



ADDIS ABABA UNIVERSITY

COLLEGE OF NATURAL AND COMPUTATIONAL SCIENCES

DEPARTMENT OF ZOOLOGICAL SCIENCES

**SPECIES COMPOSITION AND ABUNDANCE OF MOSQUITOES
IN SELECTED AREAS OF GOBU SAYO DISTRICT, WEST
OROMIA, ETHIOPIA.**

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**MSC THESIS SUBMITTED TO THE DEPARTMENT OF ZOOLOGICAL
SCIENCE IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE
DEGREE OF MASTERS OF SCIENCE IN BIOLOGY.**

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SEPT, 2018

ADDIS ABABA, - ETHIOPIA

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Acknowledgement

I would like to express my deepest gratitude to my advisor, Dr.Sisay Dugassa for his professional, consecutive advice and critical remarks from the time of preparation of the proposal to the completion of this thesis.

My greatest gratitude is extended to Addis Ababa University, College of Natural and Computational Science, Department of Zoological Science for financial support.

Besides to this, I would like also to express my heart-felt thank to the professional worker of Gobu Sayo district clinic who showed me the location of mosquitoes breeding areas and showed me the kebeles in which majorities of mosquitoes species are found.

I also would like to thank the staffs of Ethiopian Public Health Institution (EPHI), for their willingness in providing me with all the necessary equipments and different support for my research.

Finally, I owe especial respect to my wife w/o Almaz Dessalegn, for her encouragement to my graduate study and support and giving me due attention especially in editing the text.

Acronyms/ Abbreviations

CD _____ Center for Disease Control

SP _____ Sporozoite

CITN _____ Conventional insecticide treated net

EPHI _____ Ethiopian Public Health Institution

FDRoEMoH ___ Federal Democratic Republic of Ethiopia Ministry of Health

GPS _____ Global position system

ITBN _____ Insecticide Treated Bed Net

LLIN _____ Long Lasting Insecticidal Nets

PCR _____ Polymerase chain reaction

RH _____ Relative humidity

SPSS _____ Statistical packages of social science

SPECIES COMPOSITION AND ABUNDANCE OF MOSQUITOES IN SELECTED AREAS OF GOBU SAYO DISTRICT, WEST OROMIA, ETHIOPIA.

Abstract

Prior to implementing vector control, it is always important to have baseline information about the species present and their densities. This study was conducted in selected areas of Gobu Sayo district East Wollega Zone, West Oromia, Ethiopia between September and August; 2018. It was intended to identify mosquito species present and estimate their abundance. Hand collection, spray sheet collection and hand net collection methods were used. It was investigated that *Anopheles*; *Culex* and *Aedes* mosquitoes are widely found in the study areas. The mosquitoes belong to Family Culicidae ;-(subfamily anophelinae and culicinae). Those mosquitoes were morphologically identified by using identification key under compound microscope based on their morphological characteristics. *Anopheles* were 600, the most predominant in all the selected areas. The second most abundant was culicine mosquitoes 260 followed by *Aedes* 40. Generally, 900 individual adult mosquitoes were sampled from the three kebeles. The main rainy season usually extends from June to August and short rainy season occurs in March to May. The mosquitoes appear abundantly following the short rainy season (March to May) and the main rainy season (September to December). The principal malaria vectors, female *Anopheles* mosquitoes are abundant in the district.

Key words/phrases: Mosquito, species composition, abundance, Gobu Sayo district

1. Introduction

1.1 Back ground

Mosquitoes are among the most disturbing blood sucking insects affecting human beings. The behavior of female mosquitoes involving feeding on human blood is responsible for the transmission of a number of diseases (Malebo *et al.*, 2012).

Mosquitoes were belonging to kingdom –animalia, phylum-arthropoda, class-insecta, order-diptera, family-Culicidae, subfamily-anophelidae, genus-*Anopheles*, *Culex*, and *Aedes*. Species of *Anopheles* were *Anopheles gambiae*, *Anopheles funestus*, *Anopheles nili*, and *Anopheles pharoensis*. (WHO, 2010). Female mosquitoes belonging to the genus *Anopheles* transmit plasmodium parasite that transmit malaria disease.

Five species of plasmodium cause malaria disease in human: *Plasmodium falciparum*, *Plasmodium vivax*, *Plasmodium malariae*, *Plasmodium ovale* and *Plasmodium knowlesi*. Of this, *Plasmodium falciparum* is the most important in most part of tropics and is responsible for most severe illness and fatal malaria disease (WHO, 2009).

In 2008, world health organization reported estimated values of 243 million cases with mortality of about 863 thousand in the world (Anyanwu, 2017). Malaria is a major cause of mortality in the world creating a significant barrier to economic development. Some mosquitoes are enter house to bite that are being described as endophagic; other bite at outdoor that are called exophagic. After taking blood meal the mosquitoes usually rest for short period. Mosquitoes that enter a house usually for rest on wall, under furniture and on clothes hanging in house are said to be endophilic. Mosquitoes that bite outdoor usually rest on plants, in hole, on the ground or in other cool dark place is termed as exophilic (WHO, 2008).

Between 2000 and 2012, death due to malaria declined by 42% globally, and the reduction is higher (49%) in Africa. In 2013, malaria mortality rate declined by 47% globally and 54% in Africa compared to 2000, with malaria causing 5, 84,000 deaths (Massebo, 2017). It was reported that, more than 50% people in Africa slept under long

lasting insecticide mosquitoes nets compared to 2% in 2000. So due to the distribution of long lasting insecticide mosquitoes nets the mortality rate declined year to year. In Ethiopia, the coverage of long lasting insecticide mosquito's nets and ant malarial drug has increased since 2005. Today, long lasting insecticide mosquito nets threat of insecticide resistant vector. The principal female *Anopheles* mosquitoes are resistant to insecticide in endemic countries, including Ethiopia. In 2009 in Ethiopia, DDT was banned due to the wide spread problem of resistant in the population of *Anopheles arabiensis* (Massebo, 2017).

In East Wollega zone, Gobu Sayo Woreda, Gambella Tarre Kebele is one of the public health problem and one of the malarious Kebele where little no perception about malaria vectors. The knowledge gap and gap of lack of perception about species composition of *Anopheles* mosquitoes make malarious Kebeles. A better understanding of species composition, feeding pattern, resting behavior and the age structure of local malaria vector are also important to plan supplemental vector control (Massebo, 2017).

The world health organization has recommended vector control as important components of global strategy for preventing malaria, while the vector identification forms an essential component of the strategy. Mosquitoes are large arthropod groups with 3500 species, 38 genera, two subfamily groups; only about hundreds of them are vectors of human disease. Subfamily anophelinae-include the most important genus *Anopheles* which transmit malaria. *Anopheles* mosquitoes also involved in transmission of filariasis in West Africa. Subfamily culicinae- includes important genera; *Aedes*, *Culex* and *Mansonia*. Yellow fever and dengue are caused by *Aedes*. Encephalitis caused by *Culex* and all of these mosquitoes are also involved in the transmission of filariasis (WHO, 2010).

