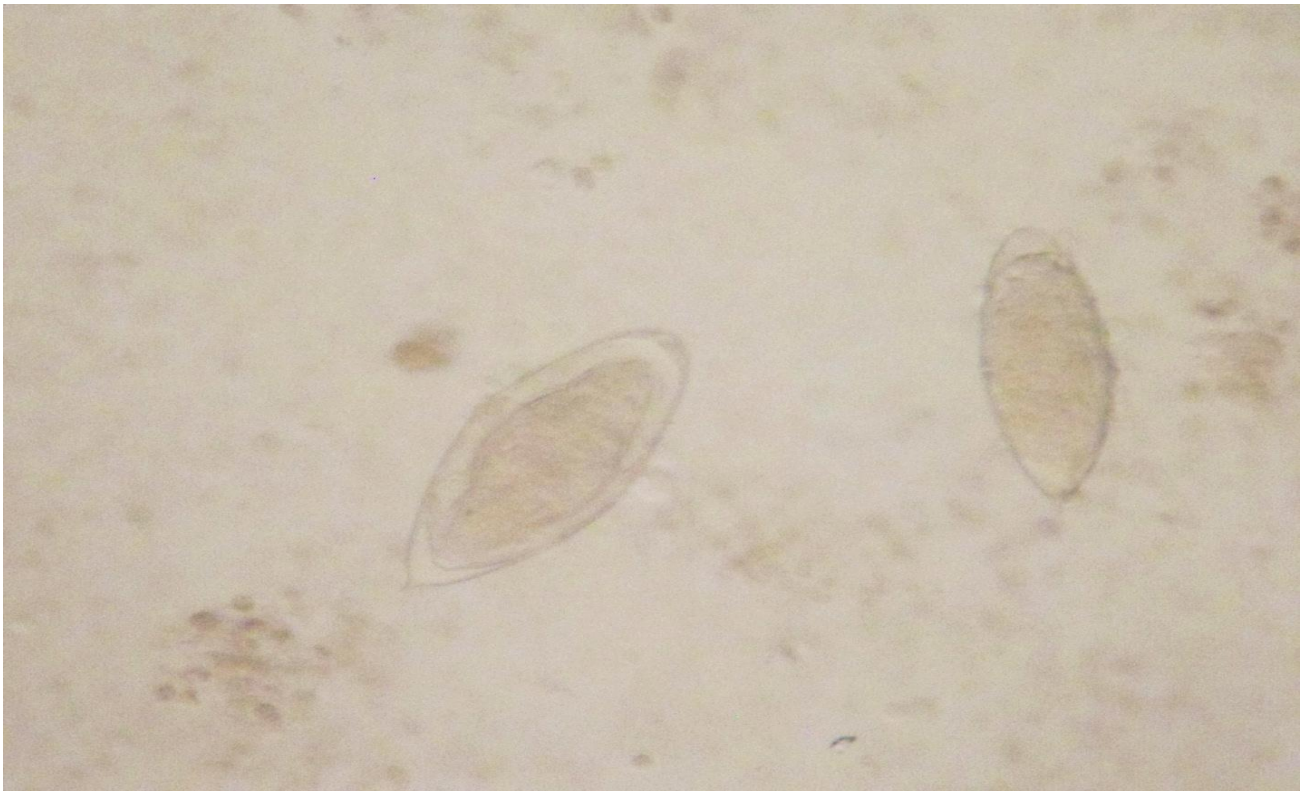


Plate VI *Schistosoma haematobium*eggs in urine sample under magnification x 400.

Table 4.7 Association of urinary schistosomiasis with rice farmers' gender in Kura LocalGovernment Area of Kano State, Nigeria.

Sex	Negative	Positive	Odds Ratio	95% CI
Male	146	163	1.4650	0.9467-2.2680
Female	63	48	0.6824	0.4409-1.0560
Total	209	211		

Legend

CI – Confidence Interval

The prevalence of urinary schistosomiasis in the farmers declined significantly ($P < 0.05$) with increasing age class intervals from 78.05% in 1-10 years age category to 19.35% in those aged 31-40years and nil (0%) in those aged 41years and above. Thus, the prevalence trends amongst the various age categories were 1-10years > 11-20years > 21-30years >31-40years > 41-50years = Above50 years (Table 4.8). In Table 4.8, the association of urinary schistosomiasis with each of the six age categories and genders of the rice farmers are presented. While there was no association (OR<1) between male rice farmers of age group 1-10 years and prevalence, female rice farmers of same age group was significantly associated (OR >1; 95% CI include 1) with the infection but the lower confidence interval at 95% was lower than 1 because there was one cell that was lower than 5, it was 1. For the male rice farmers aged 11-20 years, there was significant association (OR>1; 95% CI exclude 1) with the infection, but no infection association (OR<1) between female rice farmers of same age group and prevalence. Female rice farmers aged 31-40 years were associated (OR>1; 95% CI including 1) with urinary schistosomiasis outcome. There was no association in all other age groups with infection.

