Vector

An integrated design approach for vector control

Master thesis project by Sathishkumar

ACKNOW LEDGEMENTS

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An Integrated Design approach for vector control

Author: Sathishkumar Madheswaran

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School of Industrial DesignDepartment of Design Sciences

Examiner

Olof Kolte, Senior lecturer

Supervisor

Per Liljeqvist, Senior lecturer

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Contributors

Rickard Ignell, Professor
Head of Department of Plant Protection Biology
Disease vector group

Mengistu Dawit
PhD Student

Annika Hinze
PhD Student

LUNDS UNIVERSITET

ABSTRACT

Dengue is just regular flu but also kills many people all around the world. We all happen to know that dengue viruses have been on the march for the last 100 years. During the late 20th century, it became a serious threat to mankind. Our scientists have been putting their utmost efforts to save people from dengue infections. They have come up with a number of vaccinations and mosquito repellent solutions.

According to the recent survey on dengue from The World health organization, 400 million people have been getting infected with dengue around the globe. Approximately 100 million people have been getting severely sick from the infection and 22,000 died from severe dengue. There are a large number of private and social sectors making solutions for preventing bites from mosquitos.

This master thesis collaborates with SLU, which is a research institute at Alnarp, Sweden, focusing on Vector disease control. The mission for the thesis was to take advantage of the existing mosquito attractant(blend) to explore the efficiency with mosquito baiting station design. Our mutual goal was simple. We wanted to provide design solutions to people where they see and build it by themself. Experiments were conducted, in order to find the optimal design solution as well as the placement of mosquito attractants in the prototype for the better attraction of mosquitoes. As a part of my thesis work, I have personally made my own mosquito colony. Starting from collecting the mosquito egg, store them into a container with distilled water, feed them, feed them more when it becomes a larva, collect the pupa before they hatch into adults, and keep them in a tray with mosquito net. All these activities need to be conducted at a certain temperature. Since these mosquitoes are likely found in tropical regions, the lab maintains the same temperature and humidity as similar to a tropical region. The experiments were conducted in different ways. Based on the results, I have come up with the design parameters as well as the placement of the mosquito attractant. Test prototypes were made for further experiments and design exploration.

OVERVIEW

Ingvar Kamprad Designcentrum,
Lund University,
Lund.

In Collaboration with

SLU - Swedish Agricultural University
(Swedish: Sveriges lantbruksuniversitet)
Rickard Ignell, Professor
Head of Department of Plant Protection Biology
Disease vector group, Unit of Chemical Ecology

What	Developing a product for the people living in tropical regions with poor lifestyle and infrastructure. The product should be made locally available material. Moreover, people should be able to build it by themselves just by looking at it. It should be reliable, sustainable, involves no complex manufacturing technologies
Why	People from tropical regions are highly exposed to vector diseases such as dengue and malaria. Due to the high temperature and humidity, the disease spreads quickly.
How	Let's See how

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Chapter 01

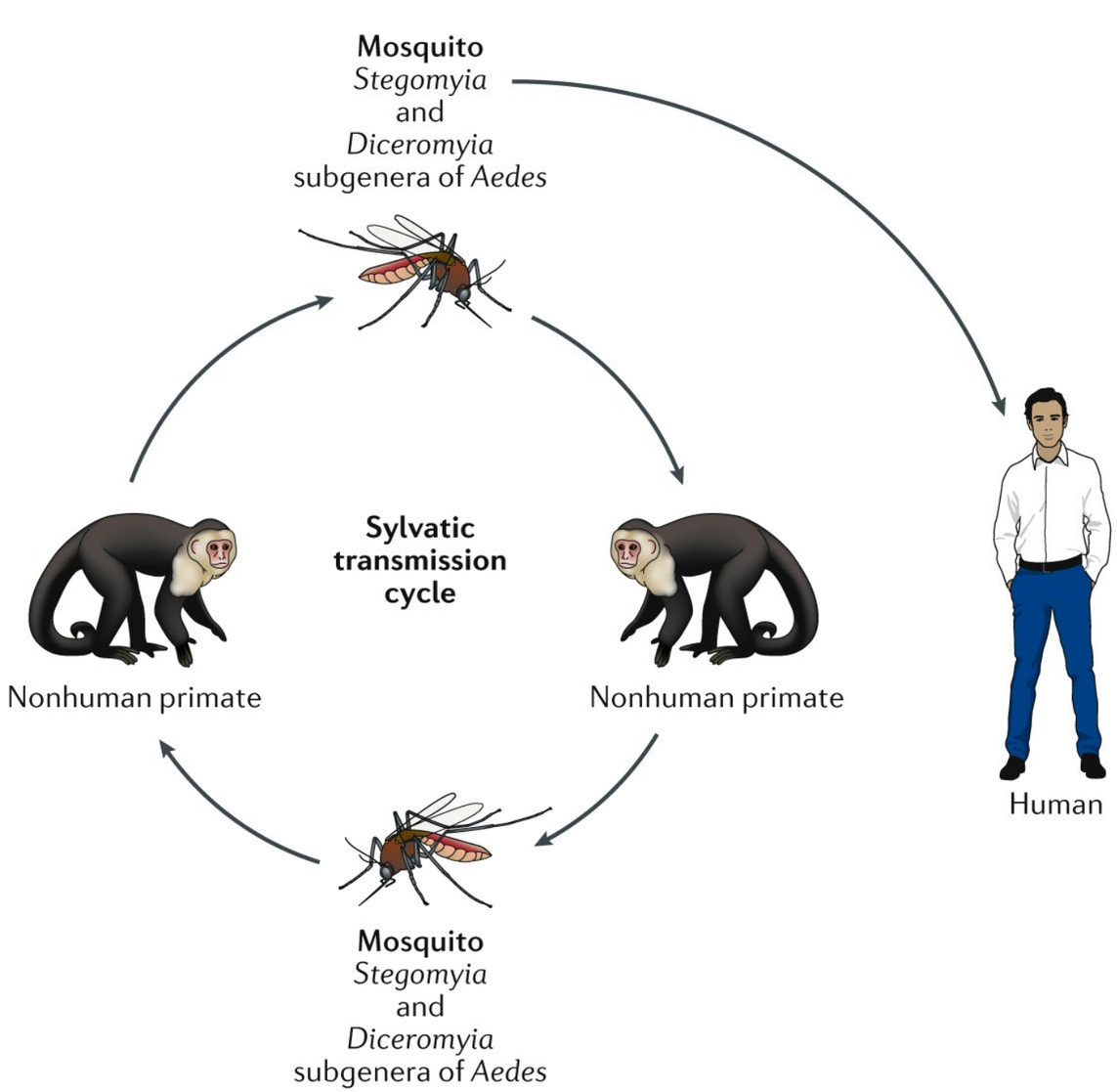
1.1 Introduction

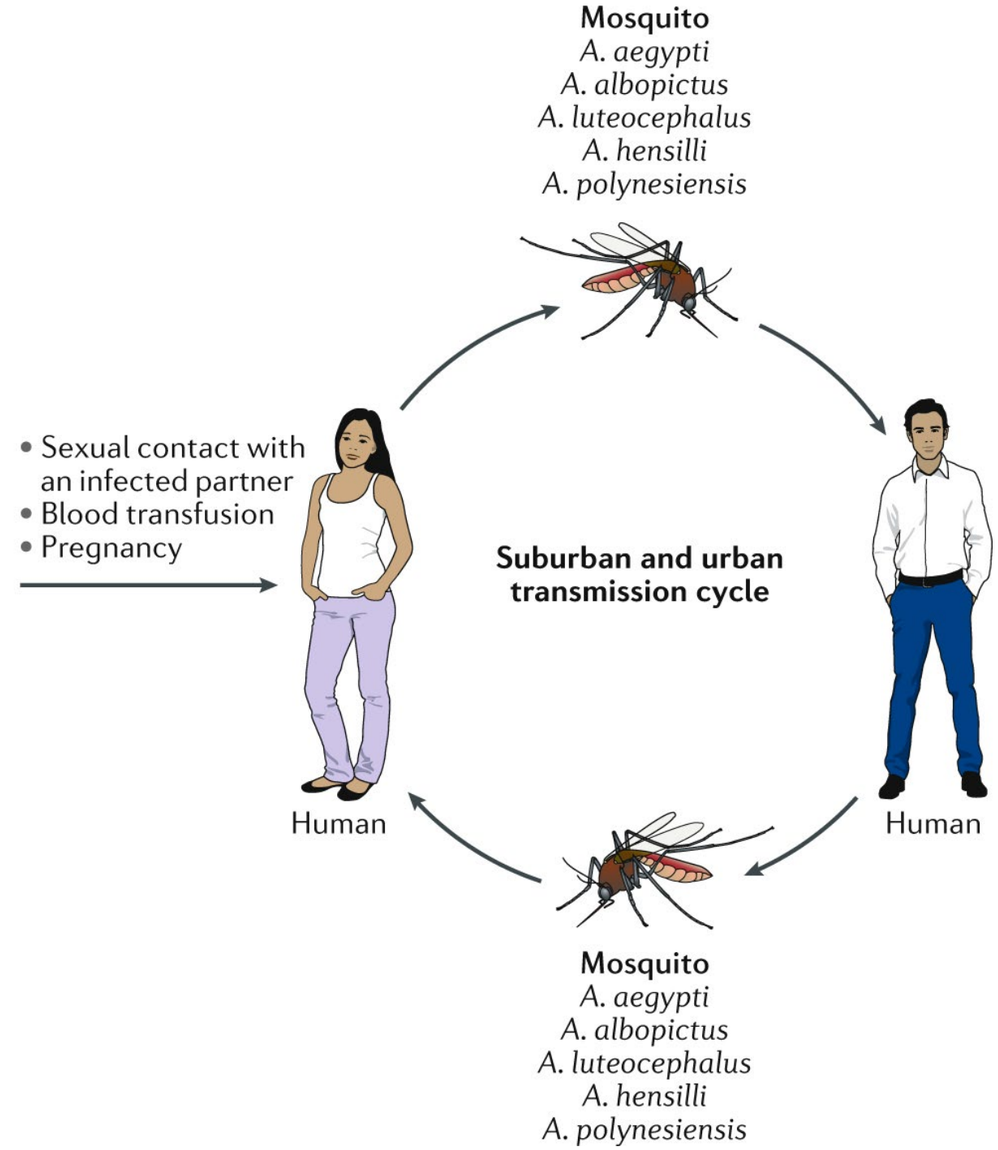
We all have basic knowledge of mosquito and the disease that can possibly spread to humankind. But for a better understanding of my thesis work, I would like to take you through from the basics. What do you know about dengue so far? No idea. Relax. Here is a deep introduction to Aedes Aegypti, Dengue virus, Mosquito management as well as a bit of existing vector control methods.

Aedes Aegypti (Dengue Mosquito) a female mosquito sitting on the plant

The picture was taken from: https://en.wikipedia.org/wiki/Aedes_aegypti

Dengue virus is a world-wide-distributed mosquito-borne flavivirus with a positive-strand RNA genome. It has been active for the last 100 years as for as know. But there is research stating that Dengue originated in wild monkeys and spilled over into humans around 800 years ago. However, Monkeys just act as a reservoir. But principally, the dengue virus was transmitted to humans by the Aedes aegypti mosquito. These mosquitos are generally found in the tropical regions. This type of mosquito originated in Africa and now it found in tropical as well as subtropical regions throughout the world. Aedes aegypti is not only for spreading dengue, but also spreading chikungunya, Zika fever, Mayaro, and yellow fever viruses. This mosquito can be recognized by the white line on the leg and a form layer on the thorax.





