**CHAPTER 1**

**INTRODUCTION**

## **1.1 BACKGROUND**

Mosquitoes are of tremendous public health importance because of their ability to host and transmit various disease pathogens and parasites including virus, protozoa and nemathggodes *( Onyido et al;2010)*. Mosquitoes are small blood sucking flying insects that constitute the most important family of insects from the stand point of human health . They the belong to the order Diptera and family culicidae, and there are about 41 genera and about 3,500 species of mosquitoes worldwide .Mosquitoes are considered a serious problem to man due to the annoyance they cause in biting , the allergic reaction associated with their bite, restlessness and nuisance *(Onyido et al;2009)* . Mosquito alone transmit diseases to more than 700million people annually (*Taubes,1997*). Among the arthropods of public health and veterinary importance, the mosquito rank first in the spread of such diseases as malaria, yellow fever, filariasis, dengue fever, encephalitis as well as other viral and bacterial diseases (Gillet 1972, service 1980 ). Anopheles species are known to are known to transmit human malaria parasite ( plasmodium) ; Aedes aegypti and some other species transmit yellow fever and dengue fever viruses, while Culex quinquefasciatus transmit lymphatic filariasis ( Onyido et al; 2010). Blood sucking habit of adult mosquitoes help them to suck up pathogens and parasites from their vertebrate hosts. This is a unique feeding habit of mosquito whereby only the adult female bites man and other animals and transmit diseases while the male feeds on plants juice only.

Mosquitoes are worldwide in distribution and is known to breed in stagnant water collections such as discarded old vehicles tires exposed to rain, tree holes, plant leaf axis, ground water pools, plastics and metallic cans littering the environment, blocked gutters and even septic tanks (Onyido et al., 2009). In Africa, Asia and America, mosquitoes have utilized the opportunity afforded by unplanned urbanization in tropical countries and the associated poor waste collection which yields waste containers, to breed profusely. Breeding opportunities of mosquitos are expanded by inadequate piped water supplies in rapidly expanding areas of poor housing, as well as the storage of rain water, water from wells and street standpipe in a variety of containers for domestic use (Barrera et al, 1993). All these factors that aid in the breeding of mosquitoes are present in many settlements in Nigeria.

**1.2 Statement of the problem**

Mosquitoes transmit important public health diseases such as Malaria, Yellow fever and Filariasis. These diseases constitute one of the major health problems in Nigeria. Malaria is a life threatening parasitic disease transmitted through the bites of infected female Anopheles mosquitoes. It remains a public health problem in Nigeria being the most common cause of hospital attendance in all age groups in all parts of the , its epidemiology and environmental impact ountry (Chukwuocha et al; 2009). In 2018, an estimated 228 million cases of malaria occurred worldwide, and 405,000 deaths recorded, with children under the age of five being the most vulnerable recording 272,000 death worldwide (World Malaria Report 2019).

**1.3 Significance of the Study**

There is need for a good and proper study of the breeding, biting activities and ecology of human- biting mosquitoes in different places before embarking on any useful control measure. The study of human-biting species of mosquitoes and their breeding sites within Okpuno,Awka as aa community will help determine ways of protecting the inhabitants from mosquito bites and mosquito borne diseases. A versatile knowledge of the ecology of the human-biting mosquito species is useful in knowing its mode of transmission, its epidemiology and environmental impact as well as planning control strategies and community awareness to ensure efficiency of the control program. Its useful in reducing costs and wastage of resources during the planning.

**1.4 Aim and Objective**

The main aim of this study is to investigate the breeding sites and biting ecology of mosquitoes in Okpuno Awka, Anambra State

The specific objective were to

* Identify the breeding site of mosquitoes in okpuno.
* Collect and Identify the various mosquito species found in the breeding site.
* Collect and Identify human-biting mosquitoes through human-baited catches.
* Determine their biting pattern ,biting rate and period of biting.

**CHAPTER TWO**

**LITERATURE REVIEW**

**2.1 Biology of mosquitoes**

Mosquitoes are two-winged insects belonging to the order Diptera of the class insecta. Within the order diptera, they belong to the family culicidae (*harbach 2008).*mosquitoes have a hemimetabolous type of development; that is, having four Distinct stages in their life cycle: egg, larva, pupa, and adult. The mosquito life Cycle begins with an adult female laying eggs. Aquatic immature stages called Larvae emerge and develop through four moults (instars), increasing in size until The final moult when it reaches the non-feeding pupal stage. Inside the pupa the adult mosquito develops (either a male or female) and the terrestrial/aerial adult Stage emerges from a split in the back of the pupal skin. The adult mosquitoes Feed, mate, and the female develops eggs to complete the cycle and begin the Next generation.

