AREA-WIDE MOSQUITO MANAGEMENT IN THE AMERICAS

Graham White
University of Florida
Carlos Finlay 1833-1915

William Gorgas 1854-1920

Fred Soper 1893-1977

Walter Reed 1851-1902
Following in Soper's footsteps: northeast Brazil 63 years after eradication of *Anopheles gambiae*

Gerry F Killeen

Sub-Saharan Africa has long suffered under the yoke of the *Anopheles gambiae* mosquito, but for northeast Brazil (Figure 1) its arrival over 60 years ago was a new and horrifying experience. This African mosquito is an exceptionally effective malaria vector because it is well adapted to feeding upon people and to exploiting aquatic habitats associated with our daily activities. *Anopheles gambiae* sensu lato probably accounts for most of the world's malaria deaths and socioeconomic burden. Fortunately, the Brazilian experience had a happy ending. The prospect of *A. gambiae* spreading across much of the Americas motivated a ruthlessly effective response that deserves a special and heroic place in the annals of public health. Building on the successes and infrastructure of the Yellow Fever Service for *Aedes aegypti* elimination, the Rockefeller Foundation and Brazilian government collaborated to form a new Malaria Service of the Northeast. This new entity rolled the invader back into oblivion with an aggressive eradication campaign, focusing primarily upon larviciding of all potential habitats. The driving force of this endeavor was an enigmatic man called Fred Soper whose sheer will and determination was a key element in this success, and a source of inspiration today (see Killeen GF, et al. Eradication of *Anopheles gambiae* from Brazil: lessons for malaria control in Africa. *Lancet Infect Dis* 2002; 2: 618–27). I recently took an opportunity to fulfill a long-held dream and follow in some of Soper's footsteps. Tired of gazing at yellowing maps like Figure 1, I went to see the northeast of Brazil for myself.

As soon as the plane emerged from the clouds and began final descent, the lush green countryside and abundant surface water of the Fortaleza area told me that I was in the right place at the right time. Mother Nature had cooperated and the rains had arrived as expected in March 2003. The view through my cabin window confirmed that the meshwork of blue lines and oblong shapes crammed onto the pages of my road atlas represented real bayous, rivers, lakes, and ponds. Even the taxi ride to downtown Fortaleza passed through surprisingly large tracts of wetland, flagged with Carauba palms. Fortaleza was Soper's administrative fortress, from which the cleansing of infested lands to the east was masterminded. He and his colleagues were gravely concerned that if *A. gambiae* reached these wet and populous areas, it would be impossible to stop. The following day I set off for the Serra do Baturité to get an overview of these bountiful valleys before heading east to the drier areas where the war against *A. gambiae* was fought. I found the mountains and surrounding lowlands lush and green, with ample natural and artificial water bodies. The prehistoric forests and valleys below were shrill with the trilling of cicadas and the screeching of owls. It was a place of mystery and intrigue.

Figure 1. A topographical map of northeast Brazil (reproduced from Soper FL, Wilson DE. Anophelloses in Brazil—1930 to 1940. New York: Rockefeller Foundation, 1940).

GFK is a research scientist at the Swiss Tropical Institute.

OH BOY!
WHAT A BREAK,
THIS IS WHERE
I COME IN!

KEEP OUT MALARIA MOSQUITOES
REPAIR YOUR TORN SCREENS
The Communicable Disease Center of the U.S. Public Health Service has initiated a program to eradicate Aedes aegypti from the United States and from Puerto Rico and the Virgin Islands. This program, conducted in conjunction with state and local departments of health, will provide two-way benefits. It will afford our country protection against a return of yellow fever, which is entrenched in portions of the hemisphere and is therefore a continuing threat so long as Ae. aegypti populations remain; and against dengue, which has continued to occur in epidemics with considerable frequency—most recently, as a widespread epidemic during late 1963 and early 1964 in the nearby Caribbean Islands. In addition, the program will contribute significantly to an on-going international effort to eradicate urban epidemics of yellow fever from the Western Hemisphere.