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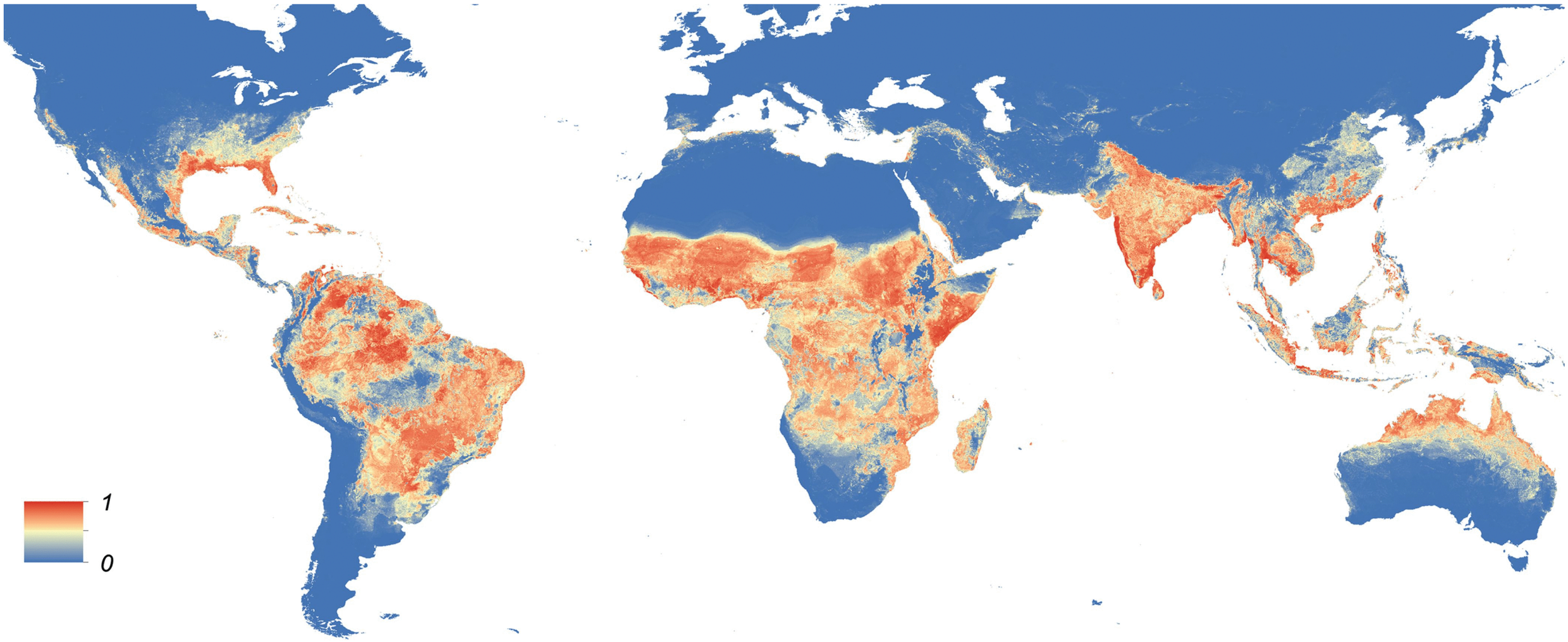
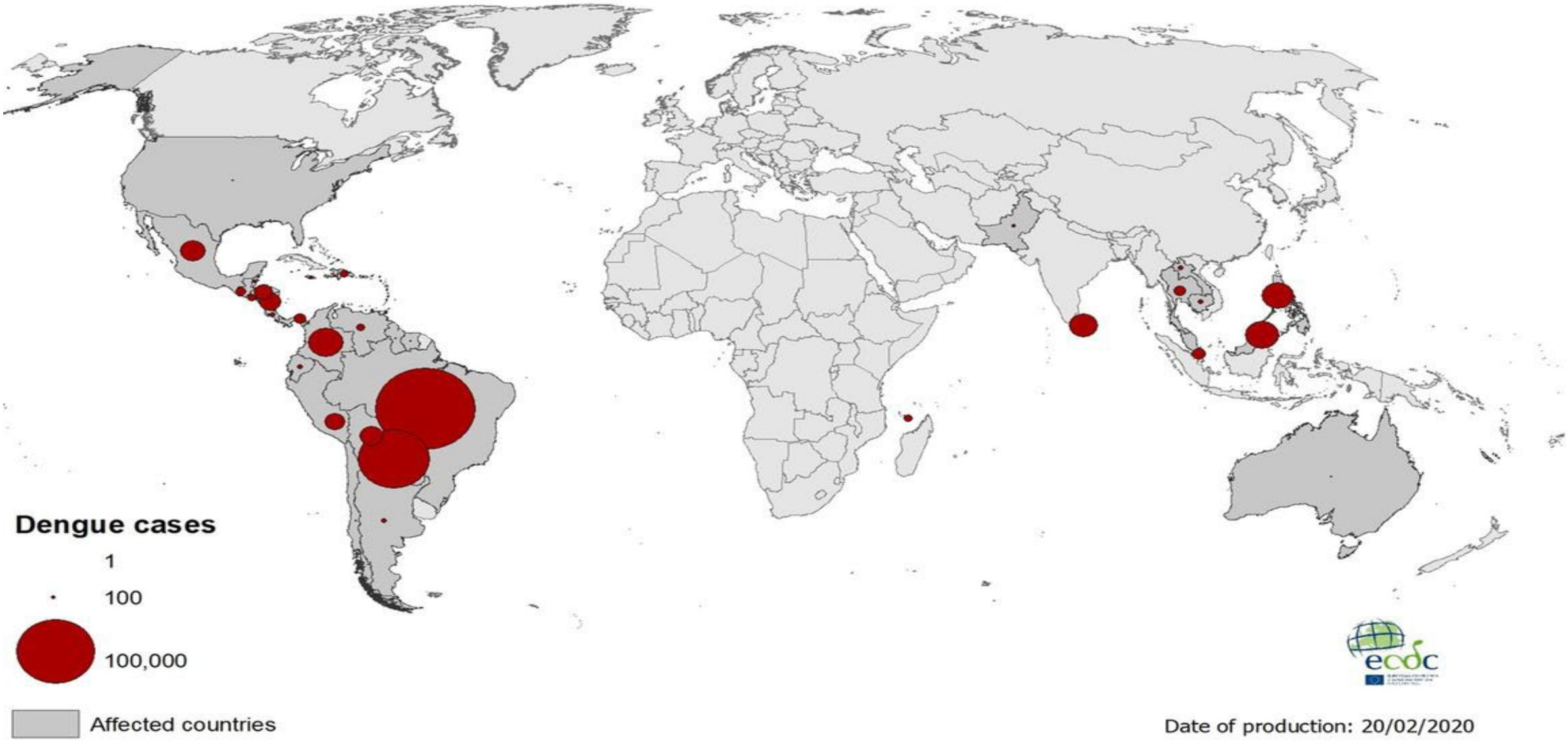
1.2 Distribution of Dengue



The picture was taken from: https://upload.wikimedia.org/wikipedia/commons/3/3f/Global_Aedes_aegypti_distribution_%28e08347%29.png

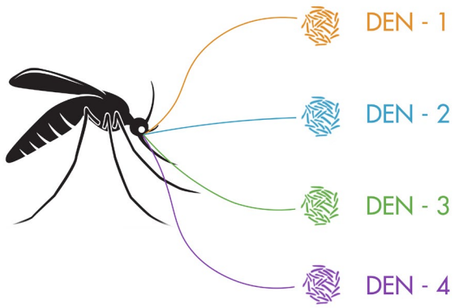


The picture was taken from: https://www.ecdc.europa.eu/sites/default/files/styles/is_large/public/images/dengue-worldwide%20overview-january-february-2020.jpg?itok=UBSmJ0Fy

According to a recent report from The World Health Organization, there are a number of new cases on dengue have been registered around the globe

1.3 About the Virus

Dengue virus is usually found in urban and suburban areas in the tropical regions. But there is some evidence that well-developed cities are likely getting exposed to this disease. People of all ages who are exposed to infected mosquitoes are possible victims of dengue fever. There is strong evidence that dengue occurs only in the monsoon/rainy season. However, a recent study found that dengue mosquitoes are active throughout the year. It has become one of the worst mosquito-borne human pathogens for tropical countries with dramatic increments in the last 20 years.



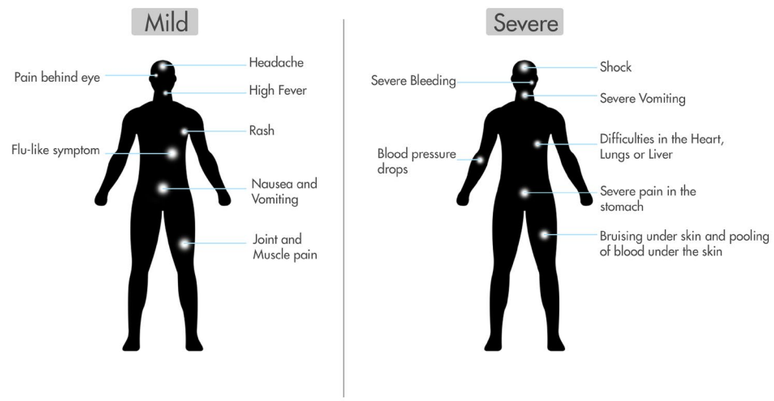
The illustration describes the four different serotypes from Aedes Aegypti mosquito

Dengue can be caused by one of four closely related to the dengue viruses **(different serotypes of dengue virus - DENV-1, DENV-2, DENV-3, DENV-4).** Infection with one serotype of DENV provides immunity to that serotype for the rest of the life. But no long term immunity for other types of serotypes. Thus, a person can be infected as many as four times, once with each serotype.

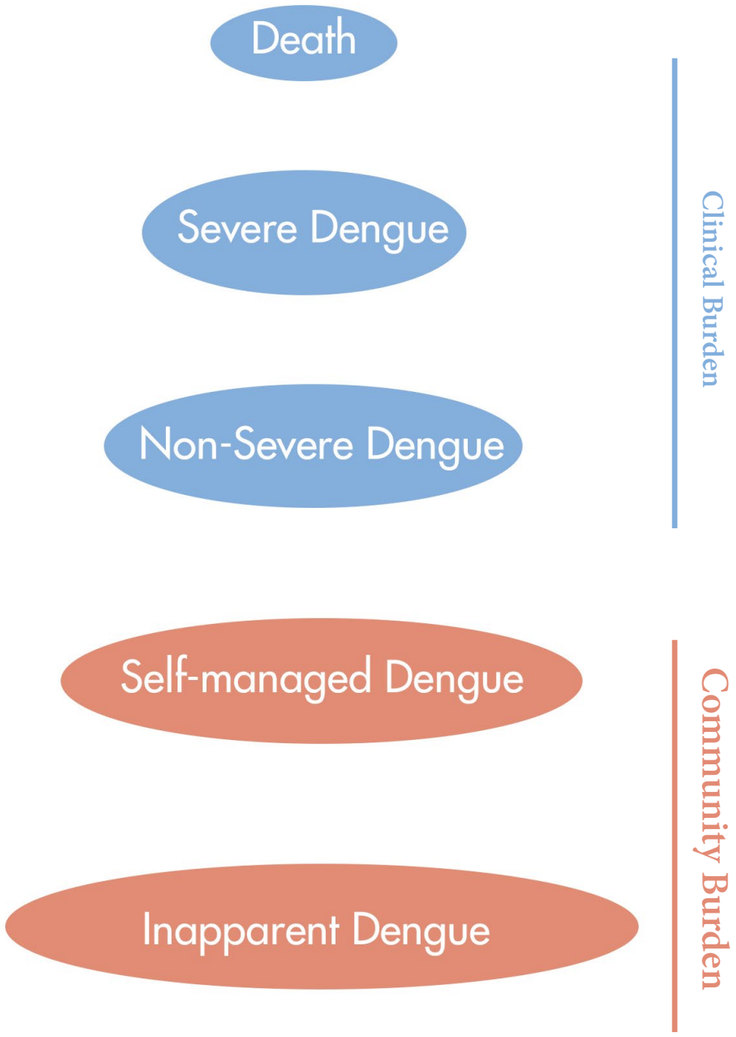
1.4 Infection classification

For better treatment, dengue is classified into two categories based on the level of the infection. One is Classic dengue fever or break-bone fever characterized by acute onset of high fever 3–14 days after the bite of an infected mosquito. Symptoms include frontal headache, retro-orbital pain, myalgias, arthralgias, hemorrhagic manifestations, rash, and low white blood cell count.

