PREVALENCE OF URINARY SCHISTOSOMIASIS AND SNAIL VECTOR INFECTIVITY ALONG RIVER KUBANNI IN ZARIA

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DECLARATION

I hereby declare that the work reported in this Thesis was carried out by me under the careful supervision of Dr. M. Galadima and Dr. S.E. Yakubu of Ahmadu Bello University, Zaria. No part of this work was reproduced from any previous work or had been presented for an award of higher degree. The work of other workers cited were duly acknowledged

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CERTIFICATION

This Thesis entitled " Prevalence of Urinary Schistosomiasis and snail vector infectivity along River Kubanni in Zaria" by me Yakubu NALE meets the regulations governing the award of the Degree of Master of Science Ahmadu Bello University, Zaria and is approved for its literary contribution.

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DEDICATION

This Thesis is dedicated to my little Daughter Miss Thelma Queenom Nale and the little ones to come.

ACKNOWLEDGEMENT

I am most grateful to God Almighty through Jesus Christ for making me what I am by His grace, and to my late parents who brought me up.

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ABSTRACT

The study was conducted to determine the prevalence and intensity of *Schistosoma haematobium* infection in two local communities and three primary schools situated near river Kubani. The seasonal occurrence and infcctivily of the snail intermediate hosts with schistosome ccrcanac were also determined.

Out of 1067 subjects (380 from (he communities and 687 school pupils) whose urine were screened parasilologically for *S haematobium* infection, 123 (11.6%) were found infected with an average egg counts of 77.7 eggs/ 10ml of urine. Prevalence was higher in males (19.4%) than in females (3.2%). Similarly, intensity was higher in males (86.6cggs/10ml urine) than in females (18.4 eggs/10ml urine). The difference in prevalence was found to be statistically significant ($P<0.01$). The peak prevalence (29.2%) occurred in the 10 - 14 years age group. Analysis shows that this age group is responsible for 72% contamination of the environment with schistosome ova.

Intensity of infection was however, highest in the 15 19 years group who had a mean egg count of 108.3cggs/10ml of urine. Both prevalence and intensity of infection declined steadily with age after their peaks in the 10 - 14 and 15 - 19 years age groups respectively. Examination of children **from** 3 primary schools situated near the river Kubani shows an infection rate of 10% and intensity of infection 111.28 eggs/10ml urine. Both prevalence and intensity of infection were higher in public primary schools than those of children in Islamic primary school.

The local community based prevalence and intensity of infection among 380 subjects also showed a similar trend such that both prevalence and intensity of infections were higher in males than in females ($P<05$). In males, both indices peaked in those aged 20 - 24 years while in females they were highest in the 10 - 14 years age group. This was discussed in relation to the duration of exposure to infection. In a related development, the lack of infection in female aged 20 - 24 years was attributed to observance of certain Islamic law (Puddah).

Three different snail species were identified throughout the 12 months sampling period which include *Bulinus spp, Bioniphalaria pfefferi* and *Limnae uataleiisis.* A total of 4908 snails were collected comprising of 51.1%. *Bioniphalaria,* 32.8%. bulin*us* and 16.1% *Limnae.* Snails population

density varied varied with season with peak collection between October and March. Seasonal trend of snail infections however, only occurred in *Biomphalaria* and *Limnae* with higher infection occurring in the dry season (November - March). Of the whole snails collected 445 (9.1%) were found to be shadding cercariae of human or animal trematodes. *Biomphalaria* recorded the highest number of schistosome infection (7.8%) while only 0.6% of Bulinus habonred schistosome ccrcariae suggesting the predominance of *S.mansoni* over S. *haematobium* in the study area. The public health significance of snail infection rate was also discussed.

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CHAPTER ONE

1.1 INTRODUCTION:

Schistosomiasis or bilharziasis is one of the most widespread diseases of man and second only to malaria in socio-economic and public health importance in the tropical and subtropical countries (Iarotski and Davis, 1981). In 1972, Wright estimated that the total annual loss due to Schistosomiasis stood at US $641,790,130 world-wide but with the current wide-spread of the disease consequent to population migration, expansion of irrigation and other water resource development coupled with the limitation of existing studies, it has made the evaluation of economic impact of Schistosomiasis very difficult (WHO, 1993; Taylor, 1994). Schistosomiasis is endemic in 74 countries and about 200 million people are infected whereas about 600 million people are at risk of infection (Iarotski and Davis,1981; WHO, 1993). Available records indicate that Schistosomiasis is endemic in Nigeria (Cowper, 1963; 1973, WHO, 1993). Historically, the disease is known to have existed in Nigeria from time immemorial and according to legend, was brought into the country by the migrating Fulani people when they travelled Westward from the Nile basin (Blair, 1956). The earliest record was that of a German explorer published in 1881(Cowper, 1963). This German explorer commented on the extensive occurrence of endemic haematuria in Bornu province. It was however, not until 1932 when the scientific appraisal of bilharziasis as a Nigerian health problem, its distribution, extent and clinical significance began in Northern region with its station headquarters at Zaria (Cowper, 1973).

Schistosomiasis is caused by digenetic trematodes belonging to the family Schistosomatoidea (Jordan and Webbe, 1982). Of the 16 species of

schistosomes known to infect man or animal, only three species namely *Schistosoma haematobium*, *S. mansoni* and *S. Japonicum* are of significant importance in man (Brown and Neva, 1983). Both *S. haematobium* and *S. mansoni* are endemic in Nigeria, however, the infection rate of the latter throughout Nigeria is generally lower than the former though it is more localised (Cowper, 1973; WHO, 1993). *S. haematobium* is prevalent in 54 countries world-wide (WHO, 1993) including Nigeria where infection rates of up to 95% had been reported in the Northern parts of the country (Cowper, 1963). Records have shown that man is the only significant maintenance host of *S. haematobium* although, a few animals such as baboons, rodents, pigs and chimpanzees have been found to be naturally infected but the recorded infection rate has always been low (WHO, 1979)

Transmission of this disease occurs when a susceptible host (man) comes in contact with water infested with the intermediate host (snail) bearing the infective stage (cercariae) of this parasite. The intermediate host snail belongs to the genus *Bulinus* which are often found among vegetation in stagnant or slow running freshwater , irrigation channels, large natural and man made lakes and smaller collections of water (Chessbrough, 1992; Estambale, 1996). Contact is achieved through water related activities such as domestic, bathing swimming washing, fishing, wadding, irrigation and religious activities (Farooq & Mallah, 1966; Fajewonyomi and Afolabi, 1994).

Transmission is often seasonal with temperature and rainfall acting as the principal controlling factors (Jordan and Webbe, 1982). The diecious adult worms live primary in the vesical and pelvic plexuses of the venous circulation where much of the damage primarily occurs but other organs such as genital, kidneys, ureters can also be affected (Faust *et al*, 1977).

The eggs released after mating are passed out in the urine but some are trapped in the bladder tissue where they induce inflammatory reactions leading to the pathology of this disease (Cheesbrough, 1992). The acute phase of the disease is characterised by blood in the urine with burning sensation during urination (Brown and Neva, 1983). The chronic stage is marked by the formation of granulomas around the eggs, fibrosis and calcification of the bladder (Jordan and Webbe, 1982). Also during this stage, bladder cancer is not uncommon and is mostly of squamous cell type (WHO, 1993). In heavy *S. haematobium* infection the parasite may be found in ectopic sites beside the bladder and include such as reproductive organs, gastrointestinal tract, lungs, central nervous system etc (Edington *et al,* 1975). Female genital Schistosomiasis (FGS) is common in urinary schistosomiasis due to the intricate vascular links between the plexus rectalis and vesicularis on the one side and veins of the genital organs on the other hand which provide the migrating worms with easy access to the internal and external genitalia (Kjetland *et al,* 1996). The presence of the parasite in the female genital organs is of gravious consequences and recently a thing of concern (Feldmeier *et al,* 1995). It has been implicated in infertility (Bullough, 1976), abortion (Youssef and Abdine, 1958) preterm delivery (Siegrist & Siegrist Obimpeh, 1992), aggravate vesico - virginal fistula (Bland & Gelfand, 1970) and ectopic pregnancy (Okonofua *et al,* 1990).

Schistosomiasis continues to be a major health problem because of more development of water resources particularly in small reservoirs and irrigation system; besides, the planning directed towards the control of the disease are inadequate (WHO, 1993). One of the effective control measures of this disease is the elimination of the snail intermediate host which is an essential link in the life cycle of the schistosome parasite and to do this, adequate

knowledge of the snail ecology is necessary (WHO, 1985) . This can be achieved through the snail surveillance system defined as a procedure or group of procedures used to collect estimate of snail vectors population and characteristics required to predict, prevent, or control the vector borne diseases (Okon, 1998).

Though several investigations have been carried out on this aspect elsewhere, there is need to carry out similar work in the study area since it has been said that the information collected from one area in this regard might not be applicable to another (Baalawy & Moyo, 1970). Previous workers therefore suggested the continual investigation on this subject matter (WHO, 1980). On this background, this work is designed with the following objectives:

i) To determine the prevalence intensity and index of *S. haematobium* infection among the inhabitants along Kubani River, Zaria, Kaduna state.

ii) To determine the snail vectors that are predominant in this river and its tributaries.

iii) To determine the seasonal occurrence of these snail and their infectivity.

iv) To determine the correlation between snail infection and the prevalence rate of *S. haematobium* and

v) To advice the communities on how to avoid schistosomiasis haematobium infection.

CHAPTER TWO

2.0. LITERATURE REVIEW

2.1. Life Cycle of the parasite:

The life cycle of *S. haematobium* has an alternation of generation, with the sexual generation of adult worm in the definitive vertebrate host and an asexual stage in a molluscan host (Jordan and Webbe, 1982). Man is the definitive host of the parasite but a few animals have been found to be naturally infected, though infection rate in these animals has always been low (WHO, 1979).

A person becomes infected by contact with water containing infective cercariae. The cercariae attach and penetrate into the skin in the process, shedding its tail and develop into schistosomule (Cheesbrough, 1992). They then migrate through the subcutaneous tissue into the blood stream and are swept along to the lungs where they remain for 10 days (Raven and Johnson, 1996). Subsequently, they re-enter the circulatory system and migrate to the hepatic and portal veins which supply the liver. There they become sexually matured and paired on their journey to this destination where they mate and then migrate *incopula* to the blood veins surrounding the bladder (Raven and Johnson, 1996). They occasionally migrate to ectopic sites such as rectal veinules, mesenteric portal system, brain, pancrease, skin and genital organs (Edington *et al,* 1975, and Cheesbrough, 1992). In this site the adult worms live for 20 - 30 years with the mean age of 3 - 8 years (Jordan & Webbe, 1982).

The female lays eggs in the venules of the bladder estimatedly 20 -200 eggs per day. Many of the eggs penetrate through the mucosa into the lumen of the bladder where they are voided in urine (Cheesbrough, 1992). The excretion of the eggs in urine occurs in proportion to the number of viable eggs in the tissues and in the lower urinary tract and also the number of worms. It follows a circadian rhymth with a peak around noon (Doerhing *et al*, 1983).

A study conducted by Weber *et al* (1967) showed that in any one micturition stream, the eggs are released in a characteristic pattern with the majority of the eggs in the first and particularly the last fractions of the urine.

About 20% of the eggs are said to be trapped in the bladder causing inflammatory reaction and subsequent calcification (Cheesbrough, 1992). In heavy and chronic infections the eggs have been found in the ureters, rectal mucosa and reproductive organs (Helling - Giese *et al*, 1996).

The eggs when released into fresh water and in the presence of light and warm temperature cause the miracidium to hatch rapidly. In a study of miracidia hatching from schistosome eggs, Abousenna and Bassaly(1964), found no hatching occurred in 0.8 - 0.9% solutions of sodium chloride while concentrations of 0.4 - 0.6% delayed hatching. The best medium for hatching was distilled water at pH 7.0 and temperature of 25 ° C to 29°C. The complete life cycle is illustrated on figure 1.

