UNIVERSITY OF PORT HARCOURT

PARASITE VS HOST: A CAT AND MOUSE GAME

An Inaugural Lecture

By

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cautious driving that have seen us safe on different roads under the ever watchful love of the Almighty Father.

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In unique University of Port Harcourt I am still standing on one leg as the proverbial new chicken but hope to put the other firmly down after this exercise. I have however enjoyed enveloping warmth from my colleagues in the College of Natural and Applied Sciences from the days of my sabbatical leave in 2010 till date. I use the Provost of the College, Professor Nnenna Frank-Peterside, Professor Ben Ndukwu (our paths crossed before now), Dean Faculty of Biological Sciences and Professor Aduabobo Hart, former Head Department of Animal and Environmental Biology and current Associate Dean, Biological Sciences as points of contact to convey my appreciation of their embracing welcome.

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The President of University of Port Harcourt Women's Association (UPWA), Mrs. Mercy Ajienka and all members of UPWA are appreciated for allowing me easy assimilation to work among them. I appreciate your goodwill. I am also grateful to the Principal Officers of the University, Prof. A.I. Joe, Mrs. Matilda Nnodim, Mr. Vitalis Aliezi and Dr. Obiageli Nwodo for their enveloping warmth.

I thank the 7th Vice-Chancellor of University of Port Harcourt, Professor Joseph Ajienka, an erudite scholar and brain box of ideas, my special friend for permitting my return to Uniport to be where my heart is, at the side of my husband. The thoughts and words took on form long ago and we only stood in fulfillment. Also thank you for approving that I give this lecture and making invaluable inputs to the draft.

We normally save the best for the last and my nuclear family occupies this eminent position. They are the soul of this journey and formed the solid pillars of the structure. My children, Barrister Ogadinma Enyioma, Pharm. Izuchika Onyinyenna, Uzoamaka Chigoziri (First Class Economics Graduate and Central Bank Scholar) and the baby Chiamaka Chinweoke are my joy and pride. Thank you for the sacrifices and encouragements. You are my fan base and I am grateful that we are friends. My husband's vision

stood him out and his inward security and confidence allowed him take the step many of his peers dreaded, marrying a Ph.D holder. He has long been vindicated as a visionary because spousal Ph.D is now trending. Professor Ethelbert Chinaka Nduka, my husband has been with me each step of the way as my most ardent supporter and best friend and I say a million thanks for being there. You are deeply loved and appreciated for diligent encouragement, non-stifling partnership and equal opportunity tenet. You are a worthy example.

All honour, all glory and deepest gratitude belong only to the Almighty Father, Creator of all the Worlds for His infinite Mercy and Grace without which nothing would have been celebrated.

PREAMBLE

Humans are hosts to nearly 300 species of parasitic worms and over 70 species of protozoa. Some of these parasites are derived from "primate ancestors" and others gotten from close contact or association with domestic animals over time. A small proportion of these arrays of parasites are responsible for some of the most important diseases in the world that have received the most attention. Evidence shows that most of these parasitic diseases occur mainly in the tropics, and the field of Parasitology has tended to overlap with that of Tropical Medicine, and thus the histories of these two fields are intertwined. The understanding of parasites and parasitic infections cannot be separated from the knowledge of the history of the human race. In particular, the spread and present distribution of many parasites throughout the world has largely been the result of human activities, and the advent of AIDS has added a new chapter to the history of Parasitology (Cox, 2002). It is thought that about 150,000 years ago, *Homo sapiens* emerged in eastern Africa (Tishkoff, et al., 2001) and spread throughout the world, possibly in several waves (Templeton, 2002), until 15,000 years ago at the end of the Ice Age, humans had migrated to and inhabited virtually the whole of the face of the Earth, bringing some parasites with them and collecting others on the way. Cox (2002) classified the parasites that infect humans as heirlooms or souvenirs. Heirlooms are the parasites inherited from primate ancestors in Africa, and souvenirs are those that have been acquired from the animals with which humans have come in contact during the course of evolution, migrations, and agricultural practices. The development of settlements and cities facilitated the transmission of infections between humans, and the opening up of trade routes resulted in the wider dissemination of parasitic infections. The slave trade, which flourished for three and a half centuries from about 1500, brought new parasites to the New World from the Old World (Desportes et al., 1985).

The knowledge of parasitic infections extends into antiquity, and descriptions of parasites and parasitic infections are found in the earliest writings and have been confirmed by the discoveries of parasites in archaeological material. The first written records of what are almost certainly parasitic infections come from a period of Egyptian medicine from 3000 to 400 BC, particularly the Ebers papyrus of 1500 BC discovered at Thebes (Bryan, 1930), which referred to intestinal worms. These records were later confirmed by the discovery of calcified helminth eggs in mummies dating from 1200 BC. Later many detailed descriptions of various diseases that might or might not be caused by parasites, specifically fevers were seen in the writings of Greek physicians between 800 to 300 BC, and from physicians from other civilizations including China from 3000 to 300 BC, India from 2500 to 200 BC, Rome from 700 BC to 400 AD, and the Arab Empire in the latter part of the first millennium. The Greeks, particularly Hippocrates (460 to 375 BC) (Jones and Whithington, 1948-1953), knew about worms from fishes, domesticated animals, and humans. Roman physicians including Celsus (25 BC to AD 50) (Spencer, 1948) and Galen (Galenus of Pergamon, AD 129 to 200) were familiar with the human roundworms *Ascaris lumbricoides* and *Enterobius vermicularis* and tapeworms belonging to the genus *Taenia.* Somewhat later, Paulus Aegineta (AD 625 to 690) clearly described *Ascaris, Enterobius,* and tapeworms and gave good clinical descriptions of the infections they caused (Grove, 1990).

Following the decline of the Roman Empire, the study of medicine switched to Arabic physicians. The descriptions of infections became more accurate and Arabic physicians, particularly Rhazes (AD 850 to 923) and Avicenna (AD 980 to 1037) wrote important medical works that contained a great deal of information about diseases clearly caused by parasites (Cox, 2002). Avicenna recognized not only *Ascaris, Enterobius,* and tapeworms but also the guinea worm, *Dracunculus medinensis,* which had been recorded in parts of the Arab world, particularly around the Red Sea, for over 1,000 years. The science of helminthology really took off in the 17th and 18th centuries following the reemergence of science and scholarship during the Renaissance period. Linnaeus described and named six helminth worms, *Ascaris lumbricoides, Ascaris vermicularis* (= *Enterobius vermicularis*), *Gordius medinensis* (=

Dracunculus medinensis), *Fasciola hepatica, Taenia solium,* and *Taenia lata* (= *Diphyllobothrium latum*) (Linnaeus, 1758).

It was not possible until the invention of the microscope and its use by Antonie van Leeuwenhoek toward the end of the 17th century, to recognize any protozoa due to their small size. The study of parasitic protozoa only really began two centuries later, following the discovery of bacteria and the promulgation of the germ theory by Pasteur and his colleagues at the end of the 19th century. History of Malaria which is a protozoon extends into antiquity. It is now generally held that malaria arose in the primate ancestors in Africa and evolved with humans, spreading with human migrations first throughout the tropics, subtropics, and temperate regions of the Old World and then to the New World with explorers, missionaries, and slaves (Cox, 2002).

The characteristic periodic fevers of malaria were recorded from every civilized society from China in 2700 BC through the writings of Greek, Roman, Assyrian, Indian, Arabic, and European physicians up to the 19th century. The earliest detailed accounts are those of Hippocrates in the 5th century BC, and thereafter there are increasing numbers of references to the disease in Greece and Italy and throughout the Roman Empire as its occurrence became commonplace in Europe and elsewhere. Over this period, it became clear that malaria was associated with marshes, and there were many ingenious explanations to explain the disease in terms of the miasmas rising from the swamps (Harrison, 1978).

Scientific understanding of malaria did not begin until the end of the 19th century following the establishment of the germ theory and the birth of microbiology, when it became necessary to discover the cause of the disease that was then threatening many parts of the European empires. The discovery of the malaria parasite and its mode of transmission are among the most exciting events in the history of infectious diseases, and this topic has been reviewed many times, particularly by Bruce-Chwatt (1988), Garnham (1966), Harrison (1978), McGregor (1996).

The systematic study of parasites was born with the rejection of the theory of spontaneous generation and the promulgation of the germ theory by Louis Pasteur, who demonstrated that diseases could be caused by bacteria. The discovery of viruses by Pierre-Paul Emile Roux, the introduction by Robert Koch of methods of preventing diseases caused by microorganisms, and the incrimination by Patrick Manson of vectors in the transmission of parasites broke the boundaries of the study of parasites. The names of Pasteur, Koch, Roux, and Manson occur time and time again in the history of Parasitology and microbiology. Thereafter, the history of human Parasitology proceeded along two lines, the discovery of a parasite and its subsequent association with disease and the recognition of a disease and the subsequent discovery that it was caused by a parasite (Cox, 2002).

The history of parasitology is a fascinating one, and parasites have been the subjects of some of the most exciting discoveries in the field of infectious diseases. It is known that many of the important parasites seen today existed and were widespread in their distribution before written records began, and our early ancestors must have been aware of the presence of the largest and most common worms and of some of the diseases caused by parasites. The subsequent history of human Parasitology revolved around early descriptions of a particular disease and the identification of the parasite causing the disease, not necessarily in this order; the elaboration of the life cycle; and, finally, the establishment of the causal relationship between the parasite and the disease.

Mr. Vice-Chancellor, this fascination captured me in my 3rd year as a Zoology student and held me ever since as I followed the tenacious journey of survival of these organisms in the hosts.

INTRODUCTION

Mr. Vice-Chancellor Sir, a parasite is single cell or multi-cellular living organism that lives on or in another organism, the host. Parasites are defined as organisms that are metabolically dependent on another, the host. Metabolic dependence refers to the parasite's ability to obtain nutrients, shelter and transport. The parasite's demand on this environment is the same for man, comfortable accommodation and good food, the chance to raise a family and enjoy the company of good friends.

The harmful effects elicited by their presence are often over-emphasized but that's not the goal of parasitism which is that of survival and perpetuation of species. The host also as a living organism wants to operate within its own ambit without hindrance and exploitation and responds by attempts to reject this foreigner. It deploys varied means to resist and reject this intrusion. In this quest to forcefully eject the parasite the host often behaves like an aggressive landlord faced with a stubborn tenant and at times extreme measures are needed to accomplish the task. These measures not only remove the tenant but cause harm to the landlord and his structure.

This task of resistance and ejection by the host and the parasite's insistence on survival constitute the game which is likened to cat and mouse and a deadly one at that. There is no love lost between the two and efforts in this game are geared toward gaining the upper hand. The host wants to be left alone and uses different responses, indigenous and external to rid itself of the presence of the unwanted guest. The parasite has also over time evolved strategies to ensure survival and keep one step ahead of the host. When the parasite gains the upper hand, infections are established often with characteristic symptoms to the discomfort of the host.

One cannot help being fascinated by the level of intelligence exhibited by these often minute organisms to ensure survival. A whole vista of study opened up around them, the field of Parasitology with sub-specializations. That is in the bid to understand these organisms and help turn the tide of the game in favour of the host which ranges from domestic, wild and cultured animals to plants and humans. Parasites exploit all these environments maximally to remain afloat and in existence.

Other microorganisms such as viruses and bacteria maybe classified as parasites in a broader sense however they are studied under Microbiology with sub specializations of Virology, Bacteriology etc. Given the current episode of the Ebola Virus it may be necessary to make a distinction between a virus and the parasites that are to be discussed.

A virus (from the Latin *virus* meaning toxin or poison) is a microscopic organism consisting of genetic material (RNA or DNA) surrounded by a protein, lipid (fat), or glycoprotein coat. Some microbiologists classify viruses as microorganisms, while others don't because they are "nonliving" and describe viruses as microscopic infective agents. Viruses are unique microorganisms because they cannot reproduce without a host cell. After contacting a host cell, a virus will insert genetic material into the host and take over that host's functions. The cell, now infected, continues to reproduce, but it reproduces more viral protein and genetic material instead of its usual products. It is this process that earns viruses the classification of "parasite" (Mandal, 2014).
A virion (virus particle) has three main parts:

1. Nucleic acid – this is the core of the virus with the DNA or RNA (deoxyribonucleic acid and ribonucleic acid respectively). The DNA or RNA holds all of the information for the virus and that makes it unique and helps it multiply.
2. Protein Coat (capsid) – This is the protective covering over the nucleic acid.
3. Lipid membrane (envelope) – this covers the capsid. Many viruses do not have this envelope and are called naked viruses (Mandal, 2014).

Natural Associations

Parasitism is often said to be different from other natural associations such as mutualism, phoresis and commensalism. Current views however suggest that they are all forms of **Symbiosis** or living together only the nature of the interactions between the participants differentiates (Schmidt *et al*., 2009).

