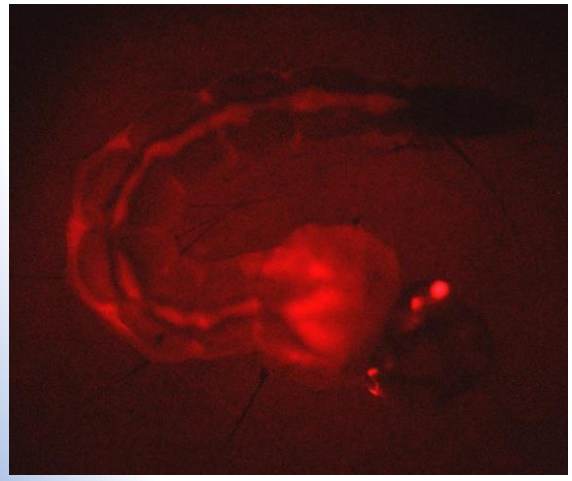
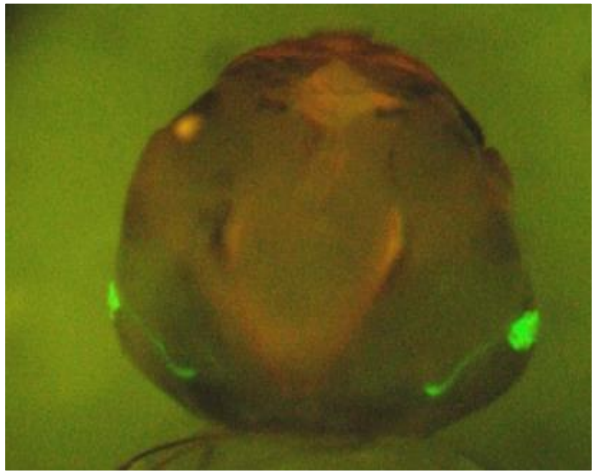
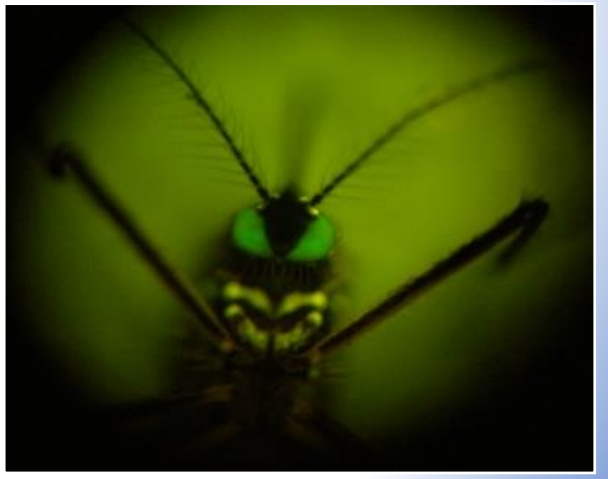
Improving *Aedes aegypti* transgenic strains

Margareth L. Capurro
mcapurro@icb.usp.br







Dengue Prevention and 35 Years of Vector Control in Singapore

Eng-Eong Ooi,* Kee-Tai Goh,† and Duane J. Gubler‡

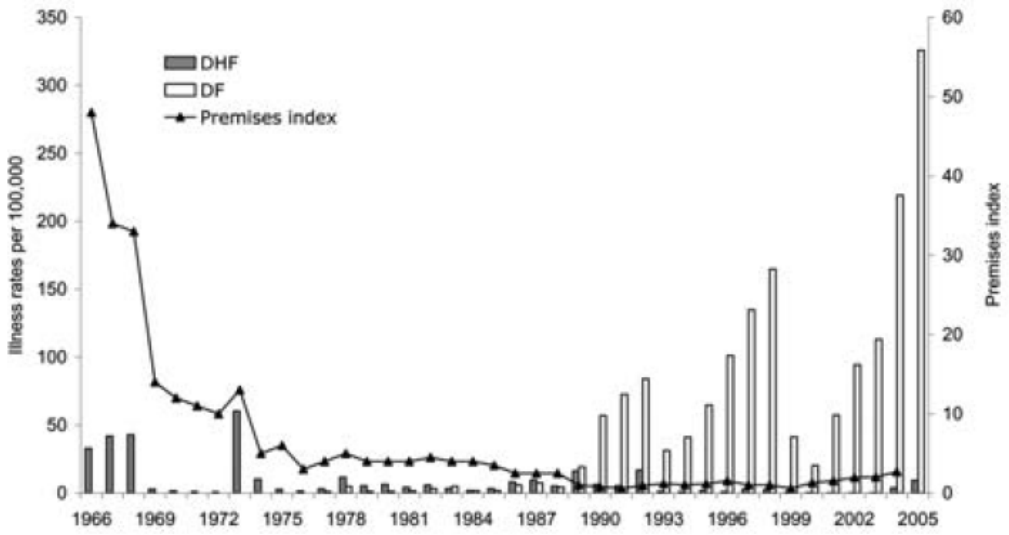
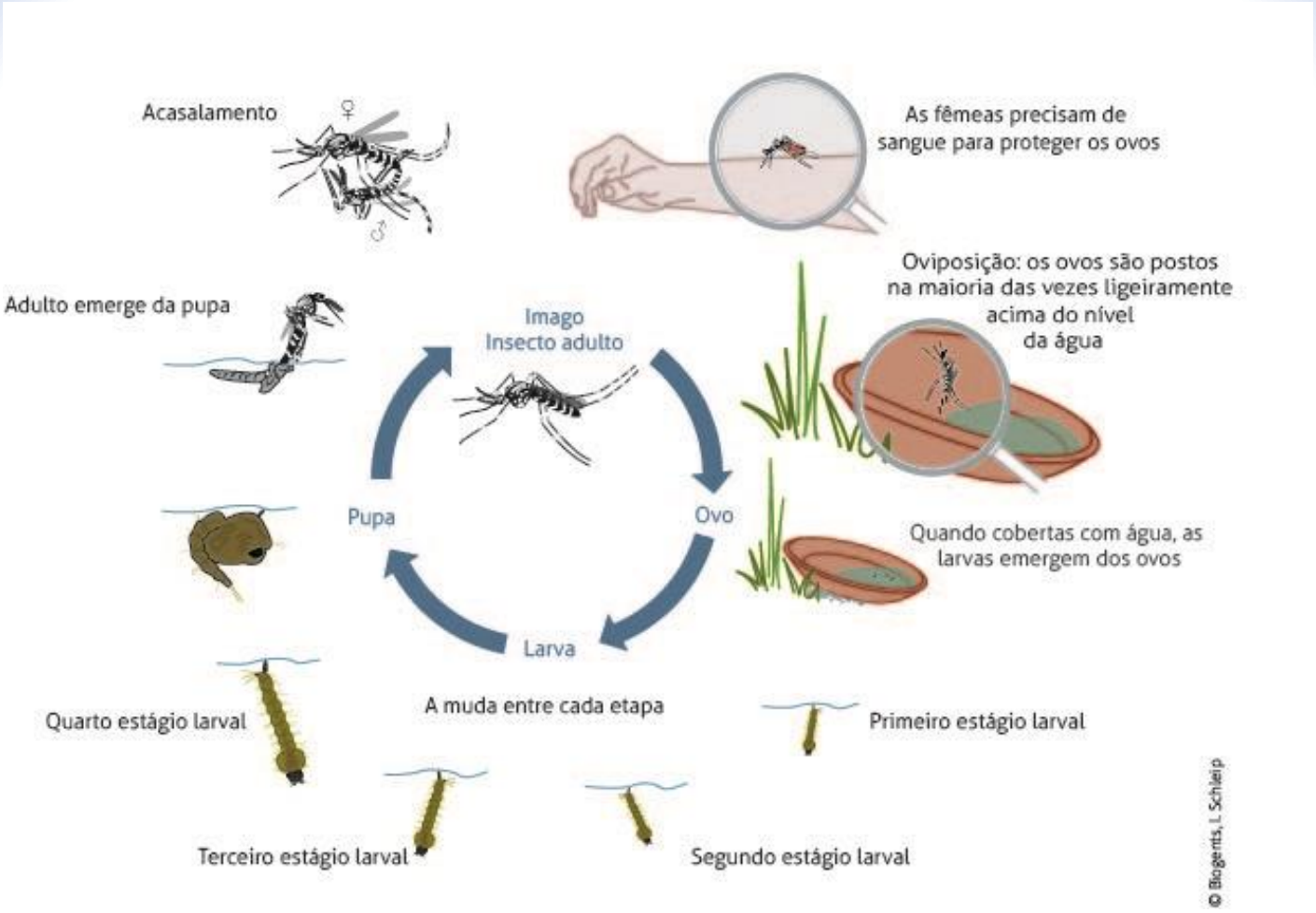


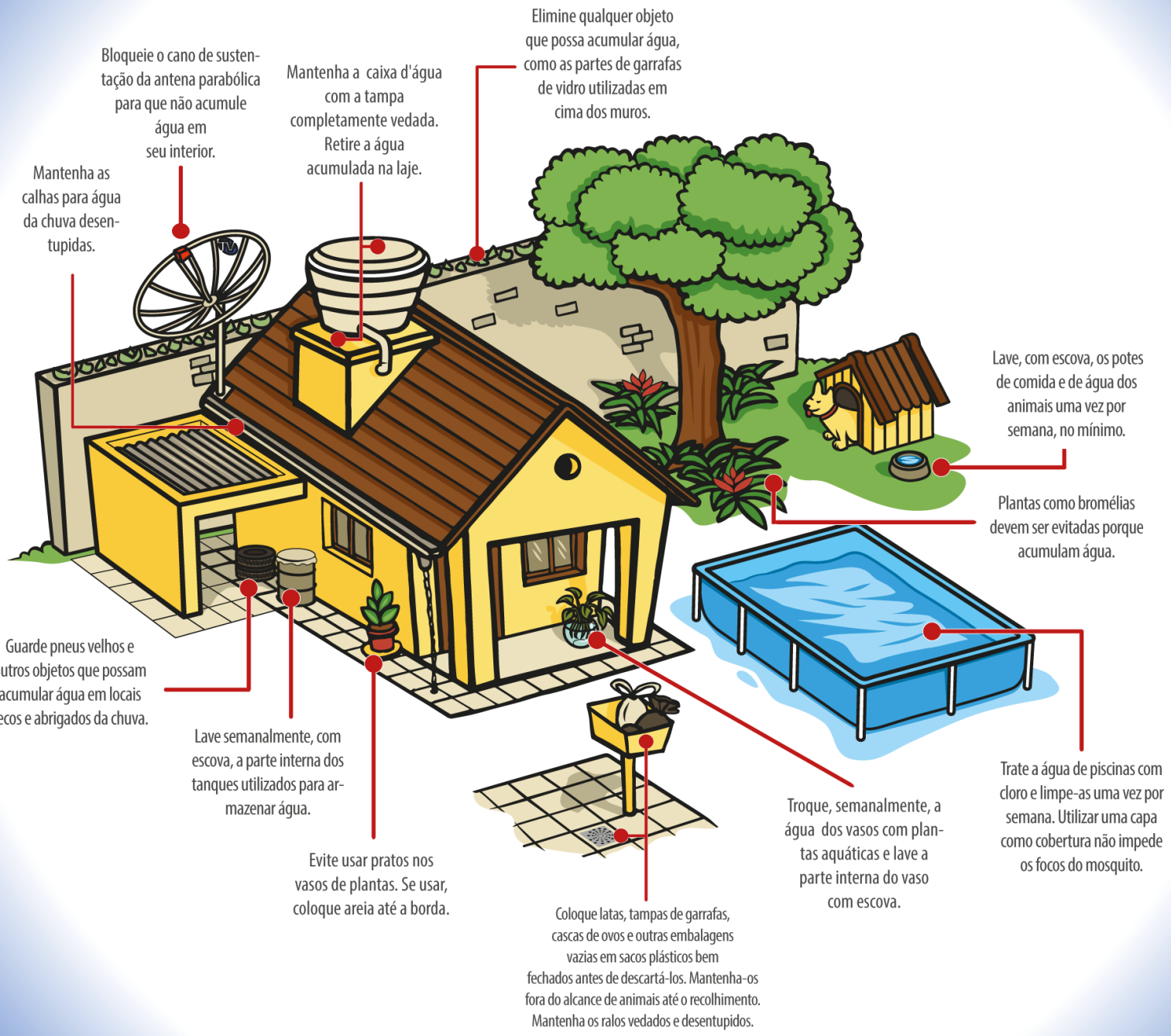
Figure 1. Annual incidence dengue fever (DF) and dengue hemorrhagic fever (DHF) and the premises index, Singapore, 1966–2005. DHF was made a notifiable disease in 1966, while DF became a notifiable disease in 1977. The annual incidences of DF and DHF reported in this figure were calculated from the number of reported cases each year from 1966 to 2004. The annual premises index is expressed as a percentage of the premises in which *Aedes aegypti* or *A. albopictus* larvae were found divided by the number of premises visited by environmental health officers.

Emerging Infectious Diseases • www.cdc.gov/eid • Vol. 12, No. 6, June 2006

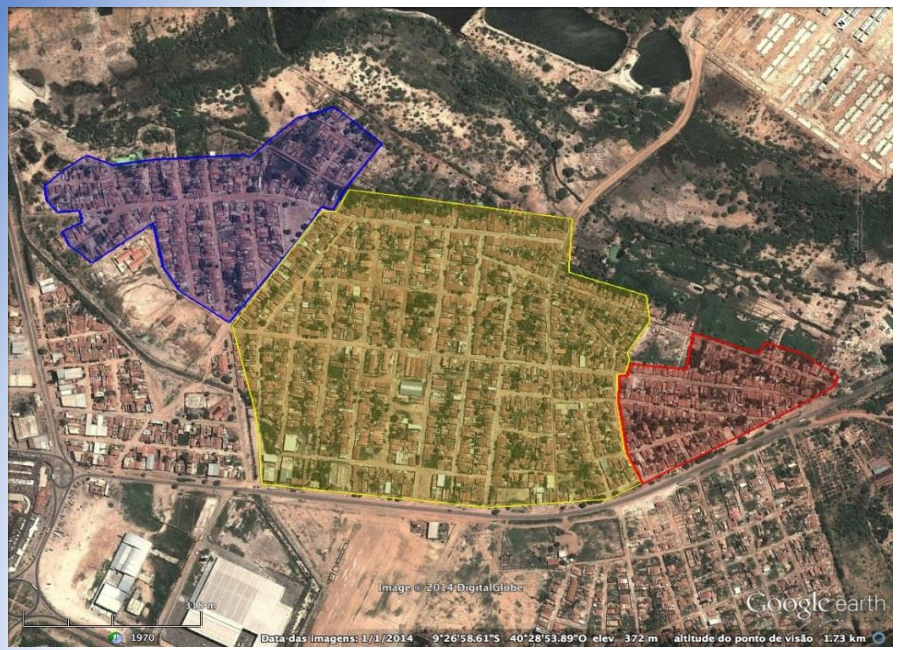
After a 15-year period of low incidence, dengue has reemerged in Singapore in the past decade. We identify potential causes of this resurgence. A combination of lowered herd immunity, virus transmission outside the home, an increase in the age of infection, and the adoption of a case-reactive approach to vector control contribute to the increased dengue incidence. Singapore's experience with dengue indicates that prevention efforts may not be sustainable. For renewed success, Singapore needs to return to a vector control program that is based on carefully collected entomologic and epidemiologic data. Singapore's taking on a leadership role in strengthening disease surveillance and control in Southeast Asia may also be useful in reducing virus importation.



Aedes aegypti Life cycle


Elimine qualquer objeto que possa acumular água, como as partes de garrafas de vidro utilizadas em cima dos muros.
Bloqueie o cano de sustentação da antena parabólica para que não acumule água em seu interior.
Mantenha a caixa d'água com a tampa completamente vedada. Retire a água acumulada na laje.
Mantenha as calhas para água da chuva desentupidas.
Lave, com escova, os potes de comida e de água dos animais uma vez por semana, no mínimo.
Plantas como bromélias devem ser evitadas porque acumulam água.
Guarde pneus velhos e outros objetos que possam acumular água em locais secos e abrigados da chuva.
Lave semanalmente, com escova, a parte interna dos tanques utilizados para armazenar água.
Evite usar pratos nos vasos de plantas. Se usar, coloque areia até a borda.
Troque, semanalmente, a água dos vasos com plantas aquáticas e lave a parte interna do vaso com escova.
Trate a água de piscinas com cloro e limpe-as uma vez por semana. Utilizar uma capa como cobertura não impede os focos do mosquito.
Coloque latas, tampas de garrafas, cascas de ovos e outras embalagens vazias em sacos plásticos bem fechados antes de descartá-los. Mantenha-os fora do alcance de animais até o recolhimento. Mantenha os ralos vedados e desentupidos.

Itaberaba – Juazeiro City 7,000 people - 1,500 houses

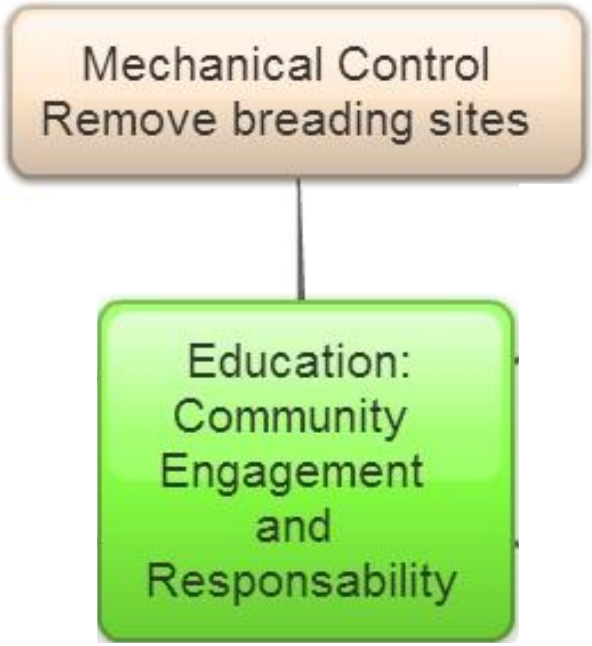


¿Educación?


FOCOS DA DENGUE
PNEUS
LATAS E GARRAFAS
VASOS
CALHA ENTUPIDA
IGNORÂNCIA
CAIXA D'ÁGUA

Educación y Saneamiento básico

Integrate Control for *Aedes aegypti* Population Supression



RECEBA BEM O AGENTE DE SAÚDE

GUARDE GARRAFAS DE CABEÇA PARA BAIXO

ELIMINE A ÁGUA DOS VASOS DE FLORES

TAMPE TONÉIS E TANQUES

NÃO DEIXE ÁGUA DE CHUVA ACUMULADA

LAVE SEMANALMENTE OS DEPÓSITOS DE ÁGUA

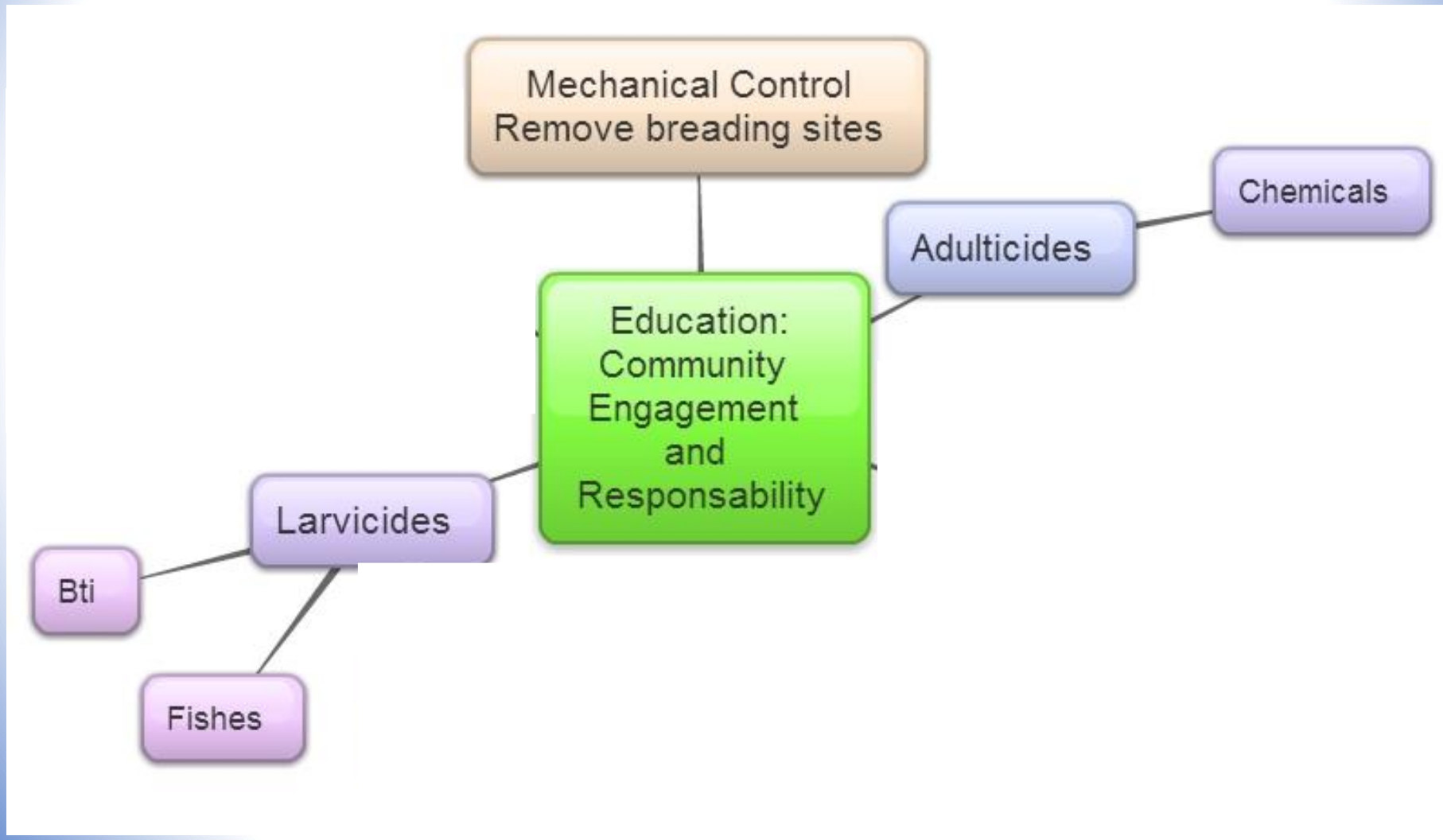
MANTENHA CAIXAS DE ÁGUA E TANQUES DEVIDAMENTE FECHADOS

ENTREGUE PNEUS VELHOS À EQUIPE DE LIMPEZA OU MANTENHA EM LOCAL FECHADO

MANTENHA CALHAS LIMPAS E EVITE ACÚMULO DE ÁGUA

COLOQUE O LIXO EM SACOS PLÁSTICOS E MANTENHA A LIXEIRA FECHADA

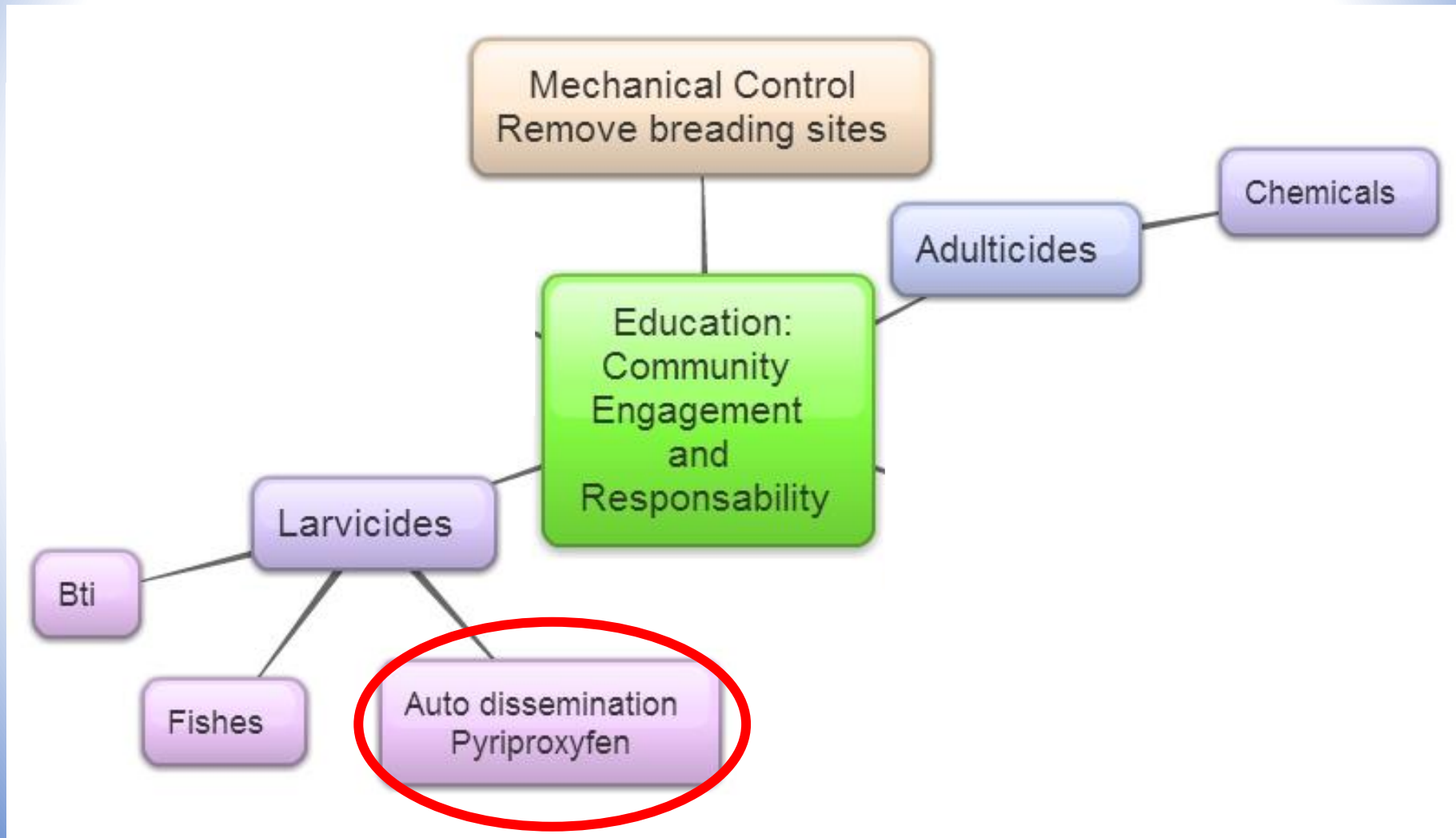
Integrate Control for *Aedes aegypti* Population Supression




VIGILANCIA EPIDEMIOLÓGICA
AGENTE DE CONTROLE DE ENDEMIAS


FKL

Integrate Control for *Aedes aegypti* Population Supression



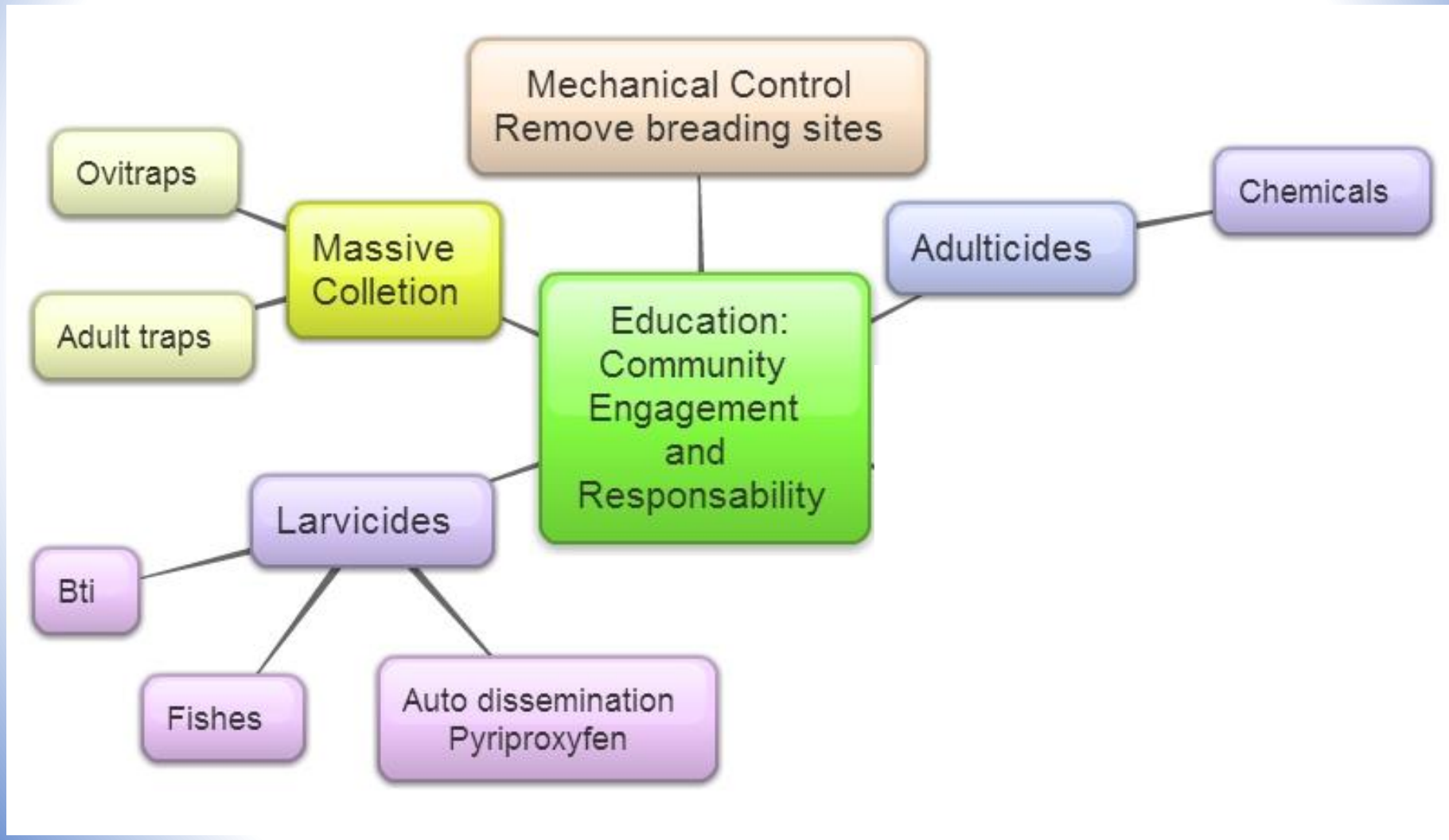
mata antes que este possa disseminar a doença.

