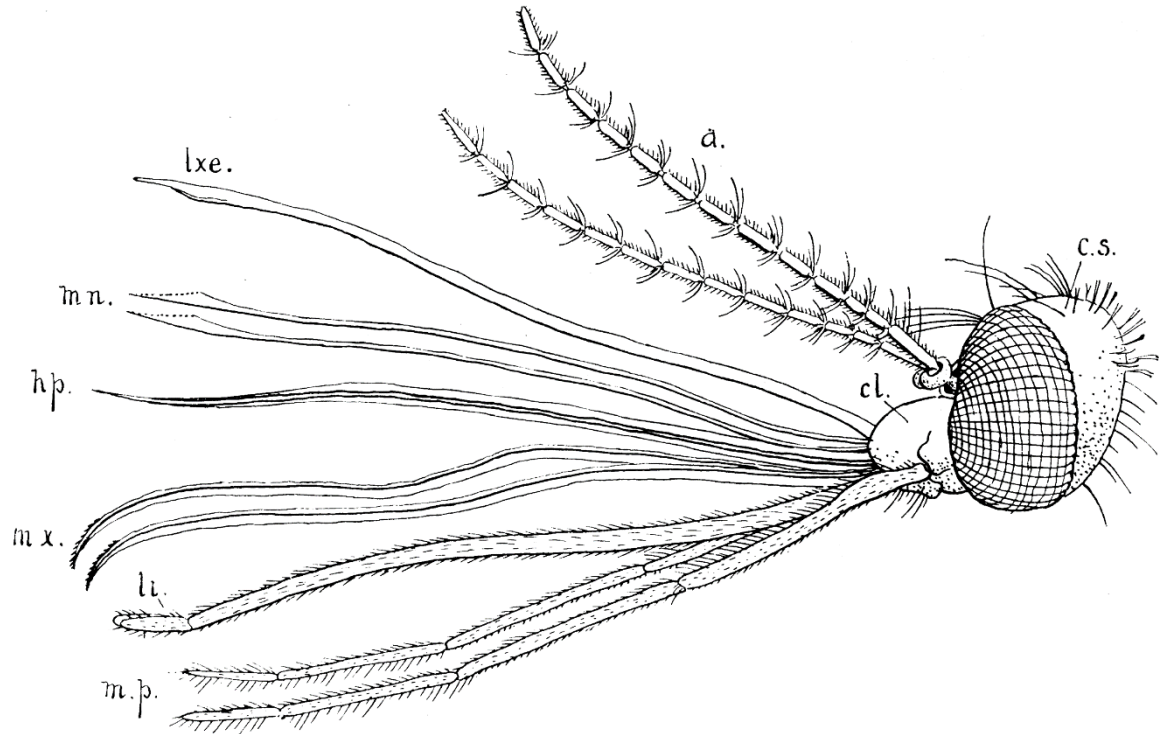
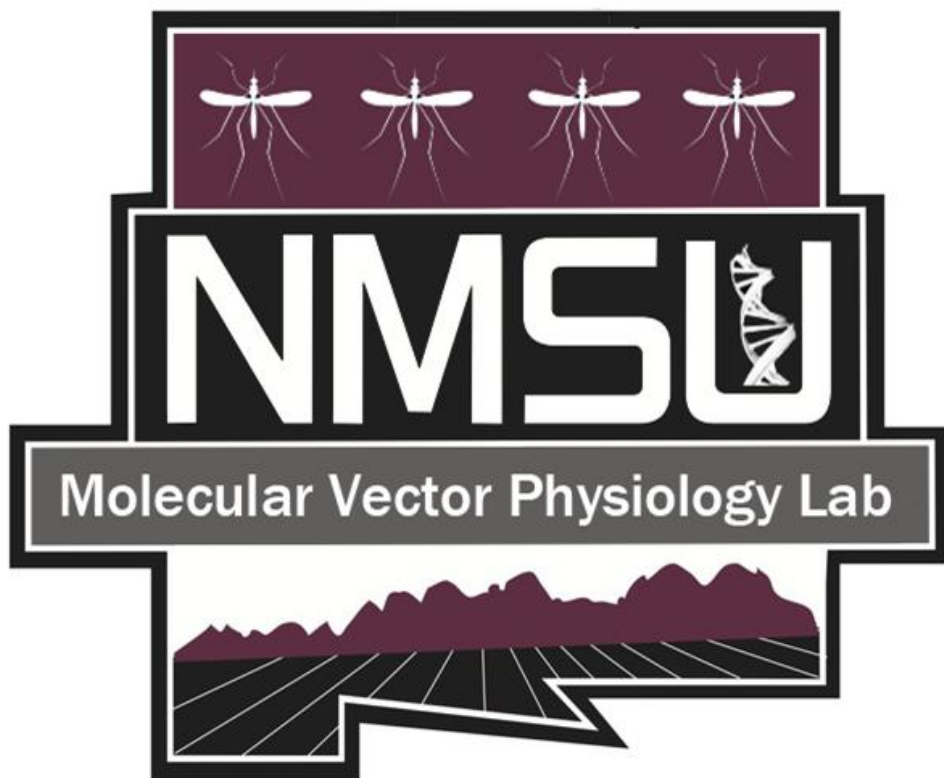


# Bug Spray: Repellants and Poisons and Mosquito Reproduction

Immo A. Hansen  
New Mexico State University





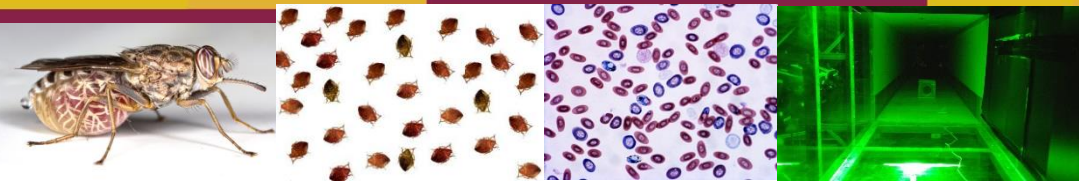
## Immo A. Hansen

Associate Professor  
Department of Biology &  
Institute of Applied Biosciences  
New Mexico State University

<http://biology-web.nmsu.edu/~hansen/>

<https://www.facebook.com/hansen.lab.7>

The Hansen Lab, 2017



# Talk:

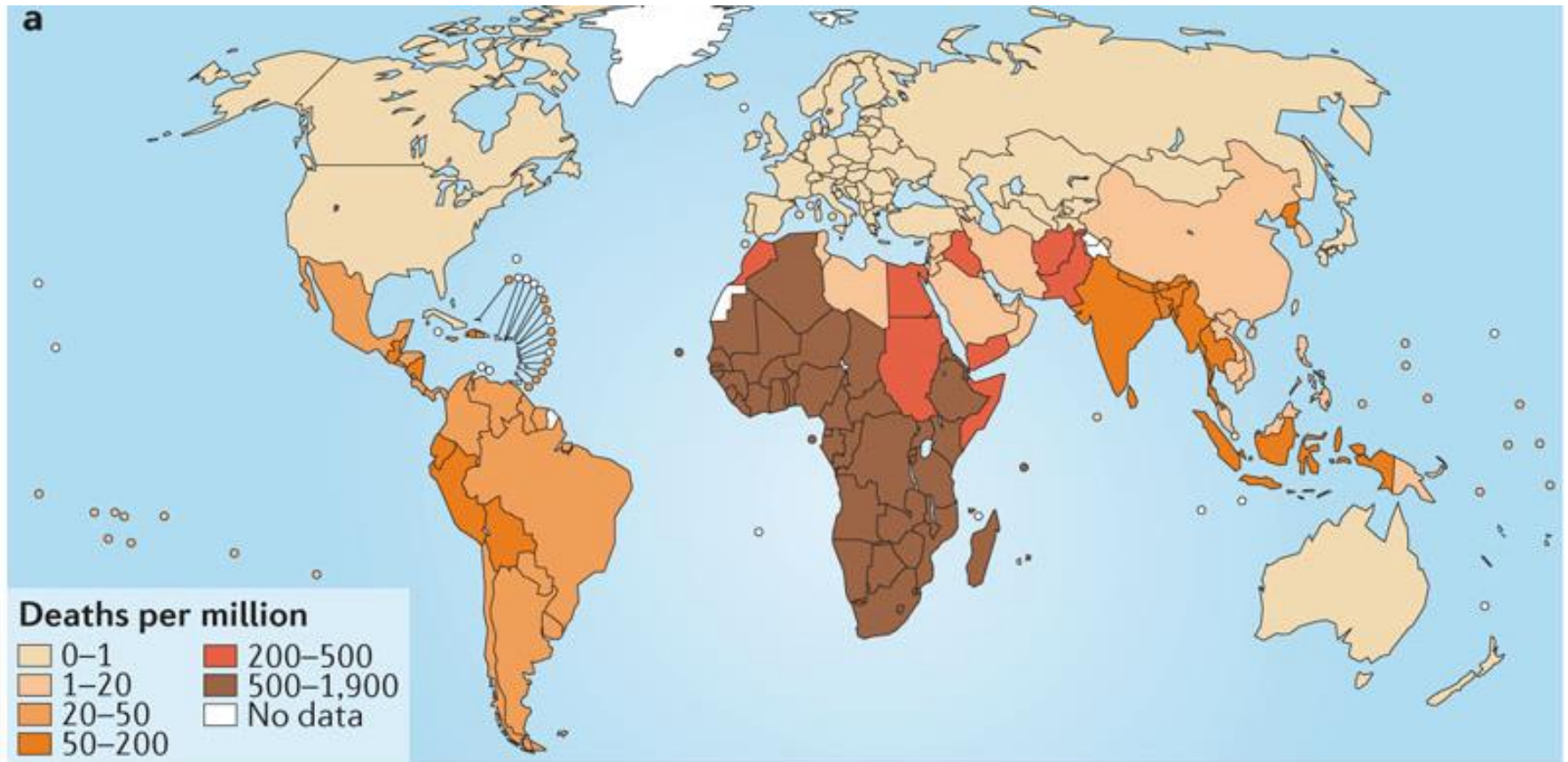
1. Intro
2. Insecticide resistance in NM
3. Not all repellents are equal
4. Sterile Insect Technique

# Vector-borne diseases

Disease that results from an infection with a pathogen transmitted to humans and other animals by blood-feeding arthropods, such as mosquitoes, kissing bugs, ticks, and fleas.



# Heat map showing the worldwide incidence of deaths caused by vector-borne disease



Elizabeth A. McGraw & Scott L. O'Neill *Nature Reviews Microbiology* 11, 181-193 (March 2013)

# Impact of VBDs

## DALY

**Disability Adjusted Life Years** is a measure of overall disease burden, expressed as the cumulative number of years lost due to ill-health, disability or early death

