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RESEARCH ARTICLE

Mosquito Control to Achieve Zero Yellow Fever and Zero Malaria

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ABSTRACT

Mosquitoes are the most harmful insects that cause 2 million illnesses and kill 28,000 people daily, mostly in underdeveloped countries.[1],[2] Their environment is like that of the Panama Canal. During its construction, mosquito control measures successfully reduced yellow fever and malaria to zero.[3] The challenge for researchers is to replicate these results in hard-hit regions. To do so, they must produce an achievable road map for communities to follow. In this study we analyze the lessons of the past, recommend the same or alternative measures based on today's technology and knowledge base, and present experiments to support their effectiveness.

Keywords: mosquitoes, malaria, dengue, West Nile virus, Zika virus, yellow fever, chikungunya

Introduction

Health authorities estimate that mosquitoes cause 700 million illnesses annually[1]. If a family of 4 contracted a mosquito disease, it would mean 2.8 billion affected people, or one-third of humanity. Mosquitoes bite their victims in home or workplace environments, so we should pay greatest attention to combating them there.

In this study we aim to address situations of mosquito-borne diseases in hard-hit regions where people do not typically screen or insect-proof their homes, they have no running water and no or unreliable electricity, and they store water in large containers for their daily needs. These conditions attract mosquitoes.

Mosquito control measures during the construction of the Panama Canal provide a perfect case study. The US government implemented highly effective sanitation measures that eliminated the lethal or debilitating effects of yellow fever and malaria. Because Panama is in a tropical region, with no air-conditioning so that people leave their windows open, construction authorities installed windows with a mosquito barrier screen. They also drained or poisoned stagnant water bodies within 100 meters of workers' living quarters. Considering mosquitoes' ability to fly long distances, a 100-meter buffer may be insufficient[4]

It's worth to note that at the time the authority aggressively treated the infected patients, in off-site facilities for although mosquito borne diseases are not contagious mean directly transfer from humans to humans, but in 2 steps, the patients infect mosquitoes first they t then to infect many others, they very much need to be relative on the site for the spreading of the diseases to occur, a pseudo type of contagiousness We think this is the biggest factor that underline the success of their efforts.

Today, even in the United States, blocking mosquitoes has limited effect because they are able to ambush humans when exiting their homes, travel on their clothes, land on pets, or infiltrate houses through open doors. Therefore, efforts to keep houses mosquito-free must be a top priority. For this endeavor to succeed, it requires a 2-pronged strategy.

First, female mosquitoes can identify, locate, and zoom in on their potential host by using olfactory, visual, and thermal cues. Thermal lure toxic bait (TLTB) traps comprising warm or thermal imaging objects as lures and boric acid solution as bait killed female mosquitoes in unobstructed areas. With that functionality, 2 TLTBs on the opposite corners of a house will prevent female mosquitoes from getting in and also kill them.[5]

Second, according to the mosquito rearing protocol, one larval mosquito habitat could release 1,000 adult mosquitoes in 6–10 days. That means about 100 mosquitoes could emerge from a 1-liter habitat per day[6]. People store their water in containers with hundreds of liters of water, so the number of released mosquitoes could be in the thousands. Because mosquitoes are primarily responsible for spreading diseases among humans, in the following experiments we explore an inexpensive, uncharm, user-friendly method to kill mosquito larvae and pupae by using carbon dioxide (CO_2) to suffocate them.

Mosquito larvae and pupae must come to the water's surface to breathe oxygen. They will suffocate to death if exposed to a millimeter-thick layer of CO_2 on the surface.[7][8]

In high school chemical classes, we learn that sodium bicarbonate, or baking soda, is a chemical compound in every kitchen that will produce CO_2 after exposure to liquid citric acid such as vinegar. The chemical reaction occurs violently and rapidly. To utilize it for generating and maintaining a millimeter-thick CO_2 layer on the water's surface for minutes[9], we controlled the reaction in people's everyday settings rather than in a laboratory with special equipment.

As a rule of thumb, 1 gram of baking soda and 2.5 grams of citric acid will produce 1 liter of CO_2 at normal temperature and pressure. Depending on the surface area of the habitat, we only need a CO_2 layer 1 or 2 milliliters thick. Thus, 10 liters of CO_2 is more than enough in most filed applications.