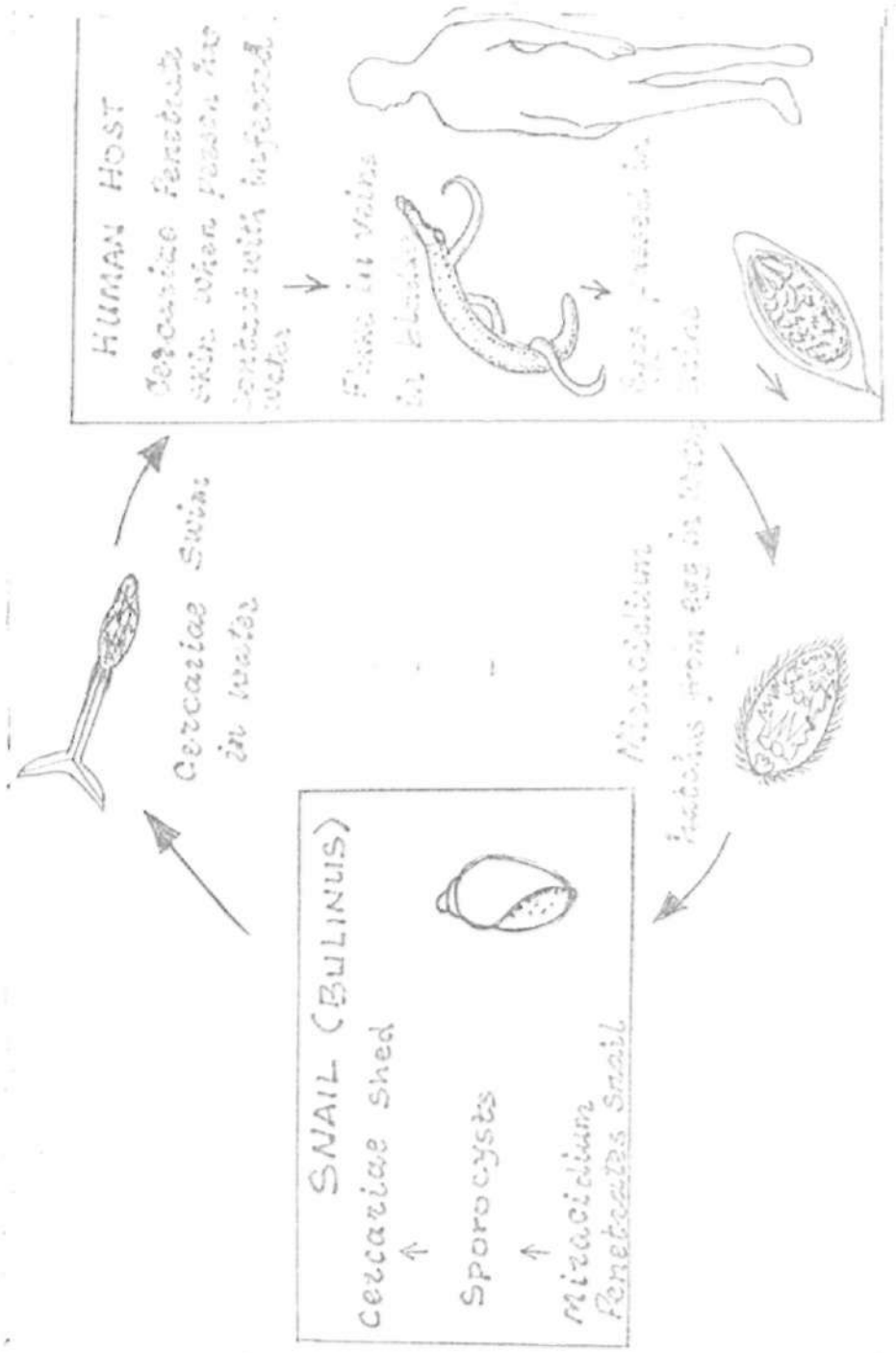


FIG 1: LIFE CYCLE OF SCHISTOSOMA HAEMATOBIUM

The ciliated miracidia swim actively in search for suitable species of freshwater snail to penetrate (Jordan & Webbe, 1982). Penetration of the snail is influenced by temperature, water velocity, age of the snail and the number of the miracidia to which a group of snails is exposed. (Berries, 1970)

In Nigeria, *Bulinus globosus* has been established to be the principal intermediate host of *S. haematobium* (Ofeizie *et al,* 1996) while *Biomphalaria Pfeiferi* is the only established intermediate host for *S. mansoni* (Cowper, 1973; Ofeizie *et al,* 1996). Each species of *schistosoma* has daily rhythm of cercarial emission which is often correlated with the period of the activity of the host that are most favourable to successful infection (Theron, 1986). In a study Vera *et al* (1992) reported a diurnal pattern of shedding with a peak emergence of *S.haematobium* cercaria from *Bulinus senegalensis* occurring between 1200 hours and 1400 hours.

2.2. Transmission

Transmission depends on contacts between the definitive host (man) and the intermediate host (snail) bearing the infective form of the parasite. These contacts are usually indirect through water and water related activities (Estambale, 1996). In Egypt, the most frequent activities that predispose human host included washing utensils, bathing, playing and ritual washing (Farooq & Mallah, 1966). Other factors have to do with the snail intermediate host and these include prevalence of the right snail species for transmission, the reproductive capacity of these snails, the number of cercariae shed at a given time and seasonal variation in snail infection rates (Shiff *et al,* 1979). The presence of water bodies such as ponds, stream, lakes, dams and wells, their salinity and whether they are permanent or temporary have also been shown to play a role in transmission (Cheesbrough, 1992; WHO, 1985;

Estambale, 1996). Another major important factor in transmission is the level of contamination of the environment with schistosome eggs which potentially can hatch and infect the snails (Jordan and Webbe, 1982).

Studies have shown that the prevalence and intensity of this disease were highest among children of school age (Cowper, 1973; Gryseels, 1991; Ahmed *et al,* 1996; Akogun and Akogun, 1996). Male children have been reported in most instances to be the most affected and main environmental contaminators (Pugh 1979; Egwunyenga *et al,* 1994). There are however other instances where the infection rates were higher in females than in the male children (Farooq & Mallah, 1966; Malik *et al,* 1975; Adeoye and Akabogu, 1996). In Bauchi, children in the 10 - 14 and 15 – 19 years age group were found to contribute about 70% to contamination of their environment (Egwunyenga *et al,* 1994). In a related development boys in Malumfashi were said to be responsible for more than 77% of transmission in this area (Pugh, 1979). Transmission has been shown to occur in areas of high and low rainfall (Sturrock, 1973). Seasonal transmission may also result from extreme changes in temperature (Marti *et al,* 1985).

Hira (1969) studied the transmission pattern of *S. haematobium* in Ibadan by determining the seasonal pattern of infection of *Bulinus (P) globosus*. The results obtained showed that infected *B. globosus* occurred seasonally with the most intense period of transmission occurring during the dry season (October - April) with a peak in January and only few in the heavy rainy period between May and August.

2.3 Pathology and Symptomatology

The pathogenesis of *S. haematobium* infection is divided into three stages; the incubation, the egg deposition and tissue proliferation and repair stage (Faust *et al*, 1977).

(a) Incubation Period

This covers the time from continuous exposure to cercariae until eggs are first laid by females. At the site of entry, the cercariae may provoke a local immunologic reaction giving rise to severe itching referred to as cercarial dermatitis. This may last 2 - 3 days and may be accompanied by the appearance of papules (Jordan & Webbe, 1982). The metabolites of the growing worm produce an acute inflammatory perivascular reaction giving rise to toxic symptoms which include anorexia, headache, malaise etc (Faust *et al*, 1977).

(b) Period of egg deposition and extrusion

This stage is usually manifested by haematuria and egg extrusion. The mature females starts laying eggs into the venules which passes into the lumen of the bladder via the perivascular tissue and by so doing cause haemorrhage of the bladder (Jordan & Webbe, 1982).

Radioactive labelling with 59 Fe was made of the blood of 18 Egyptian farmers infected with *S.haematobium*. The results showed that 9 had recurrent severe haematuria with a daily loss of blood ranging from 2.6 - 126ml and daily iron loss ranging from 0.6 - 37.3 mg/ml. Six of them had severe iron deficiency (Farid *et al*, 1968).

According to Befidi-Mengue and his co-workers, the lost of blood in urine is rarely sufficient to cause anaemia itself (Befidi-Mengue *et al*, 1993). However, it has been shown to aggravate anaemia in the presence of low dietary iron, hookworm infection or Malaria (Prual *et al*, 1992). Massive

proteinuria and amino acid have also been reported at this stage (Mott *et al,* 1983; WHO 1993).

(c) **Period of tissue proliferation and repair**

At this stage the egg trapped in the tissue matures and the miracidium begins to produce a histolytic secretion which provokes a chronic granulomatous reaction around the egg (WHO memoranda, 1974). The early granulatious lesions are highly cellular but later on the acellular fibrous lesions are produced leading to the formation of pseudotubercules referred to as "sandy patches" which are mostly present in the trigone areas but may span the whole of the bladder surface (Faust *et al,* 1977).

Fibrosis of the urinary bladder is said to be a major consequence of this disease (Houba, 1980). When the ova die in the bladder mucosa they become calcified (Buchanan & Gelfand, 1970). These lesions are capable of causing the blockage of urine flow leading to backflow and hence painful urination and increase frequency and urgency of urination (Makar, 1967).

When similar changes occur in the uretric walls it can result to stricture of the ureters (Jordan & Webbe, 1982). The involvement of the kidneys is often indirect and is associated with the involvement of the bladder and ureters giving rise to hydronephrosis, pyolonephrosis and acute pyelonephritis (Edington *et al,* 1970).

Cauda *et al* (1989) found circulating immune complex to be present in high rate in patients with urinary schistosomiasis which they attributed to be the cause of radiological abnormalities such as hydronephrosis, hydroureters, calcification of bladders and ureters and the non-functioning of the kidneys observed in their study subjects.

Genital involvement has also been reported in heavy and chronic *S. haematobium* infections (Gelfand *et al,* 1971; Edington *et al*,1975). Women

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are more prone to genital involvement than men due to the close location of the urinary bladder to genital organs which makes migration of the parasite from the former to the latter with great ease (Helling -Giese *et al,* 1996). Out of the 51 Malawian women confirmed to have urinary schistosomiasis, 33 had *S. haematobium* ova in their cervix, vagina and for vulva (Kjetland *et al,* 1996). Among the female genital organs involved, there is a preponderance of cervical involvement followed by Fallopian tubes, the ovaries and then uterus (Gelfand *et al,* 1971; Kjetland *et al,* 1996). The presence of schistosome ova in these organs have been shown to provoke inflammatory reaction leading to the formation of granulomas and subsequent fibrosis (Bullough, 1976). According to El-mahgoub (1982),the presence of granulomas in the Fallopian tubes is capable of inducing sterile salpingitis, local fibrosis, fibrotic scars and eventually tubal occlusion thereby resulting to infertility or ectopic pregnancy due to altered peristalsis.

A recent study on the causes of female infertility revealed that tubal patency ranked highest and the cause of the tubal patency was attributed more to chronic salpingitis (Phillipor *et al,* 1998). Cases of bleeding disturbances in women with schistosomiasis lesions in the upper genital tract had been reported (Bland & Gelfand, 1970). It has also been reported that ulcers and tumours in the genital tract gave rise to pain during sexual intercourse (Feldmeier *et al,* 1995).

Siegrist and Siegrist - Obimpeh (1992) reported that women with urinary schistosomiasis without necessarily presenting evidence of genital involvement showed significantly higher proportion of preterm delivery and lower birth weight of their children than the non-infected women.

It has been reported that *S. haematobium* infection predisposes patient to become chronic carrier of *Salmonella typhi* and *S. paratyphi* with clinical

picture resembling that of other urinary tract infections (Farid *et al,* 1972). In endemic areas bladder cancers have been reported to be associated with heavy and chronic *S. haematobium* infection in adults and most of these cancers were squamous cell type(Brand, 1979; Lucas, 1982; Woodhouse, 1992).

2.4 Diagnosis

2.4.1. Parasitological Diagnosis

The severity of urinary schistosomiasis has often been assessed by counting the number of ova passed in the urine and this involves the microscopic examination of urine for these eggs (Jordan & Webbe, 1982). The urine is best collected between 1000 hours and 1400 hours (WHO, 1993). Sedimentation and filtration are the two major techniques used in the detection of *S. haematobium* eggs in urine (WHO, 1991).

Sedimentation has been described as the simplest and most widely used qualitative method for the concentration of eggs in the urine and important in the routine clinical practice and in establishing the endemicity of schistosomiasis ((WHO memoranda, 1974). It has been carried out with or without centrifugation but with a reported absolute efficiency of very high egg recovery from a sample (Jordan & Webbe, 1982).

Filtration on the other hand is a quantitative method which employs the use of filters to recover the eggs from urine sample (WHO, 1991). It has been described as very sensitive and reproducible (Peters *et al,* 1976; Pugh, 1978; Cheesbrough, 1992) and is useful in the studies of epidemiology, dynamics of transmission, aspects of chemotherapy and the study of prevalence and intensity of infection (WHO memoranda, 1974).

Another parasitological method of diagnosis that has been described as highly sensitive is the viability/hatchability test which employs the use of

specific dyes to differentiate the viable/hatchable from non-viable /non-hatchable eggs (Feldmeier *et al,* 1979; WHO, 1985). This test has significance in that it has been used as a parameter to evaluate the efficiency of anti-schistosomal drugs in control programmes (Braun-Munzinger & Southgate, 1993). It is however, not well standardised (WHO 1985; Bergquist, 1992)..

During the chronic stage of infection it has been shown that the urine may be consistently negative for *S. haematobium* eggs but may be found in biopsy of the rectal mucosa examined under the microscope (Cheesbrough, 1992; Kjetland *et al,* 1996). The presence of eggs in the rectal biopsy has also been used as diagnostic tool for female genital schistosomiasis (Bullough, 1976; Helling Giese *et al,* 1996).

Though microscopic examination is described as the most reliable method, it is however said to be time consuming and expensive and requires technical skills (Partnership for child development, 1999). Besides, it has been shown that urine sample of low osmolarity tends to show spuriously low egg counts unless examined immediately, in addition the eggs may hatch within the bladder creating more error (Dukes and Davidson, 1968).

Another loophole reported is the daily fluctuation of egg excretion which necessitates repeated daily collection of urine sample in order to make reliable diagnosis (Uko *et al,* 1993). Also it is less helpful for diagnosing acute and chronic infection with no and low egg output respectively (Bergquist, 1992).

2.4.2 Non - parasitological Diagnosis

The direct observation of blood in urine has been described as a simple and reliable indicator of heavy *S. haematobium* infection in children of endemic areas (Briggs *et al,* 1971).

Chemical reagent strips that measure urinary blood and protein have been used in several studies and when evaluated for both sensitivity and specificity compared favourably with the parasitological techniques (Mott *et al*, 1983).

Wilkins *et al* (1979) reported that a combined criterion of haematuria and 30mg/100ml proteinuria was more specific as a rapid screening method. In a related study, Kassim reported that 52.6% of the children with 30mg proteinuria were positive for *S. haematobium* infection whereas 95% and 100% of all children who respectively had 30 mg and 100mg proteinuria in addition to haematuria were positive for this infection indicating increased in sensitivity and specificity when the two parameters were combined (Kassim, 1989).