$$= \text{YLD} + \text{YLL}$$

Years Lived with Disability + Years of Life Lost



Healthy life

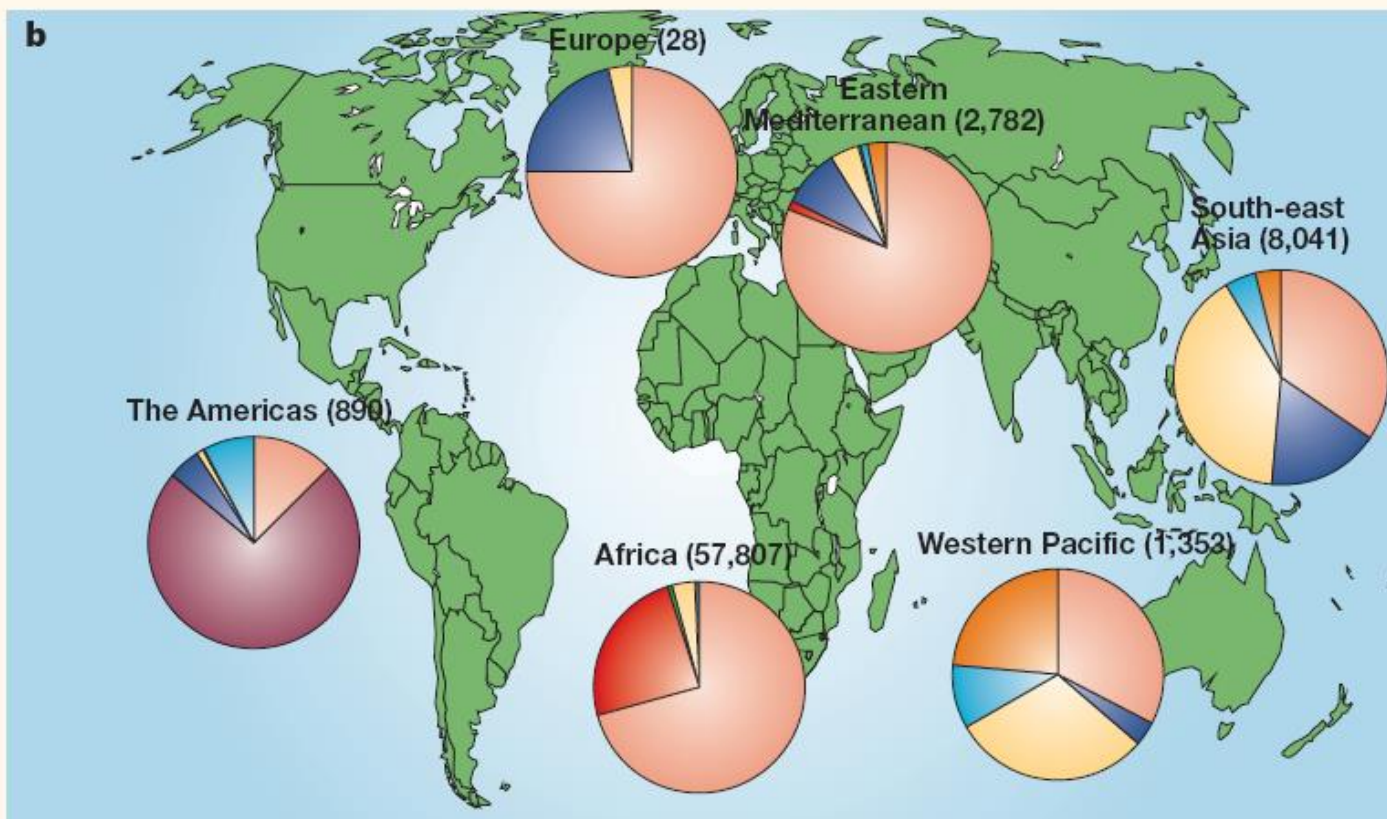
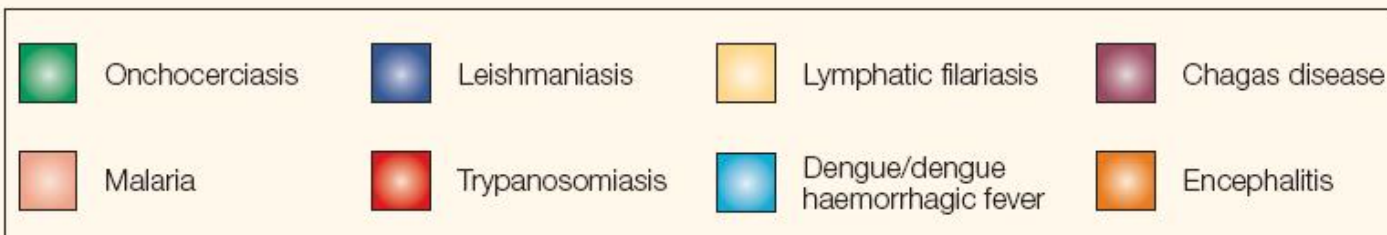
Disease or Disability

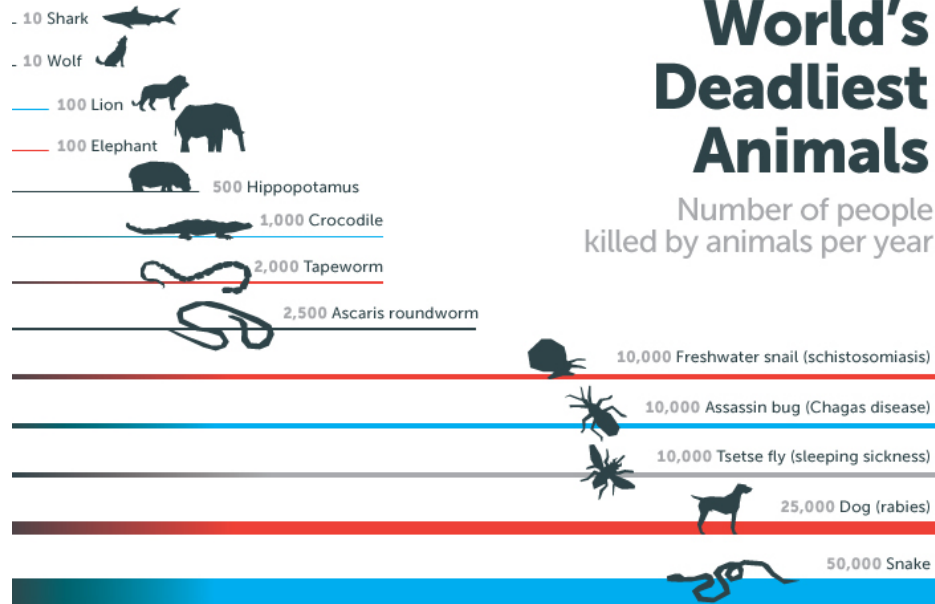
Early death

Expected life years

[http://en.wikipedia.org/wiki/Disability-adjusted\\_life\\_year](http://en.wikipedia.org/wiki/Disability-adjusted_life_year)

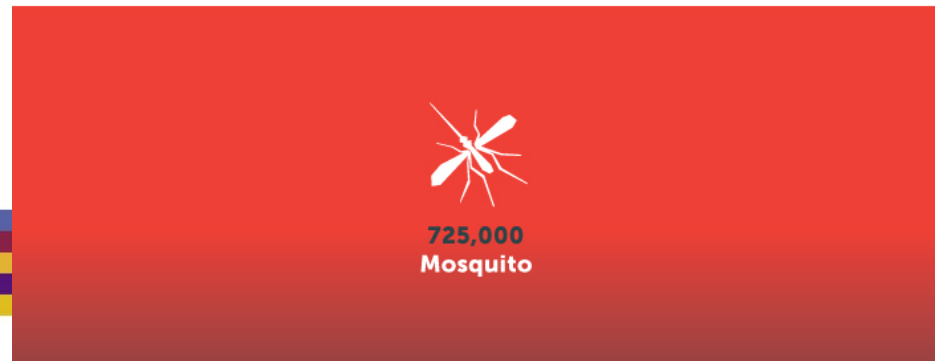
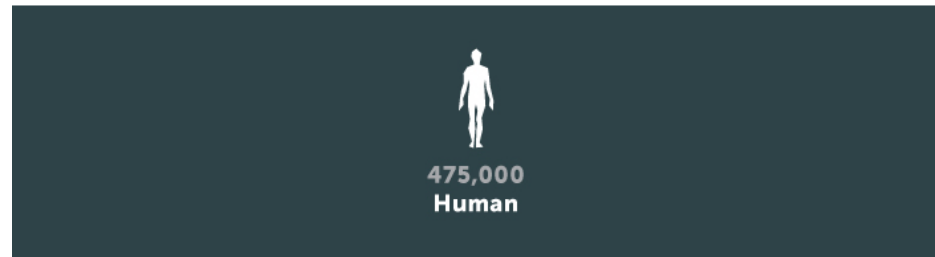
# Disability-adjusted life years (DALYs) for all major vector-borne diseases





# World's Deadliest Animals

Number of people killed by animals per year



SOURCES: WHO; crocodile-attack.info; Kasturiratne et al. (doi.org/10.1371/journal.pmed.0050218); FAO (webcitation.org/6OgpS8SV0); Linnell et al. (webcitation.org/6ORL7DBU0); Packer et al. (doi.org/10.1038/2F436927a); Alessandro De Maddalena. All calculations have wide error margins.

