FEDERAL UNIVERSITY OF TECHNOLOGY
MINNA

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INAUGURAL LECTURE SERIES 14

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Design + Print: Global Links Communications, 08056074844, 0703446818, 08080255301

INTRODUCTION

Parasitic Diseases are among the important causes of morbidity and mortality world wide. Nearly 25% of world population are infected with parasites, with *Plasmodium* parasites accounting for about 300 million new clinical cases yearly (Bogitsh and Chang, 1998). Malaria alone accounts for 2 million deaths annually with majority of cases in Africa (WHO, 2003). The climate, cultural beliefs and practices, eating habit, poor sanitary conditions, poverty and ignorance combine to create optimum environment for infection and proliferation of parasitic diseases in Africa. There are about 370 species of parasites that infect man (Cox, 2002). A larger number of parasites infect domestic and wild animals. Parasites inflict injuries to their hosts by mechanical damage to the host tissue (Dracunculus), obstruction of gut passage *Ascaris lumbricoides*, the tape worms and some Trematodes). The hookworms are causes of major Intestinal blood loss. Generally, the Intestinal parasites are responsible for malnutrition by either interferring with food absorption (Giardia) or absorbing digested food materials from the intestine. They also inhibit normal peristalsis by blocking gut lumen which is important in food digestion or reduce absorptive gut surfaces. Malaria ranks the most important parasitic infection world wide. The other commonly encountered parasitic infections include Trypanosomiasis, Filariasis, Amoebiasis, Schistosomiasis, Hook worm infections, Ascariasis, Enterobiasis, Trichuiriasis, Giardiasis, Taeniasis, and Trichomoniasis. Apart from inflicting sickness and death on mankind, parasites make life miserable for man through poverty, sapping of energy, and animal protein. Loss of several man hours and absenteeism from school and work has greatly been attributed to parasitic infections. Animal Trypanosomiasis alone accounts for losses amounting to about 300 billion naira annually in Africa (ILRAD, 1990).

1.1 EVOLUTION OF PARASITES

Evolutionists believe the parasites evolved from other organisms. The creationists believe God ab initio created everything (good or bad). The evolution of parasitism is however less controversial. Parasites (whether through evolution or creation) initially lived as free living organisms. Contact with possible hosts and the development of preadaptation qualities eventually led to the establishment of parasites in or on the host. Parasitism as a way of life evolved with the objective of acquiring metabolic dependence, development stimuli, nutritional materials, digestive enzymes, and control of maturation (Smyth, 1976). Co evolution leads to extensive local adaptation. Parasites in a particular area infect hosts from the same area more efficiently than they infect hosts from another geographically distinct population.

Contact between the parasites that were created free and their would-be hosts was very crucial in the adaptation of parasites to their hosts. Preadaption features and contact with hosts lead to the development of hosts' specificity. There are parasites that are adapted to plants, man, vertebrate invertebrate and animals. Movement of man from place to place has led to the acquisition of new species of parasites by man either from animals or from the different soil environments. The evolutionary process did not end with host selection but also involved organ or tissue specificity. The selection of which organ or tissue to be colonized by parasites had to do largely with intrinsic and extrinsic factors. Parasite intrinsic factors are largely preadaption features such as metabolic adaptation, development of suckers, spines, loss of digestive system, hermaphroditism, production of large numbers of offspring within a short time, and developmental stages. Developments of mode of transmission, utilization of intermediate hosts are all aspects of adaptation.

The extrinsic factors involve physiological conditions of the host internal and external environment which may or may not be suitable for the survival of the parasite. The evolutionary process of animal parasitism which might have taken several thousand years of trial and error in the selection of host and tissue or organ has finally resulted in parasites being classified according to their habitats viz: intestinal parasites, tissue, parasites, blood parasites etc. The evolutionary process has also led to parasites being classified as those having direct life cycle and those having indirect life cycle. Parasites with direct life cycle can complete their development in one host while those with indirect life cycle require at least 2 hosts to complete their life cycle. Ectoparasites are those that live on the external surfaces of their hosts e.g. insects, body lice and ticks. Endo parasites are those that live inside the host. These are the majority of parasites. They include, *Ascaris lumbricoides*, (Fig. 1) Hook worms, *Enterobius*, Malaria parasites, Trypanosomes, Leishmania, Filarial worms, Amoebae, Schistosomes, *Toxoplasma,* the Tape worms (Fig. 2), *Fasciola* etc.

Fig. 1. Adult Ascaris lumbricoides

Fig. 2. *Tape Worm*

1.2 Transmission of Parasitic Infections

Parasitic infections can be transmitted by man to man or from animals to man through several ways.

1. **Oral route.** Intestinal parasites such as *Ascaris lumbricoides, Trichuris trichiura, Enterobius vermicularis, Taenia solium, Taenia saginata, Dracunnculus medinensis, Diphyllobotrium latum, Echinococcus granulosus, Entamoeba histolytica, Toxoplasma, Fascliola hepatica, Trichinella, coccidian (including Cryptospridium)* are some of the parasites transmitted through the oral route.

2. **Per cutis:** The infective stages of the parasites (cercariae, filariform larvae) pierce the skin of victims who walk with bare foot or swim in infected water bodies. This includes parasites such as *Necator americanus, Ancylostoma duodenale, Schistosoma mansoni, Schistosoma haematobium* and other schistosomes.

3. **Insect vectors**: Insects can serve both as intermediate hosts and vectors of human parasites. The infective stages of the parasites develop in the insects, migrate to the mouth parts and are inoculated into the susceptible human host through insect bites during blood meals. Such parasites include malaria parasites (through Anopheles mosquitoes), African Trypanosomes through the *Glossina* flies), *Onchocerca volvulus* (*Simulium damnosum* complex, *Loa Loa* (Tabanid flies),

Wuchereria *bancrofti* (through culex, Aedes mosquitoes), *Leishmania* parasites (sand flies) *Trypanosoma cruzi* (Triatomine bugs)

4. **Through sexual intercourse**: *Trichomonas vaginalis* (in humans) and *Trypanosoma equiperdum* (in horses).

1.3 Sources of Parasitic infections

(i) Food: Uncooked or improperly cooked meat, rats, crayfish, fish, crab. The parasites include *Taenia solium, Taenia saginata, Diphyllobotrium latum, Clonorchis sinensis, Trichinella spiralis, Toxoplasma gondii.*

(ii) Contaminated Vegetables or fruits. These include parasites such as *Entamoeba histolytica, Fasciola hepatica, Fasciola gigantica, Fasciolopsis buski.*

(iii) Soil: These are soil transmitted parasites. They include Hook worms, *Trichuris trichiura, Strongyloides stercoralis, Toxocara cati, Toxocara canis, Ancylostoma braziliense, Ascaris lumbricoides.*

(iv) Water: *Dracunculus medinensis, Cryptosporidium sp, Giardia lamblia, Entamoeba histolytica, Schistosoma mansoni, S. haematobium, S. Japonicum.*

(v) Insect Vectors: *Plasmodium sp, Trypanosomes, Onchocerca volvulus, Loaloa, Wuchereria bancrofti, Leishmania sp, Babesia, Theileria, Erlichia, Hymenolepis diminuta.*

(vi) Human directly: *Trichomonas vaginalis, Enterobius vermicularis, Strongyloides stercoralis.*

(vii) Domestic Animals: *Hymenolepis nana, Echinococcus granulosus, Toxocara canis, Toxocara cati, Ancylostoma braziliense,*

1.4 Incidence of Major Helminthic Infections

1.	Schistosomiasis	-	200 million people infected globally. (170 million people infected in Africa)
2.	Hook worm	-	700 800 million people (200 million people in Africa)
3.	Trichuris	-	700 800 million people (200 million people in Africa)
4.	Ascaris	-	1.2 billion people
5.	River Blindness	-	17.7 million people (99% cases in Africa)

Parasitic infections abound world wide. Tropical and sub tropical countries suffer the greatest burden of parasitic infections. The environment, the climate and the social behaviour and economic poverty make developing countries more susceptible to parasitic infections compared to developed countries. In developing countries the following predisposing conditions to parasitic infections abound: Inadequate water supply and sanitation, crowded living conditions, lack of access to health care, low level of Education, poor personal hygiene, poor environment / lack of toilet facilities.