**2.2 Morphology of Mosquitoes**

Mosquitoes are very small insects which vary in length but is rarely greater than 6mm and weighs up to 2.5mg (Fig 1). All mosquitoes have slender bodies withThree body divisions: the head, thorax and abdomen. Mosquitoes also vary in colour According to the colour of their scales. Many species have inconspicuous colouring. Others have black and white bands or patches of coloured scales on their bodies and Legs and sometimes on their wings.

The head is specialized for acquiring sensory information and for feeding. The head contains the eye and a pair of long, many segmented antennae. The antennae are important for detecting host odours as well as odours of the breeding sites where females lay their eggs. In all the mosquito species, the antennae of the males in comparision with those of the females are noticeably bushier and contain receptors that detect the characteristic whine of the females. The compound eyes are distantly separated from one another.

The head also has an elongated forward-projecting proboscis used for feeding and two sensory palps. The maxillary palps of the males are longer than their proboscis whereas in the females, maxillary palps are much shorter as with many members of the mosquito family. The female is equipped with an elongated proboscis that she uses to collect blood to mature her eggs.

The thorax is specialized for locomotion. Three pairs of legs and a pair of Wings are attached to the thorax. The insect wing is an outgrowth of the exoskeleton.

The abdomen is specialized for food digestion and egg development. This segmented body part expands considerably when a female takes a blood meal. The blood is digested over time , serving as the source of nutrient for the production of eggs which gradually fill the abdomen.

**2.3 LIFECYCLE**

The mosquito’s life cycle includes four stages: egg, larva, pupa, and adult.

This type of development is referred to as complete metamorphosis. An adult female mosquito mátes with a male once in her life time. She then stores the sperm for the duration of her life, which is up to 100 days. Within a single feeding, a female has the ability to lay up to 200 eggs or more every 7 days (Mosquito Squad, 2020). The next life stage of a mosquito is the larva; they remain in this state for 5 days. After molting three times, the larva becomes a pupae. Mosquitoes are pupae for up to 4 days. It is within these few days that they develop into adult mosquitoes and emerge out of the

Pupal skin and to the surface (Mosquito Squad, 2020). Once mosquitoes

Have emerged from the water, they remain on the surface of the water for a

Short period of time to dry off their wings and allow their body to harden. In

A couple of days, mosquitoes are ready to breed and feed and start the cycle

Once again. Unfortunately for males, they only live for a week; meanwhile, the females live up to 100 days (Mosquito Squad, 2020)

**2.3.1 Egg Biology**

One factor common to all mosquito species is that eggs are laid in association

With free water or on a moist surface. Eggs are laid singly by some species, and others lay eggs together to form rafts. The incubation period may vary considerably

Among species. The females of floodwater species will lay their eggs on a wet substrate or on moist soil. It is a requirement that their eggs dry out for a period of

Time before they will become viable. Once they have passed through the critical

Dying time, they may hatch if the area is flooded by rain or flood water. Eggs of

Permanent-water mosquito are laid on the water surface either singly or in a raft

Containing up to 300 eggs. The permanent water eggs cannot survive if the water dry

Out and therefore must be laid in a fairly permanent source of water such as a lake

Or swamp. The eggs of permanent water species hatch within about 2-3 days.

**2.3.2 Larval Biology**

The larval stage of the mosquito is aquatic. The larvae are legless and spend the majority of its time at the surface of the water. The larval stage is commonly referred to as “Wriggler” or “Wiggler”, due to the movements of the abdomen that ve them forward, backward or sideways in the water. They can stay submerged for some time. Feeding during the larval mosquito stage is accomplished through the ingestion of particles filtered from the water surface. The larvae provide nutrition for non-feeding, yet active stage of the pupa. During the larval stage, the mosquito will shed its skin or moult four times. Each of the periods in-between the moults are called an instar. Towards the end of the 4th instar, the mosquito larva stops feeding and moults into pupal stage (FMCA 2009).

**2.3.3 Pupal Biology**

The pupal stage of the mosquito is also aquatic, the mosquito pupa is shaped like the letter comma and also spends the majority of time at the surface of water.

The head and thorax are combined to form the cephalothorax which has dorsally a

Pair of respiratory trumpets. The abdomen which is the second division consist of 10 segments. During this time the mouthparts, legs and wings of the adult are developing in sheaths that can be seen through the integuments of the cephalothorax (Service 1980).

