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Evaluation of the Effectiveness of "Electron Go out Mosquito Small Lamp" in Disease Vector Mosquito Control Benin West Africa

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Abstract

In the context of mosquito control, a plethora of devices have been put on the market. The effectiveness of these devices is not always proven, but some have interesting principles that have the potential to be a good means of mosquito control. Among these interesting devices are the photonic traps. We have carried out nightly captures of mosquitoes on human baits in the presence and absence of the device. These captures were made during the rainy season in the localities of Zogbadjè and Mènontin. The captures were made under the same atmospheric conditions at the same locations at 5-day intervals. These captures were made twice per house, indoors and outdoors, with one blank capture without the device and one capture with the device. The captured mosquitoes were identified and classified by genus and their aggressiveness determined by calculating the biting rate. A total of 845 mosquitoes were captured during these captures with 296 mosquitoes captured indoors without the device and 132 mosquitoes with the device present. This represents a decrease of 55.40% in culicidae density. Furthermore, a significant decrease was observed in aggressiveness, from 49 to 22 bites per man per night (b/m/n) with the use of the device. This decrease is even more important for nocturnal species such as Anopheles spp. whose aggressiveness decreased by 90%. The present study confirms the effectiveness of the "Electron go out mosquito small lamp" in reducing Culicidae density and mosquito aggression even in the presence of chemotactic interference. However, this study was limited in time and focused only on the ability of the device to re-

duce mosquito numbers and did not assess its epidemiological efficacy. It is therefore important to extend the work to examine the influence of the use of this device on population health and the occurrence of mosquito-borne diseases, particularly malaria.

Keywords

Mosquito Control, *Electron Go Out Mosquito*, Effectiveness, Culicidae Density, Phototactism Bénin

1. Introduction

A variety of substances and methods have been used since ancient times to repel hematophagous insects [1] [2]. The earliest methods used by humans to repel insects were smoke, the use of skin cream or the application of animal fat [2]. Despite the many advances made in the control of disease-carrying insects, particularly mosquitoes, the deadliest animal in the world with more than 725,000 deaths per year [3] [4], there is still a large gap to be filled before we can consider ourselves fortunate to have control. Indeed, most of the implemented control strategies are based on the use of insecticides which unfortunately have not shown great success in recent decades [5] [6] [7]. Moreover, they induce resistance in these vectors. In other hand some products like pesticides have impact on aquatic ecosystems and the resulting loss of biodiversity [8]. They also alter the health of animals and humans and have various adverse health effects like acute and chronic effects on the nervous system, respiratory system, reproductive system, and immune system [9]. Therefore, more effective, environmentally friendly, and publicly available alternatives are needed to overcome these mosquito-borne vector-borne diseases. Among the alternatives proposed in recent years are photonic traps with or without insecticides or an electric force field. Photonic technologies are already widely used in medical treatments, dermatology, cosmetics, etc., but their use in mosquito control is an innovation that is a more environmentally friendly way to control mosquitoes [10]. Indeed, the vision of insects is very different from that of humans. Insects are attracted to light whose wavelength is in the ultraviolet spectrum. Conversely, they will be repelled by light with wavelengths in other spectrums. Studies have shown that devices equipped with UV lights significantly reduced mosquito aggression [11]. Based on this theory, the light of the "*Electron go out mosquito small lamp*" emitted being in the UV spectrum can attract mosquitoes and other insects and can destroy them through the electric field of the device's grid. This device is one of the many devices without factual data observed on the market in recent years that people get for their well-being. We are therefore interested in evaluating the effectiveness of this device which has been a great commercial success during the year 2021.

2. Materials and Methods

2.1. Description of the Study Framework

This is a prospective, cross-sectional, descriptive study with analytical purposes in the CREC laboratory covering the period from mid-June to the end of July.

The study was conducted in two localities in the Atlantic and Littoral regions, namely: Zogbadjè in the commune of Abomey-Calavi and Mènontin in the 9^{em} arrondissement of Cotonou.