Soil transmitted helminthes *(Ascaris lumbricoides, Necator americanus, Ancylostomia duodenale, Strongyloides stercoralis)* and *Schistosoma mansoni* depend on egg contaminated environment for transmission. For intestinal helminths (i.e. STHs) the life span is between 1 and 4 years. Under favourable conditions (warm, moist, shaded environment) the eggs can remain viable for some years. Reinfection rates remain high until the adult worms are removed by chemotherapy. Soil transmitted helminth infections are generally higher in school age children (6 15 years) although that of *A. lumbricoides* and *T. trichiura* may peak before the age of 5 years. Prevalence of *Ascaris lubricoides* and Hook worms may remain high even in adult populations. Agricultural workers (who walk bare foot) are predisposed to Hook worm infections. Worm burden is also higher in children than adults probably due to Reinfection from the environment. Prevalence is generally the same between male and female children within the preschool and early school age children (18 years) (Galadima and Olatunde 1987). Soil transmitted helminthic infections are very prevalent in Nigeria.

Soil transmitted helminthes have indirect life cycle. The parasites do not require intermediate hosts to complete their life cycles. *Ascaris lumbricoides*, *Trichuris trichiura*, require a suitable environment for their eggs that have been voided with faeces to hatch into the larval stages which later develop to become infective. The infective eggs are taken through the month where the larvae are released to undergo migration and further development in the body until they finally reach their adult stages in the small intestine (see Fig.3 and 4).

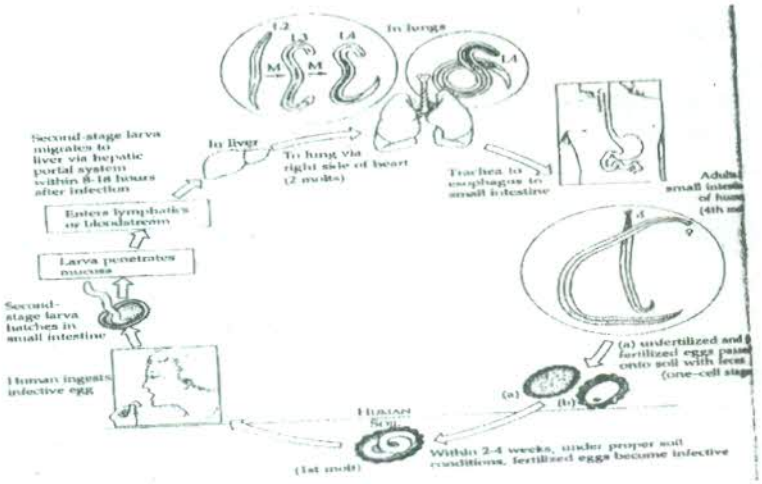


Fig. 3. Life Cycle of Ascaris lumbricoides (Adopted from Bogitsh and Chang 1998)

The eggs of Hook worms and *Strongyloides* hatch into the larval stages which become infective at L3 (Fig. 5). These larvae penetrate the skin and are carried by blood circulation until they develop into full adult forms in the small intestine (Okpala 1956, Nwosu 1981; Oyerinde, 1982; Azikiwe, 1984; Galadima *et al.*, 1989a; Galadima *et al.*, 1989b,)

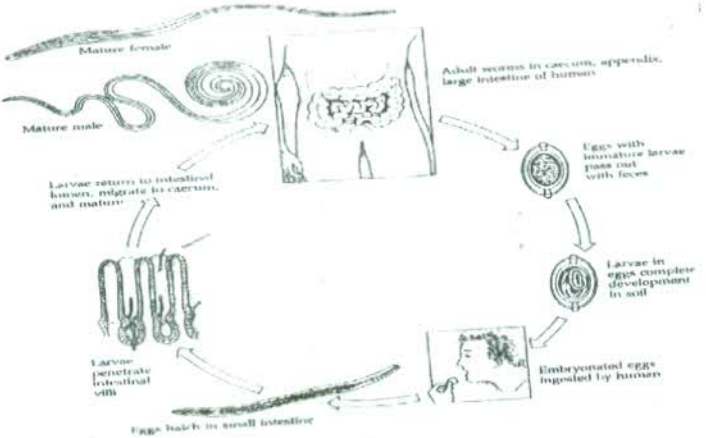


Fig. 4. Life Cycle of Trichuris trichiura. (Adopted from Bogitsh and Chang 1998)

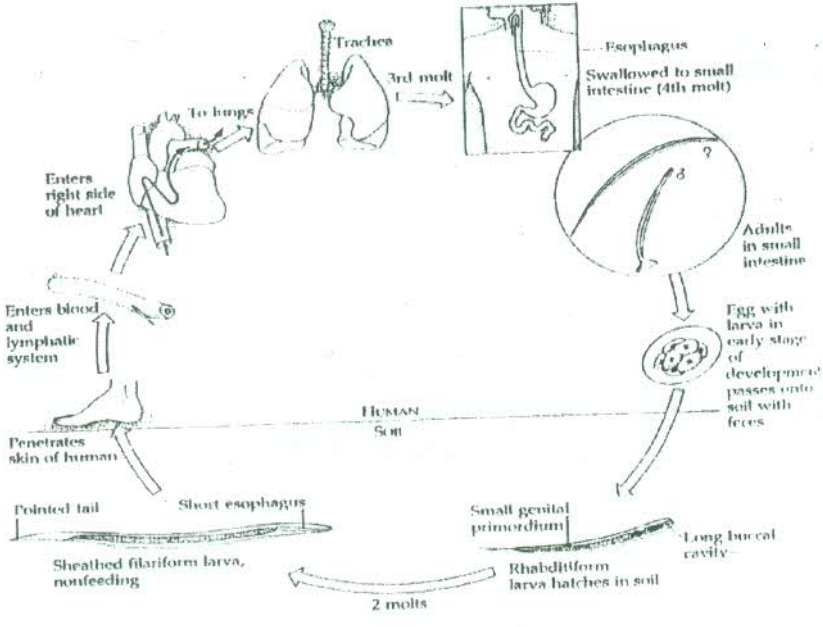


Fig. 5. Life Cycle of hookworm (Adopted from Bogitsh and Chang 1998)

Schistosomiasis is water borne disease. Infection is acquired through water related activities such as swimming, washing, fishing or wading. The cercariae which are released from the intermediate snail vectors penetrate the exposed skin and migrate through blood circulation until they mature in the respective venous plexuses(Fig.6) Studies by Galadima *et al.* (1992) showed higher prevalence in males than females in Zaria, Nigeria, similar findings were recorded by Opaluwa *et al.* (1999) in Niger State.

Adeamu and Galadima (1998) found a prevalence rate of 50% among 2000 inhabitants of the Bakolori irrigation project area of Zamfara State. Ugbomoiko (2000) reported a prevalence of 22.9% in some parts of Edo State, Nigeria. Dunah and Bristone (2000) reported prevalence of 27.4% among Primary School pupils in Mayo Belwa Local Government of Adamawa State. High prevalence rate (60%) has been reported in Kebbi State (Daniel *et al.* 2000).

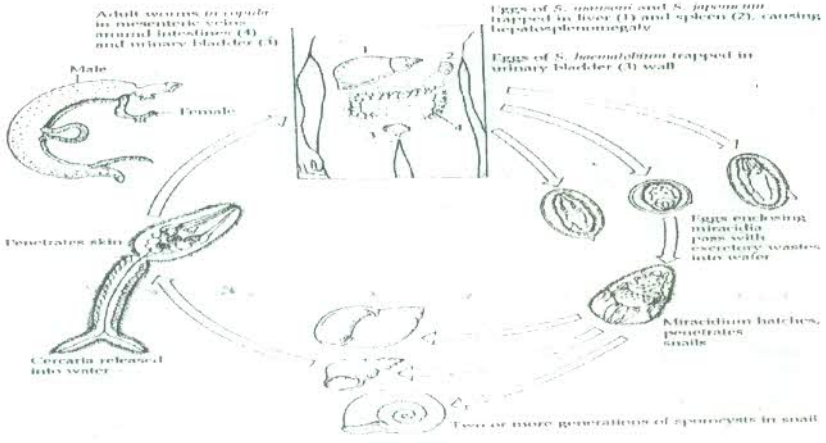


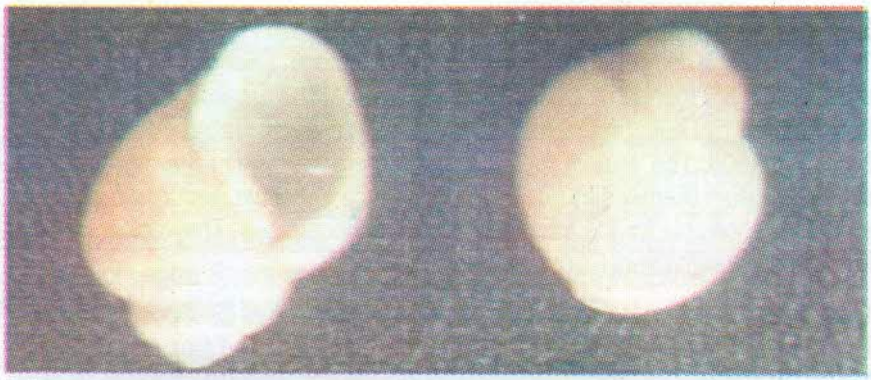
Fig. 6. Life Cycle of Schistosome (Adopted from Bogitsh and Chang, 1998)

Guinea worm, *Loa loa*, filaria worms and *Onchocerca volvulus* require intermediate hosts to complete their life cycles. Similarly, the cestodes (except *H.nana*) and the trematodes require intermediate hosts / vectors to complete their life cycles.