1.2. Statement of the problem

In East Wollega zone, Gobu Sayo Woreda, Gambella Tarre, Ongobo Dambi and Aggo Laften Kebele were malarious Kebele where little or no perception about mosquito species composition. The knowledge gap and gap of lack of perception about mosquito species composition and abundance make malarious Kebele. Mosquito Species composition and

abundances are not studied in the Woreda. I am going to fill this gap of lack of perception about mosquito species composition and abundance in Gobu SayoWoreda. Female *Anopheles* mosquito was malaria vectors that carry *Plasmodium* parasite which transmit malaria disease. A better understanding of mosquito species composition, feeding pattern, resting behavior and the age structure of local malaria vector are also important to plan supplemental vector control (Massebo, 2017).Malaria is the most serious and costly of all insects-borne disease and continues to kill between one to three million people per year. Female *Anopheles* mosquito was the most important vector-borne disease.

1.3. Significance of the study

Since *Anopheles arabiensis* were resistance to some insecticide it is important to know whether or not present in the study area to give forward other solution of control method. It is used to understand mosquito species composition and abundance in Gobu SayoWoreda. It is important to know breeding site of mosquitoes. It is used to tell types of mosquito species found in the study areas for the health center of the woreda since they do not know each species composition of mosquitoes. It is enhance, how to control mosquito species and it is important for further research. It is also important to perceive the affect of mosquitoes to human.

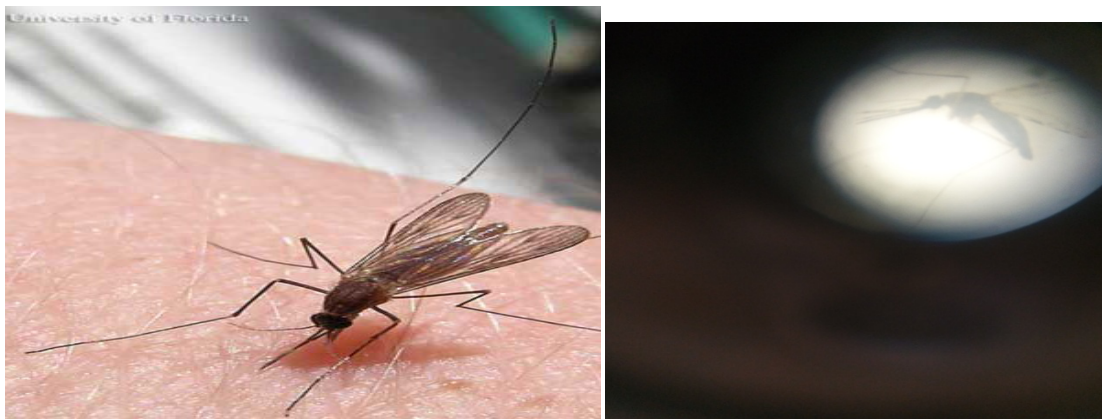


Plate 1 Female *Culex* mosquito and female *Anopheles*

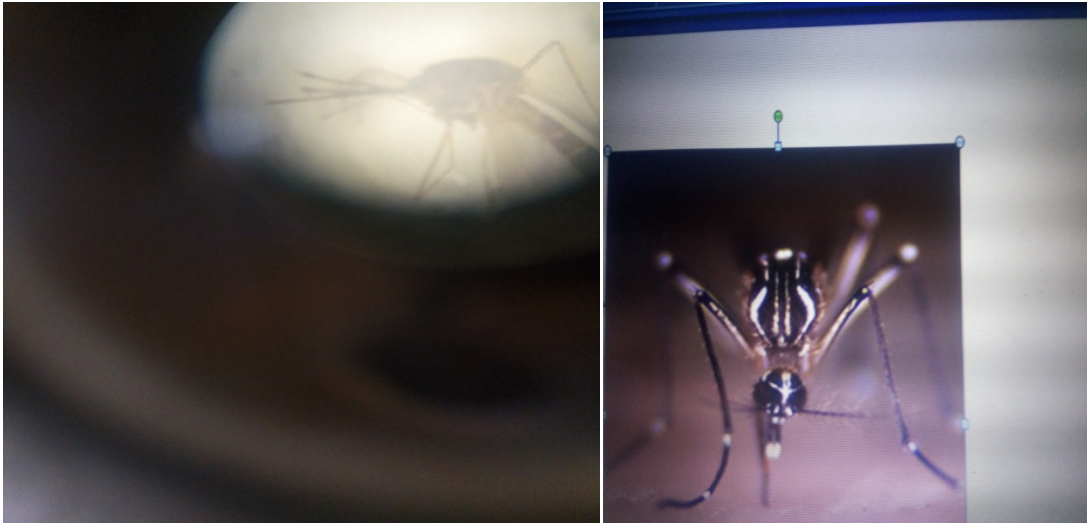


Plate 2 Male *Culex* and male *Aedes* mosquito



Plate 3 *Anopheles* mosquitoes

1.4. Research question

Research questions were:

1. Which species of mosquitoes are found in the study areas?
2. Among species of mosquitoes, which one is the most dominant in the study area?
3. What is the prevalence of mosquito that transmits malaria?
4. How can we control *Anopheles* mosquitoes?

1.5 Research Objectives

1.5.1 General objective

To know mosquito species composition and abundance across altitude along months in Gambella Tarre, Ongobo Dambi and Aggo Laften kebeles, in Gobu Sayo Woreda, East Wollega Zone, west Oromia, Ethiopia.

1.5.2. Specific objectives

- ❖ To differentiate mosquitoes species with major external morphological features.
- ❖ To identify the different mosquito species abundance and densities across altitude in different kebeles.
- ❖ To assess mosquito species abundance and density along months.

2. Review of literature

2.1 Feature Distinguishing mosquitoes from other insects

Mosquitoes belong to kingdom animalia, phylum arthropod, class insecta, order Diptera, family Culicidae, and subfamily anophelinae, genus *Anopheles*, *Culex* and *Aedes*. Species of *Anopheles* were; *Anopheles gambiae*, *Anopheles pharoensis*, *Anopheles custani*, *Anopheles nili*, *Anopheles funestus*. Arthropods includes: spider, butterfly, housefly, bees, termite, and mosquitoes. They can be recognized by the following characteristics listed below. The body was composed of several parts or segments, some of which may be jointed. The body was covered with tough skin called an exoskeleton and normally has paired jointed legs and antennae. Class insect includes several order; mosquitoes are belong to order diptera. The body has in all insects; it is divided into head, thorax and abdomen. Four characteristics can be used to identify adult mosquitoes: one pair of wings, a long proboscis, maxillary palp; the body covered with scale and wings with vein that shows a defined pattern (WHO, 2010).

2.2 Distinguishing *Anopheles* from *Culicines* and *Aedes*

A Culicines egg climbs together in a” raft “(*Culex*) or flat separately (*Aedes*): *Anopheles* eggs flat separately and each of them has “floats”. The Culicines larva has a breathing tube (siphon) which it uses to hang down from the water surface where *Anopheles* larvae have no siphon. Siphon of *Culex* larvae is longer than *Aedes* larvae. With lives mosquitoes, adult *Anopheles* and culicine mosquitoes can be distinguished by observing their resting postures. *Anopheles* rest at an angle of 50° and 90° to the surface they rest, where as Culicines more or less parallel to their rest surface (WHO, 2013).