Mutualism is a relationship which benefits both associating organisms, while **Phoresis** refers to two organisms that are merely travelling together with no physiological or biochemical dependence. **Commensalism** represents eating at the same table and only one of the associating organism benefits without harm to the other. **Parasitism** on the other hand reflects a relationship where one organism lives at the expense of the other. **Parasitism** is an ecological relationship where interaction between the organisms depends on biotic and abiotic factors such as temperature, humidity, moisture, etc.

Why study Parasite-Host Interplay

One may wonder why the study of parasites is of interest and why the massive investment in research.

It is important to note that six of the major diseases being tackled relentlessly over many decades by WHO are parasitic. These include Malaria, Leishamiasis, Trypanosomiasis, Schistosomiasis, Onchocerciasis and Filariasis. The others, HIV/AIDS and Tuberculosis are also caused by microscopic organisms which are parasites in a broad definition. These infections thrive in the tropics and sub- tropical regions of the world where environmental conditions, especially temperature and moisture favor their transmission. Some factors common in developing countries promote increased spread and establishment of these infections. The factors include: Favorable climatic conditions such as temperature, relative humidity and rainfall, occurrence of diverse animals that serve as hosts, poverty, ignorance, poor infrastructure, inappropriate lifestyles and poor sanitary conditions (Otubanjo, 2010).

The burden of parasitic infections has been economically estimated to cost millions of dollars yearly as captured in estimation of Disability-Adjusted Life Years (DALYs) which is quantifying the burden of parasitic disease in terms of morbidity and mortality and the global efforts at controlling these infections. WHO (2013) explained that one DALY can be thought of as one lost year of "healthy" life. The sum of these DALYs across the population, or the burden of disease, is a measurement of the gap between current health status and an ideal health situation where the entire population lives to an advanced age, free of disease and disability. DALYs for a disease or health condition are calculated as the sum of the Years of Life Lost (YLL) due to premature mortality in the population and the Years Lost due to Disability (YLD) for incident cases of the health condition. The calculation is obtained from the addition of YLL and YLD thus: DALY= YLL + YLD. It has been estimated that 25-28 million DALYs are lost due to Schistosomiasis while Malaria accounts for 35 million DALYs (King, 2010).

Two major parasites, *Plasmodium* (the malaria parasite) and *Schistosoma* have captured my attention over the 26 years of my academic career and provided the platform from which I have watched and participated in the game. Their fact sheets will give an idea of the problems they present and why many hands are on deck to extend the frontiers of knowledge.

Malaria (from Italian words, ‘mal’-- bad and ‘aria’—air) is an entirely preventable and treatable mosquito-borne illness caused by the Protozoa Parasite *Plasmodium* Species. Four major species affect man namely: *P. falciparum, P. malariae, P. ovale*, and *P. vivax*. A fifth specie has been acknowledged, *P. knowelsi* which is originally a parasite of monkeys. Charles Louis Alphonse Laveran, a French army surgeon stationed in Constantine, Algeria, was the first to notice parasites in the blood of a patient suffering from malaria on 6th, November 1880. Laveran was awarded the Nobel Prize in 1907 for his discovery. On August 20th, 1897, Ronald Ross, a British officer in the Indian Medical Service, was the first to demonstrate that malaria parasites could be transmitted from infected patients to mosquitoes and from infected mosquitoes to humans. This earned him the Nobel Prize in 1902 (CDC, 2015a).

Malaria has been indicted in wars as a cause of more losses and considered a problem for soldiers. Reed (2015) reported that Roman legions had to contend with malaria, so did George Washington's troops, Civil War battles in USA were won and lost because of it and malaria was a huge problem in the South Pacific during World War

II. General Douglas MacArthur a highly decorated United States General had a famous quote on malaria during the Second World War:

> *"Doctor it's going to be a very long war if for every division I have facing the enemy, I have one sick in hospital from malaria and another recovering from this dreadful disease Malaria. Malaria is a troop-waster."*

It is recorded that the U.S. military counted more than a half-million cases of malaria during World War II (Reed, 2015). Many think we owe our independence and indeed that of other endemic African countries to the Anopheles mosquito and the malaria parasite.

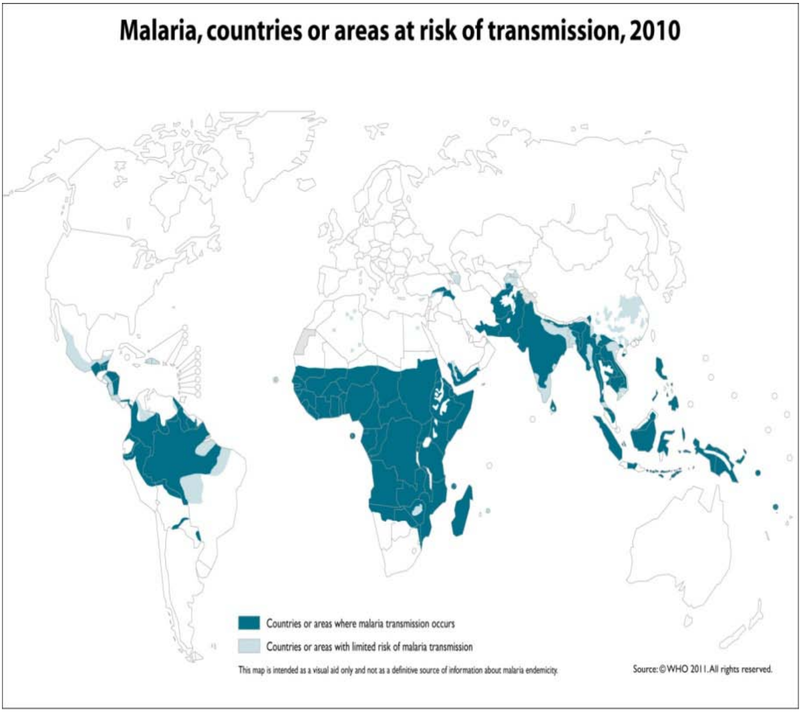
Malaria is a disease of global concern and since 2007, a day was set aside April, 25th, as World Malaria Day. The theme for 2013, 2014 and 2015 has been and still is "Invest in the future: Defeat Malaria", a clarion call to all to support the ongoing efforts to eradicate this infection.

The malaria parasite is transmitted through the bite of the female *Anopheles* mosquito. The following fact sheet is presented in WHO (2014a) World Malaria Report and highlights the burden of this infection.

1. 97 countries and territories have ongoing malaria transmission.
2. An estimated 3.2 billion people are at risk of malaria, with about 1.2 billion at high risk. In high-risk areas, more than one malaria case occurs per 1000 population.
3. There were an estimated 198 million cases of malaria worldwide (range 124–283 million) in 2013, and an estimated 584 000 deaths (range 367 000–755 000). 90% of all malaria deaths occurred in Africa.
4. In 2013, an estimated 437 000 African children died before their fifth birthday due to malaria. Globally, the disease caused an estimated 453 000 under-five deaths in 2013.

5. Between 2000 and 2013, an expansion of malaria interventions helped to reduce malaria incidence by 30% globally, and by 34% in Africa.
6. During the same period, malaria mortality rates decreased by an estimated 47% worldwide and by 54% in Africa. In the under-five age group, mortality rates have declined by 53% globally, and by 58% in Africa.
7. New analysis revealed that the prevalence of malaria parasite infection (including both symptomatic and asymptomatic infections) decreased significantly in Africa since 2000. The number of people infected fell from 173 million in 2000 to 128 million in 2013 – a reduction of 26%. This occurred despite a 43% increase in the African population living in malaria transmission areas.
8. The six highest burden countries in the WHO African region (in order of estimated number of cases) are: Nigeria, Democratic Republic of the Congo, United Republic of Tanzania, Uganda, Mozambique and Cote d'Ivoire. These six countries accounted for an estimated 103 million (or 47%) of malaria cases.
9. The malaria burden is concentrated in 14 endemic countries, which account for an estimated 80% of malaria deaths. The Democratic Republic of the Congo and Nigeria are the most affected countries in sub-Saharan Africa, while India is the most affected country in South-East Asia.

Malaria is a risk to 97% of Nigeria's population. The remaining 3% of the population live in the malaria-free highlands. There are an estimated 100 million malaria cases with over 300,000 deaths per year in Nigeria, (equivalent to 2000 plane crashes a year at 150 passengers per airplane; what a frightening situation!).This compares with 215,000 HIV/AIDS deaths annually. Malaria contributes to an estimated 11% of maternal mortality. Malaria accounts for 60% of outpatient visits and 30% of hospitalizations among children under five years of age, 30% of childhood deaths, 25% of deaths under one year and 11% of maternal deaths in Nigeria (Nigeria Malaria Fact Sheet 2011). The maps of endemic countries and mortality rates for Malaria are shown in Figures 1, 2 and 3.



The boundaries and names shown and the designations used on this map do not imply the expression of any opinion whatsoever on the part of the World Health Organization concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. Dotted lines on maps represent approximate border lines for which there may not yet be full agreement.

World Health Organization

Plate: 1 Malaria Endemic Countries

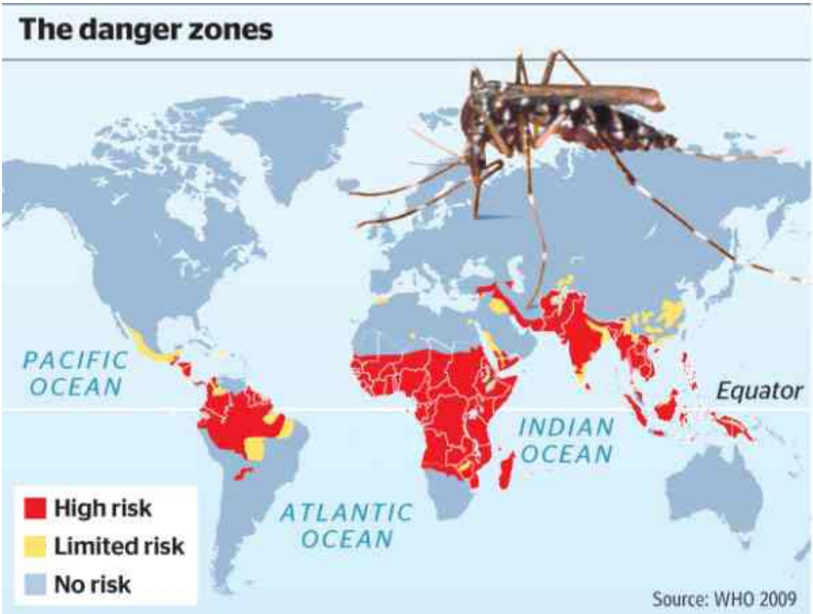


Plate 2: Malaria High Risk Areas.

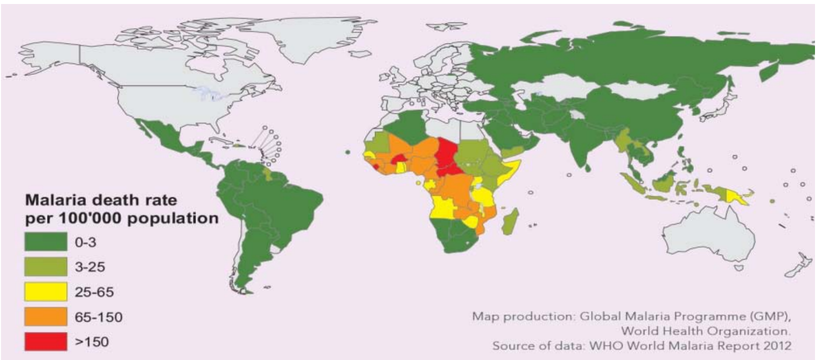


Plate 3: Malaria Mortality Rate

Schistosomiasis Fact Sheet indicates it is a widespread blood fluke infection transmitted by freshwater snails and caused mainly by the parasites Schistosoma mansoni and S. haematobium. It affects almost 300 million people worldwide. The first definitive record of this infection was thought to be that of an epidemic among soldiers in Napoleon's army in Egypt in 1798 by a French army surgeon, A. J. Renoult, who wrote that “A most stubborn haematuria manifested itself amongst the soldiers of the French army… continual and very abundant sweats diminished quantity of urine…becoming thick and bloody” (Cox, 2002). Thereafter there are numerous reports of illnesses characterized by hematuria (blood in urine), particularly among armies including those involved in the Boer War (1899 to 1902). The worm *S. haematobium* was described by the German parasitologists Theodor Bilharz and Carl Theodor Ernst von Siebold in 1851.

The following information can be gleaned from the fact sheet presented by WHO, (2014b).