Table 1. Lists the major helminthic infections and their vectors/intermediate hosts. Figure 7 are snails, intermediate hosts/vectors of *Schistosomes.*

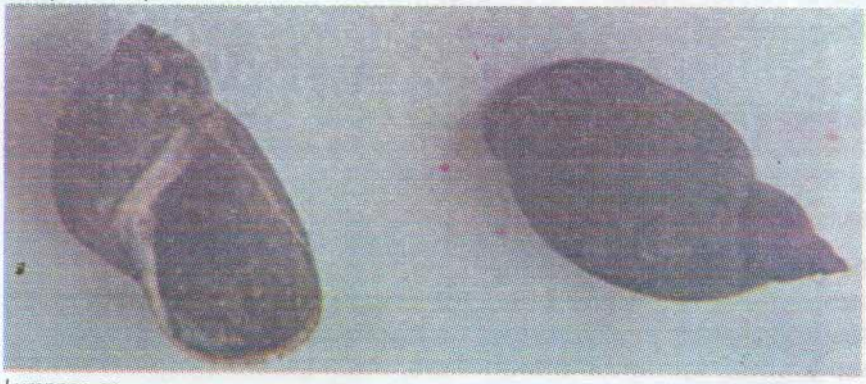
Table 1: Intermediate hosts/vector of important helminithic infections

Parasite	**Intermediate hosts/vectors**
Dracuncunlus medinensis	Water copepods (*Cyclops)*
Loa loa	Tabaniid flies
Wuchereria bancrofti	*Anopheles, Aedes, Culex* mosquitoes
Onchocerca volvulus	*Simulium* (Black) flies
Schistosoma haematobium	*Bulinus*
Schistosoma mansoni	*Biomphalaria*
Schitosoma japonicum	*Oncomelania*
Fasciola hepatica	*Lymnaea*
Fasciola gigantica	*Lymnaea*
Taenia saginata	Cattle
Taenia solium	Swine
Diphyllobotrium latum	Fish



Bulinus sp

Biomphalaria sp



Lymnnea sp

Fig. 7, Snail Vectors of Schistosomes

2.0 ONCHOCERCIASIS (RIVER BLINDNESS)

This is a disease complex caused by a tissue nematode, *Onchocerca volvulus*. The adult worms are found in the subcutaneous tissues. The parasite was first isolated from humans by Leukat in Ghana in 1893. The disease was first reported in northern Nigeria in 1908. The vectors responsible for the transmission are day biting flies called *Simulium* (Family simulidae). In West Africa *Simulium damnosum* s.s. is the species responsible for the transmission of Onchocerciasis. The vectors breed in fast flowing stream/rivers (usually rocky bedded).

The female *Simulium* is responsible for the transmission of *Onchocerca volvulus*. The female flies require blood for ovarian development. The flies preferably bite during the early hours (7am-10am) and later in the evening (3pm-6.30pm). In West Africa the flies bite at the lower parts of the body compared to the Central American forms that bite in the upper part of the body.

Other species of *Simulium involved* in the transmission of onchocerciasis include *Simulium woodi, Simulium naevei, S. ochraceum, S. metallicum, S. callidum S. Sirbanum, S. soubrense, S. yahense, S. squamosum, S. sanctipauli.* etc.

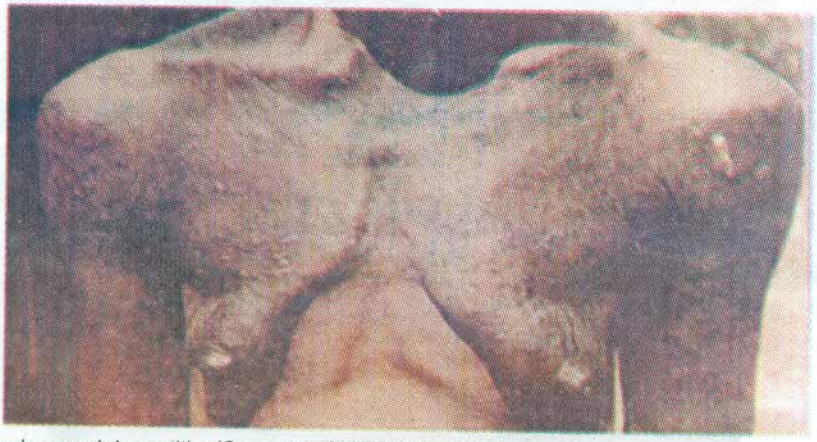
The flies may be identified morphologically, but more accurately by larval chromosomes (cytospecies).

In some places where fly population is very high farmers and cattle rearers in West Africa often tie rags round their legs to prevent fly bites. The flies can bite very far away from the breeding place when conditions are favourable (Wenk, 1981). In wet weather the insects disperse rapidly at a distance of up to 40 kilometers or more in gallery forests with favourable air current.

A period of about six days is required from the time that microfilariae are ingested to the time that infective stage larvae are produced (Duke, 1968). An average period of 12 months is observed from the time infective larvae are deposited by the flies into the human tissue to the time that microfilariae are detected in skin (Biological Incubation Period).

The average life span of the adult worm is about 15 years (Nelson, 1970). Onchocerciasis ranks as one of the world's most formidable infectious diseases. It causes an unsightly irritating skin disease which results in social ostracism due to the prematurely aged appearance of the atrophic skin and also because of the high prevalence in adults of ocular impairment especially in the many communities in the savanna regions of Africa. Other manifestations of Onchocerciasis include

depigmentation (Leopard skin), loss of skin elasticity and scaling, nodules, hanging groin, inguinal hernia, enlargement of groin lymph nodes, elephantiasis of the scrotum (Fig. 8-12) (Nelson, 1970; Edungbola *et al.*, 1983). Onchocerciasis affects about 7.7 million people in the endemic regions of the world. Most cases of Onchocerciasis are in Africa and Nigeria has the highest prevalent of Onchoceciasis in the world. The endemic States in Nigeria include Kwara, Kogi, Niger, Nasarawa, Benue, Kaduna, Kebbi, Taraba, Adamawa, Plateau and Borno States. With the exception of Lagos, Rivers and Akwa-Ibom States where infections are sporadic, the disease is prevalent in all States of Nigeria (WHO, 1995).



Onchocercal dermatitis (Courtesy of NITOR, Kaduna)

Skin Depigmentation (LPS)

Fig 8: Skin Manifestation of Onchocerciasis

Fig 9: Head Nodule (Courtesy of NITOR, Kaduna)

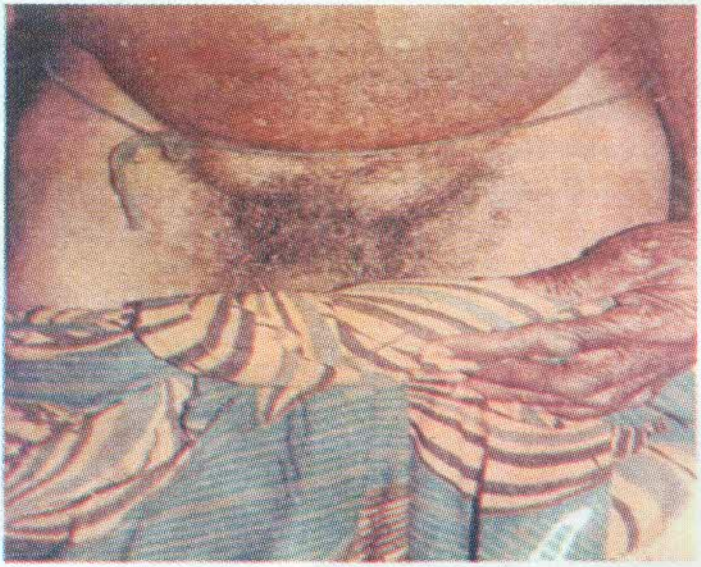


Fig 10: Enlarged Lymph nodes of Groin (Courtesy of NITOR, Kaduna)