Both male and female *Anopheles* mosquitoes feed on sugary secretions such as nectar from plants. In all species, only the female mosquitoes take blood meal from animals and humans. The female mosquitoes are attracted by the odor, carbon dioxide and heat from humans and animals. The blood sucked is used to provide protein to mature hatches of eggs. The females are able to lay 30 to 300 eggs at a time and can lay up to 1000 eggs through their life age depend on the species. Anophelinae mosquitoes can be

distinguished from culicine mosquitoes by the length and shape of the palps. Female culicine palps are much shorter than the proboscis. Female *Anopheles* palps are long as the proboscis. Male culicine, palps were longer than the proboscis while male *Anopheles* palps were long as proboscis; palps of female culicine were shorter than proboscis (WHO, 2013).

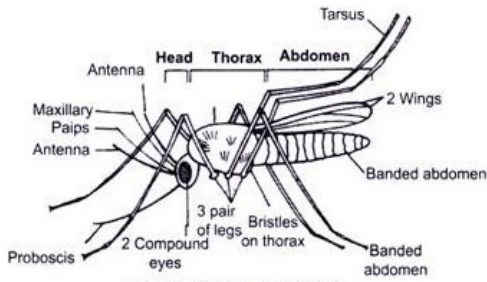


Fig. 8.5 Female *Anopheles*

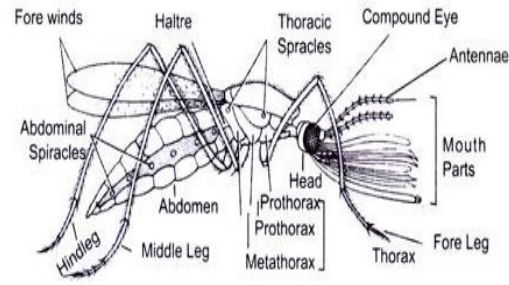


Fig. 8.6 Female *Culex*

Plate 4 Comparison of Anophelinae and Culicine; Source: (WHO, 2013)

2.3 Distinguishing between male and female *Anopheles*

It is important to be able to distinguish between female and male *Anopheles*. Because only female *Anopheles* mosquitoes take blood meal and transmit malaria disease. On the antennae of female *Anopheles*, there are relatively few hairs and there are short. In contrast, the male *Anopheles* has very long hairs on the antennae. Palps of female *Anopheles* are straight long with proboscis while palps of male *Anopheles* are not straight but long as proboscis and club shaped at the tip (WHO, 2013).



Plate 5 Female *Anopheles* (Hussen, 2014)

2.4 Identification of *Anopheles*

Anopheles species were identified using identification key (see under 2.4.2). It is essential to be able to identify the species of adult and larvae. Identification of pupae is very difficult because of their similarity. Some external characteristics of adult and larvae of *Anopheles* are useful in species identification were described (Hussen, 2014)

2.4.1 External anatomy of adult *Anopheles*

The head has large compound eyes. A pairs of antennae were joined to the head between the eyes. Pair of pulps were found below the antennae and covered with scale which may be of different colors and used in species identification. Proboscis lies at the ventral and central part of the head and extended forward. The thorax has pair of wings and three pair of legs on the lower or ventral surface. The wings had several veins. Many *Anopheles* had wings spotted with dark and pale areas which, together with other characteristics are used for species identification. The legs are long and the abdomen has eight visible segments (WHO, 2013).

2.4.2 Key for the morphological identification of *Anopheles* adult

Key for the identification of *Anopheles* adult and larvae have been developed for most part of the world. The types of identification key that is most commonly used comprises

pairs of statements and is called dichotomous or couplet key. In these types of key only one of each pair of statements correctly described the statements (Massebo, 2013)

Female *Anopheles* had maxillary palps as long as proboscis. Proboscis and the body were in the same straight line and rest at an angle 50° to 90° the surface and their wings were spotted with pale and dark scale. Female *Culex* had maxillary palps shorter than proboscis, proboscis and the body at an angle to one another, rest parallel to surface and wings uniform with dark or brown scale and tip of abdomen usually pointed. Female *Aedes* had maxillary palps as long as proboscis, proboscis and the at an angle to one another, rest parallel to the surface, wings uniform with dark or brown scale and tip of the abdomen usually blunt or rounded.

Examples specimen whose wings have pale and dark scale, the legs are speckled and half of the proboscis is pale, would be identified in the following key as species.

- ❖ Wings scales are dark----- species A
- ❖ Wings with pale and dark scale-----species B
- ❖ Wings with spotted dark-----species C
- ❖ Legs with dark scale-----species D
- ❖ Legs with pale and dark scale-----species E
- ❖ Proboscis all dark scale-----species F
- ❖ Proboscis with pale scale-----species G

2.4.3 Other techniques for species identification

Some species of *Anopheles* are similar in external morphology, but belong to different species. These are genetically related sibling species and are morphologically grouped under the same complex. For example, in the *Anopheles gambiae* complex (also known as *Anopheles sensulato*), there are seven different: *Anopheles gambiae sensu stricto*, *Anopheles arabiensis*, *Anopheles quadriannulatus A*, *Anopheles quadriannulatus B*, *Anopheles bwambae*, *Anopheles merus* and *Anopheles melas*. It is not possible to differentiate between these species by using an identification key based on external morphology. Correct species identification is essential for epidemiological studies and

control program. Polymerase chain reaction also used to analyze DNA of species of *Anopheles gambiae* complex (Massebo, 2017).

Based on their blood digestion stage or abdominal condition, *Anopheles* can be grouped as unfed, freshly fed, half gravid and gravid. Mosquitoes collected were identified morphologically using taxonomic keys. Mosquitoes were graded according to their abdominal conditions, namely; blood fed, unfed, gravid, and half gravid (Okorie *et al.*, 2014).

- Unfed- the abdomen is flattened.
- Freshly fed-The abdomen appear bright or dark red from the blood in the mid gut. The ovaries occupy only small area at the tip of abdomen and this part is not red.
- Half gravid-The blood is dark in color, almost black and occupies three to four segments on the ventral surface and ovaries occupy most of the abdomen.
- Gravid-The blood is reduced to small black patch on the ventral surface and completely digested. The ovaries occupy all the rest of the abdomen (Massebo, 2017).

2.5 *Anopheles* mosquitoes in Ethiopia

About 60 species of *Anopheles* fauna found in Ethiopia. There are; however, “small proportions of them are important as vectors”. They were *Anopheles arabiensis* (*gambiae*), *Anopheles pharoensis*, *Anopheles funestus* and *Anopheles nili* (FDRoEMoH, 2005).

Anopheles mosquitoes are vectors of malaria. It included under ; kingdom-animalia, phylum- arthropoda, class- insecta, order- diptera, family- Culicidae, (*Aedes*, *Culex* and *Mansonia*), genus-*Anopheles* and species- *Anopheles gambiae*, *Anopheles pharoensis*, *Anopheles funestus*, *Anopheles nili*, *Anopheles custani* etc.