The choice of these localities took into account the degree of urbanization and especially the living conditions of the population during and after the rainy season.

The locations of the captures are marked on the map below (Figure 1)

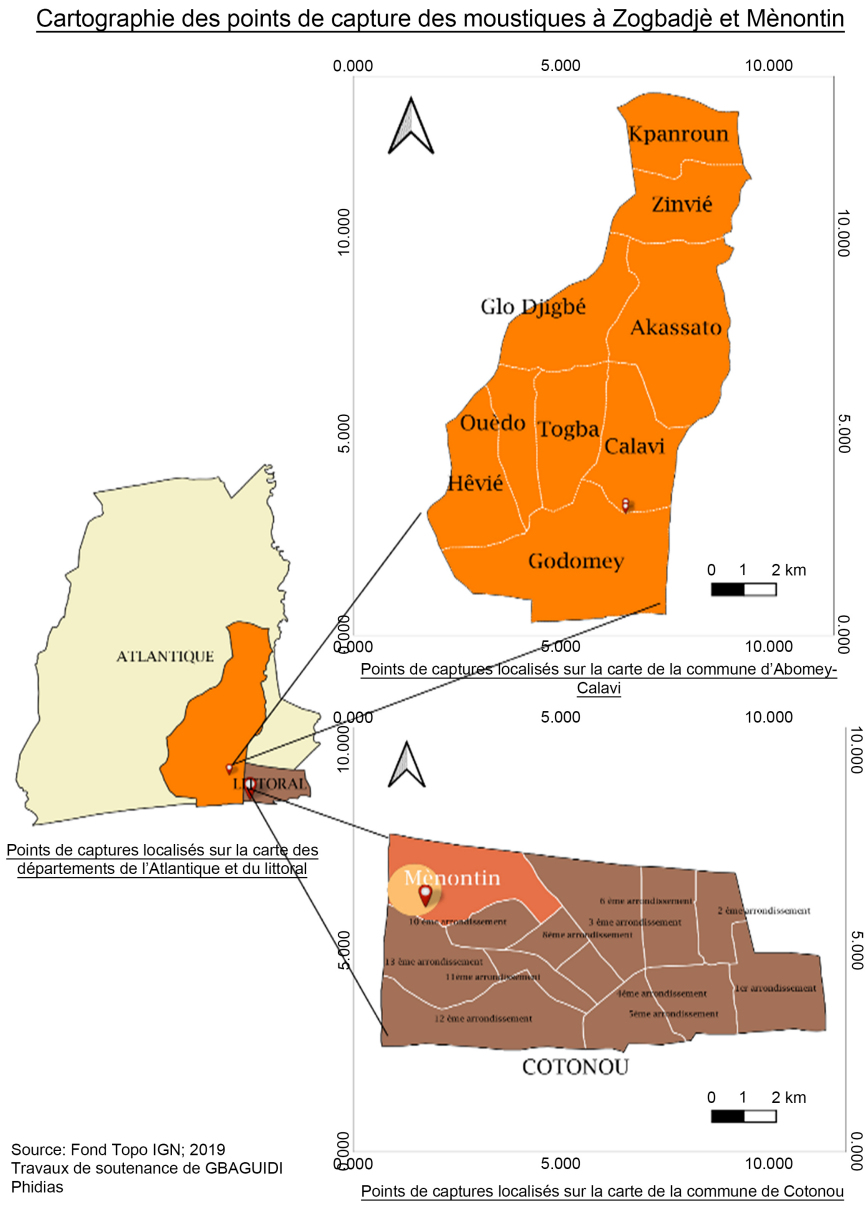

Figure 1. Map of mosquito capture points in Zogbadjè and Mènontin (Source: Fond Topo IGN; 2019).