The categorization of the intensity of urinary schistosomiasis among rice farmers in Kura Local Government Area of Kano State, Nigeria, into light, medium and heavy infections is shown in (Table 4.9). In all, the intensities ranged from 10/211 (4.74%) of the farmers who had medium intensity to 38/211 (18.01%) of who had heavy intensity and a large majority, 163/211 (77.25%), with light infection, with light infection (Table 4.9).

The results and epidemiologic analyses of six identified factors that could constitute risks for the transmission of urinary schistosomiasis to rice farmers on rice fields within Kura Local Government Area, Kano State, Nigeria were presented in Table 4.10.

Table 4.8: Age-specific prevalence of urinary schistosomiasis among rice farmers in Kura Local Government Area of Kano State, Nigeria.

	Number examined			Number % infected			Odds ratio(95% Class Interval)	
Age group (years)	Female	Male	Total	Female	Male	Total(%)	Female	Male
1-10	11	71	82	10(90.91)	54(76.06)	64(78.05)[a]	3.2(0.4-2.6)	0.3(0.0-2.7)
10-20	55	121	176	29(52.72)	87(71.90)	16(65.91)[b]	0.4(0.2-0.8)	2.3(1.2-4.4)
21-30	32	56	88	08(25.00)	17(30.36)	25(28.41)[c]	0.8(0.3-2.0)	1.3(0.5-3.5)
31-40	03	28	31	01(33.33)	05(17.86)	06(19.35)[d]	2.3(0.2-3.1)	0.4(0.0-5.8)
41-50	06	24	30	00(00.00)	00(00.00)	00(00.00)[e]	undefined	Undefined
Above 50	04	09	13	00(00.00)	00(00.00)	00(00.00)[e]	undefined	Undefined
Total	111	309	420	48(22.75)	163(77.25)	211(50.24)		

Superscript with same letter along same column are not significantly different (P>0.05)

Table 4.9: Categorisation of the intensity of urinary schistosomiasis among ricefarmers in Kura Local Government Area, Kano State, Nigeria.

Intensity of infection	Number infected	Percentage
Light infection (0-30eggs/10mL)	163	77.25
Medium (31-49eggs/10mL)	10	4.74
Heavy (above 50eggs/10mL)	38	18.01
Total	211	100

Table 4.10 Epidemiologic risk factors associated with the transmission of urinary schistosomiasis among rice farmers in Kura Local Government Area, Kano State, Nigeria.

Risk factor	No. infected	No. uninfected	Odds ratio	95% C.I
Gender				
Male	163	146	1.5	0.9 - 2.3
Female	48	63	0.7	0.4 - 1.1
Water contact activities				
Swimming	175	101	5.0	3.2 - 7.8
Washing	28	27	1.1	0.6 - 2.0
None	08	81	0.1	0.0 - 0.1
Source of water				
Well	84	91	0.8	0.5 -1.2
Borehole	31	75	0.3	0.2 - 0.5
Stream	96	43	3.2	2.1 - 4.9
Farm defaecation/urination				
Yes	206	195	3.0	1.6 - 8.5
No	5	14	0.3	0.1 - 1.0
Protective wears				
Boots	17	23	0.7	0.4 - 1.4
None	194	186	1.4	0.7 - 2.8
Awareness				
Yes	189	190	0.9	0.5 -1.6
No	22	19	1.1	0.6 - 2.2

