

Mosquito control, a simple optical method.

Phi D Tran (✉ ephitr@gmail.com)

Independent

Research Article

Keywords: Mosquitoes, control, catch, repel, malaria, dengue.

Posted Date: July 17th, 2020

DOI: <https://doi.org/10.21203/rs.3.rs-41010/v1>

License:   This work is licensed under a Creative Commons Attribution 4.0 International License.

[Read Full License](#)

Version of Record: A version of this preprint was published at Open Journal of Animal Sciences on January 1st, 2024. See the published version at <https://doi.org/10.4236/ojas.2024.141002>.

Abstract

Mosquitoes are extremely harmful to humans, spreading diseases to millions of people each year, many of whom die as a result of these infections. Mosquitoes have evolved to live in low light, to identify active, moving predators to avoid, and to recognize passive objects around which to navigate. The experiments in this paper introduce a method that involves the use of LED light to flood areas with the simulated presence of actively persisting objects. In a related paper, a highly regarded mosquito laboratory at a U.S. university used a dual-color pulsing light bulb to encourage mosquitoes to prefer one place to another. Although this was shown to be a potentially life-saving technology, further study under more carefully controlled conditions is required to ascertain whether the mosquitoes' behavior was not influenced by extraneous factors. The experiments herein capture the movement of mosquitoes away from a faintly lit, treated area towards a more well-lit one.

Introduction

Background:

The LED technology used in this study came about in response to the simple desire to address immediate mosquito bite problems. The inventors conceived of a light pulse system with asserted periods long enough to broadcast to flying mosquitoes the sudden arrival of new objects in their vicinity, but short enough that the light would disappear before the mosquitoes were able to calculate their distances from said objects denying them rationales to ignore those objects for their remoteness. Under the combination of alternately pulsing units, before a mosquito could formulate an action to address the sudden flash, another pulse would appear in a different location. The designers of this system reasoned that as a result of such instances repeatedly and continuously popping up, calling for reactions upon reactions, the mosquitoes, finding themselves in a situation where fleeing from one flash would only point them in the direction of another, would become confused. The design was a once-and-for-all attempt conceived with the hope that its failure would provide sufficient reason to shelve these ideas for good, as the inventors suspected that if such a simple approach could work it would already have been presented elsewhere. The design, consisting of two cool white LED light bulbs spaced 10 meters apart and modified to pulse at 120 events per second in correspondence with changes in the 60 Hz AC, happened to work on the first try. The system kept the mosquitoes from entering the common area.

The technology further evolved to use multiple colors instead of multiple light sources. Through trial- and-error, a 500 Hz frequency and the colors red and blue emerged as the best combination. The system alternately emits one color in its first quadrants and the other in its thirds.

With positive feedback as the background, the lights repelled the insects; numerous 16 hr experiments were conducted in the laboratory using experimental and control protocols, with experimental and normal control yellow light bulbs¹ in transparent taxis cages. Contrary to expectations, the devices were

classified as mosquito-attracting units, as the insects consistently distributed themselves 80% vs 20% for the experiment as opposed to the control. On the other hand, the results confirm the effectiveness of this technology as a means to control the movement of mosquitoes.

Subsequent experiments produced similar results. However, the protocols largely resulted in the deaths of the mosquitoes, thus requiring a new batch for each session. Slow-motion video showed behavioral differences in the way the mosquitoes approached a white obstruction upon light-on and light-off. With the lights in the off state, they either landed with their feet or made a turn from approximately 1 cm away, while with the lights in the on state, the mosquitoes approached as if the obstruction were invisible and needed to make physical contact with the surface before reacting. Close-up pictures corroborate this observation; the antennas and/or feeding tubes of the mosquitoes become crooked after a few minutes of the stress tests; upon each impact, it was the bending of these appendages that forced the insects to change direction.