Veja a nossa animação 3D
in2care.org/product/videos

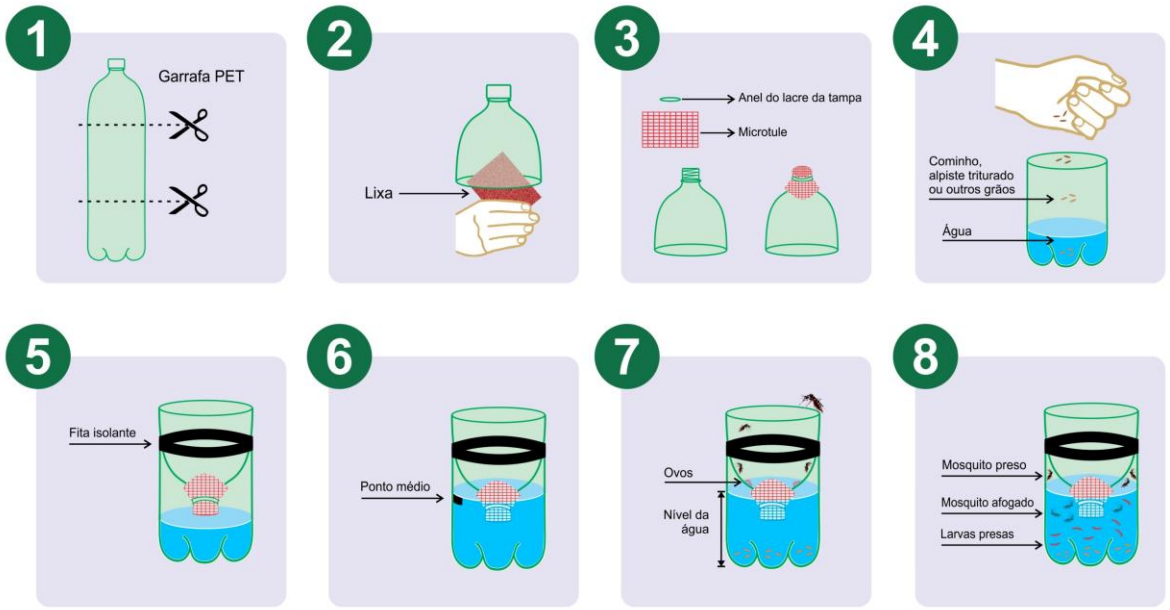
Uma ferramenta multi-impacto:

- ✓ Mata todas as larvas dentro da armadilha
- ✓ Mata as larvas em locais de reprodução nas proximidades
- ✓ Mata mosquitos que foram expostos à armadilha
- ✓ Pára o desenvolvimento do vírus da Dengue

Integrate Control for *Aedes aegypti* Population Supression



Armadilha para o mosquito Aedes aegypti



De preferência envolva o PET em papel preto. O mosquito prefere b
em lugares baixos, úmidos e de pouca luz; verificar e limpar a arma

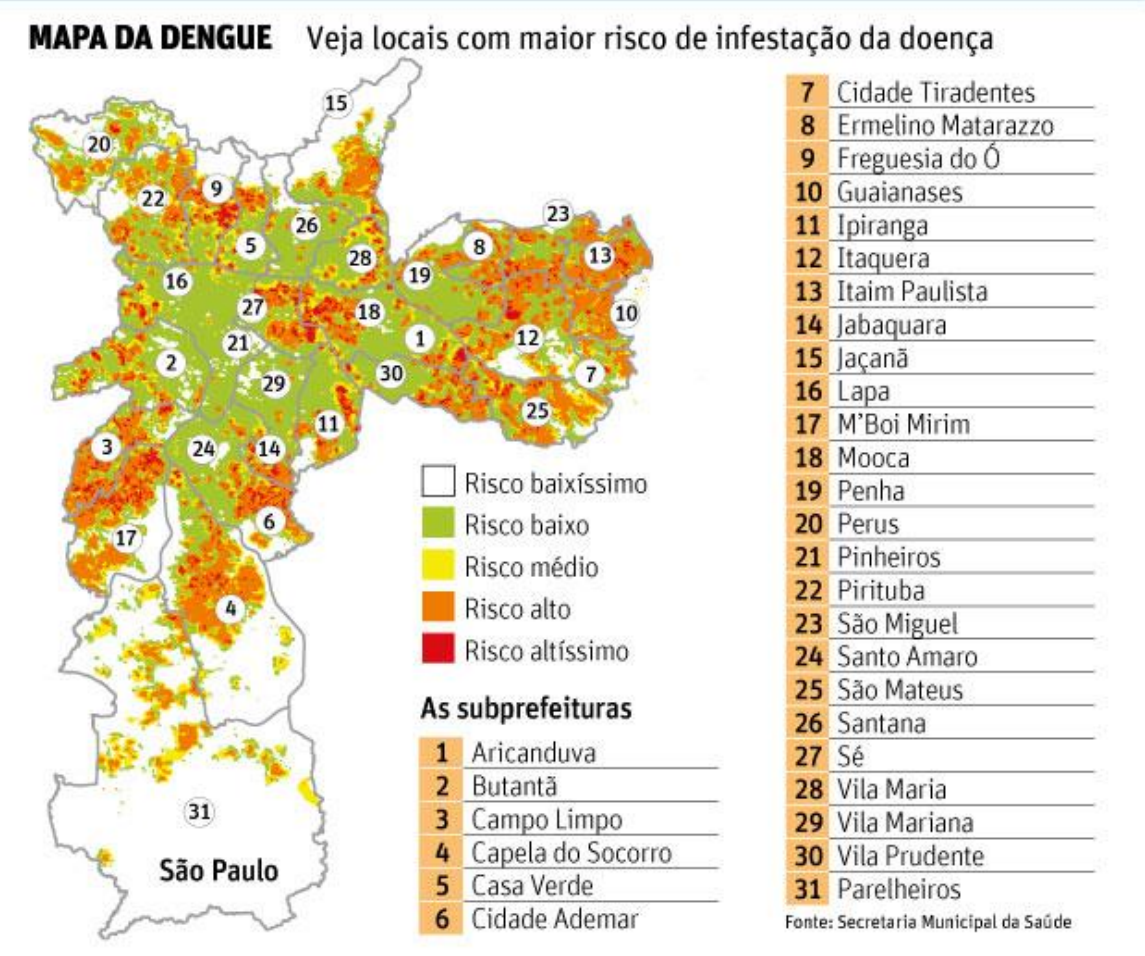
PREFE
BOM


HAMBURG SÜD


Prevenção sempre
Não importa a época do ano, os perigos do mosquito continuam.
Prevenção é um dever de todos, sempre
Vamos eliminar o mosquito da próxima estação.
Comunidade Portuária
appa
PARANÁ

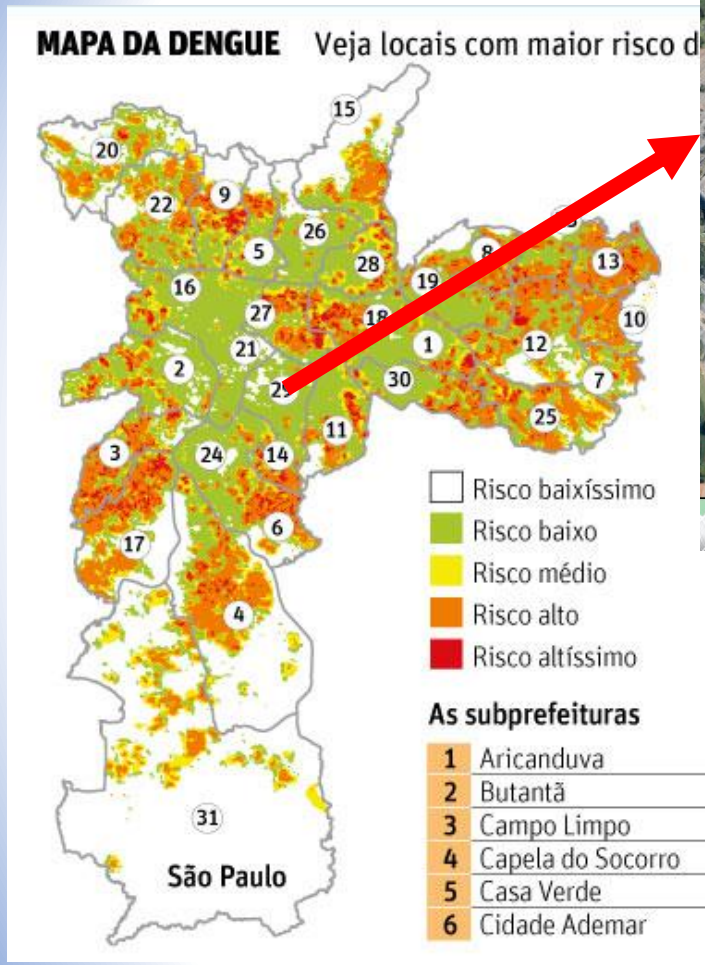

HMM
HMM

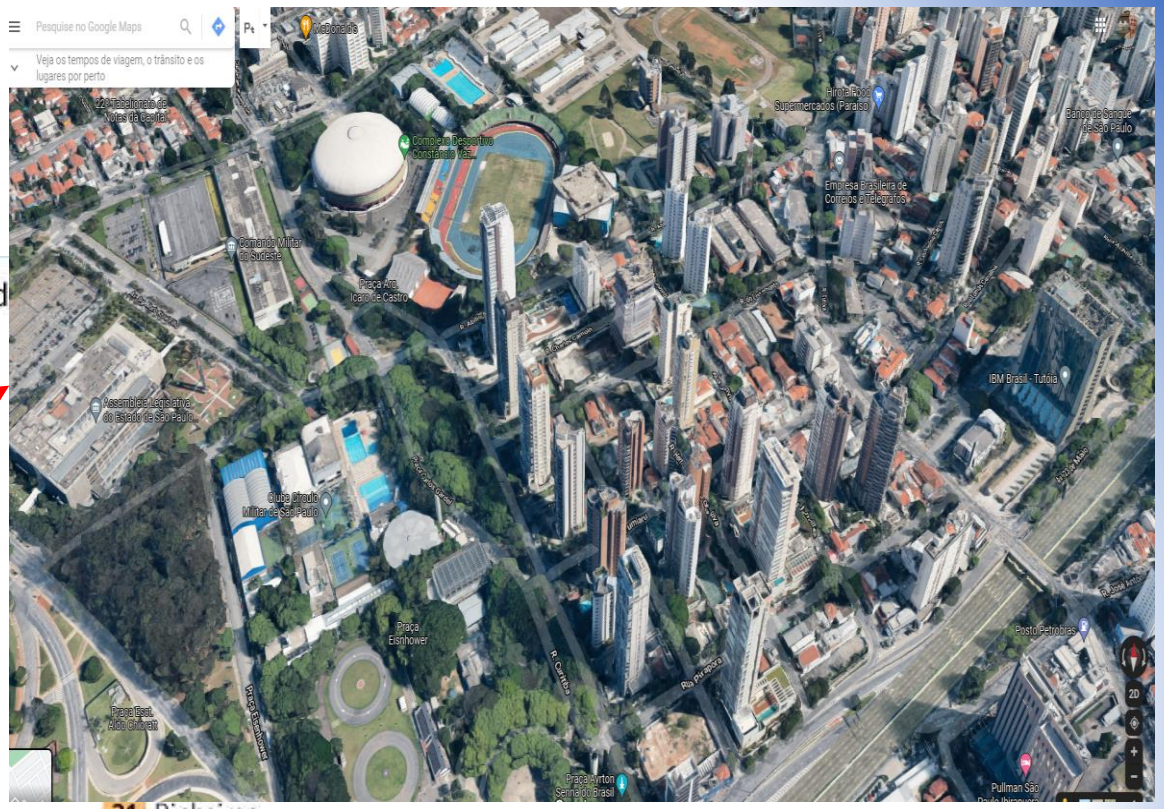
Hot Spot



São Paulo City - 12,33 million (2020) - 1.521 km²

Hot Spot





As subprefeituras

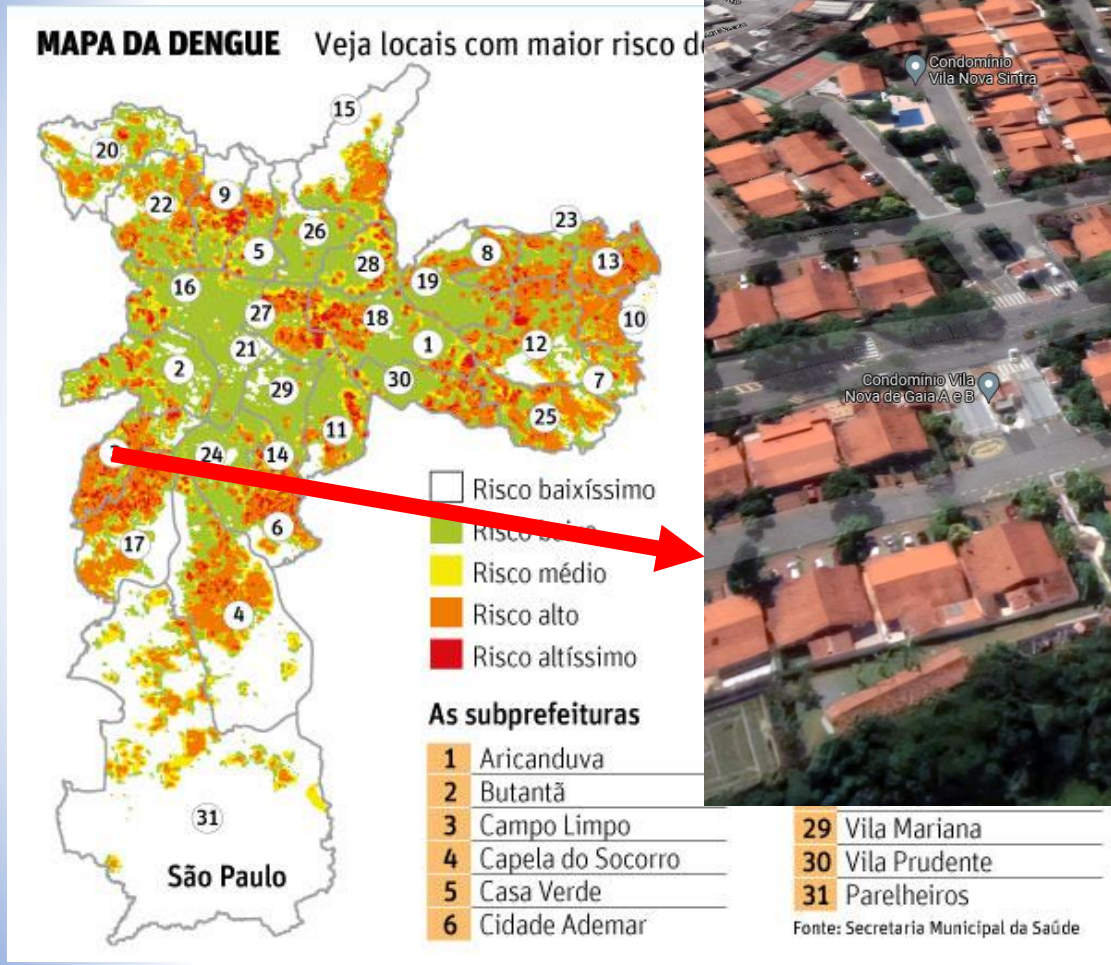
1	Aricanduva
2	Butantã
3	Campo Limpo
4	Capela do Socorro
5	Casa Verde
6	Cidade Ademar
21	Pinheiros
22	Pirituba
23	São Miguel
24	Santo Amaro
25	São Mateus
26	Santana
27	Sé
28	Vila Maria
29	Vila Mariana
30	Vila Prudente
31	Parelheiros

Fonte: Secretaria Municipal da Saúde

Hot Spot


MAPA DA DENGUE
Veja locais com maior risco de
São Paulo
Risco baixíssimo
Risco baixo
Risco médio
Risco alto
Risco altíssimo
As subprefeituras
1 Aricanduva
2 Butantã
3 Campo Limpo
4 Capela do Socorro
5 Casa Verde
6 Cidade Ademar
28 Vila Maria
29 Vila Mariana
30 Vila Prudente
31 Parelheiros
Fonte: Secretaria Municipal da Saúde
127 R. do Comércio
Guarulhos, São Paulo
GARAGEM

Hot Spot


MAPA DA DENGUE
Veja locais com maior risco d
São Paulo
Risco baixíssimo
Risco médio
Risco alto
Risco altíssimo
As subprefeituras
1 Aricanduva
2 Butantã
3 Campo Limpo
4 Capela do Socorro
5 Casa Verde
6 Cidade Ademar
29 Vila Mariana
30 Vila Prudente
31 Parelheiros
Fonte: Secretaria Municipal da Saúde

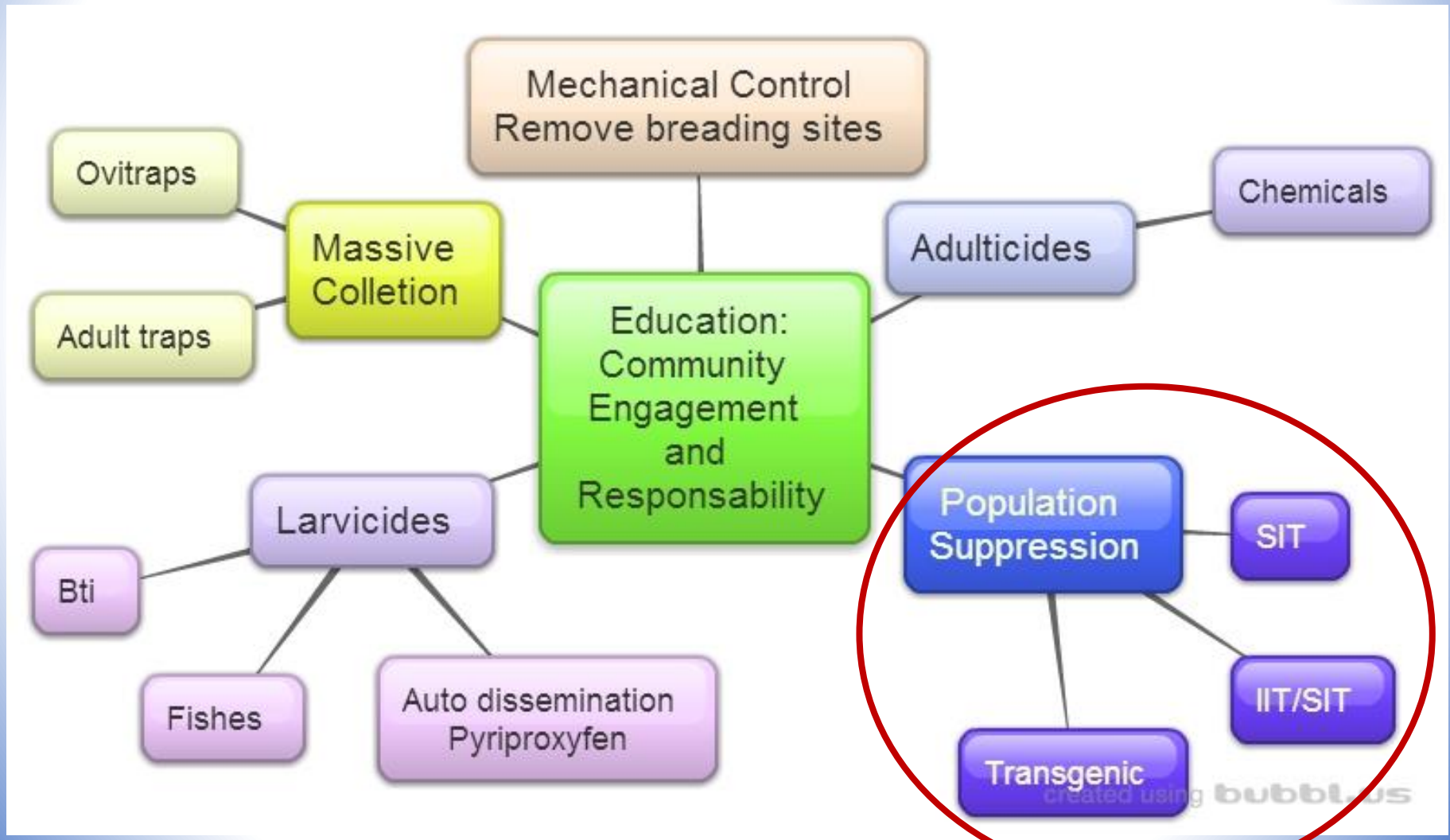

Condomínio Vila Nova Sintra
Grupo Mena
R. Lira Cearense
Condomínio Vila Nova de Gaia A e B
2D

? ? ? ?