A self diagnostic method which involves administering questionnaires to school children on symptoms of urinary schistosomiasis, history of haematuria and or visual haematuria has emerged. Lengeler *et al* (1991) used a two step method for screening school children first by administering questionnaires to pupils and then validate the self reported prevalence using reagent strips. The results showed a high level of correlation between self reported prevalence and the actual prevalence ($P < 0.0001$).

In a similar study Akogun and Obadiah (1996) reported that 87.8% of those who had ova of *S. haematobium* were able to recall previous cases of haematuria.

In a related study 75% of children with urinary schistosomiasis were correct in their self diagnosis when the results were validated using reagent strips and microscopy (Partnership for child development, 1999).

2.4.3 Immunodiagnosis

It has been reported that many techniques have been developed for quantitation of anti schistosome antibodies, however, the serologic measures based on antibody production do not distinguish between active and past infection nor were the antibody titres related to disease intensity or morbidity (Bergquist, 1992). On the other hand, the detection of parasite antigen especially the circulating anodic antigen (CAA) has been reported to be an accurate test for the quantification of the worm burden since the presence of antigen indicate active infection (Berquist 1992; El-Morshedy *et al,* 1996).

Compliment fixation has been described to be one of the best serologic tests when conducted under optimum condition but because of its complication and high delicateness, it has been regarded unsuitable for field operations (Jordan & Webbe, 1982). The circum oval precipitin (COP) test developed by Oliver - Gonzalez in 1957 has been reported as highly sensitive and specific (Koech *et al,* 1984). Although, not standardised (Jordan & Webbe, 1982) it was found to be more sensitive in chronic than in acute infections (Faust *et al,* 1977).

The ELISA system appears to be promising quantitative method that can easily be automated. In a comparative study using three diagnostic techniques, Uko *et al* (1993) reported that 17% were positive for *S. haematobium* infection by parasitological method, 23% by reagent strips method and 16.7% by ELISA method indicating the suitability of ELISA as a diagnostic screening tests for urinary schistosomiasis. It is however, reported that high specificity of ELISA could only be achieved when purified antigens are used (Voller *et al,* 1976; Uko *et al,* 1993). This however is not easy to obtain since the preparation of pure

antigens is said to involve long, highly sophisticated and costly procedures (WHO memoranda, 1974).

Recently it has been shown that the indicators of immunological mechanisms such as the eosinophil cationic protein associated with egg granuloma can be useful as indirect disease markers for the diagnosis of female genital schistosomiasis (Poggensee *et al,* 1996). Other indirect screening method in use include eosinophiluria (Eltoum *et al,* 1992). Colposcopy (Helling - Giese *et al,* 1996) and Ultrasonography (Richter *et al,* 1995).

2.5 Immunity

Epidemiologic surveys in many endemic areas have revealed that there are peaks of prevalence and intensity of infection in the younger members of the population at risk and both decrease with age (Warren, 1973; Hagan, 1996). This fall in prevalence and intensity of infection in adults have been attributed to resistance to re-infection and to gradual spontaneous death of worm burden acquired during childhood (WHO memoranda, 1974; WHO, 1985).

On the other hand, the bulk of knowledge acquired from the study of snail ecology has made some workers to suggest that the degree of exposure to contaminated water couple with the spontaneous death of adult worms is a major factor controlling the development of immunity (Warren, 1973; WHO memoranda, 1974). On the contrary, it has been reported that the snail infection rate is often too low (Sturrock *et al,* 1973; Upatham *et al,* 1981), besides, the cercariae output is intermittent on daily basis and usually seasonal (Hira, 1968; Warren, 1973). The cercariae are usually widely dispersed in large volume in rapidly moving water (Warren, 1973), more so, contact with contaminated water in time and space is often circumscribed and is dependent

on age; sex and occupation (Farooq & Mallah, 1966; Agbolade and Odabo, 1996). Finally, the life span of the worm is much shorter than it is believed (Warren, 1973). Immunologic factors rather than the degree of exposure have been advocated as the key players to immunity (Bradley, 1972).

Study has shown that there is correlation between peripheral eosinophils count and anti-worm immunoglobulin E (IgE) anti-body levels and apparent resistant to re-infection to *S. haematobium* (Ogbe, 1995; Hagan, 1996). Specific IgE levels has been shown to be low in acute *S. haematobium* infection but became elevated at latter stages of infection (WHO, 1985).

According to WHO (1993), resistance to re-infection may partly depend on IgE/IgG_4 ratio, with IgE mediating resistance while high levels of IgG_4 antibodies block these mechanisms in children. Therefore, young children remain susceptible to re-infection due to high levels of blocking antibodies (Butterworth *et al,* 1996). It has been shown that in normal infection the living adult worm is the major stimulus to protective immunity (WHO memoranda, 1974).

2.6. TREATMENT

2.6.1. Chemotherapy

The primary objective of chemotherapy in urinary schistosomiasis control has been to reduce and prevent morbidity (Siongok *et al,* 1978; WHO, 1980; 1985). Traditionally, the drugs used for the treatment of schistosomiasis are either antimonials or non-antimonials.

a. **Antimonials:** These are drugs which contain antimony as the parent compound - they include antimony sodium tartrate (AST), antimony potassium tartrate (APT), antimony dimecaptosuccinate etc. They are given either intravenously or intramuscularly and act by inhibiting the activity of phosphofructokinase, an enzyme which regulate schistosomal energy

(Jordan & Webbe, 1982). In 1964 Aslamazov treated 28 urinary schistosomiasis patients with AST and achieved a recovery in 24 patients. The side effects of antimonials are frequent, sometimes severe and occasionally fatal and include vomiting, cough, substernal pains, pain in the upper abdomen, bradycardia, dizziness and collapse. Because of the difficulty involved in the administration of these drugs, their use have become obsolete (Jordan & Webbe, 1982).

b. **Non- antimonials**

iii) **Lucandthone (Nilodin)**: Is a parent compound of hycanthone which is active against *S. haematobium* and *S.mansoni*. It is active when given by mouth for six days. The side effects are often severe and include anorexia, nausea, vomiting, abdominal discomfort and sometimes diarrhoea, consequently, has limited its general acceptance (Jordan and Webbe, 1982).

iv) **Niridazole (Ambilhar)**: It is a nitrothiazole which has been widely used for the treatment of *S. haematobium* in children. It is given orally at a total dose of 175mg/kg body weight being administered either as 25mg/kg per day for 7 days or as 35mg/kg per day for 5 days (Davis, 1966). The cure rates of between 80 and 100% was reported. It is contraindicated in patients with mental problems. Side effects though numerous, are not severe and include:- depression, confusion, hallucination etc. The drug has been shown to cause mutation and cancer in experimental animals and hence calls for caution in its use (Jordan and Webbe, 1982).

v) **Hycanthone:** Is a hydroxymethyl metabolite of Lucanthone that is administered intramuscularly at a dose of 3mg/kg body weight (Barry, 1970). Cure rate of 23% has been reported (Abdallah *et al,* 1969). The side effects were mostly anorexia, nausea, vomiting and dizziness.

vi) **Metrifonate (Trichlorphone):** It is an organophosphorus that is active against only *S. haematobium*. It is administered orally in a standard drug regimen of 7.5 - 10mg/mg body weight in 3 does forth-nightly (Siongok *et al,* 1978). The mode of action is not yet known. In a clinical trial a cure rate of 78.6% was reported with minimal side effects (Ejezie & Ade-serrano, 1981).

vii) **Praziquantel(Biltricide):-** It is a heterocyclic pyrazine - isoquinoline that is effective against all the human schistosomes (WHO, 1985). It acts by interfering with the inorganic ion transport mechanism of the worm resulting in decreased influx of potassium ions but an increased influx of calcium and sodium ions into the worms which results to the death of the parasite (Jordan & Webbe, 1982). The drug is given as a single dose of 40mg/kg body weight and has been recommended for use in mass treatment campaigns (Partnership for child development, 1999). It has also been found useful in the treatment of female genital schistosomiasis (Richter *et al,* 1996). It is simple to use and ensures compliance and has little or not side effects (Jordan & Webbe, 1982). The cure rate of between 60 - 90% with egg reduction of 90 - 95% in those not cured have been reported (WHO, 1993).

2.6.2. Surgery

During the chronic stage of this disease when stricture of the bladder and ureters might have developed, surgery alone can reverse the situation (Mee & Youssef, 1982).

2.7 Control

The control of schistosomiasis has been defined as an attempt to interrupt transmission and lower the prevalence of the disease (Estambale, 1996). The World Health Organisation primary objective of control has been to

reduce morbidity through chemotherapy and eliminate transmission by means of snail control (WHO, 1993).

2.7.1 Snail Control

Two general strategies for snail control are currently in use. These are the focal control and the area - wide control (Estambale, 1996). The former stresses on control in specific areas or foci where transmission is known or suspected whereas the latter focuses on the snail control itself rather than transmission (Adewunmi, 1993). Snail control have been achieved by the use of synthetic and plant mollucicide, Biological agents and the management of the environment (WHO, 1993).

2.7.1.1. Synthetic molluscicides

i) Copper salts ($CuSo_4$, $CuCl_2$)

They are often applied in slow-release matrices in chemical barriers and in compounds of different anionic nature (WHO, 1985). The recommended dosages are 15 - 30mg/L for impounded waters and 20 - 30 mg/L/h in flowing waters (Jordan & Webbe, 1982). $Cuso_4$ kills snails and their eggs but its action is variable under field conditions. It acts at low pH is safe to handle and less toxic to fish (Estambale, 1996) but its disadvantages are that it corrodes equipment, difficult to apply, lack residual mollucicidal effects and rapidly inactivated by mud (Chu *et al,* 1968; Amin, 1972).

ii. Niclosamide (bayluscide, mollutox)

Niclosamide is available as wetable powder and as emulsion. It is highly toxic to snails and their eggs and to schistosome cercariae but not toxic to man. It is non-corrosive, reasonably persistent but not permanent but its main disadvantages are its high cost and its lethal effects on fish and some other aquatic animals. The recommended dosage for aquatic snails is 4 - 8mg/L/h.

(Jordan & Webbe, 1982). It is presently the molluscicide of choice for the snail control programmes (WHO, 1993).

2.7.1.2. Plant Molluscicide

It has been shown that Berries of *Phytolacca dodecandra* is highly molluscicidal though not toxic to snail egg masses (Lemma, 1970). Recently, it has been reported that the seed extract of a West African Legume *Millettia uronningii* was lethal to both the snail and their egg masses (Evans, 1986; Tang *et al*, 1996). The extract from Aridan, (*Tetrapleura tetraptera*) is reported to have molluscicidal activity both in the laboratory and in the field with no record of toxicity (Adewunmi, 1993)

2.7.1.3. Biological Agents

This has been achieved by the use of organisms to attack or compete with the snail intermediate host (Jordan & Webbe, 1982). Competitive snails such as *Thiara granifera*, *Marisa cornuareetus* and *Helisoma duryi* have been used in snail control programmes but with limited success (WHO, 1993). On another hand several species of Mollusc-eating fish such as *Tilapia melanopluera* and *Serranochromis* spp. have been studied as biological control agents however, it is reported that adequate field evaluation of their effectiveness is wanting (Jordan & Webbe, 1982).

2.7.1.4. Environmental Management

Environmental management for vector control include those procedures that specifically modify the habitat of the target vector to make the habitat unfavourable for the vector or otherwise reduce animal - vector - parasite

contact (Okon, 1998). Such procedures that have been used include complete elimination of natural water bodies (WHO, 1993), . Covering of irrigation canals, lining of canals with cement to prevent silting (WHO, 1985) and the control of weeds (WHO, 1980).

2.7.1.5. **Chemotherapy**

Chemotherapeutic control in urinary schistosomiasis is directed in particular to the treatment of school age children in order to shorten the duration of heavy infection (WHO, 1993). In the long term, treatment is important in order to prevent carcinoma of the bladder (*Egwunyenga et al, 1994*). The World health Organisation recommends the use of praziquantel for mass treatment of children in schools where the prevalence of infection is greater than 50% (Partnership for child development, 1999). Although the control and even eradication of schistosomiasis have been achieved in some countries using these integrated measures, the disease is still endemic in 74 countries (WHO, 1993). The need for vaccines have been stressed. This is because the population based chemotherapy campaigns which are the mainstay of most schistosomiasis control operations are expensive, beside, re-infection after treatment may occur without the concomitant snail control (Taylor, 1994).

Though anti-schistosome vaccines are not yet available, past research efforts have reached an exciting stage where several protective antigens discovered such as GP 38/KLH, GST and irradiated vaccine -dominant antigens have been defined at the molecular level and are being evaluated in animal models as a prelude to clinical trials (Taylor, 1994).

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2.8 BIOLOGY OF THE SNAIL INTERMEDIATE HOST

2.8.1. Classification/Taxonomy

The snail intermediate hosts of schistosomes are pulmonates of the class gastropoda characterised by a single shell and a body that is generally divided into head, foot and visceral mass (Raven and Johnson, 1996). Within this class, two families of the subclass Pulmonata i.e. Planorbidae and Lyrinoeida contains natural snail hosts of schistosomes (Jordan and Webbe, 1982). Most of the intermediate hosts of *S. haematobium* comes from the genera *Bulinus* and *Physiopsis* in the family Planorbidae (Faust *et al,* 1977; Jordan and Webbe, 1982).

