

Effectiveness of ProVector Bt in Reducing Mosquito Numbers in a Simulated Village in the Swamps of Georgia

Heidi E. Hulseley, DrPH Candidate
JPHCOPH, Georgia Southern University

Bannie Hulseley
Lab Manager, MIT/MEVLABS

Thomas M. Kollars, Jr. PhD, ACE
CSO ProVector, LLC; CSA MIT Holding, Inc.

Epidemiology Consultant, Afro-European Medical and Research Network

Contact Information

Address: Dr. Tom Kollars
260 Langston Chapel Rd
Statesboro, GA 30458
Email: tomkollars@provectorllc.com

Introduction

- There are approximately 3,000 mosquito species found globally.
- Mosquitoes are among the most efficient vectors of animal and human pathogens, causing many debilitating and often fatal diseases.
- Globally, malaria is the most prevalent vector-borne disease, with over 2.4 billion people around the world at risk of contracting this disease.

Impact of Mosquito-Borne Disease

- Between 1-3 million deaths occur annually from malaria, most in children from sub-saharan Africa.
- Every 30 seconds a person dies from malaria.
- Another vector-borne disease of particular concern to children's health is dengue virus, the second most important tropical disease with approximately 50 to 100 million cases of dengue fever and 500,000 cases of Dengue Hemorrhagic Fever (DHF) each year.
- DHF is fatal to approximately 40% of children that contract this painful and deadly virus.
- Yellow fever, Chikungunya, Rift Valley fever, West Nile virus, Japanese encephalitis, and filariasis, are regionally important vector-borne diseases that are particularly dangerous for children.

Current Techniques for Preventing Mosquito-Borne Disease

- **Vaccines/Drugs**
 - No vaccine available for malaria or dengue, despite decades of research
 - Drug resistant *Plasmodium* a problem in many areas of world
- **Pesticides – Outdoor and Indoor Spraying**
 - Expensive
 - Kill non-target arthropods
 - Ineffective in areas w/ pesticide resistance
 - Human health and environment
- **Bed nets**
 - Not enough bed nets for entire family
 - Improper use
 - Not effective against dengue
 - Cannot be used in schools, churches, restaurants...

ProVector™

The ProVector™ imitates the **look**, **smell** and **taste** of flowers in order to trick the adult male and female mosquito into ingesting the Bt formulation.

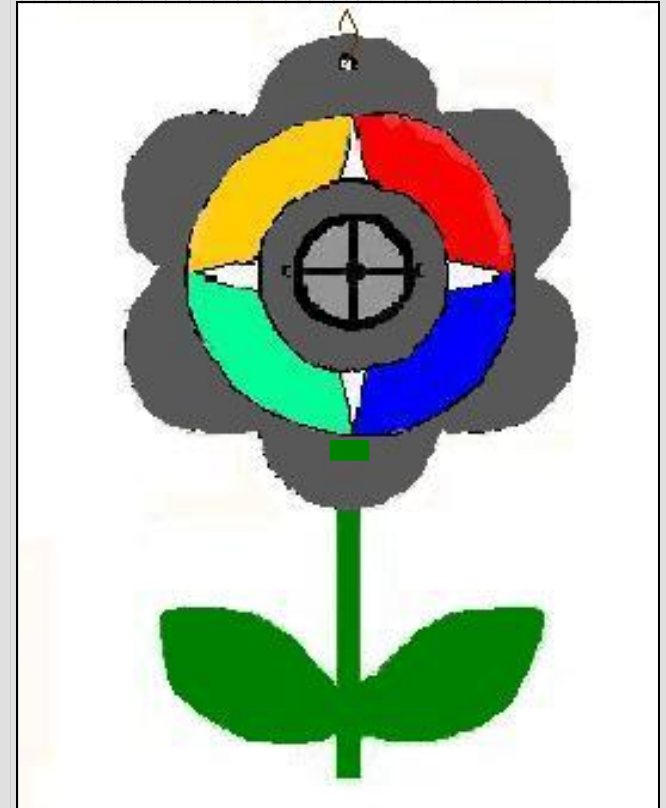


What is *Bacillus thuringiensis israelensis* (Bti)?