Equipment and Method

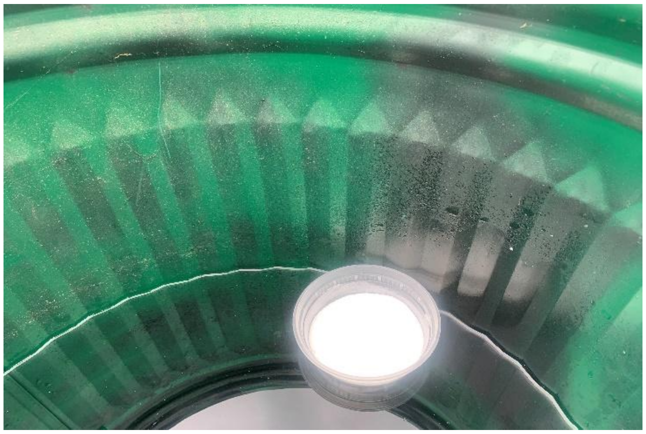
Although experiment vs control is the preferred protocol The experiments here were to address the unfriendly inferiority of our previous study[9] that used fulfilled perceptual expectations protocol we did the same In our experiment, we used a 30-gallon, or 110-liter, metal trash can; a shallow 10 cm-diameter food container; baking soda; and food-grade citric acid powder.

Method

- Fill the trash can with water and introduce about 1,000 mosquito larvae and pupae.
- Put 1 tablespoon (10 grams) of baking soda and 2 tablespoons (25 grams) of citric acid in the food container and mix thoroughly (see Figure 1).

Larva Killing Mixture
Figure 1

- Float the container in the trash can (see Figure 2).



Larva Killing Setup

Figure 2

- Add 1 tablespoon of water to the mixture.
- Close the lid.

Results

As expected, after 15 undisturbed minutes, all larvae and pupae died. For No living sample observebed and their sideway floating cracasses observed as they appeared in previous study[9] as shown in Figure 3

Sideway Dead samples

Figure 3

Discussion

We searched and could not find any other method designed to attract and kill blood seeking mosquitos and only them.

We reserved the effectiveness of TLTB in indoor environment, for female mosquitoes are drawn to it because they see it its infrared images while normal indoor settings with big items such as walls, furniture prevent them to have unobstructed lines of sight.

We recommend TLTD to be placed outside making the yards, the to become a protective, female mosquito-free buffers to preventing them to come near to the houses

If you don't mind taking care of medium size bird, then a live bird lure TLTB is the best because s through million years of natural selection and evolution blood seeking mosquitoes were programmed to choose them first.

We don't know how to set up experiments to measure the effective radius of TLTB. We only have observations and feedback Because mosquitoes will travel miles to get to their target[10] and thermal images can be observed from ten(s) km away[11]. Thus, a 100 m radius is not overstated.

Mosquito borne disease is indirectly contagious, please have their patients get medical attentions at the slightest symptom. It's better to treat one now the many others down the line.

The study concentrated more work to killed only blood seking female mosquitoes at home to prevent them to get infected to transfer and the combined recommends work best to set up mosquito -free houses.

All family members of the community should participate and cooperate to have TLTB(s) installed and replicating this experiment at home.

People are wary of any unknown substance introduced into water that their children could drink. Although baking soda and citric acid are food additives, we designed the experiment to keep white residue out of the water and discard the floating food container later.

After the larvae and pupae suffocated, they floated on the water's surface, making it easy to scoop them out with a fine-mesh kitchen strainer.

Because of its high impact on public health, the TLTB was peer-reviewed and published twice—one for the basic functionality[12], the other for the mechanism that mosquitoes used to identify and locate their hosts[5]. We used 2 TLTBs on the front porch and back patio of a single-family residence located at GPS coordinates 29.951060, -95.639500. without running water and without inside water container at the place we have not only noticed of any inside mosquito, but also on the yards as well.

The replication of the aforementioned experiment costs less than $0.10 per application. An electrical TLTB costs less than $1.00 to build. A family would need 2 or 4 TLTBs, costing less than a mosquito net. A typical 100-family village would need about $400.00 as an initial investment to make their homes mosquito-proof. Please see appendix A for alternative preventive measures.

Conclusion

Although we did not test the combined measures community wide, we did test the functionalities of individual measures and had them peer reviewed. We were able to eliminate mosquitoes in individual residences, leaving no doubt that we could successfully scale up our experiment to the houses of a whole village. At a minimum, our preventive measure could provide a means for people to make their homes mosquito-proof and thus enable them to accomplish the end goal: zero infected mosquitoes and zero disease transmission.