Ae. aegypti Proved Carrier

Yellow fever, the more formidable of the diseases spread by Ae. aegypti, was a primary public health problem during the early history of the New World. Major epidemics occurred in settlements throughout all the vast region extending from Buenos Aires, Argentina, on the south to Boston, Massachusetts, on the north. However, about the turn of the century, this terrifying disease began a rapid regression, and before the first quarter of the century had passed, it had disappeared from the United States and a number of Latin American countries.

This rapid disappearance of urban outbreaks of yellow fever from areas where it had so recently been a dreaded scourge followed close on the heels of the memorable work of Carlos J. Finlay, who first advanced the theory that urban yellow fever is spread only by Ae. aegypti; Walter Reed and the Yellow Fever Commission, who proved Finlay's theory to be true; and William C. Gorgas, who, despite the doubts of many of his contemporaries, first applied this knowledge to rid an endemic area of yellow fever.

The idea that any country could eradicate the disease by controlling Ae. aegypti populations quickly took hold throughout the yellow fever endemic areas of the hemisphere. However, in 1928 the trend toward eradication of this disease was suddenly and shockingly reversed. After an absence of 20 years, yellow fever suddenly re-

STATUS OF THE Aedes aegypti ERADICATION CAMPAIGN

DECEMBER 1963

[Map showing status of eradication efforts in various regions.]

*ERADICATION CARRIED OUT ACCORDING TO THE STANDARDS ESTABLISHED BY THE PAN AMERICAN HEALTH ORGANIZATION*
WORLD ASPECTS OF MOSQUITO ACTIVITIES
IN 1970
Highlights

HELEN SOLLERS-RIEDEL

Plant Protection Division, Agricultural Research Service
United States Department of Agriculture

In 1970 additional reinfections of Aedes aegypti were found in Mexico. All were found near the border with the U. S. and were in the States of Tamaulipas and Coahuila. A new reinfection occurred in Matamoros and was considered to be distinct from the one in October, 1969. The latter was eliminated in 1970 after the area was treated with DDT.

[Entomology Research Branch, Agricultural Research Service, USDA]

The paper describes the effect on the dynamics of insect populations subjected to competitive mating by the release of insects sexually sterilized. Simple simulation models depict the increasing adverse impact on reproductive success as the natural population declines, a type of suppressive action not produced by conventional control methods. [The SCI® indicates that this paper has been cited in over 150 publications since 1961.]

E.F. Knipling
National Program Staff
USDA/Agricultural Research Service
Beltsville, MD 20705

ects prior to and during World War II. However, the 'autocidal' approach was discussed with other scientists. The general reaction ranged from skepticism to ridicule. Nevertheless, after having been assigned responsibility for directing USDA's research on livestock pests in 1946, I made efforts, to no avail, to obtain funds for research on the concept. Then, another colleague, A.W. Lindquist, called my attention to Muller's paper describing the sterilizing effects of X rays on drosophila. I wrote to Muller describing my theory of screwworm control by releasing sterile flies in natural habitats. He had reservations about certain ecological aspects, but expressed confidence that screwworm flies could be sterilized by X-ray
Sterile Insect Technique

theoretical population trends per generation:
9 sterile males released for each fertile wild male
with a 5-fold rate of increase (Knipling, 1955)