2.5.1 *Anopheles arabiensis* (*Anopheles gambiae*)

The major malaria vector in Ethiopia is *Anopheles arabiensis*. It is widely distributed in the country and is usually the vector of epidemic malaria. *Anopheles arabiensis* mainly breeds in small, temporary, and sun-lit water collections such as rain pools. It becomes abundant at the beginning and end of the big rainfalls. However, it can also breed in a wide variety of other types of water bodies. It is usually an indoor-resting species, but with an exophilic feeding habit (Hussen, 2014). It is found in all parts of Ethiopia both in lowland as well as in the highland areas up to 2000 m above sea level.

Anopheles arabiensis is the most important species in low land region of all administrative regions in Ethiopia. It tends to breed in temporary collection of water, unshaped, sunlit pool, puddles, and hoof prints habitats. *Anopheles arabiensis* are variable feeding and resting behavior with both anthropophilic and zoophilic and exophilic and endophilic behavior. *Anopheles arabiensis* are feeding higher on cattle than on humans. It was the most abundant principal vector of *Plasmodium falciparum* and *Plasmodium vivax*. It is one members of *Anopheles gambiae* complex that is dominant species (Massebo, 2017).

2.5 .2 *Anopheles funestus* complex

Anopheles funestus are also important in the country: tend to breed in large bodies of water naturally more or less permanent water- especially with vegetation- shaded habitats is preferred; marshes, edge of stream river ditches. *Anopheles funestus* one of the important malaria vectors in terms of human mortality due to its high malaria disease. *Anopheles funestus* was widely distributed throughout tropical Africa and its activity extend seven into the dry season where other malaria vectors, such as *Anopheles gambiae* are usually in active (Ayala. *et al.*, 2005).

Indoor biters occasionally bites outdoor, endophilic occasionally exophilic. The *Anopheles funestus* complex comprises 13 morphological similar species including; *Anopheles funestus*, *Anopheles vanedeni*, *Anopheles parensis*, *Anopheles lesoni*, *Anopheles aruni*, *Anopheles confuses*, *Anopheles rivulorum*, *Anopheles brucei*, *Anopheles*

falciparous, *Anopheles funestus*-like, *Anopheles longipalpstypeC*, *Anopheles longipalpstypeA* and *Anopheles rivulorum* like species (Massebo, 2017).

2.5.3 *Anopheles pharoensis*

It is the second most frequent and widely distributed vector species of malaria in Ethiopia. It breeds in large, permanent and shaded water bodies with emergent vegetation. Lake shores and irrigation canals are also favorable breeding places. It is found along river and Lake Regions. Its indoor and outdoor feeding and resting habits are generally similar to that of *Anopheles arabiensis* (Hussen, 2014)

2.5.4. *Anopheles nili*

It is the least common and more localized species and is not adequately studied except in Gambella. It is found in the south western, western and north western parts of Ethiopia along river (Hussen, 2014). Bred in large bodies of water – swamps; important in western Ethiopia-Gambella.

Naturally shaded habitats: endophilic/exophilic-control is difficult. They are the major vector in forested and humid areas in Africa. The *Anopheles nili* comprises four morphological similar species, including *Anopheles nili* s .s, *Anopheles somalicus*, and *Anopheles carnevalei* and *Anopheles ovengensis*.The first species wide spread and efficient malaria vector in Cameroon and Senegal (Massebo, 2017). As MOH stated occurrences of *Anopheles* were seen in different parts of a country.

Definition of terms

Causative Organism – plasmodium (protozoa): *Plasmodium falciparum*, *Plasmodium vivax*, *Plasmodium ovale* and *Plasmodium malariae* are most important parasite in Ethiopia. *Plasmodium falciparum* are more important in lowland region than *Plasmodium vivax*–high land and temperate region.

Distribution – Tropics and sub tropics of the world. Worldwide, but eradicated in some region such as Europe and USA.

Symptoms- Headache then heavy fever, causes high, recurring fever and sometimes death/symptoms of malaria. Symptoms of yellow fever are acute in a set of high fever headache, blood dysentery, mucus, vomiting and death.

Silica gel- Material used to dry preserved collection of mosquitoes.

2.6. Control method of *Anopheles* mosquitoes

Anopheles mosquitoes control methods are vary in their application, cost and sustainability of their result. Here it is focused on adult mosquitoes.

2.6.1 Vector control method

Interventions using vector control methods are related to the following three major control measures.

1. Reducing human- vector contact
 - Insecticide-treated mosquitoes net
 - Improving house
 - Repellents
2. Adults mosquitoes' control
 - Insecticide-treated mosquitoes net
 - Indoor residual spraying
 - Space spraying
3. Larval controlling
 - Larviciding
 - Source reduction
 - Larvivorous fish

Not all of these methods were applicable to the entire diverse malaria vector. The two most powerful and most broadly applied vector control intervention treated mosquitoes net and indoor residual spraying.

2.6.2.1. Insecticide treated mosquitoes net

It repels and kills mosquitoes coming to contact with insecticide on the netting materials.

There are two categories of insecticide treated nets as described below.

1. Conventional insecticide treated net (CITN) is a mosquitoes net that has been treated by dipping in WHO recommended insecticide. To ensure its continued effect the net should be re-treated after three washes.

2. Long lasting insecticide nets (LLIN) Was factory treated mosquitoes nets made with netting material that has insecticide incorporating within or bound around the fibers. The nets must retain its effecting biological activity against vector mosquito for at least three years (WHO, 2011).

2.6.2.2. Other approaches for reduction of human vector contact

A) Improving house and location of settlement in relation to breeding site.

House hold and community action to improve the quality of housing (design, construction, screening or mosquito proving and protect mosquito entry and indoor resting can have more permanent effect than insecticide related control method. Draining stagnant water is also very important to avoid mosquito in the location of breeding site.

B) Repellents and protective clothing

The used of repellents and protective clothing were useful for people who are outdoors during peak vector biting period. Most repellent were very short duration of effect (8 hours repellents are available as cream, lotion, and aerosol soaps- these are applied directly on skins (WHO, 2011).

2.6.3. Adult mosquito control

A) Indoor residual spraying

Indoor residual spraying consists of the application of residual insecticide to the inner surface of dwelling where many vectors species of *Anopheles* mosquito found.

Indoor residual spraying is not useful for the control of vectors which tends to rest outdoor.

Indoor residual spraying is recommended where; majority of the vectors population were endophilic.

-spraying was done correctly.

-the vector population is susceptible to the chosen insecticide.

3. Materials and Methods

3.1. Scope of the study

Study was conducted in Gobu Sayo district, East Wollega Zone of Oromia Regional State, Western Ethiopia from September to August. It is one of the districts in east Wollega Zone and is located 272Km West of Addis Ababa and 62km East of Nekemt, the administration town of East Wollega Zone. This district is bordered in the East by BakoTibe, in the West by Sibusire, in South by BiloBoshe and North by GudeyaBila and Sibiu Sire. This district has 11 kebeles from these 9 Kebeles are rural and 2 Urban.