1. At least 249 million people required preventive treatment for Schistosomiasis in 2012.
2. An estimated 42.1 million people were treated for Schistosomiasis in 2012.
3. Nigeria is the most endemic country for Schistosomiasis, with approximately 20 million people, mostly children needing treatment.
4. People are infected during routine agricultural, domestic, occupational and recreational activities which expose them to infested water.
5. Lack of hygiene and certain play habits of school-aged children such as swimming or fishing in infested water make them especially vulnerable to infection. Children living and playing near infested water are particularly vulnerable to this disease which causes anaemia and reduced ability to learn.
6. Schistosomiasis control focuses on reducing disease through periodic, large-scale population treatment with praziquantel; a more comprehensive approach including potable water, adequate sanitation and snail control would also reduce transmission (WHO, 2014b). A map of endemic countries is shown in Plate 4.

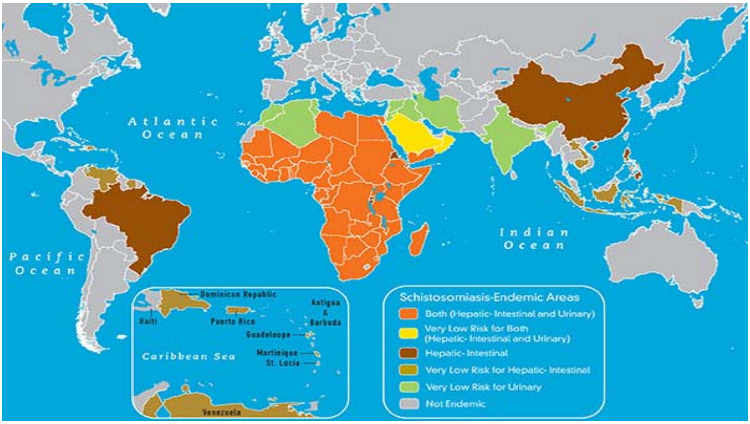


Plate 4: Schistosomiasis Endemic Countries Source: WHO (2014b)

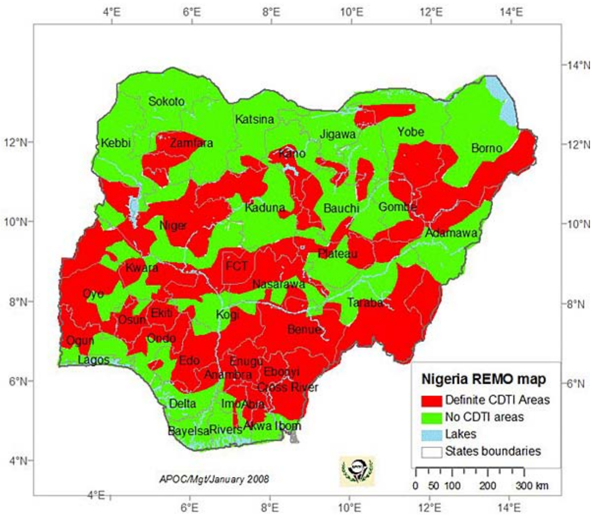


Plate 5: Nigerian Onchocerciasis Map

Another parasitic infection of note Onchocerciasis, commonly called River Blindness and caused by a filarial worm *Onchocerca volvulus* is also endemic in African Sub-Sahara region. It is transmitted through repeated bites by blackflies of the genus *Simulium*. The disease is called River Blindness because the blackfly that transmits the infection lives and breeds near fast-flowing streams and rivers and the infection can result in blindness. In addition to visual impairment or blindness, onchocerciasis causes skin disease, including nodules under the skin or debilitating itching. Worldwide onchocerciasis is second only to trachoma as an infectious cause of blindness (CDC, 2015b). The World Health Organization (WHO) estimates that at least 25 million people are infected with *O. volvulus* worldwide; of these people 300,000 are blind and 800,000 have some sort of visual impairment. Some 123 million people are at risk for becoming infected with the parasite especially in 31 African countries including Nigeria (Plate 5).

In terms of financial costs, billions of dollars have been spent on study of parasites and parasite control. Total disbursements spent on fighting these tiny organisms and their vectors maybe more than what have been spent on prosecuting some wars. International disbursements for malaria control rose from US$ 100 million in 2000 to US$ 1.94 billion in 2012 and US$ 1.97 billion in 2013. An estimated US$ 5.1 billion is needed every year between 2011 and 2020 to achieve universal access to malaria interventions in the 99 countries with on-going malaria transmission (WHO, 2012a). While many countries have increased domestic financing for malaria control, the total available global funding remained at 2.3 billion in 2011 – less than half of what is needed and US$ 2.5 billion in 2012 (WHO, 2013). Domestic Government funding for malaria programmes in endemic countries has also increased since 2004 but not at the same pace; the total for 2012 was US$ 522 million.

Other parasitic infections gulp hundreds of millions of dollars yearly in control efforts while the Bill and Melinda Gate’s Foundation has spent over $1.02 billion on grants to organizations involved in research on infectious and parasitic diseases.

Parasites also live on or in animals and plants where they cause infections and losses. Fish, cattle, goats, sheep, pigs etc. are parasitized by different parasites with consequent deprivations and economic losses.

Infection with *Fasciola gigantica or Fasciola hepatica* is regarded as one of the most common single helminth infection of ruminants in Asia and Africa (Sariözkan, 2011). Its economic importance is mostly obvious when the disease causes mortality, but even subclinical infections have been shown to cause high losses from reduced feed efficiency, weight gains, milk production, reproductive performance, carcass quality and work output in draught animals, and from condemnation of livers at slaughter (Abunna, 2010, Abraham and Jude 2014, Uduak, 2014).

Fascioliasis is a zoonosis, meaning an animal infection that may be transmitted to humans. Until recently, human cases occurred occasionally but are now increasingly reported from Europe, the Americas and Oceania (where only F. hepatica is transmitted) and from Africa and Asia (where the two species overlap). WHO estimates that at least 2.4 million people are infected in more than 70 countries worldwide, with several millions at risk. No continent is free from Fascioliasis, and it is likely that where animal cases are reported, human cases also exist (WHO, 2012b). Watercress and water-mint are good plants for transmitting Fascioliasis, but encysted larvae may also be found on many other salad vegetables. Ingestion of free metacercariae floating on water (possibly detached from carrier plants) may also be a possible mode of transmission (WHO, 2012b).
Mitkowski and Abawi (2003) stated that Nematodes account for an estimated 14% of all worldwide plant losses, which translates into almost $100 billion dollars annually. By far, root-knot nematodes *Meloidogyne* species are the most common and destructive nematode pathogens. They produce some of the most dramatic symptoms and can substantially reduce crop yield (Imafidor and Nzeako, 2007). Root-knot nematodes are found in all agricultural

regions worldwide. They can survive in temperate climates and can devastate crops grown in the tropics.

Most root-knot nematodes also have extremely wide host ranges. Although it is difficult to ascertain the number of hosts for any one root-knot nematode species, it is likely that some root-knot nematodes can survive on hundreds of different plant species. This can make it extremely difficult to control a root-knot nematode problem, particularly if the nematode can survive on weeds.

In addition, root-knot nematodes have repeatedly been shown to predispose their host plants to infection by other crop pathogens, increasing the potential for crop loss (Mitkowski and Abawi, 2003). Symptoms such as stunting, wilting, chlorosis, unthrifty appearance and declined fruit yield are common in Plant Nematode infections due to inability of the galled roots to absorb and transport water and nutrients to the rest of the plant (Imafidor and Nzeako, 2008) (Plates: 6,7,8 and 9).

PARASITE TYPES, OCCURRENCE AND HABITATS

Parasites can be grouped into two major types; Ecto-Parasites and Endo-Parasites. Ecto-Parasites live on the external surfaces of the host such as the skin, scalp, behind the ears, gills etc. while Endo-Parasites live inside the hosts in internal organs and systems such as the blood, intestine, liver, lungs, brain etc. Examples of Ecto-Parasites include the head, body and pubic lice (*Pediculus humanus capitis* (Plate 10), *Pediculus humanus* corporis and *Pthirus pubis*) and those of Endo-Parasites are the Malaria Parasite (*Plasmodium* spp.,), Tape worm (*Taenia* spp.,), Round worm (*Ascaris lumbricoides)* and Hookworms (*Ancylostoma duodenale*). In these habitats they find a home, food and transport and multiply. Some are obligate parasites which cannot complete their lifecycles without

Plate 6: Infested yam tuber;
Source: www.ucdavis.edu

Plate 7: Galled Roots of *Meloidogyne* infested Carrots;
Source: www.ucdavis.edu

Plate 8: Infested Carrot;
Source: www.ucdavis.edu

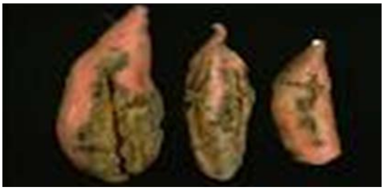


Plate 9: Infested roots of Sweet Potato ;
Source: www.googleimages.com

spending a part in a host e.g. the Malaria Parasite, *Plasmodium*, while others are facultative and are not normally parasitic but can transform into one when accidentally eaten e.g. *Naegleria fowleri*.

Different types of hosts also exist including the Definitive or Final host which represents where the parasite attains sexual maturity and the Intermediate host which is a temporary host that allows the development of some asexual stages.

The intermediate hosts have possible link with the final host either sharing the same habitats and niches or are part of the food chain. Some are Paratenic Hosts also known as transport hosts and the parasite does not undergo any development in this type but remains viable and infective to another host.

Many parasites exhibit host specificity developing only in a restricted range of host species. This specificity varies ranging from infecting only a single host to infecting a number of related species or many unrelated species. The pork tapeworm *Taenia solium* can only survive and mature in humans. This is strict host specificity while the nematode *Trichinella* is able to mature in any mammal.

Some parasites use vectors to ensure efficient transmission of their infective stages e.g. female *Anopheles* mosquito for malaria parasite and Tse-tse fly for sleeping sickness parasite. These vectors find the final host through different mechanisms and infect them either by inoculation or contamination. The vectors occupy the interest of Medical Entomologists but are still of major importance to the Parasitologist.

Parasite lifecycle is key to understanding transmission pathways which is a major component of the game and some parasites have complex life cycle patterns involving intermediate hosts and multiple asexual stages with great potential for multiplication. This is an adaptation to ensure survival of species even under adverse conditions. Understanding these complex patterns is necessary for evolving appropriate control measures to interrupt the parasite's transmission. The inability to produce a suitable vaccine for malaria and Schistosomiasis is also linked to the presence of an array of multiple stages which requires an integrated vaccine directed at different stages. Trials have shown different levels of efficacy but a suitable malaria or Schistosomiasis vaccine is still not available (MVI, 2013).

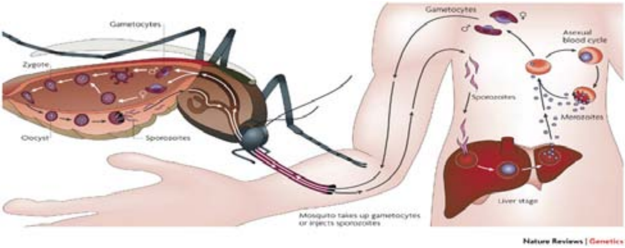


Figure 1: Lifecycle of *Plasmodium.*

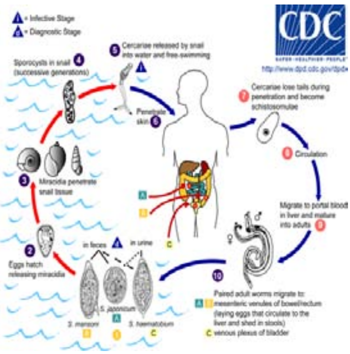


Figure 2: Lifecycle Schistosoma

Plate 10: The head Lice *Pediculus humanus* of *capitis*
Source: www.goggleimages.com

Parasites are found in the different Phyla of the Kingdom Animalia especially in the invertebrate groups of Protozoa, Platyhelminthes, Nematoda, Acanthocephala and Arthropoda.

PROTOZOA

These are single-celled organisms with different types of locomotory organelles such as Pseudopodia, flagella and cilia. Major Protozoan parasites of humans and animals are shown in Table 1.