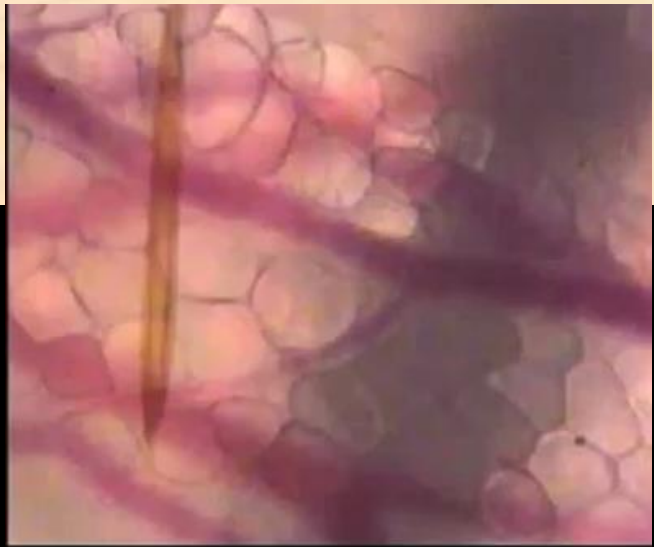


# The Yellow Fever Mosquito

## *Aedes aegypti*



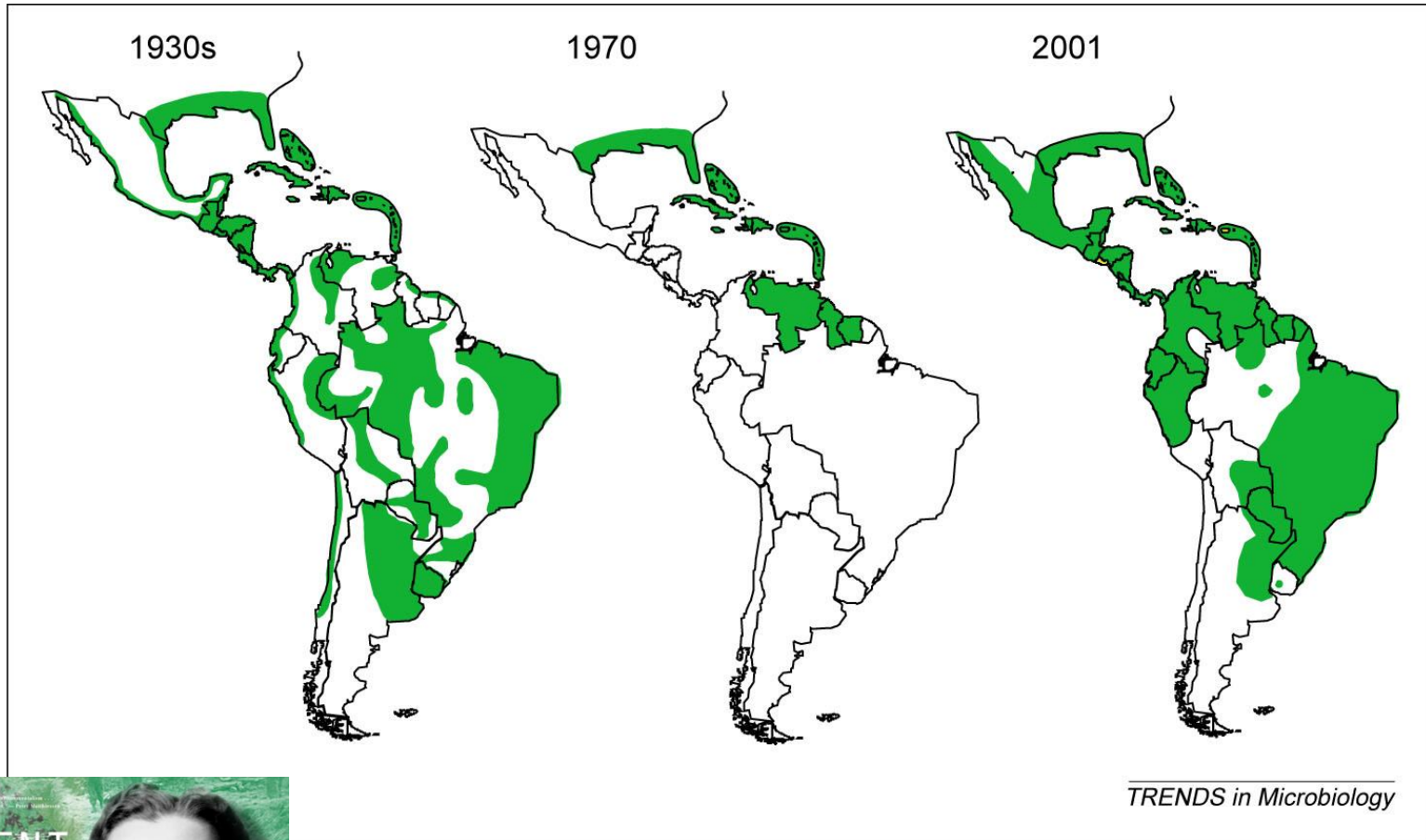
Photo by Geoffrey Attardo



<https://www.youtube.com/watch?v=tqJ54E-adGs>

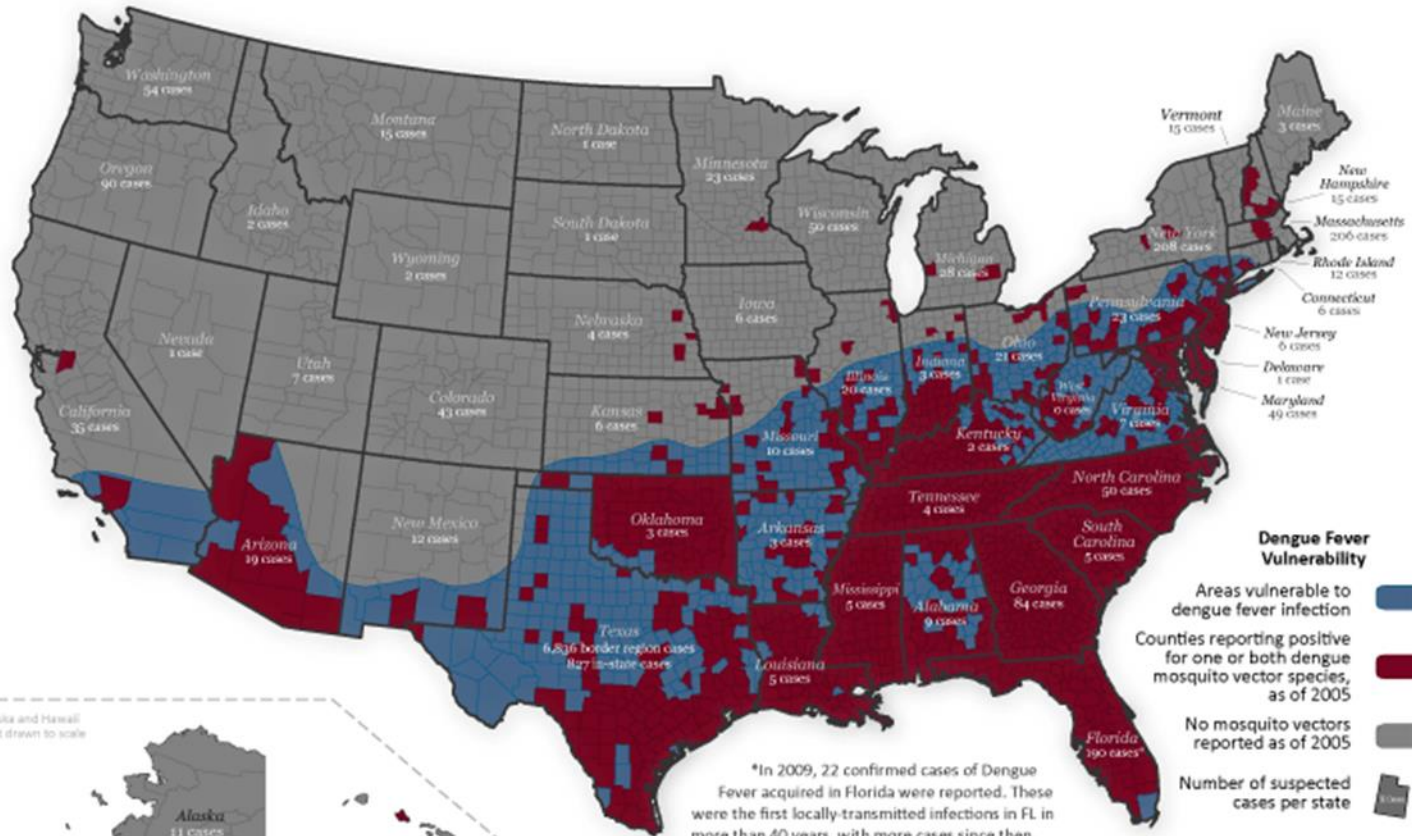
<https://www.youtube.com/watch?v=MbXSPacvuak>

# *Aedes aegypti* Recolonization





# Infectious Disease Vulnerability in the US, 1995-2005: Areas Vulnerable to Dengue Fever



\*\* Alaska and Hawaii are not drawn to scale

\*In 2009, 22 confirmed cases of Dengue Fever acquired in Florida were reported. These were the first locally-transmitted infections in FL in more than 40 years, with more cases since then.



[http://diseasemaps.usgs.gov/del\\_us\\_human.html](http://diseasemaps.usgs.gov/del_us_human.html)





# Can Las Cruces *Aedes aegypti* Mosquitoes spread Dengue virus?

Table 2. Infection of body and dissemination to the head in Las Cruces F<sub>2</sub> and Rockefeller *Aedes aegypti*.

Serotype	Isolate	Mosquito Strain	No. Fed	No. (%) Infected	P-value <sup>a</sup>	Mean Body Titer ±1SE (log <sub>10</sub> PFU/mosquito) <sup>b</sup>	No.(%) Total Dissemination from All Bodies <sup>c</sup>	No. (%) Disseminated From Infected Bodies	Mean Head Titer (log <sub>10</sub> PFU/head) <sup>d</sup>
DENV-1	Thailand 16007	Las Cruces	43	1 (2.3)	0.02	1.7 ±0.0	0 (0.0)	0 (0.0)	--
		Rockefeller	30	6 (20.0)		3.2 ±0.4	3 (10.0)	3 (50.0)	1.9 ±0.2
DENV-2	Tonga/74	Las Cruces	36	2 (5.6)	0.04	0.8 ±0.2	1 (2.8)	1 (50.0)	1.3 ±0.0
		Rockefeller	21	6 (28.6)		3.1 ±0.5	3 (14.3)	3 (50.0)	3.4 ±0.3
DENV-3	Sri Lanka 3002	Las Cruces	32	2 (6.3)	0.12	2.2 ±0.5	0 (0.0)	0 (0.0)	--
		Rockefeller	23	5 (21.7)		3.5 ±0.4	2 (8.7)	2 (40.0)	1.7 ±0.3
DENV-4	Dominica rDEN4	Las Cruces	33	3 (9.1)	0.01	1.3 ±0.3	1 (3.0)	1 (33.3)	2.8 ±0.0
		Rockefeller	26	10 (27.8)		2.9 ±0.3	4 (15.4)	4 (40.0)	2.6 ±0.3

<sup>a</sup> Results of Fisher's exact test

<sup>b</sup> From infected bodies only

<sup>c</sup> Only mosquitoes with infected bodies were screened for dissemination

<sup>d</sup> From infected heads only

"My goal is to defeat emerging viruses."

Dr. Kathryn A. Hanley  
Associate Professor of Biology



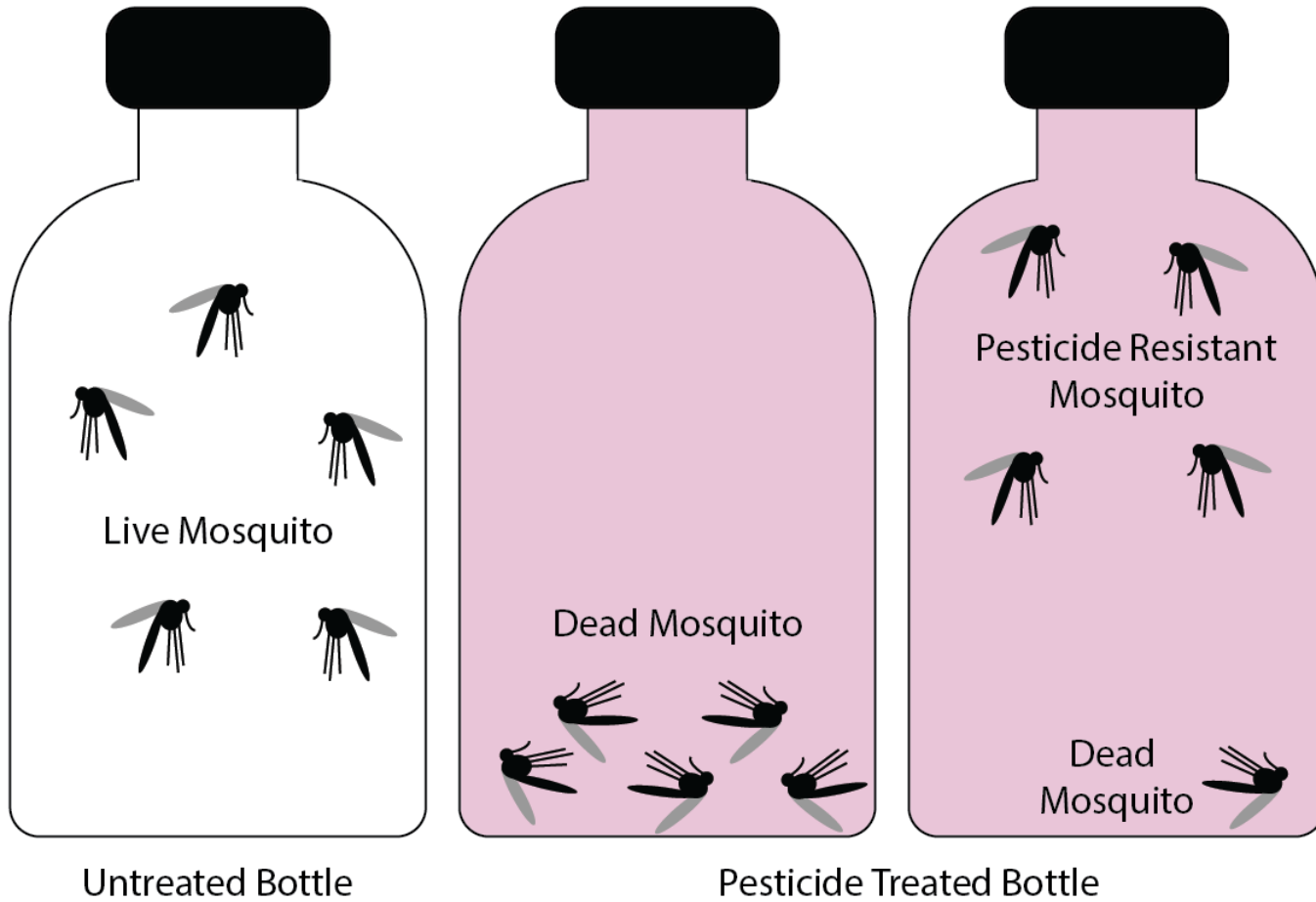
# Insecticide Resistance

The Insecticide Resistance Action Committee (IRAC) :

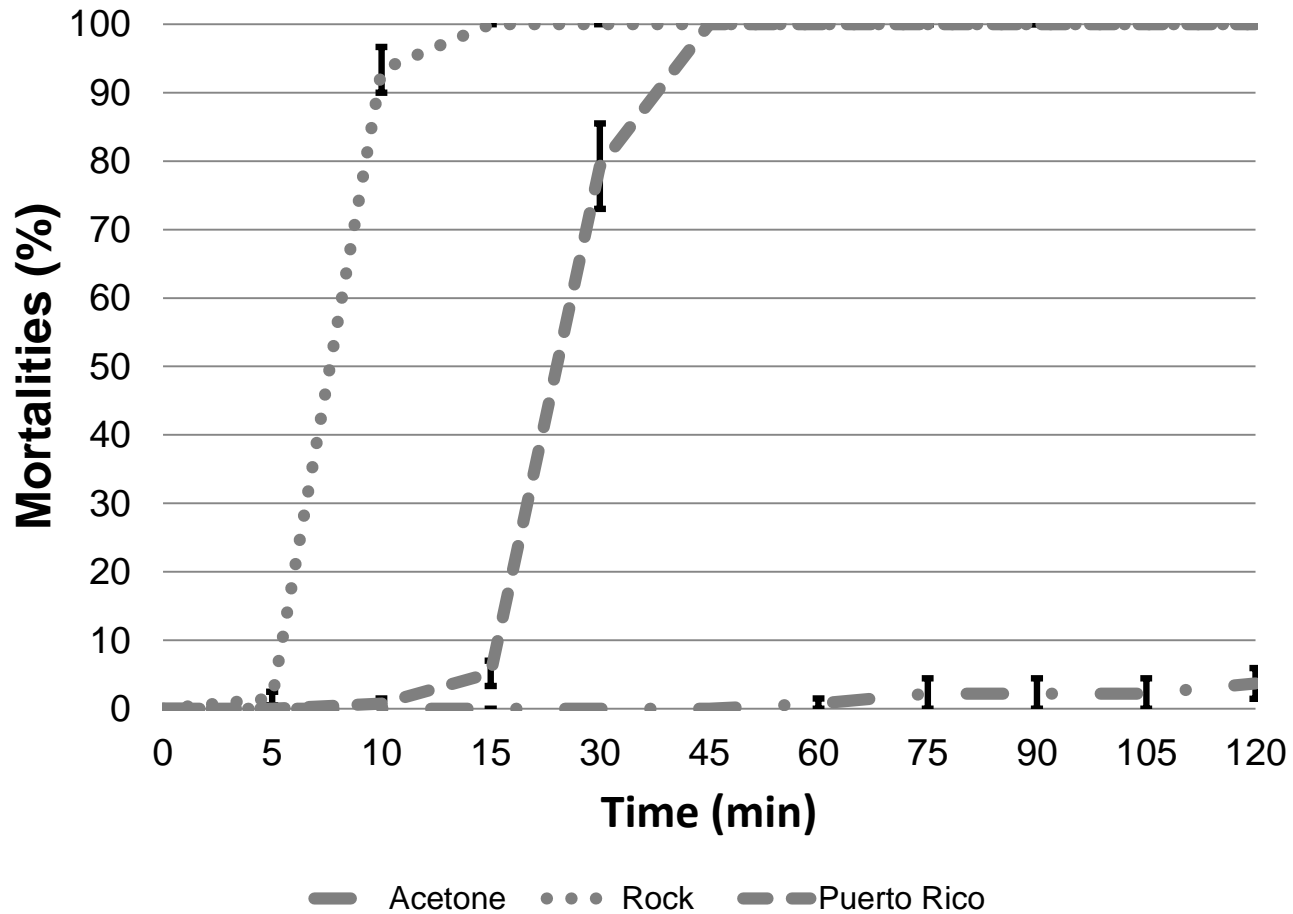
- 'insecticide resistance is 'a heritable change in the sensitivity of a pest population that is reflected in the repeated failure of a product to achieve the expected level of control when used according to the label recommendation for that pest species'.