<table>
<thead>
<tr>
<th>generation</th>
<th>fertile males</th>
<th>sterile males /generation</th>
<th>sterile:fertile male ratio</th>
<th>next generation</th>
<th>insecticidal 90% control</th>
<th>uncontrolled population</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1,000,000</td>
<td>9,000,000</td>
<td>9:1</td>
<td>500,000</td>
<td>1,000,000</td>
<td>1,000,000</td>
</tr>
<tr>
<td>2</td>
<td>500,000</td>
<td>9,000,000</td>
<td>18:1</td>
<td>131,580</td>
<td>500,000</td>
<td>5,000,000</td>
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<td>9,000,000</td>
<td>68:1</td>
<td>9,535</td>
<td>250,000</td>
<td>25,000,000</td>
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<tr>
<td>4</td>
<td>9,535</td>
<td>9,000,000</td>
<td>944:1</td>
<td>50</td>
<td>125,000</td>
<td>125,000,000</td>
</tr>
<tr>
<td>5</td>
<td>50</td>
<td>9,000,000</td>
<td>180,000:1</td>
<td>0</td>
<td>62,500</td>
<td>625,000,000</td>
</tr>
</tbody>
</table>
Anopheles albimanus is one of the main vectors of malaria in Central America, northern South America and the Caribbean. On the Atlantic coast it is found from Texas to Venezuela, on most of the Caribbean islands and on the Pacific coast, from Mexico to northern Peru.

Habitat

The larval sites used by An. albimanus are characterised across its range as open, sunlit and containing clear water. The species can be found in natural and man-made habitats where these characteristics exist. For example, it occurs in recently planted rice fields, or in older fields with sunlit areas in between the rice plants. The larvae tolerate a wide variation in water chemistry and are able to exploit diverse food sources enabling them to survive in both fresh water (e.g. irrigation channels, small ponds, marshes, slow flowing streams and river margins) and brackish water (e.g. mangrove swamps).

Behaviour

An. albimanus is predominantlv exophagic with exophilic resting behaviour, however there is some indication that in the northern reaches of its distribution (Mexico, Central America), this species exhibits a preference for resting indoors after feeding. An. albimanus bites in the evening and during the night. It appears to show a tendency for zoophily, but some reports have indicated anthropophilic activity.

Vectorial capacity

An. albimanus is considered to be a dominant malaria vector.
1972  El Salvador, Lake Apastapeque
Anopheles albimanus
Goals: rearing method development and population reduction
Numbers released: 4.4 million males over 5 mo. or about 3700/soccer field area (15 km²)
Outcome: eradication of the local population
Historical applications of induced sterilisation in field populations of mosquitoes

David A Dame*1, Christopher F Curtis2, Mark Q Benedict3, Alan S Robinson3 and Bart GJ Knols4

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Email: David A Dame* - ddame@ufl.edu; Christopher F Curtis - not@valid.com; Mark Q Benedict - m.benedict@iaea.org; Alan S Robinson - a.s.robinson@iaea.org; Bart GJ Knols - bart@malaria-world.com

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Abstract

Research on sterile mosquito technology from 1955 to the 1980s provided a substantial body of knowledge on propagation and release of sterile mosquitoes. Radiation sterilisation and chemosterilisation have been used effectively to induce dominant lethality and thereby sterilise important mosquito vectors in the laboratory. Experimental releases of chemosterilised males provided complete control of Anopheles albimanus in a small breeding population (14-15 sq km) in El Salvador. Releases of radiation sterilised males failed to control either Aedes aegypti or Anopheles quadrimaculatus in the USA. Releases of radiation-sterilised and chemosterilised male Culex quinquefasciatus in the USA and India were successful in some instances. Development of genetic sexing systems for Anopheles and improved physical separation methods for Culex have made it possible to rear and release males almost exclusively (> 99%) minimizing the release of potential vectors, the females. Factors that affected efficacy in some field programmes included reduction of competitiveness by radiation, immigration of fertilized females from outside the release zones, and

WHO recommended insecticides for indoor residual spraying against malaria vectors