Evidence and observations point to the idea that the light causes confusion that leads to disorientation, as a result of which the mosquitoes injure themselves on the surfaces of the box. However, there are other conceivable reasons that might cause these phenomena to occur, such as heat, hunger, or dehydration. The injuries incurred meant that keeping the mosquitoes alive eventually became a daunting task; unfortunately, only if the same groups of mosquitoes were kept alive and put through both the control and experimental protocols could the results objectively be said to reflect their true behavioral choices.

Experimental developments:

It is clear that mosquitoes lack the capability to see the other side of a transparent plate as off-limits, either considering it to be a reachable destination or another approaching subject. Circumstances could drive them to move toward that place if it appears safer or more favorable, resulting in their trajectories being blocked by the plate. The experiments constructed for this study employ dark room, opaque chambers, enclosure, shades, and reflective liners to minimize these adverse effects.

To further emphasize the dark-loving nature of these insects, the control part of the chamber is more brightly illuminated. Consequently, it eventually becomes warmer. As a result of the greenhouse effect under long exposure, the temperature increases, driving the insects to seek shelter in cooler places. The experiments neutralize this phenomenon by circulating the air in the test environment.

Use of a ready-made, publicly available product in the experiments would seem more logical. These products are designed for large areas and regions; thus, having low-output, specially built units is more practical for this purpose than making great efforts to lower their intensity to the desired level.

Materials And Methods

Material summary:

Both the experimental and control protocol use two halves of a 17' x 38' x 15' white chest cooler as the experimental chamber (5), an aquarium air pump (6), two pulsing LEDs (3) for the experimental side and one yellow control double LED (2). It receives the pulsing light from randomly reflective ceiling and shade surfaces (1) and interfaces with the air pump through an acrylic clear top (4). In addition to the darkroom environment, the chamber is surrounded by cardboard.

Samples:

The samples were mosquitoes that emerged from vendor-supplied aedes aegypti or yellow fever eggs; there were approximately 350 mosquitoes per batch.

Procedures:

Following a resting and feeding period of at least three hours, the session in which the experimental lights were on lasted six hours. During the first period, the experiments took advantage of the mosquitoes' preference for dark environments to lure the creatures to abandon the well-lit control side and move to the other side, which the majority of the mosquitoes did. The compiled data are based on before and after pictures. The mosquitoes can be divided into three categories based on their chosen location in the experimental or control areas, or the neutral intersection of the two, which was the nearest location where some would choose to land either prior to entering or upon leaving the line-of-sight of the LED lights.

Result Summary

The samples remained alive and well. For documentation, six marathon experiments were conducted. With a few exceptions; samples consistently cleared out of and stayed out of the experimental area of the chamber.

Conclusion

Under the Sun, most insects, mosquitoes in particular use their eyes to navigate; it's not just what they are seeing but what's appearing on the view, and it's changing continuously. LED technology enables developers to generate artificial inputs aiming to alter such perceptions to influence their behavioral choices. One example; a 500 Hz red-blue light pulse has the ability to repel mosquitoes from illuminated lines-of-sight.

End Note

¹Although this information is not published, it is in the record of a public organization and available upon request.

Declarations

I have none declared under financial, general, and institutional competing interests

Attestation of Investigator Independence/Accountability: I had full access to all study data, take fully responsibility for the accuracy of the data analysis, and have authority over manuscript preparation and decisions to submit the manuscript for publication.

Intellectual property: I declare that upon the publication in Research Square the herein technology become a part of public domain; intellectual properties of the community and her member.