Fig 11: A child leading a blind parent

Fig. 12 Enlarged Scrotum due to Onchocerciasis (Courtesy of NITOR, Kaduna)

The control of Onchocarciasis involves mainly vector control and chemotherapy. The failure of Nigeria to join the Onchocerciasis Control Programme (OCP) in the West African Sub - region which started in 1975 explains why most cases of onchocerciasis in Africa are in Nigeria (WHO, 1987). Vector control requires regional networking, dosing over a large area, and control for a long period, as isolated vector control is bound to fail. The first attempt to control vectors of Onchocarciasis in Nigeria was the pilot programme in the old Abuja Emirate in 1956. Other isolated vector control projects were those carried out on the Orji River, the Kontagora River, River Kaduna and River Hawal (Crosskey, 1981). The failure of these projects was mainly due to the following:

(i) They were isolated (ii) major rivers could not be dosed with DDT over a long period over a large area (iii) The projects were short lived as they were put in place in most cases to protect project workers from the menace of fly bites.

The prevalence of onchocercisis in the old Abuja Emirate was one of the reasons advanced by antagonists against Abuja as Federal Capital Territory.

2.1 CHEMOTHERAPHY AS CONTROL MEASURE

Various drugs have been used as chemotherapeutic and control agents of onchocerciasis. These include suramin, Diethyl Carbamazine Citrate (Banocide) and Ivermectin (Mectizan). Presently, Mectizan is the drug in use. The other drugs have been abandoned for two basic reasons namely, their toxicity (particularly Suramin) and limited activity on the adult worms (Banocide). Ivermectin is a *Macrocyclic Lactone*, a synthetic derivative of avermectin B, which is a fermentation product of *Streptomyces avermitilis*. The drug (Ivermectin) is manufactured by Merck, Sharpe and Dohme (MSD), Holland and it is given free. Mectizan clears microfilariae very rapidly from the skin, has no serious side effects and has longer lasting effect. It is given as a single dose once or twice a year (WHO 1995). Nigeria established its own National Onchocerciasis Control Programme in 1982 which is based purely on the distribution of Mectizan to affected communities. Government and Non-Governmental Organizations (NGO) are involved in the battle against the disease. Notable among the NGOs are the Carter Foundation and Sight Savers International.

In 1974 the Onchocerciasis Control Programme (OCP) comprising eleven West African countries (Benin, Burkina Faso, Cote d'Ivoire, Ghana, Guinea and Guinea Bissau, Mali, Niger, Senegal, Sierra Leone and Togo) was put in place through public private partnership involving 22 donors, WHO, UNDP, World Bank, FAO and Mark and Co. Inc. The OCP in 1999 celebrated victory of almost total elimination of Onchocerciasis in these West African countries. The programme (OCP) ended in 2002. The experience of the OCP is a lesson that concerted, integrated and public,

In both Niger and Kaduna States, virtual impairments/blindness rates were between 7.5% and 14%. Dermatitis was still the commonest manifestation of the disease (20%-100%) in all the communities examined. The rates of *Onchocercomata* (Nodules) were between 0% and 10%.

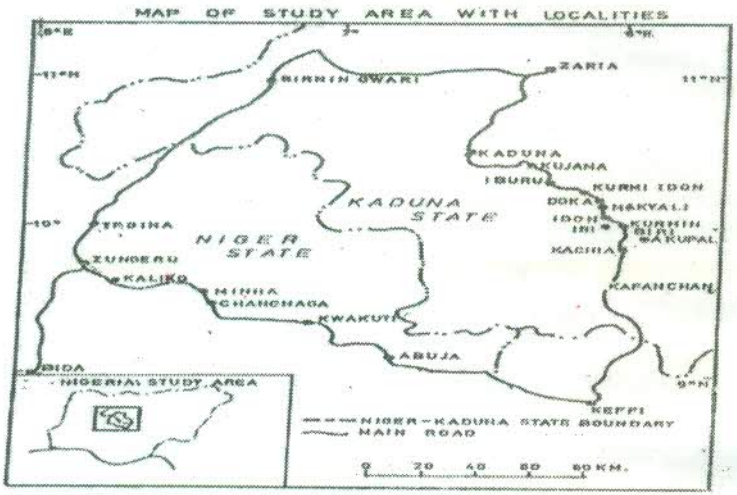


Fig: 13 Map of Niger and Kaduna States (Nigeria) showing study areas

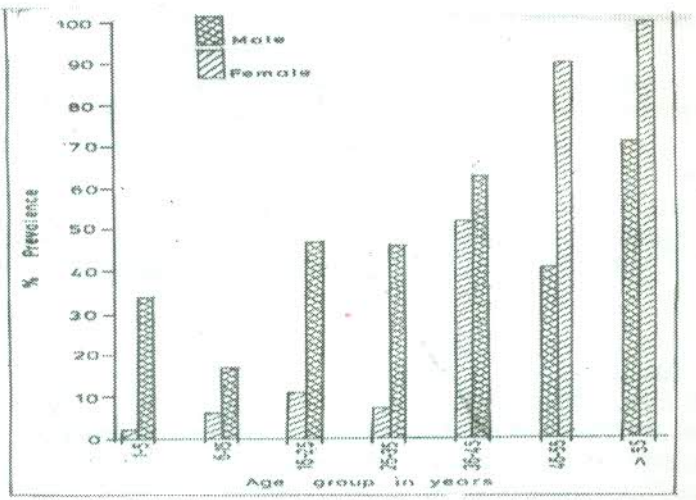


Fig 14: Prevalence of Onchocerciasis in Chanchaga Local Government Area of Niger State, Nigeria

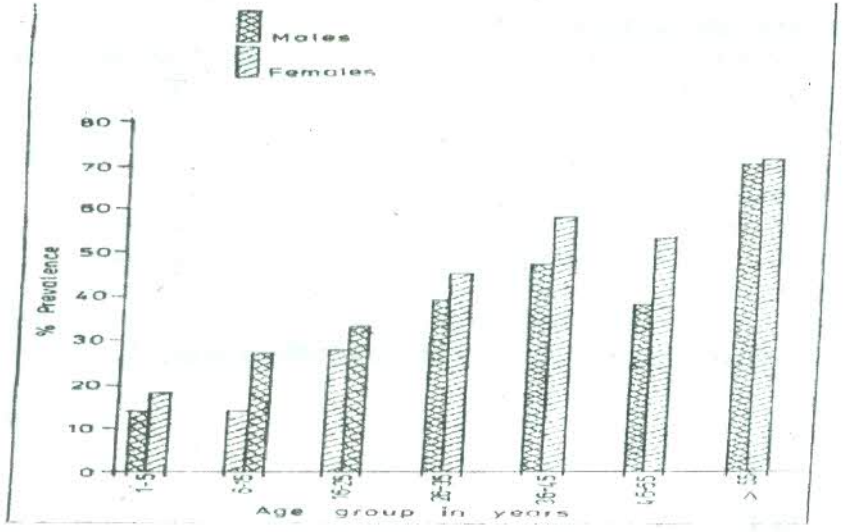


Fig 15: Prevalence of Onchocerciasis in Katchia Local Govt. Area of Kaduna State, Nigeria

Among the Etulo communities in Buruku and Kastina Ala local Government of Benue State an overall prevalence rate of 44% was found (Atu and Galadima, 2003). The males had higher prevalence (45%) compared to the females (42%). Generally infections increased with age with the peak infection in the age group 31-40 years. Gemade and Dipeolu (1983) had earlier reported on Onchocerciasis in other parts of Benue State. In the Takum and Bali areas of Taraba State, depigmentation and presence of nodules in the onchocercal patients were very prominent (Nock *et al.*, 1998). Adamu *et al.* (1996) reported a prevalence rate of 17.7% of Onchocerciasis among the inhabitants of 4 villages in Bukkuyun District of Sokoto State. Again the males had higher prevalence rate (22.60) compared to the females (11.50%)

2.4 CHARACTERISATION OF *ONCHOCERCA VOLUULUS* MICROFILARIAE USING ACID PHOSPHATES STAINING

It has been observed that the clinical manifestation of Onchocerciasis and the transmission of the disease vary from different geographical regions (Nelson, 1970). In the Savanna region the clinical manifestation is more ocular compared to the dermal nature in the forest region. These observations are partly due to the parasite strain and to the species of *Simulium* involved in the transmission (De-Leon and Duke, 1966; Duke, 1967).