On the other hand, Some patients with dengue fever go on to develop dengue hemorrhagic fever (DHF), a severe and sometimes fatal form of the disease. Around the time the fever begins to subside (usually 3–7 days after symptom onset), the patient may develop warning signs of severe disease. Warning signs include severe abdominal pain, persistent vomiting, a marked change in temperature (from fever to hypothermia), hemorrhagic manifestations, or change in mental status (irritability, confusion, or obtundation). The patient also may have early signs of shock, including restlessness, cold clammy skin, rapid weak pulse, and narrowing of the pulse pressure (systolic blood pressure – diastolic blood pressure).



1.5 Burden Measurement



Disease outcomes of a dengue virus infection divided by the clinical burden (blue line) that is measured by routine passive surveillance and the community burden (orange line), which can only be measured by community-based sampling

Human infection with dengue viruses can result in a broad range of disease manifestations of varying levels of severity. These levels of infection severity are largely distinguished by how and where the patient is treated or managed. They include

Non-sever dengue

The case classification of non-severe dengue is defined in the 2009 WHO guidelines as travel to or a resident in a dengue-endemic area plus two of the following criteria: nausea or vomiting, rash, aches, and pains, tourniquet test positive, leukopenia or any warning sign. This definition includes the classifications of dengue with and without warning signs and can include cases in whom dengue is either diagnosed using only clinical criteria or those that are laboratory confirmed.

Severe dengue

The case classification of severe dengue is defined in the 2009 WHO guidelines as a patient present with severe plasma leakage, severe hemorrhage, and severe organ impairment.

Fatal dengue

A death in which acute dengue virus infection is the sole or leading cause.

Self-managed dengue

A dengue virus infection that results in disruption to the daily routine of the individual. But that does not result in seeking diagnosis or treatment from an official healthcare provider.

Inapparent dengue

If the dengue virus is only detectable upon some examining but not affecting the routines of an individual. It might have mild symptoms or not at all. However, there are some possibilities that, this individual could be carrying the virus along with them.

1.6 Mosquito Management

The World Health Organization (WHO) and The Center for disease control and prevention (CDC) are advising people in several ways to prevent them from Dengue infection and save lives.

Conduct mosquito surveillance

Mosquito control plans include taking steps to control mosquito populations before people start getting sick with a virus spread by Aedes aegypti. People need to understand what types and numbers of mosquitoes are in an area. In order to find out this information, Surveillance activities can include

The picture was taken from: https://www.cdc.gov/zika/images/vector/mosquito_survillance.png

- Finding and monitoring places where adult mosquitoes lay eggs. The larvae that hatch from eggs are found in these same places
- Tracking mosquito populations and the viruses they may be carrying
- These activities help people to determine if, when, and where control activities are needed to manage mosquito populations before people start getting sick. If people discover that local wmosquitoes are carrying viruses (like dengue, Zika, or others), they need to start implementing other activities identified in their mosquito control plans.

Remove places where mosquitoes lay eggs

Removing places where mosquitoes lay eggs is an important step. Mosquitoes lay eggs near water because larvae need water to survive. The public can remove standing water to reduce mosquito larvae before they become adult flying mosquitoes.

The picture was taken from: https://www.cdc.gov/zika/images/vector/remove_places_where_mosquito_lay_eggs.png

- Public spaces like parks and greenways and illegal dumps need to be cleaned to maintain hygiene. local government agencies and mosquito control districts need to collect and dispose of illegally dumping near residential areas
- You, your neighbors, and the community can remove standing water. Once a week, items that hold water like tires, buckets, planters, toys, pools, birdbaths, flowerpot saucers, and trash containers should be emptied and scrubbed, turned over, covered, or thrown away.
- If needed, a community clean up event can be held to remove large items like tires that collect water.

Control larvae and pupae

Once the mosquito eggs hatch, they become larvae and then pupae. Both larvae and pupae live in standing water. Dumping or removing standing water in and around your home is one way to control larvae. For standing water that cannot be dumped or drained, a larvicide can be used to kill larvae. Larvicides are products used to kill larvae before they become biting adults.

The picture was taken from: https://www.cdc.gov/zika/images/vector/control_young_mosquitoes.png

- People have to treat water-holding structures and containers in public places like storm drain or urns in cemeteries. They may also treat standing water on private property as part of a neighborhood cleanup campaign.
- People can treat fountains, septic tanks, and pool covers that hold water with larvicides.
- Controlling larvae and pupae before they become adults can minimize widespread use of insecticides that kill adult mosquitoes

Control adult mosquitoes

Adult mosquitoes can spread viruses (like dengue, Zika, or others) that make you sick. When surveillance activities show that adult mosquito populations are increasing or that they are spreading viruses, people may decide to apply adulticides (adulticide is kind of insecticide) to kill adult mosquitoes. Adulticides help to reduce the number of mosquitoes in an area and reduce the risk that people will get sick. The public and professionals can use the US Environmental Protection Agency (EPA)-registered adulticides according to label instructions.

The picture was taken from: https://www.cdc.gov/zika/images/vector/control_adult_mosquitoes.png

- If mosquitoes are spreading viruses over larger areas, professionals spray adulticides by using backpack sprayers, trucks
- People can buy adulticides and use them inside and outside their homes.s

1.7 Vector Control

1. Environmental management
2. Mosquito-proofing of water-storage containers
3. Solid waste management
4. Chemical control: larvicides

Other than these, in the field there are two new vector control approaches are being used. One is releasing genetically modified male mosquitoes. When these **genetically modified mosquitoes** mate with females, their larvae die before they become an adult.

The second approach is the establishment of **Wolbachia bacteria** in the guts of the mosquitoes, which blocks infection by dengue, Zika and chikungunya viruses. Wolbachia live inside only insect cells and occur naturally in up to 60% of all insect species as well as many mosquito species, although not usually in Aedes mosquitoes. However, there are some researchers have been injecting Wolbachia into the eggs of Aedes aegypti mosquitoes and releasing the hatched insects. When a male mosquito that carries Wolbachia mates with a female without the bacteria, the female's eggs do not hatch. The advantage of using Wolbachia bacteria is that once they are introduced into the mosquito population, they can be maintained without constant re-releases. Again, the mosquitoes do the work of finding breeding sites. This approach is being tested currently in the field in several countries, including Australia, Brazil, Columbia, Indonesia, and Vietnam. These are some of the effective ways to control vector disease. However, They also do have a negative side. Research data shows that using genetically modified mosquitos are affecting the ecosystem. And it is not available for all the counties in the tropical region.

1.8 How I got there

1.8.1 Initial Meeting with Examiner

In this initial meeting, I discussed with my examiner the area that I wanted to work on my graduation project. To find my interest, I took Research methods in Industrial design course as an opportunity to find my interest. With all the research and findings, I chose two topics. One is proving a Non-Invasive glucose monitor and another one is Tropical region disease. Since I'm passionate about Medical device design, I proposed a Non-Invasive glucose monitor device as my graduation project. However, my examiner had a different idea.

"He said that, though it is a new technology to the market, What would your new learning outcome from this? Sometimes this technology may or may not work in the end. In case it failed to work properly, you might end up having nothing at the degree show. On the aesthetic wise, It would only take two weeks maximum. I don't see this as your graduation project. So instead of focusing on this, focus more on Tropical region disease. You might end up doing great work".

The meeting was a little disappointing though, But he really did have good points. After his comments on this, I was focusing more on the tropical region disease and considering making Non-Invasive glucose monitor as my personal project.

1.8.2 Getting to know

On Sunday morning my examiner found an article about the vector control method in the newspaper and send it to me. The article was inspiring and I did more research into it. Since I was working on tropical region disease, I sent them an email to know more about this project.

A6 Lördag 18 januari 2020 SVENSKAN

VETENSKAP

MYGGFORSKNING I ALNARP

A7 Lördag 18 januari 2020 SVENSKAN

FAKTA

Malaria

Laborationsförsöken på malariamyggor utför Rickard Ignell (till höger) och hans forskargrupp på SLU i Alnarp. Det måste vara 27 grader varmt i odlingslabbet för att myggorna ska trivas.

Femtio fällor laddade med doft av kopiss monterades i byn Magge.

Kopiss nytt svenskt vapen mot malaria

Var fjärde invånare smittades när malarian bröt ut i södra Etiopien 2019. Men människorna i byn Magge skonades. Där hade den svenske forskaren Rickard Ignell placerat ut myggfällor laddade med urindoft från kor. Doften av piss från SLU i Alnarp kan hejda sjukdomen som dödar en halv miljon människor varje år.

Addis Abeba

ETIOPIEN

1.8.3 Meeting at Espresso

As a result, we ended up having Coffee at the Expresso House at Lund. At this first meeting, I met Professor, **Head of Department of Plant Protection Biology, Disease Vector group Mr. Rickard Ignell**.

During the meeting, we discussed the article which was published in the newspaper. He gave me a glimpse of research and practices that have been happening at SLU and he also explained the problem that he is facing while conducting the experiments in the field.

But he said that “I’m not interested in making any kind of commercial products here. Rather I would like to make things that would highly impact society. We can continue further if your interest is as same as mine”.

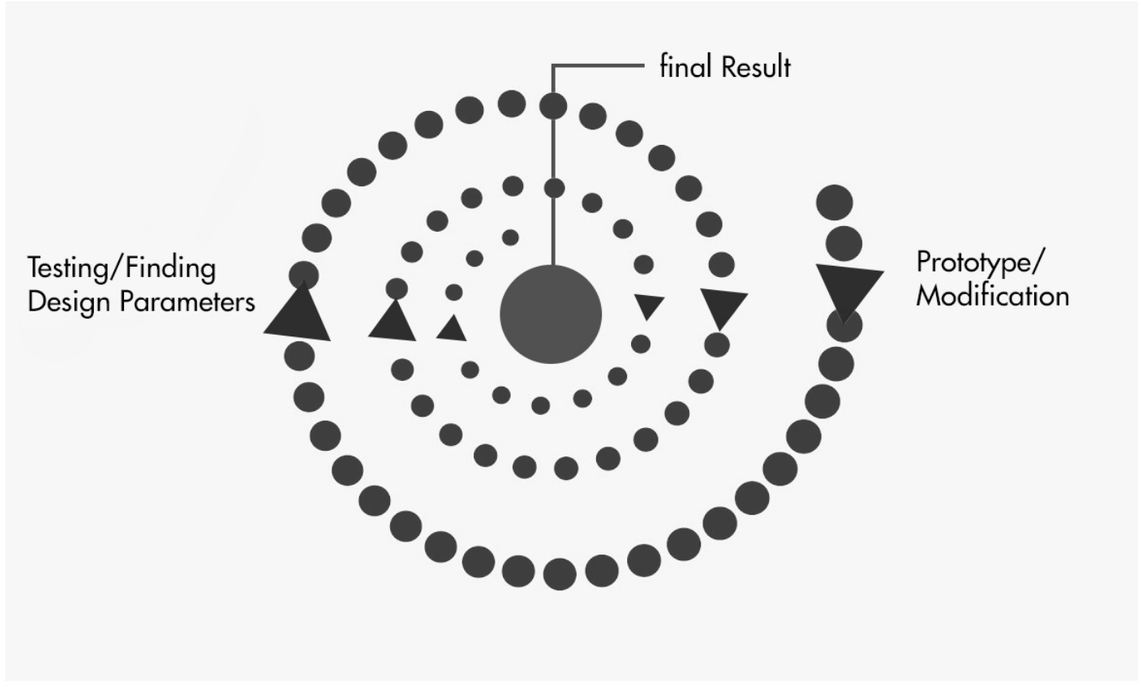
It was fortunate that mine and his idea of making an impact in society came together. In order to start working together, he wanted to see my design proposals in the following meeting.

1.9 Brief

Developing a product for people living in rural areas in tropical regions mainly with poor lifestyle and infrastructure. The product should be made locally available material. Moreover, people should be able to build it by themselves just by looking at it. It should be reliable, sustainable, involves no complex manufacturing technologies.