<table>
<thead>
<tr>
<th>Insecticide compounds and formulations</th>
<th>Class group</th>
<th>Dosage (g a.i./m²)</th>
<th>Mode of action</th>
<th>Duration of effective action (months)</th>
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<tbody>
<tr>
<td>DDT WP</td>
<td>OC</td>
<td>1-2</td>
<td>contact</td>
<td>&gt;6</td>
</tr>
<tr>
<td>Malathion WP</td>
<td>OP</td>
<td>2</td>
<td>contact</td>
<td>2–3</td>
</tr>
<tr>
<td>Fenitrothion WP</td>
<td>OP</td>
<td>2</td>
<td>contact &amp; airborne</td>
<td>3–6</td>
</tr>
<tr>
<td>Pirimiphos-methyl WP &amp; EC</td>
<td>OP</td>
<td>1-2</td>
<td>contact &amp; airborne</td>
<td>2–3</td>
</tr>
<tr>
<td>Pirimiphos-methyl CS</td>
<td>OP</td>
<td>1</td>
<td>contact &amp; airborne</td>
<td>4–6</td>
</tr>
<tr>
<td>Bendiocarb WP</td>
<td>C</td>
<td>0.1–0.4</td>
<td>contact &amp; airborne</td>
<td>2–6</td>
</tr>
<tr>
<td>Propoxur WP</td>
<td>C</td>
<td>1–2</td>
<td>contact &amp; airborne</td>
<td>3–6</td>
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<tr>
<td>Alpha-cypermethrin WP &amp; SC</td>
<td>PY</td>
<td>0.02–0.03</td>
<td>contact</td>
<td>4–6</td>
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<tr>
<td>Bifenthrin WP</td>
<td>PY</td>
<td>0.025–0.05</td>
<td>contact</td>
<td>3–6</td>
</tr>
<tr>
<td>Cyfluthrin WP</td>
<td>PY</td>
<td>0.02–0.05</td>
<td>contact</td>
<td>3–6</td>
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<tr>
<td>Deltamethrin SC-PE</td>
<td>PY</td>
<td>0.02–0.025</td>
<td>contact</td>
<td>6</td>
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<tr>
<td>Deltamethrin WP, WG</td>
<td>PY</td>
<td>0.02–0.025</td>
<td>contact</td>
<td>3–6</td>
</tr>
<tr>
<td>Etofenprox WP</td>
<td>PY</td>
<td>0.1–0.3</td>
<td>contact</td>
<td>3–6</td>
</tr>
<tr>
<td>Lambda-cyhalothrin WP, CS</td>
<td>PY</td>
<td>0.02–0.03</td>
<td>contact</td>
<td>3–6</td>
</tr>
</tbody>
</table>

X-PERT® Hand Compressed Sprayer

STIHL® Model SR450
Confirmed Zika Cases in Florida

- Counties with Locally acquired cases
- 1-3 travel associated cases
- 4-6 travel associated cases
- 7-10 travel associated cases
- Greater than 10 travel associated cases
- Sexually transmitted case

As of 8/11/2016

Total number of travel-associated cases in Florida (non-pregnant): 404
Number of cases involving pregnant women: 57
Number of cases locally acquired in Florida: 25
UPDATE: (August 12, 2016) According to a news release issued by the Wynwood Yard, a third employee was found to be Zika-positive. The Yard learned this after receiving some aggregate numbers from the Department of Health after it tested a group of more than 65 employees last Thursday, August 4. All three employees are part of the same group that was tested last week. The Wynwood Yard reports that all employees are doing well and that management is awaiting more test results.
Sterile Insect Technique
An effective alternative to chemical insecticide applications, Sterile Insect Technique (SIT) is a special activity pursued by Dynamic Aviation. With SIT operational experience exceeding 250,000 flight hours, Dynamic Aviation is recognized as the international leader in the release of sterile insects.

A plane sprays pesticide over the Wynwood neighborhood of Miami in August, the second round of aerial spraying in the area. Joe Raedle/Getty Images
Fumigating in Miami, Florida after 14 Zika cases were found last year;
from “Brazil marks end of Zika virus outbreak health emergency” 12May2017 www.dw.com
Aerosol Space Spray “fogging”

droplet size and cloud droplet density measurements by laser diffraction

DRIFT IS ESSENTIAL FOR MOSQUITO CONTROL (contrary to Ag sprays)

ultra-low volume (ULV) spray

thermal fog
Ground Adulticiding

- Accomplished using a ULV (Ultra Low Volume) fogger mounted onto a pickup.