A histochemical study using Acid phosphates as a maker was used to characterize Microfilariae isolated from patients in Kaduna and Niger States (Galadima, 1989). The method of Omar (1978) was used. Naphthol AS-TR phosphate was used as enzyme substrate. The activity of the enzyme (Acid phosphates) was detected by the deposition of red azo dye indicating the site of enzyme activity (Anal Pore, Excretory pore, Inner body or a combination of these). The microfilaria was classified. Results showed that there exists a wide variety of microfilaria population from one community to another and even in the same individual (Table 2.) The classical savanna type (Type iv) with enzyme activity at the Anal Pore accounted for about 65% of the microfilariae found in the study area followed by type v (20%) which is known to be more predominant in the forest belt) Fig. 16 and 17).

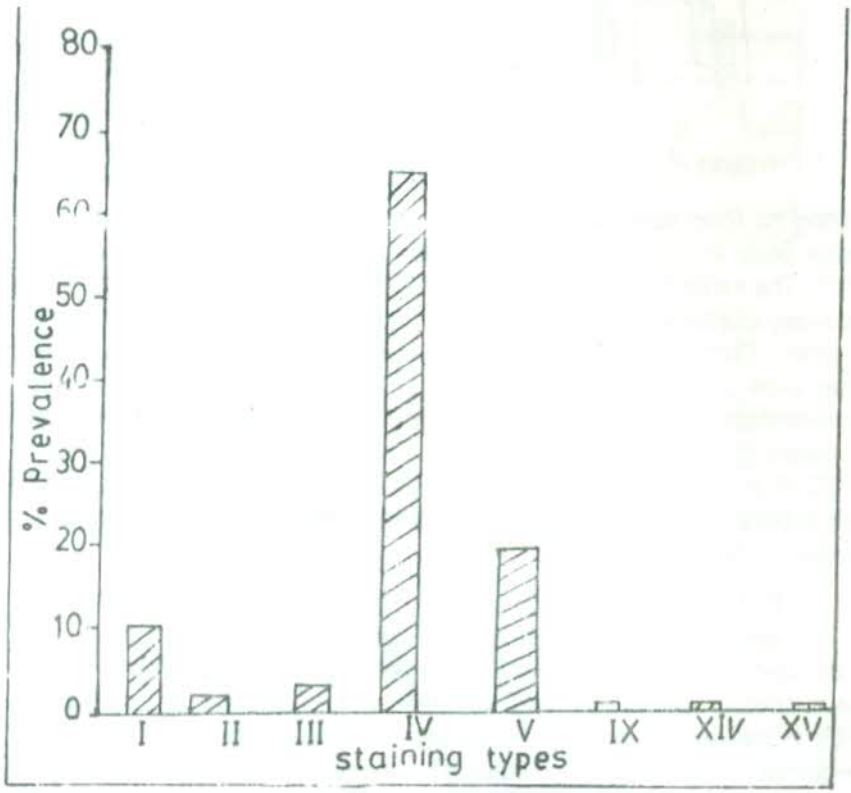
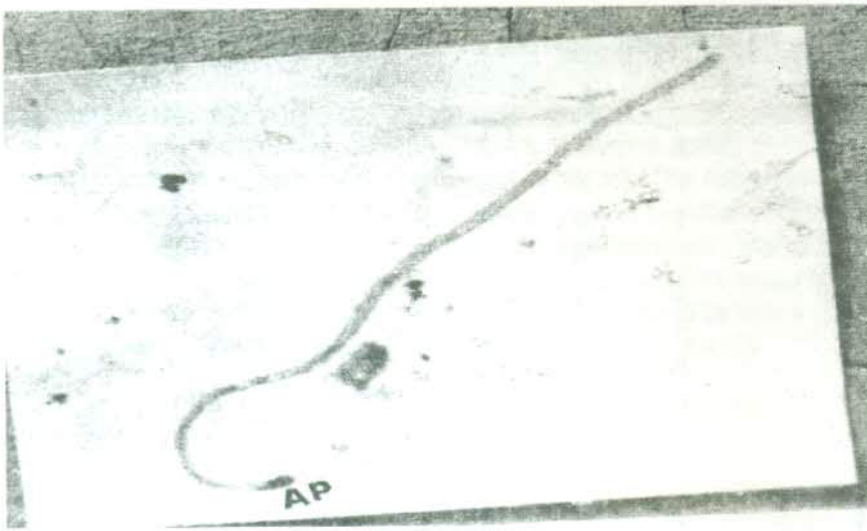


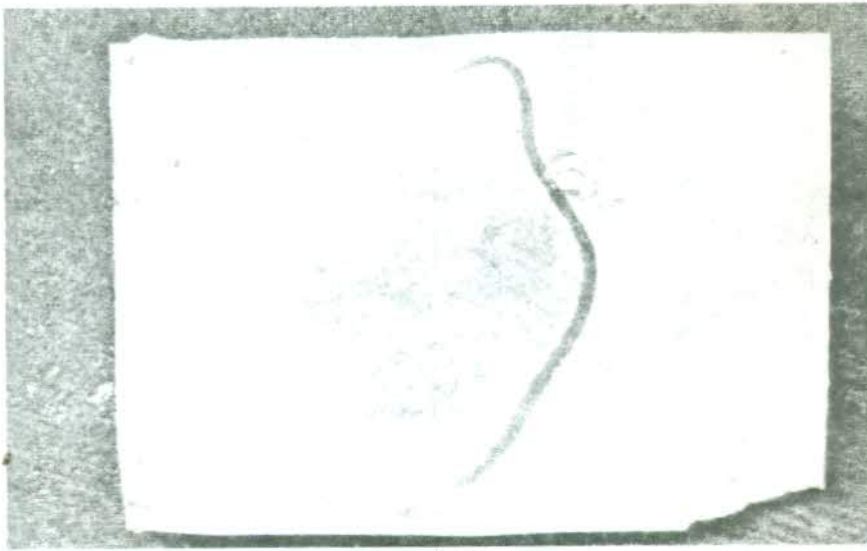
Fig. 16: Percentage Prevalence of Acid-phosphates staining patterns

Table 2. Frequency of Various Combination Pattern of Acid Phosphates reaction of Microfilariae from 112 Persons.

Number of	Types of Combinations					Frequency of Combinations
1	I	II	III	IV	V	5
2	I	II	III	V		2
3	II	III	IV			1
4	I	II	IV	V	XIV	1
5	III	IV				2
6	II	IV	V			3
7	IV	V				1
8	I	IV				1
9	V	IV				18
10	I	IV				3
11	V	IX				1
12	II	IV				18
13	I	III	IV			2
14	I	II	IV	V		1
15	I	IX				1
16	I	II	IV			2
17	I	V				1
18	III	IV	V	XIV		1
19	I	II	III	IV		1
20	IV	V	IX			1
21	I	IV	XV			1
22	III	IV	IX			1
23	I	II	IV	IX		1
24	I	III	IV	IX	XIV	1
25	IV	ALONE				27
26	V	ALONE				10
27	I	ALONE				4
28	IX	ALONE				1
	TOTAL					**112**



Type iv



Type v

Fig 17: Type iv and Type v Acid Phosphates staining patterns

3.0 HELMINTHIC INFECTION OF DOMESTIC ANIMALS AND THEIR SIGNIFICANCE TO MAN

Helminths constitute a group of veterinary pathogens. Trematodes, cestodes and nematodes cause both morbidity and mortality in domestic animals. Notably among these are *Haemonchus, Strongylus, Ancylostoma,Fasciola,* and Schistosomes. *Taenia sp* (Soulsbly, 1982). These infections have consequent economic implications to man. Helminthic infections in domestic animals lead to losses in term of protein yield, reduction in pricing and ability to work. Helminthic infections of animal origin could give rise to zoonosis. Such helminthic infections include those of *Echinococcus granulosus, Toxocara canis, Toxocara cati, Ancylostoma caninum, Ancylostoma braziliense* (Galadima *et al.*, 1989b, Nock *et al.*, 2003). Though these parasites may not complete their life cycles in man, they do produce abnormalities such as cutaneous larva migrans, visceral larva migrans, epilepsy, cardiac problems, hydatidosis and tumors in the vital organs.