The taxonomy of the snail intermediate host is based on their shell, morphology, radula and anatomy including that of the reproductive organs (WHO, 1993). The identification of snails is essential if the transmission and control of schistosomiasis is to be understood (WHO, 1985). Enzyme electrophoresis and Iso-electric focusing are now the well established techniques for studying snail chromosomes and to allow closely related species to be distinguished. Also, restriction enzyme analysis of DNA enable the poorly related species rather than closely related species to be identified (WHO, 1993).

2.8.2. Ecology and Bionomics of Intermediate Hosts

Since snail intermediate host is an essential link in schistosome life cycle, adequate knowledge of its ecology; bionomics and population dynamics will be required for proper understanding of schistosome transmission and planning and evaluation of control measures (Jordan & Webbe, 1982).

2.8.2.1. Habitat

The Bulinid and Planorbid intermediate hosts are found in many different habitat (McCullough, 1962; Dazo, 1966; Sturrock, 1973).

The general features of the habitat are shallow water in streams with a moderate organic content, little tubidity, a muddy substratum rich in organic matter, submerged or emergent vegetation, rich microflora and moderate light penetration (Jordan & Webbe, 1982).

2.8.3. Factors Influencing Snail Distribution

Under natural conditions snails are exposed to a range of varying and often interacting environmental factors which produce a collective effects on the snails, and it is usually extremely difficult to separate the effect of any one factor and conclude that it is critical (Berrie, 1970). The major factors, influencing their distribution are Physical/Chemical and Biological (Jordan & Webbe, 1982).

2.8.3.1. Chemical and Physical Factors

Snails are capable of tolerating different chemical and physical conditions within very wide limit.

i. **pH**

The pH of water depends on the number of dissolved ions and this affect the conductivity of such water which in turn should limit the distribution of snails. However, it has been shown that snails live in biotopes with wide differences in conductivity (Marti *et al,* 1985). Tolerance to conductivity varies by species and life stage of the snail where egg masses and hatchlings are more sensitive to high conductivity than adults (Donnelly *et al,* 1983).

ii. **Light**

Light affects snail survival indirectly by affecting photosynthesis of plants and hence the availability of food (Jordan & Webbe, 1982) Cercariae shedding and transmission is consequently encouraged by light (Cheesbrough, 1992).

iii. **Geology**

The distribution of snail intermediate hosts may be influenced by geological factors in many different ways. It has been shown that South African snails survived in flowing habitats only when the rock formations were heterogenous in hardness (Appleton & Stiles, 1976).

Bulinus truncatus does not usually tolerate rapidly flowing water (Appleton, 1975).

iv. **Density**

The maintenance of snail intermediate hosts at high densities may result in reduced growth rates and fecundity (Coles, 1973). Overcrowding may result to scarcity of food and nutrients and the production of inhibitory substances like ammonia (Jordan & Webbe, 1982).

v. **Rainfall**

Rainfall cycles have been shown to be one of the most important climatic factors that affect the life history of snails and determine seasonal fluctuations in their density (Baalawy and Moyo, 1970; Sturrock, 1973; Marti et al, 1985; Gryseels, 1991; Akogun and Okin, 1993). Rainfall patterns have a distinct influence on snail densities; they determine the duration of desiccation, affects

the snail by fluctuation of the water level and flushes out the snails when there is heavy rain (Sturrock, 1973; Marti *et al,* 1985).

vi. **Temperature**

The distribution and growth of snail population in a given area depend upon temperature (Jordan & Webbe, 1982). It has been reported to be the greatest abiotic factor that limits the distribution of host snails in lentic environments (Appleton, 1978). Life tables compiled for *Biomphalaria pfeiferi* showed that rapid population expansion occurred at 25°C but could not withstand higher temperature above 32°C unlike *B. globosus* (Shiff and Husting, 1966; Marti *et al,* 1985). Temperature exerts profound influence on the fecundity and maturation of *B. Pfeifferi* (Appleton, 1977). Meanwhile, infection of *B. sudanica* with miracidia has been found to increase with increase temperature up to the thermal death point of the snail (Purnell, 1966).

2.8.3.2. Biological factors

i. **Food**

Pulmonate snails are basically browsing animals which feed continuously as they move (Berrie, 1970). Most aquatic habitats contains rich microflora which together with decaying vegetable matter provide the principal food of snails (Jordan & Webbe, 1982).

The seasonal fluctuations in the quantity of microflora consequent upon changes in rainfall and temperature do affect the density of snail population since there vegetations serve as either source of food or support (Jobin, 1970,). The proliferation and spread of *B (truncatus). rohlfsi* in volta was found to be due to the presence of some specific vegetation type (Klumpp & Chu,

1977) while streams receiving the effluent from sewage works were generally free of snails (Malek, 1958).

ii. **Snail Infection**

The presence of parasites within a host generally shortens the life span of that host (Badger and Oyerinde, 1996). *S. mansoni* infection of *B. pfeifferi* of all ages did not only cause a temporary acceleration in the growth rate of the snail, but also shorten the life span (Sturrock, 1966). In many gastropods species, infection by helminth parasites results in the reduction or complete ceasation of egg production(Cooper *et al,* 1996). This the parasites do by diverting the host's metabolites to their own use thereby stimulating the production of a neuropeptide in the central nervous system of the snail which inhibits oviposition by the snail (WHO, 1993).

iii. **Aestivation**

It has been reported that the snail intermediate hosts are capable of surviving out of water for weeks or even months and this has great consequence in schistosomiasis control (Jordan & Webbe, 1982; Betterton *et al,* 1983). Consequently, infection with schistosome was shown to render the snails less tolerant to desiccation. It has been reported that snails aestivated immediately after infection were able to carry this infection through the periods of desiccation and emitted cercariae thereafter in contrast to mature infections which could not survive the period of aestivation (Badger and Oyerinde, 1996). This implies then that immature infection of *S. haematobium* and *S. mansoni* may be carried from one wet season to the next (Hira, 1968).

2.8.4. Snail life cycle

The aquatic snail intermediate hosts of schistosomes are hermaphrodite capable of self fertilisation but cross fertilisation is also found (Jordan & Webbe, 1982). The life cycle begins with the laying of eggs in water at a temperature range of 20 - 30°C. Oviposition goes on through out the year with a considerable increase in the number of young snails at the beginning of rainy season (Jordan & Webbe, 1982).

The yellowish transparent gelatinous mass of eggs then hatches after 10 - 11 days of Oviposition and the young snails grow into maturity 2 months after hatching and attains its full size of about 20.5mm in 12 months of hatching (Jordan & Webbe, 1982). It has been reported that in the tropical species of snails, egg laying did not commence when the snails were large enough to reproduce and this delay was attributed to unfavourable environmental conditions and neurosecretion stimulated by schistosomes (Berrie, 1970; WHO, 1993).

2.8.5. Snail Sampling

Several sampling methods have been adopted in estimating snail population but the choice of each method depends on the site to be searched; objectives of the survey and the skills of the available manpower (Ansari, 1973). Since neither the infected nor uninfected snails are distributed at random, Webbe (1965) suggested that any accurate estimation of infection rate in snails should require sampling the entire area under consideration. Beside, a large number of small samples should be obtained from many different foci over a long period preferably at monthly intervals for at least one year (Jordan & Webbe, 1982; Akogun & Okin, 1993; Ahmed *et al,* 1996).

Two major techniques have been widely adopted in snail sampling; the direct or man/time methods which invdlve collecting snails from a given habitat for a specific period of time and the indirect methods such as snails masking and the use of traps (Webbe, 1960).

The man/time which employs the use of long handle scoop net has been widely use (Klumpp & Chu, 1977; Upatham *et al,* 1981; Goll, 1982; Akogun & Okin, 1993; Agbolade & Odaibo, 1996). Its biggest advantages are its simplicity and the exclusion of interference of local people with equipment left at sites, besides, larger area can be surveyed than by exposure of traps. More so, it can discover few snails present in a habitat and requires less time and logistic support in addition, it allows for collection of egg masses and direct recording of snail - plant association (Klumpp and Chu, 1977; Marti *et al,* 1985). The well known disadvantages of the method are its requirement of skilful personnel, cannot search well when there is rise in water level after heavy rains, and the tendency of the observer to catch predominantly larger snails because they are more easily recognised (Marti *et al,* 1985).

The palm leaf method which is better adapted to deep water sampling and sampling in sites with little or no vegetation is also only used in areas where palm trees occur naturally (Klumpp and Chu, 1977). It is very effective in determining qualitatively whether aquatic snails are present (Webbe, 1960). It is more sensitive, does not require trained personnel and yield larger fractions of small snails (Teesdale, 1962; Klumpp and Chu, 1977). It however, fails to reveal possible predilection of snails for certain plants or sites for oviposition (Marti *et al,* 1985).

Field snail infection rate had been generally measured in one or two ways: crushing or shedding (Webbe, 1965). The former involves the low power microscopic examination of crushed snails which reveals daughter sporocysts

and cercariae from 'patent' infections (Klumpp & Chu, 1977; Sturrock *et al,* 1979). The latter involves searching for shed cercariae by naked eye or low power microscope from individual snails illuminated in glass tubes containing a small volume of water (Jordan & Webbe, 1982; Frandsen & Christensen, 1984). This latter technique has been widely used especially in longitudinal studies in which the snails are expected to be returned to the field in order to avoid artificial depletion of small snail population (Chu and Dawood1970; Sturrock, 1973).

It has been shown that the shedding method is capable of detecting all 'patent' infections (Sturrock *et al,* 1979) and therefore has several advantages over the crushing method. In the first instance it ensures the return of snails to the field after study to avoid artificial depletion (Sturrock, 1973). Besides, it is quick and simple and the cercariae emitted can easily be used to infect experimental animals (Sturrock et al, 1979). On the other hand, it was reported that the crushing method was tedious and not suitable for small habitats and where transmission data are required over a long period(Webbe, 1965), more so, the process may result in the release of immature cercariae which are unsuitable for identification (Frandsen & Christensen, 1984).

It has been said that the knowledge of the age distribution of snail population is of importance in sampling as it helps in estimating their ability to survive under natural conditions. Consequently, the measurement of size has been the only method of determining the age of snails in the field (Jordan and Webbe, 1982). This involves the use of vernier callipers to measure the largest diameter to the nearest 0.1mm (Sturrock, 1973; Upatham *et a,l* 1981). The proportion of infected snails found in many endemic areas has been reported to be very low, seasonal and focal (Chu & Dawood,1970; Sturrock et al,1979; Jordan and Webbe,1982; Marti *et al*,1985; Akogun & Okin,1993).

The identification of cercariae up to the family level and occasionally genus level is reported to be possible using morphological criteria alone while the differences in cercarial morphology between different genera of trematodes and between different species within trematode genus requires supplementation with biological characteristics (Frandsen and Christensen,1984). The combination of observations on morphological and biological characteristics however, does not always enable a proper identification especially on the species level and may therefore necessitate the identification of the adult worm and or its egg morphology following infection of the proper definitive host (Frandsen & Christensen,1984). Since this also is not practicable in field studies, the use of starch gel electrophoresis and DNA analysis have been recommended(Shiff *et al*,1979; WHO,1993).

CHAPTER THREE

3.0. MATERIALS AND METHODS

3.1 Study Location, Demography and Climate:

The study covered Samaru, Kore, Jama'a, Hayin Liman and Hanwa Villages which lie between latitude 11° 11'N and longitude 07° 38'E with an estimated population of 25,000, 2000, 3,500, 1,300 and 10,000 respectively. The annual average rainfall ranges from 45mm to 100mm. The rainy season starts from April to October with precipitation maxima usually in July and August.

Modal air temperatures range from 28°C to 38°C. Temperatures are coolest during the months of maximum rainfall and usually highest in march and April. The greatest daily temperature fluctuations usually occur between November and January (Harmattan period).

The major river which passes through these villages is the Kubanni river which is fed by two major streams arising from Institute for Agricultural Research (IAR), Samaru and Ungwar Maigamo villages. The two streams meet in Ahmadu Bello University where they are dammed. The river is also fed by some tributaries that get dry during dry season (Fig. 2).