**2.4 ECOLOGY OF MOSQUITOES**

**2.4.1 Feeding and Breeding Behaviour of Mosquitoes**

Mosquitoes exhibit host preference behaviour and rhythmic patern in the biting

Behaviour. The difference in the feeding pattern contributes significantly in the

Transmission pattern of diseases among various hosts during different seasons.

The spatial distribution of a disease may be influenced by the blood feeding

Behaviour of the mosquitoes (Dye & Hasibeder, 1986)

The choice of host in nature by the mosquitoes mainly depends on the

Availability of different hosts and the innate behaviour of species preference.

Based on the feeding behaviour on different hosts, mosquitoes have been

Classified predominantly as anthropophilic (preferably feed odn human) and

Zoophilic (preferably feed on animals).

The high degree of anthropophilic feeding behaviour of mosquitoes determines the efficient transmission of pathogens to human. Multiple intake of blood meals by the mosquitoes is considered to be more dangerous and is an efficient way in the transmission of the pathogens to humans. The host selection behaviour of mosquitoes is not uniform in all places (Reuben, 1995)

The biting rhythm of mosquitoes is controlled by an intrinsic biological clock mechanism and the extrinsic light and dark cycle factor (Senthilkumar & Pandian, 2007). The availability of host also determines the change of feeding behavior by vectors, i.e. shifting of exophagic feeding behaviour endophagic feeding behavior and vice versa (Pandian & Chandrashekaran. 1980). The difference in the rhythmic pattern of biting behavior of mosquitoes is an effective adaptive behavior share the hosts in the cycle.

In addition to the feeding behaviour, identification of breeding behavior of mosquitoes in an ecosystem is very vital and this helps in better understanding Of the life cycle of mosquitoes. Mosquitoes select their preferable breeding habitats for oviposition. Though they breed in almost all the available breeding sites (particularly the lentic aquatic habitats) in the ecosystem, some of them are selective in nature and exhibit preferential habitat selection. (Devi & Jauhari,2005) reported different breeding habitats of mosquitoes such as natural (river Bed, forest pools, stagnant water, tree holes, rock pools, streams etc.) and man – made artificial breeding habitats (containers, fridge trays, plastic drums, mud pot, cement cisterns, discarded tyres etc.). The mosquito genic breeding habitats are permanent or temporary, lighted or shady. However, it is interesting to know that each mosquito preferably breed in selected breeding sites by exhibiting preferential habitat selection.

Several anthropogenic factors impose an alteration in the population dynamics of mosquitoes or create new breeding sites, which in turn increases the breeding surface areas for mosquitoes.

Construction of dam in Brazil, water coolers (Sharma et al., 2005), cement

Cisterns and unused grinding stones (Tewari et al.. 2004) in India, home gutter

Roofs in Australia (Montgomery and Ritchie 2002), flower vases in the

Cemeteries in Argentina (Vezzani. 2007), stagnate water stored in buckets by Farmers in southern Taiwan to irrigate their dry farmland (Chuang et al., 2009) Etc. are some of the man-made breeding habitats, which have been shown to be Successfully exploited as breeding sites by mosquitoes. The above habitats are Utilized by the mosquitoes, not only in the cited countries but also in many Countries.

Agronomical practices of human create potential breeding sites for the rapid Proliferation of certain species of mosquitoes. Periodic monitoring of the Breeding habitats of mosquitoes in an ecosystem facilitates the public health Personnel to identify the key breeding sites of mosquitoes and to target the Control operations especially during outbreak situations. Therefore, the number And type of breeding habitats are increasing everyday in different parts of the World. Mosquitoes tend to change their breeding behaviour because they have Enormous options to choose different habitats.

**2.4.2 Biting Behavior of Mosquitoes**

Female mosquitoes feed on animals and humans. Most species show a Preference for certain animals or for humans. They are attracted by the body Odours, carbon dioxide and heat emitted from the animal or person. Some species prefer biting at certain hours, for example at dusk and dawn or in the

Middle of the night. Feeding usually takes place during the night but daytime

Biting also occurs. Some species prefer to feed in forests, some outside of

Houses, others indoors. Because digestion of the blood-meal and development of

The eggs takes several days, a blood-fed mosquito looks for a safe resting place

That is shaded and offers protection from desiccation. Some species prefer to rest

In houses or cattle sheds, while others prefer to rest outdoors, on vegetation or at

Other natural sites. Mosquitoes do not usually bite while eggs are developing.

The behaviour of mosquitoes determines whether they are important as nuisance

Insects or vectors of disease, and governs the selection of control methods.