4.0 PROTOZOAN INFECTIONS

The major protozoan parasites of medical importance include malaria parasites (*Plasmodium* sp), Trypanosomes (African and South American Trypanosomes), *Entamoeba histolytica, Giardia lamblia, Leishmania sp, Toxoplasma gondii,* pathogenic free living amoebae, *Cryptosporidium sp, Trchomonas vaginalis* etc.

Malaria has for long been regarded as the king of diseases. Four *Plasmodium* species namely *Plasmodium falciparum, P.malariae,P.vivax and P.ovale* are known to cause malaria in man.

Similar parasites are common in monkeys and apes. The female anopheles mosquitoes are principal vector for the transmission of malaria parasites. Malaria constitutes a major threat to health and blocks the path to economic development of individual communities and nations. About 50% of the world population is at risk. Malaria causes over 400,000,000 clinical cases and over 2 million deaths each year (Gilles and Warrell, 1993). Malaria kills 1 out of 20 children before they reach the age of 5 years. The disease causes anemia in children and pregnant women and it afflicts the poor and underprivileged, sapping productivity and causing chronic ill health. Although 80% of malaria cases and deaths occur in Africa, malaria is a problem in every region of the world. The problem of malaria control and eradication is multifaceted. Resistance of the malaria parasite to every anti-malaria drug is on the increase. The mosquito vectors easily develop resistance to available insecticides. Ignorance and poor attitude to health make environmental management towards control of mosquito vectors difficult.

Trypanosomiasis in Africa is now majorly a problem of domestic animals. Virtually trypanosomiasis and sleeping sickness has been brought under control in humans in Africa. *Trypanosoma cruzi* the causative agent of Chaga's disease has however remained a major health problem in Latin America. It is estimated that in Africa 500,000 people are infected with annual death rate of 50,000.

African Trypanosomes are causes of the disease sleeping sickness in human and Nagana in livestock with resulting considerable economic and social consequences.

Livestock in tsetse flies infested areas are characterized by anaemia, underweight, infertility, abortions, long calving intervals, neonatal death, low productivity, low milk yield and reduced capacity to work as a result of *Trypanosoma* infection (Losos, 1986, ILRAD, 1990). Trypanosomes also affect other animals such as dogs, sheep, goats, camels, horses, donkeys, elephants and pigs. While the economic losses due to Animal Trypanosomiasis are greater in Cattle, the economic losses from infection in other animals are also of great importance (Soulsby, 1982).

Trypanosomiasis in cattle is more prevalent in the central part of Nigeria compared to the Southern part of Nigeria (Ogunsanmi *et al.,* 2000; Usman *et al.*, 2008). In Nigeria an estimated land area of 587,273km^2 is infected by trypanosomes.Infection in the Ndama cattle is lower than in Muturu, Keteku and Zebu (Ogunsanmi *et al.* 2000).

Amoebiasis due to *Entamoeba histolytica* and diarrhea caused by *Giardia lamblia* are very important causes of ill heath in man. Water and vegetables are the major sources of infection (Galadima and Olatunde, 1987; Inabo *et al.* 2000; Okafo *et al.* 2003).

Cryposporidium is another water borne infection which has become very prominent in HIV AIDS patients (WHO, 1993, Collins, 1997) *Cryptosporium* species are known to cause diarrhea in immuno compromised patients but without significant health implication in normal healthy individuals.

Toxoplasma gondii and *Leishmania* infections have not been documented to be of serious health problem in Nigeria. Cutaneous leishmaniasis has been reported in some parts of Nigeria but not the life threatening visceral leishmaniasis (Nock *et al,* 2001).

Serological evidence of Toxoplasmosis has been well documented (Bello 1987) but not much report on clinical disease.

Coccidian parasites pose serious health problems to animals such as sheep, goat, cattle, pigs, horses and especially in poultry with significant economic losses (Soulsby, 1982).

5.0 MILLENNIUM DEVELOPMENT GOALS AND PARASITIC DISEASES

The millennium development Goals (MDG) were set by all Governments at the UN millennium summit in September 2000. Leaders agreed to strive individually and collectively towards those goals through International, Regional and National action. All UN organizations decided to be guided by MDG in their future actions.

The millennium development Goals were set as a result of the faltering progress made in the 1990s. **The MDGs are eight goals intended to improve life for populations living on less than a dollar per day**. 189 UN State members along with International organizations agreed to adopt these goals and to try to achieve them by the year 2015. Some countries have achieved many of the goals while others are yet to be on track to realize any (http://en.wikipedeia.org/wiki/millenium - development Goals).

The eight millennium Development Goals and the 21 targets are listed as follows:

Goal 1. Eradicate extreme poverty and hunger

Target 1. Halve between 1990 and 2015 the proportion of people whose income is less than one dollar a day.

Target 2. Achieve full and productive employment and decent work for all including women and young people.

Target 3. Halve between 1990 and 2015 the proportion of people who suffer from hunger.

Goal 2. Achieve universal primary education

Target Ensure that, by 2015, children every where, boys and girls alike will be able to complete a full course of primary schooling.

Goal 3. Promote gender equality and empower women

Target. Eliminate gender disparity in primary and secondary education preferably by 2005 and at all levels by 2015.

Goal 4 Reduce child mortality

Target. Reduce by two thirds, between 1990 and 2015, the under five mortality rate.

Goal 5. Improve maternal health

Target 1 Reduce by three quarters, between 1990 and 2015, the maternal mortality ratio.

Target 2. Achieve by 2015, universal access to reproductive health.

Goal 6 Combat HIV / AIDS, Malaria and other Diseases

Target 1. Have halted by 2015 and begun to reverse the spread of HIV / AIDS.

Target 2. Achieve by 2010, universal access to treatment for HIV / AIDS for all those who need it.

Target 3. Have halted by 2015 and begun to reverse the incidence of malaria and other major diseases.

Goal 7. Ensure environmental sustainability

Target 1. Integrate the principles of sustainable development into country wide policies and programmes; reverse loss of environmental resources.

Target 2. Reduce bio-diversity loss, by 2010, a significant reduction in the rate of loss.

Target 3. Halve by 2015, a proportion of people without sustainable access to safe drinking water and basic sanitation.

Target 4. By 2020, to have achieved a significant improvement in the lives of at least 100 million slum dwellers.

Goal 8. Develop a global partnership for Development

Target 1. Develop further an open trading and financial system that is rule-based, predictable and nondiscriminatory. Include a commitment to good governance, development and poverty reduction nationally and internationally.

Target 2. Address the special needs of the least developed countries. This includes tariff and quota free access for their export; enhanced programme of debt relief for heavily indebted poor countries; and cancellation of official bilateral debt; and more generous official development assistance for countries committed to poverty reduction.

Target 3. Address the special needs of land locked and small Island developing states.

Target 4. Deal comprehensively with the debt problems of developing countries through National and International measures in order to make debt sustainable in the long term.

Target 5. In cooperation with pharmaceutical companies, provide access to affordable essential drugs in developing countries.

Target 6. In cooperation with the private sector, make available the benefits of new technologies, especially information and communication.

5.1 PARASITIC DISEASES AND MILLENNIUM DEVELOPMENT GOALS

Parasitic diseases are very common in tropical developing countries for reasons Earlier given at the beginning.

5.1.1 ERADICATE EXTREME POVERTY AND HUNGER

To eradicate extreme poverty and hunger will require tackling the problems of parasitic diseases. Ignorance, poverty and disease always go together. Human sickness leads to inability to work, lowering of production of food items and industrial products.

* Malaria will prevent victims from going to work for about 3 days or more.
* Amoebic dysentery could keep victims pot bound for 2-3 days.
* Intestinal helminthic infections make the victims weak and unthriftful.
* *Dracunculiasis* (Guinea Worm) can prevent the victim from working throughout the rainy season.
* River blindness (*Onchocerciasis*) loss of man hours due to body itch, desertion of fertile agricultural land due to the disease and the menace of the biting flies. Those rendered blind become economic burden to others.
* Parasitic infection of domestic animals such as *Trypanosomiasis* will lead to poor milk yield, poor productivity, loss of protein, inability to plough, low pricing of the animal due to weight loss. About three billion Naira is lost annually due to animal *Trypanosomiasis* in Africa.

5.1.2 ACHIEVE UNIVERSAL PRIMARY EDUCATION

* Parasitic diseases could lead to absenteeism from schools due to malaria, amoebic dysentery and Enterobiasis.

* Poor performance in school is associated with parasitic infections such as Hook worm and *Enterobius*. Poor mental capacity could lead to dropping out from school or spending more years to complete primary school. The teachers if affected could be absent from school and inability to cover the syllabus adequately.