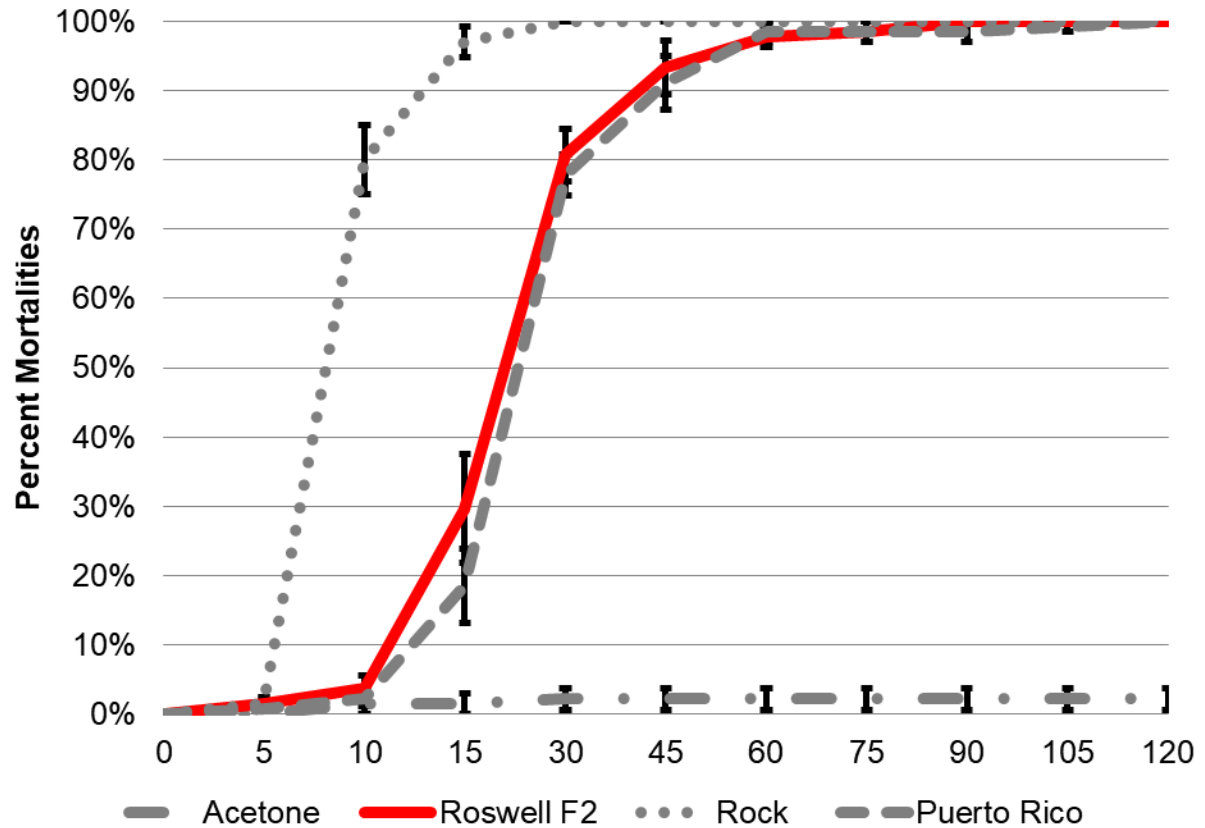
# CDC Bottle Test for Detection of Insecticide Resistance



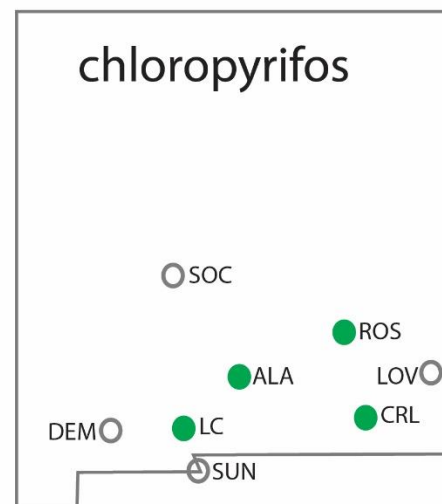
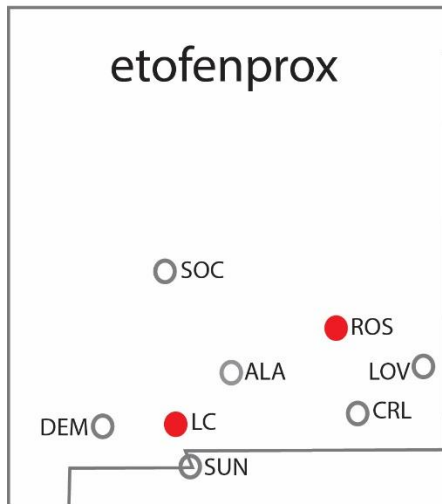
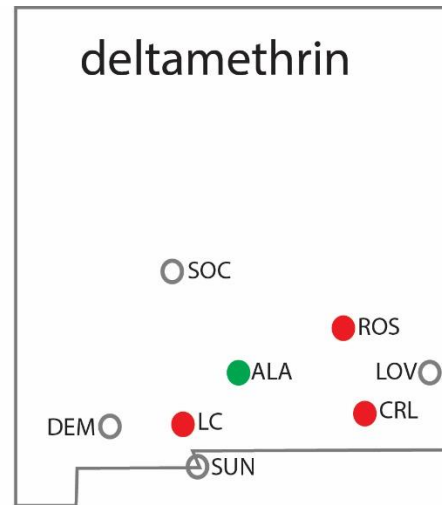
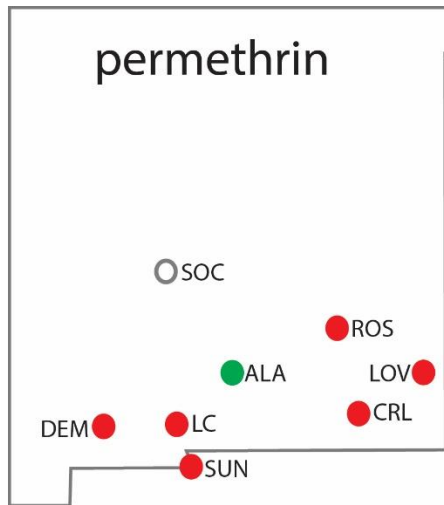
# Deltamethrin IR Bottle Test



# Deltamethrin IR Bottle Test

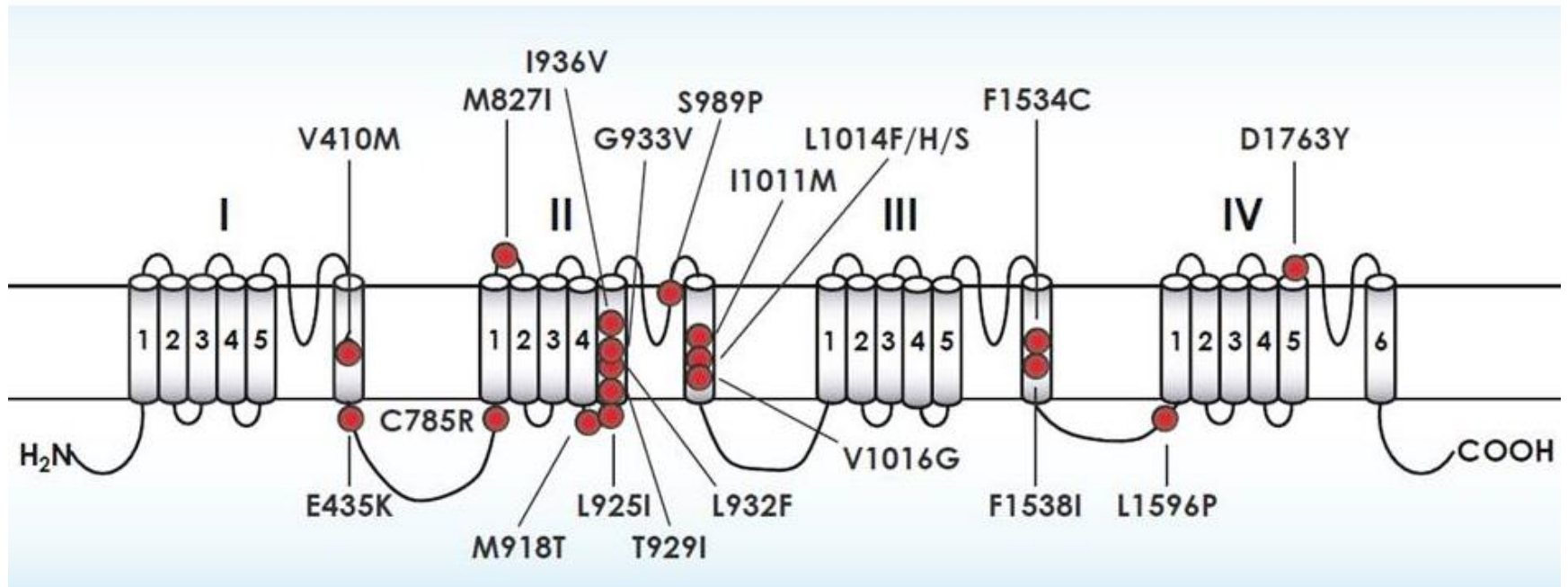


# Insecticide Resistance in *Aedes aegypti* from New Mexico.

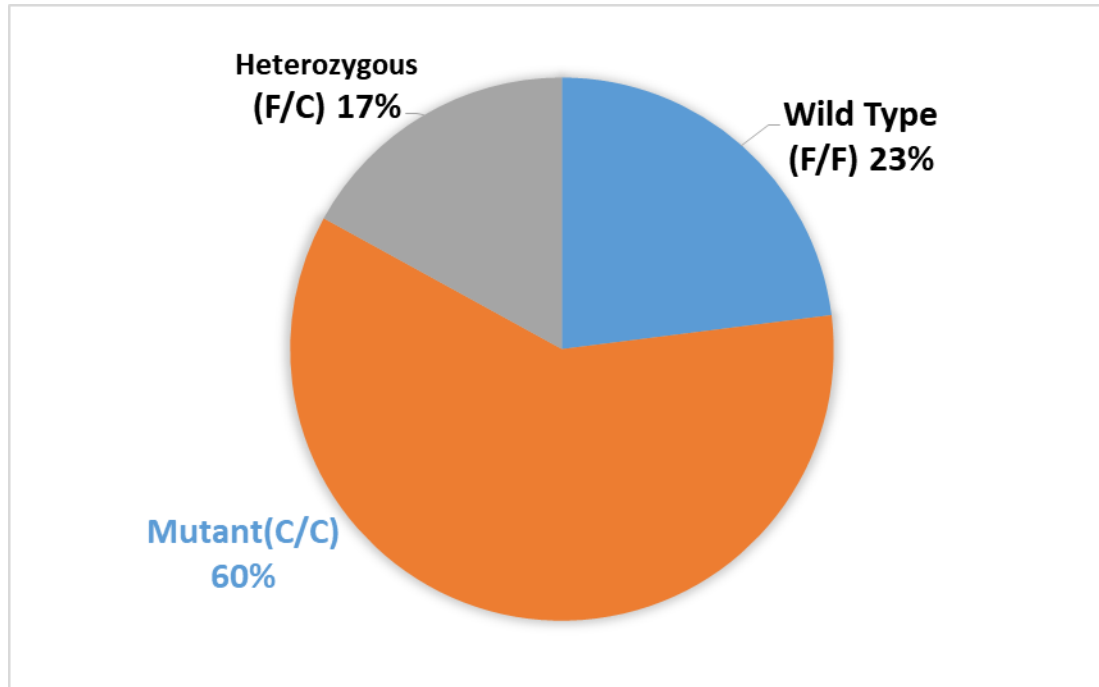


**Resistant** populations are marked with **red** dots, **sensitive** populations are marked with **green** dots. The grey circles represent lab populations that have been established but not yet been tested for resistance. ALA – Alamogordo, CRL- Carlsbad, DEM-Deming, LC- Las Cruces, LOV-Lovington, ROS- Roswell, SOC-Socorro, SUN- Sunland Park.