Species that prefer to feed on animals are usually not very effective in

Transmitting diseases from person to person. Those that bite in the early evening

May be more difficult to avoid than species that feed at night. Mosquitoes that

Rest indoors are the easiest to control

**2.5 Classification of Mosquitoes**

According to Harbarch, (2008), mosquitoes are classified into:

Kingdom- Animalia

Phylum – Arthropoda

Class – Insecta

Order – Diptera

Suborder – Nematocera

Family – Culicidae

Super family – Culicoidea

Subfamilies -i. Anophelinae

ii. Culicinae

ii. Toxorhynchitinae.

**2.6 Diseases Transmitted by Mosquitoes**

Mosquitoes are carriers or vectors for some of humanity’s most deadly Illnesses and they are public enemy number one in the fight against global infectious Diseases. Mosquito-borne diseases cause millions of death worldwide, every year With a disproportionate effect on children and the elderly in developing countries ([www.nationalgeographic.com](http://www.nationalgeographic.com)). Some of the important diseases transmitted by mosquitoes are described below.

**2.6.1 Malaria**

Malaria is a mosquito-borne infectious disease affecting Caused by single-cell parasitic protozoa plasmodium(WHO 2014),transmitted to humans via the bite

The female Anopheles

Mosquito; parasites multiply in the liver attacking red

Blood cells resulting in cycles of fever, chills and sweats accompanied by

Anemia; death due to damage to vital organs and interruption of blood supply to

The brain(Caraballo, 2014).Endemic in 100,mostly tropical countries with 90%

Of cases and the majority of 1.5-2.5 million estimated annual deaths occurring in

Sub-Saharan Africa.

**2.6.2 Dengue Fever**

Dengue fever is a mosquito- borne tropical disease caused by dengue

Virus(WHO,2015).The disease is associated with urban environments.

Symptoms typically begin three to fourteen days after infection (Kularatne,

2015).This may include a high fever, severe headache, vomiting, muscle and

Joint pains, and a characteristic skin rash. Occasionally produces shock and

Hemorrhage leading to death in 5% Of cases. Dengue is spread by several

Species of mosquito of the Aedes type, principally A.aegypti.

**2.6.3 Yellow Fever**

Yellow fever is a viral disease of ypically short duration(WHO, 2013).In most cases, symptoms include fever, chills, loss of appetite, nausea, muscle pains particularly in the back and headaches The disease is caused by the yellow

Fever virus and is spread by the bite of an infected female mosquito.

**2.6.4 Chikunguya**

Chikumguya is an infection caused by the chikunguya virus (WH0,

2016).Symptoms include fever and joint pain (CDC April 2016).These typically

Occur two to twelve days after exposure. Others symptoms may include

Headache, muscle pain, joint swelling and a rash. The virus is spread between

People by two types of mosquitoes. Aedes albopictus and Aedesaegypti

**2.6.5 Zika Fever**

Zika fever, also known as Zika virus disease or simply Zika, is an infectious

Disease caused by the zika virus (WHO, 2016) .Most cases have no symptoms,

But when present they are usually mild and can resemble dengue fever (European Centre for Disease Prevention and Control, 2015) Symptoms may

Include fever, red eyes, joint pain, headache, and a maculopapular (Chen, Lin, Hammer, Davidson, 2016) .It has not caused any reported deaths during the

Initial infection (European Centre for Disease Prevention and Control, 2015) .

**2.6.6 West Nile Virus**

West Nile virus is a single stranded RNA virus that causes West Nile fever. It is a member of the family Flaviviridae, specifically from the genus Flavivirus,

Which also contains the Zika virus, dengue virus and yellow fever Vzirus.West

Nile virus is primarily transmitted by mosquitoes, mostly species of the ge genus

Culex. The primary hosts of West Nile virus are birds, so that the virus remains

Within a “bird-mosquito-bird”

**2.6.7 Filariasis**

Filarias is a parasitic disease caused by an infection with roundworms of the

Filarioidea type (CDC, 2010).These are spread by blood-feeding mosquitoes

And black flies. This disease belongs to the group of diseases called

Helminthiases. Eight known filarial nematodes use humans as their definitive

Hosts. These are divided into three groups according to the niche they occupy.

Lymphatic filariasis is caused by the worms Wuchereria bancrofti,Brugia

Malayi and Brugia timori. These worms occupy the lymphatic system.

Subcutaneous filariasis is caused by Loa loa, Mansonella streptocerca and

Onchocerca volvulus.