MAPA DA DENGUE Veja locais com maior risco de infestação da doença

7	Cidade Tiradentes
8	Ermelino Matarazzo
9	Freguesia d
10	Guaianases
11	Ipiranga
12	Itaquera
13	Itaim Paulis
14	Jabaquara
15	Jaçanã
16	Lapa
17	M'Boi Mirin

Integrate Control for *Aedes aegypti* Population Supression



Sterile Insect Technique
SIT

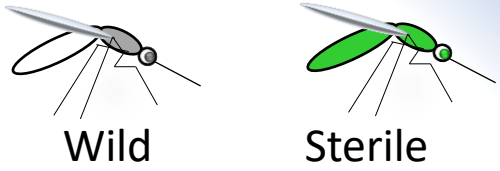
Sterilization by radiation

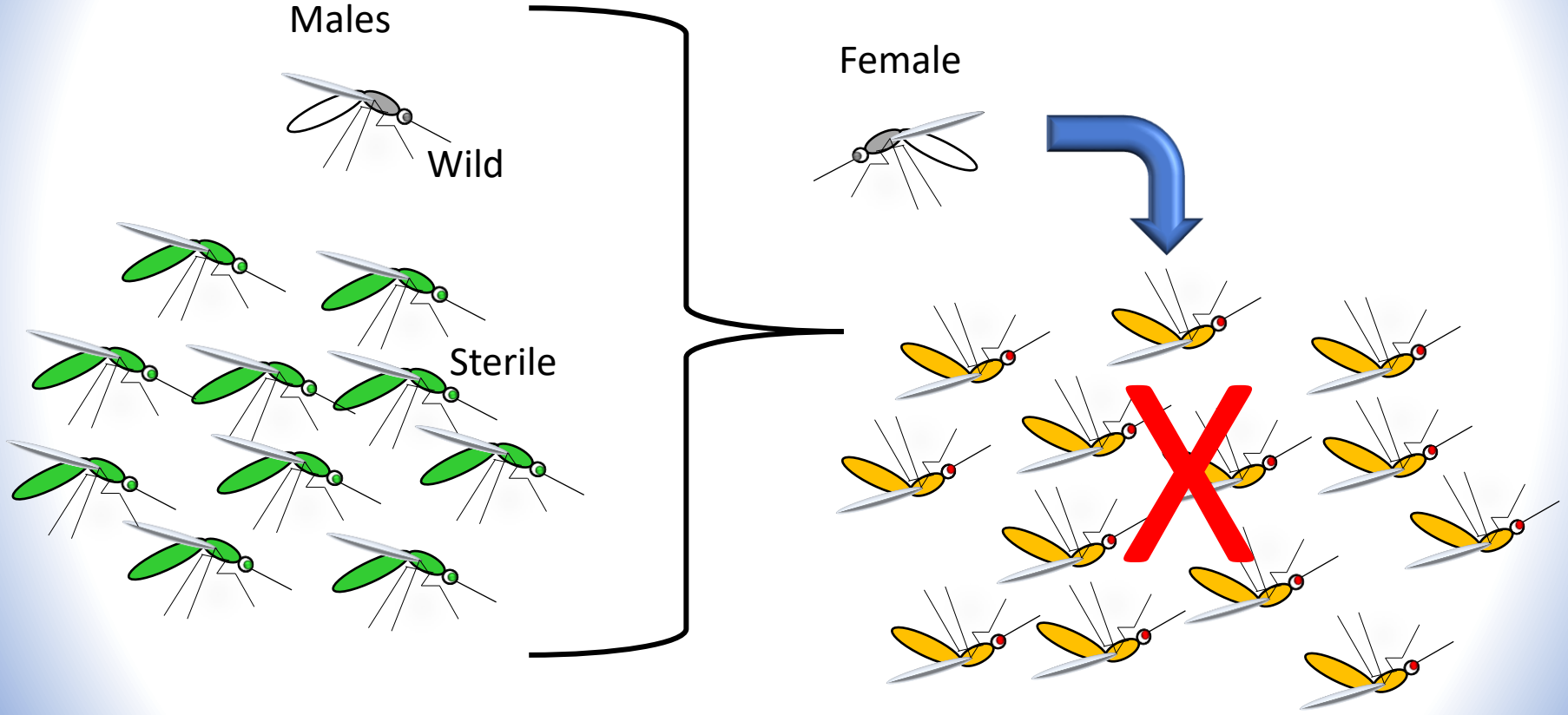
EDWARD F. KNIPLING

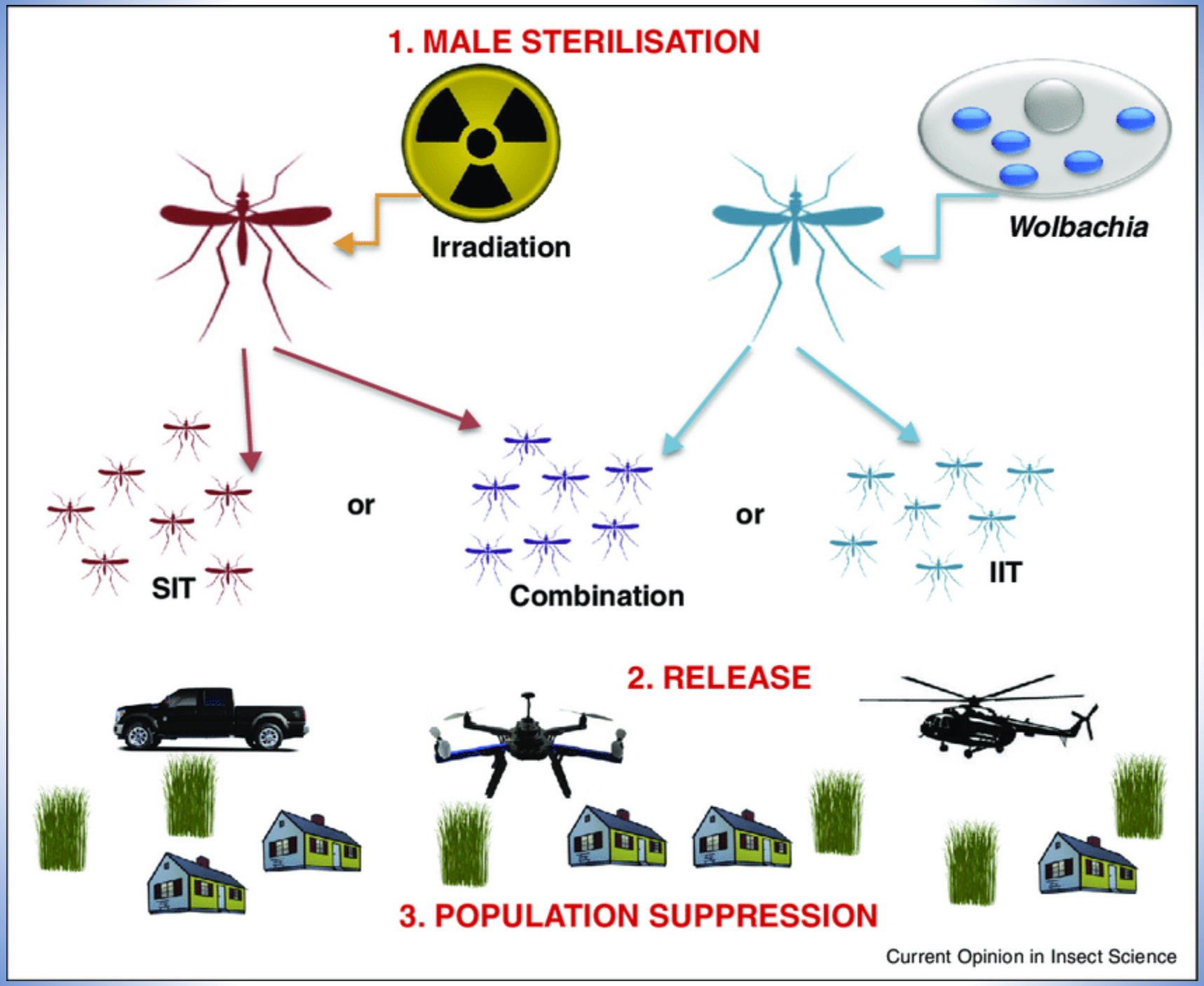
The idea came in: 1937

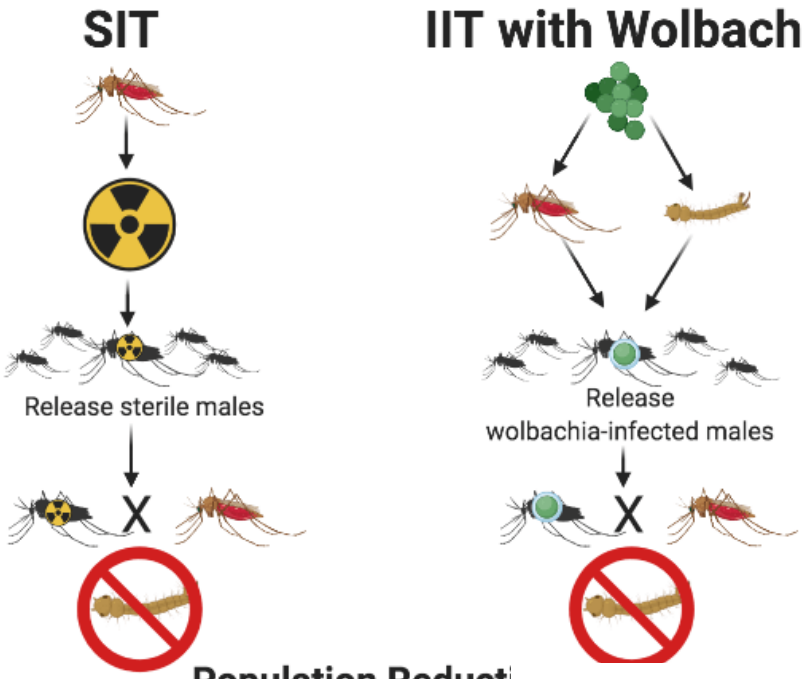
The success of the technique was achieved:
1955 - Curaça Island- control of screwworm fly

SIT

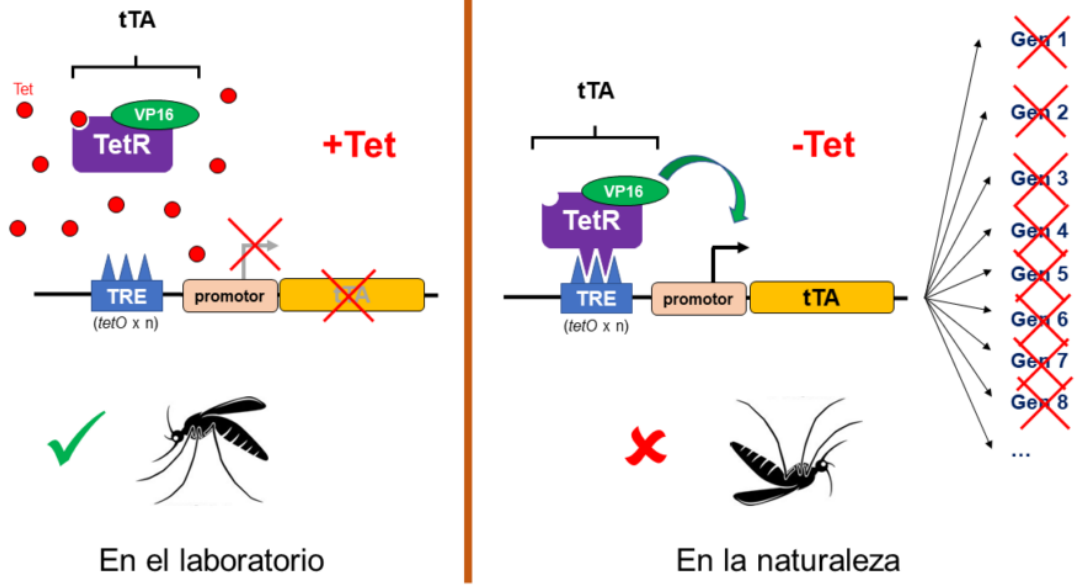




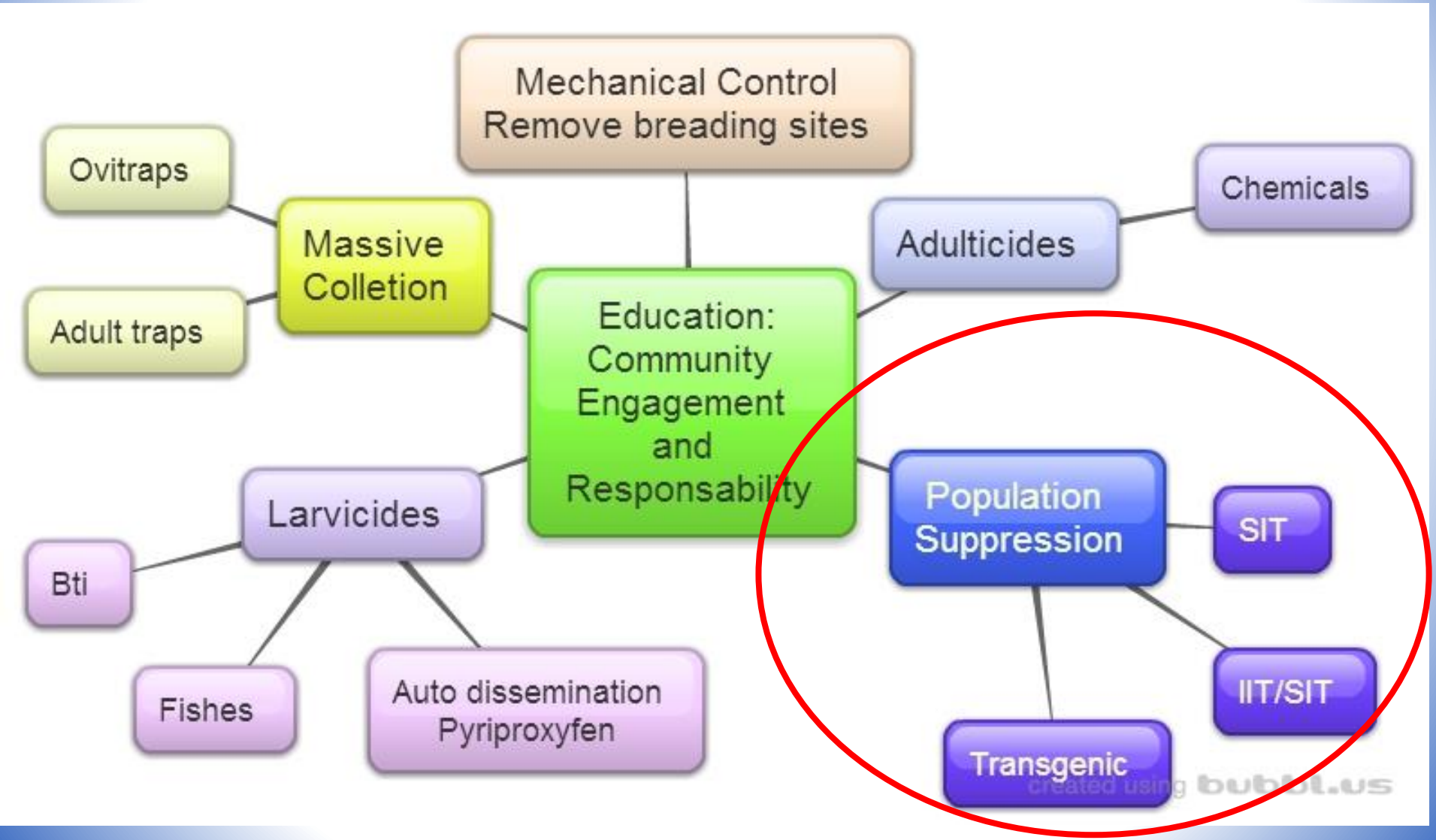

1. MALE STERILISATION
Irradiation
Wolbachia
SIT
or
Combination
or
IIT
2. RELEASE
3. POPULATION SUPPRESSION
Current Opinion in Insect Science

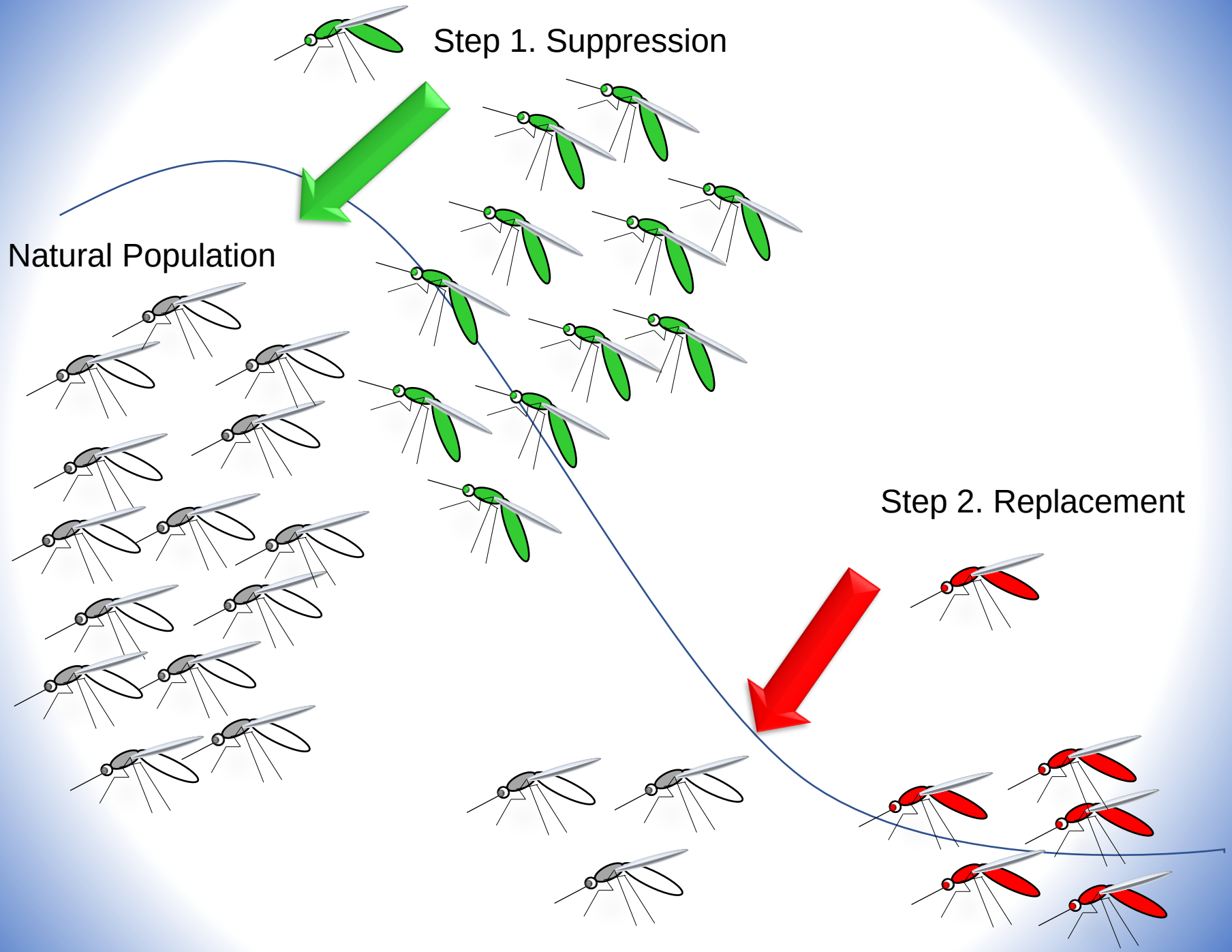


Aedes aegypti Transgenicos

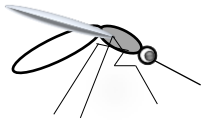


Integrate Control for *Aedes aegypti* Population Supression



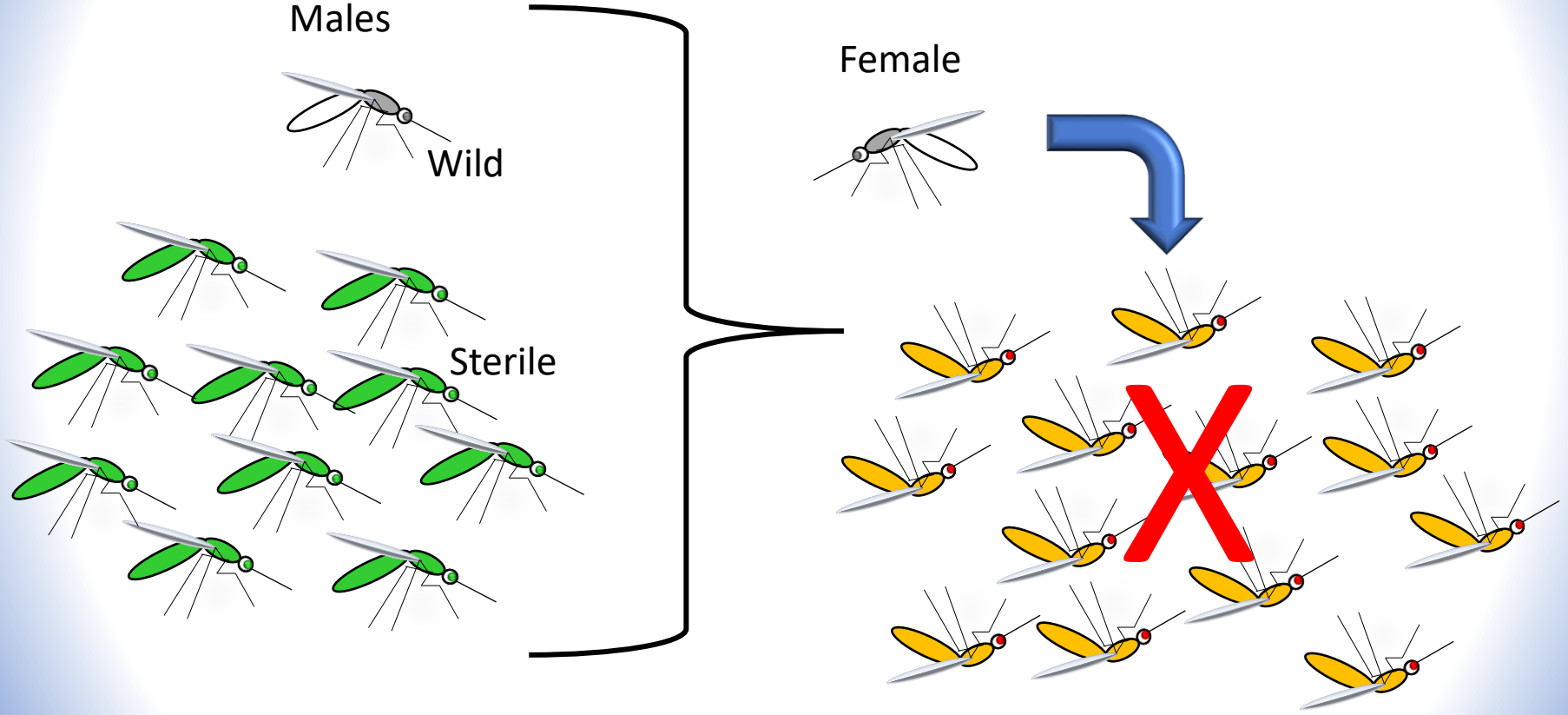

Step 1. Suppression
Natural Population
Step 2. Replacement

Step 1. Suppression

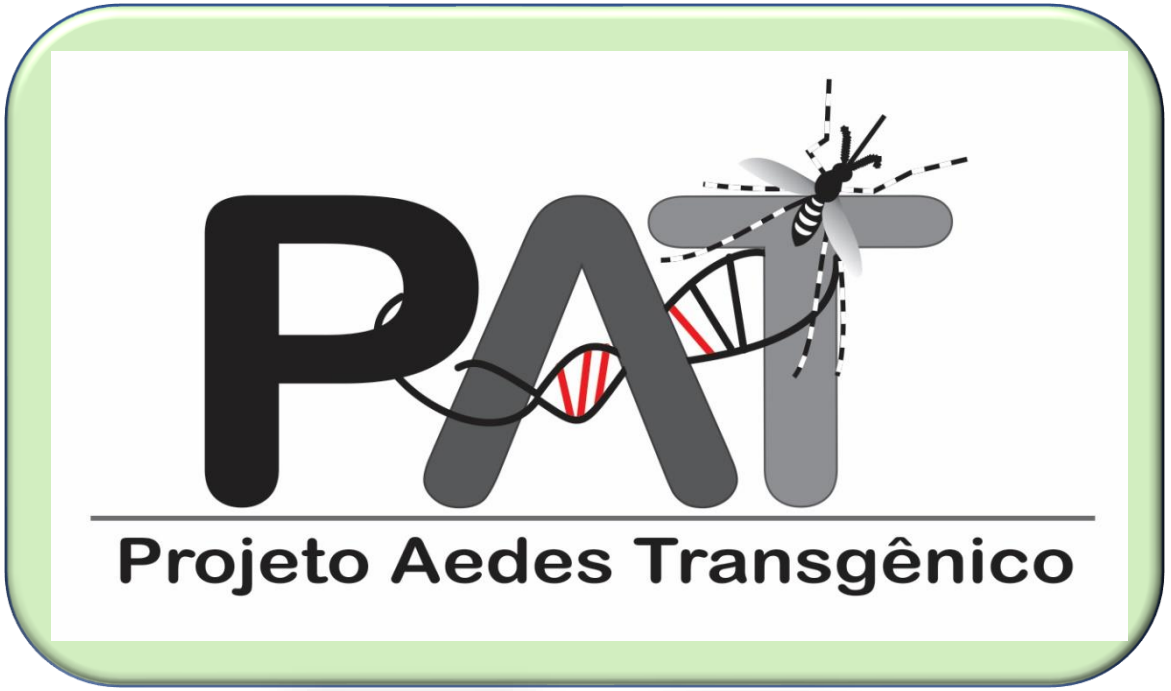


Wild

SIT
IIT/SIT
Transgenic



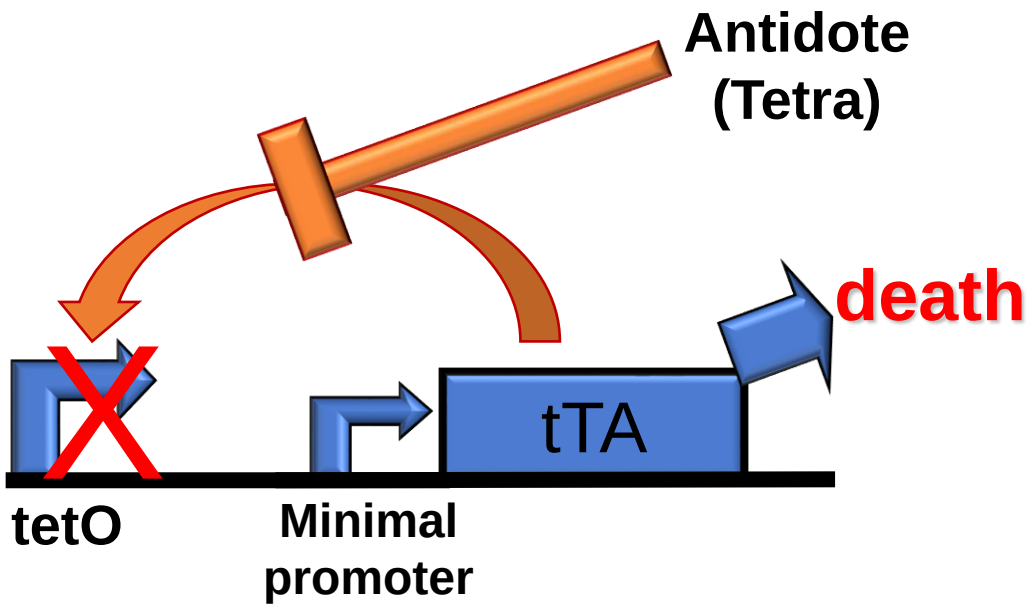
Open Field Release of **OX513A** *Aedes aegypti* Transgenic line evaluation



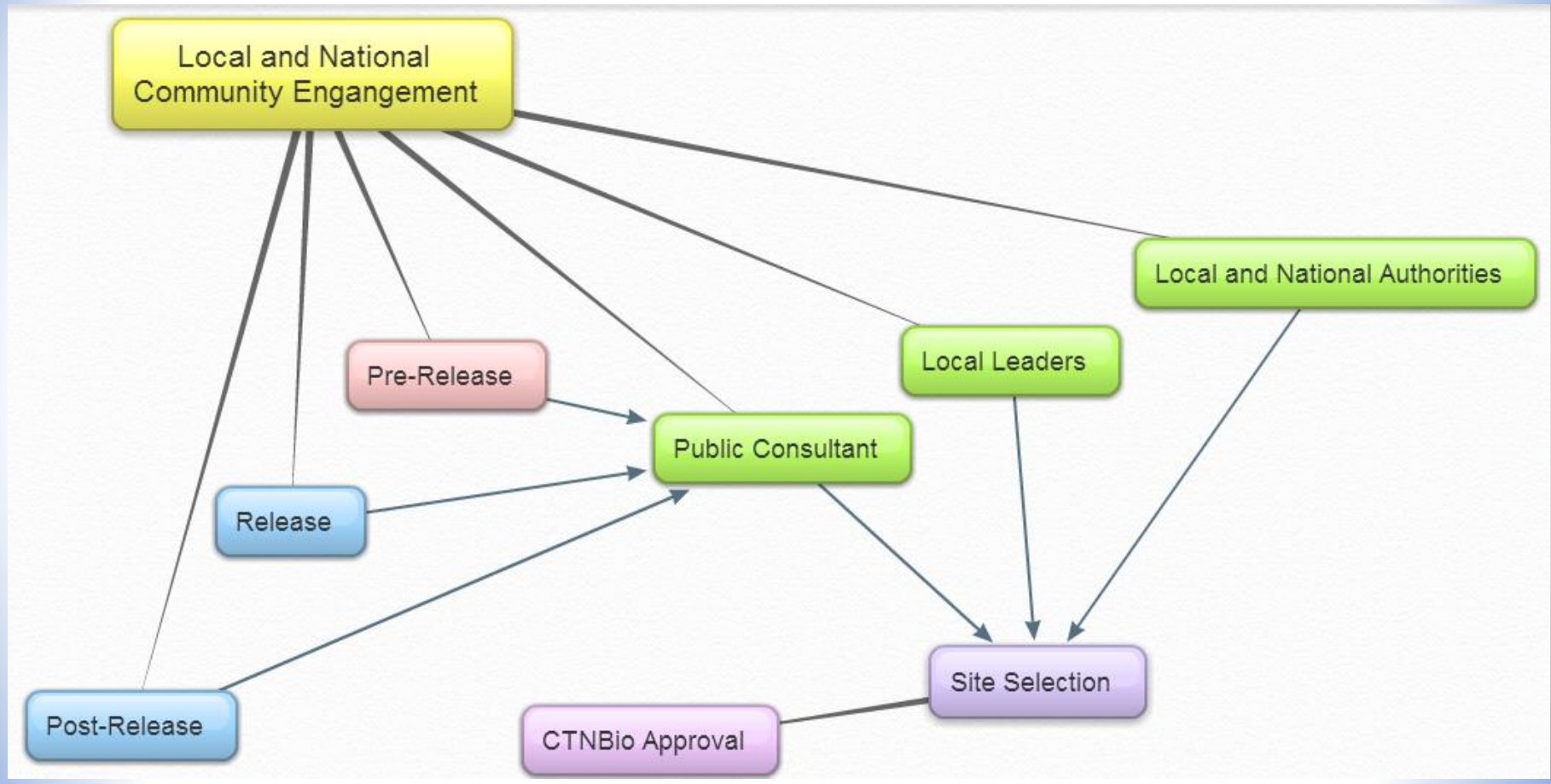
MOSCAMED BRASIL

USP Universidade de São Paulo

Repressive of **I**nsects carrying a **D**ominant **L**ethal gene (RIDL)