## kdr mutations in the sodium channel



# Kdr genotypes in NM *Aedes aegypti*



# Message for Vector Control Professionals:

In case of a Zika outbreak

- Don't use pyrethroids
- Use organophosphates

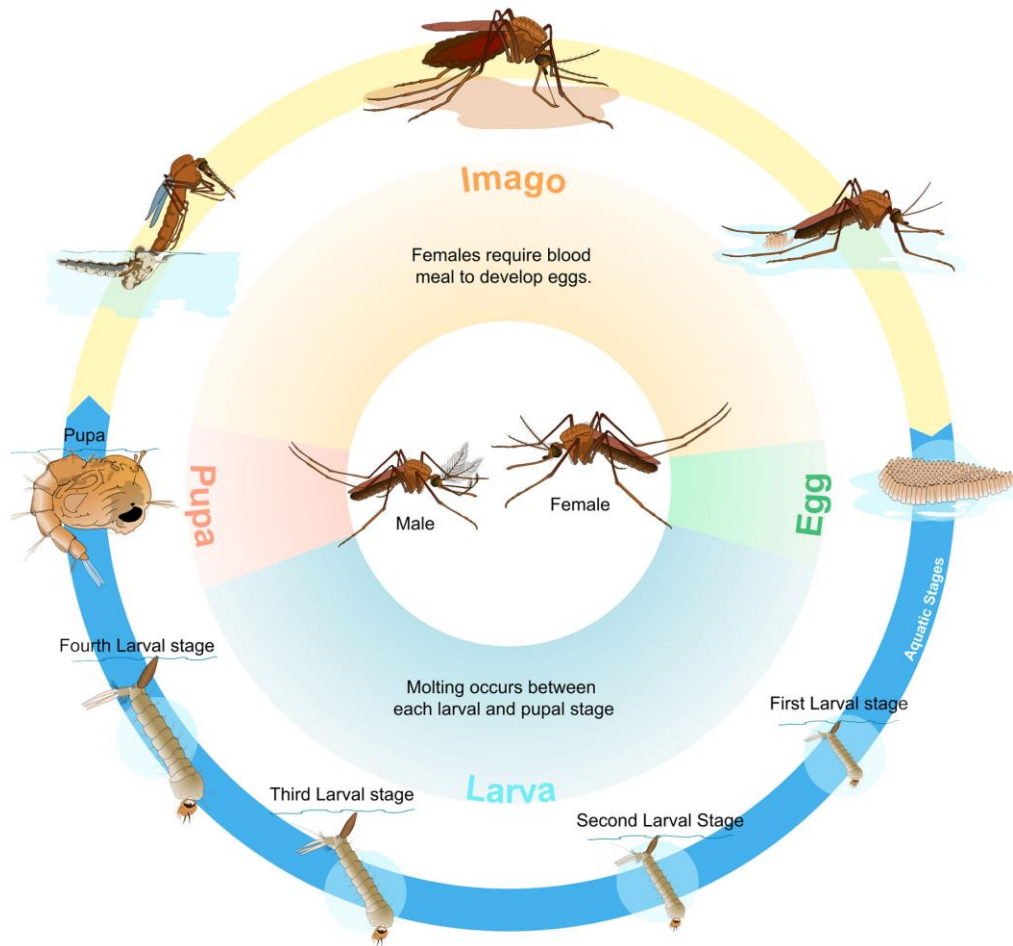
To control mosquitoes



# Why do they bite?

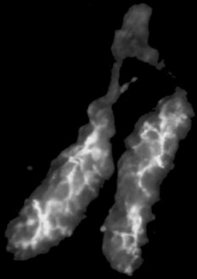






Mosquitoes take blood to obtain nutrients  
for egg development *(mosquito ovaries)*

unfed



# Host finding

- Visual cues
- Heat
- Chemical cues



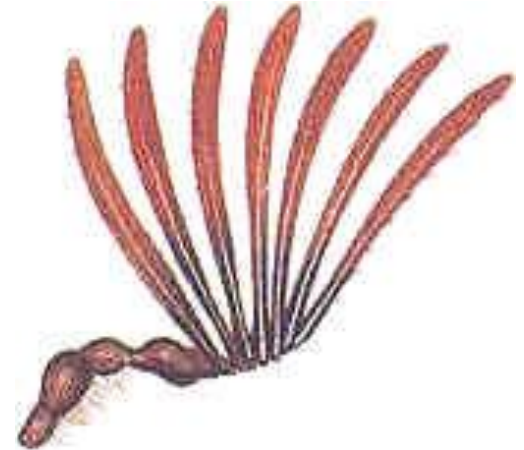
# Olfaction-driven behavior in insects

- Mating behavior
- Host-seeking behavior
  - **Blood** is not detectable from the distance – **what is?**
  - Metabolic byproducts of living things are
  - **CO<sub>2</sub> / lactic acid / butter acid**
- Host selection
  - anthropophile / zoophile



## How do insects smell?

# The insect antenna



# A typical antennal sensillum

(from Steinbrecht)

TH=Thecogen (sheath cell)

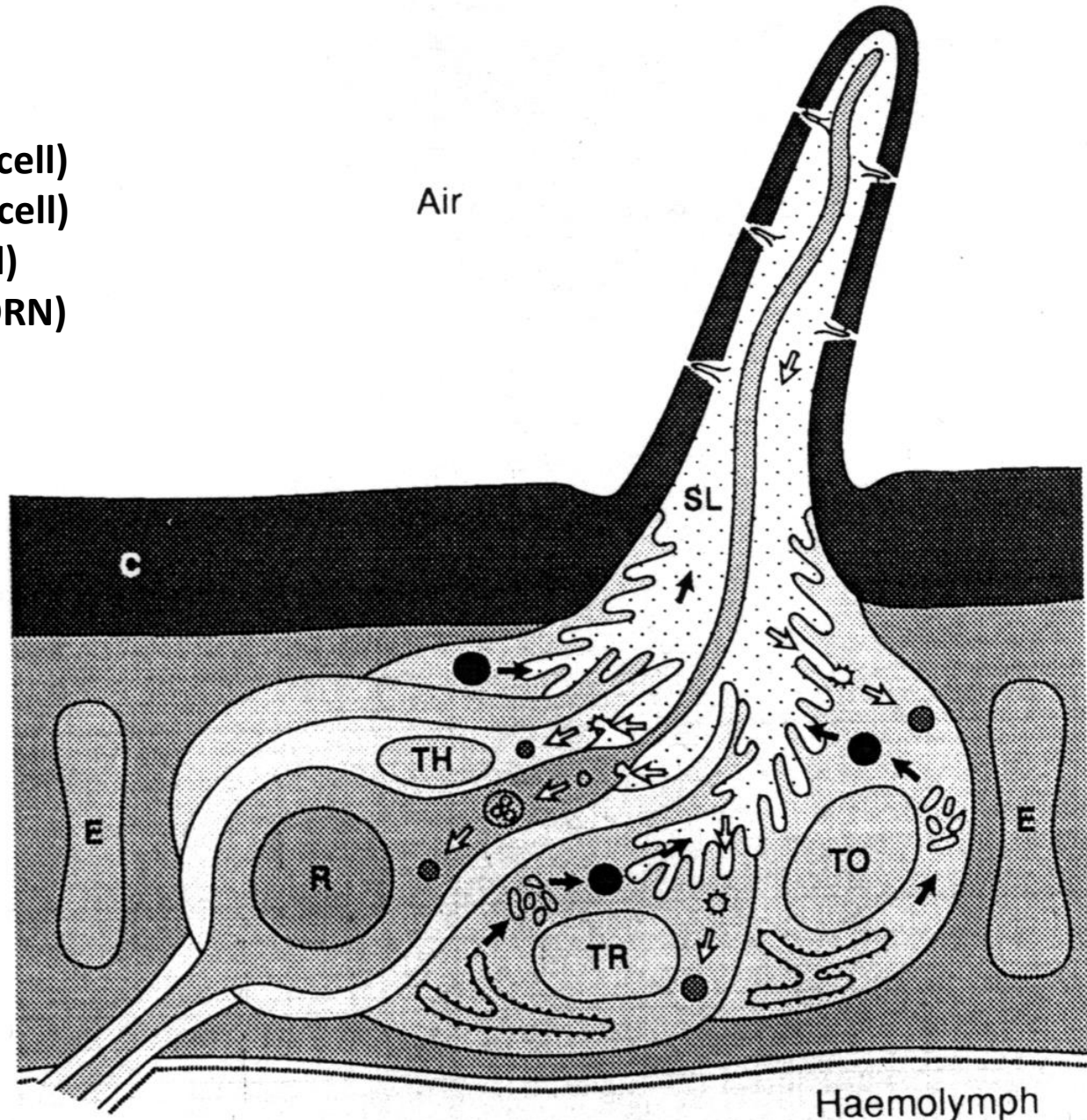
TO=Tormogen (socket cell)

TR=Trichogen (hair cell)

R=Receptor Neuron (ORN)

E=Epithelial cell

SL=Sensillar lymph



Odor molecules

AIR

cuticle

pore

Sensilla Lymph

bind

OBP

Conformation  
change

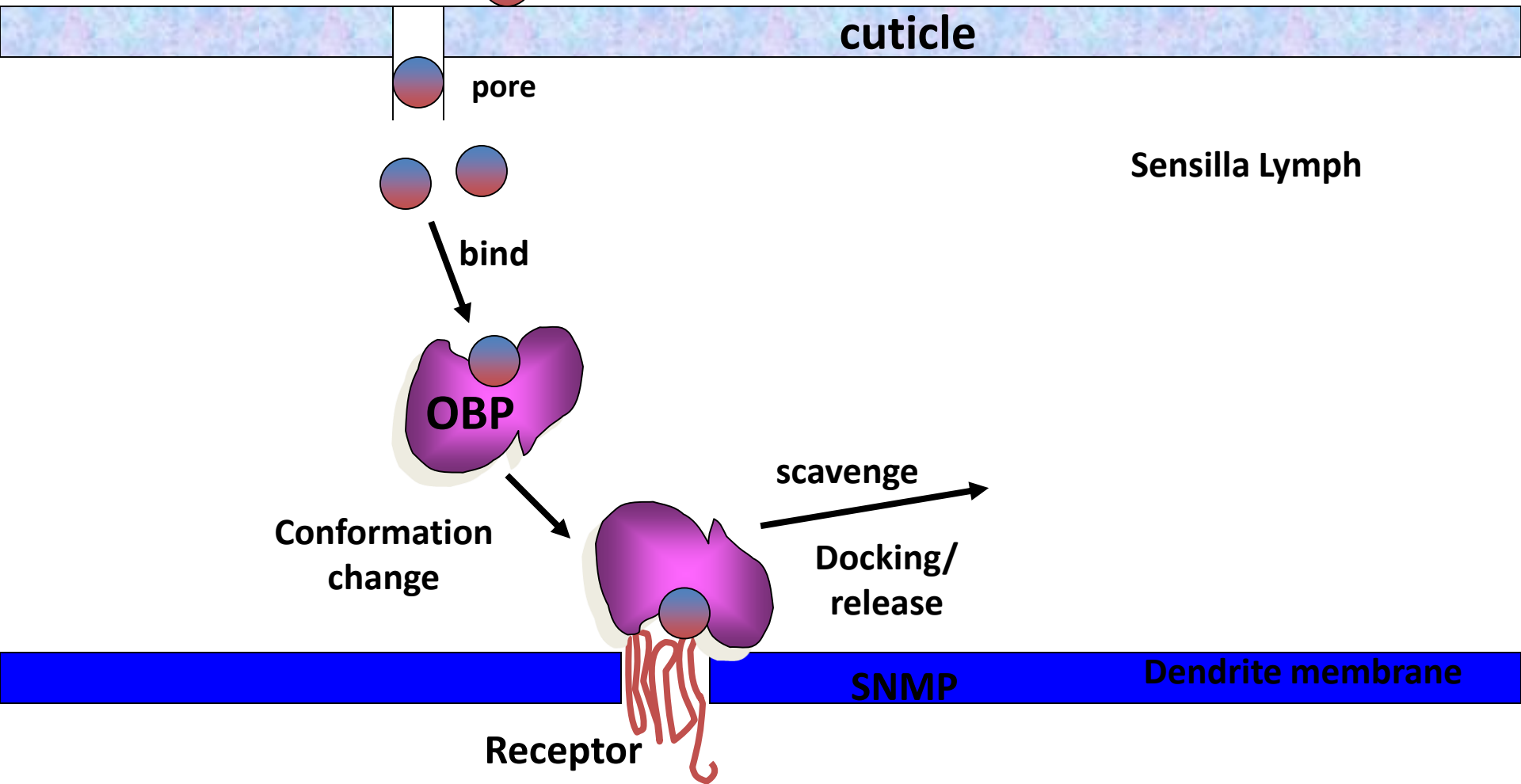
scavenge

Docking/  
release

SNMP

Dendrite membrane

Receptor



# Mosquito Repellents

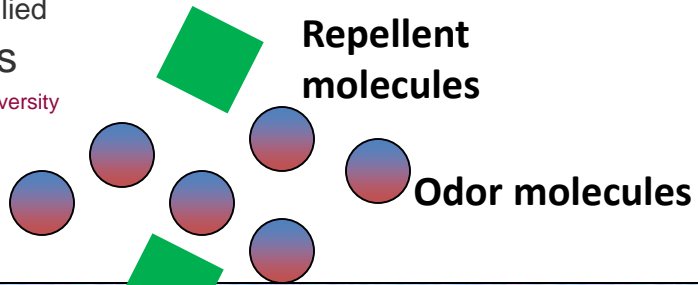
Definition:

a substance that deters mosquitoes from approaching or settling.



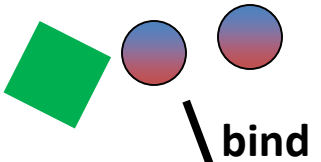
The use of repellents to alter mosquito host seeking behavior is an effective method for the prevention of mosquito-borne diseases.