  Poverty inflicted on guardians due to parasitic diseases could disallow them to cater for the schooling of their wards. This could lead to another

social malaise which is early marriage among the females. Early marriage would give rise to Vesico - Vaginal Fistula (VVF).

5.1.3 PROMOTE GENDER EQUALITY AND EMPOWER WOMEN

Parasitic diseases are among the factors militating against gender equality and women empowerment. When there is a sick member in the family it is always the women who have to abandon other engagements to take care of the sick thereby losing several hours that could have been used in gainful work. Eradication of parasitic diseases such as malaria will give women more opportunities to put in their best. The time they will spend in taking care of the sick especially children will be saved for useful work. When women are empowered it will reduce maternal and child mortality and also improve the welfare of the entire family including prevention of parasitic diseases.

5.1.4 REDUCE CHILD MORTALITY

Reduce by 2/3, between 1990 and 2015, the under five mortality rate. Malaria is one of the leading causes of mortality of children between 0 and 5 years.

Over I million children under five years die of malaria annually in Africa. Death rate due to other parasitic diseases in children may not be as high as that due to malaria but nonetheless important. Diarrhea due to Giardiasis, hepatic amoebiasis, toxoplasmosis acquired in utero are other silent killers of children. The Niger State Government is presently providing free medical care for children under 5 years and to pregnant women. This is in the right direction and highly commendable.

5.1.5 IMPROVE MATERNAL HEALTH

Malaria is a serious threat to life for pregnant women. Anaemia in pregnancy is a major cause of maternal death. Anti-malarial drugs have to be evaluated for their safety for use on pregnant women. Hook worm infections are also life threatening to both the foetus and the mother. Parasitic infections including malaria, Hook worms infections and, Schistosomiasis affects negatively the reproductive capacity of women.

5.1.6 COMBAT HIV / AIDS, MALARIA AND OTHER DISEASES

To halt by 2015 and begin to reverse the incidence of malaria and other major diseases. This will be a major revolution in health and wealth for developing countries.

In addition to malaria, Government should seriously look into the control of River Blindness, Schistosomiasis and intestinal parasitic infections.

5.1.7 ENSURE ENVIRONMENTAL SUSTAINABILITY

Halve by 2015 the proportion of people without sustainable access to safe drinking water, and basic sanitation. Lack of adequate water supply promotes a number of parasitic diseases such as Guinea worm, Amoebiasis, Giardiasis, *Cryptosporidium* infection and other intestinal parasitic infections. Provision of safe drinking water will significantly reduce the burden of parasitic disease thereby improving the well being of man.

Poor sanitation accounts for the spread of parasitic infections. Absence or inadequate toilet facilities, stagnant bodies of water that support the breeding of mosquito vectors abound in our environments. (Water could collect in old tyres. (Fig. 18) to as breading site for mosquitoes. Other sources of stagnant water are tubes, coconut shells, broken pots, discarded containers and damaged septic tanks.

Fig 18: Pile of old tyres that could serve as breeding sites for mosquitoes

5.1.8 DEVELOP GLOBAL PARTNERSHIP FOR DEVELOPMENT

The gains through partnership will make meaningful development if our Society is free from parasitic diseases. The money gained would be used for food production And other developments rather than in the treatment of diseases.

6.0 CHALLENGES FOR THE CONTROL OF PARASITIC INFECTIONS TOWARDS THE ATTAINMENT OF THE MILLENNIUM DEVELOPMENT GOALS

6.1 WHAT GOVERNMENTS SHOULD DO

1. Provision of safe drinking water to all communities through partnership with non-Governmental organizations, International bodiesand private individuals.

2. De-worming of school children. Through public private partnership Government should periodically de-worm primary school pupils.

3. Enforce sanitation and public health laws. Government should make it mandatory the provision of toilet facilities in every house hold even in the rural areas and penalize households that fail to keep up to public health standards.

4. Provide Insecticide Treated Nets (ITN) at subsidized cost and mount campaigns for its usage.

5. Support Research into the control and eradication of parasitic diseases by providing specific scholarship for training in *Parasitology* and Entomology as well as discovery of new drugs for the treatment of parasitic diseases (including the use of medicinal herbs).

6. Health Education: Governments should use available sources of communication to educate people on transmission, dangers and control measures of parasitic diseases. Pamphlets / booklets containing *Dos and Don'ts* of public health should be produced and given out to households.

(Fig. 19). Children walking through the water, unaware of Schistosomes

A men washing, unaware of Schistosomes

Fig 19: Unsuspected victims of Schistosomiasis

- Adequate toilet facilities.

- Have adequate water supply for sanitation.

- Clear bushes around houses.

- Avoid walking bare footed especially during raining season.

- Adequate disposal of animal faeces.

- Ensure domestic animals are examined and treated by veterinarian.

2. Employ insecticide as in ITN or residual insecticide.
   - Avoid stagnant water near your houses.

   - Educate members of your household on how parasitic diseases are transmitted and measures to control them.

3. Be quick in seeking medical attention when a member of the family is sick.
   - Health is wealth therefore spend to keep your family healthy.

4. Have adequate feeding to help your body fight parasites and minimize effect of parasitic infections.

7.0 WHAT NEXT?

1. Adequate information on the situation of parasitic infections in Niger State is not available.

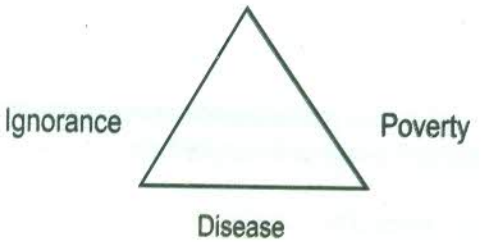
2. The Universities in the country should know the prevailing parasitic infections in its immediate neighborhood. This is lacking.

3. There is need for Niger State to have adequate data on the major parasitic diseases – Malaria River blindness, Schistosomiasis and Trypanosomiasis.

4. The Department of Geography through GIS should work together with Microbiology, Chemistry and Biological Sciences to predict the burden and out - break of parasitic infections.

5. The University needs a parasitic Disease Research Laboratory or a more encompassing infectious disease research laboratory.

8.0 CONCLUSION



No Society can cope with this enigma. Where you find a member of this triangle you will find the other two. It is likened to pelvic inflammatory Disease (PID) in women.

Breaking the contact between man and the Parasites is simple and achievable. It only requires commitment, health education and provision of basic facilities which can be attained through collaboration between Governments, the Public, and the Private Sector.

Let us fight the parasites that we may enjoy life and live long.

ACKNOWLEDGMENT

To the Almighty God, the creator and sustainer of life I give all the credit for whatever good things have come to me and have been achieved through me. *"For whom he did foreknow, he also did predestinate to be conformed to the image of His Son, that he might be the first born among many brethren* (Romans 8: 29) My earnest desire and prayer is that for all you have done for me may I not forget and may I not depart from the righteous way. Let not truth and mercy forsake me.

To the Galadimas (Grand pas, Grand Mas, Uncles, Daddy, Mummy, Brothers, Sisters, Sons and daughters) I can not thank you enough for what God did to me through you. For those who have departed to the great beyond, may the merciful Lord continue to grant you eternal rest. Rest in perfect peace. For those of you who are still alive, take my words that I will never forget you and will do my best to appreciate your love. May the Almighty God make your years on this planet peaceful and blessed. I will strive to portray the good name for which the Galadima family is known.

I appreciate all my teachers from 1964 to date. There is no place to put down all your names. I will mention just a few as points of contact. I am grateful to the missionaries for their love for God and for humanity. Without your generosity and magnanimity people like me will be no where. I say thank you to my Christian Religious Instruction (CRI) class teacher Mr. Dogara Kumba.

I cannot thank enough My Late Headmaster Mr. Makun Ojengbede and his wife, Mrs. Lami Makun. You took me as your son and as one of your favorite children. I also acknowledge the lesson I learnt from Captain (Rtd.) James Baitachi, Member, Federal House of Representatives.

Rev. Fr. J. D. O'Connell, if other missionaries were like you, this earth would have been a paradise. You are entirely a reflection of Christ in love, compassion, sacrifice, and devotion. God brought you as an apostle to Minna Emirate to lift the moral and social standard of our people. There is no material on this earth that can be used to reward you for your goodness. Surely your reward is in Heaven. May our heavenly Father sustain your health and bless you for the remaining days you have on earth.
To my other teachers in the Secondary School (Fatima Secondary School now

Government Secondary School, Minna, 1969-1973) Dr. Jacob Kolo, Bishop (Prof.) C. S. S. Bello, Sister Jane, Fr. Fulton, Mr. Patrick Adamu, Dr. Peter Sarki, Justice Auta, Mrs. Agbola (Anti Lade"), Prof. J. B. Ameh and others that can not be mentioned, I say thank you for giving me the foundation I needed.