To design a non-commercial efficient mosquito trap/ a baiting station, I need to fully understand the behaviors of mosquito. I was planning to conduct 45 experiments. And each experiment takes 24hours to finish. Due to the pandemic situation, I can only able to conduct 10 experiments so far.

1.10 Methodology



Chapter 02

2.1 Meeting - 1 at Alnarp

As discussed in the earlier meeting at the espresso house, I had done some homework and made quick modeling for feedback.

Design considerations

- It should be simple but effective,
- User-friendly,
- No Complex manufacturing process

How to make

We all happen to throw a lot of E-waste these days. Someone's waste could be someone's treasure. Exhaust fan from the old electronics part can be used as a suction fan.

For containers, It would be a good idea to use aluminum food containers as a dead mosquito collector.

This picture was taken from: https://images-na.ssl-images-amazon.com/images/I/61svrA%2BjbxL._AC_SL1000_.jpg

https://i.ya-webdesign.com/images/metallic-vector-aluminium-1.png

It is designed to have two suction fan to capture and trap the day and night mosquitoes. Because of the difference in mosquito's behavior

2.2 Discussion

Richard really liked the idea of designing a mosquito trap with battery and fan. And he also liked the idea of utilizing waste from the local community. But he did put some questions ahead.

Richard: Why did you come up with this design?

Me: Thought giving a simple solution would impact society more. Moreover, giving knowledge of waste management would be a perfect way for sustainability.

Richard: Who is your target group?

Me: I'm focusing on all the countries which are infected with the dengue virus.

Richard: How much it would cost if one decides to build/buy?

Me: Users do not need to spend money if they could find the required parts from home/recycling centers. Else they might be spending little money on a few parts. However, the instruction will be given to the user's on how to make it at home

He replied that, However, the feasibility was a little questionable. Not everyone can get access to the waste recycling center or not everyplace has electronic components. If one can make it, what would be the lifetime of this? If it can't work anymore, How one can fix the issue? There are chances that they might run out of motivation. So it's better to for a simple solution as possible.

Besides, Richard stated that "I do personally not favor for making trap design. Because it is not as effective as we might think. Since I have the field experience, I don't think people like to/want to empty the trap every morning. And cleaning the trap would be a difficult task for the users"

2.3 Reflection

I was thinking that this one was the simplest solution. But it turned out it has little complexity in making. Based on Richard's field experiences, I understood that people are not expecting any design solution with the trap. I remembered a saying **" We must design for the way people behave, Not how we would wish them to behave"**

I decided to pick a particular place to make the design simpler. The reason is, there is a huge difference in finances, people, and the environment from one country to another. Since SLU is already conducting experiments in Ethiopia, I choose that place as my target group.

*https://miro.medium.com/max/3508/1*HL6-ItsWOwiwlxrPiP9WJA.png*

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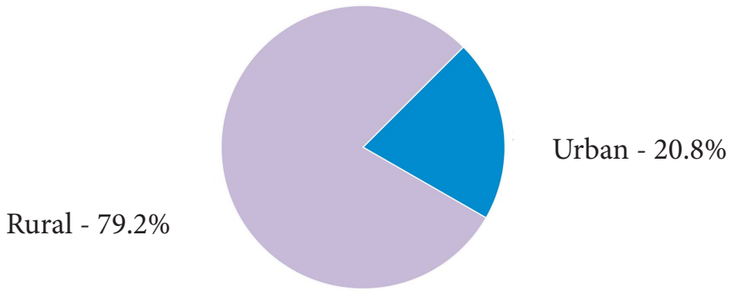
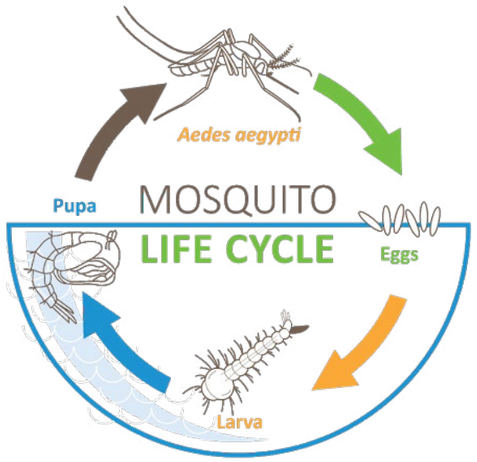
Ethiopia Urban-rural (2018)



2.4 Meeting - 2

In this second meeting, Mr. Richard Ignell gave me a lecture on different behaviors on mosquitos. He thought that I need to know the basic principles of mosquito in order to deal with them.

He started by explaining the lifecycle of mosquitoes



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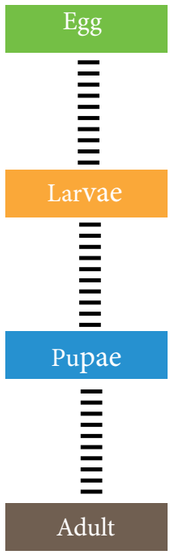


2 to 7 days

less than 4 days

2 days

An Aedes Aegypti can fly up to 400 meters at once

Average Lifetime - 1.5 to 3weeks (Depends on the environment)

When looking for nectar

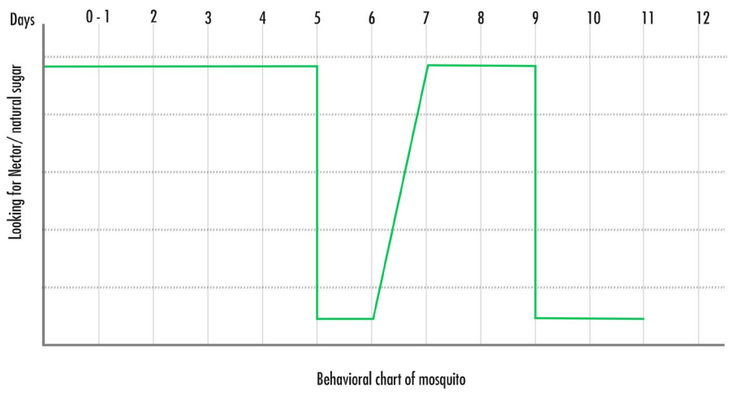
Day active mosquitoes fly from above to the ground

Night active mosquitoes fly from the ground to above

Fly against the wind's Direction

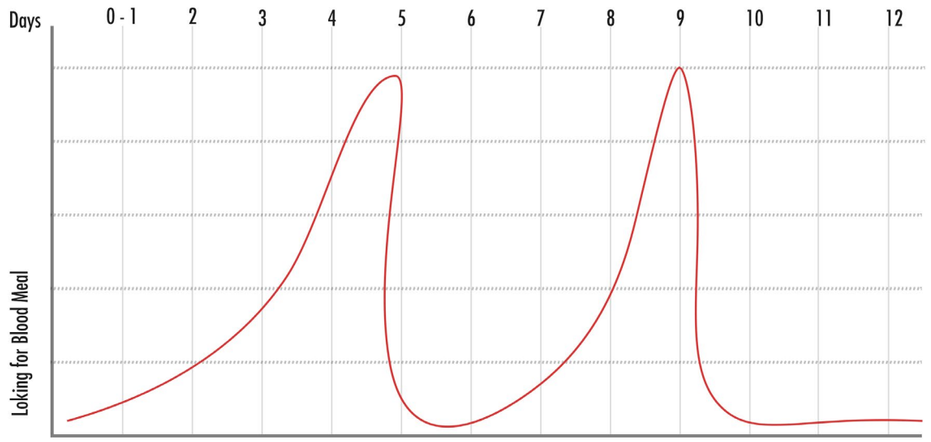
2.5 Behavior chart

Sugar Meal



- The first thing that mosquito do after one day emerges is to look for nectar (flower, honeycomb, fruits) or other natural sugar-based meal.
- Mosquitos need sugar meal to stay active and to gain energy for reproduction
- Both male and female take sugar meal
- Aedes aegypti takes sugar meal up until 5 days. Female mosquitos switch to blood meals for the egg-laying purpose where male mosquitoes are continuing the sugar meal for the rest of its life.
- There is some evidence shows that after the egg-laying female mosquitoes are again going for sugar meal

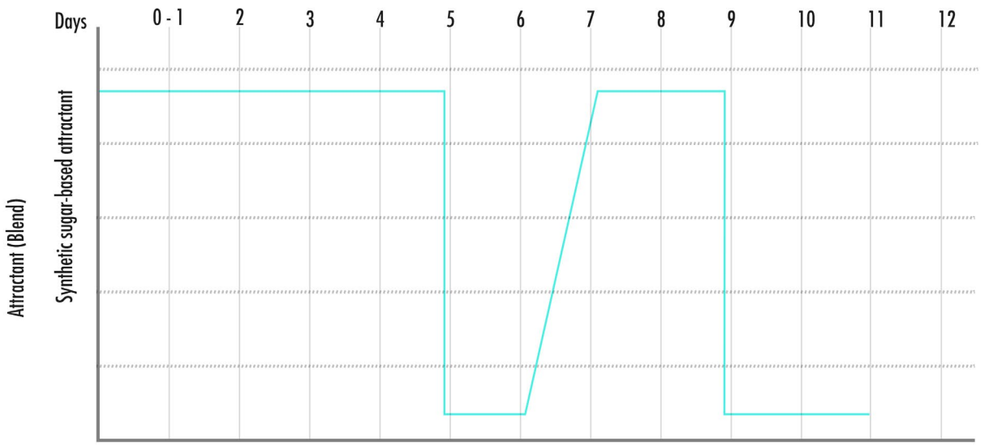
Blood seeking behavior



- Only female mosquitos seek for blood meals
- Most female mosquitos take a blood meal anywhere between 4 to 6 days. But in the lab, mosquitos take a blood meal in 5 days in under ideal circumstances.
- Once the mosquito is enough blood meal, then the interest in the blood goes to zero and they do nothing for a long time.
- Again they look for blood meal anywhere in between 36 to 48 hours

2.6 Attractant chart

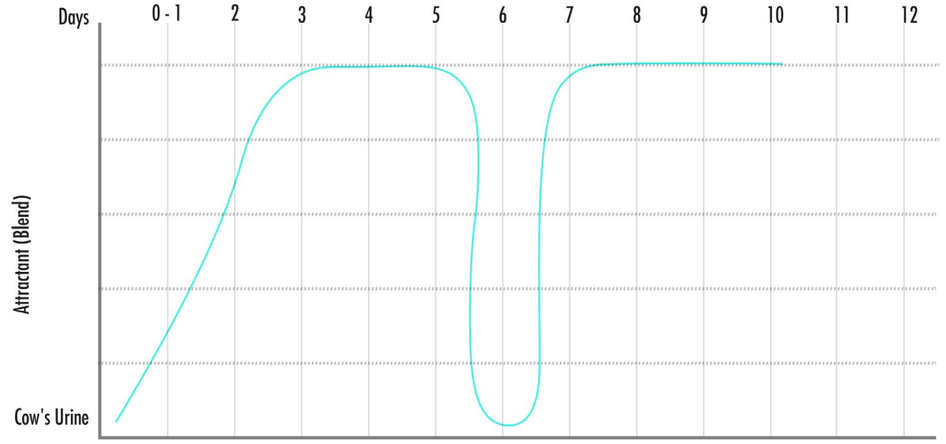
Synthetic sugar-based odor



Behavioral chart of mosquito

- Based on the field research and experiments, SLU states that synthetic sugar attractant works really well. It attracts both male and female mosquitoes.
- Making this blend is an easy and quick process. Requires minimum resources (Only 5 compounds)
- More importantly, it doesn't need CO2
- It is not just for Aedes Aegypti. Study proves that the same can be used for attracting other vector species in the filed

The odor from Cow's Urine



Behavioral chart of mosquito

- We know that the mosquito which is looking for blood meal are highly attractant to the Odor made from cow's urine.
- There are some possibilities that mosquitoes are attracting to this Odor in the earlier stage.
- But this needs to be accessed in the field.
- The Ethiopian field study showed that we can able to capture mosquitoes that are looking for a blood meal or recently had blood meal.
- The study also accessed that, the mosquitoes which about to lay eggs are also attracted by this type of Odor
- But it only works on females
- Does not require CO2
- Requires 6 compounds
- Only works on Malaria, and Culex in the African region

2.7 Meeting - 3

Our third meeting held via skype. At this meeting, we discussed the design and development part. I took this as an opportunity for understanding expectations from his side. We discussed many things. But I would like to mention a few here

Mosquito magnet

This picture is taken from: https://www.mosquitomagnet.com/

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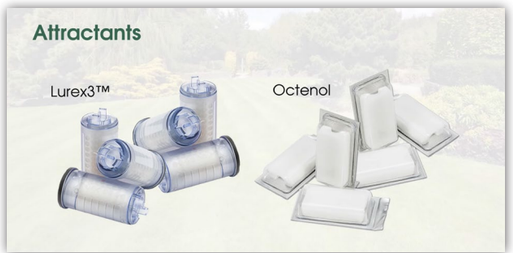


This picture is taken from: https://www.mosquitomagnet.com/

Model Model #	Patriot Plus Model #MM4200B	Executive Model #MM3300
Price	$349.99	$749.99
Power	A/C Power Cord	Rechargeable Battery
Coverage	Up to 1-Acre	Up to 1-Acre
Net Size	Small	Large
Warranty	1 Year	1 Year
	In The Box	
Octenol Attractant	✓	✓
Mosquito Net	✓	✓
Battery Charger		✓

This picture is taken from: https://www.mosquitomagnet.com/

https://www.bole.se/media/product/a12/myggfangare-mosquito-magnet-executive-594.jpg

Disadvantage

Really effective and kills a high number of mosquitoes

It is bulk and hard to transport to the rural areas of Ethiopia.