2.2. Presentation of "*Electron Go out Mosquito Small Lamp*"

The "*Electron go out mosquito small lamp*" is a small device based on photonic technology designed to control mosquitoes and other flying insects (Figure 2). It incorporates an LED lamp emitting ultraviolet light around 400 nm that attracts light-sensitive insects into an electrically charged metal grid killing them by administering an electric discharge. The metal grid is covered by a plastic cover to ensure the safety of the user. Portable and light, it is user-friendly, easy to handle and can easily be carried from one room to another or even on a trip. Moreover, it has a low energy consumption and does not contain any steam, ideal for people with allergies and safe for human health. The model used in this study is the DW-777 of the Chinese manufacturer DINWANG acquired from street vendors in the city of Cotonou.

2.3. Mosquito Collection Method

Mosquito samples were collected using the "Human Landing Catches (HLC)" protocol and identified. All of this was done according to the following process.

- **Direct capture of aggressive mosquitoes on human volunteers.**

These captures were carried out at night, during the rainy season, in July 2022 in 03 houses, including two (02) in Zogbadjè and one (01) in Mènontin. The capture teams were placed inside and outside the houses. The captures took place under the same atmospheric conditions with a temperature of 25˚C ± 2˚C and a humidity level of 81% ± 6%. These captures were carried out twice per house with one blank capture without the device used as a reference for the determination of culicidal density of the environment and one capture with the device to evaluate its effectiveness.

- **Description direct capture of aggressive mosquito on volunteer.**

Collections were made throughout the night from 10:00 pm to 6:00 am using the human subject capture (HSC) technique. This entomological technique of sampling adult female mosquitoes that land on or near humans allows for the assessment of the number of bites a person receives per unit of time and is the

Figure 2. Photo of "Electron go out mosquito small lamp" seen from the front.

most direct method of measuring host-vector contact. As shown in Figure 3 and Figure 4, this method consists of an individual (the captor) uncovering his or her legs to the knee, barefoot, and sitting motionless on a chair or stool. Once he feels the mosquito land on his leg, he turns on the flashlight to see and immobilize the mosquito, which is then skillfully retrieved in a tube and plugged with absorbent cotton. There is no question of letting the mosquito bite since it is caught as soon as it lands. The measurement is therefore more related to the landing than to the bite. In order to estimate the aggressiveness of endophagous (which bites inside the house) and exophagous (which bites outside the house) anopheles, the captures were carried out simultaneously inside and outside the houses.

Figure 3. Photo of a captures inside a house in Zogbadjè, commune of Abomey-Calavi.

Figure 4. Photo of a captures at outside a house in Zogbadjè, commune of Abomey-Calavi.

- **Description of the direct capture of mosquitoes in the presence of the device.**

For captures in the presence of the device, the capture technique is the same as described above. The camera is installed in the chamber 20 to 30 minutes before the start of the capture according to the manufacturer's instructions (DINWANG). The captor is installed on the opposite side of the device at a distance of about 2 meters in order to evaluate the effectiveness of the photo-attractivity of the device in the face of captor-induced chemotaxis.

3. Data Analysis

The data for this study were entered and processed in excel. Some indices were calculated to measure the transmission of mosquito-borne vector diseases in the study area.

In a given location, several factors influence the transmission of malaria from mosquitoes to humans. The quantitative estimation of this transmission is done through a number of mathematical indices calculated from the collected entomological data.

Aggressive density, also called aggressiveness rate, is the product of the density of a given species in relation to humans (m) and the anthropophilicity rate (a). It is expressed as the number of Anopheles bites per human per unit time. It is obtained by dividing the total number of mosquitoes obtained for a given species captured by the number of subjects used, per unit of time.

4. Results

4.1. Results by Catch Point

A total of 845 mosquitoes were captured during these night captures with 296 mosquitoes captured indoors in the absence of the device and 132 mosquitoes when the device was present. This represents a decrease of 55.40% in culicidae density. Similarly, 417 mosquitoes were captured outdoors, 212 without the device and 205 with the device present. In addition, a minimal decrease of 53.15% of the culicidian fauna was observed at each of the capture points between the control capture (without the device) and the one with the device. The results obtained by capture point are summarized in Table 1.

Table 1. Results by catch point.