- Naturally occurring, rod-shaped bacterium common in soils
- Remains in dormant stage as a spore until ingested
- First discovered in 1977 the Negev Desert, Israel, by Goldberg & Margalit
- Mosquito and black fly larvicide
- Has been used effectively since 1982 for insect control
- Damages digestive system, causing larvae to starve to death
- Affects target organisms only
- Bio-friendly

ProVector™ continued

- New formulation of *Bti* delivers pesticides directly to adult mosquitoes
- ProVector™ Bt (Patent Pending) was developed by Dr. Tom Kollars at ProVector, LLC to be an economical & environmentally safe "GREEN" device for killing adult mosquitoes
- The ProVector™ is the first device capable of killing adult mosquitoes with Bt biopesticide; which is virtually non-toxic according to the EPA
- Because the ProVector™ is targeted towards adult mosquitoes it is approximately 8,000 times more cost effective than aerial sprayed pesticides does not have harmful environmental effects on non-target species



ProVector™ continued



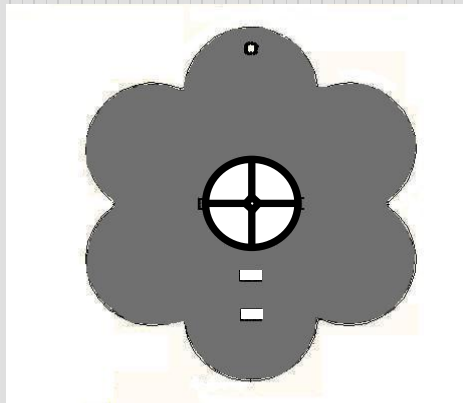
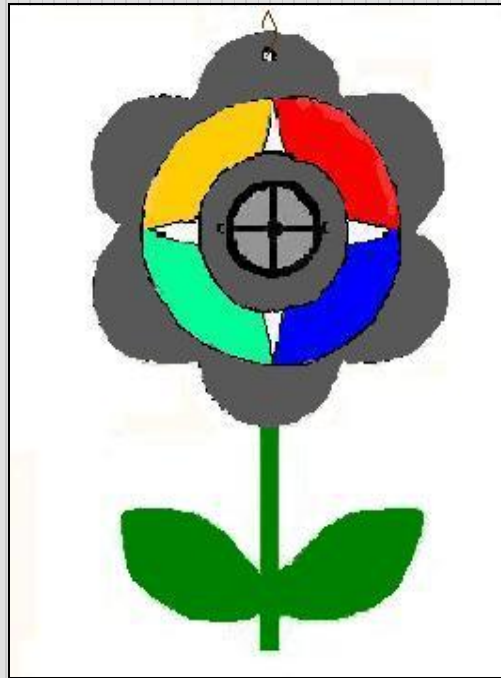
Early ProVector™ prototype w/ mosquitoes

- Bednets effectively protect one person at a time; ProVector™ can help entire household, 24 hrs a day
- Whenever possible, insect treated bed nets, indoor residual spraying & ProVector™ should be used for integrated vector control
- One refill disc lasts six months & will kill approximately 10,000 mosquitoes
- ProVector™ is used indoors to effectively reduce mosquito populations

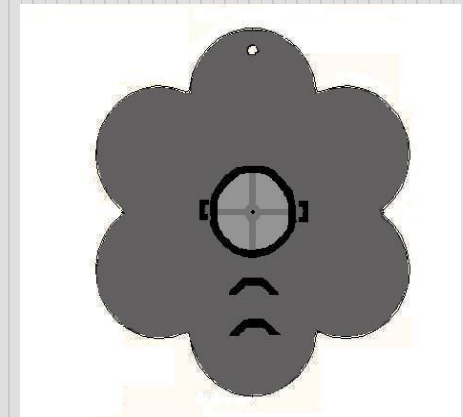
Parts of the ProVector™

Plastic flower w/ color, chemical attractants & refill disc containing Bti.

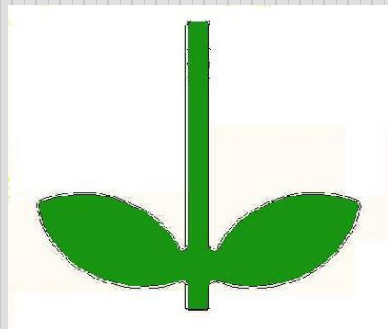
Color wavelengths are optimized to attract different mosquito spp.



Flower - front

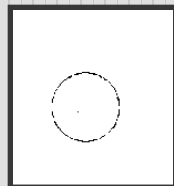


Flower - back



Flower stem

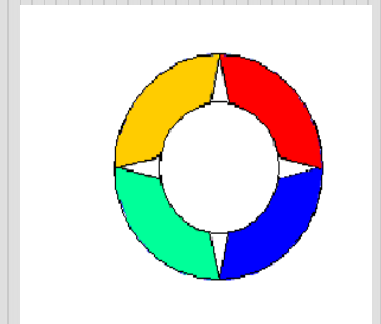
Center of the flower contains fine mesh that allows only mosquitoes to feed through - blocking non-target species from eating the bait.