Legend

CI – Confidence Interval

Extrapolations from Table 4.10 indicate that over 77% and 22% of infected male rice farmers were male and female respectively. Being a male rice farmer was associated (odds ratio -OR > 1) with increased risk of contracting urinary schistosomiasis, but not significantly (95% CI include 1). The Odds for male rice farmers contracting urinary schistosomiasis are 50% higher than the odds for female rice farmers to contract the disease within rice fields' foci in study districts. Extrapolations from table 4.10 indicate that over 82% and 13% of rice farmers with urinary schistosomiasis were engaged in swimming and washing as water contact activities respectively. Engagement of rice farmers in such water contact activities as swimming and washing were associated (OR >1) with increased risk of contracting urinary schistosomiasis. While those rice farmers that were engaged in swimming had 5times greater odds of contracting urinary schistosomiasis over those not making water contact. Those engaged in washing as water contact activity had 10% higher odds of contracting the disease. Swimming, as a water contact activity, was significantly associated (95% CI exclude 1) with the acquisition of urinary schistosomiasis, but washing was not significantly associated (95% CI include 1).

A total of 96/211 (45.50%) of the rice farmers that were positive for urinary schistosomiasis attested to drinking water from streams was 3.2 times higher than those not drinking stream water. The use of stream as a source of water was significantly associated (OR<1; 95% CI exclude 1) with the acquisition of urinary schistosomiasis. The use of wells and boreholes as sources of water were not associated (OR <1) with acquisition of urinary schistosomiasis. A total of 206/211 (97.63%) of the rice farmers that were positive for urinary schistosomiasis attested to have urinated / defaecated on rice farms. The odds of contracting urinary schistosomiasis due to urination/defaecation on rice farms was three times higher than those who did not. Urination/defaecation on rice farms were significantly associated (OR > 1; 95% CI exclude

1)with the acquisition of urinary schistosomiasis by rice farmers. Majority (91.94%) of the rice farmers that had urinary schistosomiasis attested to non-use of protective wears while working on rice fields. Wearing of boots and its non-use were not associated (OR<1) and insignificantly associated (OR > 1; 95% CI include 1) respectively with the acquisition of urinary schistosomiasis by the rice farmers. A total of 189/211 (89.57%) of rice farmers that had urinary schistosomiasis had awareness of the disease while 22/211(10.43%) infected others had no awareness about the disease. Awareness about urinary schistosomiasis was not associated (OR < 1) with acquisition of the disease by rice farmers. Rice farmers that are not aware of urinary schistosomiasis had 10% higher odds of contracting the disease than those that are aware of it. Non- awareness of urinary schistosomiasis was insignificantly associated (OR > 1; 95% CI include 1) with acquisition of the infection.

CHAPTER FIVE

5.0 DISCUSSION

Rice fields constitute effective habitats for mollusc colonization in agrarian districts within Kura Local Government Area of Kano State, Nigeria as confirmed by the results of this study. The colonization of rice fields by diverse species of mollusc could be due to the availability of aquatic habitats with favourable physicochemical and biotic conditions for the sustenance of the observed mollusc species encountered in rice fields in this study, three species which included *Biomphalaria pfeifferi*, *Bulinus globosus* and *Lymnaea natalensis* are important snail intermediate hosts supporting the development of parasitic trematodes of medical and veterinary importance (Ntonifor and Ajayi, 2007). *Biomphalaria pfeifferi* and *B.globosus* are gastropod snail intermediate hosts of *Schistosoma mansooni* and *Schistosoma haematobium* respectively; the causative agents of human intestinal and urinary schistosomiasis respectively. It was only *B.globosus*, and at very low infection rate, that shed cercariae which are the human infective larval stages of *S.haematobium* in the study location. *Lymnaea natalensis* is the gastropod snail intermediate host of the food-borne hepatic trematode, *Fasciola hepatica* and *Fasciola gigantica*, which are infective in ruminant mammals and humans in several worldwide foci; causing fascioliasis of liver rot disease. The presence of these three species of mollusc in rice field ecosystems was suggestive that such diseases as urinary schistosomiasis, intestinal schistosomiasis and fascioliasis could be contracted by humans and animals within the vicinity of rice fields. Thus, apart from urinary schistosomiasis which has been confirmed in rice farmers in this study, rice farmers could also be susceptible to intestinal schistosomiasis and or fascioliasis in the study locations. It may be worthwhile to investigate the nature of these diseases among rice farmers in future line of research. Oguike (2015) also encountered these