Uses propane which makes it more expensive

Releases CO2 which is not environment friendly

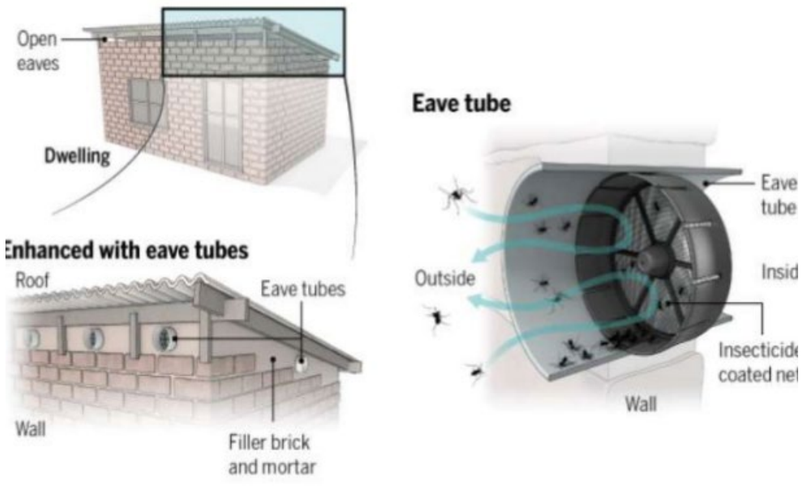
If it needs to be serviced or replacement of parts, the user needs to call the appropriate person

Eave Tubes

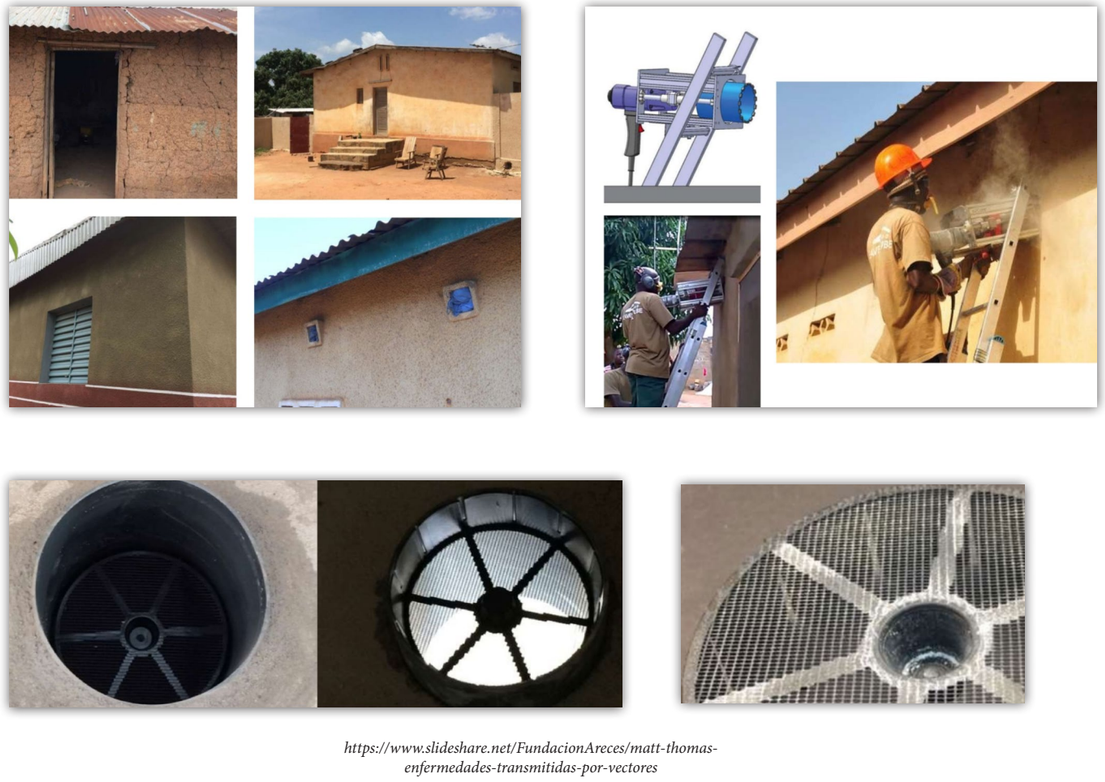
When all happen to know that hot air goes up and the exhaust we have at home takes it out. Hot air is mixture of human odor and CO2. These works as a high attractant to the host-seeking mosquitoes.

Eave Tubes come with electrostatic coating technology to bind insecticides. These eave tubes are replaced in the exhaust for trapping and killing the mosquitoes. When a mosquito comes and makes physical contact with the electrostatic coating technology to bind insecticide net, it passes the high doses of insecticide to the mosquito. Research data shows that this method works effectively on all types of host-seeking mosquitoes.

https://www.in2care.org/eave-tubes-work/



https://image.slidesharecdn.com/mattthomas11-12052017218asistentes-170814095703/95/matt-thomasenferme-dades-transmitidas-por-vectores-3-638.jpg?cb=1502704654



https://www.slideshare.net/FundacionAreces/matt-thomas-enfermedades-transmitidas-por-vectores

Disadvantage

https://www.in2care.org/eave-tubes/

It only works on host-seeking mosquitoes. Especially on night active mosquitoes.

It can be fixed in the existing exhaust hole. If there is no hole, need to make a-holes on the house wall

Since it is a patented technology, People need to pay if they wanted to have one.

Baiting station

Westham, the company has involved in making baiting stations successfully. So far they have launched two types of baiting stations. JennyPro Bait Station and Sarabi Bait Station are successfully deployed in the project sites.

https://westhamco.com/

Both have chemical compounds in a sealed with the plastic package. It is comprised of a two-dimensional (28X20 cm) plastic surface overlaid on both sides with a wave-like permeable membrane that encapsulates the bait mixture (attractant, sugar, active ingredient). Mosquitoes die quickly When they try to penetrate and consume the chemical compounds.

They both are low-cost, lightweight, and can be easily placed inside or outside the residence. It is inaccessible to non-targets.

Lifetime
JennyPro Bait - 3 months
Sarabi Bait - 6 months

https://westhamco.com/

https://westhamco.com/

2.8 Meeting - 4

Keeping all the information like Behaviour of mosquitoes, the behavior of people, and their need and requirement, I started making a quick prototype. I and Mr.Richard believed that Making a quick prototype would help us to conduct experiments to identify the efficiency of the attractant and find the design parameter. Since I had little time to finish my thesis, we hurried up the process a little.

Concept 1

Concept 2

Concept 3

Discussion

When I presented the mockup, he felt happy and said that this what pretty much he had in his mind. He felt that the design is so simple that It can be made easily and implemented in a cost-effective way. Since all these materials are accessible to the people in rural places (Places that are highly exposed to dengue) it would be easy for anyone to make one for them or replace if any damage happens unexpectedly.

In terms of design, we discussed what could be improved in the future. How it can be prevented from the changing environment. What materials can be changed to make it cheaper or more effective? We also discussed the size of the mockup. How mosquito would react if the area of contact is small or big? And depending on the size of the design how the scent will be displaced or affected? How all these can be improved? Also, he gave me the suggestion of conducting the experiment 10 times with two identical mockups. One with odor and one without odor. Besides, he suggested me to switch the height of the odor in the mockup, just to see if that makes any difference.

In the end, Richard suggested making two identical prototypes in order to start the experiments. Our plan was to place the attractant in one prototype and one without attractant to assist the efficiency of the attractant as well as finding the design parameters for the final working model.

A functional prototype for conducting experiments

Chapter 03

3.1 Became a member

I joined this amazing team as an experiment conductor where I was given private lab facilities to do so. It was an exciting opportunity where I actively participated and worked and interacted with living things.

Mengistu Dawit
PhD Student

Rickard Ignell, Professor
Head of Department of Plant Protection Biology
Disease vector group, Unit of Chemical Ecology

Annika Hinze
PhD Student

You know me!

3.2 Tour at SLU

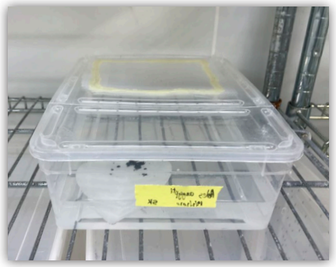
It is a rearing house where we do activities from collecting the egg to grow it as an adult under a pre-set fixed environment.

Bio chamber 2. It is where I was conducting all of my experiments. Temperature and Humidity were set as similar to the tropical region

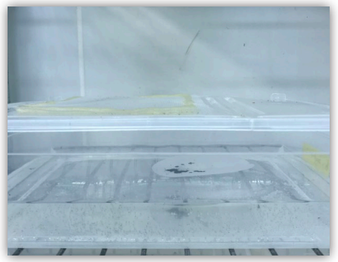
Environment chamber where mosquitoes grow up with uninterrupted environmental change

3.3 Making own colony

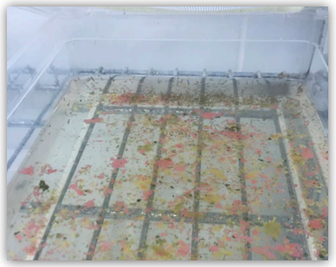
I was involved in making my own colony of mosquitoes to conduct experiments. The activities that I took.



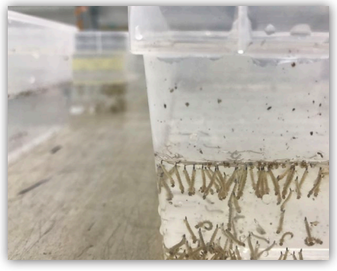
Eggs are usually given in the filter paper. After I receive them, I need to put them in a container filled with distilled water.



Identifying if all the eggs are hatched

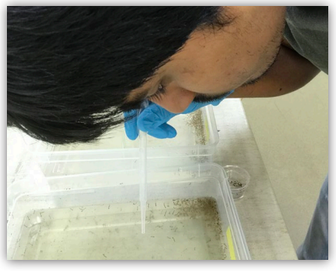


Feeding time. Feed them once in two days. The food contains seafood type.