Capture points	Interior		Evolution of indoor culicidae density	Exterior		Evolution of outdoor culicidae density
	Witness	With device		Witness	With device	
1	190	89	−53.15%	125	129	+2.1%
2	38	11	−71.05%	30	17	−6.84%
3	68	32	−52.94%	57	59	+1.05%
Total	296	132	−55.40%	212	205	−3.68%

4.2. Diversity of Mosquito Species Collected

Three different species of mosquitoes were recorded, dominated by *Culex quinquefasciatus* with 89%, followed by *Anopheles gambiae* with 10% and *Aedes aegypti* 1% (as shown in Figure 5).

4.3. Evolution of Culicidae Density and Culicidae Aggressiveness in the Presence and Absence of the Device

The results of the captures made are presented in Table 2 as well as the rate of bites per man per night with and without the device inside the rooms and outside by species and for all species combined.

The decrease in the total indoor biting rate in the presence of the device (22 b/m/n) with the device versus 49 p/h/n without the device) shows that the presence of the device significantly reduces mosquito aggression. This is even more remarkable with nocturnal species, in particular *Anopheles gambiae*, *the* vector of malaria, whose biting rate dropped drastically in the presence of the device (Figure 6). In addition, 212 mosquitoes were captured outdoors in the absence of the device and 205 mosquitoes in the presence of the device. This difference of only 1.68% confirms, in correlation with the range of the device described by the manufacturer, that the density of the culicidian fauna was the same between the captures made in the absence of the device and those made in the presence of the device.

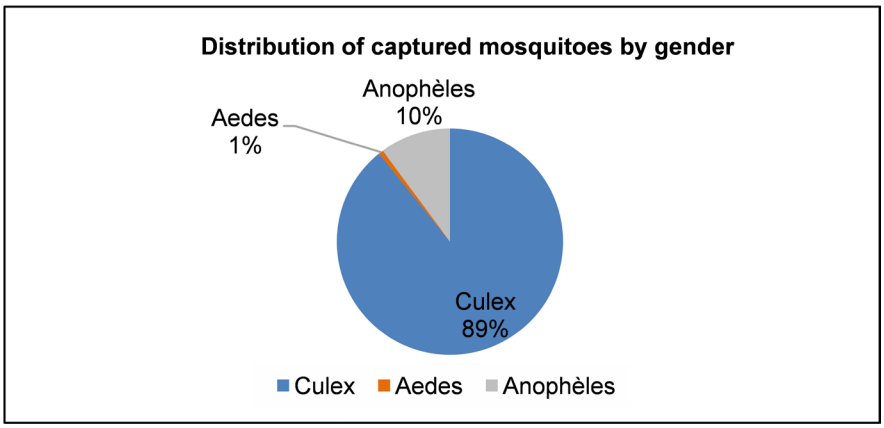

Figure 5. Genus's distribution of mosquitoes obtained during capture.

Table 2. Diversity, culicidal abundance and calculation of bite rate per man per night.

Species	Indoor Capture		Capture Outdoor		No. of people/per night	Interior sting rate		External sting rate	
	Witness	Device	Witness	Device		Witness	Device	Witness	Device
Culex	264	129	194	196	6	44.00	21.5	32.33	32.66
Aedes	2	0	5	1	6	0.33	0.00	0.83	0.16
Anopheles	30	3	13	8	6	5	0.5	2.16	1.33
Total	296	132	212	205	6	49.33	22.00	35.33	34.16