The topology and climate of the altitude of the district ranges between 1400 meters above sea level to 2000 meters above sea level. 14.09° 933N latitude and 27.3° 3705E longitudinal that is measured with global position system (GPS). Population numbers of the study Kebeles were: Aggo Laften Kebele (6779), GambellaTarre Kebele (2889) and OngoboDambi Kebele (7070). The population numbers of the three Kebeles were 16,738 and the total population in the Woreda was 55,867. Because of I took this three kebeles were, they bitted by mosquitoes. The main rainy season usually extends from June to August and short rainy season occurs in March to May. Most spread of the mosquitoes are at the beginning of the rain come (March to May) and at the end of the main rainy season (September to December) (Worku, 2017).

The majority (74.3%) of the district is classified as mid-land with lowland (18.27%) and only 7.53% is considered as highland. The minimum, maximum and mean temperature of this area was 14.09 °c, 27.30 °c, and 22.55 °c, respectively. The highest temperature occurs in February and March. The lowest temperature occurs in July and August. The annual average rainfall of the district is 1295mm (rain gage) (Gemechu, 2015).

AggoLaftenKebele, GambellaTarreKebele and OngoboDambi Kebele were the study Kebeles. Because of I took this three Kebeles were, they bitted by mosquitoes. The population numbers of the three Kebeles were 16,738 and the total populations in the Woreda were 55,867. The main rainy season usually extends from June to august and short rainy season occurs in March to May.

Most breeding of the mosquitoes are at the beginning of the rain come (March to May) and at the end of the main rainy season (September to December).

3.2. Adults mosquitoes' collection method

3.2.1. Hand collection of indoor-resting mosquito

Indoor collections were made monthly from September-July simultaneously in the three areas. Five houses were selected randomly in each area. Human landing catches were carried out using World Health Organization (WHO) standard procedure (Okwa *et al.*, 2007). Samples of mosquitoes caught were preserved dry on silica gel. Many of the *Anopheles* mosquitoes, which are malaria vector rest-indoor. Hand collection provides information about usual resting place, resting density and seasonal change in density. Needed material- flash light, forceps, silica gel, aspirator, eppendorf tube, paper cups, and rubber band. Mosquitoes should normally be collect at morning (0.6:00-12:00) and night from 12:00-0.6:00. In the three kebeles five houses should be searched in order to provide a representative sample.



Plate 6 Aspirator

3.2.2 Spray sheet collection of indoor-resting mosquitoes

Spray sheet collection involved using aerosol insecticide (tiptop killer) to resting inside house and collect them on white sheet spread on the floor and other flat surfaces in the house. By using hand collection method all the mosquitoes resting in the house do not

collected, but by using spray sheet collection method, it should be possible to collect almost all the mosquitoes from well closed room sprayed with fine pyrethrum.

Equipment- white cotton sheet (size:2x1m,2x2m, 2x3m);aerosol insecticide, hand sprayers, paper cups, rubber band, cotton, forceps, eppendorf tube and pyrethrum solution. This method of collection allows quantitative studies (WHO, 2013).

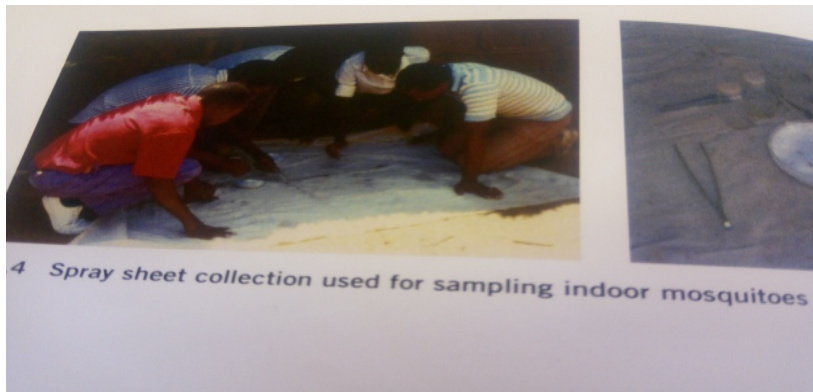


Plate7 Spray sheet collection

3.2.3. Outdoor collection method of adult mosquitoes

Some mosquito species do not enter house but bite outside and rest on vegetation or on solid surface in sheltered place such as; hole in rocks, animal foot burrows, bank of stream, on stem of larger trees and in old termite mounds. It provides information on:

- Species that rest outdoor
- Relative number of mosquitoes rest outdoor
- Seasonal changes in outdoor resting habits.

Outdoor collection is carried out in either the natural resting place described above or artificial sheltered

Equipments: Hand net, resting tube (eppendorf tube), paper cups, cotton rubber band and forceps outdoor collection method.

The common method used to collect mosquitoes resting on vegetation involves the use of a sucking tube, hand net and paper cups.

Hand net was used to collect mosquitoes resting on vegetation.

The correct method of use is to move hand net on swiftly over the top of tall grasses or around natural resting of their place (WHO, 2013).



Plate 8 Hand net

3.3 Data collection procedure

First of all study area was identified across altitude where mosquito species abundance was available and then materials used for collection were prepared .Different mosquito species were collected by using aspirator and spray sheet collection from September to June and preserved using silica gel. The samples were collected from the three Kebeles in Gobu Sayo Woreda and collected data were organized and analyzed.

3.4 Data processing and analysis

Primarily the availability of the mosquito species and the feasibility of the methodology were checked with necessary modifications. The mosquito species were collected step by step manually and checked for completeness and accuracy. The collection of all mosquitoes species were processed to assess the identification of different mosquitoes

and analyzed using identification key of mosquito species observing under compound microscope were illustrated in tables and graphical expression.

The collected mosquitoes were identified using identification key under compound microscope. Finally, the variables result on the sample were names of wing characteristics such as dark scale, pale scale and dark scale and spotted scale, leg characteristics such as dark scale, pale scale, spotted white on legs (*Aedes*) proboscis characteristics such as all dark scale, pale scale, hair on the antennae characteristics such as few and short as well as palps are straight with proboscis (female *Anopheles*), in contrast, many hair and not straight but long with proboscis (male *Anopheles*), palps characteristics such as short palps (female *Culex*), long palps as proboscis having more hairs (male *Culex*).



Plate 9 When different mosquito species identified under microscope by observation in Ethiopian public health institute training center using identification key

4. Results and Discussions

A total of 900 Adult mosquitoes were collected from the three Kebeles, about 600 of the mosquitoes were *Anopheles*, about 260 were culicines and about 40 were *Aedes*.

Table 1 Mosquitoes species Composition and abundance based on morphological characteristics

Mosquitoes	Densities		Total
	M	F	
<i>Anopheles</i>	190	410	600
<i>Culex</i>	180	80	260
<i>Aedes</i>	0	40	40
Total	370	530	900

High number of female *Anopheles* was caught in the study area. Anophelines were distinguished from Culicine mosquitoes according to the morphological characteristics of their maxillary palps (Okwa *et al.*, 2007).

The abdomens were preserved for blood meal analysis while the heads and thorax were preserved for Sporozoite – antigen (SP) detection. The highest mosquito collection was made in GambellaTarre (dominated by *Anopheles* mosquitoes while the lowest was in Aggo Laften which was also dominated by *Anopheles* species. Although the morphological identification of mosquito species was near to the study, which carried out in the southern Ethiopia Welkite areas (Massebo, 2017). A research carried out at nearer to the same study site showed that out of 1246 total mosquitoes 800(*Anopheles*), 300(Culicines) and 146 (*Aedes*) were identified globally, based on the observation of morphological feature (WHO, 2013).