Thomas *et al.* 2000 Science 287: 2474-6


Local and National Community Engangement
Local and National Authorities
Local Leaders
Pre-Release
Public Consultant
Release
Site Selection
Post-Release
CTNBio Approval

jove Journal of Visualized Experiments www.jove.com

Video Article

Mass Production of Genetically Modified *Aedes aegypti* for Field Releases in Brazil

Danilo O. Carvalho[1,2], Derric Nimmo[1], Neil Naish[1], Andrew R. McKemey[1], Pam Gray[1], André B. B. Wilke[3], Mauro T. Marrelli[3], Jair F. Virginio[4], Luke Alphey[1,5], Margareth L. Capurro[2,6]

COLONY
4 to 6 million eggs/week

Males for releases
1,5 million/week

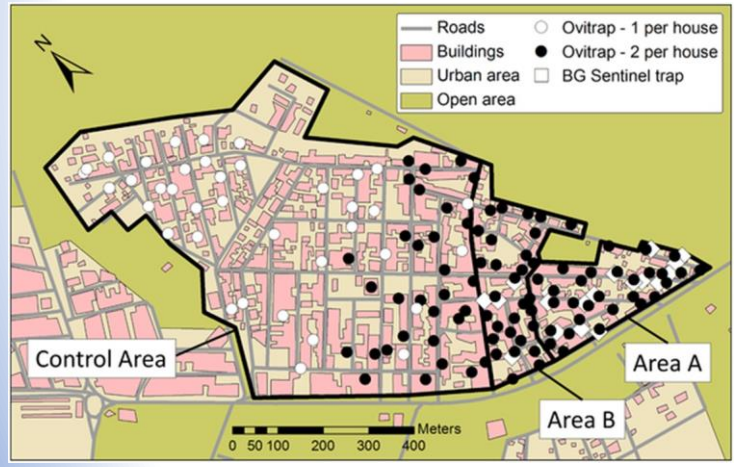
PLOS | NEGLECTED TROPICAL DISEASES

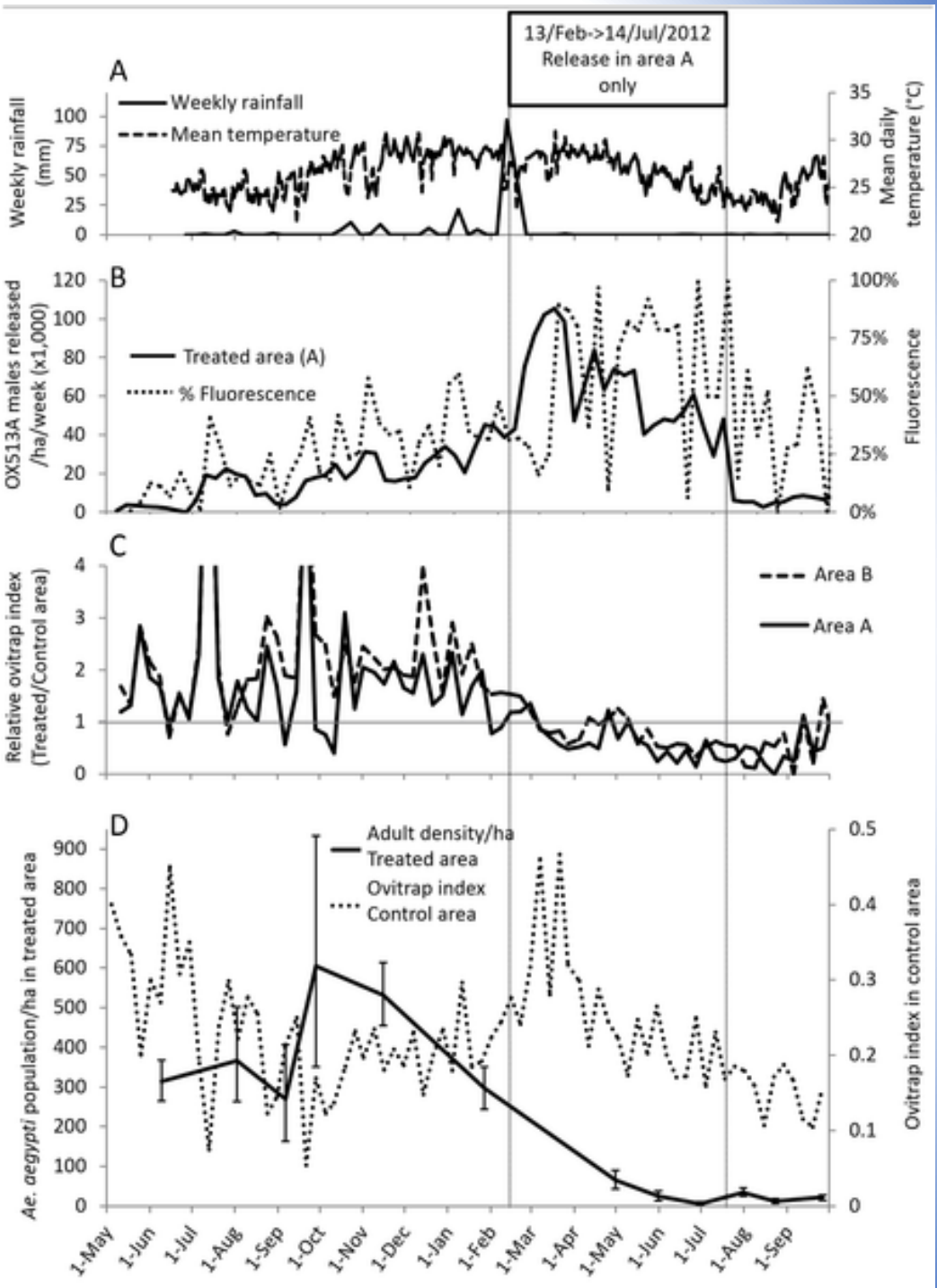
RESEARCH ARTICLE

Suppression of a Field Population of *Aedes aegypti* in Brazil by Sustained Release of Transgenic Male Mosquitoes

Danilo O. Carvalho[1,2☯], Andrew R. McKemey[1☯*], Luiza Garziera[3], Renaud Lacroix[1], Christl A. Donnelly[4], Luke Alphey[1,5,6], Aldo Malavasi[3], Margareth L. Capurro[2,7]

PLOS Neglected Tropical Diseases
|
DOI:10.1371/journal.pntd.000386
4 July 2, 2015





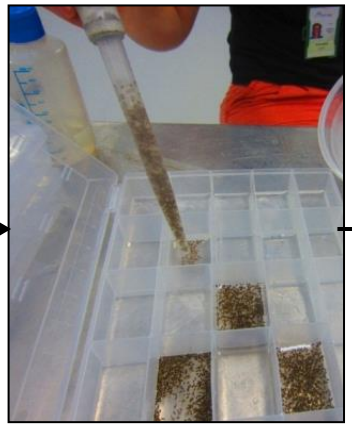
Pupa Transportation

Pupa transportation (LEMI)

C25

BOD 16ºC ON

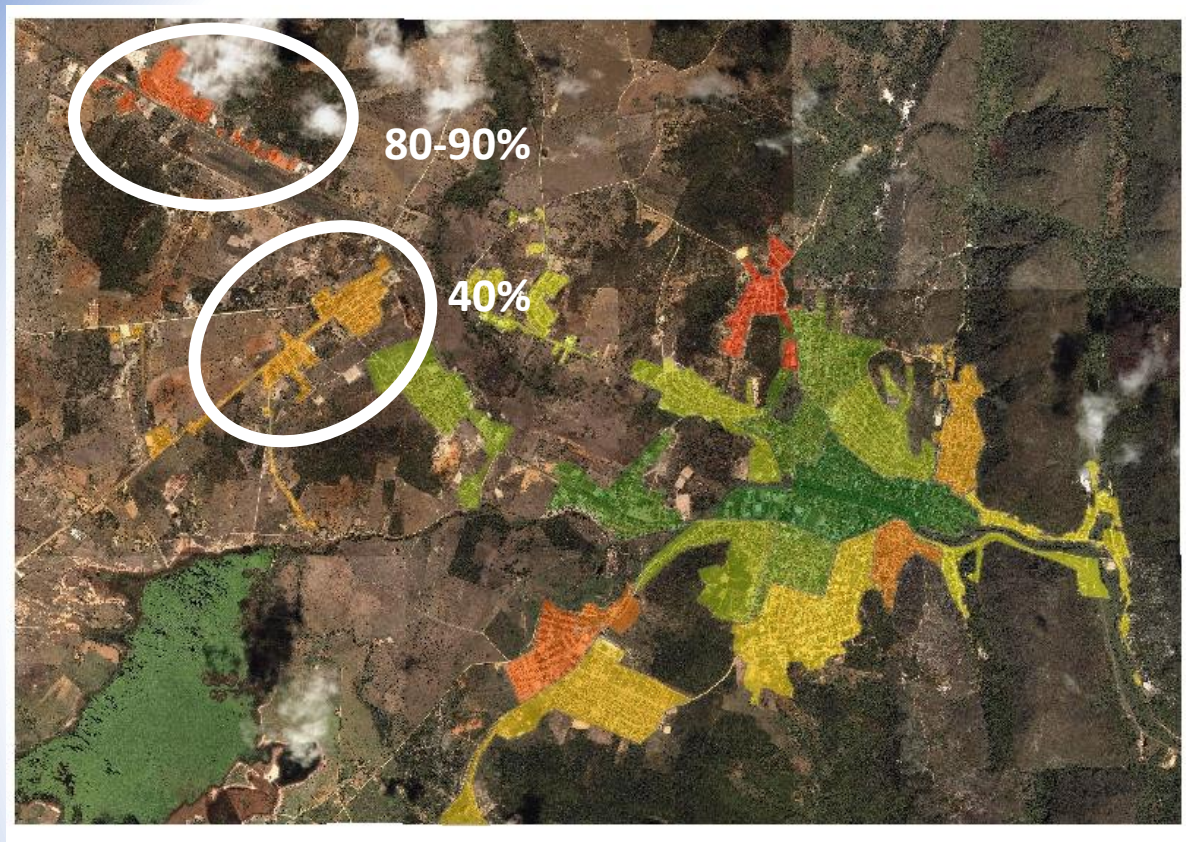
180,000 per container



Arriving at LEMI
Emergency , Monitoring and Information Lab

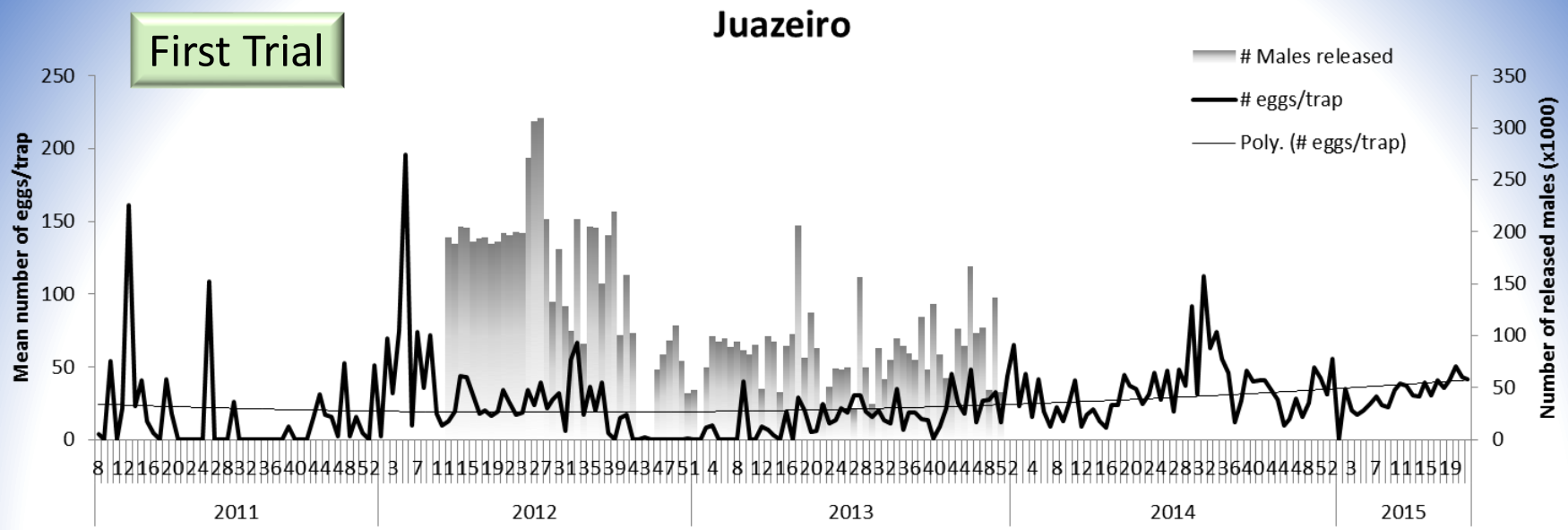
Preparation for release

Phase 2 – Jacobina - Bahia

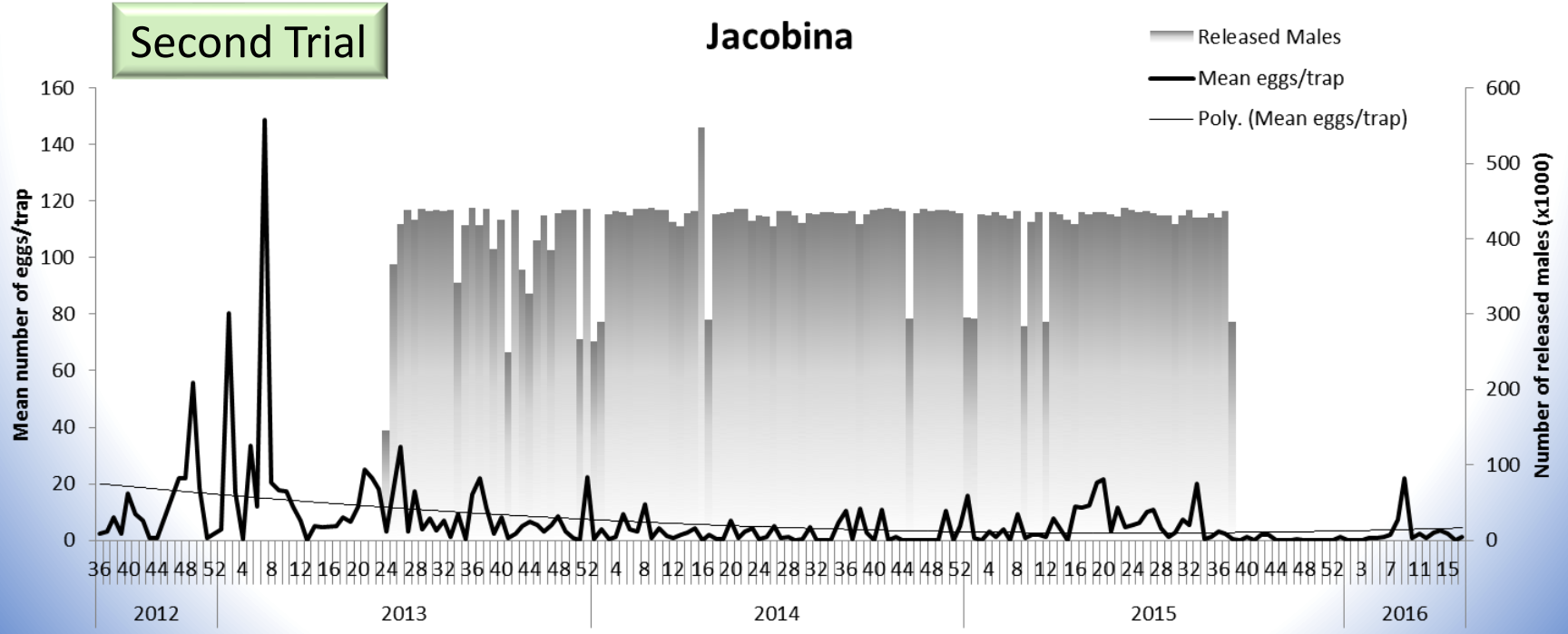


Ano	IIP	Ovos/ovitrampa
2012	11,5	12,6
2013	6,6	12,3
2014	2,2	2,8

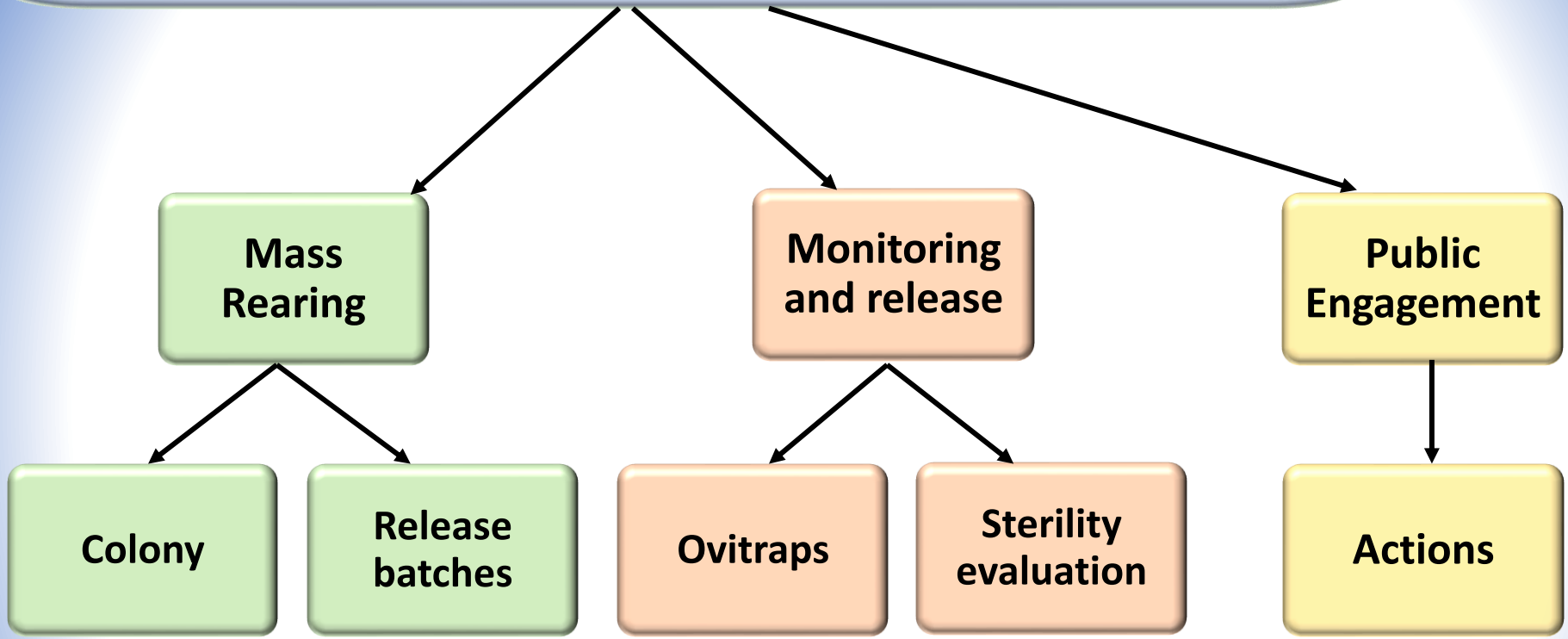
First Trial



Second Trial



Population Suppression Program



jove Journal of Visualized Experiments www.jove.com

Video Article

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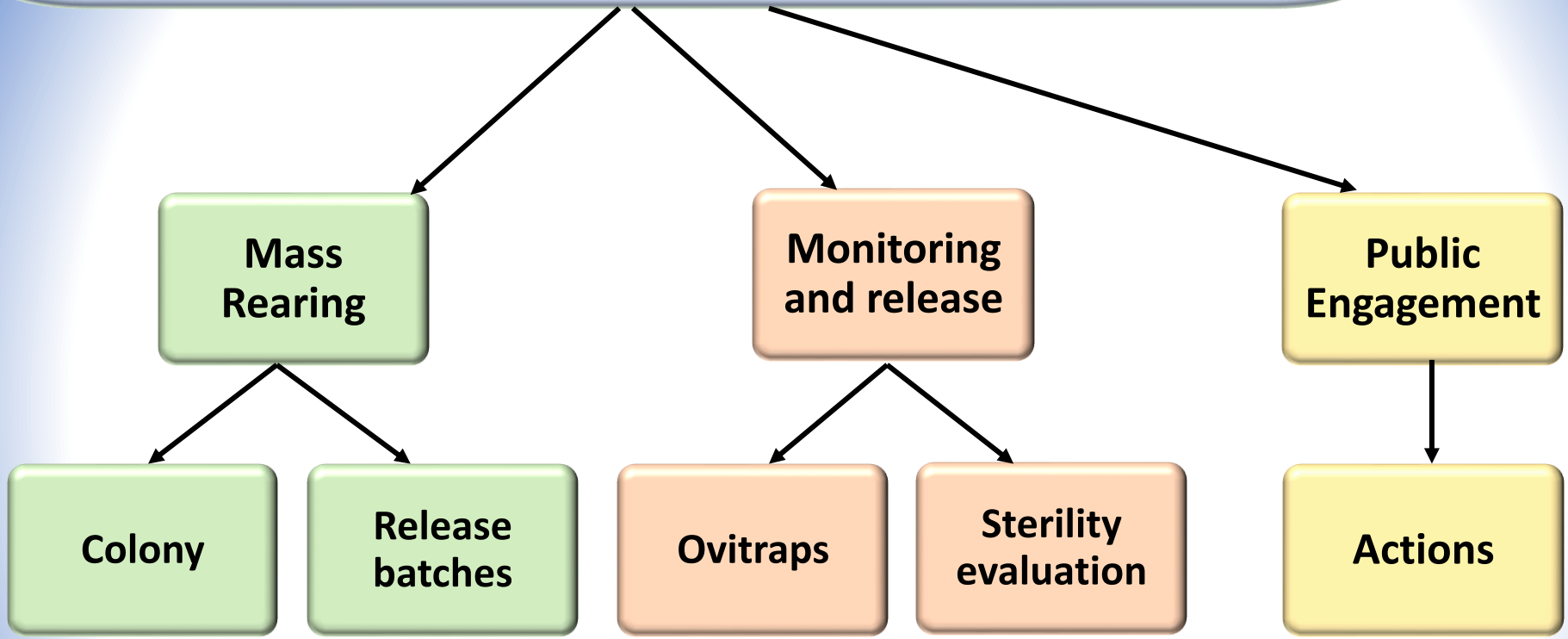
COLONY
4 to 6 million eggs/week

Males for releases
1,5 million/week

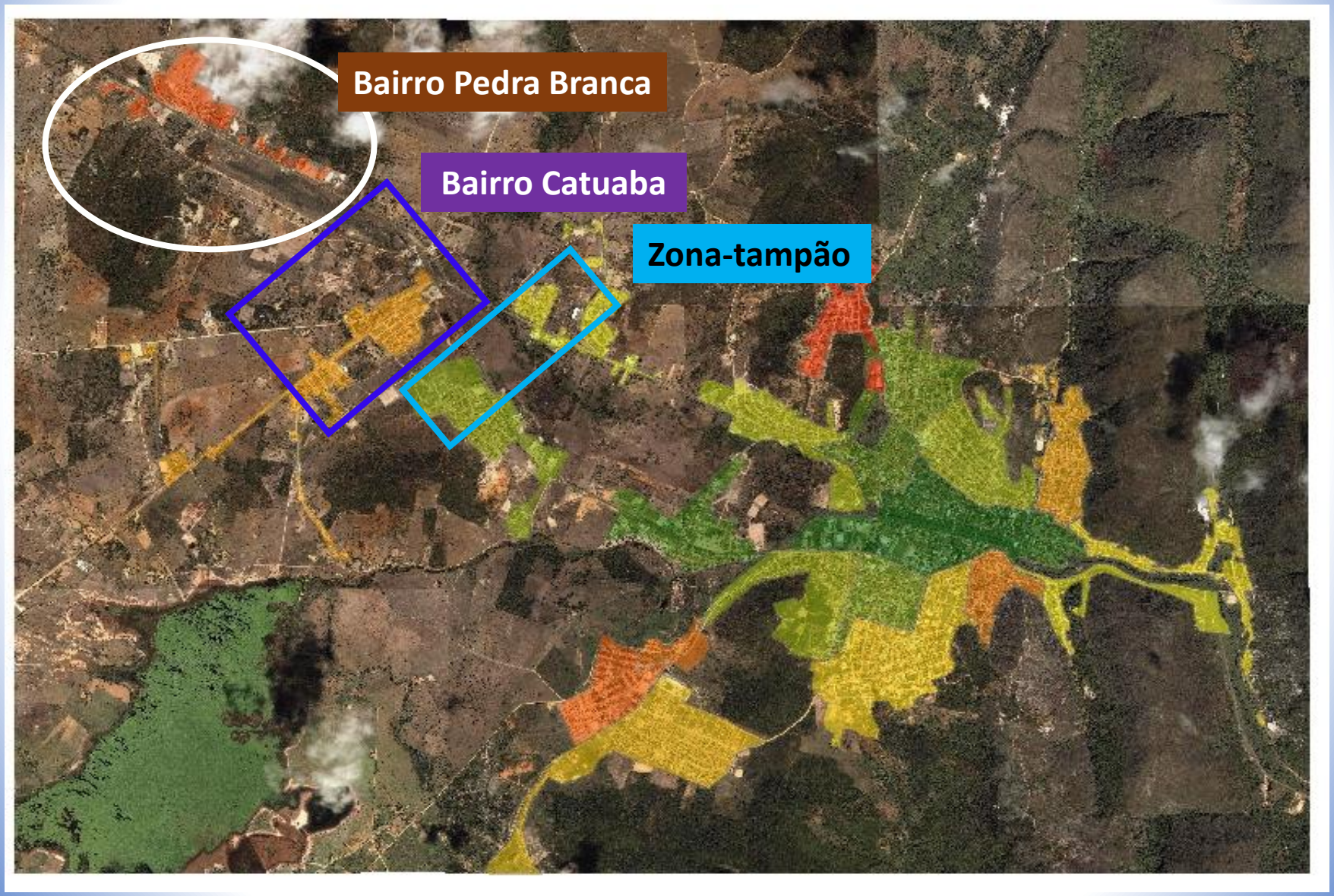
X-Ray sterilization

LIBERACIÓN DE *Aedes aegypti* MASCULINO

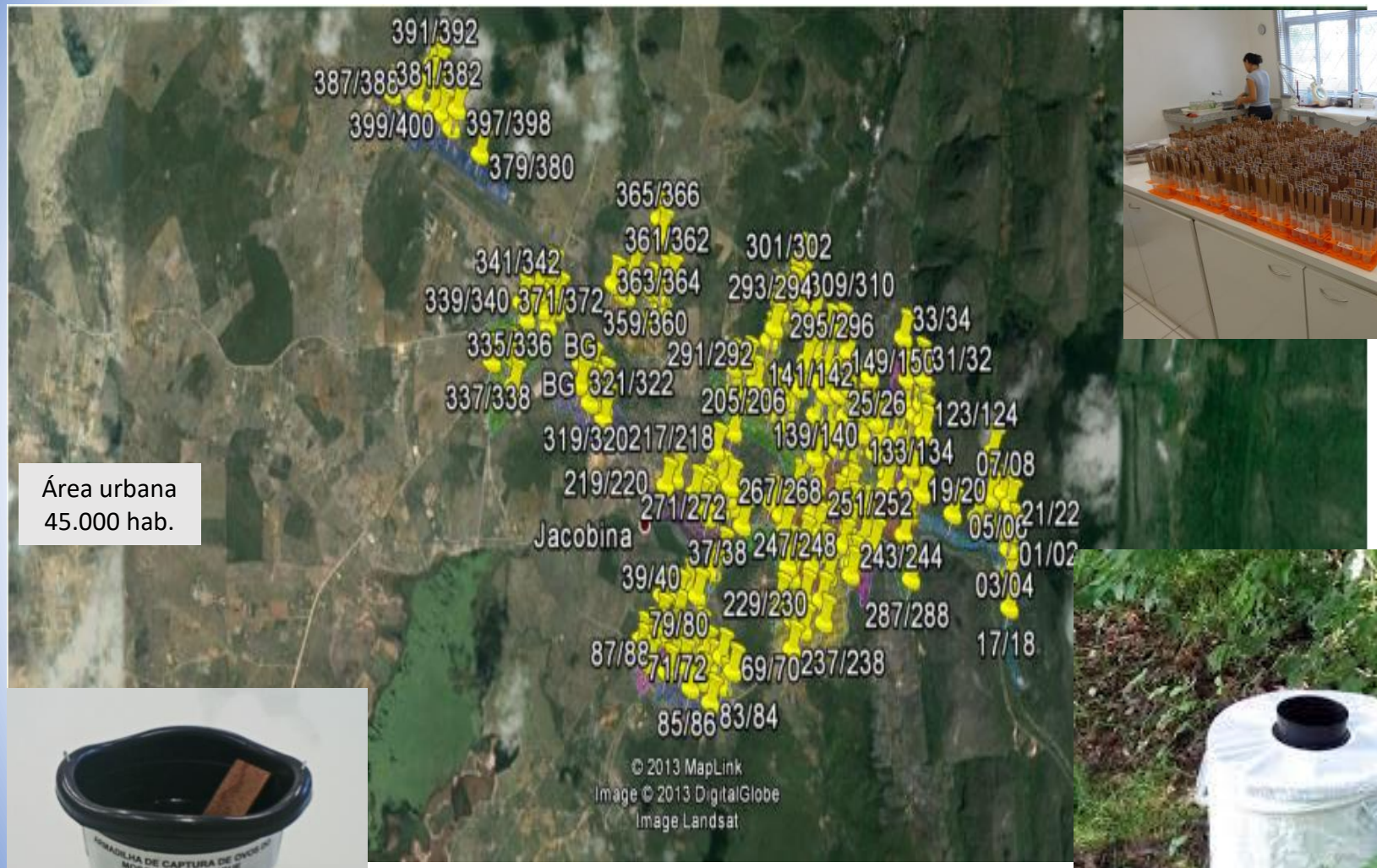
Population Suppression Program



Release site / Sitio de Lanzamiento



MONITORAMENTO



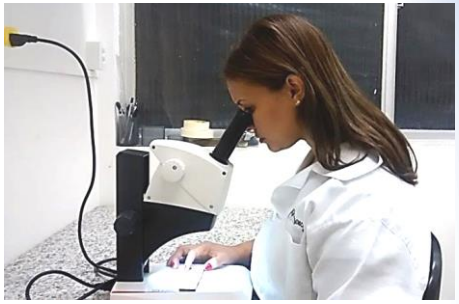
Área urbana
45.000 hab.

