aic agricultural industries confederation

Agribusiness 2017

Driving today's agricultural revolution

Genetic pest management – the future?

Prof Luke Alphey
Pirbright Institute

Genetic pest management – the future of pest management?

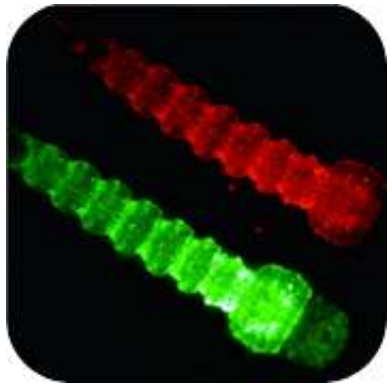
Luke Alphey

BBSRC bioscience for the future

The Pirbright Institute receives strategic funding from BBSRC.

www.pirbright.ac.uk

goals



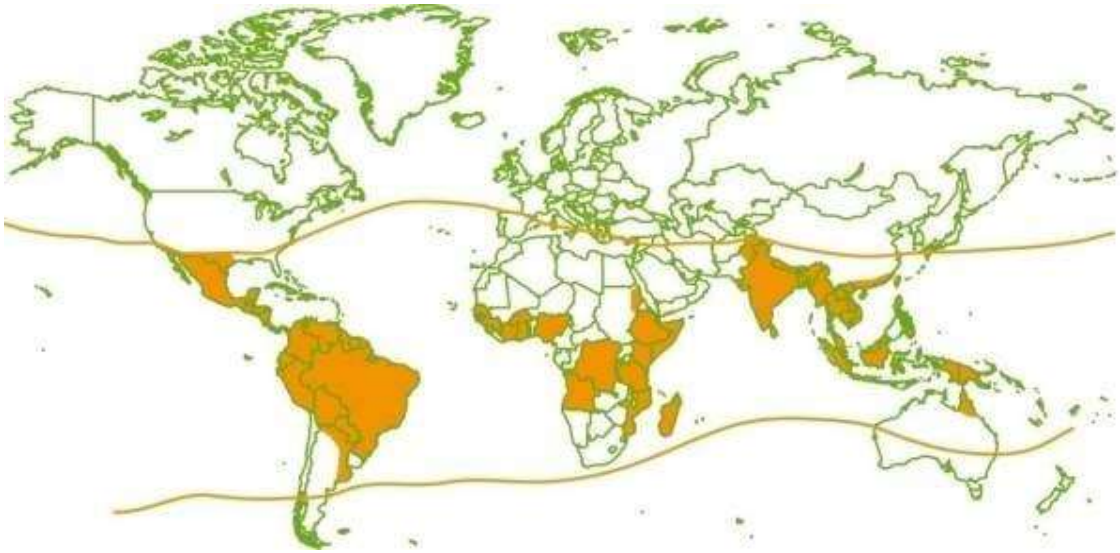
Combat insect borne diseases

Improve crop yields

through the reduction of the insect population causing disease or damaging crops

genetic approach that is safe, sustainable, economic and applicable to many insect species worldwide