Table 2 Comparison of mosquito species composition abundance from Global to Local and National Level of Ethiopia.

Study area	Period of the study	Mosquitoes			References/sources
		<i>Anopheles</i>	Culicines	<i>Aedes</i>	
Gobu Sayo	2010	600	260	40	This study
Welkite	2017	1200	500	300	Fikadu Massebo,2017
Ethiopia	2005	800	600	300	FDRoEMoH, 2005
Nigeria	2017	900	700	400	Anyawu.A, 2017
South east Asia	2013	700	300	246	WHO Global report 2013

The association results of mosquito species starting from local to global. Research reported from global (WHO, 2013) with lived mosquitoes, adult *Anopheles* (700), *Culex*(300) and *Aedes* (246),research reported from Nigeria (Anyawu, 2017) *Anopheles* (900), *Culex*(700) and *Aedes* (400), research reported from Ethiopia(FDRoEMoH,2005) *Anopheles* (800), *Culex*(600) and *Aedes* (300),research reported from Welkite (Massebo, 2017) *Anopheles* (1200), *Culex*(500) and *Aedes* (300),this thesis from Gobu Sayo *Anopheles* (600), *Culex* (260) and *Aedes* (40)mosquitoes can be distinguished by observing their external morphology

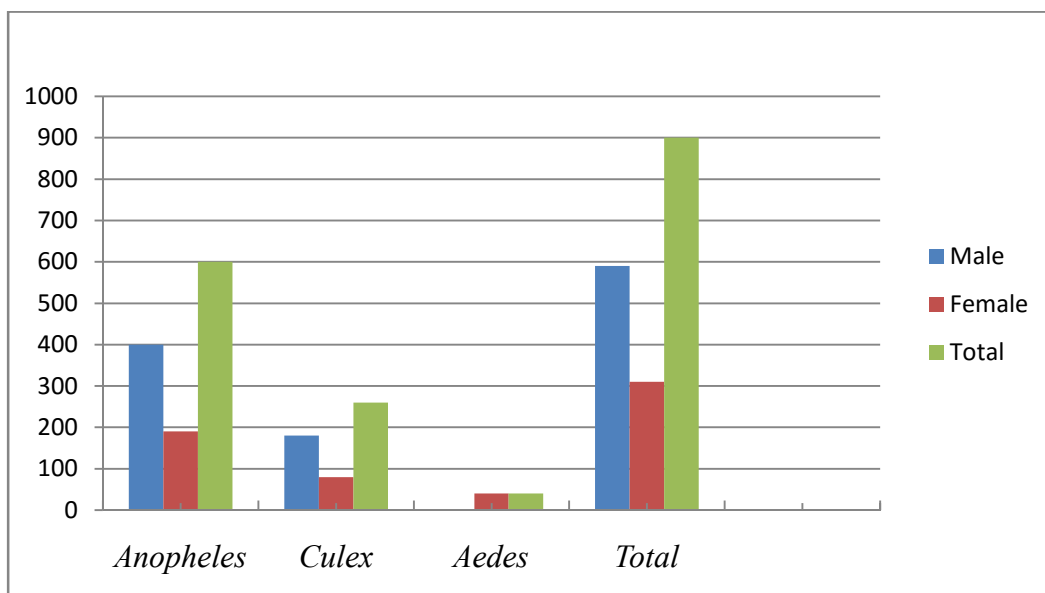


Figure 1 Results of identified different mosquito species by external morphological feature

The abundance of *Anopheles* mosquitoes identified in my study areas were higher than that of research reported from Nigeria (Anyanwu, 2017), because of my study site were malarious kebeles. In general, mosquitoes can be differentiating in to genus using identification key under compound microscope based on their morphological feature both at the national and global level.

Morphological identification of mosquito species was near to the study, which carried out in the southern Ethiopia Welkite areas (Massebo, 2017). A research carried out at nearer to the same study site showed that out of 1246 total mosquitoes 800(*Anopheles*), 300(*Culicines*) and 146 (*Aedes*) were identified globally, based on the observation of morphological feature (WHO, 2013).

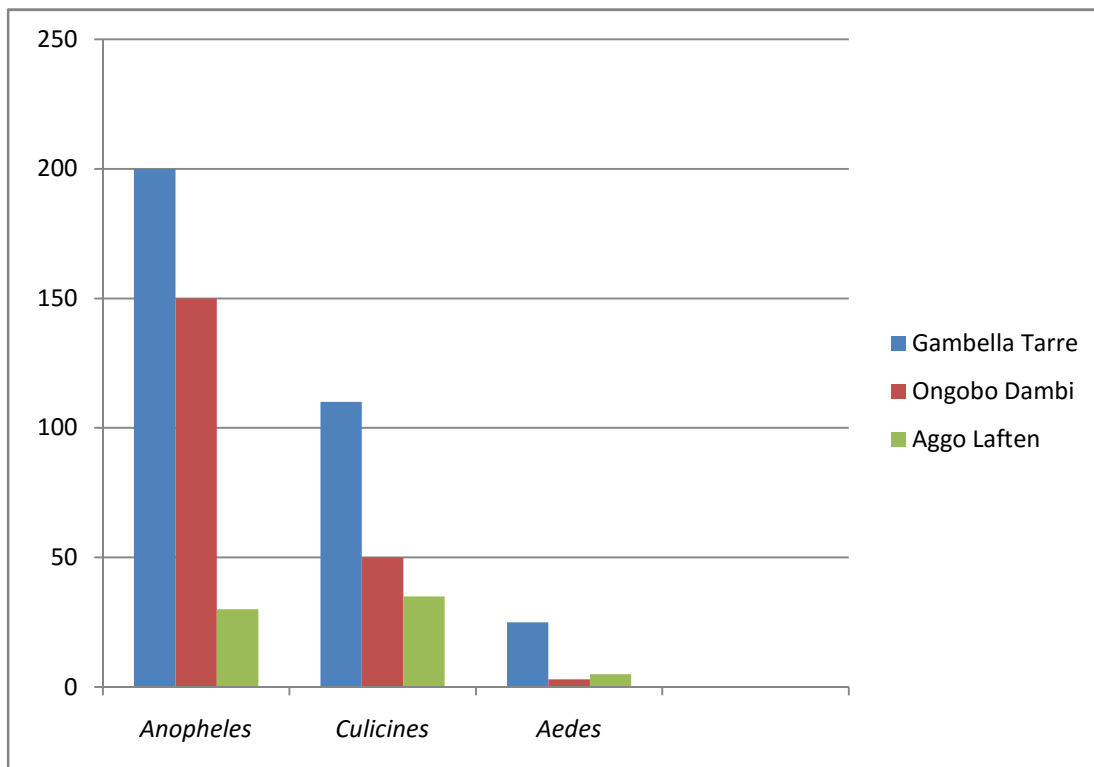


Figure 2 Result of mosquito species abundance and densities across altitude from 1400meters to 1600meters above sea level