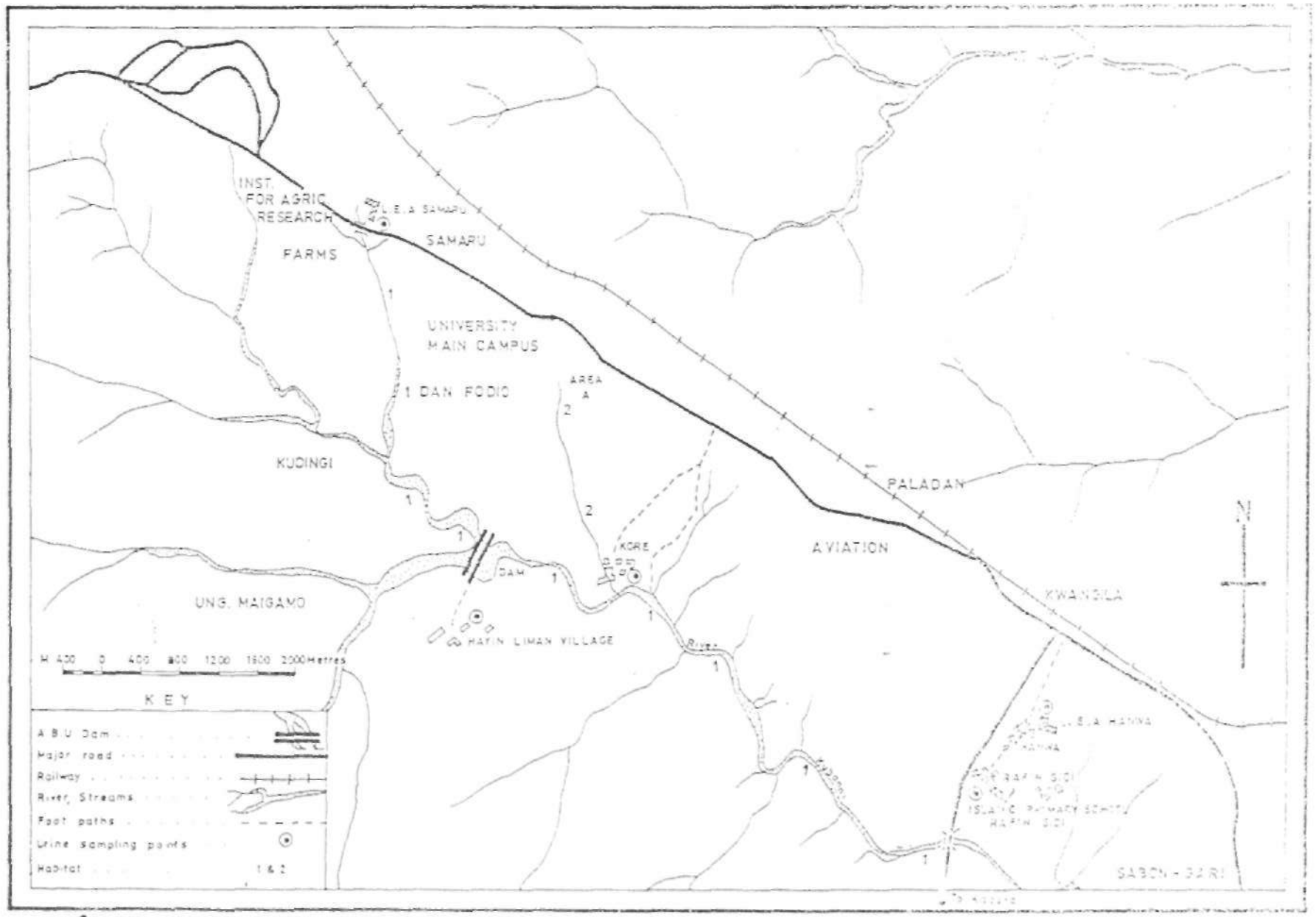


FIG.2 MAP OF THE STUDY AREA SHOWING SAMPLING POINTS.

The inhabitants of these villages are mostly Hausa farmers. They practice both rainy and dry season farming. During the dry season, water from the river is used to irrigate their crops which include:- Sugar cane, Vegetable, Okro, Tomatoes, Pepper, Cocoyam etc., Fishing activities are also carried out in the dam throughout the year but during dry season when water from the main streams have abated young boys are seen emptying the water in order to recover the fishes in it. During this same time when most of the well water has dried these villages use this river system for washing, bathing and other domestic needs.

3.2. Sample Collection

Both urine and snail samples were collected for the purpose of this study.

3.2.1 Urine Collection and Analysis:

Urine samples were collected from pupils of Hanwa L.E.A primary School; L.E.A. Samaru and Islamic Primary/Nursery School Rafin Sidi and the young and adults of Kore and Hayin Liman villages all situated along Kubanni River and its tributaries. Between 10.a.m and 2.p.m clean labelled sample bottles were issued to the subjects instructing them to pass in the last stream of their Urine. The Urine samples were either fixed there and then or in the laboratory by adding 2 - 3 drops of 0.002% carbolfulchsin prepared by mixing 100ml of absolute ethanol, 50ml of phenol, 830ml distilled water and 0.02g carbolfuchsin (Richards *et al,* 1984).

A drop of eosin was added to enhance subsequent staining and to decrease the development of Urine odour. It was shaken by inverting the bottle two times for proper mixing (Pugh, 1978).

3.2.1.1. **Laboratory Analysis of Urine:**

After a gentle agitation, 10ml of the preserved urine was withdrawn using a 10ml syringe and was passed through a number 1 Whatman filter paper (W&R Balston England), 4.25cm in diameter, held in a millipore suction filtration apparatus to which a vacuum source was applied after filtering each samples. The filter paper was placed in an open container and allowed to air-dry (Richards *et al,* 1984). The filter paper was then stained with saturated solution of ninhydrin (Pugh, 1978). For examination the stained paper was place face up on a clean glass slide moistened with a drop of tap water and examined under the microscope using X 10 objective. *Schistosoma* ova with characteristic terminal spine were counted and recorded (Jordan & Webbe, 1982).

3.3. Snail Collection

Snail sampling was carried out forth-nightly using the man-time technique (Klumpp & Chu, 1977). In this method, snail samples were collected using a short-handed plastic filter of 18cm in diameter attached to a wooden rod 1 meter in length. The snails were collected from several sites in two main habitats; River Kubanni and the tributary draining into Kubanni via Area 'A' quarters and Kore village. Each site was carefully searched between 7.30 - 9.00am for snails for 30 minutes forth-nightly for a period of one year.

The forth-nightly collection from the index sites were pooled each month for convenience of presentation. Rainfall and temperature data were obtained from the Institute for Agricultural Research, Samaru - Zaria. The plants associated with snails were collected and taken for identification in the herbarium of Biological Sciences Department. Finally, water contact activities were also noted.

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3.4 Laboratory Analysis of Snail Infection:

The snails collected were carried to the laboratory, washed, sorted out into species and counted. The sorting of the snails was done using the guideline of Jordan & Warren (1982). Snail infection was determined by crushing and shedding methods(Sturrock *et al*, 1979).

Shedding Method: Each individual snail was placed in a sample container containing 5 - 10ml of stream water. It was then illuminated by strong artificial light for 4 - 6 hours. Cercariae shedding was determined by removing some water from the container using Pasteur pipette and placed a drop of it on a clean glass slide. It was examined first as unstained preparation and as stained preparation under X 10 objective for cercariae. Staining was done using a drop of 0.1% neutral red (Frandsen & Christensen, 1984).

Crushing Method: The use of this method was to confirm those snails that were not found to shed cercariae using the above method but were suspected for pre-patent infection. Such snails were each crushed in-between two slides, the pieces of the shell were carefully removed using a pair of forceps while the mass of snail was teased apart using a needle and was examined for cercariae or sporocyst as above (Klumpp and Chu, 1977; Sturrock *et al*, 1979). Thereafter, the snails were scattered over the searching area where they were collected to avoid creating artificial depletion.

Schistosome cercariae were identified by observing the curving backwards of their tail furcae in the resting position when observed unstained without coverslip (Frandsen & Christensen, 1984).

3.5 STATISTICAL ANALYSIS

Statistical Analysis was performed with spss/pc software statistical packages for IMB personal computer.

Prevalence of infection were compared among age groups using X^2 tests while the differences in sex and school prevalence were compared using t-test. The mean egg counts (positives only) and correlation between indices of infection were either compared by t -test or one-way analysis of variance and linear correlation analysis respectively (Mahajan, 1991).

CHAPTER FOUR

RESULTS

Out of the 1,067 persons screened for urinary schistosomiasis, 123 (11.5%) were found to be infected. The average egg output in those infected was 77.7 eggs/10mls of urine. The overall prevalence of *S.haematobium* infection in males (19.4%) was significantly higher than that in females (3.2%; $P < 0.01$). In the like manner, the mean egg count in males (86.6eggs/10ml urine) was significantly more than females (18.4 eggs/10ml urine).

The results of the prevalence and intensity of *S. haematobium* infection in Kore/Liman community is presented in Table 1. The total prevalence and intensity of infection in these subjects were 14.2% and 34.8 eggs/10ml urine respectively and as in the general results, both indices were higher in male than in their female counterparts ($P<0.05$). Prevalence but not intensity of infection varied significantly with age in males ($P<0.005$). In females however, both indices exhibited little or no variation with age. Both prevalence and intensity of infection in males rose to peak in the 20 - 24 years age group whereas in females both indices peaked in those aged 10 - 14 years. There was a decline in prevalence and intensity after the peak in males, however, in females this trend did not strictly follow as there was no infection recorded in those 20 - 24 years whereas a significant number of women aged 25 years and above were found infected.

Table 1: Prevalence and intensity of *S. haematobium* infection in Kore & H/Liman community according to sex and age.

Age (Years)	No. examined	No Infected	Prevalence%	Intensity egss/10ml
MALES				
0 - 4	4	0	0	0
5 - 9	67	7	10.4	41.86
10 -14	60	17	28.3	44.47
15 - 19	27	11	40.7	20.73
20 -24	17	7	41.2	65.0
⩾ 25	20	1	5.0	33.0
TOTAL	195	43	22.05	
FEMALES				
0 -4	2	0	0	0
5 -9	52	2	3.80	13.0
10 -14	32	5	15.60	16.2
15 -19	14	1	7.1	2.0
20 -24	21	0	0	0
⩾ 25	64	3	4.70	1.67
TOTAL	185	11	5.95	

The results of 687 school pupils is presented in Table 2. About 54(10%) of this number were found infected with *S. haematobium* and had a mean egg count of 111.3 eggs/10ml of urine. Prevalence and intensity of infection were higher in the male pupils (17.9% and 117.14 eggs/10ml) than in the female pupils (1.55% & 36.2 eggs/10ml).

Prevalence and intensity of infection showed no significant variation with age in female pupils and always peaked in those 10 - 14 years of age, however, in the male pupils only prevalence of infection was highest in this age group whereas the peak intensity was recorded in the 15 - 19 years age group. Unlike in their female counterpart, both indices varied significantly with age in the male pupils ($P < 0.001$ & $P < 0.05$ respectively).

Generally, there was a positive correlation between prevalence and intensity of *S.haematobium* infection for both sexes in Kore/Liman community and in the School children.

Table 2: Prevalence and intensity of *S. haematobium* infection in primary school children according to sex and age.

Age (Years)	No. examined	No. Infected	Prevalence%	Intensity egss/10ml
MALES				
0-4	10	0	0	0
5 - 9	160	15	9.4	21.53
10 -14	168	42	25.0	149.93
⩾ 15	20	7	35.0	125.29
Total	358	64	17.9	
FEMALES				
0-4	11	0	0	0
5 - 9	148	2	1.4	28.5
10 -14	166	3	1.8	41.33
⩾ 15	4	0	0	0
Total	329	5	1.55	

Table 3 is a summary of the prevalence and intensity of *S. haematobium* infection in the 3 separate schools. The prevalence of infection ranges from 6.1% to 18.6% with the highest prevalence recorded in LEA Hanwa while the highest intensity of infection (206.5 eggs/10ml urine) was recorded in LEA Samaru. Both indices of infection were however, lowest in the Islamic school R/sidi. Both prevalence and intensity of infection in L.E.A. Hanwa and Islamic Primary School R/Sidi peaked in those aged ≥ 15 years and 10 – 14 years respectively. On the other hand, the peak prevalence in LEA Samaru was obtained in those aged 15 years and above meanwhile, the intensity of infection was highest in the 10 – 14 years age group.

Table 3 Prevalence and intensity of *S. haematobium* infection in 3 primary schools in zaria.

	L.E.A. SAMARU				L.E.A. HANWA				ISLAMIC PRIM.SCH.R/SIDI			
Age (Years)	No. Examined	No. infected	Group prevalence %	Mean egg count egg/10ml	No. Examined	No. infected	Group prevalence %	Mean egg count egg/10ml	No. Examined	No. infected	Group prevalence %	Mean egg count egg/10ml
0 -4	10	0	0	0	3	0	0	0	8	0	0	0
5 -9	77	1	1.3	38	63	6	9.5	33.2	168	10	6.0	14.3
10 -14	219	22	10.0	216.9	95	21	22.1	68.2	20	2	10.0	108.5
≥ 15	13	2	15.4	176.5	11	5	45.5	104.8	0	0	0	0.00
Total	319	25	7.8		172	32	18.6		196	12	6.1	

The age-related pattern in prevalence and intensity of *S. haematobium* infection for the entire study population are presented in Figure 3. Prevalence of infection rose rapidly from zero level in the 0 - 4 years age group to reach its peak (29.2%) in those aged 15 - 19 years, thereafter it declined steadily with age. The intensity of infection on the other hand, did not strictly follow the same pattern as prevalence, rather it rose to peak in the 10 - 14 years age group and fell from 108.3 eggs/ml of urine in this age group to 58.3 eggs/10ml in the 15 - 19 years age group. It slightly rose again to 65.0 eggs/10ml in the next age group before declining.