MONITORAMENTO

Preparação do material

Coleta e substituição

Secagem



Contagem de ovos

Eclosão

Monitoring *Aedes aegypti/albopictus*

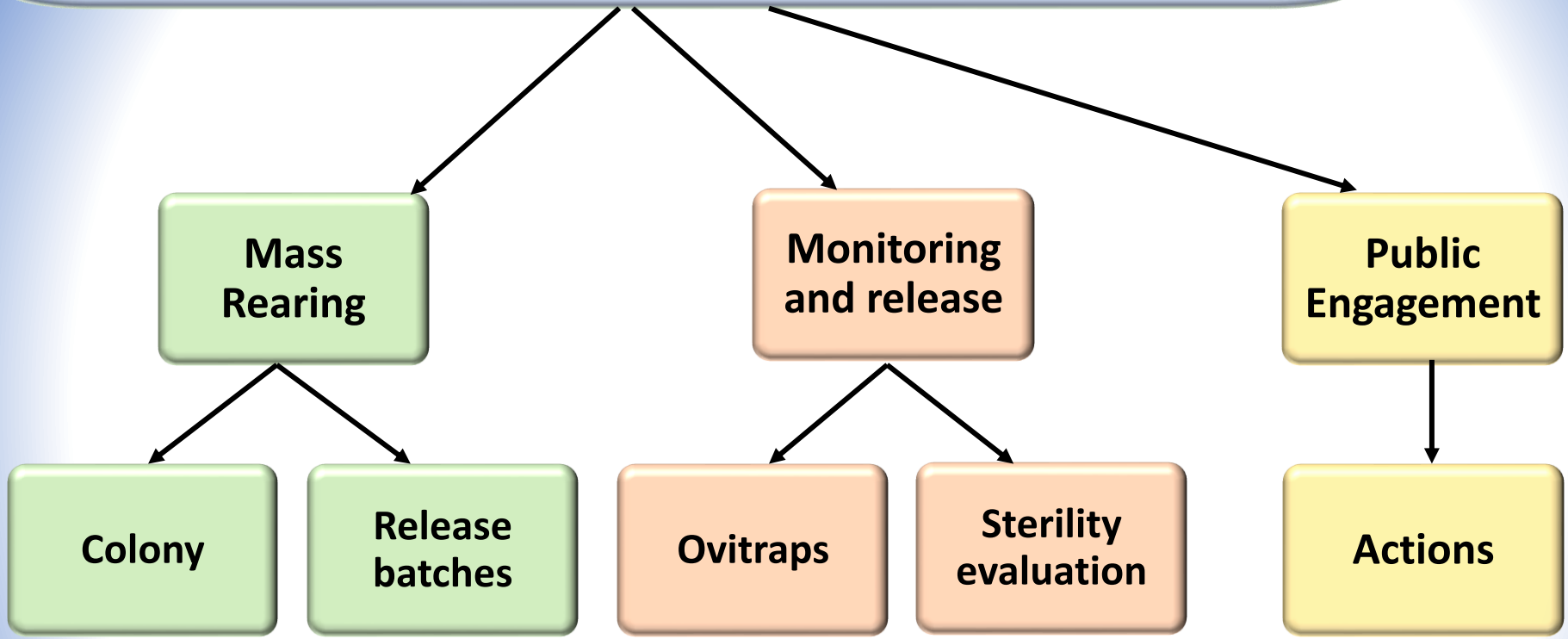
-Colony for genetic markers
-Monitoring flavivirus presence
-Population estimation

Ovitraps and Adult Traps

Community Engagement

-Folders
-TV
-Radio
-Meeting with the community

Population Suppression Program



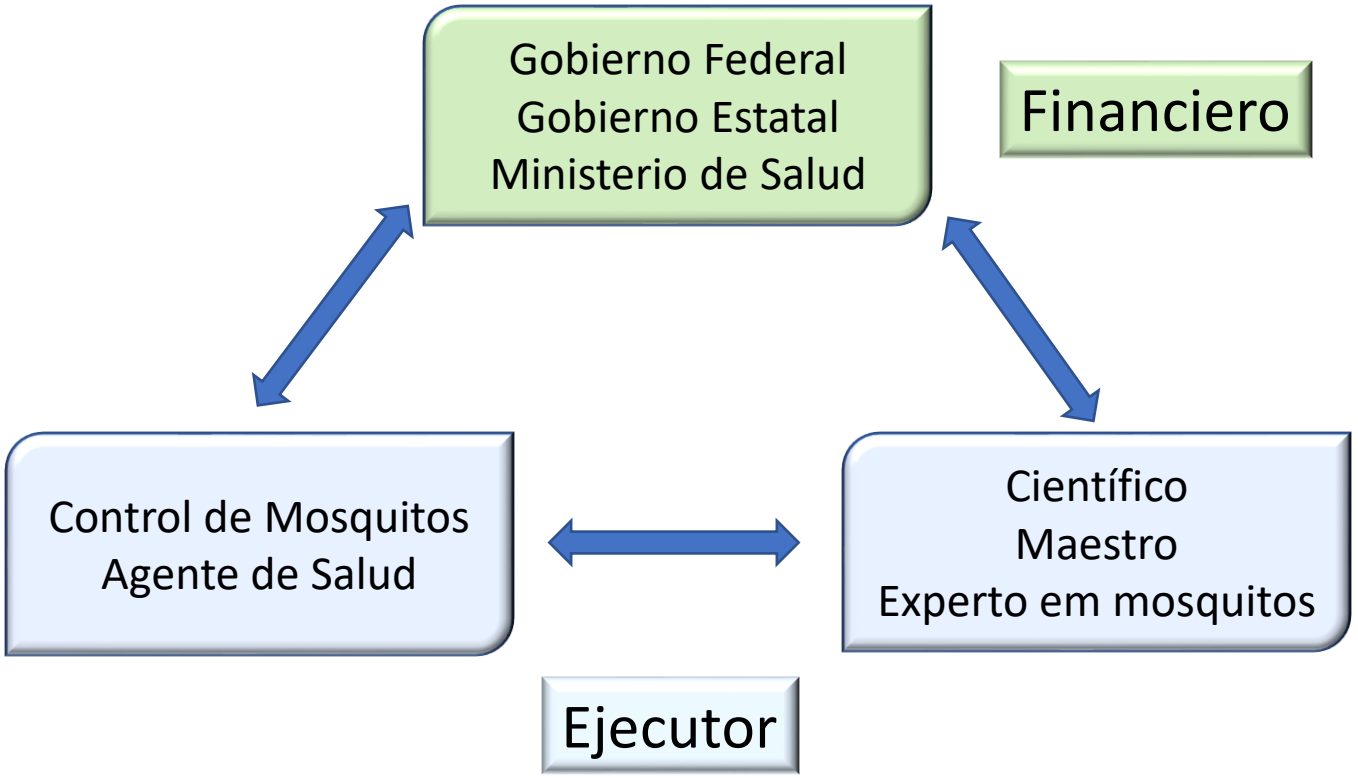
Stakeholders - partes interesadas

- *Stakeholders* significa audiencia estratégica y describe a **todas las personas** o "**grupos de interés**" que se ven afectados por las acciones de una empresa, proyecto, empresa o negocio.

- Ampliamente utilizado en las áreas de **comunicación, administración y tecnologías de la información,** cuyo objetivo es designar a las partes interesadas de una planificación estratégica o plan de negocios.

- empleados
- gestores
- gerentes
- proprietarios
- provedores
- competidores
- ONGs
- clientes
- el Estado
- acreedores
- sindicatos
- otras personas o empresas relacionadas con el proyecto.

Stakeholders - partes interesadas



Expertos
y
Gobierno
(financieros)

- Reuniones con: agentes de salud y endémicos, líderes comunitarios (Ejecutor)

Conferencias em las escuelas







Visitas domiciliarias (Agentes y expertos sanitarios)

Conferencias para la comunidade

Media: Radio and TV

Local Festivals and Events

Local Festivals and Events


BAHIAACONTECE.COM

BAHIAACONTECE.COM

Information

Mosquito *Aedes* /Dengue

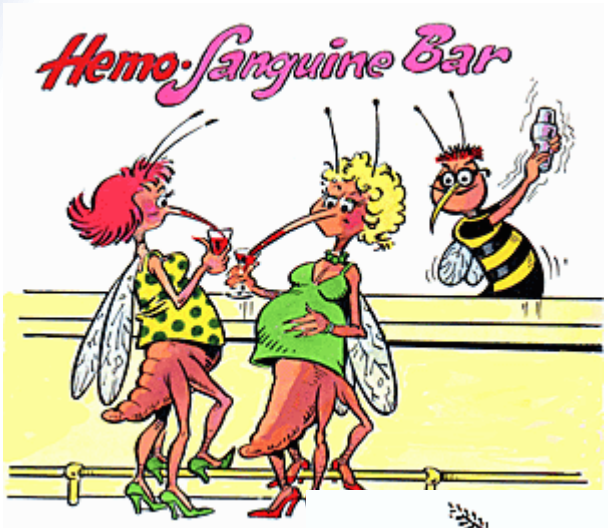
Pica durante o dia (bite during the day)

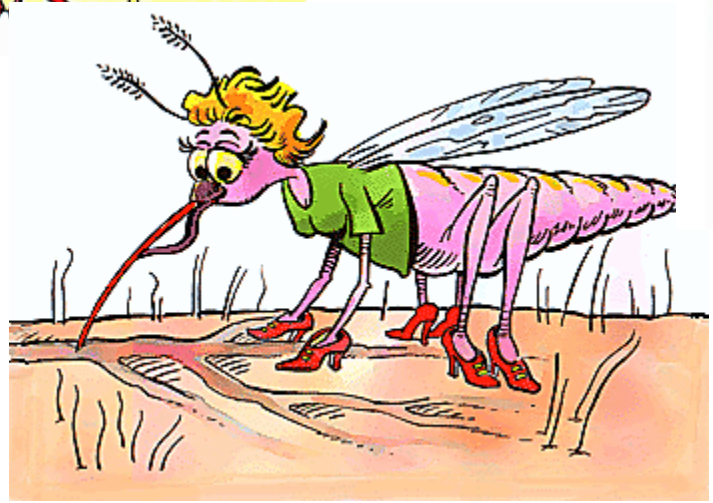
Muriçoca (*Culex)*

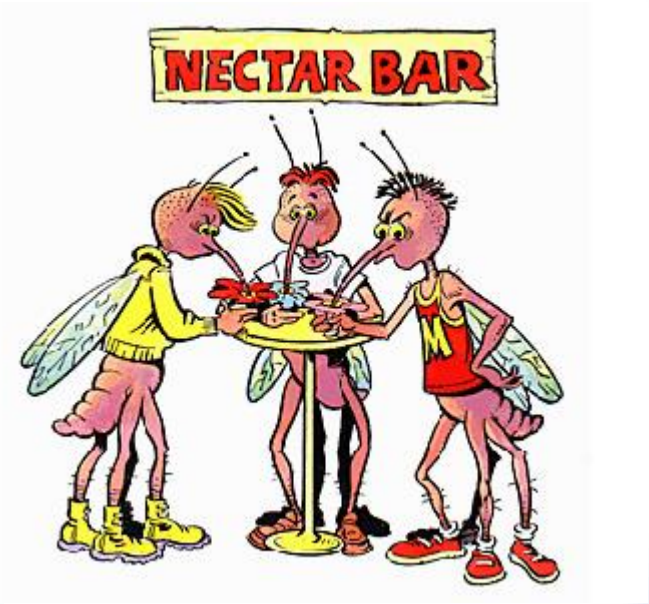
Pica durante a noite (bite during the night)

Information

Only females (girls) bite







Fonte: Google

Como isso acontece?

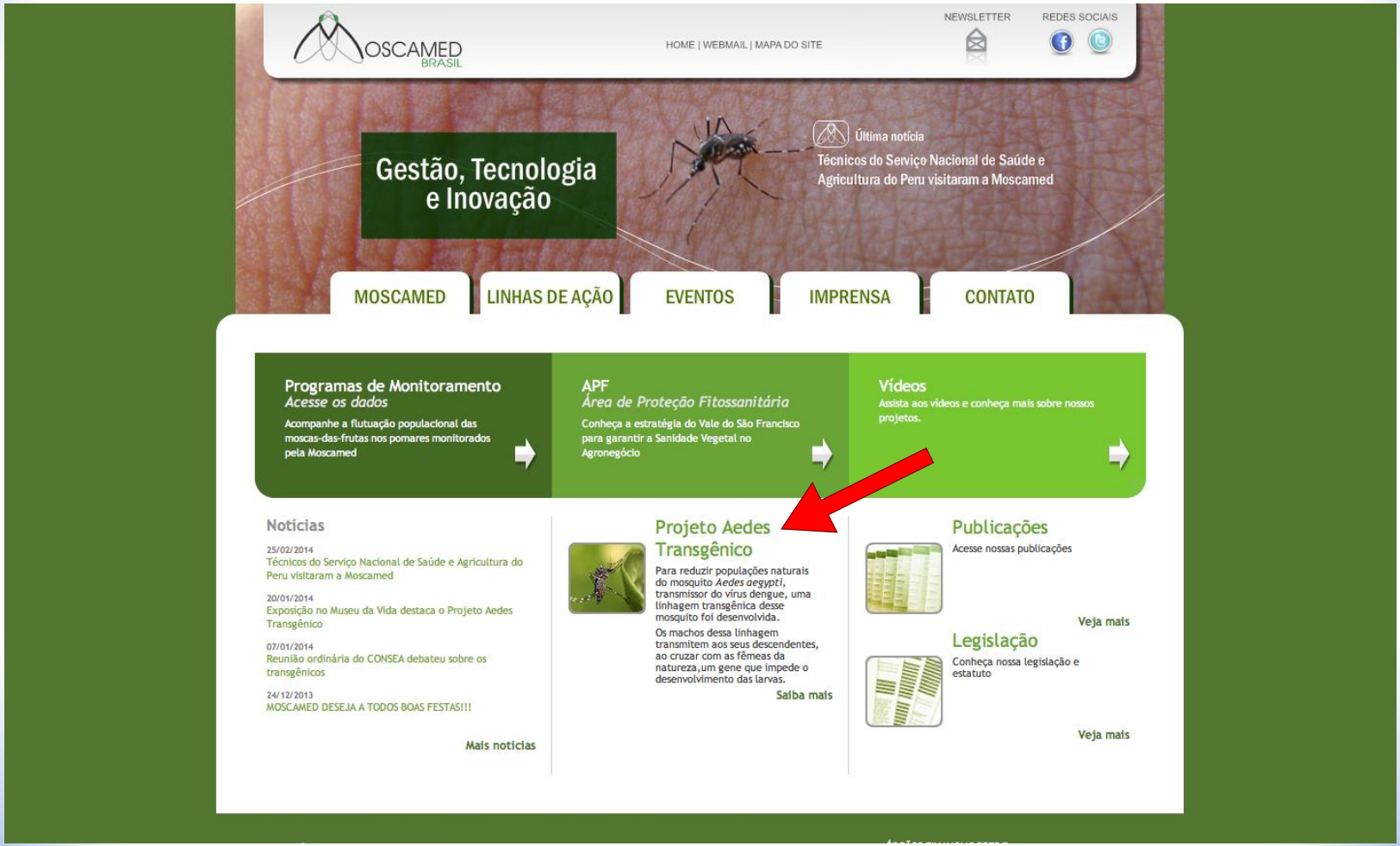
- Após namorarem a fêmea do mosquito fica grávida
- Ela “bota” os ovos.
- Mas as larvas não nascem!!!!

A fêmea coloca os ovos

NÃO NASCE!!!!

Leaflet distribution

The project on internet

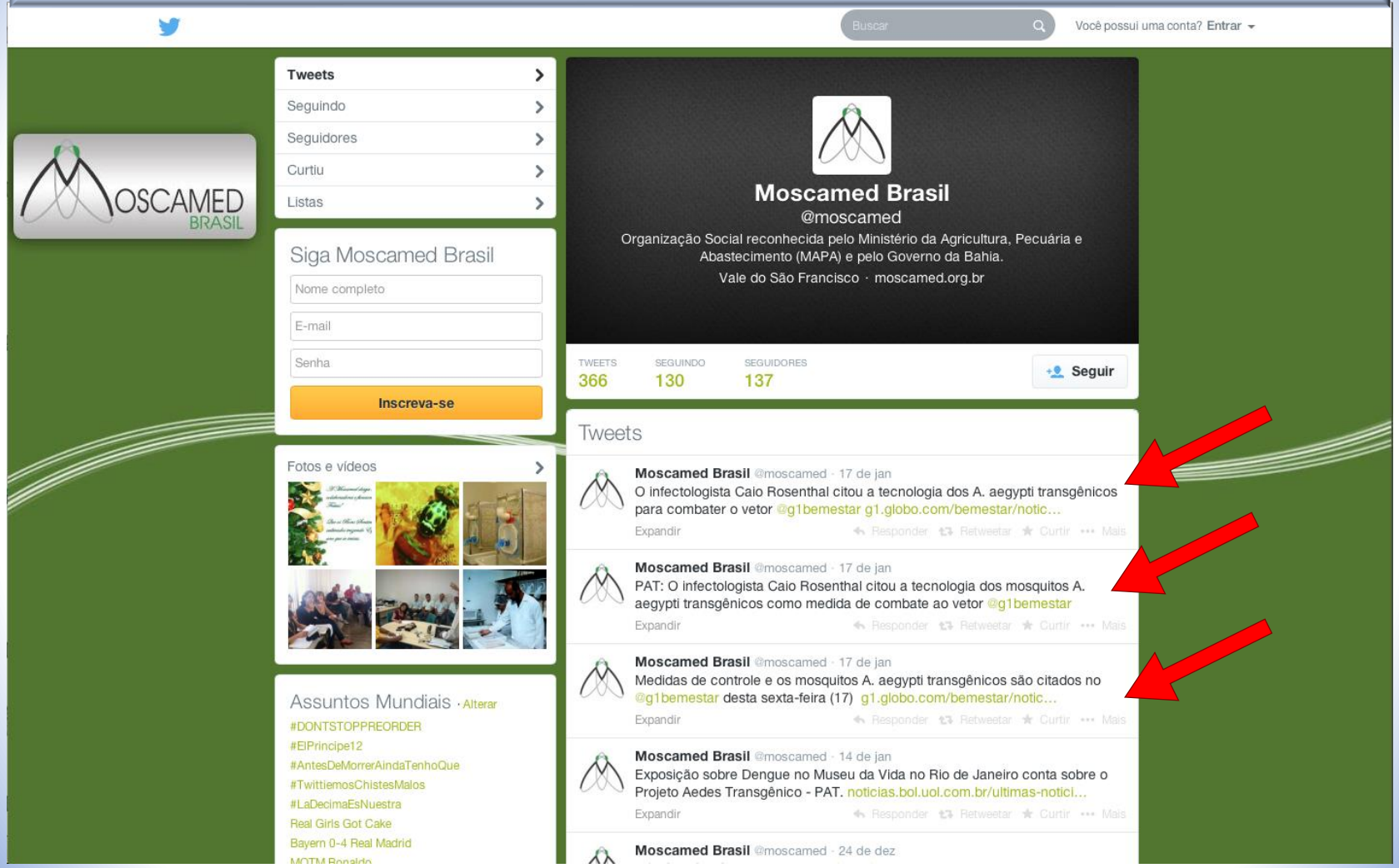


http://www.moscamed.org.br

The project on internet

facebook.com/Moscamed-Brasil

The project on internet



twitter.com/moscamed

Acciones de Comunicación

Acciones	Nivel de población	Repeticiones	Gente informada
Presentación de la conferencia	Local/Regional	10	962
Folletos	Local		10.000
Jingle	Local		
Reuniones	Nacional/Internacional	39	6.020
Entrevistas de radio	Regional	15	1.500
Entrevistas de televisión	Regional/Nacional	9	17.094.000
Entrevistas en periódicos y revistas	Local/Regional/Nacional	13	
Internet (website/social media)	Regional/Nacional/Internacional	24	
Casas visitadas/entrevista con residentes	Local	581	2.341
Reunión con líderes locales, trabajadores de la salud	Local	16	820
Presentaciones escolares	Local	8	452
Presentaciones en centros comunitarios y Cámara de Concejales y otros	Local	6	456
Coche de sonido	Local		500
Spots, Jingles, mensajes de estaciones de radio	Local	52	1.200
TOTAL			17.101.269

CUESTIONARIO DE EVALUACIÓN POSTERIOR A LA LIBERACIÓN PAT-JUAZEIRO

Evaluación Posterior a la Liberación	Itaberaba (%)	Mandacaru (%)	Combinado (%)
¿Alguna vez has oído hablar de PAT?	84	93,5	88
¿Sabe si se han producido liberaciones en esta zona?	94,1	97,3	95,5
¿Han cambiado los lanzamientos tu rutina?	12,7	4,3	9
¿Cree que este proyecto puede ayudar con el control del dengue?	83,1	95,2	88,4
¿Le molestaron las visitas de los agentes?	0,8	1,1	0,9
¿Entendiste los resultados del Proyecto?	46,8	77	60,1
¿Quieres que el proyecto continúe?	89,5	95,7	92,2
¿Sabías que incluso con el proyecto se deben realizar acciones de control contra el dengue?	98,7	98,4	98,6

Public Engagement Timeline

Action		Period			
		Pre-release	Release		Post-release
		2010*	2011	2012	2013*
Domiciliary visit					
Internet	Social Network				
	Web site				
Interviews / appearances	TV				
	Radio				
	Newspaper				
	Magazines				
Jingle broadcast					
Leaflets distribution					
Meeting local leaders					
Questionnaires					
School presentations / lectures					
Trapping					
Truck loudspeakers					

* - In both years, the columns are representing the last two semesters and the first two respectively.

Ejemplo de Spot y Jingle utilizado durante o PAT

SPOT

To control dengue Moscamed is releasing in this community

A large amount of TRANSGENIC MOSQUITOES .

We would like to recall that this mosquitoes are not the well known

CULEX

They are transgenic MALES and they DON'T BITE.

They are good fellows that will give you protection against dengue.

For more information call a health agent or get in touch with

MOSCAMED

By the phone

(74) 3612-5399

PAT –AEDES TRANSGENIC PROJECT

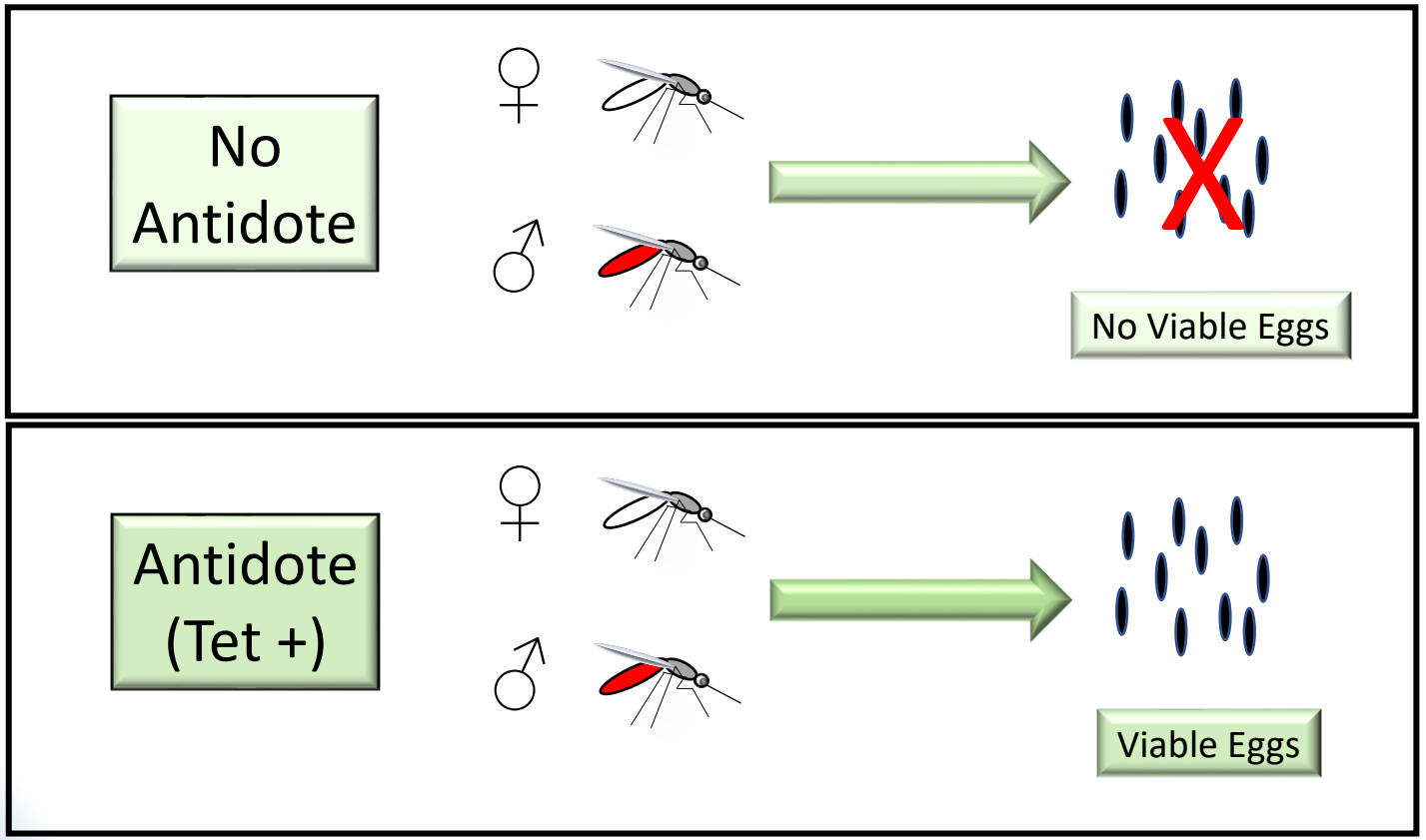
This one makes the difference.