dengue fever – a global unmet health challenge



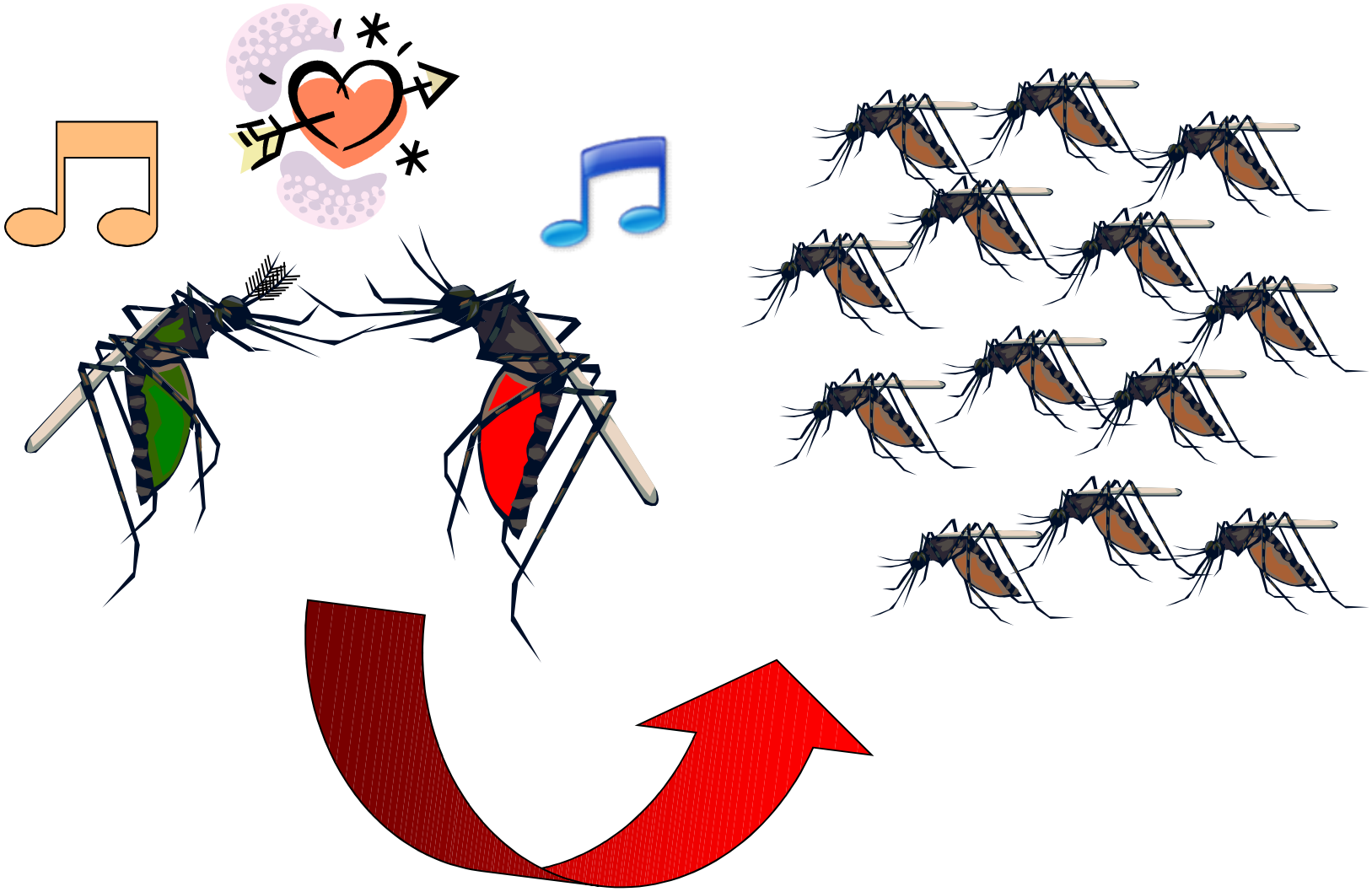
50 -100 million cases pa, increasing
$5 Bn burden of cost
Aedes aegypti: alien invasive species in most countries
Symptoms – joint/muscle pain 'Breakbone fever'
Severe form Dengue Haemorrhagic Fever (DHF)
No specific medication or vaccine yet
Same vector – Chikungunya, Yellow Fever and Zika viruses

"Today, dengue ranks as the most important mosquito-borne viral disease in the world. Everywhere the human and economic costs are staggering"

Dr Margaret Chan, 2012
Director General, WHO

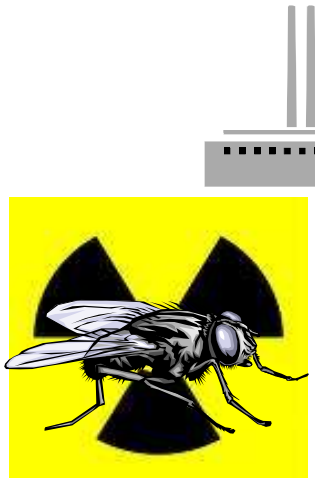
dengue control

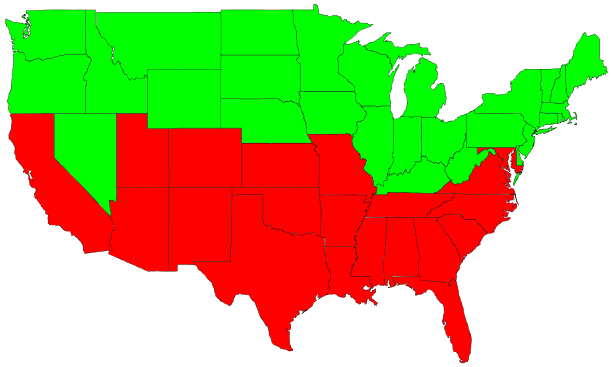
mosquito reproduction



RIDL “genetically sterile” males

Sterile Insect Technique

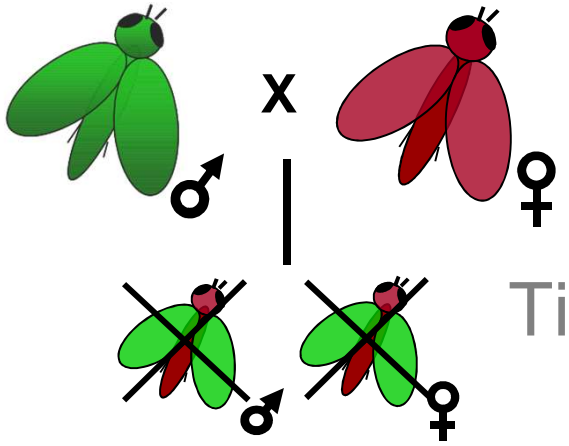




RIDL – “genetic sterility”