Refill holder



ProVector™ Bti refill



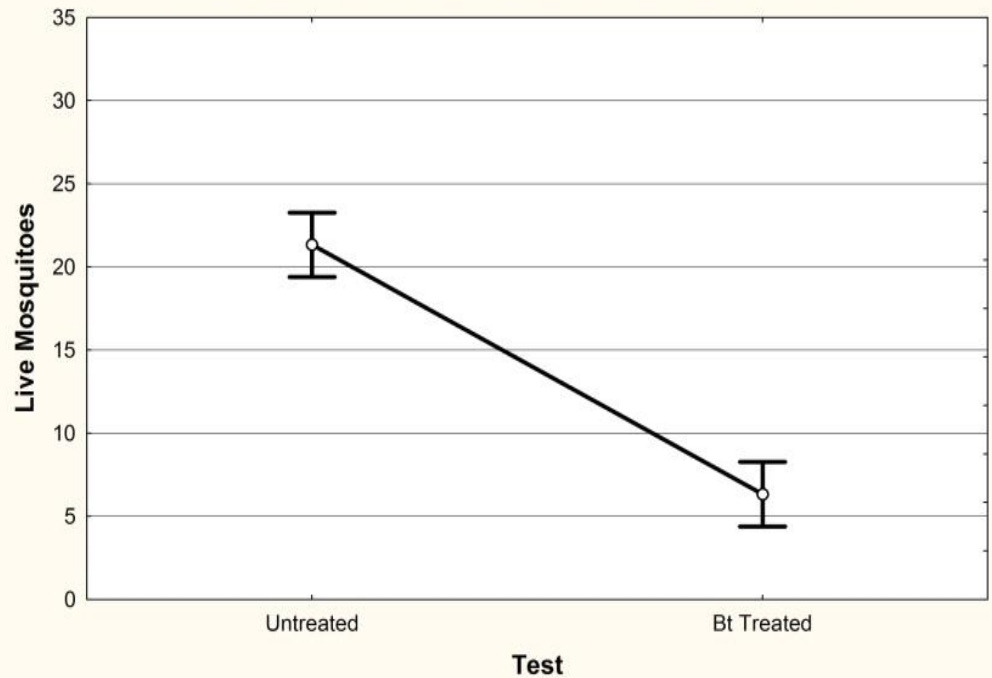
Flower decal

Laboratory Trials

MIT/MEVLABS

The efficacy of the ProVector™ Bt formulation against *Aedes aegypti* (transmits dengue virus) was 80% within 24 hours after one feeding.

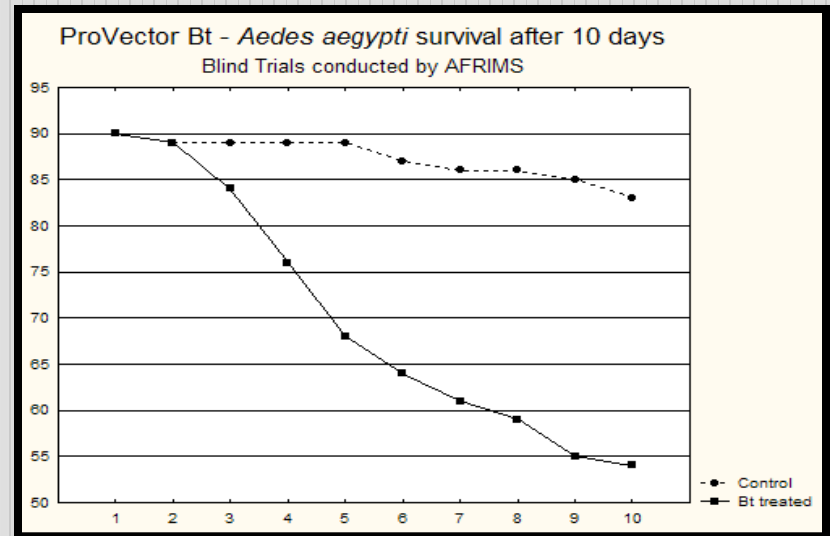
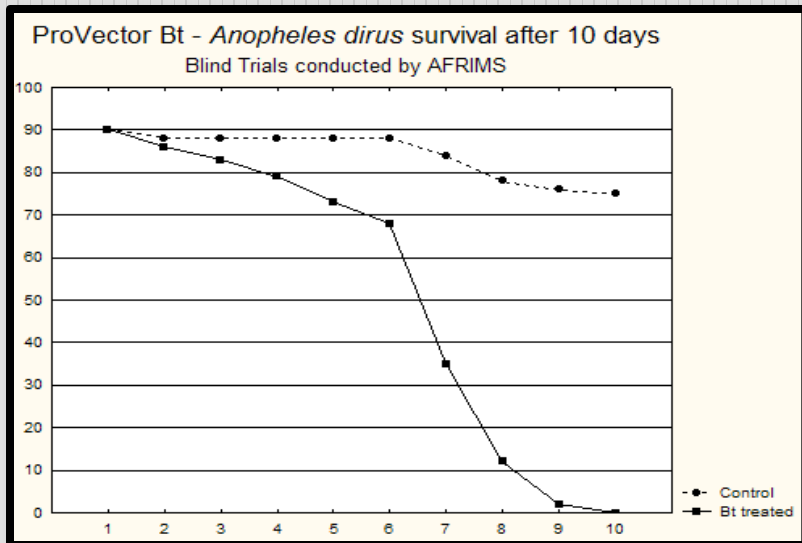
Figure 1. ProVector Bt - Mosquito Survival After One 24hr Period
Vertical bars denote 0.95 confidence intervals ($P \leq 0.05$)