Jingle Transgenic *Aedes*

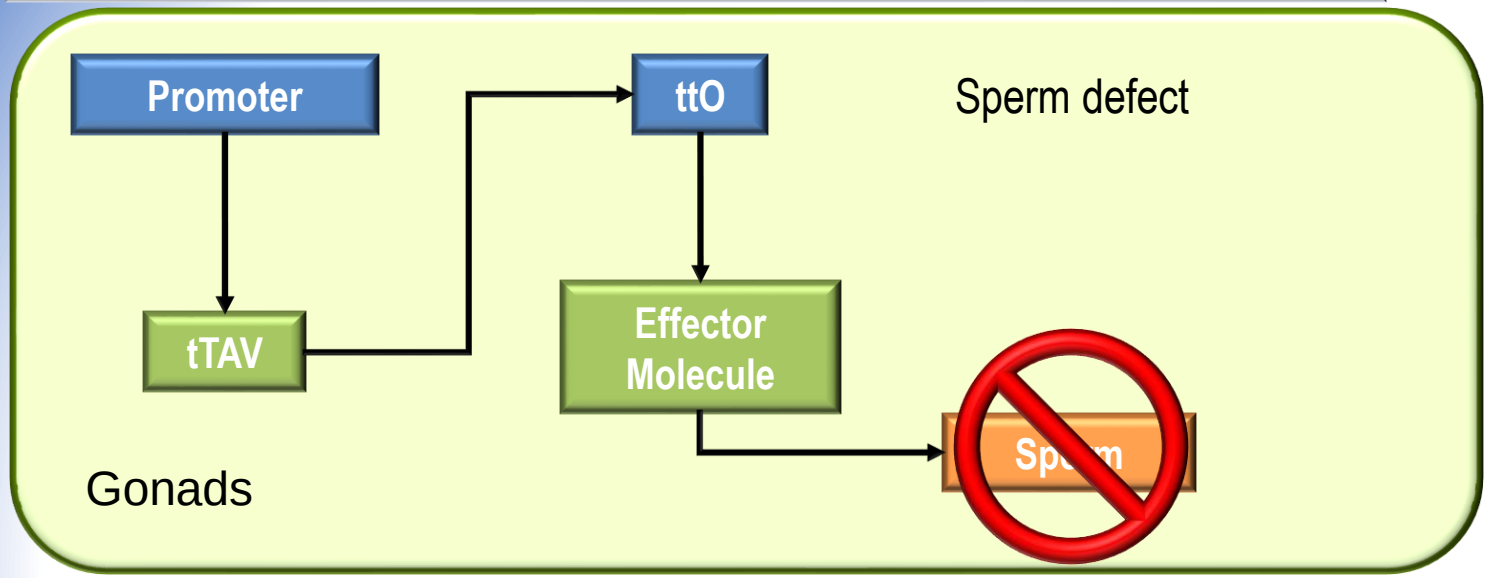
What did we learn?

- We need Genetic Sexing Strain (GSS)
- Producing Sterile male strain (no Larvae)
- Use of tetracycline only in colonies

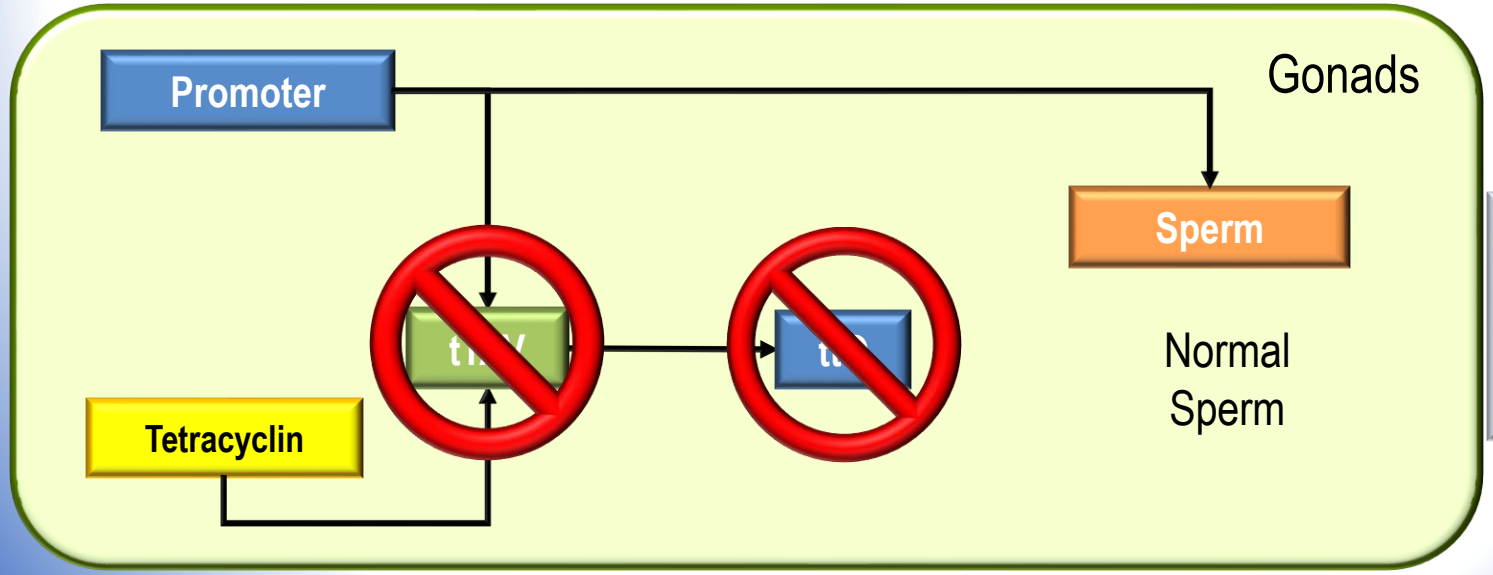
Sterility Conditional Construct - SCC



Sterility Conditional Construct - SCC

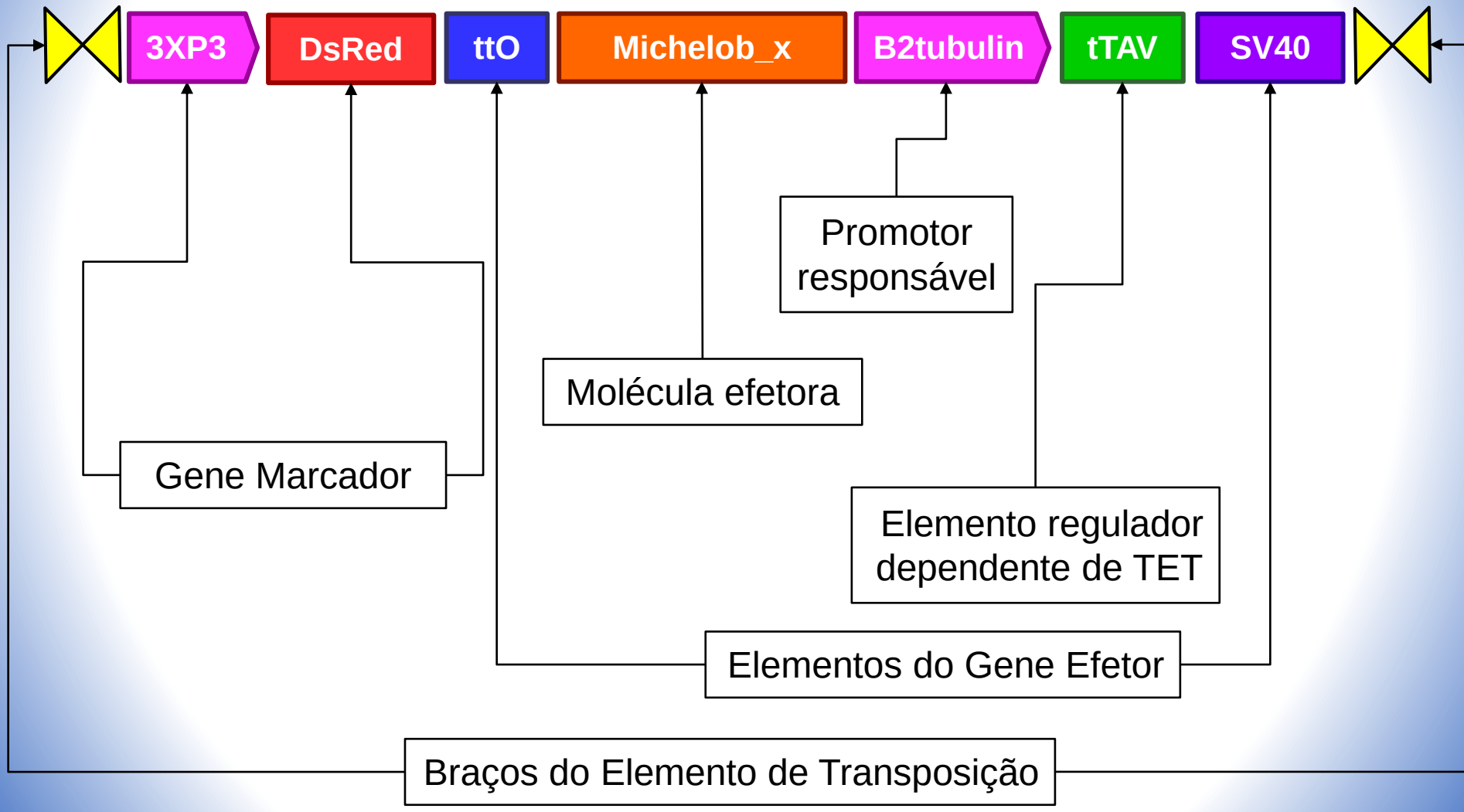


Males to Release

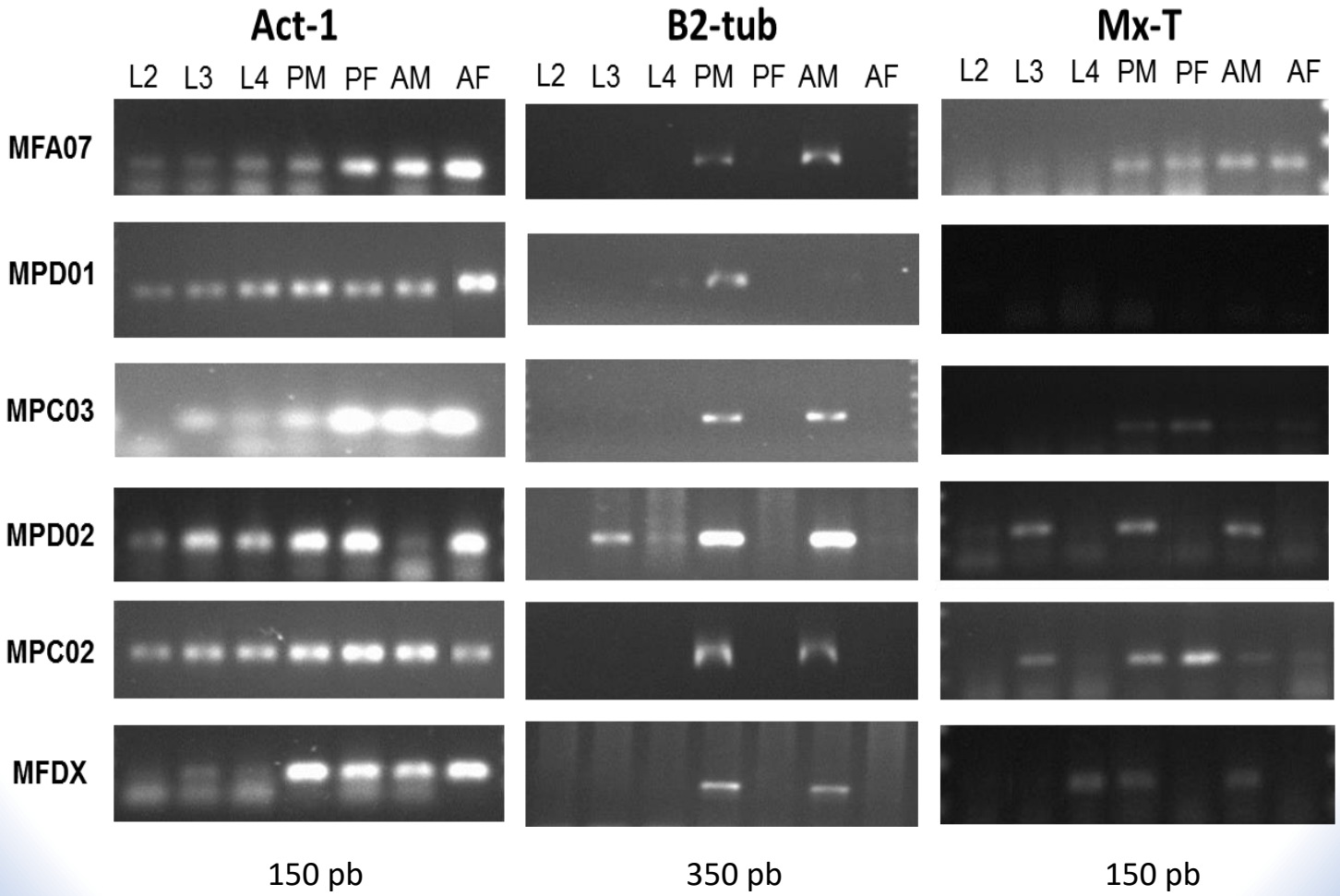


Egg Production

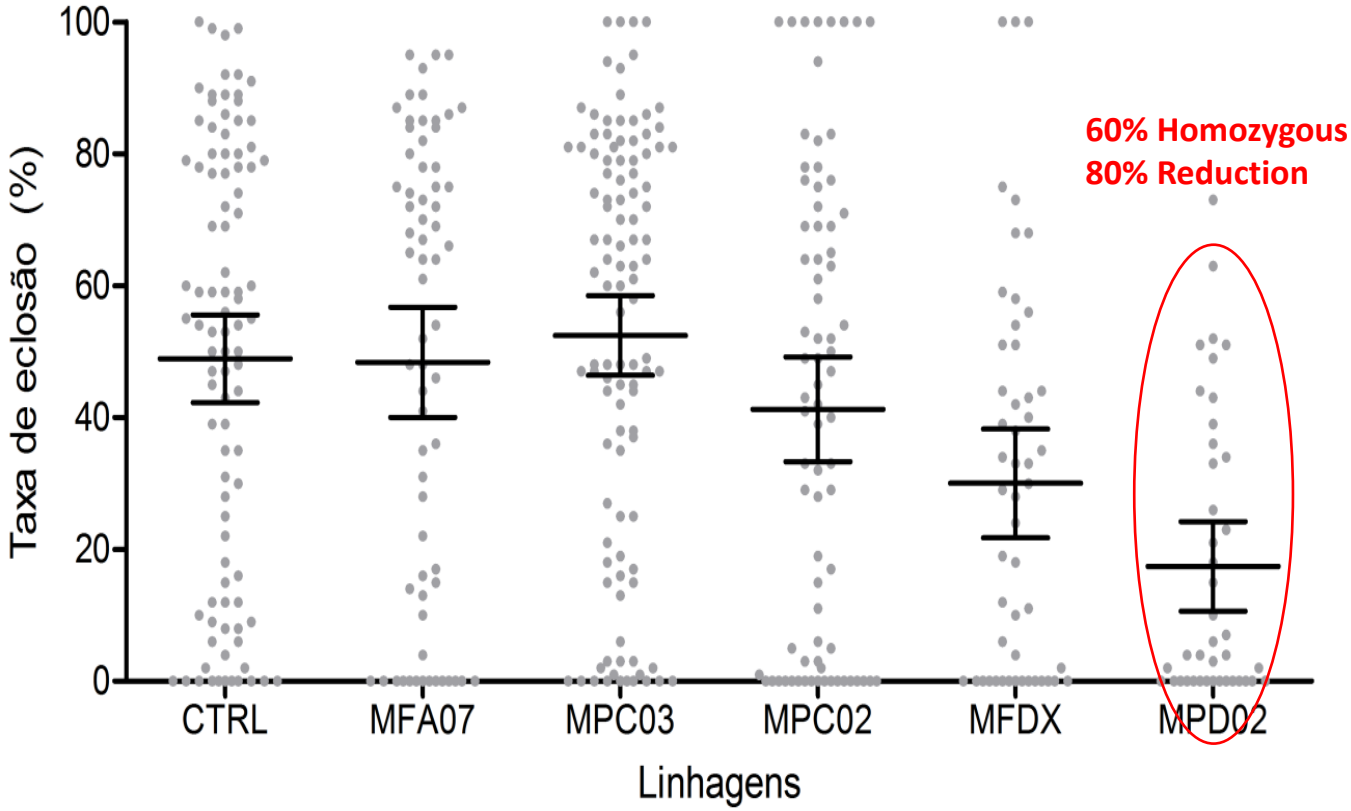
SCC Transgene



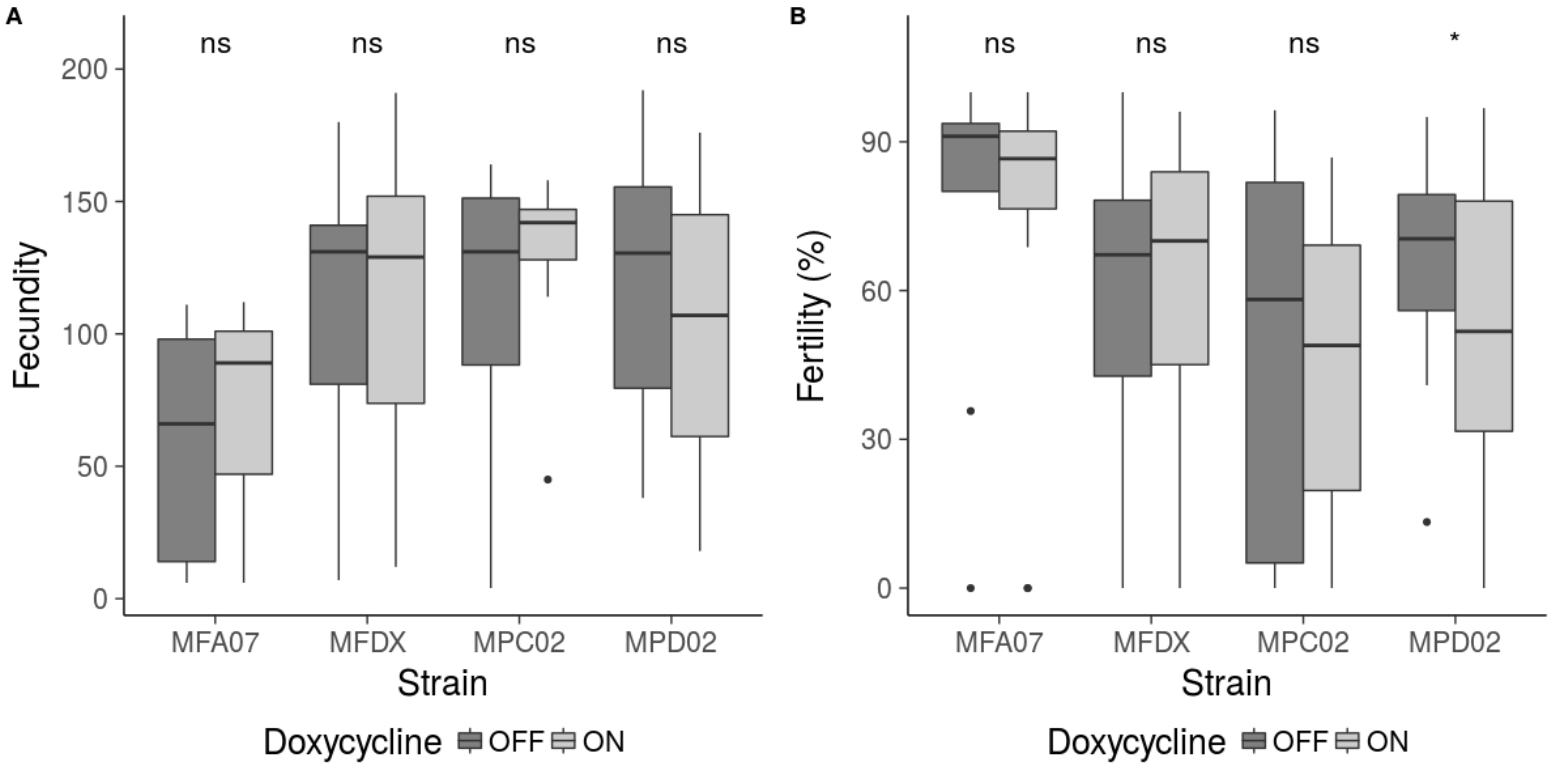
Transgenic Lines



Sterile Conditional Construct (SCC)



Sterile Conditional Construct (SCC)



Dengue Prevention and 35 Years of Vector Control in Singapore

Eng-Eong Ooi,* Kee-Tai Goh,† and Duane J. Gubler‡

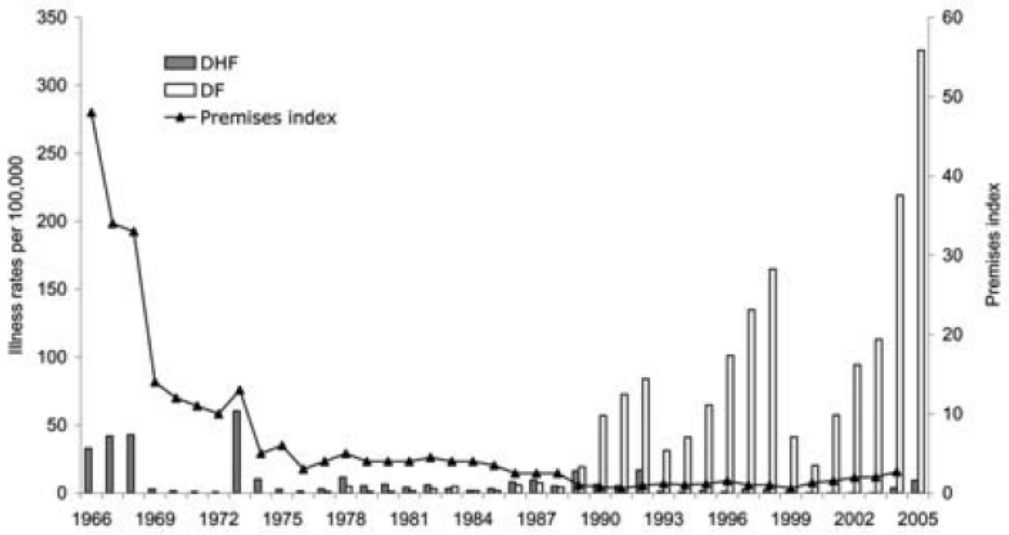
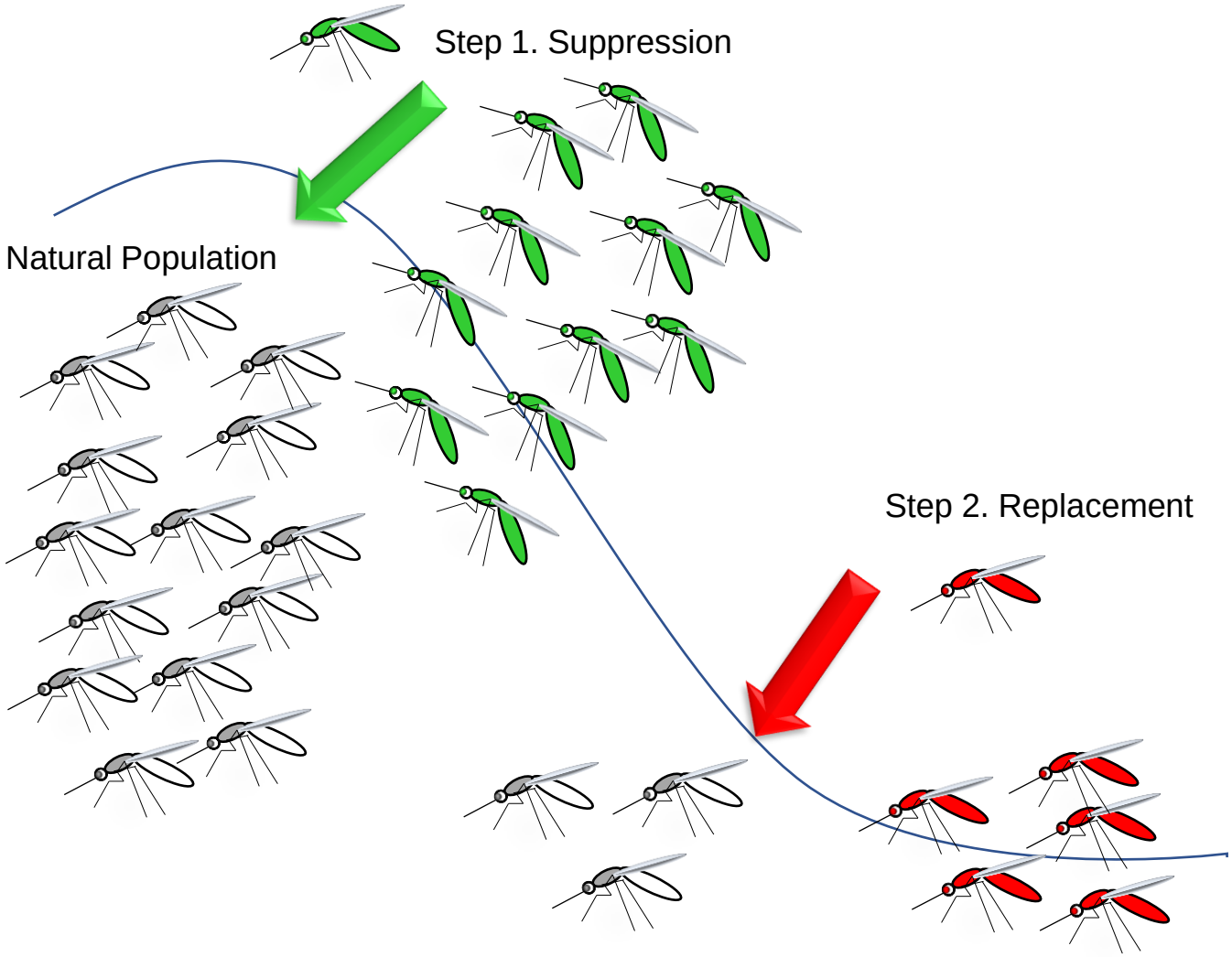


Figure 1. Annual incidence dengue fever (DF) and dengue hemorrhagic fever (DHF) and the premises index, Singapore, 1966–2005. DHF was made a notifiable disease in 1966, while DF became a notifiable disease in 1977. The annual incidences of DF and DHF reported in this figure were calculated from the number of reported cases each year from 1966 to 2004. The annual premises index is expressed as a percentage of the premises in which *Aedes aegypti* or *A. albopictus* larvae were found divided by the number of premises visited by environmental health officers.