- These trucks usually begin just after sunset and apply materials at 10 mph.
Lee County is flat and holds a lot of temporary standing water with almost 60,000 acres of saltmarsh and several hundred thousand acres of other wetlands and fresh water habitats for mosquito breeding.
LCMCD
Former Buckingham Army Airbase

Seven Heliports
Aedes taeniorhyncus
black saltmarsh mosquito

Can fly 25 to 30 miles
Aggressive Biter
Mosquito larvae are located by using a white dipper to sample water habitats. The stage of development and temperature will indicate how much time is left before they become adults.
Adult mosquito surveillance can be accomplished with several different types of traps as well as landing rate observances.
Huey ULV Larviciding System
# Application Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aircraft</td>
<td>Bell 206</td>
</tr>
<tr>
<td>Air Speed kns</td>
<td>60</td>
</tr>
<tr>
<td>Altitude</td>
<td>100 ft</td>
</tr>
<tr>
<td>Nozzle System</td>
<td>AU5000</td>
</tr>
<tr>
<td></td>
<td>6000 rpm</td>
</tr>
<tr>
<td>Material</td>
<td>Vectobac WDG</td>
</tr>
<tr>
<td>Application Rate</td>
<td>200 gm/ac</td>
</tr>
<tr>
<td></td>
<td>100 gm/ac</td>
</tr>
<tr>
<td>Flow Rate per acre</td>
<td>1 gal</td>
</tr>
<tr>
<td>Tank Mix</td>
<td>200 gm/gal</td>
</tr>
<tr>
<td></td>
<td>100 gm/gal</td>
</tr>
</tbody>
</table>
interspecific differentials for IVM & SIT consideration

<table>
<thead>
<tr>
<th>aegypti aegypti</th>
<th>factor</th>
<th>albopictus</th>
</tr>
</thead>
<tbody>
<tr>
<td>ex Africa – circumglobal between 10° isotherms</td>
<td>geographical range</td>
<td>ex SE Asia, expanding to temperate latitudes</td>
</tr>
<tr>
<td>domestic/urban</td>
<td>ecology</td>
<td>wider peridomestic</td>
</tr>
<tr>
<td>mostly humans</td>
<td>bloodmeal hosts</td>
<td>wider range of animals/birds</td>
</tr>
<tr>
<td>very limited (usually &lt;&lt; 100m)</td>
<td>adult flight range</td>
<td>less than most other mosquitoes</td>
</tr>
<tr>
<td>perennial, no diapause</td>
<td>seasonality</td>
<td>Winter diapause of eggs &amp; larvae</td>
</tr>
<tr>
<td>can be &gt; 1 year</td>
<td>egg aestivation/desiccation</td>
<td>weeks/months</td>
</tr>
<tr>
<td>mostly artificial containers, thrives in dark drains</td>
<td>“breeding sites”</td>
<td>wider range of natural (e.g. axils) and artificial containers</td>
</tr>
<tr>
<td>not naturally</td>
<td>Wolbachia symbionts</td>
<td>Yes: wAlbA, wAlbB prevalent</td>
</tr>
<tr>
<td>CHIKV, DENVs, YFV, ZikaV etc.</td>
<td>vector competence</td>
<td>CHIKV (alanine&lt;valine advantage), DENVs, (YFV), ZikaV etc.</td>
</tr>
<tr>
<td>prevalent vs DDT, SPs, some OPs</td>
<td>Insecticide resistance</td>
<td>incipient (no problems yet)</td>
</tr>
<tr>
<td>loser vs albopictus in subtropical Americas (satyrization)</td>
<td>competitive displacement</td>
<td>loser vs aegypti in Asia</td>
</tr>
</tbody>
</table>

pros: easily mass produced & released for SIT/IIT - males polygamous, females usually monogamous

cons: very high R0 and limited dispersal of adults; mosquitoes more fragile than tephritids & tsetse
The Asian tiger mosquito

These webpages contain the results of operational research. You will have access to scientific publications, unpublished data, contact information and multiple tools developed during the project.