Walter Reed Army Institute – Thailand Trials

Survival of *Anopheles dirus* after 10 day trial
conducted by Armed Forces Research Institute of
Medical Sciences

Survival of *Aedes aegypti* after 10 day trial
conducted by Armed Forces Research Institute of
Medical Sciences



Georgia ProVector™ Field Study

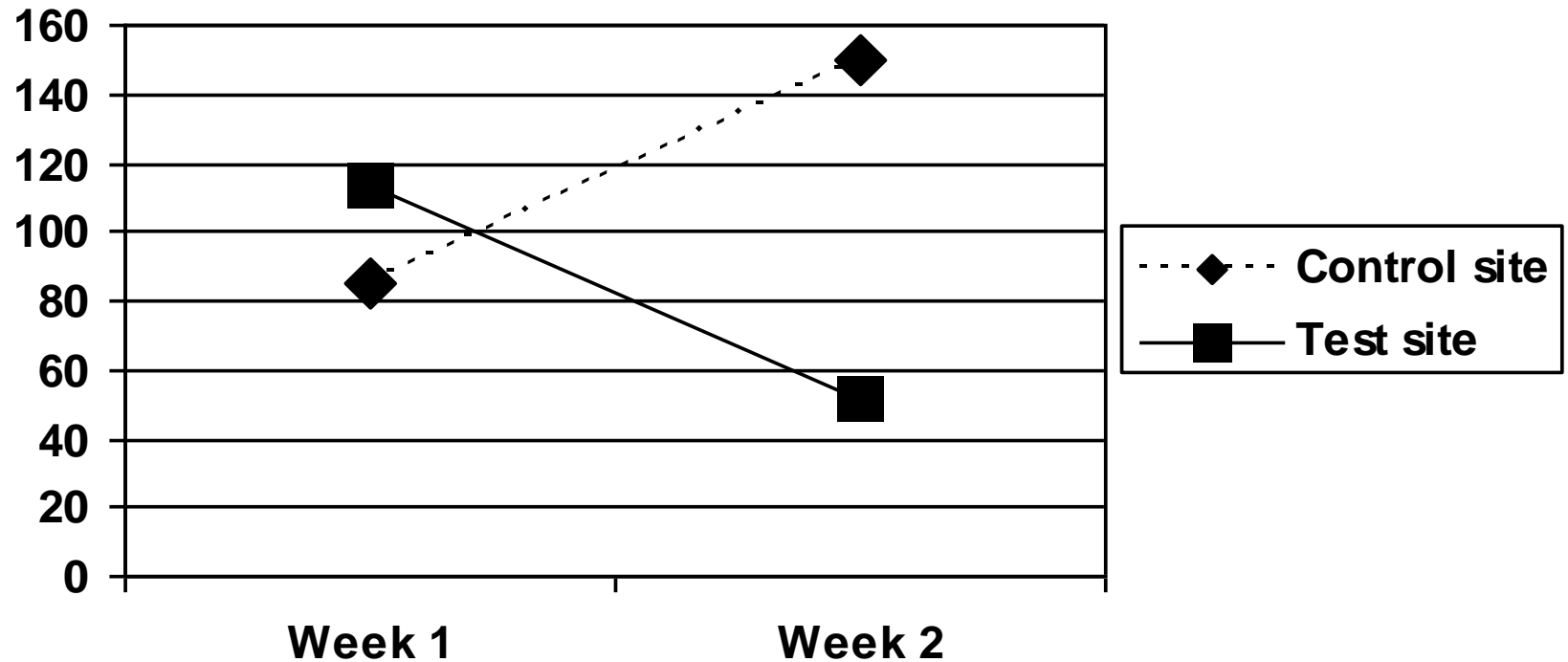


Georgia Field Study – Test Site



Georgia Field Study - Results

ProVector Bt - Simulated Village

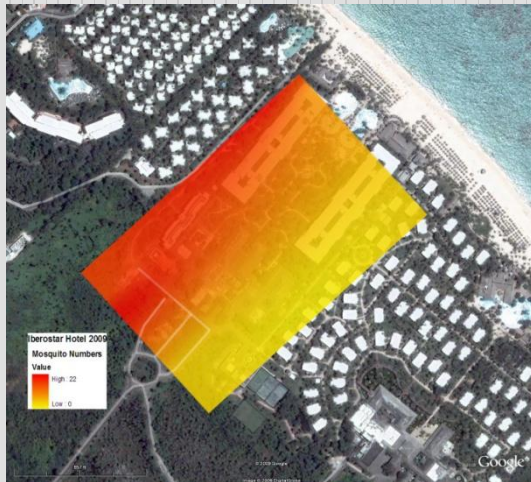


Genus	Species	Total Collected
<i>Aedes</i>	<i>vexans</i>	90
<i>Anopheles</i>	<i>atropos</i>	1
<i>Anopheles</i>	<i>crucians</i>	315
<i>Culex</i>	<i>nigrapalpus</i>	3
<i>Culex</i>	<i>pipiens complex</i>	3
<i>Culex</i>	<i>restuans</i>	5
<i>Culex</i>	<i>salinarius</i>	1
<i>Ochlerotatus</i>	<i>atlanticus-tormentor</i>	8219
<i>Ochlerotatus</i>	<i>fulvus pallens</i>	1