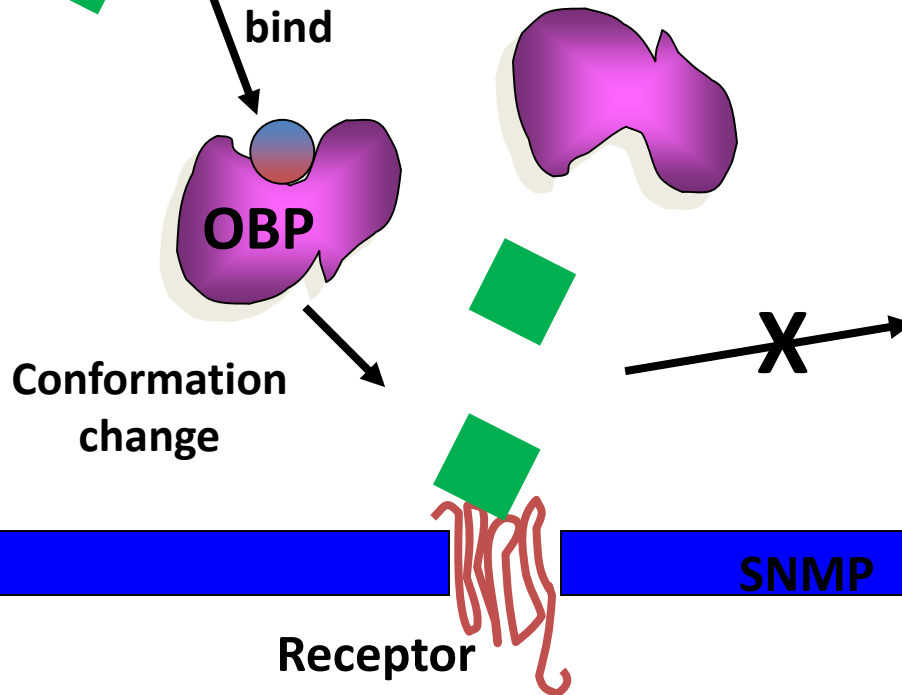


cuticle

AIR



Sensilla Lymph



1-24 of 20,453 results for "insect repellent"

Sort by Relevance ▾

Show results for

Outdoor Recreation >

- Camping Insect Repellent
- Camping Lanterns
- Camping Personal Care Products
- Camping Safety & Survival Equipment
- Camping First Aid Kits

Health & Household >

- Insect & Pest Repellent
- Baby & Child Care Products
- Vitamins & Dietary Supplements
- Vinyl Gloves

Patio, Lawn & Garden >

- Pest Repellents
- Outdoor Power & Lawn Equipment
- Pest Control Sprayers
- Beneficial Pest Control Insects
- Picnic Baskets, Tables & Accessories

Tools & Home Improvement >

- Power Tools & Hand Tools
- Emergency Survival Kits
- Personal Protective Equipment & Safety Gear

Baby Products >

- Baby Grooming & Health Kits

+ See All 33 Departments

Refine by

Amazon Prime



Pantry



SPONSORED BY INNOVA LLC

### Get Rid Of Pests With Our Zero Chemicals Repeller

> [Shop now](#)



5 in 1 FULLY FEATUR...

Ad feedback



Sponsored

### Sawyer Products Premium Permethrin Clothing Insect Repellent

by Sawyer Products

\$14.99

Some options are Prime eligible

★★★★★ ▾ 2,490



Sponsored

### Sawyer Products Premium Insect Repellent with 20% Picaridin

by Sawyer

\$7.50 [Subscribe & Save](#)

Save more with monthly [Subscribe & Save](#) deliveries.

\$7.50 ~~\$9.99~~ (4-5 days)

Some options are Prime eligible

★★★★★ ▾ 1,934



### Repel 100 Insect Repellent, 4 oz. Pump Spray, Single Bottle

by Repel

\$9.99 (35 new offers)

★★★★★ ▾ 1,705

Product Features

Formulated for severe *insect* conditions

1-24 of over 10,000 results for "mosquito repellent"

Sort by Relevance

Show results for

Patio, Lawn & Garden

- Pest Repellents
- Pest Control Products
- Bug Zappers
- Outdoor Power & Lawn Equipment
- Pest Control Sprayers
- Pest Control Traps

Health & Household

- Insect & Pest Repellent
- Baby & Child Care Products

Outdoor Recreation

- Camping Insect Repellent
- Camping Personal Care Products
- Camping Lanterns
- Camping Safety & Survival Equipment

Tools & Home Improvement

- Outdoor Lighting Products

Home & Kitchen

- Candles
- Seasonal Décor

Beauty & Personal Care

- Aromatherapy Products
- Aromatherapy Oils

Cell Phones & Accessories

- Cell Phone Stands

See All 20 Departments

Refine by

Subscribe & Save

Subscribe & Save Eligible

Amazon Prime

prime



SPONSORED BY MOSQUITO MAGNET

**Mosquitoes Are Here - Defend Your Property**

Shop now >



Mosquito Magnet MM3300B Executive Mosquito Trap

★★★★☆ 4

prime



Mosquito Magnet MM4200B Patriot Plus Mosquito Trap

★★★★☆ 19

Ad feedback



Sponsored ⓘ

**Arkra [2018 UPGRADED] Ultrasonic Pest Repellent - Electronic Pest Repeller Plug In Effective Indoor & Outdoor Insects Control Home Pest Free, for...**

\$29.99 prime

★★★★★ 36



Sponsored ⓘ

**[NEW 2018] Effective Ultrasonic Mosquito Repellent (2-Pack) - Odorless Non-Toxic Portable Pest Control Repeller Anti Insects, Bugs, Roaches w/Dragonfly Mode - For Indo...**

\$27.95 prime

★★★★★ 210

Buy It Again



Spectracide Terminate Termite Detection...

\$16.17 Subscribe & Save

prime



Best Seller



**Subscribe & Save**

Subscribe & Save Eligible

**Amazon Prime**

prime

**Prime Wardrobe**

prime wardrobe

Try on items for FREE at home for 7 days.

**Pest Type**

- Insect
- Rodent
- Spider
- Rabbit

**Brand**

- Repel
- Sawyer Products
- TheraCell
- Cutter
- Summit...responsible solutions
- Hoont
- Mosquito Repeller
- Mosquito Repellent
- Kinven
- OFF!
- Neatmaster
- STURME
- Amuoc
- Cliganic
- I-pure items

**Health & Personal Care Format**

- Patches
- Sprays
- Liquids
- Wipes
- Roll-Ons
- See more

**Avg. Customer Review**

- ★★★★★ & Up
- ★★★★☆ & Up
- ★★★☆☆ & Up
- ★★☆☆☆ & Up

**International Shipping**



Sponsored ⓘ  
**Ultrasonic Electromagnetic Pest Repellent**  
 Electronic Control Smart bug Repeller Plug in  
 Home Indoor and Outdoor Warehouse Get Rid of...

\$26<sup>99</sup> ~~\$50.99~~ ✓prime  
 ★★★★★☆ ▾ 240

**Best Seller**



Sponsored ⓘ  
**12 Pack Mosquito Repellent Bracelet Band -**  
 [320Hrs] of Premium Pest Control Insect Bug  
 Repeller - Natural Indoor/Outdoor Insects -  
 Best Products with NO Spray for Men,...

\$13<sup>99</sup> ✓prime  
 ★★★★★☆ ▾ 377

**Amazon's Choice**



**Repel Lemon Eucalyptus Natural Insect**  
 Repellent Pump, 1 unit, 4-oz

\$4<sup>99</sup> ~~\$6.99~~ ✓prime  
 ★★★★★☆ ▾ 4,172

**Best Seller**



**12 Pack Mosquito Repellent Bracelet Band -**  
 [320Hrs] of Premium Pest Control Insect Bug  
 Repeller - Natural Indoor/Outdoor Insects -  
 Best Products with NO Spray for Men,...