Figures

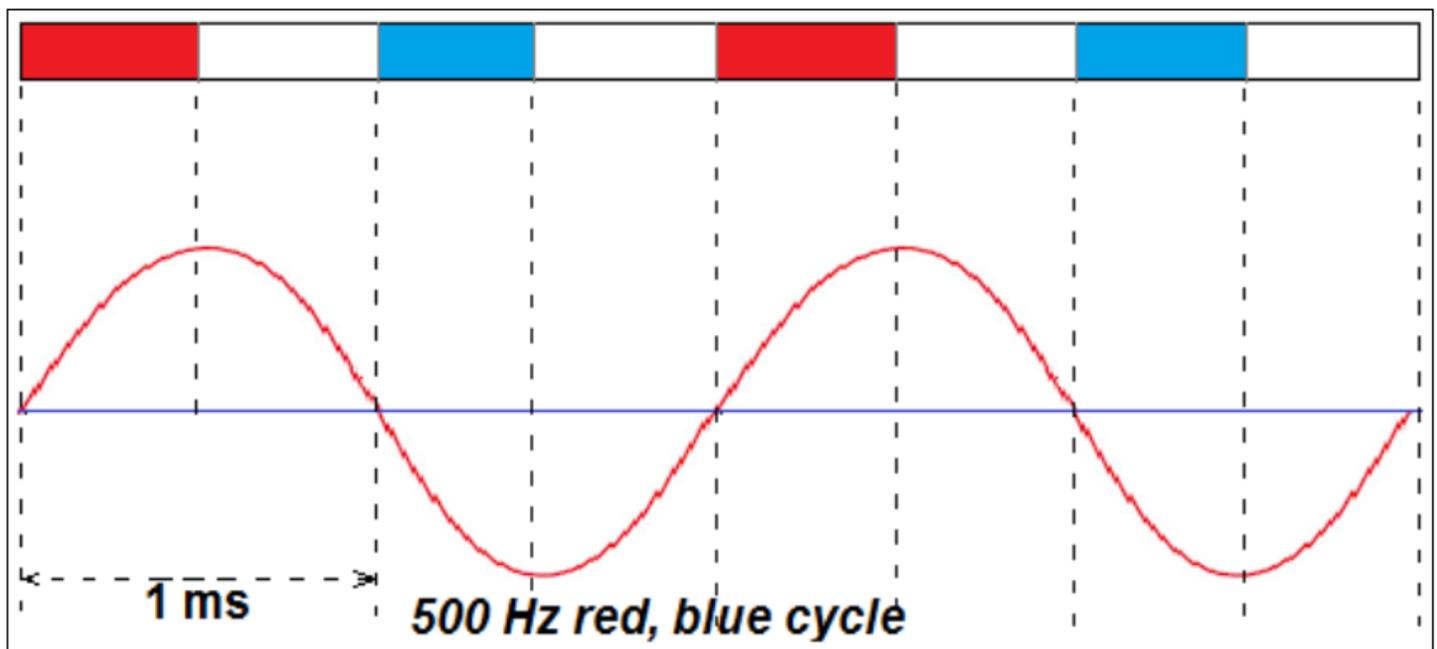


Figure 1

Figure caption not provided with this version.