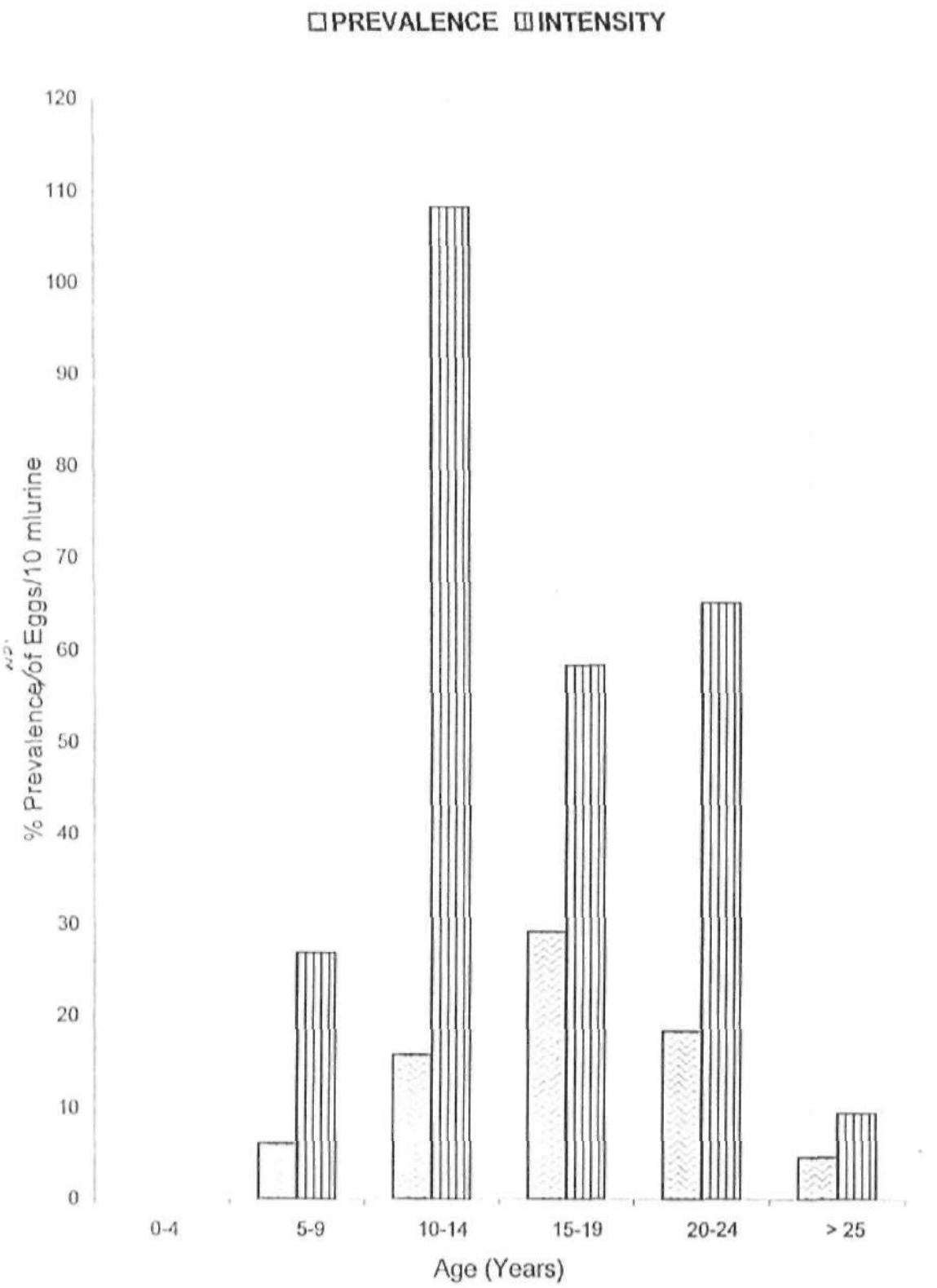


Fig 3: Age specific prevalence and intensity of *S. haematobium* infection in the study subjects

Table 4 shows the distribution of egg output by age among the 123 infected subjects in this study. The investigation of the relative index of *S. haematobium* infection revealed that children between the ages of 10 and 19 years account for about 92% of all the transmission of urinary schistosomiasis in this area, however, the highest contribution of 71.71% came from the 10 - 14 years age group.

Table 4 : Urinary schistosomiasis: Distribution of egg counts, intensity and index of infection among the 123 infected subjects

Age Group	No infected (n)	Total egg count $\sum x$	Intensity (I) $\sum x \pm SD$ N	% prevalence (p)	Index of infection(y) npI / 100	Relative index of infection (RI) $= \frac{y}{\sum y} \times 100$
0 -4	0	0	0	0	0	0
5 - 9	26	699	26.9 ± 54.3	6.2	43.36	2.71
10 - 14	67	7258	108.3 ± 210.0	15.8	1146.41	71.71
15 - 19	19	1107	58.3 ± 91.0	29.2	323.45	20.23
20 - 24	7	455	65.0 ± 96.3	18.4	83.72	5.23
⩾ 25	4	38	9.5 ± 15.9	4.7	1.79	0.11
Total	123	9557	77.70	11.5	1598.78	100

Table 5 shows the records of the prevalence of *S. haematobium* and *S. mansoni* infections among the patients who attended A.B.U. Sick Bay and A.B.U Teaching Hospital Zaria in 1999. Of the 5431 urine sample screened, only 111 (2.14%) were positive for *S. haematobium* infection. On the other hand, 104 (1.46%) of the 7136 stool samples examined had ova of *S. mansoni*. Statistically, there was no significant difference between the overall prevalence of the two infections.

Table 5 Some hospital records on the prevalence of schistosomiasis in Zaria for 1999

Hospital	*S. haematobium*		*S. mansoni*	
	No. examined	No. positive	No. examined	No. positive
ABU Health Centre(Sick Bay)	2625	100(3.8%)	3627	83(2.3%)
ABU Teaching Hospital	2806	16(0.57%)	3509	21(0.60%)
Total	5431	116(2.14%)	7136	104(1.46%)

4.1 Snail Studies

The snail fauna recovered from the study habitats were identified as *Biomphalaria pfeifferi*; *Bulinus* species and *Limnae natalensis* (Plates 1 – 3). The typical Schistosome cercaria found in these snails is presented in plate 4. The snails were commonly found in association with certain water plants which included *Commelina gbenghalensis, Hypoethes carcellata, Eichornia crassipes, Ipomoea aquatica, Typha autralis, Hydrophilla auriculata* and *Vossia cuspidata*. They were also often found attached to the surface of submerged rocks, dead logs and other debris in water.



PLATE 1A: BULINUS SPECIES

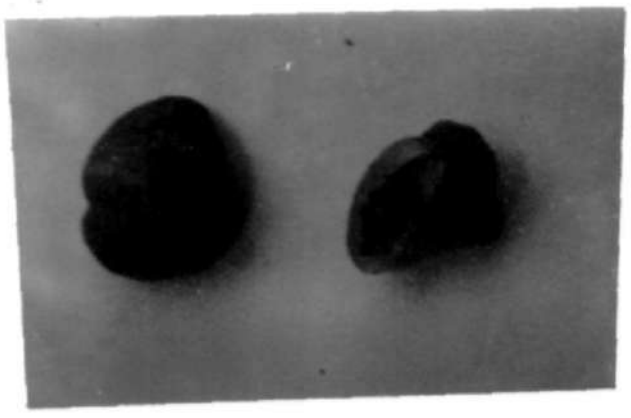


PLATE 1B: BULINUS SPECIES

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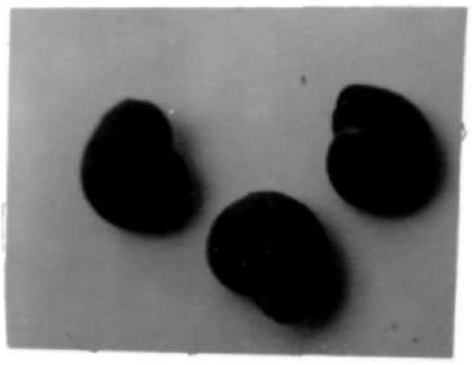


PLATE2: BIOMPHALARIA PFEIFFERI



PLATE 3: LIMNAE NATALENSIS

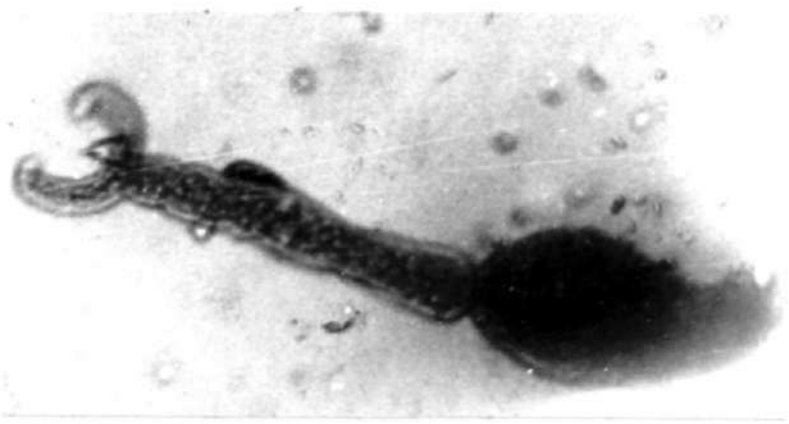


PLATE 4: SCHISTOSOME CERCARIA

Figures 4 and 5 are summaries of the monthly collection of snails in relation to rainfall in the study area. A total of 4.908 snails comprising of 51.1% *Biomphalaria*, 37.8% Bulinus and 16.1%, *Limnae* were collected. Of this figure 1792 (36.2%) were collected from the main Kubanni river (Fig. 4) while the remaining 3,116 (63.8%) were collected from the tributary (Fig. 5). The bulk of the snails (2586) were collected during the dry season (November - March). All the 3 species of snails were found in kubanni river while only Bulinus and *Biomphalaria* were found in the tributary.

In river kubanni, snail density varied markedly during the 12 months sampling period (Fig. 4). It started reducing from April to virtually no snail in June to August corresponding to the period of heaviest rainfall. Snail population thereafter started to build up from September reaching the maximum number between February and March with several peaks in between.

Being a temporary flowing habitat (Fig 5) snails were not found in the tributary between April and July until August. The snails population started to build up rapidly from August to reach the maximum number in October and thereafter started declining at the end of the rainy period till February when no snail was found following the complete dryness of this habitat.

