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Reducing Mosquitoes in Freetown, Sierra Leone Using the Provector Pesticide System



Magdalene Nze-Daniel¹, Thomas Kenneth Ausumana¹, Philip Brewahl¹, Charles Senessie² and Thomas Martin Kollars^{3*}

¹Roll Back Malaria, Freetown, Sierra Leone

²Afro-European Medical and Research Network, Bern, Switzerland

³Health Sciences, Liberty University, Lynchburg, USA

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***Corresponding author:** Thomas Martin Kollars, Health Sciences, Liberty University, Lynchburg, USA, Email: tkollars@liberty.edu

Abstract

Drug resistant malaria parasites and pesticide resistant mosquito populations are growing in prevalence. Several arboviruses transmitted by mosquitoes continue to expand their range globally. Communities in Sierra Leone are at high risk to several mosquito-borne diseases. The ProVector® Pesticide System was developed in order to reduce mosquito populations, including pesticide resistant mosquitoes. A three month study was conducted in Freetown, Sierra Leone to determine the efficacy of the ProVector Flower with Entobac™ biopesticide in controlling mosquitoes in homes using a long lasting bait pad incorporating Bti as the active ingredient. There was a significant reduction of reported mosquitoes within two weeks and after three months the estimated number of mosquitoes was reduced by approximately 91%. The current study demonstrated the ProVector Flower with Entobac rapidly reduced mosquito populations for up to three months using a toxic sugar bait system with *Bacillus thuringiensis israelensis*. The ProVector System is the only system that effectively uses Bti to reduce adult and larvae mosquitoes.

Keywords: Bio-pesticide; Malaria; Arbovirus; *Anopheles*, *Culex*, *Aedes*

Introduction



Figure 1: Many communities in Freetown, Sierra Leone live in extreme poverty and are at risk from vector-borne diseases, including malaria, Zika, dengue, and Chikungunya.

Mosquito-borne diseases, including malaria, dengue, yellow fever, Zika, etc. are a significant health threat to families and communities in Sierra Leone [1]. Many families in Freetown, Sierra Leone are at risk of these mosquito-borne diseases (Figure 1). New technologies are needed to provide public

health professionals with tools to combat these mosquito-borne diseases due to the increasing prevalence of drug resistance of malaria parasites, lack of vaccines for most arboviruses, and the increasing pesticide resistance of mosquitoes in West Africa [2,3]. The ProVector® Pesticide System was developed

in order to provide a new method of mosquito control. The ProVector Flower with Entobac™ (PFE) uses colors and bait to attract different species of mosquitoes, where they feed through holes and ingest Entobac™ pesticide consisting of an attractant toxic sugar bait with active ingredient *Bacillus thuringiensis israelensis* Bti (Figure 2). Entobac is the first commercially available pesticide that uses Bti to effectively kill both adult and larvae mosquitoes and it is virtually non-toxic. After feeding, the adults fly away and die within a few days; if they die and land in water, the larvae mosquitoes are also killed [4]. One Entobac bait pad is sufficient to provide control for a minimum of 50,000 mosquitoes and when used as part of the ProVector System large areas of property can be protected. The amount of pesticide needed to cover an area is reduced by approximately 10,000 times due to target specificity and dissemination of the pesticide to breeding sites by target species. Through auto-dissemination of the biopesticide, mosquito control beyond the area where the ProVector Systems are deployed is attainable. In the Dominican Republic, the total mosquito population was reduced significantly within 30 days. The area at highest risk on the hotel property was reduced by over 200% within 70 days [5]. Malaria contributes to approximately 20% of child mortality in Sierra Leone and is the cause of nearly 40% of hospital consultations (WHO 2016).

Methods and Results

A 12 week ProVector Community Project was conducted in Sierra Leone in collaboration with Roll Back Malaria (RBM), WHO and the Afro European Medical Research Network. ProVector Flowers with a long lasting Entobac bait pad (PVE), and surveys were independently distributed and data independently

gathered by Roll Back Malaria personnel. Entobac uses a nectar like formulation with *Bacillus thuringiensis israelensis* (Bti) as the active ingredient. One PFE was provided to 41 homeowners in the Freetown communities of Congo Town, Goderich and Hasting. Homeowners were surveyed every two weeks for three months to evaluate the effectiveness of the ProVector Flower in homes. Estimates were based on lingual descriptors and assigned to fuzzy memberships, then defuzzified to numeric values based upon the number of mosquitoes using Boolean logic [5]. There was a significant reduction of the estimated number of mosquitoes within 2 weeks using the t-test (Table 1). By the end of the 12 weeks there was an 91% reduction in the mean number of mosquitoes in homes, from approximately 808 to 71 (Figure 3) using one ProVector Flower with Entobac.



Figure 2: The ProVector Flower should be used in conjunction with an insecticide treated bed net to reduce risk of mosquito-borne diseases when families are outside of the net and to reduce the number of pesticide resistant mosquitoes.

Table 1: There was a significant difference between the pre-estimate mean number of mosquitoes and all subsequent mean estimates every two weeks for 12 weeks.