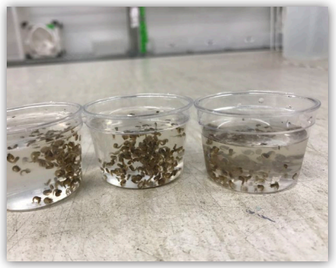


In one week it becomes a fully developed larva

A matured larva turns into pupae in just two days



Collecting the pupae and storing it in a small container with distilled water



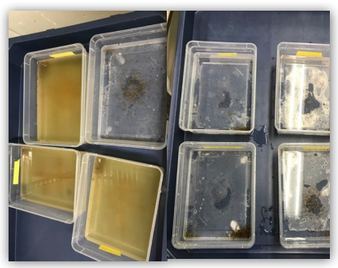
I can able to collect around 200 to 300 pupae for one turn

Pupae usually take less than two days. So I keep the pupae in the cage with mosquito net. Pupae usually take less than two days. So I keep the pupae in the cage with mosquito net.

The sugar water is also kept in the cage along with pupae. It helps mosquitoes to gain energy.

In about 12 to 14 days all the pupae emerge into fully developed adults. Likewise, I have made 10 more colonies for my experiments.

A Fixed temperature as similar to the tropical region



Due to overfeeding the water might get too dirty. If the water is too dirty, it would be difficult to collect pupae from the container. So the water needs to be changed

3.4 Experiments

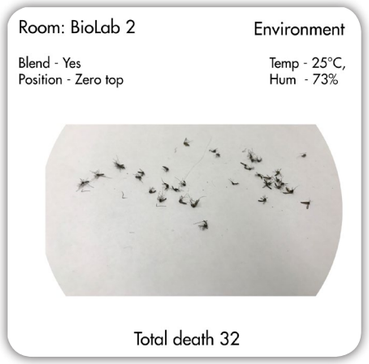
I have start conducting the experiments once the mosquitoes are ready. In order to find the efficiency of the blend and design, we decided to conduct two experiments in parallel. We have taken two mosquito cages, Placed prototypes in each cage. We placed Attractant in one prototype in one cage where the other one was just the prototype. Initially, we kept both cages in a separate room under same environment settings.

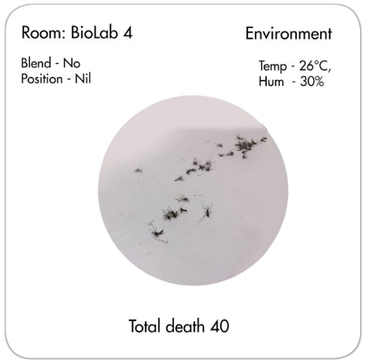
I usually start the experiment by leaving 50 mosquitoes in both cages. In that 25 are male and 25 are female. Run the experiments for 24 hours. Collect the dead mosquitoes from both cages and segregate them into male and female. Count how many died and continue the same process two more times. When two reparations are done, we change the position of the trap as well as the placement of the attractant and repeat the same procedure again.

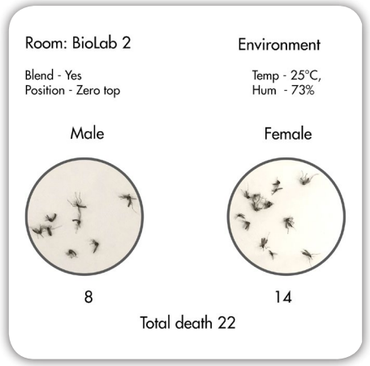
Experiment chaper which I used for conducting experiments

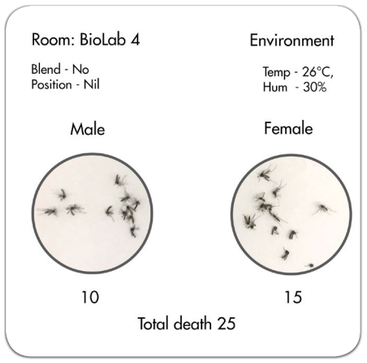
Test tube to store the affected/Died mosquitoes.

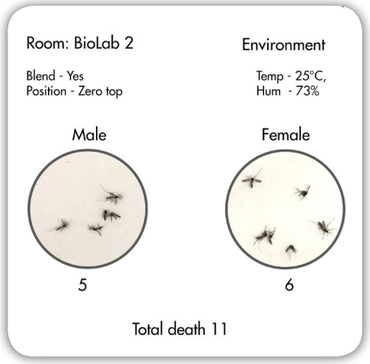
Aspirator for transferring the mosquitoes from mosquitoes cage to experiment chamber.

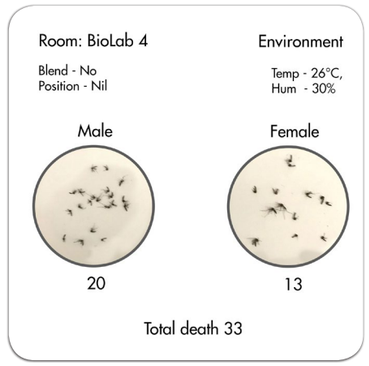


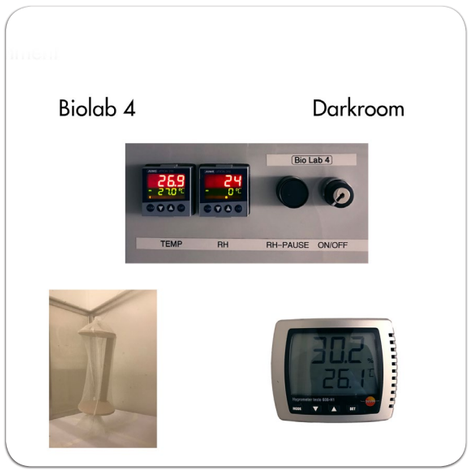




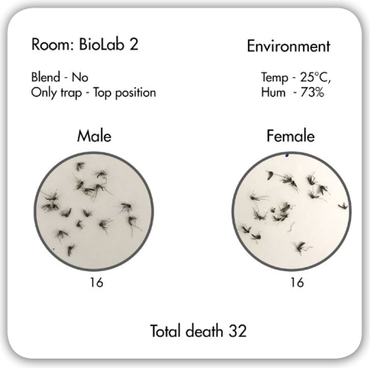


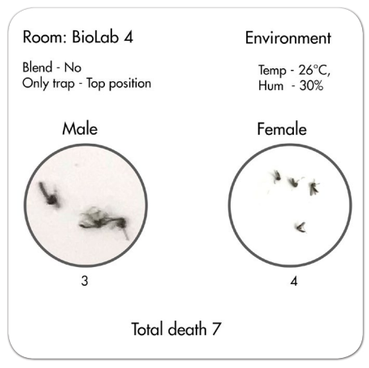


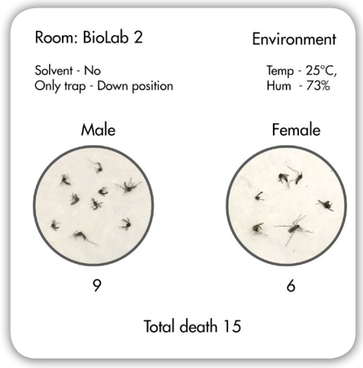


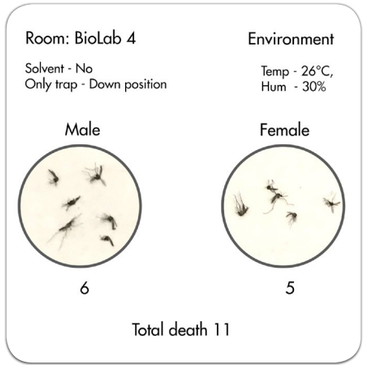


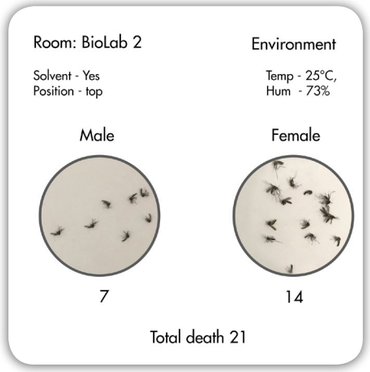
We found huge difference in environments settigns in both lab which was influencing the experiment's results. So we decided to conduct in the same lab.

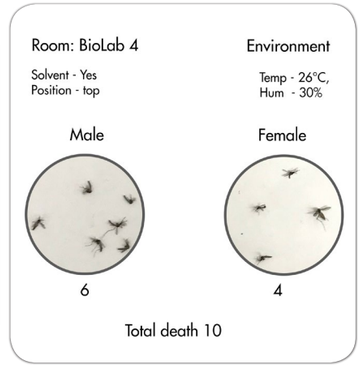


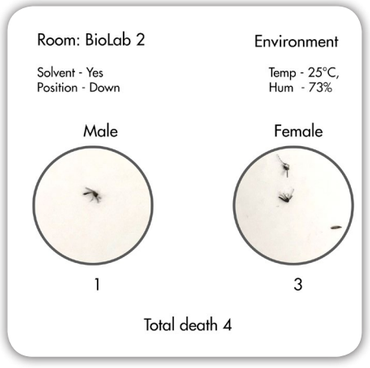


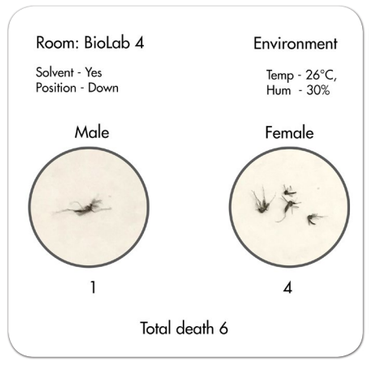


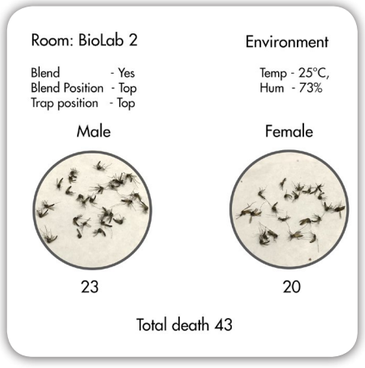


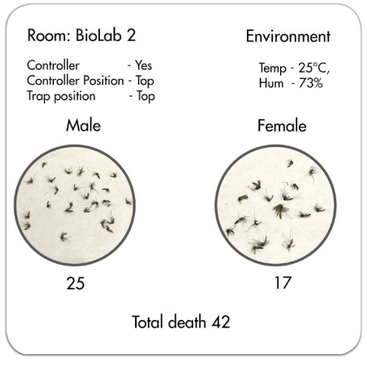


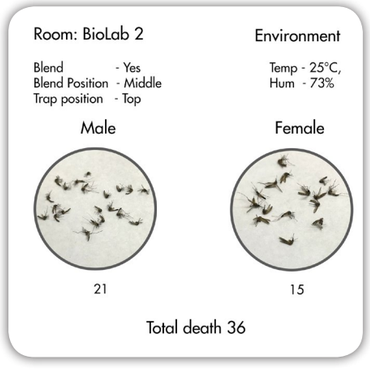


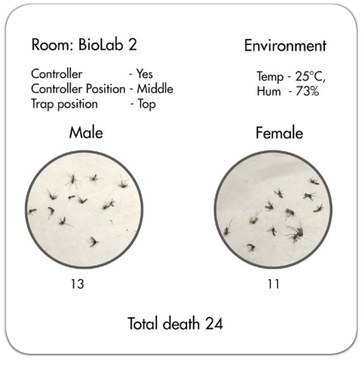












3.5 Sum up of the experiments

Under the lab environment, we found that the trap with attractant worked well than trap without attractant. We also found that the bigger in size, is higher in the efficiency. Placing the attractant little above from the mid-position in the trap attracts more mosquitoes than keep it in the top or bottom position in the trap. Placing the whole set up in the well-ventilated area works much better than the non-ventilated area.

Chapter 04

4.1Material and Texture

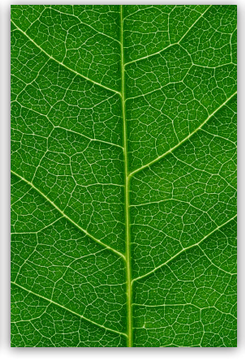
Mosquitoes are not only attracted by the scent. But also for material and color. A study provides datum on material and color that are attracted by mosquitoes and other vectors.