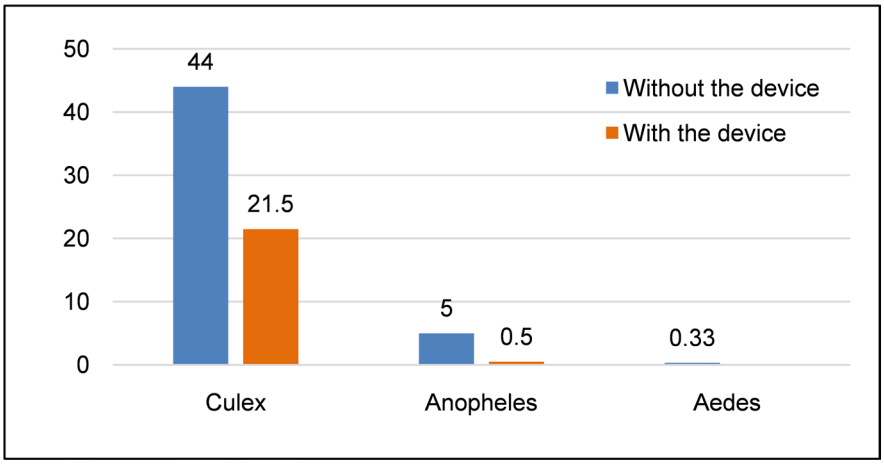

Figure 6. Evolution of the bite rate by species with and without the device.

5. Discussion

The main objective of this study was to verify the effectiveness of the "Electron go out mosquito small lamp", one of the many devices on the Beninese market whose effectiveness has not been demonstrated. This helps to improve the safety of the population, to guide them in the choice of acquiring mosquito repellent devices and contributes to vector control in Benin by promoting alternatives to insecticides, most of which have already become ineffective on mosquitoes [5] [6] [7]. This study thus showed that the use of the "Electron go out mosquito small lamp" induces an average decrease of about 55.4% of culicidal density in the human habitation structure of its use. Confirming the results of work done in 2021 by Huang, Run *et al.* [12] on the effectiveness of light traps for the capture of mosquitoes which had shown by the method of capture and recapture in the laboratory that such devices have a success rate between 34.7% and 65%. This study also demonstrates the attractive capacity of blue UV light whose wavelength is around 400 nm, confirming the attraction of mosquitoes to blue and green light [13]. It also allowed us to observe a significant decrease in the aggressiveness of the mosquitoes, which is reflected by the decrease in the biting rate when using the device compared to the control, which went from 49 p/h/n to 22 p/h/n. In addition, the results of the captures attest to the nuisance induced by the mosquitoes through the importance of the culicidian density observed. Three (03) species of mosquitoes were recorded during these captures with a strong predominance of *Culex quinquefasciatus* which represents 89% of the captured mosquitoes followed by *Anopheles gambiae* (10%) and finally *Aedes aegypti* (1%). In addition, captures on human baits demonstrated the efficiency of phototactism despite the presence of an interfering stimulus due to chemotactism induced by the presence of humans. However, is to note that some other domestic devices have light with same wavelength. The insects, including mosquitoes, are attracted to light with wavelengths in the ultraviolet (UV) spectrum, which is not visible to humans. Therefore, presence of this kind of light can interfere with "electron go out mosquito" normal activity. In other hand, the specific wave-

lengths within the UV spectrum may affect the attraction and effectiveness of the device. Some studies like study of Barnard *et al.* in 2016 [14] about *Aedes aegypti* mosquitoes, which are the primary vectors for Zika, dengue, and chikungunya viruses, suggest that there were most attracted to light in the 350 - 400 nm range of the UV spectrum. Additionally, the intensity of the light can also play a role in attracting and killing insects. Overall, the presence of light with same wavelength, the specific wavelength and intensity of the light used in the "electron go out mosquito" device may impact its effectiveness in repelling and killing mosquitoes.

6. Conclusion

The significant decrease in culicidae density and the bite rate illustrates the effectiveness of the "*Electron go out mosquito small lamp*". Moreover, its size, its easy handling and its price make it an interesting vector control product to use, preferably in combination with other means of control, in order to increase the level of protection of users. Many more advantages of this device better known as bug zapper like the fact is chemical-freewho, make them a safer option for use in homes and other indoor areas, especially for those with allergies or sensitivities, her low maintenance, her cost-effective, her quiet operation and the fact is eco-friendly, which makes it like good choice for fight against mosquito and associated diseases. This study also confirms the effectiveness of phototactics on mosquitoes and continues to prove itself even in the presence of chemotactic interference from human presence.

Conflicts of Interest

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

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