Area-wide management of the Asian tiger mosquito (AW-ATM)

funded by USDA-ARS (2008-2013)
Click this box to enter. Below are links to general information on this mosquito's life-history and critical management topics.
Surveillance, Education, Control, and the Economics of it all. Click for details.

http://asiantigermosquito.rutgers.edu/
Overview of Aedes Control

**Immature control**

**Major categories**
- Container cleaning (bleach/wash/dump)
- Container manipulation (polystyrene beads)
- Container treatment
- Social campaigns (education, source reduction)
- Environmental Management
- Legislation

**Existng Methods**

**Bleach**
- Insecticides
  - Temephos
  - Novaluron
  - Spinosad
- Biologicals
  - Copepods

**Container treatment**
- Methoprene
- Pyriproxyfen
- Larvivorous fish

**Eggs**

1st 2nd 3rd 4th Pupa

**Larval instars**

**New entomopathogenic fungi**

**Adult control**

**Major categories**
- Space spraying
- Indoor residual spraying
- Personal protection

**Methods under Development**

**PLOS NEGLECTED DISEASES**

**A Critical Assessment of Vector Control for Dengue Prevention**

Nicole L. Atcheson, R. Fred Good, T. Alex Perkins, Robert C. Reiner Jr., Amy C. Morrison, Scott A. Ritchie, Diane J. Gubler, Mary T. Yeo, Thomas W. Scott

**Space spraying**
- Track ULV, Low-flying aircraft, hand-held portables, peri-focal treatment

**Personal protection**
- DEET
- Picaridin
- Bed nets
- Consumer products

**Indoor residual spraying**

**Behavior modification**
- Wolbachia
- Other within-tissue symbionts
- Para-transgenesis
- Antipathogen genes without drive

**Lethal Ovitraps**
- Auto-dissemination

**Molecular insecticides, meflo/HEGs, new insecticides**
Keep mosquitoes out of your septic tank

Mosquitoes can get inside broken or unsealed septic tanks and lay eggs. Each day thousands of mosquitoes fly out of cracked or broken septic tanks. Mosquitoes can spread viruses like Zika, dengue, West Nile, and chikungunya.

**Mosquitoes may be laying eggs inside your septic tank if it is:**
- Open or unsealed
- Broken with cracks or spaces between the blocks
- Missing a ventilation pipe screen cover

**Inspect and repair your septic tank to keep mosquitoes out**

**Here’s how:**
- Seal the septic tank.
- Repair cracks or gaps in the exterior walls of the septic tank using cement.
- Cover ventilation pipes with a screen mesh, repair broken pipes, and seal at the joints.
- Fill abandoned or unused septic tanks with dirt or gravel.
Welcome to the American Mosquito Control Association

AMCA® is a nonprofit organization that is dedicated to providing leadership, information and education leading to the enhancement of public health and quality of life through the suppression of mosquitoes.

Learn More About Mosquito-Borne Diseases

» Leadership
AMCA is a professional association with members in over 50 countries, representing researchers, educators, vector control professionals, industry representatives, and students.

Learn more »

» Information
There are over 3,000 different species of mosquitoes throughout the world, about 200 species occur in the United States.

Learn more »

» Education
AMCA is proud to offer educational events that highlight the latest science, technology, and products used to conduct research and control vectors.

Learn more »

Click here to view our Zika Virus Fact Sheet.


**Recently updated from 2009 version by the AMCA expert advisory panel as part of the CDC sole-source contract for Establishment of Training and Certification Programs for Mosquito Surveillance and Control.

NEW!! Click here for AMCA's New Video that debuted at the 83rd Annual Meeting!
AMCA President, Wayne Gale, along with AMCA members met with Congressman Francis Rooney’s office as part of the 2017 AMCA Washington Conference.
Skeeter Life Merchandise
Living the Skeeter Life? Show your pride, get the gear! Check out the online "Skeeter Life" catalog and order your merchandise today!