Leather

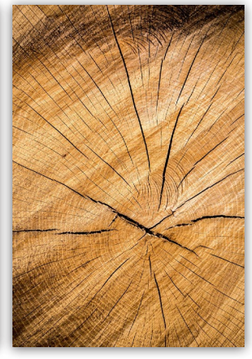
Fabric

Rusted materials

Plastic



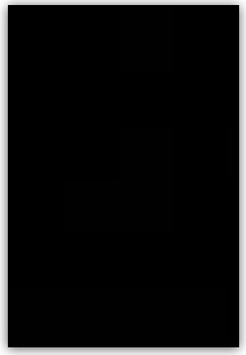
Plant

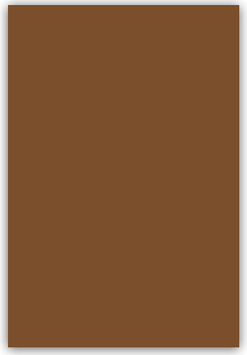


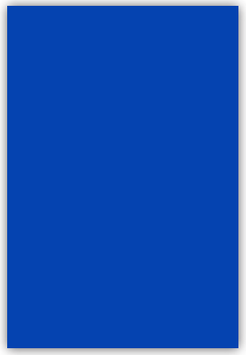
Wood

4.2 Color

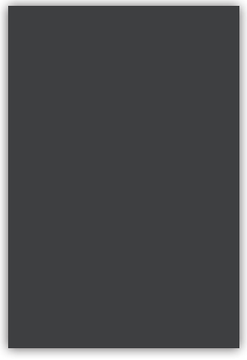
According to studies, Colors that are attracted by Mosquitoes.

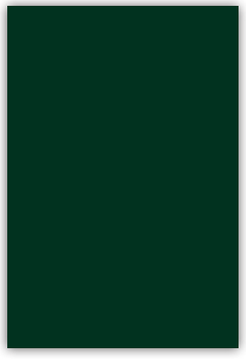






Mostly dark colors like & Heat retention color





4.3 Market Exploration

There plenty of mosquito repellent products are used by people. Though such products are popular among consumers, They do have negative sides. Here are some of them that i want you to go though

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https://images-na.ssl-images-amazon.com/images/I/71H4nrOXz6L._SL1500_.jpg

https://5.imimg.com/data5/IY/SC/SJ/SELLER-34513362/hit-mosquito-spray-500x500.jpg

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https://image3.mouthshut.com/images/imagesp/925008294s.jpg

Most of this product contains harmful substances to humans and animals. Due to continuous contact with these substances, Consumers put their health at risk. Besides, Not all the above products are available everywhere. Also, some of them are expensive to a certain group of people. certainly, these products are not accessible to people living in rural Ethiopia.

https://lh3.googleusercontent.com/proxy/p5IkqpjEsUXryHzD-djgKvSMSOvTAbLjrmxHGEFFuoUBu9wWtgGUHCSwpNrMgO9pkjiX-3dlpj-AV0my0DECvFE9N9sCbAg4OP3fKcysJVZK8VNjb1JTLEIXuIudH-1Q1KH4G5VkfgG4wObvUJ2RgnEoICH

https://www.statnews.com/wp-content/uploads/2017/03/TMBFBana-SG26.jpg

https://www.rosario3.com/__export/1586818731536/sites/rosario3/img/2020/02/06/fumigacion_dengue.jpg

4.4 Objectives

Affordable

Sustainable

Should fit with different culture

Should fit with different geological Environment

Should not incorporate with complex manufacturing or Electronics

4.5 Design Parameters

Minimum diameter - 120mm (But the bigger in size works better)