Table 1: Common Protozoan Parasites

Parasite	Disease	Location
Trypanosoma gambiense, T. rhodesiense, T. cruzi	African Trypanosomiasis, (Sleeping Sickness) Chagas disease or American Trypanosomiasis	Blood and tissue fluids
Leishmania donovani	Leishmaniasis (Espundia, Kala-azar)	Macrophages
Entamoeba histolytica	Amoebic dysentery, liver abscess	Digestive system
Giardia lamblia	Giardiasis	Digestive system
Trichomonas vaginalis	Trichomoniasis	Urino-genital system
Toxoplasma gondii	Toxoplasmosis	Blood and body tissues
Plasmodium falciparum, P. vivax, P. ovale, P. malariae	Plasmodiasis (Malaria)	Blood

Source Nduka(2014)

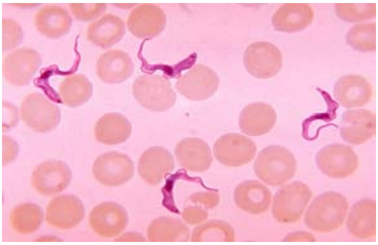


Plate 11: *Trypanosoma* forms in blood smear from patient with African trypanosomiasis (Source: Shapiro, 2013)

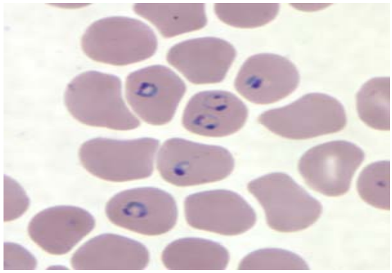


Plate 12: Rings of *P. falciparum* in a Thin blood smear. (Source: CDC-DPDx, 2013)

THE PLATYHELMINTHES OR FLAT WORMS

These constitute the flukes and tapeworms. They are bilaterally symmetrical with well defined anterior end. They are dorso-ventrally flattened, often leaf or oval-shaped though tapeworms are elongated. Some like the Digeneans have oral and ventral suckers for attachment. Cestodes (tapeworms) bear a head or scolex which may be equipped with variety of attachment organs in order to maintain position in the digestive tract of the host. This scolex may bear suckers, grooves, spines, glands or hooks.

Tapeworms lack digestive system and absorb nutrients from the host across the body surface, (Tegument). The tegument has numerous finger-like projections, microtriches to increase the absorptive surface. These attachment organs are part of the structural adaptations of parasites to living inside very mobile and fluid systems. The lifecycles of flat and tape worms involve the use of intermediate hosts. Table 2 shows some of the common flat worms often encountered by humans and domestic animals and typical structures of adults and eggs are shown in Plates 13, 13a,13b, 14, 14a, 15a and 15b.

Table 2: Common Plathyhelminthes

Parasite	Disease	Location
Fasciola hepatica, Fasciola gigantica (Liver fluke)	Fasciolasis (Liver abscess)	Digestive System
Paragonimus westermanii, P. uterbilateralis (Lung fluke)	Paragonimiasis	Lung
Schistosoma mansoni, S. haematobium	Intestinal and Urinary Schistosomiasis or Bilharziasis	Digestive System, Pelvic plexus
Cestoda (Tape worms), Taenia solium, Taenia saginata, Diphyllobothrium latum	Taeniasis	Digestive System

Source: Nduka (2014).

Plate 13: *Schistosoma haematobium;*
Source: www.goggleimages.com

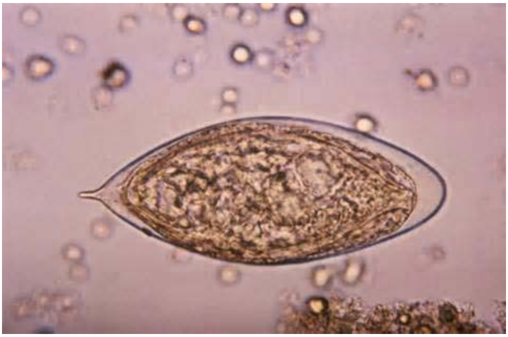


Plate 13a: *Schistosoma haematobium* egg;
Source: CDC/DPDx (2013).

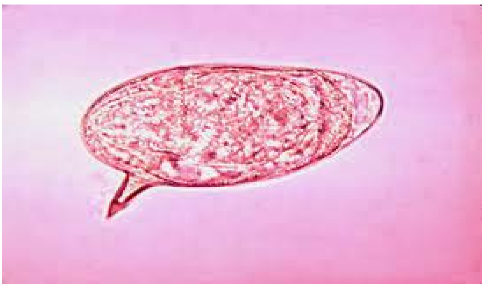


Plate 13b: *Schistosoma mansoni* egg;
Source: CDC/DPDx (2013).

Plate 14: ***Paragonimus westermani*** **adult**

Plate 14a: ***Egg of P.westermani***
Source: CDC/DPDx (2013)

As long as the head survives, the tapeworm will continue to grow and shed segments

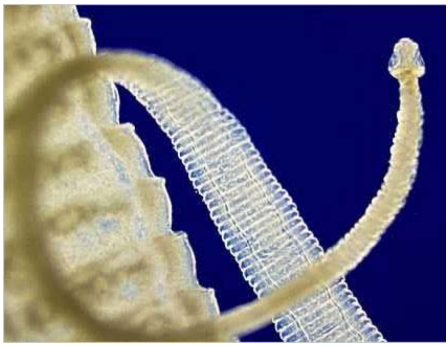


Plate 15a and b: Typical Tape Worm showing Scolex and long Proglottids.
Source: www.images.goggle.com

NEMATODES OR ROUND WORMS

These are very successful animals because they inhabit every available biotope and are very abundant. They are found as free-living forms in the soil, in marine and fresh water and as parasites in plants and a variety of animals including man. They are bilaterally symmetrical, elongated and tapered at both ends. They have a body cavity, the pseudocoel and a complete digestive system. Their success is attributed to the structural adaptation of possessing an inelastic cuticle and high fecundity rates. This is the group of the common round worm, *Ascaris*, hookworms and filarial worms (Table 3) and Plates 16, 16a, 17, 18 and 18a).

Table 3: Some Nematode Parasites

Parasite	Disease	Location
Ascaris	**Ascariasis**	**Digestive system**
Hookworm Ancylostoma duodenale Necator americanus	**Hookworm infection**	**Digestive system**
Trichuris (Whipworm)	**Trichuriasis**	**Digestive system**
Filarial worms, Onchocerca, Wuchereria	**Filariasis, Elephantiasis, River Blindness**	**Lymphatics**
Dracunculus (Guinea worm)	**Dracontiasis or guinea worm infection**	**Lower limbs**

Source: Nduka (2014).

Plate 16: ***Ascaris*** **worms;**
Source: www.sparticl.org

Plate 16a: ***Ascaris*** **Egg;**
Source: CDC/DPDx (2013)

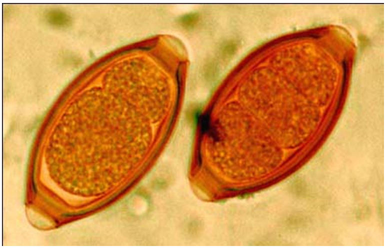


Plate17: ***Trichuris*** **Egg;**
Source: CDC/DPDx (2013)

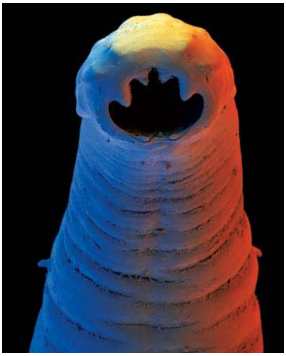


Plate 18: Typical Hookworm;
Source: CDC/DPDx (2013)

Plate 18a: Hookworm Ova;
Source: CDC/DPDx2013

SOME EVASION MECHANISMS

A host is termed susceptible to a parasite if the host cannot eliminate the parasite before establishment of infection. A host is considered resistant if the physiological status of the host prevents establishment and survival of the parasite (Phillips, 1993). A host exhibits immunity if it has cells or tissues that are capable of recognizing and protecting itself against non-self invaders (Bartl et al., 2003). All animals show some degree of innate immunity, mechanism of defense that does not depend on prior exposure to a foreign organism. In addition to innate immunity, jawed vertebrates develop adaptive immunity which is specific to the particular non-self material (Phillips, 2009). Some hosts are asymptomatic and they retain the parasite in check with their immune system.

In addition to the different structural adaptations that enable the parasites to establish infection, high fecundity levels with complex lifecycles, location within the host, synchronization of life cycle with that of the host, periodicity, parasites have also evolved mechanisms to evade the hosts' immune responses.

The Malaria parasite *Plasmodium falciparum* adheres to the deep veins of the endothelial cells to avoid splenic clearance in a process known as sequestration. The sleeping sickness parasite *Trypanosoma brucei* exhibits antigenic variation where it switches its surface glycoprotein coat into other forms to evade the host immune reaction. This constant changing of the coat, Variant Surface Glycoprotein (VSG) and its variant antigen (VAT) aid the parasite in the survival battle against the host. The host is unable to recognize the new forms immediately so that they multiply to continue the infection. *Schistosoma* mimics the host's antibodies and covers its surface with host serum proteins. This serves as camouflage and confuses the host while the parasite escapes.

Parasite Morbidity

Parasites may cause mechanical injury such as boring a hole into the host or digging into the tissue, may elicit and stimulate a damaging inflammatory or immune response or simply rob the host of food. When an *Ascaris or Hookworm* young adult penetrates a capillary of the lung to enter airspace it damages the blood vessels and causes bleeding and possible secondary bacterial infection. The hookworm does a circuitous migration to the small intestine where it feeds by biting deeply into the mucosa to suck blood which may result to anaemia especially in heavy infections. The protozoa *Entamoeba histolytica* digests the mucosa of the large intestine leading to the formation of ulcers and abscessed pockets of severe disease (Phillips, 1993).

The fish tapeworm *Diphyllobothrium latum* absorbs large amount of vitamin B_{12} from the host which may give rise to anaemia. The roundworm *Ascaris* occurs in large number and consumes a lot of food meant for the host's metabolism which may contribute to childhood malnutrition and retarded growth (Hadju et al., 1996). Worms can decrease host nutrient intake, increase nutrient excretion and or decrease nutrient utilization leading to malnutrition (Stephenson, 1987). Another protozoa *Giardia lamblia* operates in large numbers and covers large areas of intestinal absorption surface and interfering with host's absorption of nutrients (Bayne 2003).

However it is thought, that host immune response and inflammation appear to be responsible for the most serious and most pervasive pathogeneses. Some of the large amount of antigen-antibody complex formed in infections with African *Trypanosoma* adsorbs to the host's Red Blood Cells (RBCs) activating complement causing lysis with resulting anaemia (Barry and McCulloch, 2001). Also the flow of blood carries many eggs laid by *Schistosoma* to the liver where they lodge, leaking antigen and causing chronic reaction. The formation of granulomas around the eggs eventually impedes blood flow through the liver resulting in Cirrhosis and portal hypertension (Phillips, 1993). Granulomas form when the immune system attempts to wall off substances that it perceives as foreign but is unable to eliminate (Wikipedia, 2015). In Malaria parasite infection, the destruction of uninfected Red blood cells is thought to be part of host autoimmune reaction. This destruction may limit the infection and is known as autohaemolysis.

Symptoms of malaria include cyclical fever and shivering as a result of the bursting of infected red blood cells with the release of Haemozoin which is a disposal product formed from the digestion of blood by some blood-feeding parasites. Malaria parasites digest haemoglobin and release high quantities of free haeme, which is the non-protein component of haemoglobin. Free haeme is toxic to cells and it gets converted into an insoluble crystalline form called haemozoin by the parasites. In malaria parasites, haemozoin is often called *malaria pigment*. Haemozoin formation is an excellent drug target, since it is a process that is essential to the survival of the malaria parasite and absent from the human host. This has been utilized in the formulation of some drugs which may inhibit biocrystallization of Haemozoin in the parasites allowing the accumulation of free haeme which is toxic to the parasite.

Some morbidity of parasitic infections are shown in Plates 19-24 below.

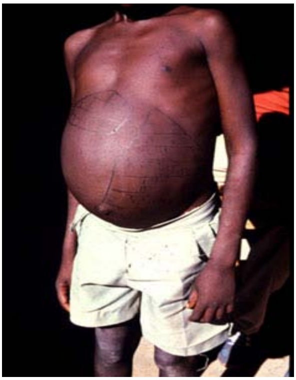


Plate 19: Distended Stomach due to Schistosoma mansoni; Source: CDC/DPDx (2013)

Plate 20: Children displaying Blood In Urine Sample Source:The Carter Center 2009

Plate 21: **High Burden of infection with Ascaris.**
Source: www.rotten.com

Plate 22: Guinea Worm Infections.
Source: CDC/DPDx2013

Plate 23: Leopard Skin due to Onchocerciasis;
Source: www.yahooimages.com

Plate 24: Elephantiasis due to Filariasis; Source: WHO (2012a).

WATCHING THE GAME

The game has played out over a long period and many researchers have served as watchers. They have tried to understand aspects of it and to contribute to turning the tide in favor of the hosts. No wonder the parasite is ever watchful because many researchers are not on its side. Indeed some of the researchers are active participants in the game having been infected from time to time and are indeed biased umpires. We have also watched and participated in this game and have made some contributions in trying to understand the dynamics and how to use the knowledge acquired to further control of parasitic infections.