Emerging Infectious Diseases • www.cdc.gov/eid • Vol. 12, No. 6, June 2006

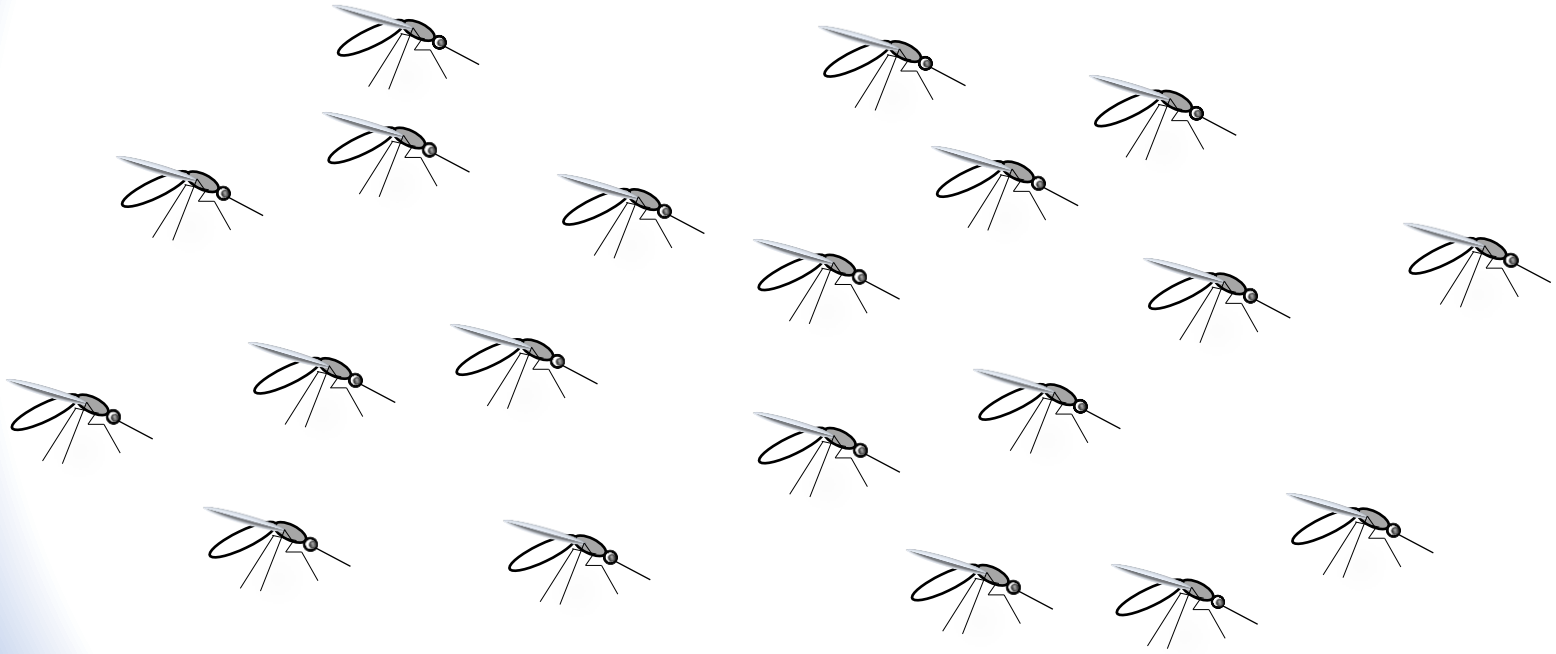
After a 15-year period of low incidence, dengue has reemerged in Singapore in the past decade. We identify potential causes of this resurgence. A combination of lowered herd immunity, virus transmission outside the home, an increase in the age of infection, and the adoption of a case-reactive approach to vector control contribute to the increased dengue incidence. Singapore's experience with dengue indicates that prevention efforts may not be sustainable. For renewed success, Singapore needs to return to a vector control program that is based on carefully collected entomologic and epidemiologic data. Singapore's taking on a leadership role in strengthening disease surveillance and control in Southeast Asia may also be useful in reducing virus importation.

Gene Drive – Introdução Gênica


Step 1. Suppression
Natural Population
Step 2. Replacement

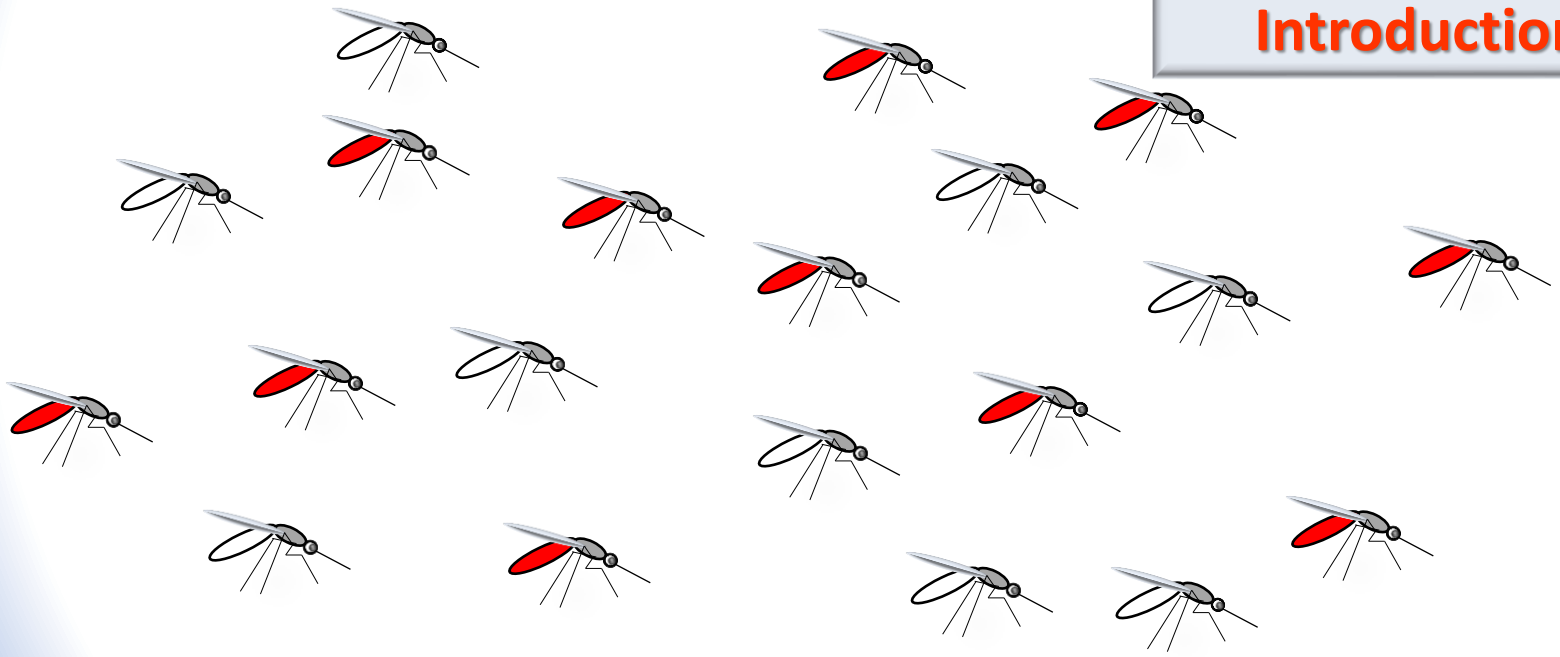
Gene Introduction
Virus-regulated mosquito gene
Suicidal Model (Double death model)

Natural Population



Gene Introduction
Virus-regulated mosquito gene
Suicidal Model (Double death model)

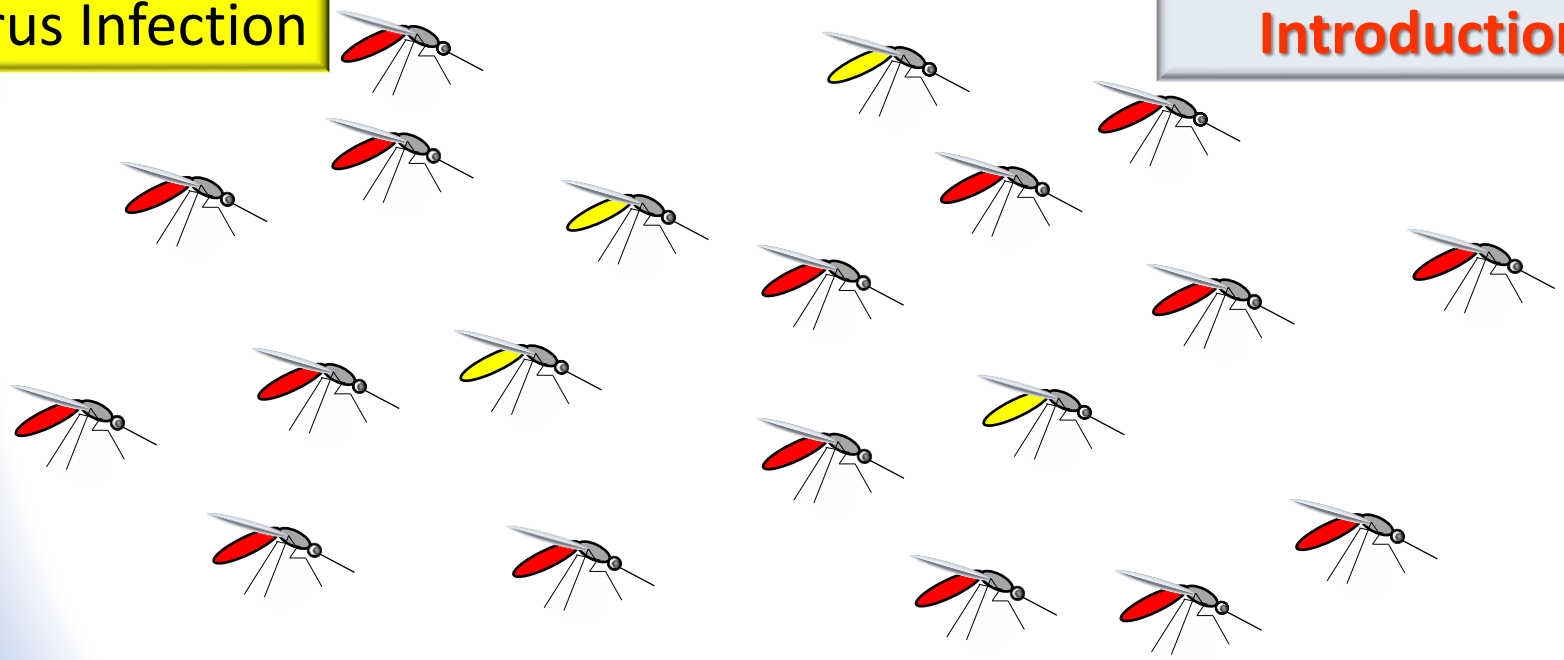
Natural Population
+
Introduction



Gene Introduction
Virus-regulated mosquito gene
Suicidal Model (Double death model)

Natural Population
+
Introduction

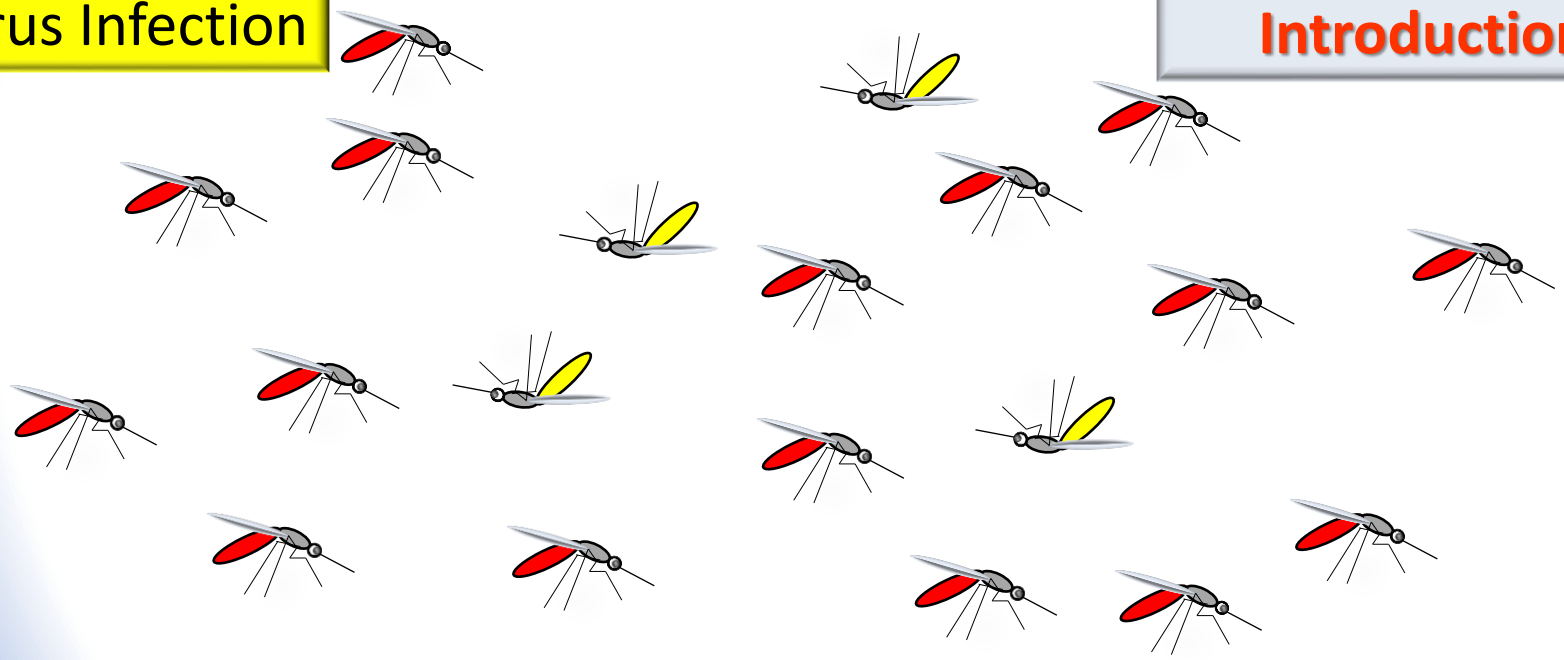
Virus Infection

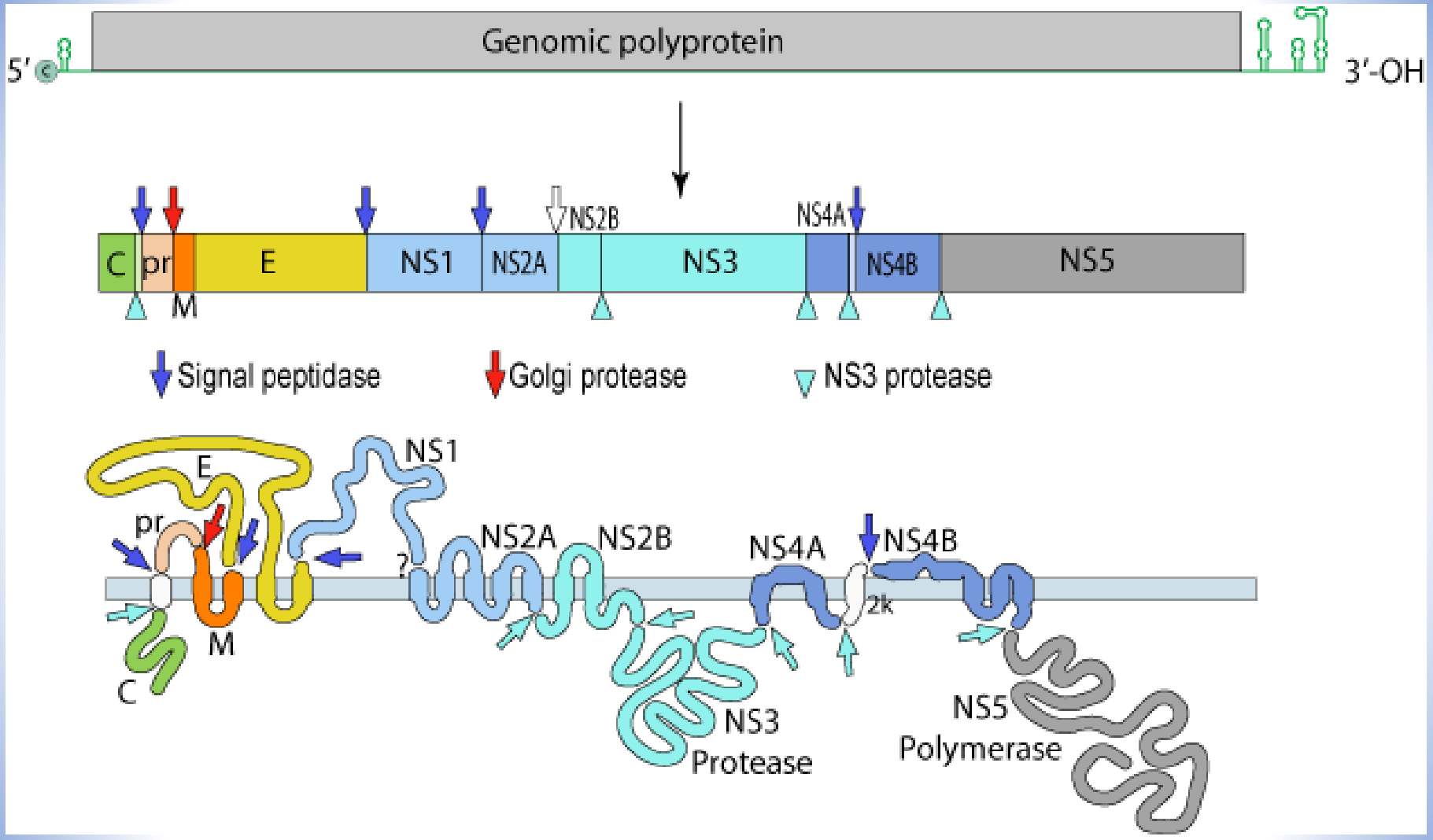


Gene Introduction
Virus-regulated mosquito gene
Suicidal Model (Double death model)

Natural Population
+
Introduction

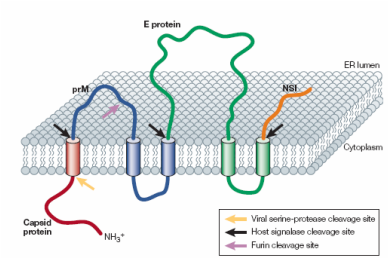
Virus Infection




Genomic polyprotein
5′
3′-OH
C
pr
M
E
NS1
NS2A
NS2B
NS3
NS4A
NS4B
NS5
Signal peptidase
Golgi protease
NS3 protease
?
2k
NS3
Protease
NS5
Polymerase

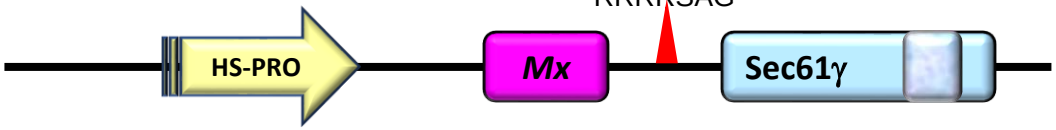
Gene Introduction
Virus-regulated mosquito gene
Suicidal Model (Double death model)