Shop Now »

Annual Conference
This year’s Annual Conference is at Hawk’s Cay in Marathon and it will be here before you know it... Watch for details here soon! Don’t miss out!

Register now »

Become a Member
Members enjoy many benefits including networking opportunities, and up-to-date information on industry news. Join us today!

Join now »
WE HAVE A MISSION

To provide quality public information, comprehensive mosquito and vector-borne disease surveillance, training to high professional standards, and effective legislative advocacy on behalf of California mosquito and vector control districts. Learn more...

LATEST MVCAC NEWS

California’s wet winter could lead to an early mosquito season and increased virus transmission (April 14, 2017)
Screen Drums, Tanks

WELCOME

The Mosquito Research and Control Unit (MRCU) was established in 1965 to suppress mosquito populations so as to minimise discomfort from mosquito biting. To protect residents and visitors from mosquito-borne disease, and thereby enhance the quality of life and promote the economy of the Cayman Islands.

GM Mosquitoes

Why are they Friendly
The "Friendly Aedes aegypti Project" utilizes a pioneering technique using genetically modified male mosquitoes to control the Aedes aegypti species. Here's why they are "friendly".

- Modified genes cannot be transferred to other species, even if the GM mosquitoes are eaten.
- GM males cannot pass their genetic modification to the females only to the offspring.

BBC NEWS

Zika Virus The Facts
Innovative Control Approaches

Can we use *Aedes* mosquitoes against themselves?

- Mosquitoes are much better at finding each other (for mating) and their preferred cryptic larval sources than we are

Two concepts were evaluated in California in 2015

- A *Wolbachia*-based autocidal approach (Los Angeles County)
- Auto-dissemination of insect growth regulators (Fresno County)
## Oxitec Development History

<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>2002/4</td>
<td>Company formed as spin out from Oxford University</td>
</tr>
<tr>
<td>2005/7</td>
<td>Global first release of a GE insect Pink Bollworm (marker only) in USA</td>
</tr>
<tr>
<td>2008/9</td>
<td>First outdoor release of OX513A mosquito in the Caymans</td>
</tr>
<tr>
<td>2010/12</td>
<td>First outdoor release of OX513A in Brazil</td>
</tr>
<tr>
<td>2013</td>
<td>Outdoor trials of OX513A in Panama and Brazil</td>
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<tr>
<td>2014</td>
<td>Oxitec Brazil National Biosafety approval in Brazil</td>
</tr>
<tr>
<td>2015/16</td>
<td>First direct projects OX513A Brazil scale up underway</td>
</tr>
</tbody>
</table>

Technology platform developed and exemplified in both agricultural and mosquito species.

OX513A developed.

Pink bollworm - Global first release of a GE insect Pink Bollworm (marker only) in USA

Mosquito development spurred by Gates funding.

First outdoor release of OX513A mosquito in the Caymans - Environmental Impact Statement in the USA – environmentally preferred solution.

First outdoor release of OX513A in Brazil - First agricultural collaborations.

First larger scale urban project starts in Jacobina, Brazil.

First agricultural insect strains into development.

Oxitec Brazil established.

Oxitec Brazil National Biosafety approval in Brazil - Panama outdoor trial.

USDA FONSI for agriculture trial in USA.

Brazil approval for agricultural trial.

First direct projects OX513A Brazil scale up underway - WHO VCAG recommendation for stage 3: larger scale / epi.

Oxitec acquired by Intrexon to accelerate development.

Zika crisis emerges.
The Mosquito Information Website is all about mosquitoes and their impact on Florida. From mosquito biology to the current status of West Nile Virus in Florida, this is the one-stop source for mosquito information including research, training, extension and education.

LATEST INFORMATION ON ZIKA VIRUS

Registration for the 2017 Advanced Mosquito Identification Course is now CLOSED. MORE INFORMATION...