The control of Parasitic infections is of utmost importance and we have contributed to this effort in terms of providing base-line data and evaluating measures for control. Through our research we have contributed to knowledge of Host-Parasite relationships, epidemiology of Schistosomiasis,Paragonimiasis and Malaria in Abia State, highlighting factors affecting spread, incidence and prevalence and suitability of habitats. We have drawn attention to the hazards posed by Quarry mining companies in Umuchieze, Lokpanta, Lokpaukwu and Ishiagu axis of Abia and Ebonyi States in the spread of 2 major parasitic diseases, Malaria and Schistosomiasis. We embarked on advocacy both to the communities and Government agencies on the risk posed by the presence of these abandoned quarry mining pits to the inhabitants of such environment and the need to legislate on revegetation of the environment after mining. We have supported with evidence based research the need for sleeping under Long Lasting Insecticidal Net (LLIN) and adoption of Intermittent Preventive Treatment (IPTp) in Pregnancy to reduce the burden of malaria infection in pregnant women who are the second vulnerable group after children 0-5years old. With grants from WHO and L'FORD we mapped endemic communities in Imo River Basin for Onchocerciasis and evaluated the Community's acceptance of Community Directed Intervention (CDI). A few examples will suffice.

In Host—Parasite Relationships we established the factors that enhance infection in the snail host of *Schistosoma haematobium,* the effect of infection on reproductive capacity with regards to life table studies and the fact that *Bulinus rholfsi* can serve as alternative Snail host if there is a crash in the population of the preferred host, *Bulinus globossus* both in Nkalagu and Umuchieze Communities of Ebonyi and Abia States (Anya & **Okoronkwo,** (1991a, 1991b**,** 1993; Nwaugo, et al., 2006, 2007).

Schistosomiasis was endemic in Umuchieze and Ishiagu communities of Abia and Eboinyi States (**Nduka, et al.,** 1995). More disturbing was the fact that abandoned water-filled pits left by Quarry mining companies were the foci of infection (**Nduka, et al.**, 2006). These pits were nearer to the residential areas than natural streams and became social and recreational centers for the villagers. They gathered to wash clothes, swim, bathe, leach cassava, fish and collect water for domestic use. Infected fresh water snails were found in these pits and contact with such water bodies encouraged transmission of the infection, (Plates 25 and 25a). Quarry pit workers were mostly affected as they had most contact with the waters especially swimmers who spent longer periods with most of their bodies exposed (**Nduka, et al.,** 2008).

Plate 25a: Community Water Body; Source: The Carter Center (2009)

Plate 25: Typical Community Water Body; Source: The Carter Center (2009)

We also validated WHO Rapid Assessment method for Urinary Schistosomiasis which sought to replace laborious microscopy for large scale community diagnosis. We used presence of blood in urine (haematuria) as a diagnostic factor instead of observing the characteristic egg in urine samples. Our validation showed that this method had high sensitivity and specificity and can be used for fast diagnosis during mapping (Nduka and Nwosu, 2007).

Having identified the problem of Schistosomiasis in these communities we also embarked on public enlightenment and health education through focus study. This was aimed at helping the communities appreciate the source of infection and guide control of the spread after evaluating their Knowledge, Attitude and Perception (KAP). This provided their appreciation of the causative agents, associated symptoms, local names and treatment seeking behavior. This effort reduced the infection significantly from 59% in 2001 to 21.3% in 2009 and currently to 4% in 2013 after a recent mapping by The Carter Center (**Nduka, et al.**, 2009).

We also paid Advocacy visits to Committee of Local Government Chairmen, Abia State and Abia State House of Assembly to present our findings on the effect of abandoned Quarry mining pits on the transmission of Urinary Schistosomiasis and Malaria. We advised that there is need to monitor the activities of these companies and put legislation in place to reduce degradation of the environment.

High presence of Malaria was also observed in these areas and also associated with the abandoned quarry pits. The pits provided adequate breeding sites for the mosquito vectors especially the efficient *Anopheles gambiae* and with the closeness to human habitat, biting of humans was enhanced (**Nduka, et al.,** 2007, Kalu et al., 2012a & b). Malaria in pregnancy is a situation health care personnel would like to avoid and efforts are continuously being made to educate pregnant women on the dangers of becoming infected with malaria. Different control measures are in place to reduce the effect of malaria in pregnancy and these include Intermittent Preventive Treatment (IPTp) and sleeping under LLINs.

A major problem of malaria in pregnancy is the ability of the malaria parasites to adhere to the placenta in a process of sequestration. In pregnancy, malaria has the following maternal outcomes: Anaemia, Renal Failure, Cerebral Malaria, Pulmonary Oedema and death.

More importantly is the serious effects it has on the foetus which include Abortion or miscarriage, Still Birth, Low Birth Weight (LBW), Intra-Uterine Growth Retardation (IUGR) and preterm delivery.

Malaria in pregnancy has been studied extensively and several reasons have been adduced to explain the strong effects on pregnant women especially those in their first pregnancy. These include depressed immunity as a result of shift in cytokine profiles from cellular immune system of Type 1 Helper cells (Th1) which is Anti-foetal immunity to Type 2 Helper Cells (Th2) which supports establishment of pregnancy. This shift leaves the woman open to other infections including Malaria, hence the support for prevention during this state.

However there is increasing evidence that malaria susceptibility in women of first pregnancy could be largely explained by the lack of antibodies that can block adhesion of Infected Erythrocytes(IEs) or Red Blood Cells to placental Chondroitin Sulfate A (CSA) (Ricke et al., 2000). The decreasing risk of malaria with subsequent pregnancies is attributed to parity-dependent acquisition of antibodies against placental parasites expressing variant surface antigens, VAR2CSA, that mediate placental sequestration through adhesion to Chondroitin Sulfate A (CSA). This explanation takes care of the parity dependent difference observed among pregnant women who presumably are under the same state of depressed immunity (**Nduka et al.,** 2005). The placenta is a complex, sophisticated organ with several important functions throughout gestation, with the primary purpose of providing sustenance for the developing fetus. The placenta is also a site for *P. falciparum* sequestration. Placental sequestration of *Plasmodium falciparum* results in the accumulation of parasitized erythrocytes in the intervillous space, infiltration by inflammatory cells. The release of pro-inflammatory mediators, which cause pathologic alterations that can impair materno-fetal exchanges, often resulting in adverse pregnancy outcome.

We have demonstrated this fact by studying the placenta after delivery with consent of the mothers and ethical clearance from health authorities in three towns: Afikpo, Umuahia and Okigwe. Peripheral blood smears yielded 15.9% infection while placental blood smears and placental histology gave 24.9% and 60.7% respectively (Nwosu, et al., 2011). The high infection level observed with placental histology gives credence to the fact that pregnant women should be given two doses of Sulphadoxine Pyremethamine (SP) in alternate months during the second and third trimesters of pregnancy taken as directly observed therapy (DOT) in Ante-Natal clinics (ANC). This is the concept of Intermittent Preventive Treatment (IPTp) and the dosage has been increased to four doses (WHO, 2013).

Our research also evaluated levels of compliance and effectiveness of IPTp in pregnant women in the three towns. Our observations showed only 32.7% compliance and significantly lower infection rate of 39% against 61% in those not on IPTp (**Nduka, et al.**, 2011). Federal Ministry of Health set a target of 60% compliance by 2005 yet National average was 17% by 2011 when study was conducted. This showed a disconnect between National policy and reality on ground. Part of the reasons adduced are the attitude of health care personnel in public health facilities, the fact that government policies often stop at public facilities without filtering down to private concerns and lack of adequate monitoring and evaluation.

Distribution of Long Lasting Insecticidal Net (LLIN) has taken center stage in malaria control and different donor agencies are supplying nets to countries to enable them meet set targets. Nigeria set a target of distributing 63 million nets by 2010. We also investigated the compliance by and effectiveness of these nets on reduction of malaria infection on pregnant women in the three selected towns. There was an observed 26.7% LLIN compliance and 36.9% infection rate among the LLIN users which was lower than that of non-users. Similar studies in Port Harcourt, Rivers State, showed a higher compliance of 79% in the use of LLINs and a low infection rate of 9.1% in contrast to 90.4% infection in non-users of

LLINs (Wogu et al., 2013).Non availability of the free ITN/LLIN in many communities coupled with the long wait and bureaucratic hurdles encountered in obtaining these nets have made their use fall below the expected target of government. Some women also complained of discomfort of the net given the hot weather as the reason of their non-use. Many also stay outdoors for long periods allowing exposure to mosquito bites before sleeping under the net (Nwosu, et al., 2011).

Occupation and educational status also played a role in rates of malaria infections; rates were higher in housewives and farmers, 66.7% and 57.1% respectively. Students and Civil servants had lower infection rates of 11.8% and 14.3% respectively. Those with tertiary education had 10% infection, Secondary education 26.1% and Primary education 61.0%. (Wogu, et al., 2014). Increased awareness of preventive measures by the educated class and occupation associated exposure may account for the differences observed.

The relationship between malaria infection and enlargement of the spleen was studied in children and adolescents aged 1-15years in collaboration with medical colleagues in Aba town. A high correlation was observed with 338 (83.9%) of the 403 persons with spleno-megaly examined infected with malaria while 65(16.1%) were not. Interestingly 114(28.3%) consulted qualified medical doctors for diagnosis and treatment and had 22.18% of the malaria infection while 289(71.1%) consulted traditional healers for treatment and accounted for 77.51% malaria infection. This difference was statistically significant ($p<0.05$), (Etusim, et al., 2012)

The observations of 403 children with confirmed cases of splenomegaly in six healing centres in Aba metropolis is of immense public health concern. The number of people that patronized the traditional healing centres even in the presence of modern facilities is also alarming. Peter (1995) and Merlin (2004) emphasized the role of traditional medicine in modern times. Many reasons have been adduced for this attraction to traditional healers; and these include their informal setting, cost, proximity and quick service delivery. Bertrand *et al.,* (2011) noted that patients use traditional treatment for many reasons. They may belong to communities whose habits and treatment seeking behavior resort to traditional medicine as the first choice. They may prefer traditional medicine, believing for example that they produce fewer side effects and are more effective. They may have experienced a failure with the modern treatment and want to try traditional treatment. They may want to avoid modern health facilities because they perceive them as expensive, unfriendly, dangerous or ridden with corruption. Patients may also avoid modern drugs sold in the market because they are aware of the fact that many of them are counterfeit or "fake" drugs.

Paragonimiasis (infection with lung fluke) was shown to be endemic in Lokpanta and Lokpaukwu axis, communities of Abia State located on the Enugu-Port Harcourt express road. In that study the factors affecting spread were also determined. These include consumption of raw or poorly cooked crabs and the chewing of raw limbs of the crab, presumed to be effective cough remedy (**Nduka, et al.,** 2000, 2001). Crabs from this area of study and in general should be cooked properly before eating and this includes pickled crabs.

An L'FORD grant supported our study on the acceptability of Community Directed Intervention (CDI) in some Onchocerciasis endemic communities of Imo State. We established the effectiveness of CDI, and the willingness of the communities to embrace the Ivermectin treatment, its distribution through trained members of the community and the social stigma attached to the ugly rashes associated with the disease and discrimination against the victims especially young girls. The victims could not get married and the rashes provided grounds for divorce of married couples. This study was carried out in collaboration with a colleague in Sociology and drew attention to the social angle which may be overlooked in understanding the dynamics of the disease (Mberu et al., 1998).

WHO/TDR grant supported our evaluation of prevalence of Onchocerciasis, causative agent of River Blindness in some communities along the Imo River Basin using the Rapid Assessment method of identifying presence of leopard skin, lizard skin, nodules, and rashes etc as indicators of the disease instead of traditional skin snips. Many of the communities were found to be endemic (Nwoke, et al., 1994).

Mr. Vice-Chancellor Sir, these studies lend support to the efforts to actualize the targets of the Millennium Development Goals (MDGs) of the Government. Our studies have direct bearing on Goal 4, Reduction of Child Mortality, Goal 5, improving maternal health, and Goal 6, combating HIV/AIDS, Malaria and other diseases. Our data further emphasizes the need to pursue more vigourously the stated strategies for actualizing set targets by 2015 and the end year is here.

NEW FRONTIERS

With my appointment as In-Country Consultant on Neglected Tropical Diseases (NTDs) to the Federal Ministry of Health (FMOH) in 2010, a new vista of research activities opened to provide expert and technical support to States on domestication and implementation of global health policies relating to these diseases.

Neglected Tropical Diseases are one of the key areas of global concern and are considered neglected because relatively little attention has been devoted to their surveillance, prevention, and/or treatment. These diseases affect an estimated one billion people, primarily poor populations living in tropical and subtropical climates, with children being the most vulnerable to infection. WHO lists 17 diseases under the NTD group. They flourish in impoverished, tropical environments and, though medically diverse, tend to co-exist. Most are ancient diseases that have plagued humanity for centuries and have been largely wiped out in parts of the world with better living conditions and hygiene (EFINTD's, 2015).