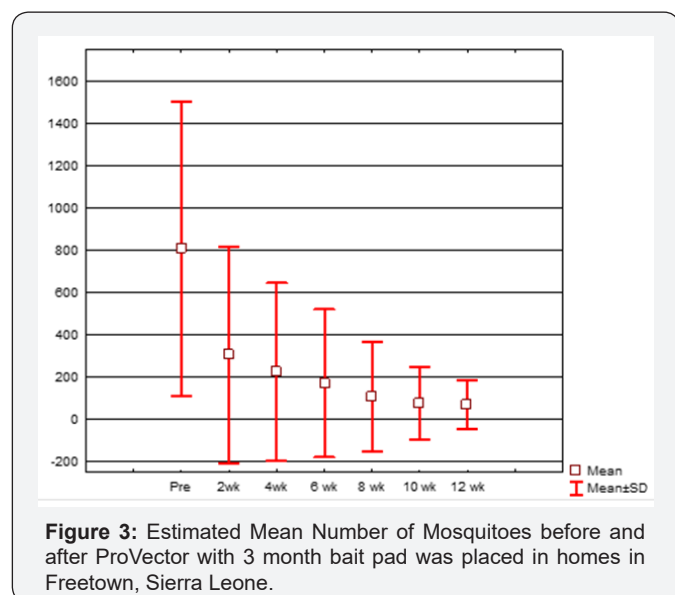
Weeks	Mean	Mean	t-value	df	N	N	Std.Dev.	Std.Dev.	F-ratio
0 vs. 2*	807.93	304.13	3.58	75	41	36	694.94	511.42	1.85
0 vs. 4*	807.93	224.65	4.33	74	41	35	694.94	419.77	2.74
0 vs. 6*	807.93	170.71	4.55	68	41	29	694.94	349.61	3.95
0 vs. 8*	807.93	107.34	4.83	64	41	25	694.94	259.98	7.15
0 vs. 10*	807.93	75.43	4.96	62	41	23	694.94	171.19	16.48
0 vs. 12*	807.93	70.81	4.57	58	41	19	694.94	117.11	35.21

Discussion

Insecticide treated bed nets (ITN) and indoor residual spray (IRS) are the primary means of controlling adult mosquito populations and reducing the incidence of mosquito-borne diseases, primarily focused on malaria. Reducing vector density and survival results in a decrease in malaria exposure for protected individuals; and once a particular threshold is reached in ITN coverage, the rest of the local human community will be

protected as well [6]. However, during the past decade, there have been several records of behavioral changes by malaria mosquito vectors to avoid contact with ITNs by either feeding predominantly outdoors or by feeding in the early part of the evening [7-10]. ITNs with pyrethroids have been shown to be effective against organophosphate resistant *Anopheles gambiae* but they were not effective against *A. arabiensis*. Mathias et al. [11] suggested persistence of *A. arabiensis* due to behavioral traits such as outdoor feeding and/or feeding on non-human

hosts by which this species avoids interaction with insecticide-treated nets. Application of Bti larvicide has also been shown to reduce malaria (Geissbühler et al. 2009).



The ProVector Flower with Entobac pesticide has several advantages over other pesticides used for mosquito control. ProVector pesticide with Entobac is the only pesticide that kills adult and larvae mosquitoes, is eco-friendly, inexpensive, and target specific. Non-target organisms such as bees and butterflies are not harmed. Use of a device to deliver a target specific pesticide has advantages by reducing pesticide contamination of the environment as well as reducing cost of controlling the pest species. The PFE can be used indoors or outdoors (used under an overhang, etc.) to reduce adult mosquito populations. There are numerous advantages to using Bti to reduce mosquito populations including its nontoxic properties to non-target organisms, e.g. humans, mammals, birds, fish, beneficial insects, plants and most aquatic organisms (EPA 1998). Another advantage of using Bti is the lack of development of pesticide resistance in mosquito populations; it has been called an ideal pesticide (Glare and O'Callaghan, 1998). The Entobac™ used within delivery devices such as the ProVector® Flower provides a safe and effective means of delivering Bti as an adulticide for mosquitoes. The amount of pesticide needed to cover an area is reduced by approximately 10,000 times due to target specificity and dissemination of the pesticide to breeding sites by target species and control to areas outside of the immediate vicinity of the ProVector System is attained. In the Dominican Republic, the total mosquito population, including medically important genera, were reduced significantly within 30 days. The area at highest risk from mosquitoes was reduced by 217% within 70 days [10].

Conclusion

The ProVector Pesticide System is well tested technology that is effective in reducing the number of mosquitoes in several

countries and on several continents. The current study used only one ProVector Flower per home yet was effective in reducing the number of mosquitoes. Multiple ProVector applicators should be used in multi-room homes or where populations of mosquitoes are high in order to more rapidly reduce the number of mosquitoes; and should be used in conjunction with insecticide treated bed nets. Another complimentary ProVector Pesticide System is the ProVector Super Netty, which uses an empty water bottle with colored paper and Entobac mixed with Deltamethrin to rapidly reduce mosquito numbers and filth-flies. The Super Netty costs approximately \$1.50 USD and lasts approximately three months. The ProVector Pesticide System may be a valuable within IVM strategies to reduce malaria and other mosquito-borne diseases, even where pesticide resistance in mosquitoes is a problem.

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