<i>Ochlerotatus</i>	<i>mitchellae</i>	1
<i>Ochlerotatus</i>	<i>sollicitans</i>	81
<i>Ochlerotatus</i>	<i>sticticus</i>	1
<i>Ochlerotatus</i>	<i>taeniorhynchus</i>	5
<i>Psorophora</i>	<i>ciliata</i>	44
<i>Psorophora</i>	<i>columbiae</i>	1
<i>Psorophora</i>	<i>ferox</i>	61
<i>Uranotaenia</i>	<i>sapphirina</i>	190
	TOTAL	9022

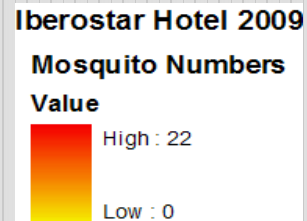
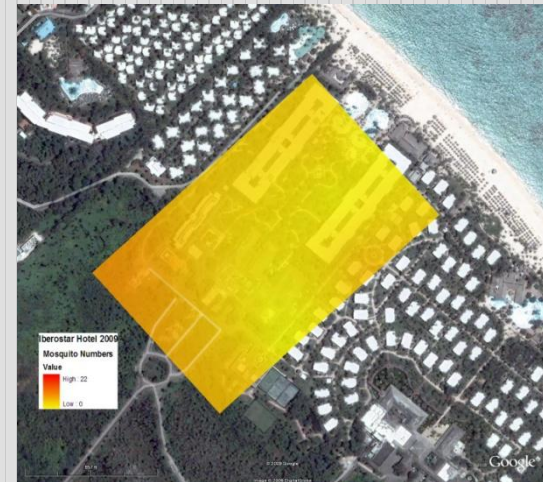
- Meldrim study summary:
- 2 sites selected in Bulloch Co. (Meldrim Plantation)
- One Control: Four CDC light traps
- One Test: Four CDC light traps; 16 10'x10' tents (to simulate a village); one ProVector hanging from inside each tent; traps were placed at each corner of tent grid
- Length of study: June – Sept 2009
- Mosquitoes collected every two weeks

Collaboration with EcoLab, Inc. at the Iberostar Hotel, Punta Cana, Dominican Republic