These include Schistosomiasis and Soil Transmitted Helminth infections (STHs) which are currently the focus of FMOH in the battle against NTDs. Soil-transmitted helminth infections are among the most common infections worldwide and affect the poorest and most deprived communities. They are transmitted by eggs present in human faeces which in turn contaminate soil in areas where sanitation is poor. The main species that infect people are the roundworm (*Ascaris lumbricoides*), the whipworm (*Trichuris trichiura*) and the hookworms (*Necator americanus* and *Ancylostoma duodenale*).

WHO (2014c) fact sheet on Soil Transmitted Helminth infections estimated that more than 1.5 billion people, or 24% of the world's population are infected worldwide. Infections are widely distributed in tropical and subtropical areas, with the greatest numbers occurring in sub-Saharan Africa, the Americas, China and East Asia. Also it indicated that over 270 million preschool-age children and over 600 million school-age children live in areas where these parasites are intensively transmitted, and are in need of treatment and preventive interventions. These parasites are transmitted by eggs that are passed in the faeces of infected people. Adult worms live in the intestine where they produce thousands of eggs each day. In areas that lack adequate sanitation, these eggs contaminate the soil. This can happen in several ways:

1. Eggs that are attached to vegetables are ingested when the vegetables are not carefully cooked, washed or peeled;
2. Eggs are ingested from contaminated water sources;
3. Eggs are ingested by children who play in soil and then put their hands in their mouths without washing them.

In addition, hookworm eggs hatch in the soil, releasing larvae that mature into a form that can actively penetrate the skin. People become infected with hookworm primarily by walking barefoot on the contaminated soil.

Heavier infections can cause a range of symptoms including intestinal manifestations (diarrhoea, abdominal pain), general malaise and weakness, and impaired cognitive and physical development. Hookworms cause chronic intestinal blood loss that can result in anaemia (WHO, 2014c). They can also impair nutritional status either by feeding on host tissues and increased malabsorption of nutrients or by reduction of nutritional intake due to loss of appetite.

WHO strategy for control is to give periodic treatment to at-risk people living in endemic areas. Treatment should be given once a year when the prevalence of soil-transmitted helminth infections in the community is over 20%, and twice a year when the prevalence of soil-transmitted helminth infections in the community is over 50%. This intervention reduces morbidity by reducing the worm burden. This periodic deworming can be part of child health days and school health programmes. Schools provide a particularly good entry point for deworming activities, as they allow easy provision of the health and hygiene education component such as the promotion of hand washing and improved sanitation.

WHO recommended medicines – albendazole (400 mg) and mebendazole (500 mg) – are effective, inexpensive and easy to administer by non-medical personnel (e.g. teachers). They have undergone extensive safety testing and have been used in millions of people with few and minor side-effects. Both albendazole and mebendazole are donated to national ministries of health through WHO.

The global target is to eliminate morbidity due to soil-transmitted helminthiases in children by 2020. This will be obtained by regularly treating at least 75% of the children in endemic areas (an estimated 873 million).

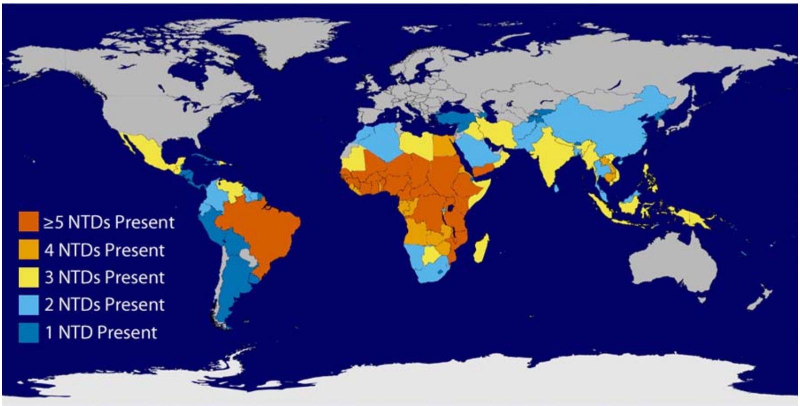


Plate 26 : Global Overlap of Six of the Common NTDs.
Source: www.cdc.gov

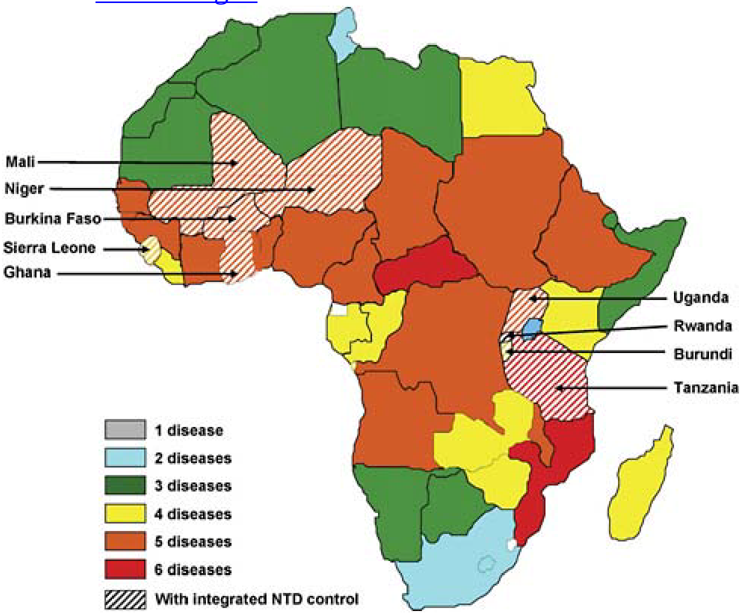


Figure 27: Distributions of NTDs in Africa www.nap.edu

These WHO policies listed above are being implemented in Nigeria although slowly, due to poor Government funding. Donor agencies have been of immense support to map the country in phases, obtain data and commence intensive de-worming exercises. Under the Consultancy we have trained health workers from the States on strategic plans and program development in Abuja and Lagos and also led the mapping effort. New mapping technologies utilize electronic data entry at the point of collection and rapid transmission of information to a central database using mobile phone technology. Once the data have been compiled, geographical information systems (GIS) simultaneously manage and display the data and include estimates of such variables as temperature, vegetation, and humidity, which affect NTD distribution.

In 2013-2014 this effort supported by the Carter Center, Sight Savers and Children Investment Funds Foundation (CIFF, UK) saw my team in Delta, Bayelsa and Rivers States where we trained the local personnel in the use of pre-configured digital hand held devices including Android Smart Phones in capturing coordinates and inputting and uploading data obtained from sampled population in different communities of the Local Government Areas and also in using Kato-katz and Urine filtration techniques in examining stool and urine samples for these infections respectively. We assisted in the mapping of the different communities for Schistosomiasis and STHs and realized the following objectives:

1. To determine the prevalence and endemicity of infections in the States.
2. To build capacity of State technical officers on coordinated mapping of Schistosomiasis/Soil Transmitted Helminths.
3. To obtain information that will form the basis for estimation of drug requirements for preventive chemotherapy interventions.
4. To provide mapping data needed for planning, implementation and monitoring of control progress of Mass Drugs Administration (MDA) in the States.

In every State mapped, five schools were selected from each LGA and 50 children aged 6-16 years of both sexes were randomly selected from each school. The consent of the children and their parents were obtained. Stool and urine samples were collected from each pupil and examined microscopically in the laboratories for the characteristic eggs or cysts of the parasites. Attempts were made to select equal number of boys and girls where possible.

Preliminary results showed that out of the eight LGAs sampled in Bayelsa State, seven or 87.5% had >20% prevalence of STHs which met the WHO treatment threshold while the State had an overall prevalence of 44.52% (Table 4).

Table 4: Prevalence of STHs in the 8 LGAs of Bayelsa State.

S/N	LGA	% of infection
1	Yenagoa	40.56
2	Kolokuma/Opokuma	16.47
3	Ogbia	37.77
4	Ekeremor	53.33
5	Sagbama	30.58
6	Southern Ijaw	74.40
7	Nembe	21.43
8	Brass	81.97
	Total	**44.52**

Source FMOH, 2014

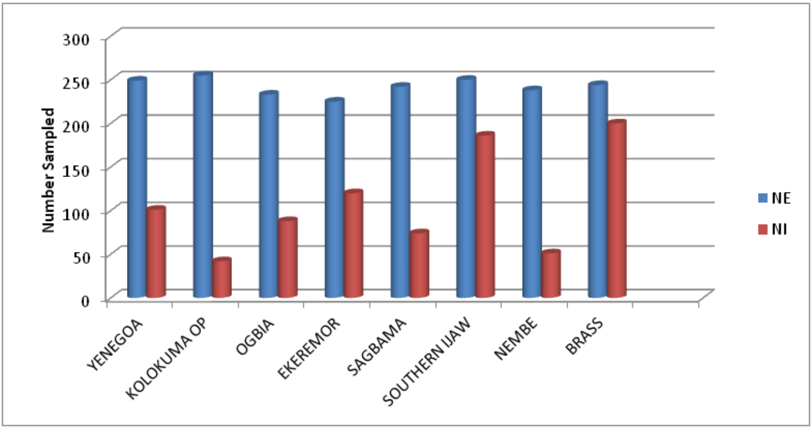


Figure 3: Prevalence of STHs in Bayelsa State; Source of data: FMOH (2014)

Rivers State had an overall prevalence of 42.8% and 21 of the 23 LGAs (91.30%) mapped had > 20% infection and also met the WHO treatment threshold (Table 5). Similar studies in Rivers State have shown these NTDs are endemic. Awi-Waadu, (2005) observed higher prevalence of 84.6% and 99% respectively in pupils and adults inhabiting Bori Military Cantonment, Port Harcourt. Abah and Arene (2006) observed a prevalence of 42.7% in Akpor area of Rivers state and Odu, et al., (2010) recorded high worm infections often double and triple co-infections in pupils of Ekpeye and Ogba Kingdoms of Rivers State. Hookworm infections topped the chart with 72.6% in these Kingdoms.

Table 5: Prevalence of STHs in 23 LGAs of Rivers State.

S/N	LGA	% INFECTION
1	PORT HARCOURT	19.8
2	OBIO/AKPOR	23.6
3	EMUOHA	53.9
4	IKWERRE	40.3
5	OMUMA	50.4
6	ETCHE	43.6
7	OKRIKA	51.5
8	OGU/BOLO	28
9	ELEME	23.1
10	TAI	25.6
11	KHANA	53
12	GOKANA	51.6
13	ANDONI	76
14	OPOBO/NKORO	52.1
15	OYIGBO	18
16	AKUKU-TORU	32.1
17	BONNY	52
18	ASARI-TORU	29.1
19	DEGEMA	21.3
20	ABUA/ODUAL	86.3
21	AHOADA EAST	60.1
22	AHOADA WEST	43.8
23	OGBA/EGBEMA/NDONI	46.9
	OVERALL	42.8

Source: FMOH, 2014.

Some LGAs in both States, 10 (43.5%) in Rivers State and 3 (38%) in Bayelsa State had over 50% infection therefore qualifying for the twice a year WHO treatment regimen. Co-infections of two or more parasites were observed in many of the pupils and students further heightening concerns. Similar results obtained in other parts of the country clearly place Nigeria as endemic for these parasites and efforts must be stepped up to swing the game in favour of the host. Mapping is evidence-based research that guides interventions to areas of need and not the blind probing which involves arbitrary deployment of resources out of parochial interests or whim. It also points to areas that need improved infrastructure to further reduce the burden of these infections.

These preliminary findings were presented to the Commissioners of Health, Permanent Secretaries, Directors of Public Health, State NTDs Coordinators etc, at the end of the exercise. The State Governments were encouraged to support future studies and de-worming programmes by appropriating funds for provision of local logistics and training of State officials. In addition they should partner with specific donor agencies for ease of implementation of these WHO guidelines.

GAME BARRIERS

Many challenges are faced in the course of watching the game especially in our environment, plagued by ignorance. Many field researchers are now exposed to increased danger of personal harm occasioned by false rumours and the enemy syndrome currently in circulation by agents of religion. They have fuelled the fear of the enemy at every turn that obtaining samples for examination to collect data has become an uphill task. People now input non-existent motive especially that of ritual and other fetish ideas to the field exercise of collecting blood, stool and urine samples. In extreme cases they not only chase the research team away, they manhandle some and confiscate already collected samples. This still happens even after publicity of the programme and presence of local guides and State officials.

Funding is still a major barrier to watching this game and some governments do not consider it a priority. Even when donor agencies and partners make the effort to bring in funds and other resources needed, provision of matching grants and local logistics to implement recommended interventions still encounter bottle necks. Funding is also reducing globally due to economic down turn. This means that millions of people living in highly endemic areas continue to lack access to effective malaria prevention, diagnostic testing, and treatment. Efforts to prevent the emergence and spread of parasite resistance to antimalarial medicines and mosquito resistance to insecticides are also constrained by inadequate funding (WHO, 2012a). Control efforts toward other major parasites also suffer from inadequate funding.