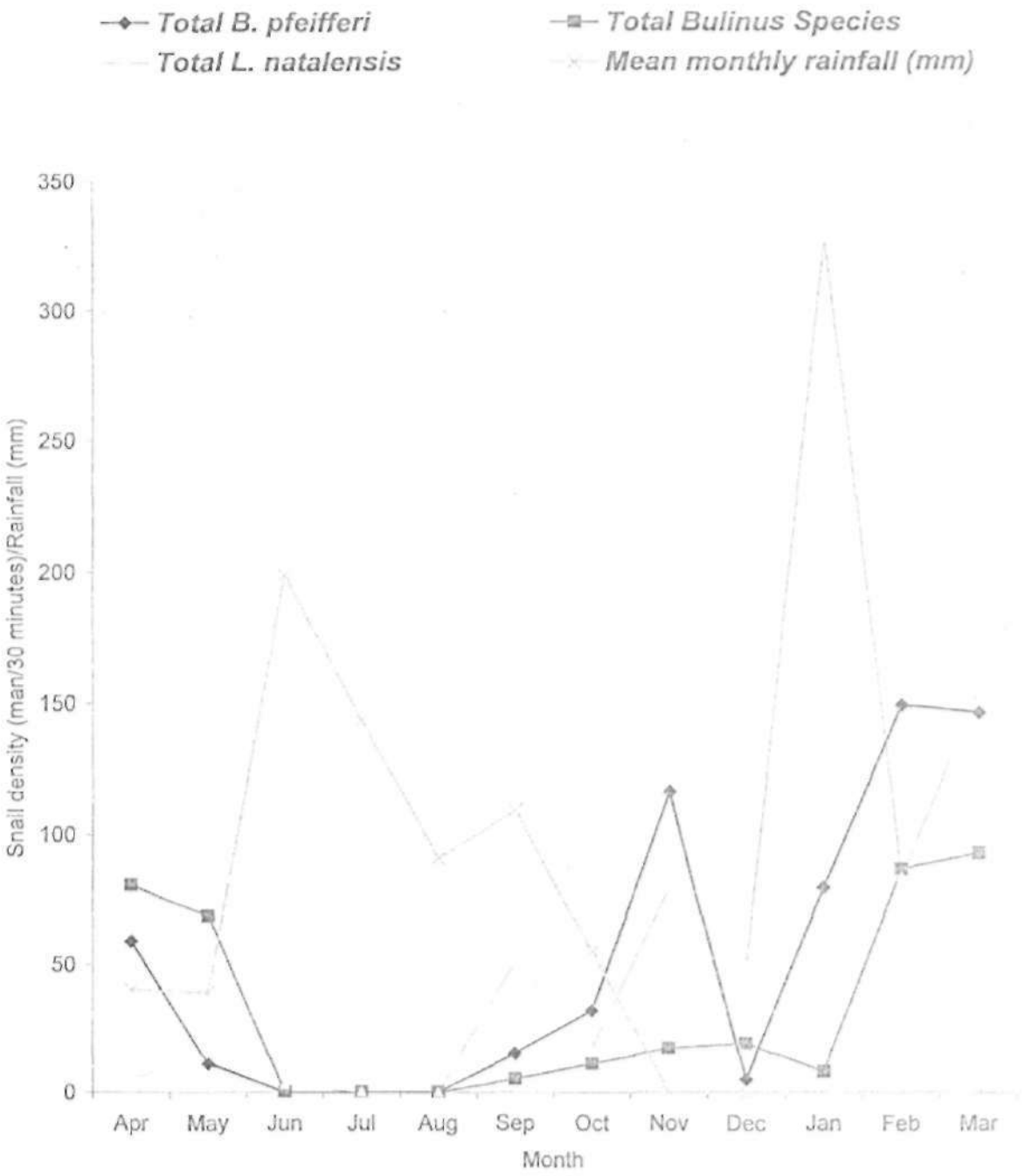


Fig. 4: Relationship between snail density and rainfall in River Kubanni

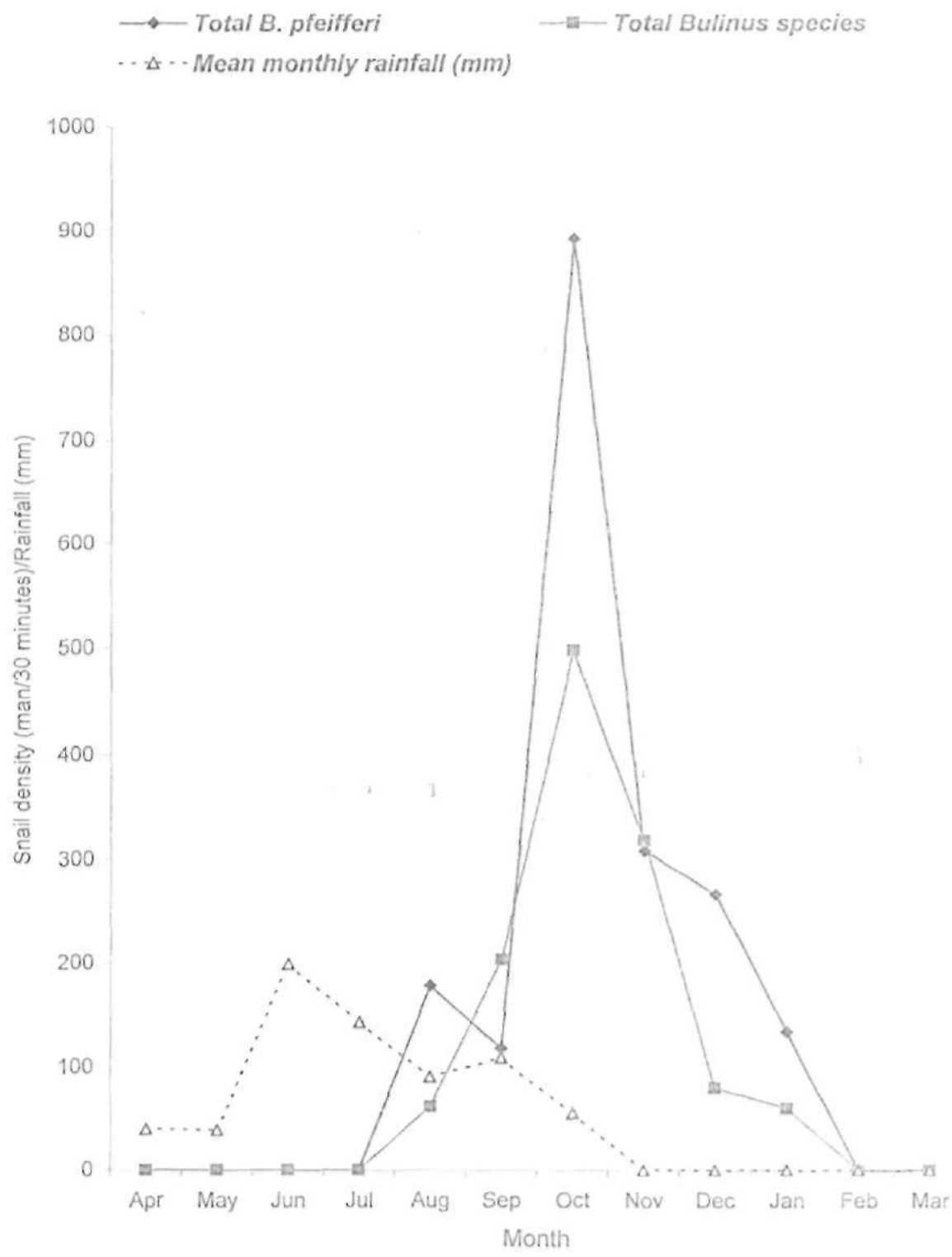


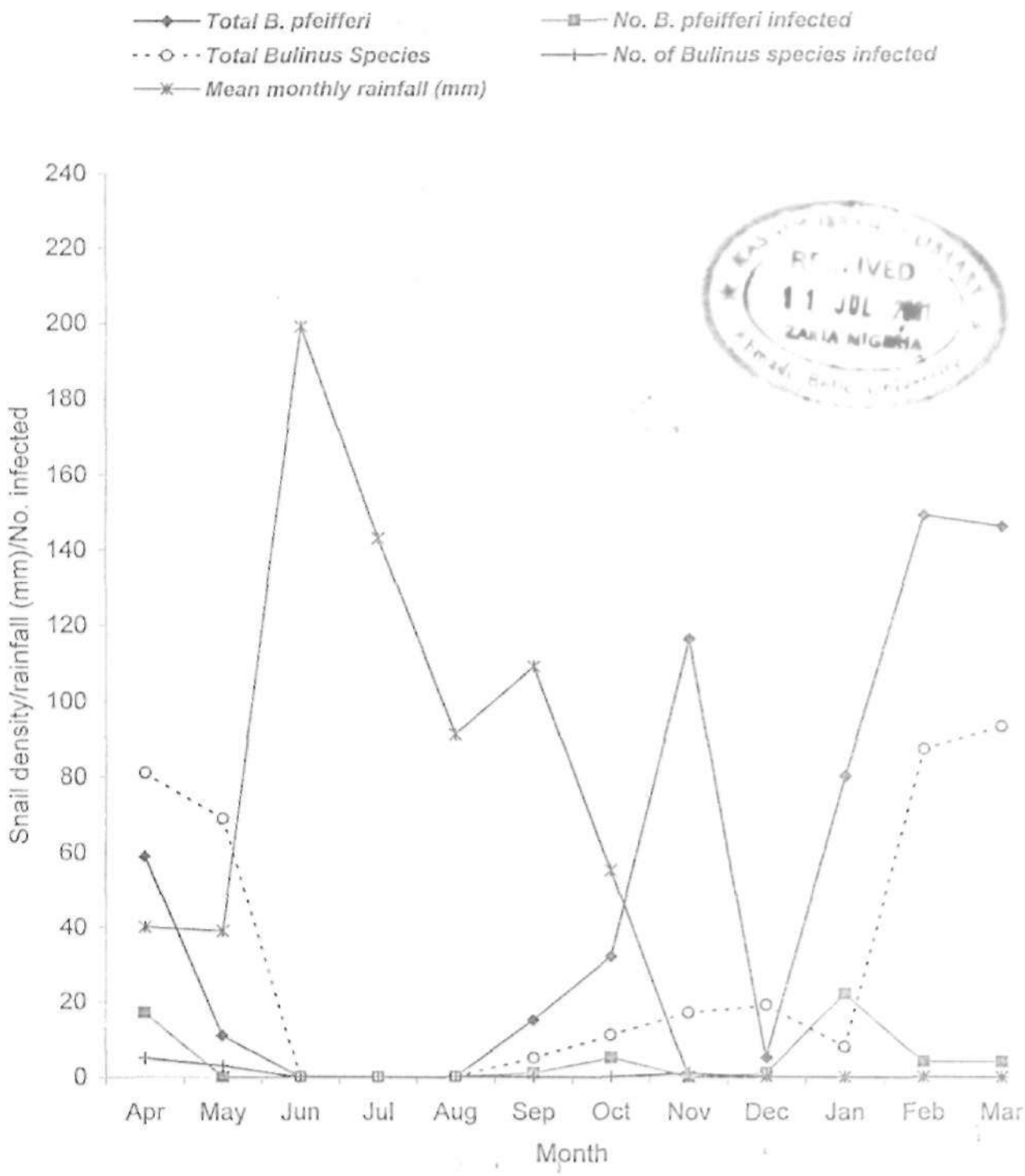
Fig. 5: Relationship between snail density and rainfall in the tributary

Of all the snails collected, only 445 (9.1%) were found shedding cercariae of one or more species of human and animal trematodes; 204 (4.2%) of the infected snails mainly *Bulinus* and *Biomphalaria* were shedding schistosome cercariae (Plate 4). The rest 241(4.9%) were shedding cercariae of other types including *Xiphidiocercariae*, *Cystrophorus monostome*, *Echinostome*, *Gymmoscepharous*, *Longifurcate* and *Fasciola* species.

The highest number of schistosome infected snails, about 148 were recorded in dry season (November - March) and mostly from the tributary. The over all *S. haematobium* infection rate in *Bulinus* was 0.6% while that of *S. mansoni* in *B.pfeifferi* was 7.8 % (Appendix 2 & 3).

The relationship between schistosome infection rate in *Bulinus* and *Biomphalaria* and rainfall in river Kubanni is presented in Figure 6. Schistosome infected *Bulinus* were only found in the months of April, May and November and did not follow a seasonal trend as the density. On the other hand schistosome infection rate in *Biomphalaria* varied with season, the highest number occurring between September and January.

Figure 7 also shows the relationship between rainfall and schistosome infection rate in the tributary. It followed a similar pattern as the density except that the peak infection was recorded in November. The greater percentage (82%) of the schistosome infected *Biomphalaria* from this habitat was recorded between November and January. Not a single *Bulinus* was found harbouring schistosome cercariae in this habitat.



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Fig. 6: Relationship between Schistosome infection rate and Rainfall in River Kubanni

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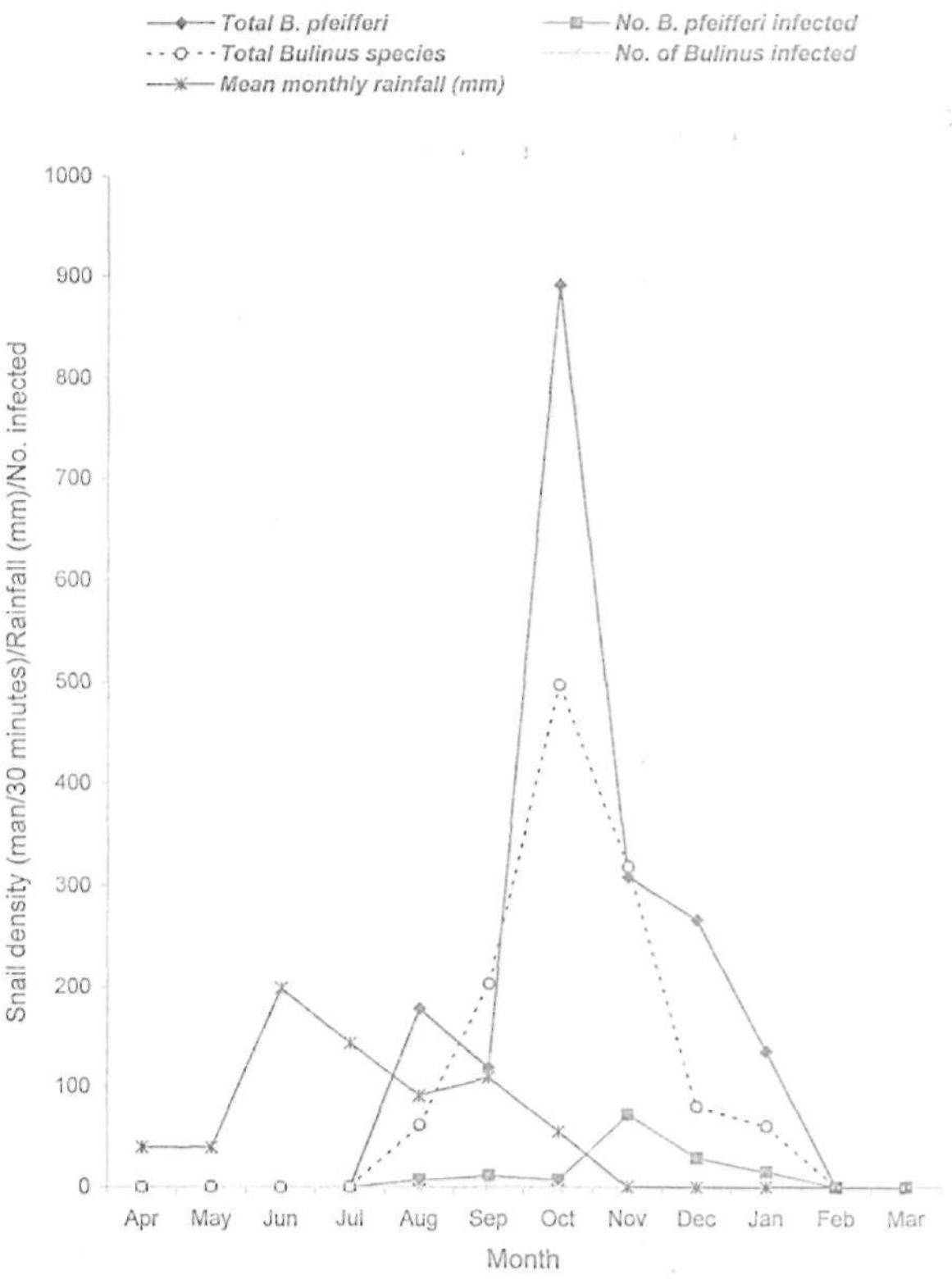


Fig. 7: Relationship between Schistosome infection rate and rainfall in the tributary

CHAPTER FIVE

DISCUSSION AND CONCLUSION

The present study has shown that *S. haematobium* is prevalent in communities situated along kubanni river. Infections were generally higher in males than in females. This may be due to differences in the pattern of water contact which is generally known to be more frequent and prolonged in males than in females (Akogun & Akogun, 1996). Similar observations have been made by other workers (Fajewonyomi and Afolabi, 1994; Ahmed *et al,* 1996; Ofeizie *et al,* 1996). Some observations made on water contact activities in the course of this work showed that males were almost exclusively involved in fishing, farming and bathing in this river and its tributaries though a handful of females were occasionally seen washing and fetching water for domestic purposes.

In the local communities of Kore and Hayin Liman, villages prevalence and intensity of infections in males reached their peaks in the 20 - 24 years age group as opposed to the usual school-age of between 10 and 14 years (WHO, 1985; Muchiri *et al,* 1996). This may be attributed to the duration these individuals became exposed to infection since immunity is known to develop only after a sufficient time of exposure. Kloetzel and Da Silva (1967) in their experiment, similarly reported that amongst a population of uninfected adults who migrated into an *S. mansoni* endemic area, irrespective of age, a peak prevalence was found after 15 - 19 years of residence whereas those who had been there longer showed declining rates suggesting that immunity developed after 15 - 19 years of exposure to infection. Presently, the world health organisation in its mass control programmes places more emphasis on screening and treating school aged children being the most cost effective and since children typically harbour

the heaviest infection (Ogbe, 1995; Partnership for child development, 1999; Utzinger *et al,* 2000). Based on the present results especially in irrigation areas, control strategy should include the age group of 20 -24years. In agricultural irrigation communities, this age group is proposed for rapid assessment of schistosomiasis.