Step 2. Replacement



NS3 Cleavage site

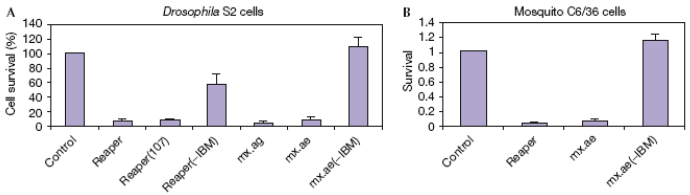
RRRRSAG

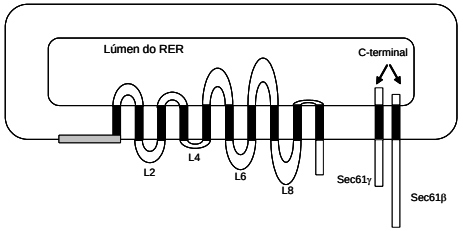


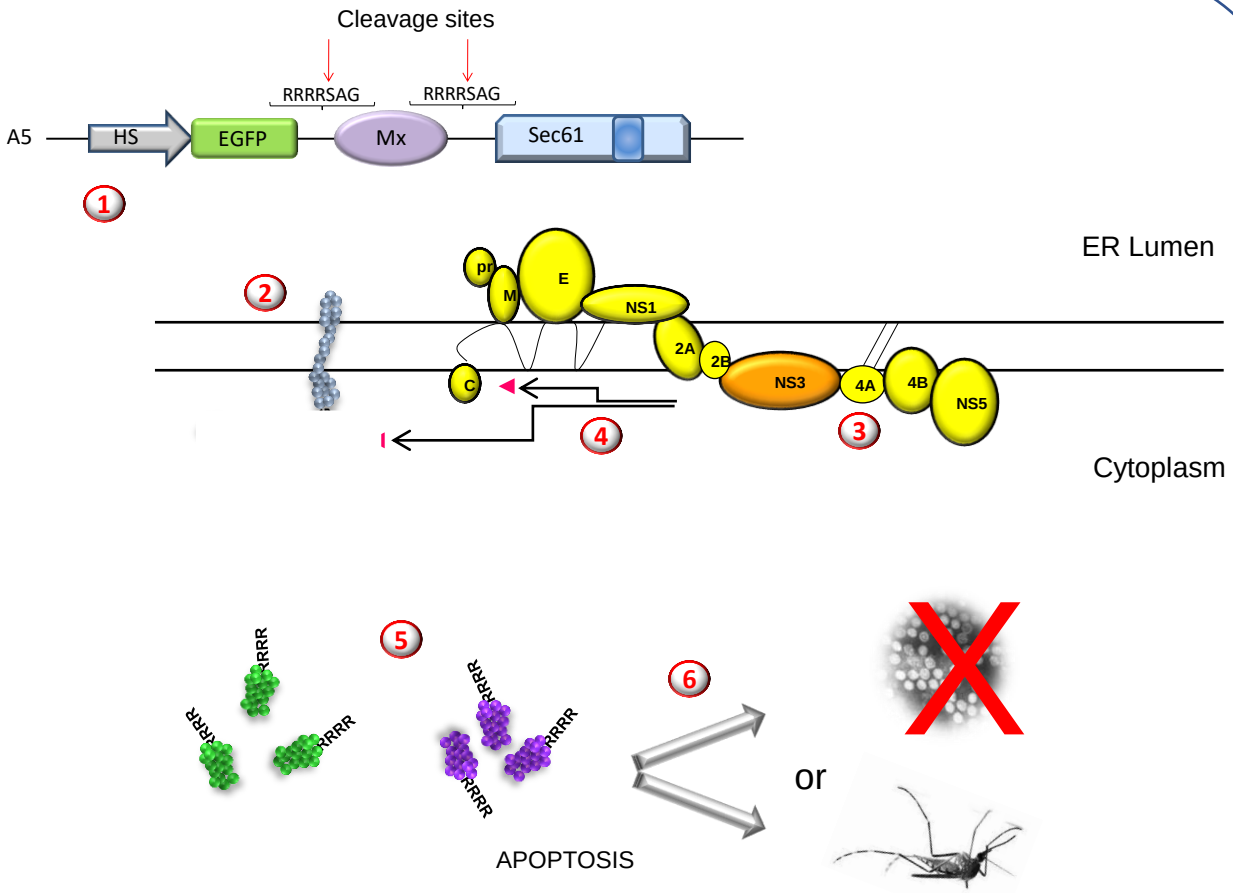
Constitutive Promoter

Lethal protein

ER localization

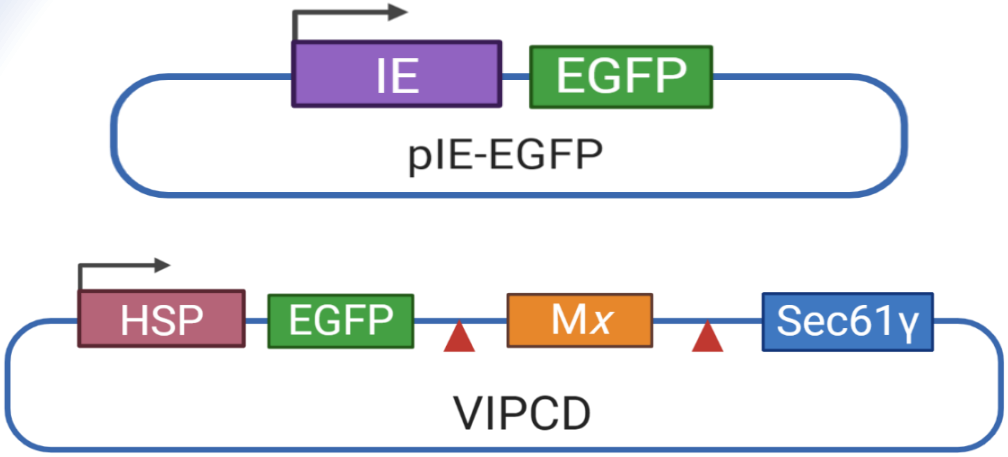




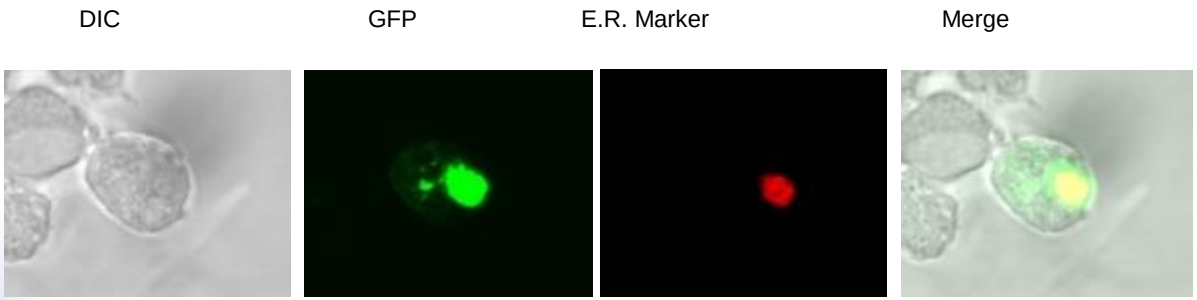


- **Double death model - Infection phenotypes in dengue challenged mosquito?**

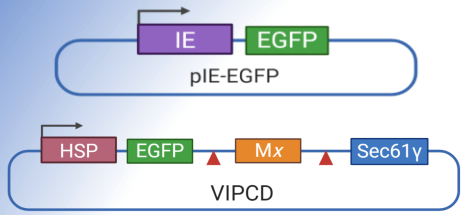
a


IE
EGFP
pIE-EGFP
HSP
EGFP
Mx
Sec61γ
VIPCD

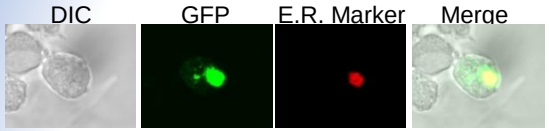
b


DIC
GFP
E.R. Marker
Merge

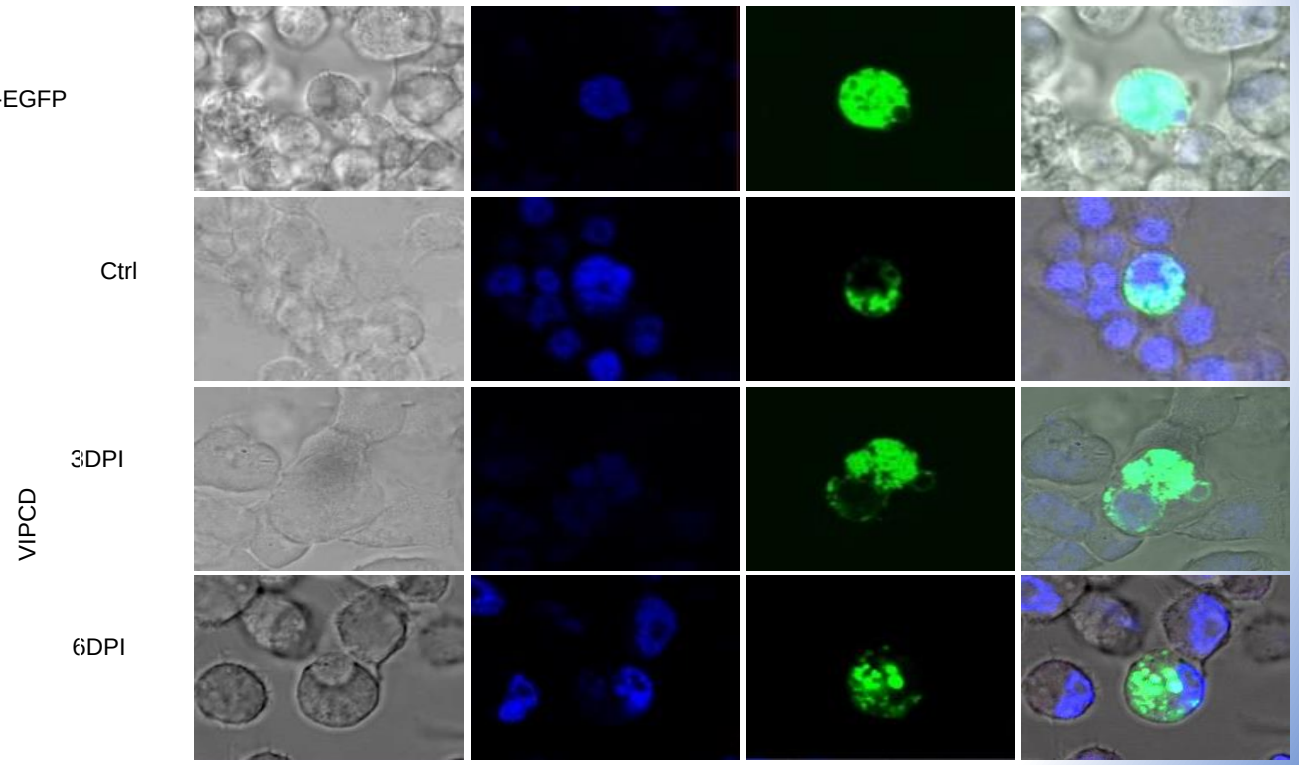
a


IE
EGFP
pIE-EGFP
HSP
EGFP
Mx
Sec61γ
VIPCD

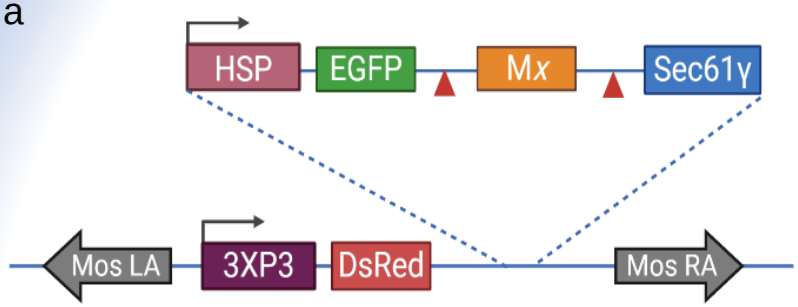
b


DIC
GFP
E.R. Marker
Merge

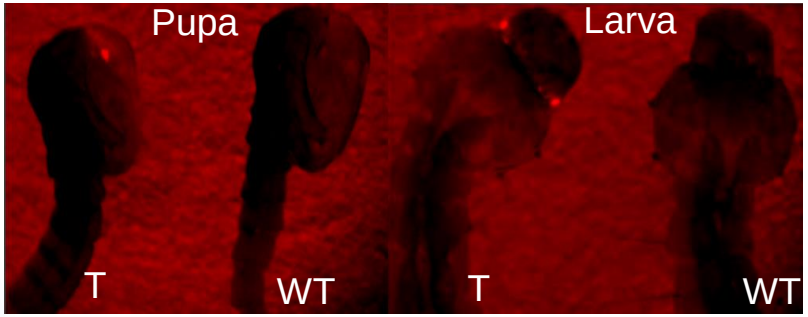
c


Phase
DAPI
GFP
Merged
pIE-EGFP
Ctrl
VIPCD
3DPI
6DPI

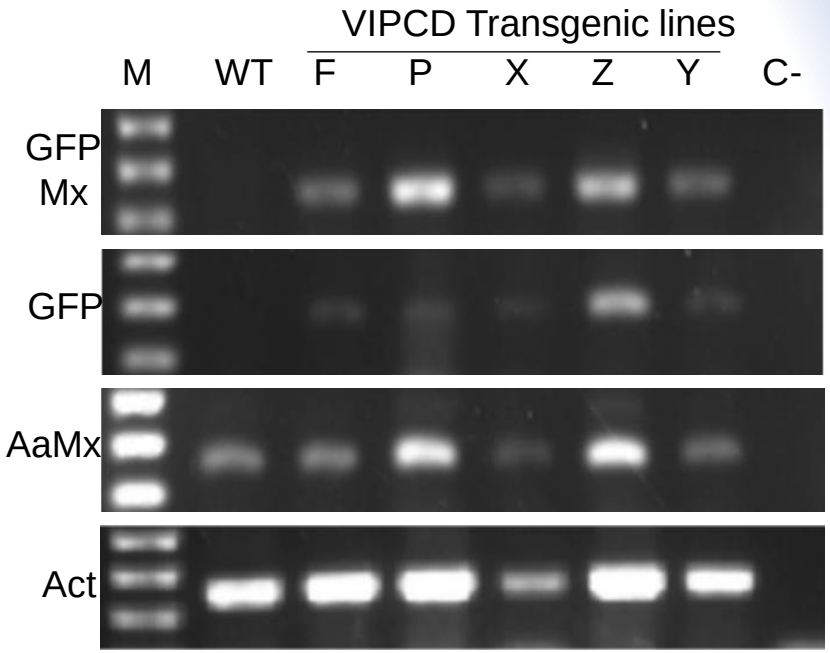
a


HSP
EGFP
Mx
Sec61γ
Mos LA
3XP3
DsRed
Mos RA

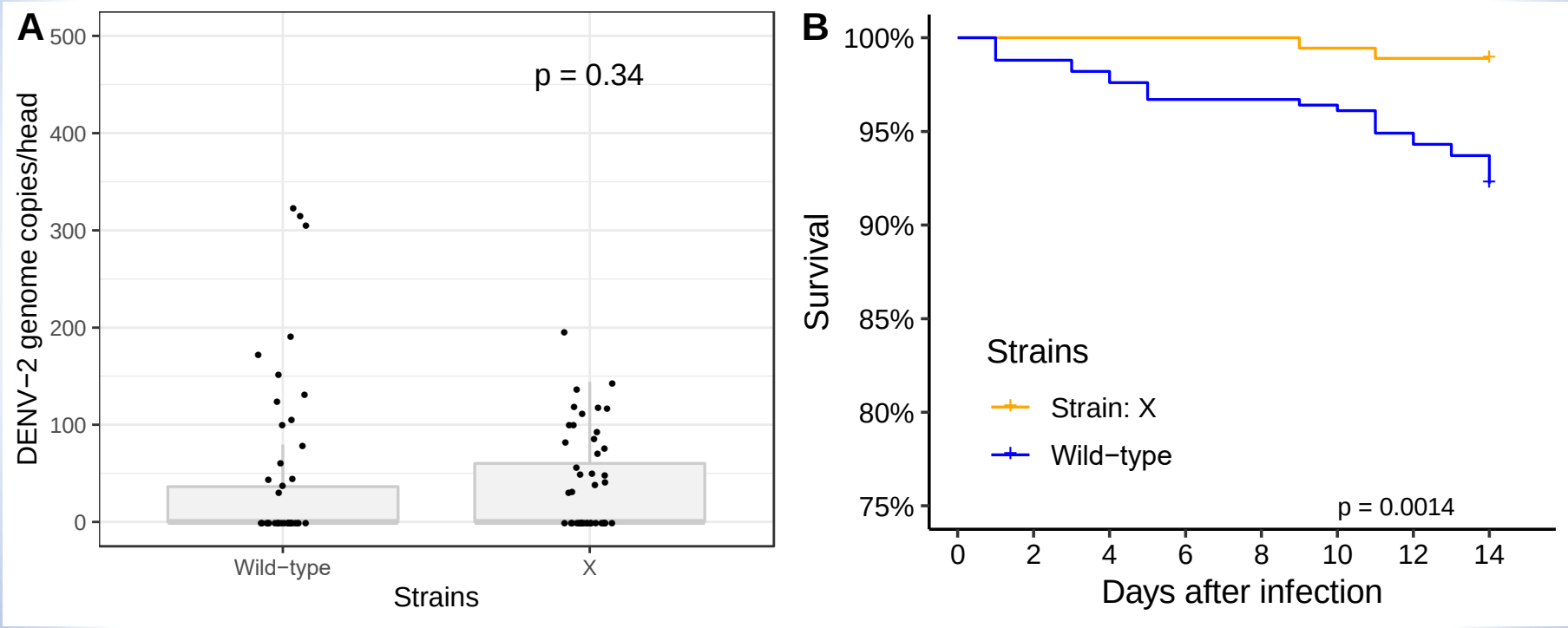
b


Pupa
Larva
T
WT
T
WT

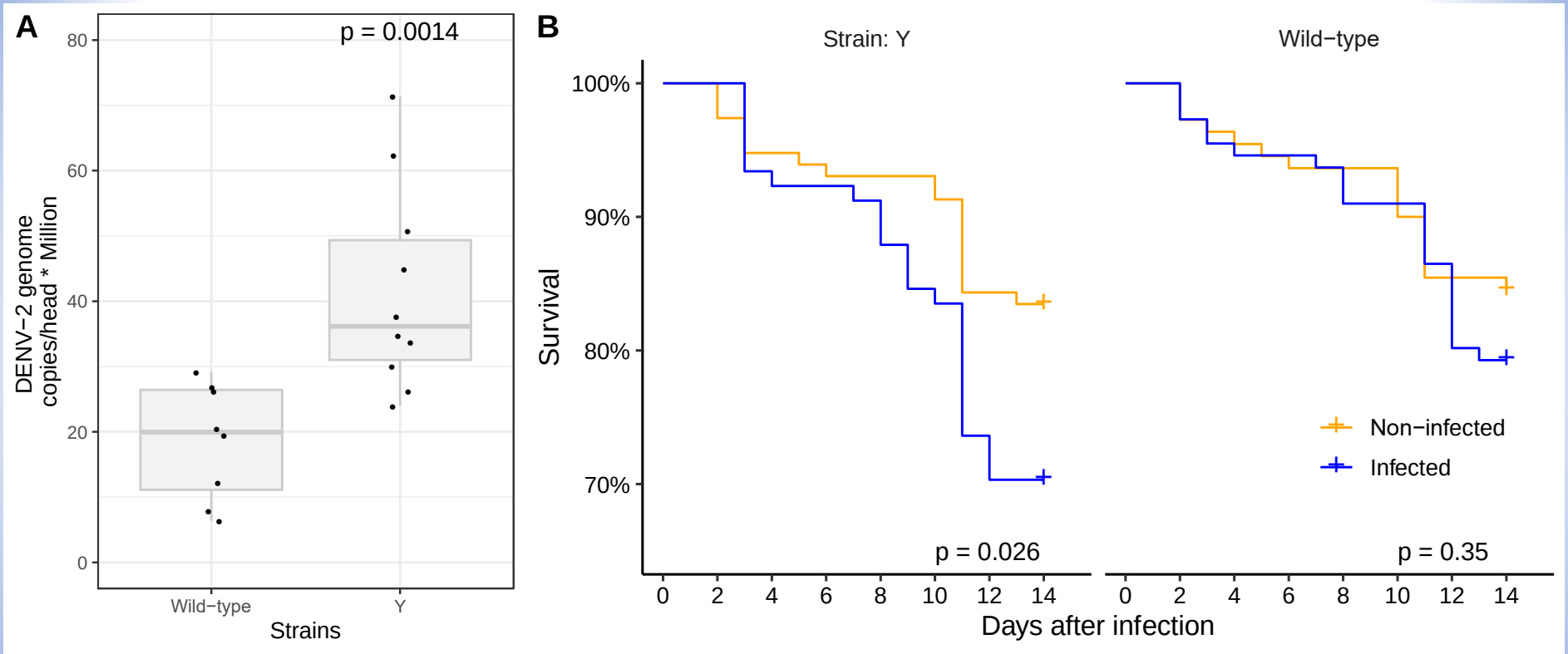
c

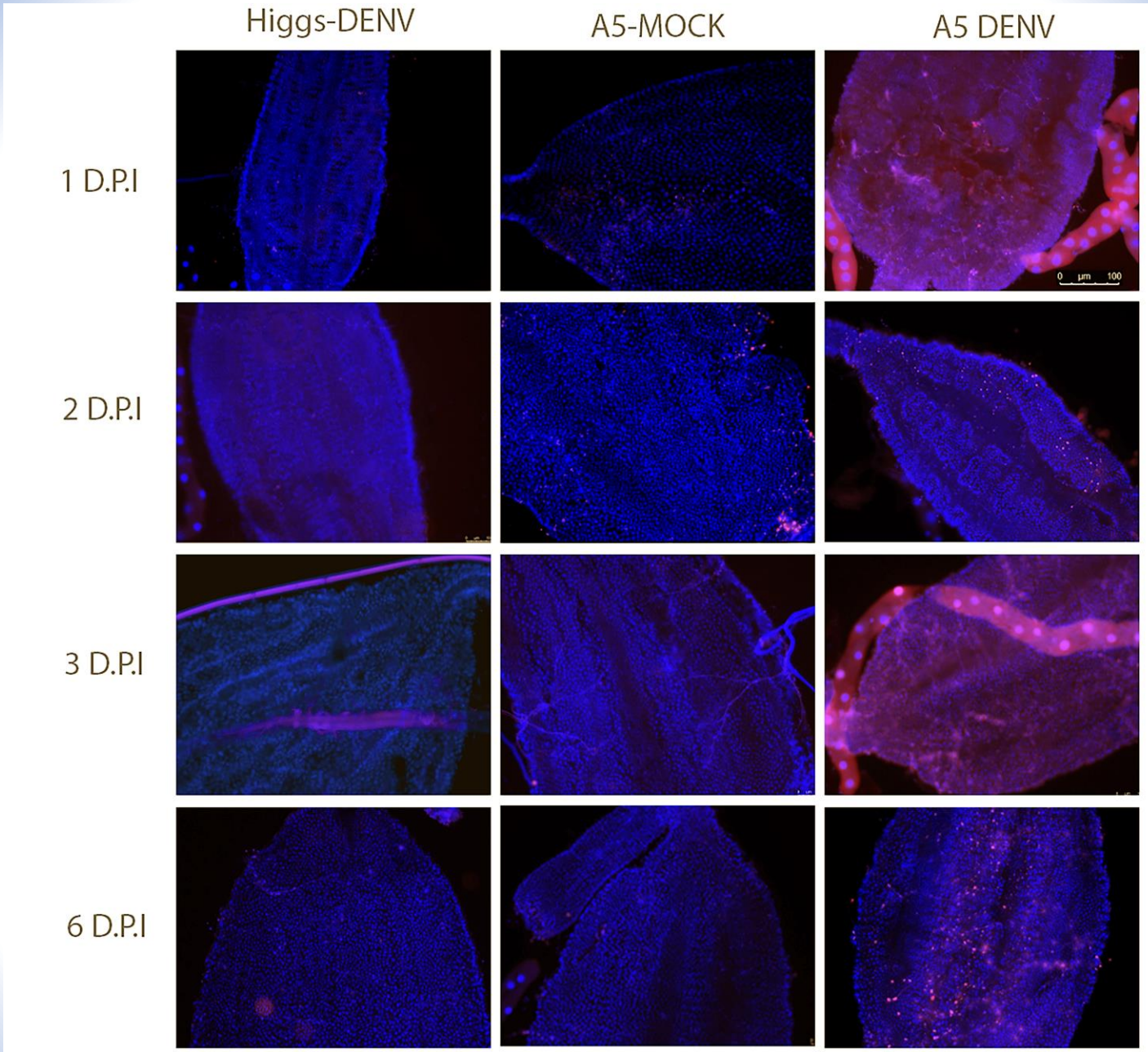

VIPCD Transgenic lines
M
WT
F
P
X
Z
Y
C-
GFP
Mx
GFP
AaMx
Act

Strain: X

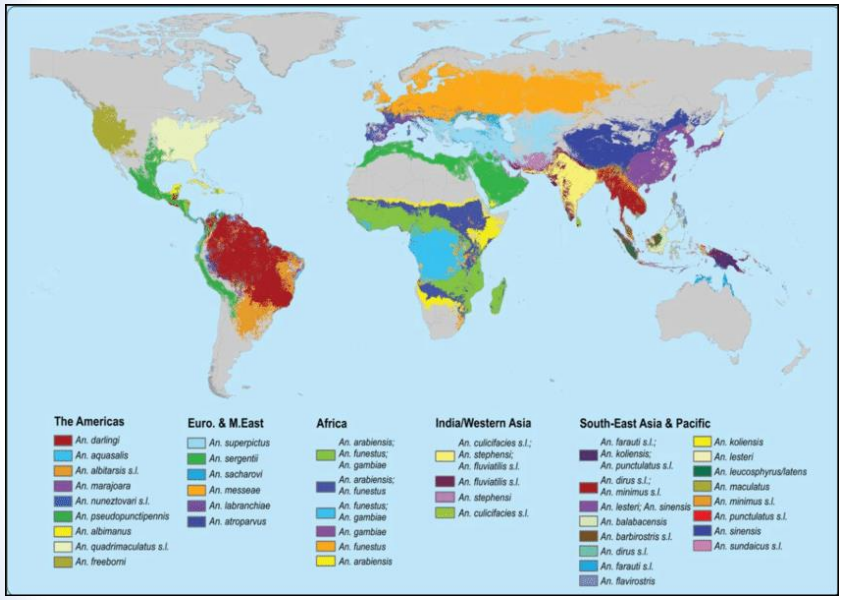

A
DENV−2 genome copies/head
500
400
300
200
100
0
p = 0.34
Wild−type
X
Strains
B
Survival
100%
95%
90%
85%
80%
75%
Strains
Strain: X
Wild−type
p = 0.0014
0
2
4
6
8
10
12
14
Days after infection

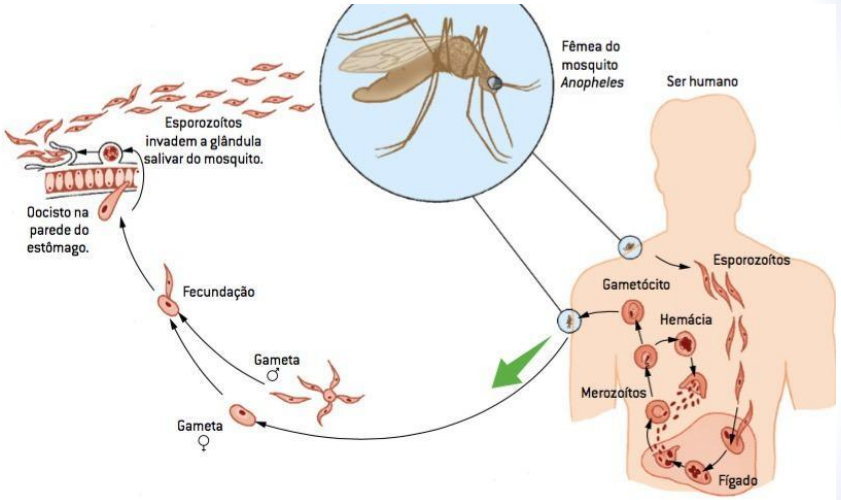
Strain: Y


A
p = 0.0014
DENV−2 genome copies/head * Million
80
60
40
20
0
Wild−type
Y
Strains
B
Strain: Y
Wild−type
Survival
100%
90%
80%
70%
p = 0.026
p = 0.35
0
2
4
6
8
10
12
14
Days after infection
Non−infected
Infected


Higgs-DENV
A5-MOCK
A5 DENV
1 D.P.I
2 D.P.I
3 D.P.I
6 D.P.I
0 µm 100

Malaria


The Americas
An. darlingi
An. aquasalis
An. albitarsis s.l.
An. marajoara
An. nuneztovari s.l.
An. pseudopunctipennis
An. albimanus
An. quadrimaculatus s.l.
An. freeborni
Euro. & M.East
An. superpictus
An. sergentii
An. sacharovi
An. messeae
An. labranchiae
An. atroparvus
Africa
An. arabiensis; An. funestus; An. gambiae
An. arabiensis; An. funestus
An. funestus; An. gambiae
An. gambiae
An. funestus
An. arabiensis
India/Western Asia
An. culicifacies s.l.; An. stephensi; An. fluviatilis s.l.
An. fluviatilis s.l.
An. stephensi
An. culicifacies s.l.
South-East Asia & Pacific
An. farauti s.l.; An. koliensis; An. punctulatus s.l.
An. dirus s.l.; An. minimus s.l.
An. lesteri; An. sinensis
An. balabacensis
An. barbirostris s.l.
An. dirus s.l.
An. farauti s.l.
An. flavirostris
An. koliensis
An. lesteri
An. leucosphyrus/latens
An. maculatus
An. minimus s.l.
An. punctulatus s.l.
An. sinensis
An. sundaicus s.l.


Fêmea do mosquito *Anopheles*
Ser humano
Esporozoítos invadem a glândula salivar do mosquito.
Oocisto na parede do estômago.
Esporozoítos
Gametócito
Hemácia
Fecundação
Gameta ♂
Merozoítos
Gameta ♀
Fígado

PNAS

Fighting malaria with engineered symbiotic bacteria from vector mosquitoes

Sibao Wang[a], Anil K. Ghosh[a], Nicholas Bongio[b], Kevin A. Stebbings[b,1], David J. Lampe[b], and Marcelo Jacobs-Lorena[a,2]

[a]Department of Molecular Microbiology and Immunology, Malaria Research Institute, Johns Hopkins Bloomberg School of Public Health, Baltimore, MD 21205; and [b]Department of Biological Sciences, Duquesne University, Pittsburgh, PA 15282

Edited by Nancy A. Moran, Yale University, West Haven, CT, and approved June 7, 2012 (received for review March 9, 2012)

The most vulnerable stages of *Plasmodium* development occur in the lumen of the mosquito midgut, a compartment shared with into wild mosquito populations. Various genetic drive mecha- nisms have been proposed to accomplish this goal (12, 13), but

PNAS

Engineering RNA interference-based resistance to dengue virus type 2 in genetically modified *Aedes aegypti*

Alexander W. E. Franz*†, Irma Sanchez-Vargas*†, Zach N. Adelman‡, Carol D. Blair*, Barry J. Beaty*§, Anthony A. James¶||, and Ken E. Olson*§

*Arthropod-Borne and Infectious Diseases Laboratory, Department of Microbiology, Immunology, and Pathology, Colorado State University, Fort Collins, CO 80523; ‡Department of Entomology, 320 Price Hall, Virginia Polytechnic Institute and State University, Blacksburg, VA 24061;

OPEN ACCESS Freely available online

PLoS PATHOGENS

Engineered Resistance to *Plasmodium falciparum* Development in Transgenic *Anopheles stephensi*

Alison T. Isaacs[1☯], Fengwu Li[2☯], Nijole Jasinskiene[3], Xiaoguang Chen[4], Xavier Nirmala[5,6], Osvaldo Marinotti[3], Joseph M. Vinetz[2], Anthony A. James[1,3]*

1 Department of Microbiology and Molecular Genetics, School of Medicine, University of California, Irvine, California, United States of America, 2 Division of Infectious

Kojin *et al. Malar J (2016) 15:153*
DOI 10.1186/s12936-016-1207-8

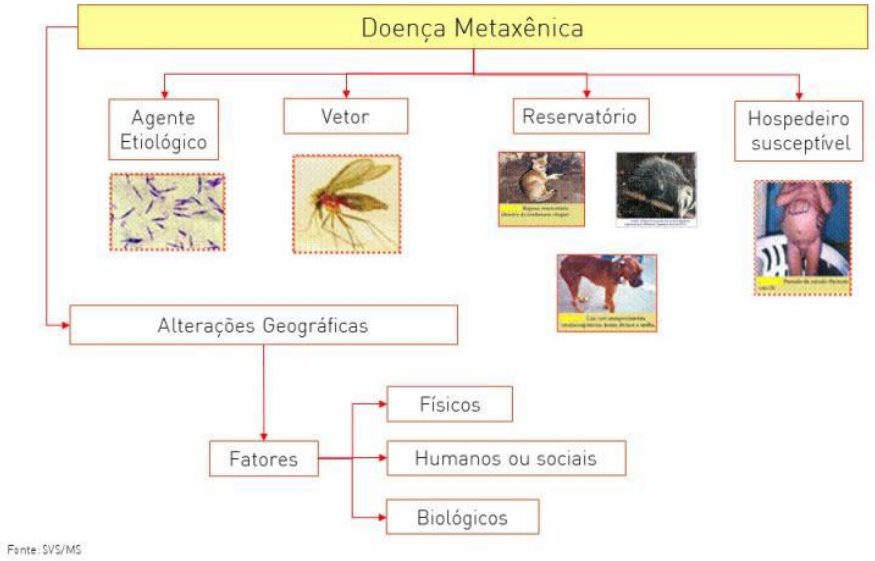
Malaria Journal

RESEARCH Open Access

Endogenously-expressed NH_2-terminus of circumsporozoite protein interferes with sporozoite invasion of mosquito salivary glands

Bianca B. Kojin[1], André Luis Costa-da-Silva[1], Ceres Maciel[1], Dayane Alves Henriques[2], Danilo O. Carvalho[1], Kelcie Martin[3], Osvaldo Marinotti[3], Anthony A. James[3,4], Myrna C. Bonaldo[5] and Margareth Lara Capurro[1*]

Leishmaniose



Fonte: SVS/MS

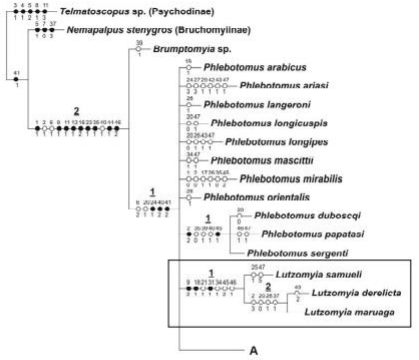


Figura 13 - Cladograma de consenso estrito das relações filogenéticas de algumas espécies de Phlebotominae e grupos externos produzidos pela análise dos dados da matriz da tabela 3. Continuação do ramo A na figura 14. Comprimento (L): 174 passos; Índice de consistência (CI): 0,5; Índice de retenção (RI): 0,75. ● = apomorfia; ○ = homoplasia. Números sublinhados representam os suportes de Bremmer.

Chagas

Annu. Rev. Entomol. 2002. 47:123–41

BACTERIAL SYMBIONTS OF THE TRIATOMINAE AND THEIR POTENTIAL USE IN CONTROL OF CHAGAS DISEASE TRANSMISSION*

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