three medically important snail species in rice field ecosystems in Kachia Local Government Area of the nearby Kaduna State, Nigeria. As far as their disease transmission potentials are concerned, both *B.pfeifferi* and *B.globosus* that occurred in high populations and in all the four districts explored in this study, could present higher schistosomiasis transmission than for the transmission of fascioliasis due to *Lymnaea natalensis* that occurred at a relatively lower abundance and in only two of the four districts. By far, the most abundant mollusc species encountered in rice fields in all the four districts in this study was *M.maculata*. This species, together with the least abundant *B.crawshayi* are of no medical significance. The latter has been categorized amongst the red list of endangered species that could become extinct due to the low number at which it occurs in relatively few locations in the world International Union for Conservation of Nature (IUCN), 2006. The endangered status of *B.crawshayi* could be responsible for its rareness in this study. Oguike (2015) in a similar study conducted in rice fields, also encountered *M.maculata* more frequently than*B.crawshayi* at highest and least abundance respectively in Kachia Local Government Area of Kaduna State, Nigeria.

The five species of mollusc encountered in this study occurred at slightly alkaline waters in the rice fields (Table 4.3). The pH of water in the ricefields as well as their TDS, EC and temperature did not differ significantly for the microhabitats of all the five species of molluscs (Table 4.3). It could thus,be inferred that all the five species of mollusc occurred in microhabitats of similar physicochemical attributes in the rice fields. Thus, water alkalinity, in terms of its pH, is a key factor determining the occurrence of mollusc species in rice fields within Kura Local Government of Kano State, Nigeria. The pH of water in rice fields within virtually all the districts variously showed high positive correlation with molluscs abundance (Table 4.5a-4.5e). Significantly high correlation were only observed between the abundance of *B.pfeifferi*and pH as

well as temperature of rice fields ' water (Table 4.5). Furthermore, Dalili district with significantly highest water pH values (Table 4.4) was supportive of a high abundance of mollusc species (Table 4.1).

These results corroborated the work of Gorg *et al*. (2009) who attributed the richness of molluscs to the alkaline nature of water. As was obtained in the study, Malhotra *et al*. (1996) and Sharma *etal*. (2013) also demonstrated the importance of temperature in the distribution of gastropod mollusc. Both the total dissolved solids and electrical conductivity of water showed high negative correlation with the abundance of molluscs in the rice fields (Table 4.5a-4.5e); which implied reciprocal effects of both factors on mollusc colonization of rice fields.

This study also revealed a high prevalence of urinary schistosomiasis among rice farmers in Kura Local Government Area of Kano State, Nigeria. An overall prevalence of 50.24% (Table 4.6) obtained in this study was indicative of very high exposure risk and high morbidity burden of urinary schistosomiasis due to occupation of rice farming by the farmers. The study has further revealed that rice farming occupation and humans engaged in this occupation in parts of northern Nigeria are a high risk occupation group for contracting urinary schistosomiasis. This conclusion is right following the report of Oguike (2015) that an overall 60.99% of rice farmers in parts of the neighbouring Kaduna State had urinary schistosomiasis. Thus, rice fields present a very ideal epidemiologic setting for the acquisition and transmission of urinary schistosomiasis; especially with the presence of favourable environment for colonization by snail intermediate hosts, presence of water bodies that favour the cultivation of rice by farmers, human contact with cercariae-infested waters, often for long hours, while engaged in rice farming activities and infected rice farmers that urinate egg-laden urine to continuously pollute aquatic environments in rice fields. This scenario will remain unabated for continued disease transmission unless and

untill a deliberate disease awareness and therapeutic interventions are put in place to stem the negative tide. The current efforts by the governmental agencies to boost local rice production in Nigeria may not be sustainable if schistosomiasis control strategies are not put in place to rescue infected rice farmers from the clutch of this deadly disease. The urinary schistosomiasis prevalence figure obtained in this study is comparable with the 48.70% obtained by Balla *et al*. (2015) from studies carried out in parts of north eastern, Nigeria. An earlier study conducted by Abdullahi *et al*. (2009) within the same SarkinKura Local Government Area of Kano State, but not strictly on rice farmers revealed a higher prevalence of 64.00%. This higher prevalence could be reflective of high burden of schistosomiasis amongst residents of Kura Local Government Area of Kano State, Nigeria. It is plausible that residents of Kura Local Government Area of Kano State, Nigeria might have sought medical treatment for urinary schistosomiasis between the time of the earlier study by Abdullahi *et al*. (2009) and 2016 when this study was done.