Citing:

In the past we were accused of self-citing or citing spam. We did so in the interests of relevance, for the benefit of the journals that published our work, and out of respect for their reviews. Please understand.

Conflict of interest:

The authors declare no conflicts of interest regarding the publication of this article.

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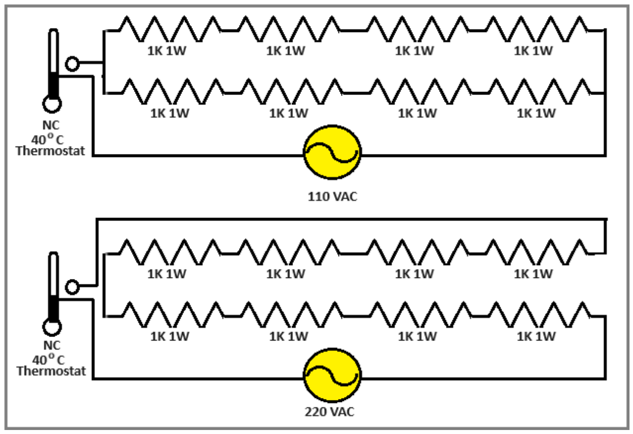
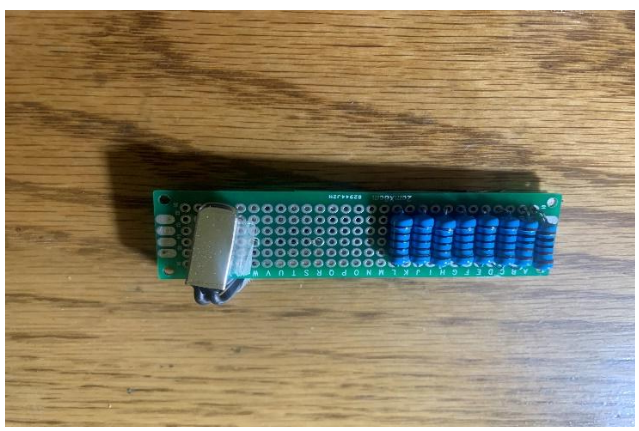
Appendix A

Various TLTB Thermal Lure Types

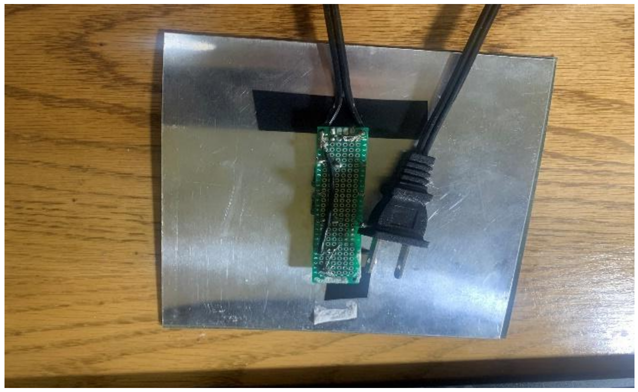
Self-Made Electrical Lure



Electrical lure schematic


Component pictures and lay out

Note: According to the manufacturer's recommendations, the connections of the normally closed 40 °C work best on wire twisted, soldered, and placed away from the heating element that heats the resistor to 40 °C or less.



Typical back side of the lure

Live Lures

When electricity availability warrants live lures, it may be necessary to prevent disease and lifesaving.

- The TLTB works best at about 42 °C, which is the body temperature of birds.
- We need to determine (a) how to protect our birds from mosquito bite without yielding the effectiveness of the intended function, and (b) how to stop other animals from eating our bait.
- We need to experiment before we give our recommendations. In our experiment we used a 6.5 cm x 5.5 cm (D x H), 41.7 °C aluminum puck to simulate the presence of a bird and a transparent plastic mosquito barrier mesh over a birdcage. We used to spend, holed and clear water bottom to house our bait and left it operational for 3 days.

TLTB with simulated live bird lure

The results indicated clearly formed crystal rings inside the bottles, allowing us to draw the conclusion that the system functioned well.

Alternative Off-the-Shelf Lures

We evaluated an under-tank reptile heat mat like this one:

Reptile heat mat

Available at Amazon.com and set to MAX.

We also evaluated a heating mat like this one with no auto shutoff set at minimum:

No auto shutoff heat mat

Available at Amazon.com and set to MIN.

For a heat mat to function as a TLTB lure, it must be set at maximum but equal to or slightly cooler than the underside of a chicken's leg. It is necessary to use the hands to feel the temperature.