Adequate research facilities are lacking in most of our institutions and this hinders cutting edge studies that bring on board innovations. Where running water in laboratories is still a challenge imagine the difficulty of fixing or staining samples and doing routine cleaning.

Power is still a major challenge in the country and simple microscopy cannot go on under the circumstance. We had to log generators around different communities in order to examine the samples within specified periods. The added cost and risk are high. A situation where there is no electricity in academic areas of the University for hours on end does not make for productivity.

Drug resistance and insecticide resistance by parasites and vectors respectively are major challenges in the control of the infections. Genetic mutation coupled with presence of fake drugs, wrong usage and incomplete dosage of drugs enhance this challenge.

At present, malaria surveillance systems detect only one-tenth of the estimated global number of cases. This makes it difficult to track progress in malaria control. In as many as 41 countries around the world, it is not possible to make a reliable assessment of malaria trends due to incompleteness or inconsistency of reporting over time. Stronger malaria surveillance systems are urgently needed to enable a timely and effective malaria response in endemic regions in order to prevent outbreaks and resurgences and to ensure that interventions are delivered to areas where they are most needed. This will strengthen WHO T3: Test, Treat and Track Policy.

GAME CHANGERS

Mr. Vice-Chancellor Sir, these parasitic infections are preventable and treatable. It is saddening to note the burden they still impose on individuals especially in developing countries mainly in the tropics and sub-tropics. These infections thrive in poverty and its attendant poor infrastructure. Poverty and parasitic diseases have been highly correlated over time. They are tied closely together with each factor supporting the other. Many diseases that primarily affect the poor also deepen poverty and worsen conditions. Poverty also significantly reduces people's capacity, making it more difficult to avoid poverty related diseases (UNFPA, 2002).

High mortalities in poor countries are due to preventable, treatable diseases for which medicines and treatment regimes are readily available. Poverty has been implicated in many cases as the single dominant risk factor in higher prevalence rates of these diseases. These factors: Poor hygiene, ignorance in health-related education, non-availability of safe drinking water, inadequate nutrition and indoor pollution are exacerbated by poverty (Singh and Singh, 2008). For example the first line of treatment for Malaria recommended by WHO is in the use of ACTs. Research has shown that these drugs cost about $7.8-$10.3 (about N800 to N 1600) which are clearly unaffordable by majority of the poor (Onwujekwe et al., 2010). The purchasing power is limited and exposes the individuals concerned to inadequate treatment by quacks and ill equipped care providers.

Governments in developing economies are being encouraged to empower the people through building strong institutions which support equity and provide enabling environment for individual growth and development. High level corruption is the most cited impeding factor against providing basic infrastructure in education, health and economic sectors to empower and improve the living standards of individuals of many developing countries. No doubt the environment captured on Plates 27 and 28 which depict poverty will promote the transmission of these parasites in contrast to that of Plate 29.

Plate27: Urban Shanties;
Source: www.googleimages.com

Plate 28: Urban Slum;
Source: www.googleimages.com

Plate 29: Victoria Island Lagos;
Source: www.googleimages.com

Provision of basic amenities such as portable water and increased economic spending will improve the environment and support reduction of the numbers of these infections. Presence of portable water in endemic communities will reduce the frequency to visit infected natural or man-made water bodies. With this reduced contact, infections with Schistosomiasis will also decrease as has been demonstrated by the Carter center in Ethiope LGA of Delta State through the provision of boreholes and intensive health education of the LGA authorities. Improved water supply through donations by UNICEF, the Carter center and other agencies is a major factor in the eradication of Guinea worm in Nigeria, heartening news which came on December 6, 2013 when WHO declared Nigeria Guinea worm free. Improved water supply will also encourage the installation of water closet toilet systems which will reduce contamination of farmlands and nearby bushes especially in the rural areas, with faecal matter which are sources of infection with intestinal worms.

Adequate waste disposal systems including sewage should be erected to reduce transmission of these parasites. Untreated waste waters are not suitable for irrigation and the chances of contamination of farm produce with eggs and cysts of parasites are very high. Unsightly waste dumps dot our environment and are good breeding sites for insect vectors and other vermin that transmit infection.

Researchers should be at the forefront of Advocacy to bring to the attention of Government the need to enact legislation on degrading of the environment by mining and other careless engineering practices. This is necessary to stop the increased presence of suitable breeding sites of vectors and intermediate hosts, which extend the foci of infections. Re-vegetation of such abandoned pits and other forms of excavation is a right step to reduce further spread and transmission of infections. Impact assessment studies on irrigation processes and dams are still advocated. Evidence from studies in different parts of the world indicted these processes as epidemiologic factors enhancing transmission of Schistosomiasis and malaria (Dazo and Biles, 1972).

Intensive public health education and enlightenment of the populace create increased awareness which promotes more sanitary lifestyles that support improved health indices through reduction of infections. Community diagnosis studies and Knowledge, Attitude and Perception (KAP) evaluation of communities and at risk groups have clearly revealed the necessity to mount health education campaigns which explain sources of specific infections, prevention and treatment options. The population is encouraged to imbibe good hygiene practices such as cleaning and clearing the surroundings of homes, markets and work places, clearing bushes around the compounds-: covering of water pots and water storage containers that may serve as breeding sites for vectors, and good drainage.

Washing of raw fruits and vegetables thoroughly before consumption and regular washing of hands are still standard practice towards keeping parasitic infections at bay.

Visiting health care facilities for proper treatments and advice is recommended. These facilities are expected to implement first line policies and standard protocol for addressing the problems posed by these infections. However the attitude of health care professionals should become more patient-friendly in-order not to drive away those that need help. They need to draw a line between professionalism and downright rudeness, arrogance and lack of empathy.

Integrated control approach should receive increased support. For instance it has been shown that in most areas Soil transmitted helminthes, Schistosomiasis, Lymphatic Filariasis and Onchocerciasis co-exist. Using integrated approach will involve teams working together, armed with appropriate drugs to treat affected individuals. This will reduce the cost of individual teams going in to target specific infections. The evolvement and use of Community Directed Interventions (CDIs) have greatly improved surveillance and treatment regimes. These efforts include Mass Drug Administration (MDA), Public Health Surveillance and Vector control.

MDA involves treatment of several infectious diseases with the same drugs or a similar schedule of drug treatments in areas where they are prevalent such as Albendazole, Ivermectin and Praziquantel for STHs, Onchocerciasis and Schistosomiasis. This needs a large scale coordinated effort especially in securing commitments for the donation of the drugs, mobilization of communities and deployment of scientific teams. Individual governments and donor agencies partner in this venture in which the level of commitment and sincerity of the government are key to success. Vector Control is as important as MDA and should be pursued more vigorously to reduce vector populations and man-fly contact (**Nduka, 2014**).

Pharmaceutical Industries have played leading roles in trying to support the host win this game turned battle. Drugs play an important role in stemming the tide of infections and strike at the heart of the lethal team of parasites and microorganisms. Drug treatments are major components of control of parasites and Pharmaceutical companies have made major contributions in committing huge resources in Research and Development (R&D) and donating free drugs to endemic countries. In January 2012, WHO launched a roadmap to combat 10 key neglected tropical diseases, with support from 13 major pharmaceutical companies. This campaign is meant to target diseases that are widespread only in the developing world and form major barriers to the economic development of the affected countries. The contributory companies pledged to work in partnership with WHO, Governments and health and finance groups to strengthen their drug donation programmes, support drug distribution and implementation, and increase R&D in this disease area.

In the 'London Declaration on Neglected Tropical Diseases', WHO and 13 drug companies committed to these objectives for 2020: to eradicate guinea worm disease; make progress towards eliminating lymphatic filariasis, blinding trachoma, sleeping sickness and leprosy; and achieve control of schistosomiasis, river blindness, Chagas disease, visceral leishmaniasis, and soil-transmitted helminthes. The companies involved are Abbott, AstraZeneca, Bayer, Bristol-Myers Squibb, Eisai, Gilead, GSK, Johnson & Johnson, Merck KGaA, Merck Sharp & Dohme (MSD), Novartis, Pfizer and Sanofi (Pharmafield 2015).

It must be noted that the most successful treatment for Onchocerciasis or River Blindness is MSD's Mectizan (ivermectin). This is an oral medication that kills the parasite in its larval stage. On 11 October 2012 (World Sight Day), MSD celebrated 25 years of its programme to donate Mectizan for treatment of River Blindness. Through this programme, progress has been made towards eliminating the disease in Nigeria, Uganda, Senegal, Mali and Sudan through the African Programme for Onchocerciasis Control (APOC) and the use of CDI. MSD is committed to maintaining drug donations until the disease is eliminated.

Cesol (Praziquantel) is the only medicine with which all forms of schistosomiasis can be treated. This drug is manufactured by Merck Serono (a division of Merck KGaA). In 2007, the company committed to donate over a period of time, 200 million Cesol tablets to WHO for distribution to school-age children primarily in Africa, and to support awareness programme in schools. In January 2012, Merck Serono doubled its annual donation of 25 million tablets to 50 million, to be maintained until the disease is eliminated. It has committed to work with partners to develop a pre-school version of the drug. Seven million children were treated with Cesol in 2012, bringing the total to 28 million since inception of the programme. At the end of November2014, Merck Serono symbolically donated the 100 millionth Cesol tablet to WHO, and announced a new programme to distribute the medicine throughout Kenya (Pharmafield, 2015).

For over ten years, Sanofi has worked with WHO to provide drugs and develop treatment protocols for the disease Human African Trypanosomiasis or Sleeping Sickness. In 2011, the company renewed its commitment to fighting sleeping sickness through a $25m donation, extending its partnership with WHO by another five years. The company donates three of the five drugs used to treat the disease. In January 2012, Sanofi announced a global partnership with Eisai and the Bill & Melinda Gates Foundation to eliminate five NTDs including sleeping sickness and lymphatic filariasis. In July 2012, it noted that the sleeping sickness treatment programme had saved 170,000 lives and reduced the number of new cases from 30,000 in 2001 to 6,500 in 2011 (Pharmafield, 2015). WHO estimates that Africa may be clear of the disease by 2020 through these efforts and that will be a welcome development.

The Novartis Malaria Initiative is one of the pharmaceutical industry's largest access-to-medicines programs, focused on treatment, access, capacity-building and research & development.

Over the last decade, the initiative has delivered 700 million treatments without profit, mostly to the public sector, including 250 million pediatric antimalarials developed specifically for children. Moving forward, Novartis is committed to working towards malaria elimination by driving the development of next-generation antimalarials, with two new classes of drugs currently in Phase II clinical development (Novartis, 2015).

These efforts by the drug companies are very commendable and represent giant strides towards containment and possible elimination of these parasites. Researchers are the driving force behind R&Ds and Faculty of Pharmaceutical Sciences, Department of Pharmacology, The Centre for Malaria Research and Phytomedicine and other Biomedical Scientists are to lead this effort in this University. It is time to drop rigid stances and become open to possibilities of alternatives in the environment.

The concept of "reverse pharmacology" which has been expounded by Graz, et al; (2010a and b) working in Mali may serve as a guide to the future of finding solutions to parasitic infections in the African context. After *in vivo* studies which compared effect of popular phytopreparations on malaria parasite clearance in comparison with frontline ACTs, they concluded that, "reverse pharmacology" is an interesting alternative for the development of a validated phytomedicine because its results have public health and health policy implications. The primary objective of the study was not to develop new drugs but to provide information on phytopreparations already in use locally by the population. It complements existing strategies and can be used as a parallel with conventional drug development (Figure 4). The effort of the Centre for Malaria Research and Phytomedicine in validating some phytopreparations *in vitro* is noteworthy but more innovative approaches are recommended and the researchers in the core sciences are the bedrock of such forays.

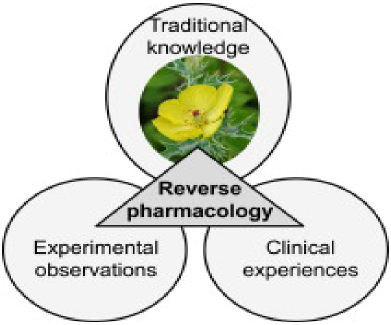


Figure 4: Concept of Reverse Pharmacology;
Source: Graz et al; (2010a).

Collaborative studies are important in changing the game in favour of the host. The idea of staying and working in silos, hugging tiny corners in feigned self importance is restrictive and unproductive and gives the parasite the upper hand. There is need for Public and Environmental Health Practitioners, Bio-medical Scientists, Bio-statisticians and Clinicians to collaborate with those in the Social Sciences, Economics, Sociology, Political Science and Geography in finding best possible points of interruption of transmission processes, evaluate the cost and effective means of intervention delivery, understand and highlight socio-cultural practices that encourage transmission, impede control and preventive measures and identify treatment seeking behavior. The political will to enact relevant laws and implement global agreements is key to winning this game especially in the face of evidence-based data.