Prevalence of urinary schistosomiasis amongst rice farmers varied amongst the four districts investigated in this study and this could be a reflection of differences in exposure risks to disease determinants within the districts. Prevalence of the disease was also found to be higher among male farmers than in their female counterparts. Acquisition of urinary schistosomiasis was also positively associated with the male gender. The higher male prevalence could be due to socio-cultural and religious factors in the study area that tend to limit and or reduce females engagement to such outdoor activities as rice farming by the restriction of women- in –purdah to mainly household chores. Men are thus disproportionately more involved and engaged in rice farming with the attendant higher exposure risk to epidemiologic conditions for the acquisition of schistosomiasis in rice fields. Okon *et al*. (2007) had also reported higher schistosomiasis prevalence of 39.20% in males than 30.60% in females. In his studies in the neighbouring

Kaduna State where women-in-purdah system was not practised and females were vigorously more engaged in rice farming activities, Oguike (2015) obtained a higher female schistosomiasis prevalence of 80.35% as against a male prevalence of 40.44%. Thus, the levels of involvement of male and female farmers in rice farming occupation are predisposing factors that could determine disease prevalence for urinary schistosomiasis.

In this study the use of childs' labour in rice farming activities was very high to the extent that children (minimum age of 6 years) in the 1-10year age category had the highest prevalence. This high prevalence of urinary schistosomiasis could be associated with the high water contact activities of these young farmers as a result of frequent swimming activities in snail infested irrigation canals aside their water contacts due to farming chores. Oguike (2015) reported the next older age group (11-20 years) as those with modal prevalence in the neighbouring Kaduna State of Nigeria. Prevalence of urinary schistosomiasis decreased significantly with farmers' ages except in those aged 41years and older. It could be inferred that rice farmers become exposed to urinary schistosomiasis infection early in life, accumulate the parasites due to immune naivety and subsequently acquire immunity against the parasites. Ukoli (1984) observed a decline in reinfection with schistosomiasis at the attainment of second decade of life when humans acquire infection earlier in life. Thus, the prevalence of urinary schistosomiasis decreased steadily with increasing age of rice farmers in Kura Local Government Area of Kano State, Nigeria. This finding corroborates the reports of Ugbomoiko *et al*. (2010) and Yusuf *et al*. (2015) that prevalence and intensity of schistosomiasis declined gradually with increasing age. Apart from the slowly acquired immunity to schistosomiasis, other factors as reduction in water contact activities with advancement in age and decrease in longevity, survival and fecundity of

Schistosoma wormsin infected human hosts could have accounted for observed decline in prevalence with advancement in age.

Several epidemiologic risk factors, including male gender, swimming, drinking of stream water, urination and or defaecation on farmlands, non-use of protective wears and lack of disease awareness, were identified as being contributory to the acquisition of urinary schistosomiasis by the rice farmers (Table 4.10). Irrigation canals around the rice fields that supplied irrigation water from the main reservoir constituted important water contact points, where several of the relatively younger rice farmers were observed to have engaged in swimming activities. These young and often underaged farm labour hands often immerse their entire body to snails' cum-cercariae-infested waters while swimming; which could enhance cercarial penetration. Rikoto and Danladi (2013) also found high prevalence of schistosomiasis among individuals who engaged in swimming. The drainage feature of the rice fields' ecosystems in Kura Local Government Area consists of a main water reservoir, irrigation canals and several seepages, that form streams and rivulets which constituted drinking sources to the rice farmers in homesteads, while they were physically engaged in farming activities far removed from their dwellings. The significant association of stream water, as a source of drinking water, with urinary schistosomiasis (Table 4.10), could be due to the possibility of acquiring infection through drinking from cercariae-infested water. It is possible for infective cercariae to penetrate mucosal lining of human buccal cavity to initiate schistosomiasis infection. Nanvya *et al*. (2011) also reported higher schistosomiasis infection among individuals that used stream or lake water as sources of drinking water. Furthermore, pollution of the farm environment with human excreta containing the eggs of *Schistosoma*species is vital for thecontinous transmission of schistosomiasis in endemic foci (Ukoli, 1984). In this study, a very high proportion (97.63%) of