The result of the study showed that mosquito species abundance and densities were highest in the GambellaTarre than that of OngoboDambi and AggoLaftenKebele, because of most of GambellaTarreKebele area was (1400masl) above sea level (low land) and

most of OngoboDambi area was mid land (1700masl) and most of Aggo Laften area was high land (2000masl). When an elevation increased, the abundance and densities of mosquito species decreased. In contrast when an elevation was decreased, the abundance and densities of mosquito species increases. In this study I was identified mosquito species through looking external morphology using morphological feature under compound microscope. Example, *Anopheles* mosquitoes had long palps as proboscis unlike Culicines which had short palps and *Aedes* had spotted white on their legs which was identified in Ethiopian public health institute training center. Similarly, research reported from global (WHO, 2013) with lived mosquitoes, adult *Anopheles* and culicine mosquitoes can be distinguished by observing their resting postures. *Anopheles* rest at an angle of 50⁰ and 90⁰ to the surface they rest, whereas culicines more or less parallel to their rest surface. Anopheline mosquitoes can be distinguished from culicine mosquitoes by the length and shape of the palps. Female culicine palps are much shorter than the proboscis. Female *Anopheles* palps are long as the proboscis. Male culicines, palps were longer than the proboscis while male *Anopheles* palps were long as proboscis. In contrast, research was done by Gemechu (2015) at Sibusire woreda East Wollega zone.

Table 3 Result of mosquito species abundance and densities across altitude from 1601meters to 1800meters above sea level

Mosquito species	GambellaTarre	OngoboDambi	Aggo Laften
<i>Anopheles</i>	120	30	25
<i>Culex</i>	25	15	7
<i>Aedes</i>	4	1	1

The above table shows that: when the altitude increased, from 1601meters above sea level to 1800meters above sea level, the abundant of mosquito species decreased since at the higher elevation, temperature become lower which is not comfortable for the breeding of mosquito species. The most predominant and abundance mosquito species were *Anopheles* mosquito from all collected area. The second most abundance was culicine mosquito and the third one was *Aedes*. . Similar research was done by (Hussen, 2014).

Table 4 Result of mosquito species abundance and densities across altitude greater than 1800meters above sea level

Mosquito species	GambellaTarre	OngoboDambi	Aggo Laften
<i>Anopheles</i>	20	15	10
<i>Culex</i>	9	6	3
<i>Aedes</i>	1	0	0

This result shows; when altitude increase, abundance and densities of mosquito species decrease. Because, low temperature was not comfortable for the breeding of mosquitoes.

This result shows; when altitude increase, abundance and densities of mosquito species decrease. Because, low temperature was not comfortable for the breeding of mosquitoes. Similarly research carried out in Nigeria by Anyawu, A (2012) support this thesis.

Table 5 Result of mosquito species abundance and densities along month's in Gambella Tarre.

Kebele	Months and years	<i>Anopheles</i>	<i>Culex</i>	<i>Aedes</i>
GambellaTarre	Sept 2018	30	10	0
	Oct 2018	50	15	1
	Nov 2018	65	26	7
	Dec 2018	60	24	5
	Jan 2018	0	1	2
	Feb. 2018	2	0	1
	Mar 2018	25	10	3
	Apr 2018	30	10	2
	May 2018	40	10	4
	Jun 2018	20	3	1
Jul 2018	10	5	0	

Table 5 shows that collected mosquito species were increased from highland to lowland. The highest peaks of mosquito species were observed in spring season, September to December and because this season was at the end of highly rainfall which was very comfortable for the spread of mosquito species (mosquito species in November month which was one of the spring season was identified as 65 were *Anopheles* mosquito, 26 were *Culex* mosquito and 7 were *Aedes* mosquito and at the beginning of big rain fall (March to May). The highest peak of month at the beginning of heavy rain come was May which was 40 were *Anopheles* mosquito, 10 were *Culex* mosquito and 4 were *Aedes* mosquito. Mosquito species were widely distributed in the country. Most of mosquito species mainly breeds in sun-lit water collections such as rain pools. It becomes abundant at end of the big rainfalls. Similar research was done by Hussien (2014) and Ayala *et al.* (2005). Gambella Tarre was one of the lowland Kebele in which most of the mosquito species were collected. In the Gambella Tarre Kebele; among a total of 472 mosquito species were collected, 332 were *Anopheles* mosquitoes, 11 were *Culex* and 26 were *Aedes*. Majorities of the mosquitoes were collected in this Kebele. Gambella Tarre was malarious Kebele, since most of identified mosquito species were *Anopheles* mosquitoes. The second most abundance and densities followed *Anopheles* mosquitoes were *Culex* mosquitoes.

Mosquito species occurred in almost every seasons of the year. The highest peak of mosquito species observed in summer. In contrast, the highest peak of mosquito species was observed in spring season, because this season was at the end of highly rainfall which was very comfortable for the breeding of mosquito species. It is widely distributed in the country. Most of mosquito species mainly breeds in sun-lit water collections such as rain pools. Similar research was done by (Hussien, 2014).

It becomes abundant at end of the big rainfalls (Hussien, 2014).

It can also breed in a wide variety of other types of water bodies' mainly stagnant water. It is found in all parts of Ethiopia both in lowland as well as in the highland areas up to 2000 meters above sea level. High number of female *Anopheles* was caught in the study area. Anophelines were distinguished from Culicine mosquitoes according to the morphological characteristics of their maxillary palps (Okwa *et al.*, 2007).