I agree with Otubanjo (2010) that epidemiological data are required for many areas on parasitic diseases in Nigeria and there is a dearth of current data on all parasitic diseases in the country. No effective control and prevention can occur in the absence of epidemiologic data. Evidence-based decisions and implementations are needed by policy makers as vital ingredients for effective control.

Base-line data of prevalence is expedient and should be made available for effective control. This is a major aspect of surveillance that enhance national planning and monitoring of growth indices.

The current support by Donor agencies to Federal Ministry of Health to map some parasitic infections prior to intervention processes is laudable. This will provide the required data for National planning and surveillance (**Nduka, 2014**). The Government at various levels should consider counterpart funding and provision of logistics priorities for these internationally led efforts.

CONCLUSION

Mr. Vice-Chancellor Sir, I have in the past several minutes drawn attention to the fact that the parasite is an organism on the quest for survival, looking for shelter, food and transport howbeit in or on another organism which presents a mobile environment. The host on the other hand also wants to survive without the harassment of this imposed intruder. The host more often than not tries to eject this unwanted guest and the game of wits commences. The parasite has evolved varied adaptive strategies to outwit the host and ensure the perpetuation of its species. Some of these strategies harm the host and impose health, financial and social burden. This game is currently being played in our environment and for many of us in our bodies. Anyone, regardless of race or economic status, can become infected and all it takes is one carless step and exposure to source of transmission. CDC (2015a) states that:

1. More than 300,000 persons living in USA are infected with *Trypanosoma cruzi*, the cause of Chagas disease.
2. At least 1,000 people are hospitalized with neurocysticercosis every year.
3. Each year at least 70 people, most of them children, are blinded by the parasite that causes *Toxocariasis.*
4. More than 60 million persons are chronically infected with *Toxoplasma gondii.*
5. Each year 1.1 million people are newly infected with *Trichomonas,* a sexually transmitted parasite.

CDC (2015a) qualifies the above assertion that minorities, immigrants, and people living in poor or disadvantaged communities appear to be most at risk.

This deadly game which is a battle with many warfronts has been ongoing for centuries with casualties on both sides evidently documented from ancient writings till date. The effort to eradicate disease causing parasites is a movement fed from varied points with noticeable giant strides but the parasites keep one step ahead especially in environments where policy implementation is bogged down by insincerity and bloated bureaucracy. Many Generals and Commanding officers are leading this onslaught to defeat the parasites and invest in the future especially the future of the children. This is the same attitude the world adopts when faced with terrorists or rampaging dictators. They unite and deploy human and financial resources to challenge the threat and restore order. This cause is on but it is noteworthy that more commitment and concern are shown by many who are outside the endemic zones than those confronted with the problems. A coalition of funders led by Bill and Melinda Gate' s Foundations, including WHO, Global Fund, World Bank , USAID, The Carter Center and Pharmaceutical industries have committed human, infrastructure and monetary resources to this effort. Figure 5 shows clearly the poor commitment of funds to the fight against malaria by the countries with the highest risk in Africa. This attitude allows the parasite to keep winning the game especially in poor settings.

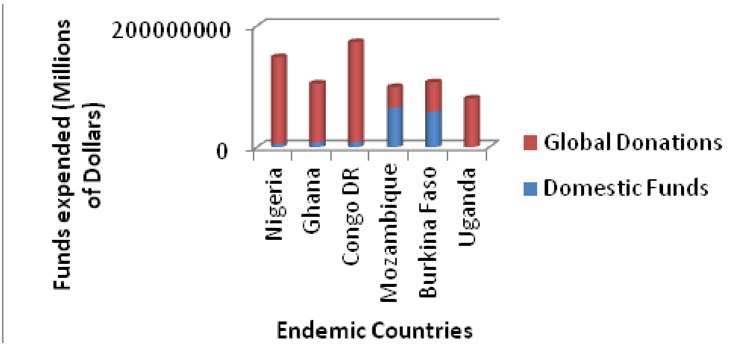


Figure 5: Funding of Malaria Interventions;
Source of Data: WHO (2014a)

Humans can achieve equilibrium relationship with their parasites if they are not malnourished or immune-compromised. A case in point is Toxoplasmosis which is acquired through eating raw or poorly cooked contaminated meat or by close contact with infected pets leading to accidental ingestion of the oocyst in the pet's faeces. More than 60 million men, women, and children in the U.S. carry the *Toxoplasma* parasite, but very few have symptoms because the immune system usually keeps the parasite from causing illness. However, Toxoplasmosis can have severe consequences in pregnant women with new infections and anyone with a compromised immune system (CDC, 2015a). However malnutrition is rife in poverty stricken environments and parasite burden may lead to morbidity. The parasite shows consideration in this situation by not laying eggs and only drawing enough nutrients for basal metabolism. It does not want the host dead.

Some argue that parasites contribute to biodiversity while others suggest they are unnecessary irritants. Their presence is a continuous reminder of the inability to use the gifts of nature aright. In developed climes where the consciousness of the inhabitants is high the beauty of their environment is on display and they make every effort to maintain structures and reduce transmission- enhancing factors of parasites. The purer their inner thoughts the more beautiful and uplifting are their surroundings. They are ever on the alert to lower the chances of infection and have infrastructure to handle any challenge to the best of their abilities.

In contrast the less conscious individuals populate the developing clime and their selfish pursuits show clearly in the ugliness of the environment defined by high levels of dirt and impurities. The open drains filled with trash, gullied roads with stagnant smelly water, grasses whose heights compete with trees in living quarters and even in surroundings of health facilities tell the story of an unconscious group that does not care to positively impact the individual corners positively for wider benefits. They perpetually trade blames and abuse their leaders for everything that goes wrong. Meanwhile leaders reflect the collective strengths and weaknesses of a people.

The parasites and their friends are there to keep individuals on their toes to get things right, to pay attention to Nature, to understand the mechanics that govern existence and cooperate with same. The more humans tamper with the ordained order the more ugly forms arise. The tampering has given rise to deformed environment such as the front burner issues of climate change and global warming. This observed change in temperature will no doubt influence the mutation and distribution of parasites and their infections and may extend the frontiers of transmission.

Imagine the following dialogue between parasite and host.

Parasite: Knock knock

Host: Who is there?

Parasite: Me, parasite

Host: What do you want?

Parasite: To come live with you. I need a house, food and transport and I will also raise children.

Host: Not on your life. Lock down all escape routes.

Parasite: Please don’t react this way, my needs are small. Just eat well and you won’t know I am here.

Host: Are you still here? Now soldiers charge!

Soldiers report: We have killed many, but they change. Ah! They are looking like us, they are even infecting our cells, and they multiply faster. We are being overwhelmed.

Parasite: I asked you to live and let’s live but you chose to fight.

Oh! I love this game.

Bring it on.

Thank you so very much for listening.

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CITATION ON
PROFESSOR FLORENCE ONYEMACHI NDUKA
(Nee OKORONKWO)

When a baby of the fairer sex arrived the family of Anthony Christopher Onyewuchi Okoronkwo (now late) and Mrs Kate Adaure Okoronkwo (still with us today), on the 20th February 1958, hardly could anyone hazard a guess as to the rapidity or magnitude of achievements that lay in wait for that baby girl. Today we are the wiser.

Education

Professor Florence Onyemachi Nduka started her academic voyage with nursery and part of primary education at Christ the Kings School, Aba (CKS) 1961-1964; and continued this at St. Paul's School, Diobu, Port Harcourt, 1965-1967. Although the war briefly interrupted the process, the ship set sail again and anchored in Immaculate Hearts Secondary School Umungasi Aba, Abia State in 1971 where she picked her WASC with Grade 1 in 1975. Armed with this, she proceeded to the University of Nigeria Nsukka in 1976 and graduated with a BSc Honours Degree, Second Class Upper division in Zoology 1980. Professor Nduka (Mrs) obtained her Phd Degree in Parasitology, UNN at 27 years and joined the prestigious and select group called the Lions and Lionesses. At this point Mr.

Vice Chancellor, Professor Florence O. Nduka switched from a sailing ship to a soaring jet and how meteoric a soar, it has been.

Professional Experience

Our inaugural lecturer today rose through the ranks in academia albeit, rapidly. She joined the Imo State School system in 1982 after her national service, was employed as Lecturer 11 in Abia State University in 1988 and rose to the rank of Professor of Parasitology in 2006. Professor Nduka meritoriously occupied that Chair till 2012 when she joined the University of Port Harcourt and is the current HOD of Animal and Environmental Biology, Uniport.

She is widely published in both local and international peer-reviewed high impact journals in her field of specialty; has supervised several undergraduates, 8 Masters and 7 PhD students, two of whom are professors already. She is also widely travelled and has attended and delivered papers at numerous conferences in different parts of USA, in China, Glasgow, Britain, Brazil, South Korea, Senegal etc.

Mr. Vice- Chancellor, Sir, Professor Nduka's contributions to knowledge and nation building cannot in any way be gainsaid or belittled. She has chaired and served simultaneously in various capacities in well over 14 university-wide committees/panels at ABSU and has indeed continued the trail since she joined Uniport. In all these she has carried herself with dignity, grace, forthrightness and has made excellent intellectual inputs without arrogance or rancour. She always sings the song of rectitude in a way she alone can i.e. she exudes that calmness of a resting lioness and comes across with her arguments in a gentle, poetic almost musical voice, delivered with such decided firmness that the unwary and unserious minded is taken aback at her strength of character.

How can anyone then adequately sing the praise of one who since 1995 has bestrode several positions of responsibility and has delivered in all? Which of these is for mention or for neglect? Her membership of admissions Committee for 8 years (1995-1998;

2002-2008), 3-term ASUU Treasurer (1993-1998), Faculty Senate Representative (1996-2000) or Senate representative, A & PC (1999-2008). Others include: HOD, Zoology and Microbiology 2000-2002; Director, SIWES 2003-2006; Director, Academic Planning 2006-2010, Director, Research and Publications 2011-2012; Representative, Senate Ceremonial Committee 2000-2010; Senate Representative, Abia State University Teaching Hospital Board 2003-2006; Editor, *Sciencia Journal,* Faculty of Biological/Physical Sciences, Abia State University; University Orator for 7 years 2005-2012; Visiting Professor on Sabbatical Leave, University of Port Harcourt 2010-2011; HOD, Animal and Environmental Biology, University of Port-Harcourt, 2014 to Date. She is also External Examiner B.Sc, M.Sc. and PhD /Assessor to UNN, IMSU, EBSU, FUTO.

Membership of Professional Bodies

- Member, Parasitology and Public Health Society of Nigeria (PPSN)
- Member, Third World Women in Science (TWOWS) now OWDWS
- Member, American Society for Tropical Medicine & Hygiene

Academic Awards Received;

- International Conference on Women and Infectious Diseases, Scholar 2006.
- British Society of Parasitology Bursary Award, to attend International Congress of Parasitologists, Glasgow Scotland, 2006.
- TETFUND award to Thailand. 2011.

Consultancy Services

Our inaugural lecturer today is a Consultant to Federal Ministry of Health, Nigeria and Bayelsa and Rivers State Governments.
Currently she is listed on the WHO Expert Database for *Schistosomiasis* and Soil-transmitted Helminths.

Community service

Professor Nduka's influence extends to the larger society where her efforts have been severally rewarded with rare and prestigious titles including: ***Ugo Si Mba***, Conferred by Catholic Women Association (Though not a Catholic); ***Ugegbe Eji Ahu Uzo*** of Umuaro Umunumo; **Chief Nneoha** of Ebem Ohafia, 2011. **President-General**, Umunumo Women Association, Ehime Mbano LGA 2012-Date and **First Vice-President**, University of Port Harcourt Women Association (UPWA) 2012-date. Lest we forget, in her days in the university she competed and roundly defeated her two male opponents to clinch the post of Secretary General, Graduate Students Union, UNN.

With such a profile, Vice-Chancellor, Sir, who cares about affirmative action?

Professor Florence Nduka is joyfully married to Professor Ethelbert C. Nduka, the immediate past Deputy Vice-Chancellor (Administration), University of Port Harcourt. They have four successful children. She loves flowers around the home, classical music and poetry.

Mr. Vice-Chancellor, Sir, Distinguished and Honourable Ladies and Gentlemen, may I humbly and formally present to you: the 120^{th} Inaugural Lecturer, a renowned Parasitologist, excellent Academic and Administrator, a Trainer of trainers, a multi-tasker, recognized in WHO's pool of experts, *Ugo si mba*, *Ugegbe eji ahu uzo*, Chief Nneoha, an eloquent orator, a sweet mother, a wife and astute researcher the female masquerade of today - Professor (Mrs) Florence Onyemachi Nduka!!!

Thank you.

Professor Gordian Chibuzo Obute