\$13<sup>99</sup> ✓prime  
 ★★★★★☆ ▾ 377

**Best Seller**



# How efficient are the different products?

## AG Schneiderman Warns Against Deceptive Mosquito Repellant Ads Amid Zika Concerns

By PATRICK GARRETT • AUG 3, 2016

PROGRAM  
Morning Edition

 Tweet

 Share

 Google+

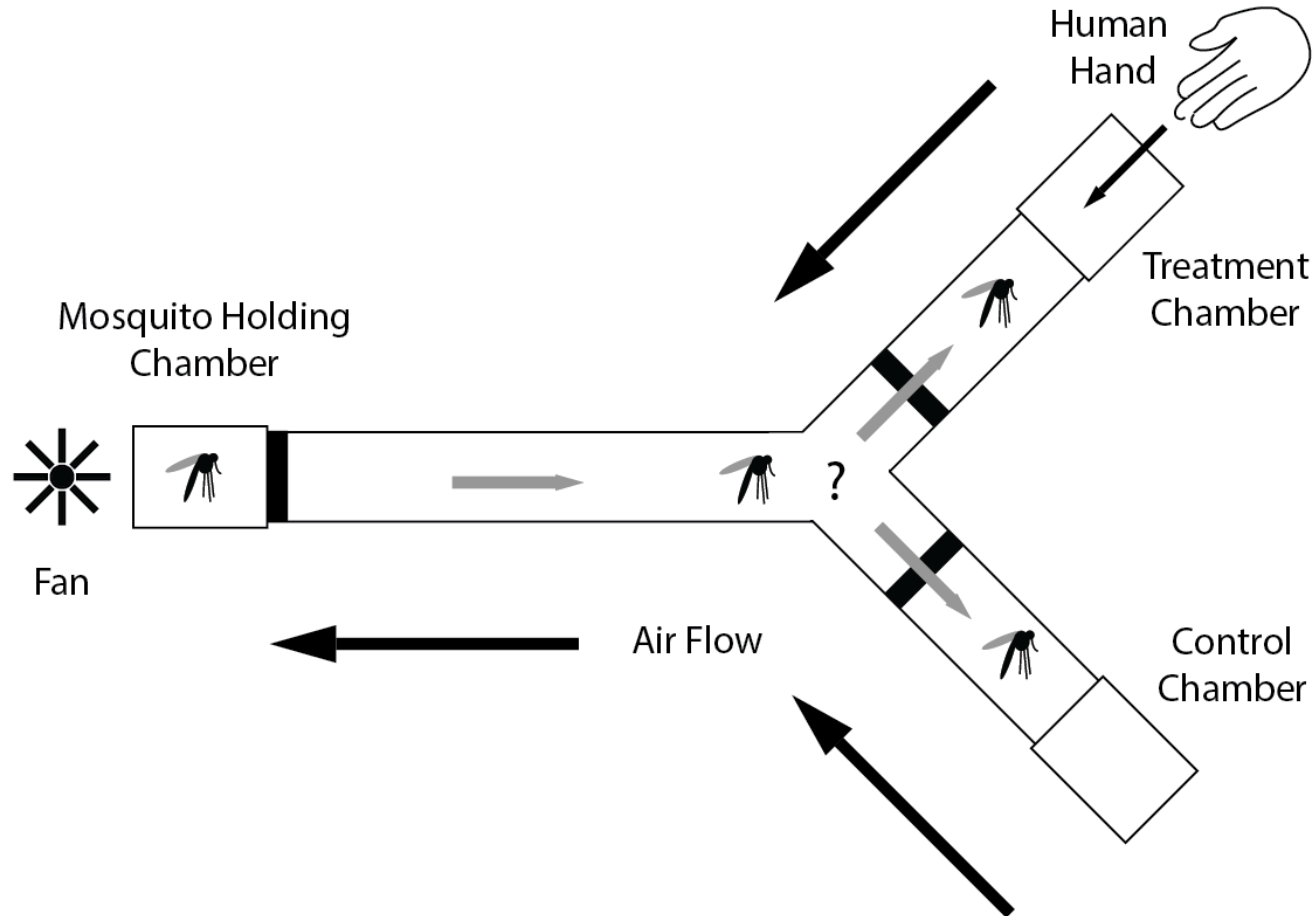
 Email

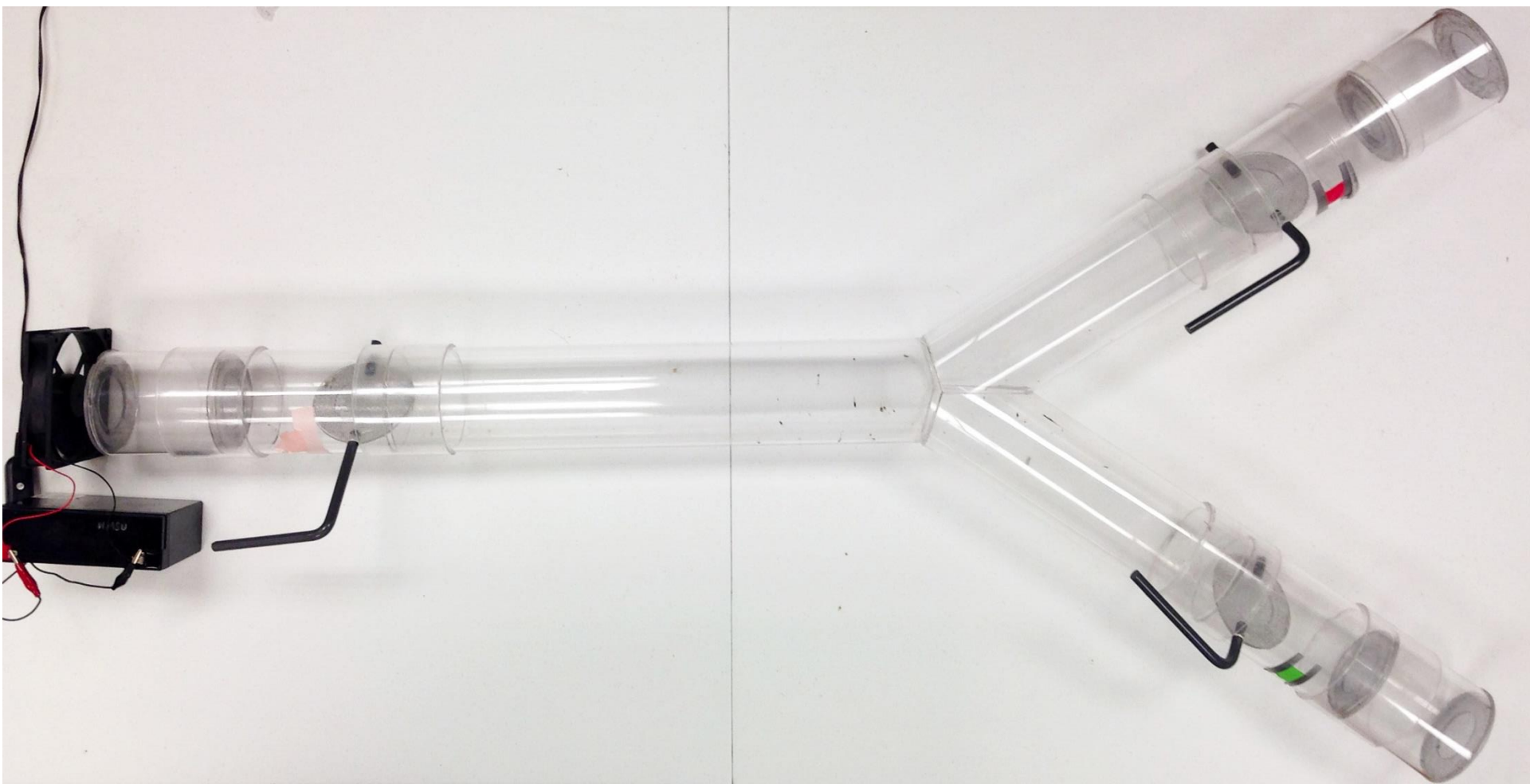


*New York State Attorney General Eric Schneiderman*

New York's attorney general is targeting companies advertising ineffective insect repellents to cash in on concerns over the Zika virus.

# The Efficacy of Some Commercially Available Insect Repellents for *Aedes aegypti* (Diptera: Culicidae) and *Aedes albopictus* (Diptera: Culicidae)





**Table 1. Active ingredients, manufacturers, and estimated protection time of the repellents, fragrances, and patch**

Product name	Product type	Active ingredient(s)	Manufacturer/distributor	Estimated protection time <sup>a</sup>
<b>Repel 100 insect repellent</b>	Repellent spray	DEET (98.11%)	WPC Brands, Inc.	10 h
<b>OFF deep woods insect repellent VIII</b>	Repellent spray	DEET (25%)	S.C. Johnson & Son, Inc.	Not provided
<b>Cutter skinsations insect repellent</b>	Repellent spray	DEET (7.0%)	Spectrum Division of United Industries Corporation	Not provided
<b>Cutter natural insect repellent</b>	Repellent spray	Geraniol (5%) Soybean oil (2%)	Spectrum Division of United Industries Corporation	2 h
<b>EcoSmart organic insect repellent</b>	Repellent spray	Geraniol (1.0%) Rosemary oil (0.5%) Cinnamon oil (0.5%) Lemongrass oil (0.5%)	EcoSMART Technologies Inc.	2 h
<b>Cutter lemon eucalyptus insect repellent</b>	Repellent spray	Oil of lemon eucalyptus (30%) This oil contains 65% p-menthane-3-8-diol	Spectrum Division of United Industries Corporation	6 h
<b>Avon Skin So Soft Bug Guard</b>	Repellent spray	Oil of citronella (10%)	Avon Products, Inc.	2 h
<b>Avon Skin So Soft Bath Oil</b>	Fragrance	Unknown	Avon Products, Inc.	Not Recommended
<b>Victoria Secret Bombshell</b>	Fragrance	Unknown	Victoria Secret	Not Recommended
<b>Mosquito skin patch</b>	Patch	Thiamin B1 (300 mg)	AgraCo Technologies International, LLC	36 h

<sup>a</sup> Manufacturer provided estimated protection time.



**Table 2. Average percentage of *Ae. aegypti* mosquitoes trapped in the port with the hand**

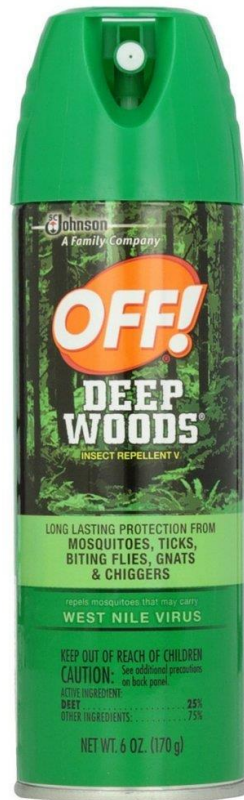
Treatments ( <i>N</i> = 5)	Initial ( $\pm$ SE)	30 min ( $\pm$ SE)	120 min ( $\pm$ SE)	240 min ( $\pm$ SE)
<b>Control</b>	61 ( $\pm$ 4.30)	61 ( $\pm$ 4.00)	58 ( $\pm$ 2.00)	68 ( $\pm$ 3.39)
<b>Repel 100 insect repellent</b>	10** ( $\pm$ 1.58)	18** ( $\pm$ 3.39)	15** ( $\pm$ 5.24)	14** ( $\pm$ 4.85)
<b>OFF deep woods insect repellent VIII</b>	6** ( $\pm$ 1.87)	17** ( $\pm$ 1.22)	14** ( $\pm$ 1.00)	29** ( $\pm$ 3.32)
<b>Cutter skinsations insect repellent</b>	11** ( $\pm$ 3.67)	22** ( $\pm$ 5.15)	17** ( $\pm$ 2.55)	30** ( $\pm$ 5.24)
<b>Cutter natural insect repellent</b>	57 ( $\pm$ 3.39)	47 ( $\pm$ 4.06)	64 ( $\pm$ 1.87)	65 ( $\pm$ 6.12)
<b>EcoSmart organic insect repellent</b>	9** ( $\pm$ 1.87)	55 ( $\pm$ 3.16)	68 ( $\pm$ 2.00)	67 ( $\pm$ 3.39)
<b>Cutter lemon eucalyptus insect repellent</b>	9** ( $\pm$ 2.45)	8** ( $\pm$ 3.00)	13** ( $\pm$ 4.64)	18** ( $\pm$ 3.74)
<b>Avon Skin So Soft Bug Guard</b>	48 ( $\pm$ 4.06)	42* ( $\pm$ 2.55)	52 ( $\pm$ 2.55)	67 ( $\pm$ 5.15)
<b>Avon Skin So Soft Bath Oil</b>	31** ( $\pm$ 1.00)	35** ( $\pm$ 5.70)	43* ( $\pm$ 6.04)	53 ( $\pm$ 8.00)
<b>Victoria Secret Bombshell</b>	17** ( $\pm$ 5.39)	15** ( $\pm$ 5.24)	18** ( $\pm$ 3.00)	47 ( $\pm$ 5.39)
<b>Mosquito skin patch</b>	68 ( $\pm$ 5.10)	67 ( $\pm$ 5.61)	48 ( $\pm$ 4.90)	68 ( $\pm$ 5.15)

*N*, number of replicates.

\*Significantly different than the control,  $P < 0.05$ .

\*\*Significantly different than the control,  $P < 0.01$ .

# Stuff that works



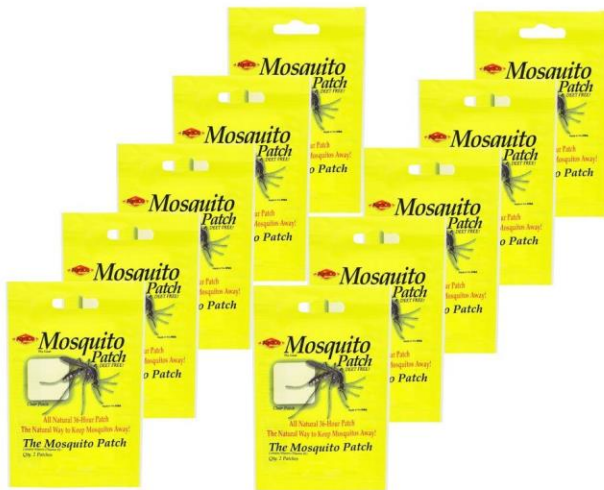
This one works too...



© Victoria's Secret

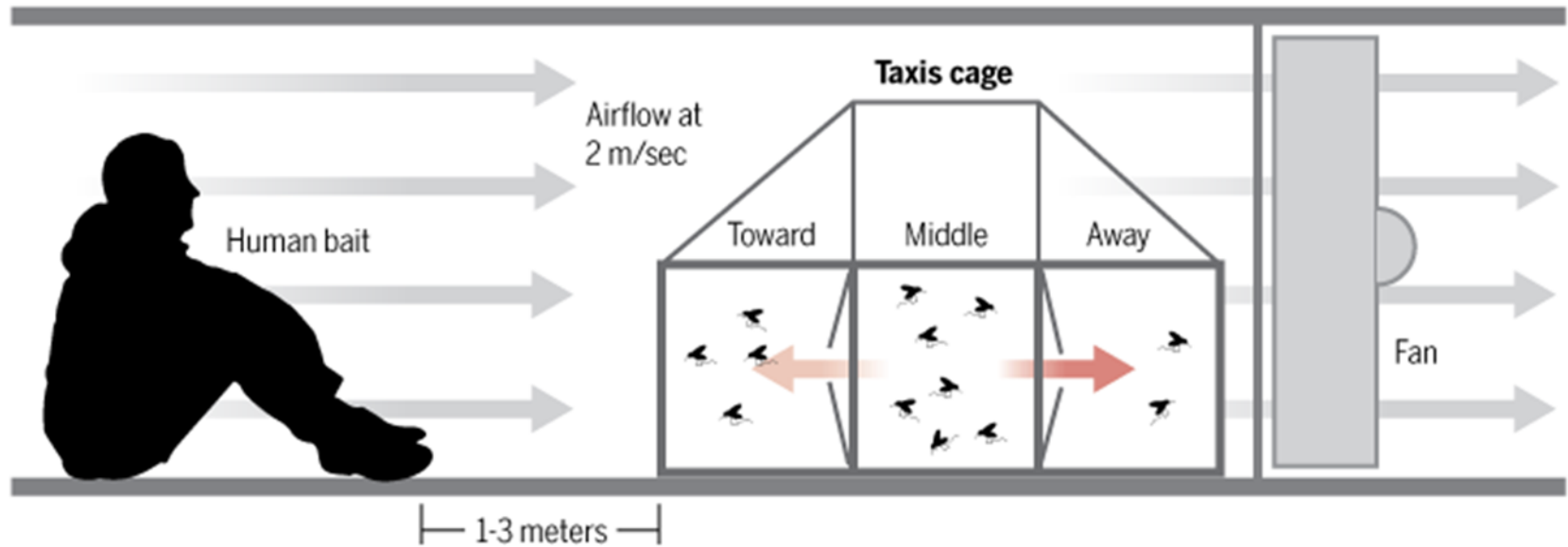
# Stuff that does not work

- Vitamin B patches
- Geraniol and citronella based sprays



# Efficacy of Some Wearable Devices Compared with Spray-On Insect Repellents for the Yellow Fever Mosquito, *Aedes aegypti* (L.) (Diptera: Culicidae)

Wind tunnel





**Table 1.** Product Name, product type, active ingredients, manufacturer/distributor/seller, and estimated time of protection

Product name	Product type	Active ingredient(s)	Manufacturer/ distributor/sold by	Estimated protection time <sup>a</sup>
OFF! Clip-on	Wearable Device (fogger)	Metofluthrin (31.2%)	Sold by S.C. Johnson & Son, Inc., Racine, WI, USA	12 h
Personal Sonic Mosquito Repeller	Wearable Device (speaker)	N/A	PIC Corporation, Linden, NJ, USA	50 h
Mosquitavert	Wearable Device (bracelet)	Geraniol	Body Harmonic, LLC., Portland, OR, USA	N/A
Mosquito-NO!	Wearable Device (bracelet)	Geraniol Oil (30%) (extract from citronella, lavender and peppermint)	Mosquito-NO!	10 d
Invisaband	Wearable Device (bracelet)	Geraniol Oil (30%)	Invisaband	120 h
Cutter Lemon Eucalyptus	Spray-On	Oil of lemon eucalyptus (30%) ~ 65% PMD	Spectrum, Division of United Industries Corporation, St. Louis, MO, USA	6 h
Kids Herbal Armor	Spray-On	Oil of Soybean (11.5%) Oil of Citronella (10%) Oil of Peppermint (2.0%) Oil of Ceder (1.5%) Oil of Lemongrass (1.0%) Oil of Geranium (.05%)	Tender Corporation, Littleton, NH, USA	10 h
Avon Skin-So-Soft Bug Guard Plus Picaridin	Spray-On	Picaridin (10%)	Avon Products, Inc. Distr. New York, NY, USA	6 h
Repel Sportsmen Max Formula	Spray-On	DEET (40%)	WPC Brands Inc.	N/A
Ben's Tick & Insect Repellent	Spray-On	DEET (98%)	Tender Corporation, Littleton, NH USA	10 h
Cutter Citro Guard	Area repellent (candle)	Oil of Citronella (3%)	Spectrum, Division of United Industries Corporation, St Louis, MO, USA	40 h

<sup>a</sup> Based on reapplication suggestions and/or estimated protection times provided on the label of the product.