the infected rice farmers attested to have defaecated and urinated on their farms (Table 4.10). The significant association of this pollution indices with urinary schistosomiasis amongst the rice farmers pointed to the positive contributed of these habits to the acquisition of the disease. Okpala (2010) also found a positive associated of schistosomiasis in individuals that utilized bush/farmlands as toilet facilities over those that used water closet toilet systems and pit toilets. The use of protective wears by the rice farmers to prevent them from contracting schistosomiasis was non-existent in Kura Local Government Area. A whopping 91.94% of rice farmers admitted not to have used protective wears while working on farms. This translates to the exposure of body parts to direct penetration of cercariae by a majority of rice farmers. This explains the association of non-use of protective wears with prevalence of urinary schistosomiasis among the rice farmers. Several of the farmers complained that boots and gloves were not comfortable and or convenient to wear for farm work. Despite the high awareness about urinary schistosomiasis due to the dramatic haematuria symptoms amongst the rice farmers, non-awareness of the disease was associated with prevalence of the infection. This could be due to the fact that those that are ignorant of the nature of the disease may not seek medical treatment for the ailment. Those that are familiar with the symptoms of the disease are often ignorant of the aetiology agent and the mode of transmission to warrant effective protection against the disease. Ugbomoiko *et al*. (2010) also observed significant ignorance on the mode of schistosomiasis transmission amongst individuals in areas endemic for the disease.

CHAPTER SIX

6.0 CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions:

i. A total of 1959 specimens of five snail species including 39-*B.crawshayi*, 307- *B. pfeifferi*, 548- *B. globosus*, 95-*L.natalensis* and 970-*M.maculata* were obtained from rice field and four specimens of *B globosus* shedded cercariae, thus intermediate host of urinary schistosomiasis was present in the rice fields in Kura Local Government Area, Kano State, Nigeria.

ii. The snails occurred at pH (8.24-9.70), TDS (30-39ppm), EC (64-77µs/cm) and temperature (24-27.5 ^{o}C) with no significant difference in species specific preference, therefore snails were found in alkaline aquatic rice fields habitat in Kura Local Government Area, Kano State, Nigeria.

iii. Overall urinary schistosomiasis prevalence of 50.24%; male and female prevalence of 52.75% and 43.24% ($p < 0.05$) respectively were obtained for rice farmers in all the four districts.Modal prevalence (78.04%) occurred in children 10yrs and younger. Intensity of infection ranged from light (77.25%) to heavy(18.0%).

6.2 Recommendations:

i. Efforts should be made to prevent transmission of schistosomiasis by adequately treating the infected rice farmers and control of the snail intermediate hosts in rice fields.

ii. Policy makers should recognize the disease as a focal public health problem and should be willing to promote and support control where and when necessary.

iii. Health education should be intensified to create needed awareness on preventive measures amongst rice farmers.

6.3 Contribution to knowledge

- The overall prevalence of urinary schistosomiasis was 50.24%, with the prevalence among males being 52.75% while in femalesit was 43.24%.This revealed that there is high prevalence of urinary schistosomiasis and active transmission of schistosomiasis among the rice farmers in Kura Local Government Area, Kano State, Nigeria.
- This study revealed the presence of intermediate host of urinary schistosomiasis *Bulinusglobosus,* intestinal schistosomiasis; *Biomphalaria pfeifferi*andalsofascioliasis; *Lymnaea natalensis* in the study districts of Kura Local Government Area. This implies that the rice farmers may be at risk of urinary schistosomiasis as already revealed in this study and also may be at risk of intestinal schistosomiasis and fascioliasis.

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APPENDIX

Appendix I Sample questionnaire

Ahmadu Bello University, Zaria, Kaduna State

M.sc. Zoology

Questionnaire form

DEMOGRAPHIC DATA

1. Gender male( ) female( )
2. Age 1-10 ( ) 11-20 ( ) 21-30 ( ) 31-40 ( ) 41-50 ( ) above 50
3. Farming experience 6-10 ( ) 11-15 ( ) 15-20 ( ) 21-25 ( ) 26-30)31-35 ( ) 36-40 ( ) above 40 ( )
4. District / village _____

RISK BEHAVIOURS

1. Swimming activities Yes ( ) No ( )
2. Do you drink from the stream or river? Yes ( ) No ( )
3. Do you urinate / defecate in the farm? Yes ( ) No ( )
4. Do you wear protective clothing while farming Yes ( ) No ( )
5. Reasons lack of finance ( ) farming convenience ( ) other reasons ( )

KNOWLEDGE AND PERCEIVED RISK

1. Have you heard about schistosomiasis? Yes ( ) No ( )

2. Do you know about water snails? Yes ( ) No ( )

3. What is your perception about snails? Harmful ( ) safe ( ) indifferent ( )