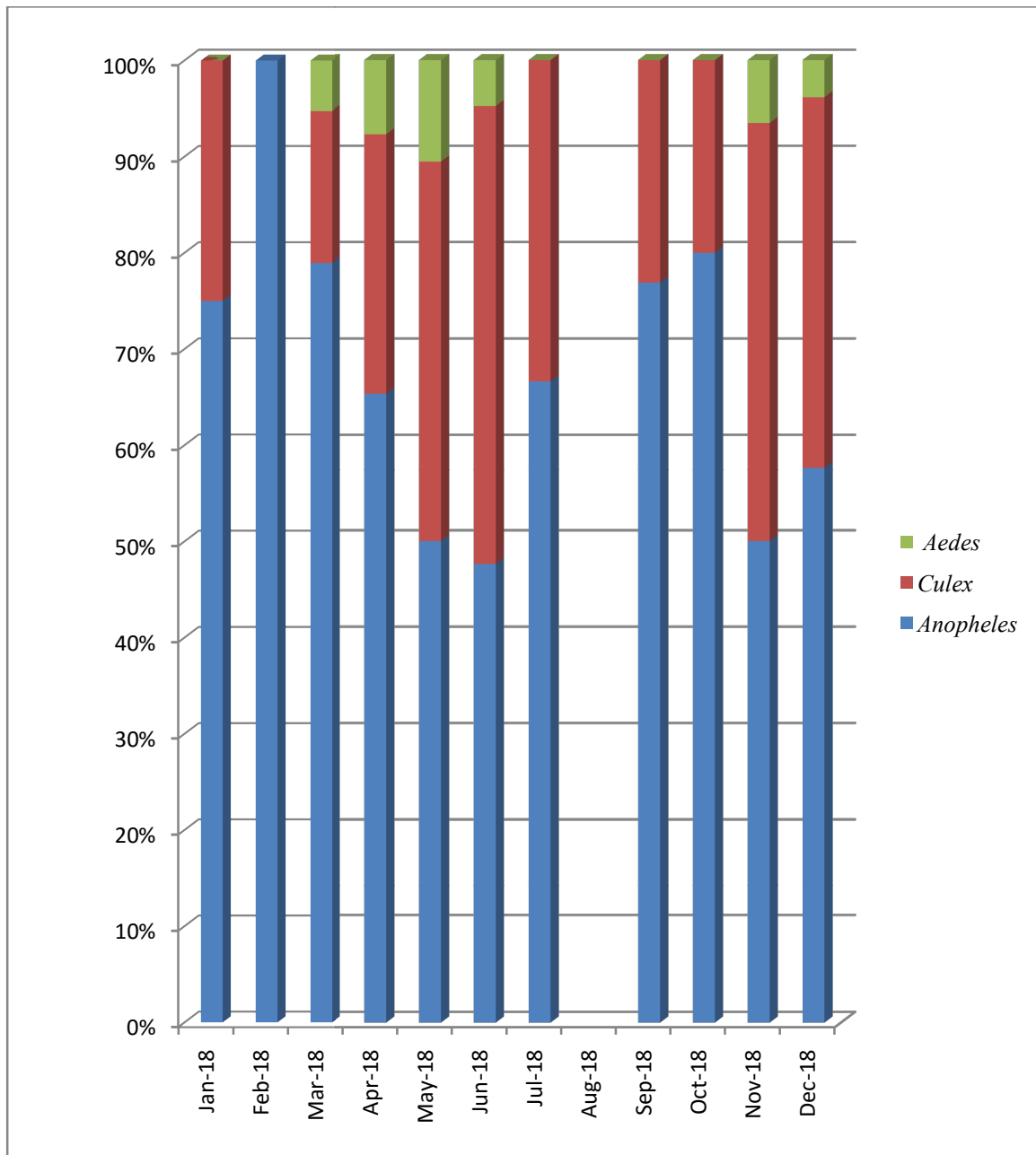


Figure 3 Result of mosquito species abundance and densities along months in Ongobo Dambi.

Different mosquito species were yield at Ongobo Dambi in small amount than collected in the GambellaTarre. Because, its elevation greater than the topography of GambellaTarreKebele. Density and mosquito species abundance was less in Ongobo Dambi than that of in GambellaTarre. When altitude increased, the mosquito species abundance and density were decreased (Okwa *et al.*, 2007).

Table 6 Result of mosquito species abundance and densities along months in Aggo Laften.

Kebele	Months and years	<i>Anopheles</i>	<i>Culex</i>	<i>Aedes</i>
Aggo Laften	Sept 2018	4	1	0
	Oct 2018	14	6	0
	Nov 2018	20	11	1
	Dec 2018	15	9	0
	Jan 2018	3	1	0
	Feb 2018	2	0	0
	Mar 2018	10	5	0
	Apr 2018	10	8	0
	May 2018	17	8	0
	Jun 2018	7	5	0
Jul 2018	7	3	0	

The above table showed that different mosquito species were yield at Aggo Laften in small amount than that collected in the Ongobo Dambi. Because its elevation greater than the topography of OngoboDambi. Density and mosquito species abundance was less in OngoboDambi than that of in GambellaTarre. When altitude increased, the mosquito species abundance and density were decreased. The highest peak of mosquito species densities and abundance were also November month similar in GambellaTarre at the end of heavy rain fall 20 were *Anopheles* mosquito, 11 were *Culex* mosquito and 1 was *Aedes* mosquito. Similar research was done by Hussen (2014). In contrast, research was done by Gemechu (2015) at SibuSire woreda East Wollega zone.

5. Conclusion and Recommendation

5.1 Conclusion

Three genera of mosquitoes were identified. These are *Anopheles*, *Culex* and *Aedes*. Attention should be on *Anopheles*. The differentiation and identification were found in the result. The identification of the mosquito species were based on their external morphology by using identification key under compound microscope with 10x objective.

Most of mosquito species mainly breeds in sun-lit water collections such as rain pools. It becomes abundant at end of the big rainfall. When altitude increased, the mosquito species abundance and density were decreased. When altitude increased, the mosquito species abundance and density were decreased. In all the selected kebeles the highest peak of mosquito species abundance density were November to December which were at the end of heavy rain fall and April to May which were at the beginning of heavy rain fall. The prevalence of mosquitoes were increased from highland to lowland, because of climatic change had an effect on the breeding of mosquitoes.

House hold and community action to improve the quality of housing (design, construction, screening or mosquito proving and protect mosquito entry and indoor resting can have more permanent effect than insecticide related control method. Draining stagnant water is also very important to avoid spreading of mosquito in the location of breeding site. The two most powerful and most broadly applied vector control intervention treated mosquitoes net and indoor residual spraying. The used of repellents and protective clothing were also useful for people who are outdoors during peak vector biting period. Most repellent were very short duration of effect (8 hours repellents are available as cream, lotion, and aerosol soaps- these are applied directly on skins).

5.2 Recommendation

- The abundance and density of mosquito species composition across altitude along months were very high but due to lack of necessary needed material few amount of mosquito species were collected. To improve special apparatus that used for the collection of mosquito species must fulfill by the government.
- Mosquito bite humans indoor and outdoor. Therefore, every community must aware about mosquito species to prevent themselves. They must share the information about malaria vectors and which climatic conditions were comfortable for *Anopheles* mosquito and bite humans and how to avoid them.
- Every community must know method of protection from mosquito species. Breeding site of mosquito species must be avoided by community. House hold and community action to improve the quality of housing (design, construction, screening or mosquito proving and protect mosquito entry and indoor resting can have more permanent effect than insecticide related control method. Draining stagnant water is also very essential to avoid spreading of mosquito in the location of breeding site
- To ensure treated mosquito nets continued effect the net should be, re –treated after tree washes and factory treated mosquitoes nets made with netting material that has insecticide incorporating within or bound around the fibers. The nets must retain its carrying out biological activity against vector mosquito for at least three.
- This study requires further research to identify species composition of mosquito by polymerase chain reaction. Since morphological identification of mosquito species was not enough to identify similar species of mosquito.
- This result may provide to implement integrated vector management for policy makers in mosquito elimination program and must studied more on the contribution of *Anopheles* mosquito control option in malaria endemic areas of Ethiopia.

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Declaration

This is to certify that we have read and evaluated the thesis prepared by Mekonnen Dugasa Duressa entitled: **Species composition and abundance of mosquitoes in selected areas of Gobu Sayo district, Western Oromia, Ethiopia**'. Submitted to the Department of Zoological Science in partial fulfillment of the requirements for the degree of masters of Science in Biology complies with the regulation of the university and meets the accepted standards with respect to originality and quality.

Name: Mekonnen Dugasa Duressa

Date of submission: ____/____/2018

Approval for presentation

Advisor _____ Signature _____ Date _____