Iberostar Hotel Grounds Aug09
Before ProVector Bt was deployed



Iberostar Hotel Grounds Sept09
After ProVector Bt was deployed

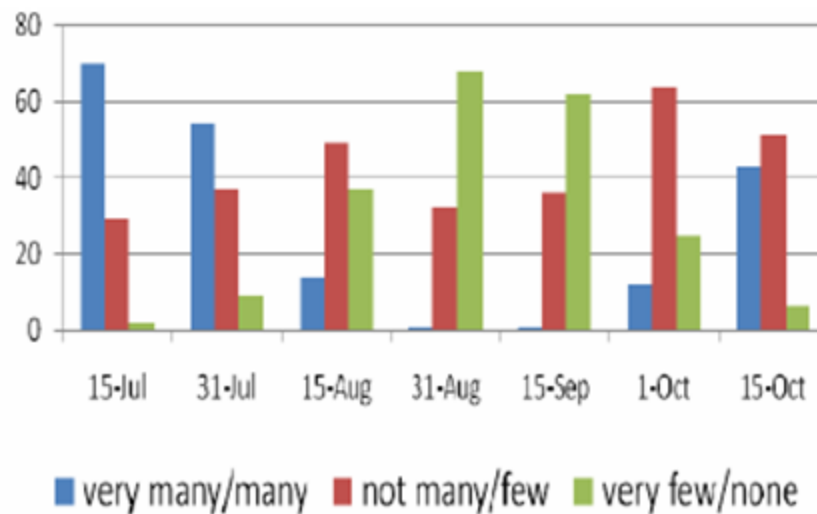


ProVector Community Projects

- ProVector Community Projects (PVCP) were begun in June 2009 with a number of goals in mind; specifically,
- 1) ascertain the receptiveness of ProVector Bt and gain feedback from the target populations in developing countries,
- 2) determine the effectiveness of the ProVector Bt in homes in developing countries,
- 3) develop relationships with non-governmental organizations, and
- 4) gain a foot hold and grow demand for ProVector in developing countries

Feedback received from Riziki, Kenya

Percent of Homes Reporting Mosquito Abundance After Using ProVector Bt in Kibera Slums, Kenya (2009)



Location	Collaborating Organization	Mosquito Control Reported by Collaborator	Additional ProVectors Requested	Requesting Grant Assistance
Africa				
Cameroon	Swiss African Forum	Awaiting feedback	Awaiting feedback	
Ghana (Accra Region)	Department of Agriculture	✓	✓	
Ghana (Accra Region)	Swiss African Forum	Awaiting feedback	Awaiting feedback	
Kenya (Kitale)	AEMRN	✓	✓	✓
Kenya (Kisumu)	AEMRN	✓	✓	✓
Kenya (Kibera)	Riziki Kenya	✓	✓	✓
Kenya (Kibera)	Tunza Children’s Center	✓	✓	
Kenya (Nairobi)	St. Peter’s Methodist Church	✓	✓	
Kenya (Nairobi)	Ushirika Medical Clinic	✓	✓	
Kenya (Mombasa)	Swiss African Forum	✓	✓	
Nigeria (Yola)	Shalom International	Awaiting feedback	Awaiting feedback	
Nigeria	Swiss African Forum	Awaiting feedback	Awaiting feedback	
Sierra Leone (Wilberforce)	Roll Back Malaria	Awaiting feedback	Awaiting feedback	
Sierra Leone (Freetown)	AEMRN	✓	✓	✓
Uganda (Entebbe)	Ministry of Health, Division of Virology	✓	✓	✓
Uganda (Kampala)	Ministry of Health, Division of Virology	✓	✓	✓
Central America				
Dominican Republic (Algodon)	Children of the Nations	✓	✓	✓
Haiti (Port-au-Prince)	Uplift Help International	✓	✓	✓
Haiti (5 locations)	Uplift Help International	Awaiting feedback	Awaiting feedback	
Honduras (Puerto Cortes)	Eternal Family Project	✓	✓	
Nicaragua (Diriamba)	Mustard Seed Communities	✓	✓	
Asia				
Afghanistan (Kabul)	US Embassy	✓	✓	

ProVector™ Summary



- Plastic flower with visual attractants
- Refill disc containing Bti, chemical and gustatory stimulants
- One refill disc lasts six months & will kill approximately 10,000 mosquitoes
- ProVector™ is used indoors to reduce mosquito populations
- Can be used alone but recommend use with ITN or LLIN
- ProVector, LLC develops Community Projects
- MIT Holding, Inc. is licensed to manufacturer and distribute the ProVector™