The lack of infection recorded in female between the age of 20 - 24years despite the significant infection recorded in the elderly women may not be unconnected to the strict observance of "puddah", an Islamic law which restricts the young married women from going out of their matrimonial homes during the day, while relaxing such law in the elderly women. Similar findings was reported in the Muslims dominated states of Sokoto, Katsina, and Kebbi (Ofeizie *et al,* 1996).

The survey of the school children (Table 2) shows that for both male and female pupils, prevalence and intensities of infection rose to peak in the 10 - 14 years age group. This is in agreement with the findings of other workers in endemic areas (Scott *et al,*1982; Egwunyenga *et al,* 1994). Children at this age are known to have the most frequent and most prolonged water contact possibly because they are subjected to little or no restriction of movement which gives them ample time to play in water. Secondly, they easily succumb to peer group influence; more so, they love adventures. Consequently these attributes are capable of exposing them to more contacts with cercariae infested water than any other school age group.

The variation of the indices of infection with the age in male pupils which were not so in female pupils has also been documented (Ahmed *et al,* 1996) and may be due to the regular water contact in the former than in the latter.

Table 3 shows that prevalence and intensity of *S. haematobium* infection were higher in the public schools (L.E.A. Hanwa & L.E.A Samaru)

than in the Islamic School. The imposition of strict Islamic principles resulting in the pupils having minimal contact with water could be responsible for such low level of infections experienced in the latter. In the public schools, however, the population were mixed Christians and Muslims and this might have contributed to the high level of infections recorded there. In Ethiopia, Christians of all ages and both sexes were seen to have more contacts with water than Muslims (Jordan and Webbe, 1982).

In general, the present results which shows age related pattern of *S. haematobium* infection (Fig. 3) is similar to those of several other studies in different endemic areas (Wilkins, 1977; Jordan & Webbe, 1982; Ogbe, 1995). Three factors are likely to account for this trend of infection viz: water contact; immunity and multiple helminths infections.

Most investigations revealed that water contact is by far most frequent and of longest duration in children which predisposes them to more infections (Wilkins, 1977; Ogbe, 1995; Akogun and Akogun, 1996) however, in older age groups water contact decline as adult tasks increases and hence the decline in prevalence and intensity of infection after their peaks (Fig. 3).

Studies have shown that immunity to schotosomiasis develops gradually with age (Warren, 1973; WHO, 1993) and of course, with the degree of exposure to infection (Kloetzel & Da Silva, 1967; Gryseels, 1996) that may be why there was high level of infections in children whose immunity is still building up while the adults who are assumed to have developed immunity due to long exposure to infection showed a decline.

It has almost become a norm rather than exception for school-aged children in endemic areas to harbour several helminths species at a time consequently, such children have been shown to have a higher egg count and more severe disease of each helminth species than in children with single species infection due to a complex interaction occurring between the

parasites (Buck *et al*, 1978; Tshikuka *et al*, 1996; Partnership for child development, 1999; Brooker *et al*, 2000). This concept of poly-parasitism in children could be responsible for the higher intensity of infection recorded in children than adults (Fig 3).

From the results of the analysis of index of *S. haematobium* infection (Table 4). It appears children between the ages of 10 and 14 years are the main environmental contaminators in this area. Consequently, they are expected to contribute most of the transmission of schistosomiasis in this locality (Jordan & Webbe, 1982). This was also evident by the large number of *S. haematobium* eggs which they released into the environment (Fig. 3). Similar results were made in Bauchi (Egwunyenga, 1994), Malumfashi (Pugh, 1979) and Yola (Akogun & Akogun, 1996).

It is therefore obvious that any intervention programme directed on this age group will help to reduce potential for transmission, morbidity and minimise the risk of developing complication later in life (Muchiri *et al*, 1996).

From the results of snail studies it can be seen that snail density and schistosome infection rate in *Biomphalaria* generally followed a seasonal pattern in both habitats; this is in harmony with the numerous works done in this aspect (Hira, 1969; Baalawy and Moyo, 1970; Shiff *et al*, 1979; Marti *et al*, 1985; Ahmed *et al*, 1996).

Rainfall cycles probably influenced snail population and infection from the two habitats in two ways:

I. In River Kubanni (Fig 4 & 6), the snails which were mostly attached to water plants and other objects in water were easily dislodged and flushed away by the water currents due to heavy rainfall which lasted between June and September. This accounted for the complete absence of snails between June and August and the increased in number as from September corresponding to the reduction in rainfall.

II. In the tributary (Fig 5 & 7), the heavy rains in June to August helps to establish this habitat and caused the resurgence of snails which had previously passed through a period aestivation in the dry mud. The hibernation of the snails deep in the mud protected them from being flushed out and this probably explains the sudden population explosion during the heavy rains in August. This phenomenon of aestivation is an important factor which aid in the dissemination and colonisation of new habitats through the agency of animals and even vegetation (Jordan & Webbe, 1982).

Generally, schistosome infection rate in *Bulinus* was low, similar low infection rate has been reported by some workers (Sturrock *et al,* 1979; Upatham *et al,* 1981; Gryseels, 1991). This may be responsible for the low prevalence of *S. haematobium* infection recorded in this study which also agrees with the work of Agbolade and Odaibo (1996). Although, a high prevalence of *S. haematobium* infection in Egypt had been associated with low rate of *Bulinus* infection (Hairston, 1965; WHO, 1993).

The rate of infection of *B. pfeifferi* with *S. mansoni* was 13 folds more than the rate of infection of *Bulinus* with *S.haematobium* suggesting that *S. mansoni* infection may be more in magnitude than *S. haematobium* infections in this area. Hospital records collected to verify this claim did not however, help matters as it showed no significant difference in the two

infections. Hospital records though, are not reliable for prevalence studies due to non-compliant with sampling procedures (Mahajan, 1991), past records however, showed that *S. haematobium* is generally more widespread than *S. mansoni* in Nigeria and indeed, in Zaria (Cowper, 1973; WHO, 1993) though, *S. mansoni* is more localised than *S.haematobium* (Cowper, 1973; Utzinger *et al*, 2000).

This focal nature in the distribution of *S.mansoni* infection may explain why it should be more than *S. haematobium* in this study area as evident from the results of snail infection rate. A preliminary survey by Galadima *et al* (1992) also showed that *S. mansoni* infection was predominant in this area. The changing pattern of the two infections over the time could possibly have resulted to the predominance of *S. mansoni* over *S. haematobium* infection as also reported by some workers (Tayo & Jewbury, 1978; Elkhoby *et al*, 1991).

The presence of cercariae shedding *Bulinus* in the Kubanni river and its absence from the tributary despite the large number of *Bulinus* snails recovered there may be due to the absence of sources of infection. The main river Kubanni has its origin from Samaru village where most dwellers are of low socio-economic status. It is therefore subjected to more contamination with possible infectious materials than the tributary which has its origin from Area 'A' (ABU residential area).

The infection of *Biomphalaria* in the tributary could have occurred as a result of the washing of contaminated faeces from the surrounding into the tributary. During period of water scarcity people especially children defecate in the open fields thereby leading to the contamination of water bodies whenever the rains start. On the other hand, contaminated urine deposited on the surrounding land probably get absorbed leading to the

death of the eggs. A similar result was obtained by Farooq *et al* (1966) in which the main canal was found to play a significant role in the transmission of *S. haematobium* while the tributaries were more important in the transmission of *S. mansoni*.

From Figure 7 it is shown that infection rate in *Biomphalaria* peaked later than the snail density. This was probably so because the larger proportion of the snails collected during the peak density were young and probably unable to carry infection but as the age increased the probability of becoming infected also increased and hence, the peak infection recorded in November.

The higher number of infected snails recorded during the dry season than rainy season has also been documented elsewhere (Hira, 1969; Akogun & Okin, 1993; Ahmed *et al*, 1996). This corresponds to the most intense period of transmission and has a public health implication in the study population in the sense that most of the water related activities are performed during this period consequently, more people will be infected.

The present study has shown that *S. haematobium* is very prevalent in communities situated along kubanni river. The river and its tributary serve as sources of human infection. The proximity of river Kubanni and its tributary to the University is of significant public health hazard to both staff and students of the University.

Efforts should be made to educate the communities especially children who swim in these water bodies and those who are actively involved in farming in these areas on the danger of acquiring schistosomiasis as a result of water contact activities. It is further suggested that farmers should wear boots during farming to avoid contact with water infested

cercariae. Similarly, relevant departments in the university should look into the possible use of molluscicides to clear the snails from their habitats. In addition, Kaduna State Government and Zaria Local Government council should be involved and those individuals found infected should be treated. The high rate of *Biomphalaria* infection also signals the possibly occurrence of *S. mansoni* in this area which should also be looked into.

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APPENDIX 1

The distribution of egg count by sex and age among the 123 subjects infected with *S haematobium*

S. No.	Age(yrs)	Sex	Eggs/10mlof urine		S.No.	Age(yrs)	Sex	Eggs/10mlof urine
1	10	M	110		29	14	M	176
2	11	M	15		30	14	M	958
3	8	M	12		31	13	M	24
4	8	M	6		32	14	M	11
5	8	M	28		33	16	M	510
6	6	M	9		34	14	M	240
7	10	F	107		35	14	M	5
8	8	F	50		36	14	M	150
9	9	F	7		37	11	M	261
10	5	M	5		38	15	M	340
11	8	M	8		39	10	M	36
12	9	M	3		40	15	M	5
13	13	M	23		41	10	M	15
14	13	M	17		42	15	M	2
15	13	M	41		43	11	M	10
16	12	M	30		44	8	M	132
17	14	M	386		45	15	M	129
18	8	M	38		46	13	M	177
19	14	M	144		47	10	M	100
20	1	M	420		48	10	M	25
21	10	M	988		49	14	M	8
22	11	M	70		50	12	F	10
23	14	M	134		51	10	M	15
24	14	M	53		52	13	M	3

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25	13	F	7		53	12	M	11
26	11	M	3		54	12	M	81
27	14	M	360		55	13	M	6
28	15	M	113		56	14	M	847
59	10	M	5		57	10	M	36
60	6	M	4		58	10	M	6
61	11	M	16		89	9	M	6
62	7	M	28		90	30	F	2
63	11	M	6		91	22	M	8
64	8	M	17		92	20	M	65
65	15	M	48		93	9	F	24
66	8	M	3		94	10	M	5
67	12	M	18		95	14	M	47
68	7	M	15		96	19	M	15
69	10	M	2		97	6	M	1
70	12	M	7		98	20	M	17
71	18	F	2		99	9	M	3
72	10	M	11		100	12	M	20
73	10	M	14		101	20	M	77
74	15	M	9		102	20	M	14
75	10	M	12		103	8	M	260
76	13	M	182		104	18	M	32
77	10	M	4		105	10	F	3
78	25	M	33		106	14	F	32
79	50	F	1		107	18	M	8
80	15	M	52		108	12	M	12
81	21	M	1		109	15	M	16
82	15	M	3		110	15	M	61
83	15	M	22		111	8	M	10
84	15	M	7		112	8	M	10

85	10	M	50		113	5	M	3
86	40	F	2		114	12	M	51
87	13	M	3		115	10	F	16
88	9	F	2		116	14	M	50
					117	10	F	25
					118	10	M	12
					119	11	F	5
					120	20	M	273
					121	16	M	3
					122	12	M	3
					123	14	M	273

APPENDIX 2

Monthly distribution and infection rate of snails vectors in relation to rainfall in Kubanni River.

Monthly (April 99 to March 2000)	*Biomphalaria pfeifferi* Total No.	No Positive For *S. mansoni*	No. Positive for others	*Bulinus* species Total No.	Positive *S.haema-tobium*	positive others	Total No.	Positive fasciola And others	Mea mon rain (mm
Apr	59	17	22	81	5	0	5	0	40
May	11	0	1	69	3	0	16	2	39
Jun	-	-	-	-	-	-	3	1	199
Jul	-	-	-	-	-	-	-	-	143
Aug	-	-	-	-	-	-	-	-	91
Sep	15	1	4	5	0	0	51	5	109
Oct	32	1	4	11	0	0	17	8	55
Nov	116	0	2	17	1	0	80	17	-
Dec	5	1	0	19	0	0	50	5	-
Jan	80	22	8	8	0	0	328	18	-
Feb	149	4	4	87	0	2	84	12	-
Mar	146	4	6	93	0	0	155	12	-
Total	613	54	48	390	9	2	789	80	

APPENDIX 3

Monthly Distribution and infection rate of snail vectors in relation to rainfall in the tributary.

Month April '99 to March 2000	Biomphalaria pfeifferi			Bulinus species			Mean monthl Rainfall (m
	Total	No positive schistosome	No positive others	Total	No positive schistosome	No positive others	
APRIL	-	-	-	-	-	-	40
MAY	-	-	-	-	-	-	39
JUNE	-	-	-	-	-	-	199
JULY	-	-	-	-	-	-	143
AUGUST	178	7	17	62	0	0	91
SEPTEMBER	118	11	2	203	0	1	109
OCTOBER	892	7	71	497	0	0	55
NOVEMBER	308	72	6	318	0	0	0
DECEMBER	266	29	2	80	0	0	0
JANUARY	134	15	12	60	0	0	0
FEBRUARY	-	-	-	-	-	-	-
MARCH	-	-	-	-	-	-	-
TOTAL	1896	141	110	1220	0	1	