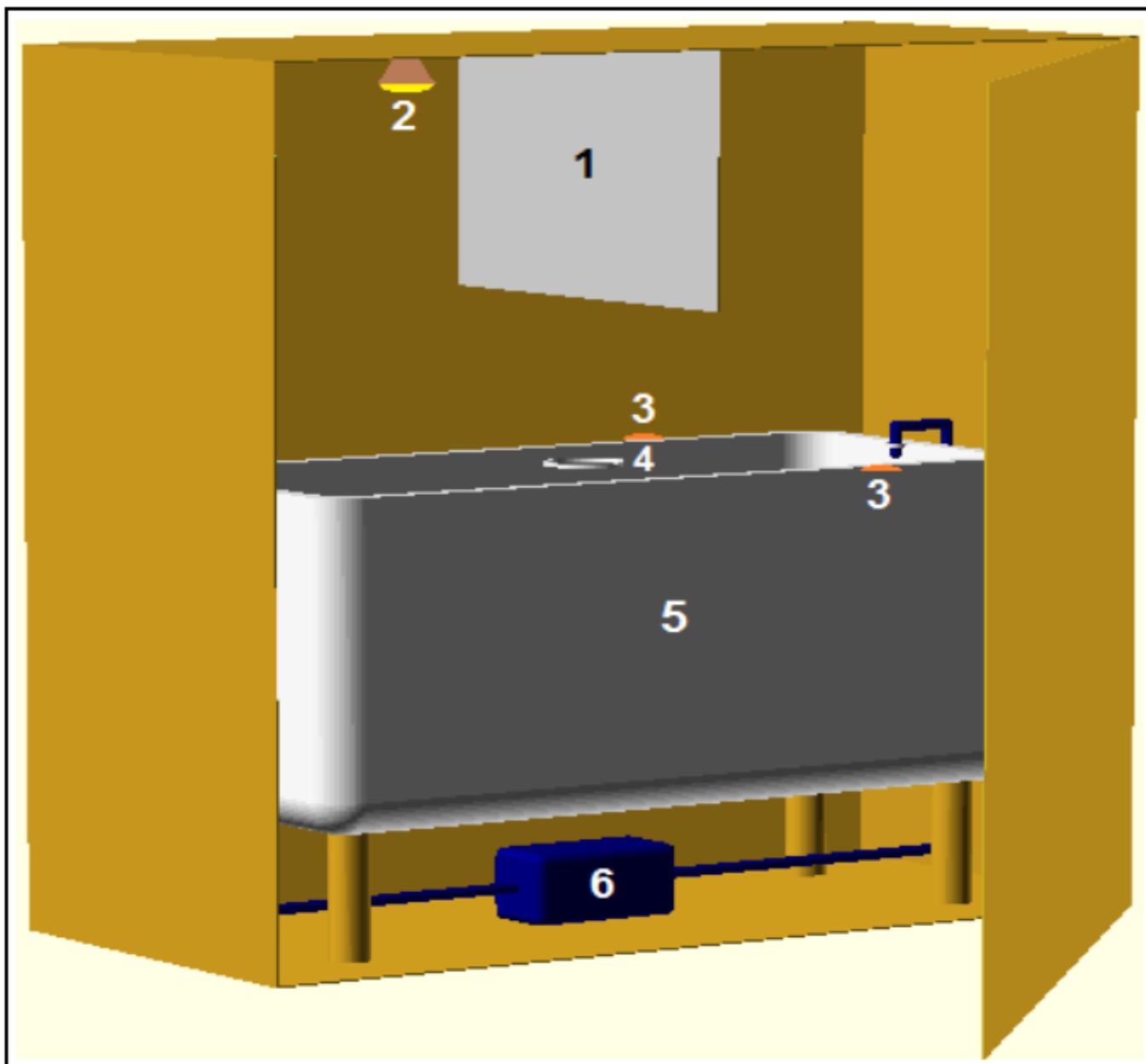


Figure 2

Figure caption not provided with this version.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- [PhiDTranMosquorepellingsupplement.pdf](#)
- [PhiDTranImage1.png](#)
- [PhiDTranImage2.png](#)

- [PhiDTranImage3.JPG](#)
- [PhiDTranImage4.JPG](#)
- [PhiDTranImage5.JPG](#)
- [PhiDTranImage6.JPG](#)
- [PhiDTranImage7.JPG](#)
- [PhiDTranImage9.JPG](#)
- [PhiDTranImage8.JPG](#)
- [PhiDTranImage10.JPG](#)
- [PhiDTranImage11.JPG](#)
- [PhiDTranImage12.JPG](#)
- [PhiDTranImage13.JPG](#)
- [PhiDTranImage14.JPG](#)
- [PhiDTranImage15.JPG](#)
- [PhiDTranImage16.JPG](#)
- [PhiDTranImage17.JPG](#)
- [PhiDTranVideo2.MOV](#)
- [PhiDTranVideo1.MOV](#)
- [DECLARATIONOFCOMPETINGINTERESTS.pdf](#)
- [Mosquorepellingsupplement.pdf](#)