I also wish to thank my Teachers at the School of Basic Studies (A.B.U., Zaria 1974-1975) such as Prof. A. A. Oladimeji, Prof. Sam Ale, Dr. B. E. N. Dauda, late Prof. J. Adeniyi, Dr. Abdulrahman, Prof. N. Gomwalk, Dr. (Miss) Dikko, Prof. Ekanem, for preparing me for University academic life. I learnt Microbiology from the table of those that can be regarded as the fathers of Microbiology in Nigeria – Prof. S. O. Emejuaiwe, late Prof. L. J. Egler, Prof. P. Ado (late), Prof. A. A. Ahmad, Dr. Okagbue, and Prof. A. Olayemi. I wish to acknowledge my other teachers at the University level: Prof. M. A. Olatunji. Late Prof. J. Abalaka, Prof. G. Ogbadu, Prof. M. Hallaway, Prof. G. S. Harrison, Prof. S. Okecha, Prof. B. J. Harris, and Dr. S. Muazu just to name a few. Most especially I want to acknowledge the people who taught me how to do research, namely Dr. (Mrs.) A. M. Porebska, Prof. S. O. Emejuaiwe and Prof. C. G. Vajime.

I thank my colleagues of the Department of Microbiolgoy (A.B.U. Zaria) Prof. J. B. Ameh, Prof. V. J. Umoh, Prof. A. A. Ahmad, Dr. S. Olonitola, Dr. S. E. Yakubu, Dr. (Mrs.) H. Inabo, Dr. S. Ado, Dr. I. O. Abdullahi, Dr. E. D. Jatau, Mr. Machido Dauda, Prof. J. D. Dada, Prof. Mrs. L Ogbadu and Prof. (Mrs.) L. E. Odama. I warmly acknowledge my research team members, Prof I. H. Nock and Dr. S. Ibrahim of Biological Sciences and Biochemistry Department respectively. I wish to thank all my colleagues in my present Department of Microbiology (F.U.T. Minna). They are very pleasant people to work with. I appreciate the elders in the School of Science and Science Education, all the Professors, Heads of Department, Lecturers and Students I thank the secretarial staff of the Dean's office led by Mal. N. Babaniya; you have been vary kind, supportive and dedicated. May God reward you abundantly. I am most grateful to Mrs. H. M. Babatunde and Mrs. B. T. Akande who typed this lecture piece.

I deeply appreciate the Successive Administrations of ABU Zaria (1982-2005) and those of FUT Minna (2005-date) for the opportunity given me to serve as a lecturer in these great institutions of leaning. I thank the former Vice-Chancellors of FUT Minna in the person of Prof. S. A Garba, Prof. M. Daniyan and Prof. T. Sa'ad and Prof. M. S. Audu for the period of my sabbatical leave and my current appointment. I

wish to particularly appreciate the current Vice-Chancellor Prof. M. S. Audu for his support and advices. Working with Prof. M. S. Audu has giving me a lot of impetus particular his push for all academic staff to be ICT compliant. 1 also want to appreciate the love of old friends and colleagues, Prof. T. Z. Adama (former DVC) Mal. M. D. Usman (Registrar) Prof. S. Lamai (Dean, PG School) and Dr. Bolaji Adeniji for your love and encouragement.

I wish to acknowledge my past postgraduate students who faithfully carried our research assignment. This has contributed in achieving my research objectives; they include Dr. (Mrs.) H. Inabo (ABU Zaria), Prof. S. Olonitola (HOD Microbiology ABU Zaria), Prof. G. Sharubutu (UDUS Sokoto), Prof. Adamu Tukur (UDUS Sokoto) Dr. Bala Manga (UDUS Sokoto) Mr. Atu Bernard (BENSU, Makurdi), Mr. A. Opaluwa (ABUTH, Zaria) Mr. H. Osue (NITOR, Kaduna) and Mr. Yakubu Nale (UK).

I thank the National Institute for Trypanosomiasis and onchocerciasis Research (NITOR) for some of the Photographs.

Behind every successful man is a woman. I acknowledge the truth in the word of God- "and God saw that it was not good for a man to be alone and God made for him a helpmate suitable for him" (Gen. 2:18). Thanks be to God for my wife, Joyce Hajara Galadima for the support, prayers and love; it is not good to be alone, especially after a hard day's work. May the good Lord continue to uphold you and give you long live and joy. The faith of **Joshua** and **Caleb** lead the Israelites to the promised land and eventually the **Grace** of God to mankind. Thanks be to God for you three. You will live your fullness of years and take the battle to the camp and door steps of the enemy.

The Chief Servant of Niger State, the most Pragmatic Governor this country ever had, I acknowledge you for inspiring and encouraging me to present this Inaugural lecture. I have tried to talk on something that touches your heart which is development and improvement of the life of the people. I hope that this very little presentation will assure you that FUT Minna can partner with you towards the Development of Niger State. Keep moving in the right direction being conscious of the fact that hereafter we all shall give account of our stewardship to the Almighty. "Fyashe wo bma ho zhi". Amin. I love you.

I thank God for the vision of Sir, Ahmadu Bello the Saradauna of Sokoto for the

vision to have a University for the North (A.B.U. Zaria). May our present leaders emulate his selfless service and not to waste our resources on contracts that are never executed. I am grateful to the Governments of Northwestern State and Niger State for the Scholarship I enjoyed (1974-1982) for my undergraduate and master degree programmes. May I appeal to Niger State Government that there are still millions of Nigerlite who are indigent as me and cannot pay their Remedial and Undergraduate fees. Keep the scholarship programme alive. May be through it will come a scientist who will produce a highly protective vaccine against malaria or a wonder drug with multiple efficacy against the parasites.

My spiritual fathers have been very wonderful and source of faith in God when things looked hard and insurmountable. I thank you all – Rev. Fr J. D. O'Connell, Rev. Agai, Rev. Musa Dada, Pastor S. Oyekale, Rev. G. Na' Allah, Rev. Hamman, Rev. J. Reni, Rev. Ahmadu and all ministers of the Gospel that have ministered to me in one way or the other. When the Battle is over we shall be more than conquerors.

I must acknowledge the fellowship of the Saints at Salama Baptist Church, Pyata, Sihiyona Baptist Church, Minna, Shiyona Baptist Church Samaru, Zaria and Victory Baptist Church, Minna. I am grateful to you all. The men and women who distribute God's word, the Gideon's International, Zaria North Camp and Minna North Camp, I appreciate your love. What I missed most apart from Microbiology in Zaria is the Gideon Fellowship.

I am very grateful to the Royal Fathers; HRH Alhaji (Dr.) Umar Farouk Bahago (CON) Emir of Minna for his encouragement and open door policy. May your enemy not succeed you and may your reign be memorable and uninterrupted. May the principle of de defunct Gwari Federation/Gwari Native Authority which is Love, Justice and Unity continue to be your watchwords.

I thank my father, Mal. Musa Abubakar the District Head of Bosso for his fatherly guide, truthfulness and firmness. I also appreciate the role that Mal. Ibrahim Lolo, the Dakacin Bosso has played in my life in these years of being on the throne. The young Fya Pyatai, the barrister, Mal. Ibrahim Umar, my ward head, I thank you and may God uphold you on the throne to guide the Pyatas aright.

Finally to all that meet me with greetings and smiles and those yet to do so, as I walk on this planet I say seeing your faces tells me there is God and I thank God for you.

Without the parasites there will be no parasitologist (including Musa Galadima) so I thank God for creating the parasites.

PARASITOLOGICAL PRAYER

Since it was not the intention of God to create dangerous parasites to kill man but that man may prosper even in good health, so the war against parasites is according to God's will so that we may have *"mens sana in corpore sano"*. While you may not avoid the bite of mosquitoes may they not be those that are infected; may the Water be free from *Dracunculus*, Amoebae, *Giardia, Cryptosporidium* and the schistosomes. May you enjoy fruits and vegetables free from parasite eggs and cysts. May the meat and fish you eat be free of parasite larvae and cysts. May your eyesight not grow deem due to onchocerciasis and be free forever from soil transmitted helmiths. Amen.

Thanks to you all.

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