Minimum height - 210mm

Minimum Height from the ground - 1 meter

should be placed in the well-ventialted area

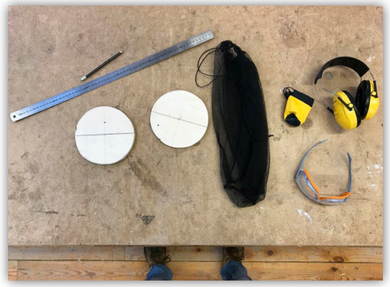
4.6 Concept Exploration

4.6.1 Concept - 1

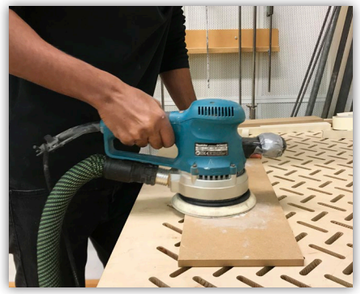
4.6.2 Concept - 2

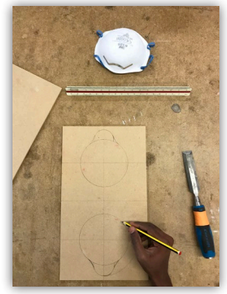
4.6.3 Concept - 3

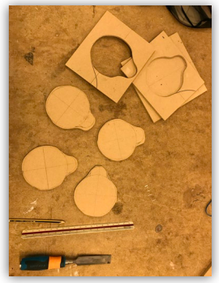
4.6.4 Concept - 4



4.6.5 Concept - 5

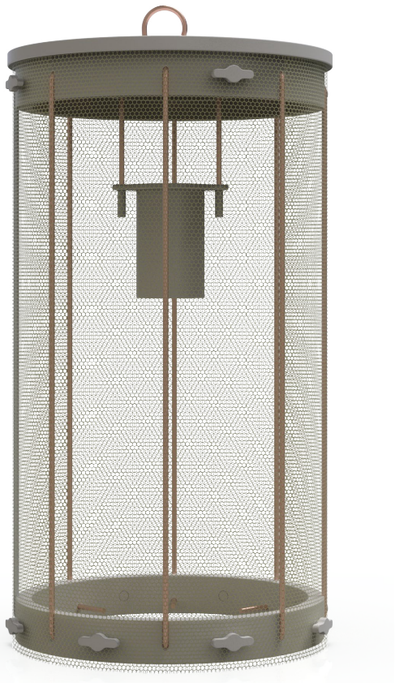


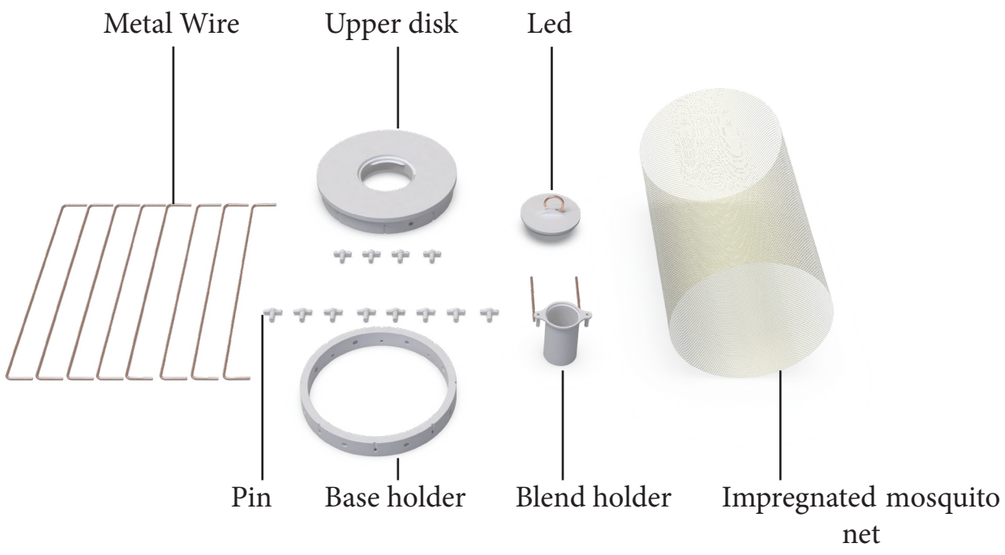




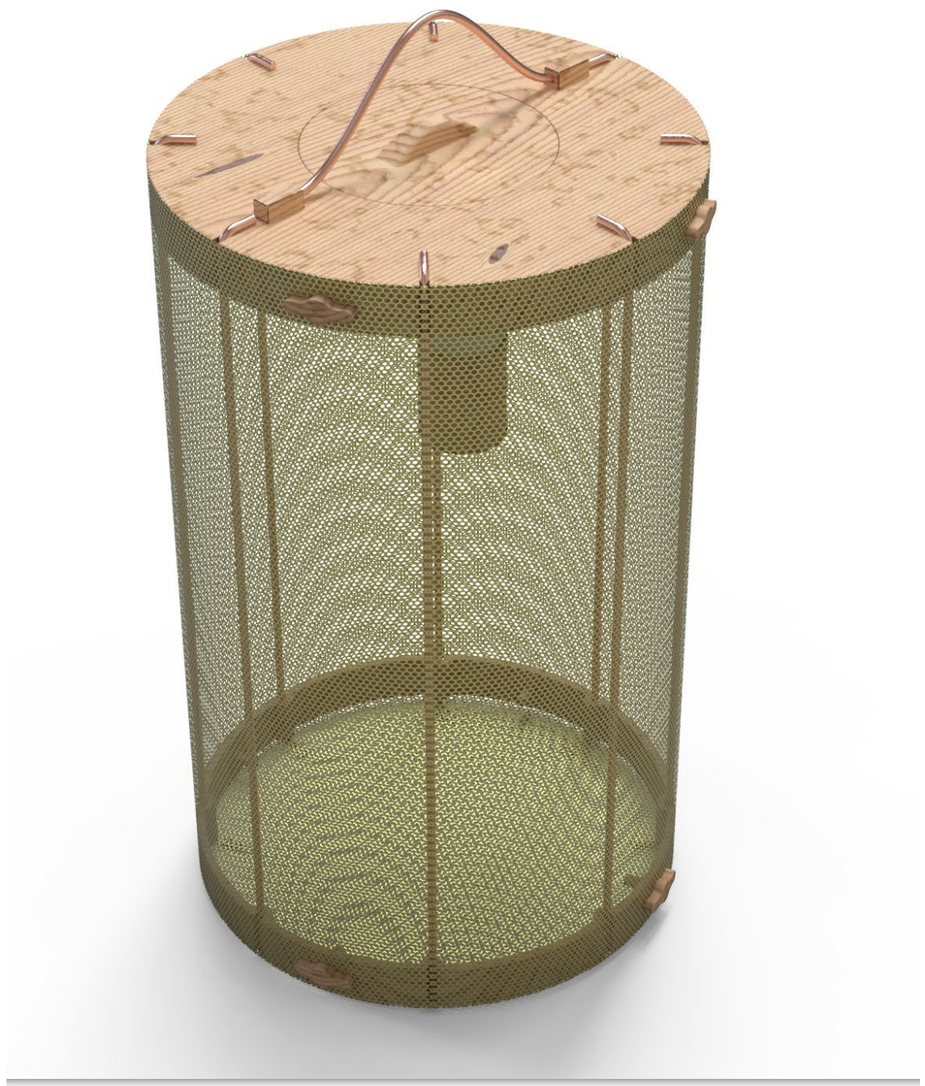
Impregnated Mosquito net

4.6.6 Concept - 6

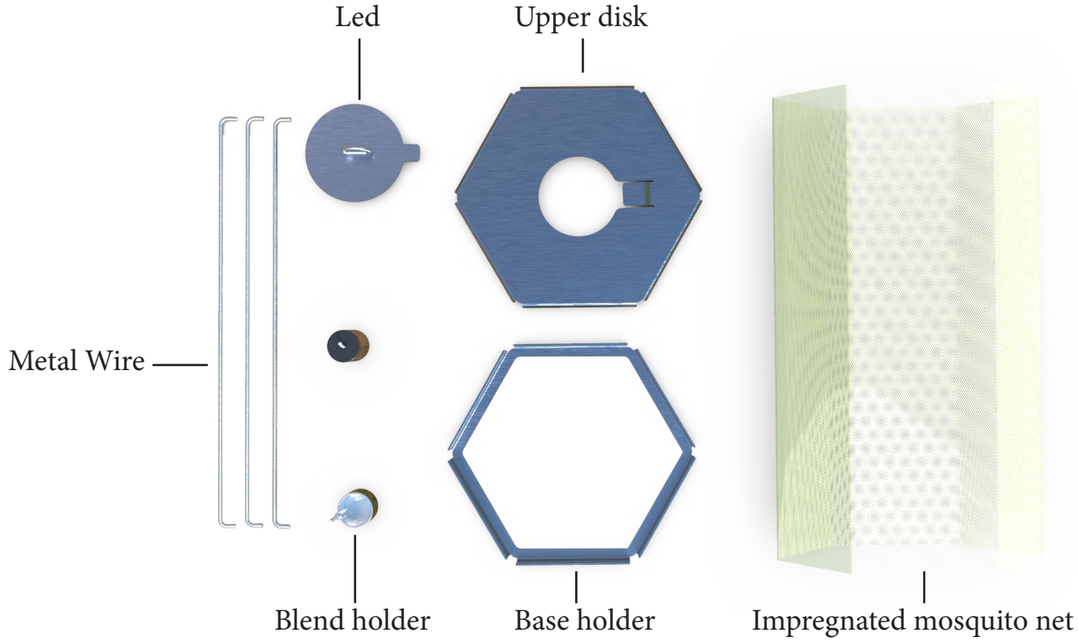




4.6.7 Concept - 7



4.7 Final Concept



Chapter 05

5.1 Methodology

Product Transfer

Energy

Cost

Time

Sustainability issue

Lead to accumulate different kinds of waste

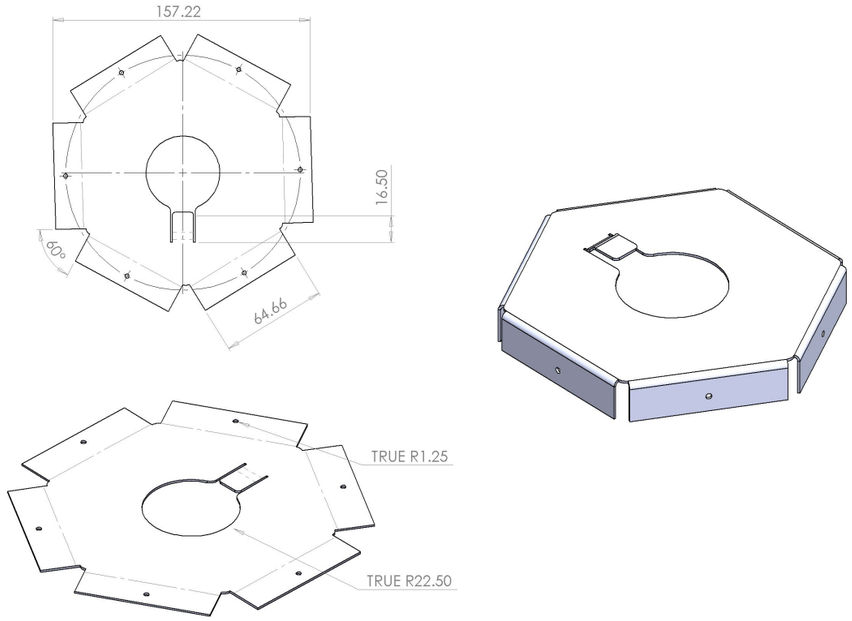
Knowledge transfer

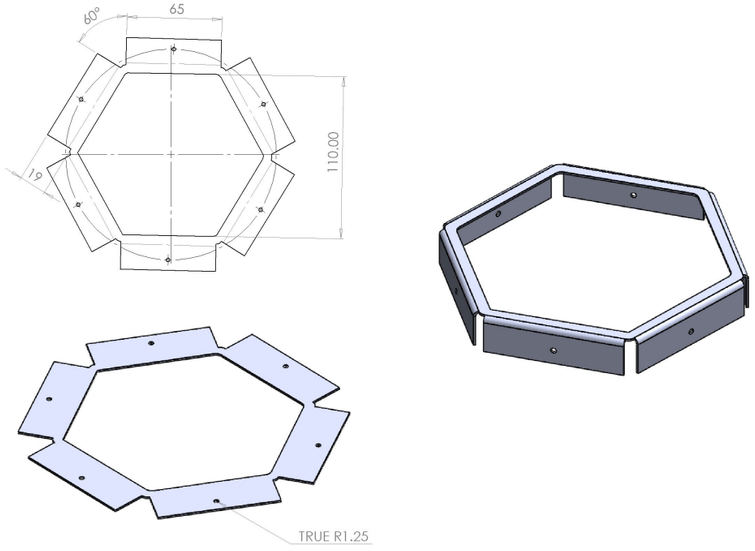
Saves time

Space for Innovation

Just some papers

5.2 Manufacturing Design





5.3 Choosing materials

Commonly used cooking oil container

These are the basic tools which help one to make the working model

https://www.phcppros.com/ext/resources/PRODUCTS/Product-July-2018/Klein-Tools-Complete-Line-of-Duct-And-Sheet-Metal-Tools.jpg?1531947277

In order to make sheet metal work, nobody needs to buy materials. When it comes to a rural area, it would be really difficult to get materials. It is designed in a way that one can utilize materials at home. Also, one can see the dimensions and make it for themselves.

5.4 Process of Impergnating

Getting an impregnated mosquito net would be really difficult. Especially when it comes to rural places. Treating a mosquito net with chemicals in one part of the world and shipping them to other parts of the world would definitely increase the cost of the product. Also when the impregnated mosquito net gets damaged or inefficient, one needs to buy new one which is added expense to the users. The impregnating process becomes cheaper when one does the process at home. The process is simple, quick, and cost-effective. inorder to do this, one just needs to buy insecticide. Here I have elaborated on the process of treating the mosquito net.

5.5 Available Forms

Tablet Form

Powder Form

Liquid Form

5.6 Procedure

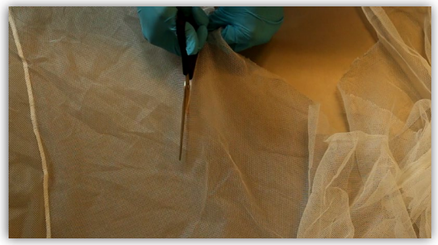
1

In order to start the process, we need to have these following things. Water, insecticide, Ordinary mosquito net, and most importantly hand glove.

2

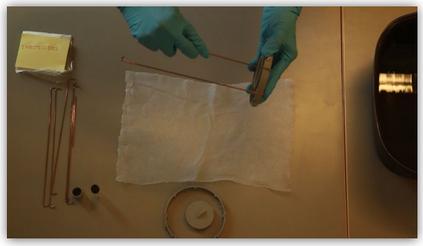
Wear hand gloves are very important to begin the process.

3



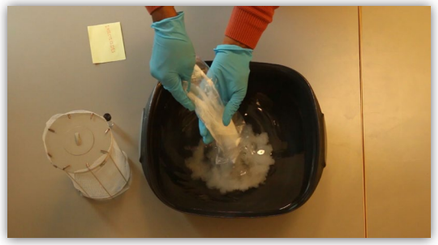
Cut off the required size of the mosquito net.

4



Assemble the prototype and attach the mosquito net on it.

5



Mix 100 grams of insecticide with 2 litters of water.

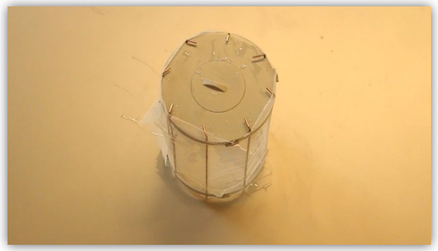
6

Sink the whole device in the insecticide water.

7

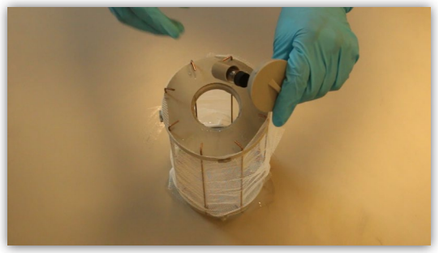
Leave it in the insecticide water for 30 to 45 minutes

8



Keep it under the shade for drying

9



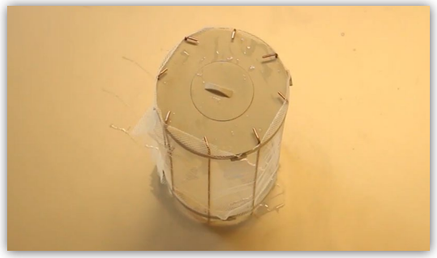
Put the attractant inside and it's ready for hanging it in the respective place.

10

When all the processes are done, one should pour out the water into the toilet or dig a hole in the ground to dispose of the treated water

5.7 Lifecycle

Since the water is already mixed with insecticide, it can be kept for 3 months for reuse. But this needs to be kept far from kids because of the poisonous. this processed water can be reused 3 times in total before it goes completely bad.



As per the test under the lab environment, once the mosquito net is treated, it can work for 25 to 30 days. the efficiency would go down if the mosquito net kept under strong sunlight and rain.

5.8 Concerns

Ethiopia is located in Africa's Horn where drought and politics are two leading causes of water shortage. In a study conducted by Water.org they found that "42% of the population has access to a clean water supply" and only "11% of that number has access to adequate sanitation services". In rural areas of the country, these figures drop even lower, resulting in health problems in the villagers as well as their animals

https://www.worldbank.org/content/dam/photos/780x439/2019/mar-5/WBG-WASH-Ethiopia-2017-2789.jpg

This impregnated process should get it done carefully. Especially when there are kids at home. this treated water should be kept far from kids' reach. incase if anything happens, it could lead to disaster.

https://www.weekendnotes.com/im/005/09/wateraid-water-challenge1.jpg

5.9 VDRC

This vector disease research center is funded by the European Union where there are people with good knowledge on how to handle all the chemicals. In this way, we can save the resources consumed.

we can take the following advantage,

The usage of water can be minimized By not giving access to chemicals to people,

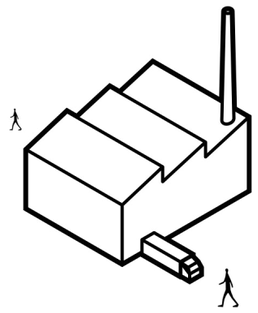
it would increase personal Hygiene.

It would eventually stop access to kids.

since the insecticide water can be used for 3 months, many can treat their mosquito net.

By asking one to visit vector disease research center, the awareness can rise among people

Go home with Impregnated mosquito net



Get in with ordinary mosquito net

5.10 Sustainability

When it comes to sustainability, we should consider material, Manufacturing, transport, and all other aspects. Based on the market research, most of the product in the market is designed in such a way that it requires electricity for functioning. To make it less expensive, the manufacturers are using plastic as a prioritized material. It is a toxic material, can not be recycled. Recycling is an expensive process, also emits toxic waste. Most importantly, products need to transport from A to B which consumes more time and energy. It counts for added expenses.

All the sustainable aspects are taken considered in this thesis project. First of all, it doesn't need to be transported as it is designed to be manufactured in the local areas with available material. One just needs to follow the given dimension when manufacturing. the appropriate dimension is already given in the document. When a product is produced locally, It creates local job opportunities which eventually increases the circular economy.

In terms of material selection, The vector is designed in such a way that, it can be produced with locally available material. personally I myself proposing the wood and sheet metal materials are perfect and promising for building high quality working prototypes. Besides, these materials are found everywhere. It doesn't involve any complex manufacturing process. So a layman can build the product just by looking at the dimension or the real prototype.

When using wood or sheet metal for building products, it doesn't release any form of toxic wastes. These materials only use minimum energy during the manufacturing process. Afterlife the materials will go back to earth without releasing any toxic wastes.

5.11 Future work

Need to test it out in the actual field to assess the efficiency

Assess the efficiency of the impregnated net in the actual filed

The product dimension needs to be changed when the environment changes. A fixed dimension needs to be assessed in the field.

Planning to conduct a workshop to school kids and see how this knowledge transfer brings innovative thinking.

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