**Table 2.** Average attraction rates of *Ae. aegypti* mosquitoes in the taxis cage at 1 m

Treatments (N = 4)	Average attraction rate ( $\pm$ SE)
Positive control	88.82% ( $\pm$ 1.36%)
Negative control	17.43% ( $\pm$ 1.14%) ***
OFF! Clip-on	27.14% ( $\pm$ 6.04%) ***
Mosquito-NO!	84.00% ( $\pm$ 1.52%) ns
Invisaband	87.54% ( $\pm$ 2.24%) ns
Personal Sonic Mosquito Repeller	91.17% ( $\pm$ 2.97%) ns
Mosquitavert	91.31% ( $\pm$ 2.56%) ns
Cutter Lemon Eucalyptus	29.62% ( $\pm$ 6.31%)***
Ben's Tick & Insect Repellent	33.70% ( $\pm$ 4.06%)***
Kids Herbal Armor	59.66% ( $\pm$ 4.89%)***
Repel Sportsmen Max Formula	68.55% ( $\pm$ 6.42%)***
Avon Skin-So-Soft Bug Guard Plus Picaridin	78.65% ( $\pm$ 6.00%)**
Cutter Citro Guard	90.95% ( $\pm$ 1.96%) ns

P values:  $P < 0.05^*$ ;  $P < 0.01^{**}$ ;  $P < 0.001^{***}$ ; not significant (ns); N, number of replicates.



# Stuff that works



# *Stuff that does not work*



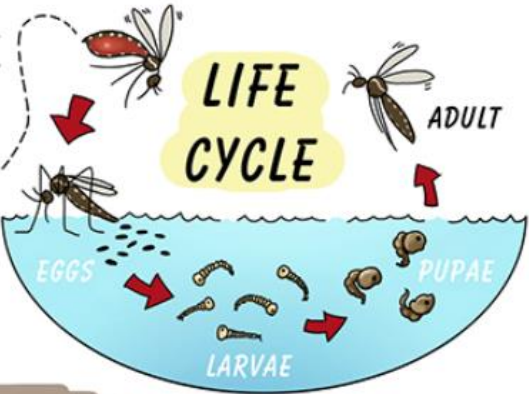
# Mosquito Tips

**STOP THOSE SUCKERS!**

AGGIES VS. MOSQUITOES

COMIC BROUGHT TO YOU BY: THE HANSEN LAB

ILLUSTRATIONS BY: JULIA VULCAN



**MOSQUITOES CAN TRANSMIT SEVERAL DISEASES...**

ZIKA	DENGUE	WEST NILE
CHIKUNGUNYA	ENCEPHALITIS	

**MOSQUITOES LAY THEIR EGGS IN STANDING WATER AROUND THE HOME...**



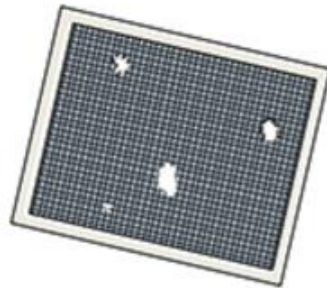
# PROTECTION AGAINST MOSQUITOES



**MOSQUITOFISH**  
THEY EAT MOSQUITO LARVAE! PLACE  
IN BACKYARD PONDS!



**DEET SPRAY**  
SPRAY ON MOSQUITO  
REPELLENT



**CHECK WINDOW  
SCREENS FOR HOLES!**



**PICARIDIN**  
INSECT REPELLENT



**BTI**  
(MOSQUITO DUNKS)  
INSECTICIDAL BACTERIA  
FOR BACKYARD PONDS



**OFF CLIP-ON**  
MOSQUITO REPELLENT/KILLER



**LEMON EUCALYPTUS**  
INSECT REPELLENT

**PYRETHROID**  
HOUSEHOLD  
INSECTICIDES





# STERILE INSECT TECHNIQUE (SIT)

A method of biological mosquito control



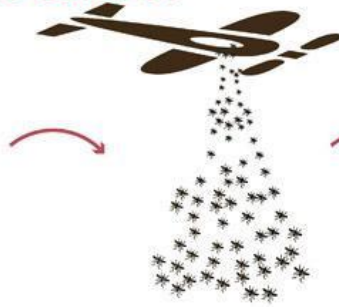
Joint FAO/IAEA Programme  
Nuclear Techniques in Food and Agriculture



Mass-rearing of mosquitoes takes place in special facilities.



Male and female mosquitoes are separated. Ionizing radiation is used to sterilize the male mosquitoes.



The sterile male mosquitoes are released over towns or cities...



...where they compete with wild males to mate with females.



These females lay eggs that are infertile and bear no offspring, reducing the mosquito population and disease transmission.



Rodriguez et al. *Parasites & Vectors* 2013, **6**:211  
<http://www.parasitesandvectors.com/content/6/1/211>



## RESEARCH

## Open Access

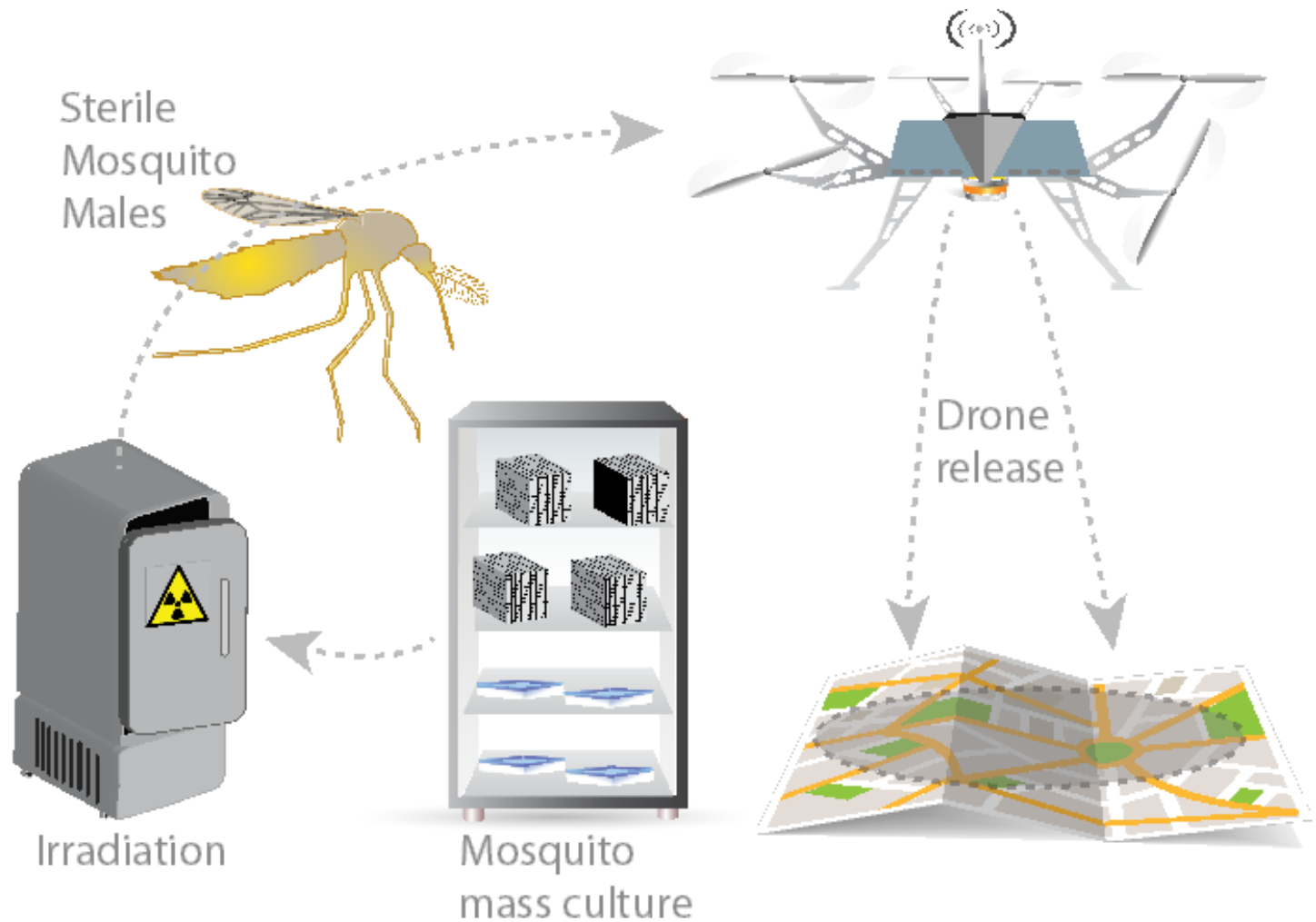
# The effect of the radio-protective agents ethanol, trimethylglycine, and beer on survival of X-ray-sterilized male *Aedes aegypti*

Stacy D Rodriguez<sup>1</sup>, Ramaninder K Brar<sup>2</sup>, Lisa L Drake<sup>1</sup>, Hannah E Drumm<sup>1</sup>, David P Price<sup>3</sup>, John I Hammond<sup>5</sup>, Jacob Urquidi<sup>2</sup> and Immo A Hansen<sup>1,3,4\*</sup>

### Abstract

**Background:** Sterile Insect Technique (SIT) has been successfully implemented to control, and in some cases, eradicate, *dipteran* insect populations. SIT has great potential as a mosquito control method. Different sterilization

# Implementing Mosquito SIT

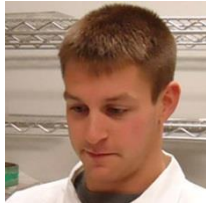
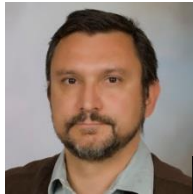
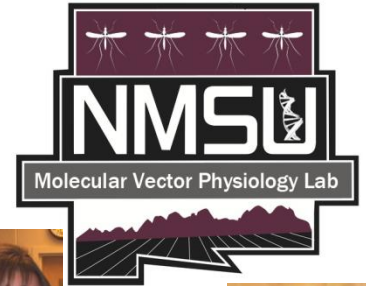


# SkitoSnack

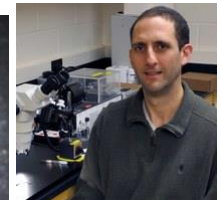
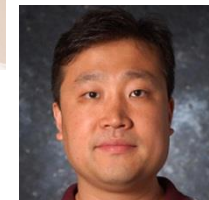




# Collaborators



Dmitri Boudko-Rosalind Franklin Osvaldo  
Marinotti- UC Irvine  
Alexander Raikhel - UC Riverside  
Geoffrey Attardo - Yale  
Joshua Benoit - University of Cincinnati  
Alvaro Romero – NMSU  
Jacob Urquidi – NMSU  
Sang-Yeon Cho – NMSU  
Phill Lewis – NMSU  
GC Lopez - NMSU  
Peter Piermarini – Ohio SU  
Sergei Smirnov – NMSU  
Omar Holguin – NMSU  
Eric Yukl – NMSU  
Kathryn Hanley – NMSU  
Peter Houde – NMSU  
Brook Milligan – NMSU  
John Gustafson – Oklahoma SU  
Wyatt Hoback – Oklahoma SU  
John Hammond – UNM  
Donovan Bailey – NMSU  
Angus Dawe – NMSU  
Shelley Lusetti – NMSU  
Mary Alice Scott – NMSU  
William Boecklen – NMSU  
Avis James – NMSU  
Alvaro Molina-Cruz - NIH



# Funding



National Institute of Allergy and Infectious Diseases

*Leading research to understand, treat, and prevent infectious, immunologic, and allergic diseases.*

BILL & MELINDA  
GATES foundation

NM  
STATE



New Mexico  
**INBRE**

IDEA Network of Biomedical Research Excellence

HHMI  
HOWARD HUGHES  
MEDICAL INSTITUTE

NEW MEXICO  
**AMP**





Questions