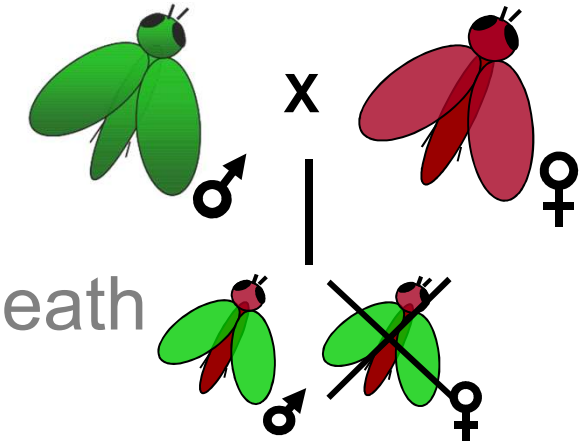
RIDL insects are genetically sterile
Repressible
Release homozygous males

Bi-sex lethal



Time of death

Female-specific lethal



Thomas et al. 2000 Science 287: 2474-6
Gong et al. 2010 Nat Biotech 23: 453-6

Fu et al. 2007 PNAS 107: 4550-4
Wise de Valdez et al. 2009 PNAS 108: 4772-5

classifying pest control strategies

Population suppression

Goal: reduce numerical size of pest population

engineered sterile males

"Population replacement" or
"Refractory insect strategy"

Goal: change pest population to less harmful form

Self-limiting

Modification will be eliminated from population unless maintained by periodic releases

- *Sterile insect methods*

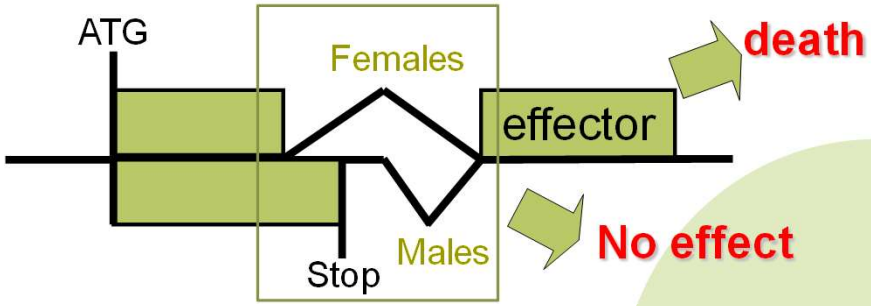
engineered sterile males

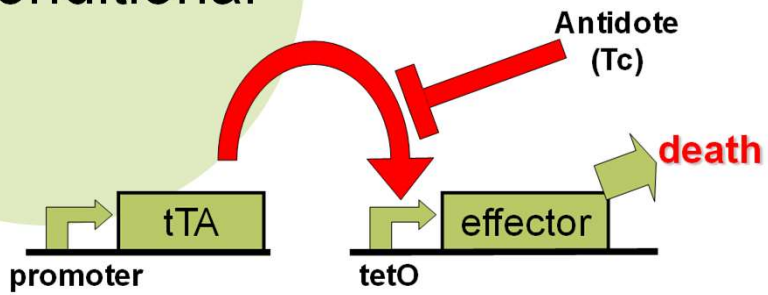
Self-sustaining (invasive)

Modification will persist and spread in population (and potentially beyond)

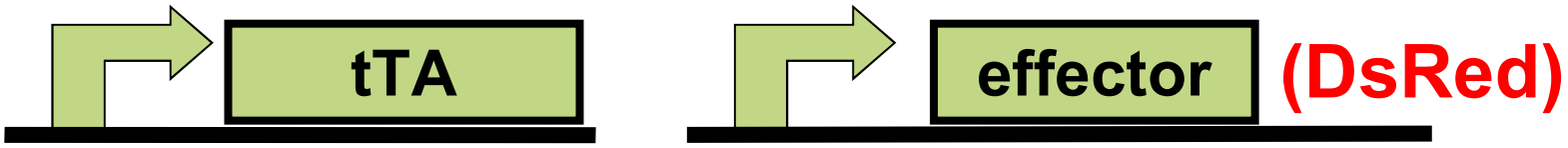
- *Gene drive systems*

combinatorial control



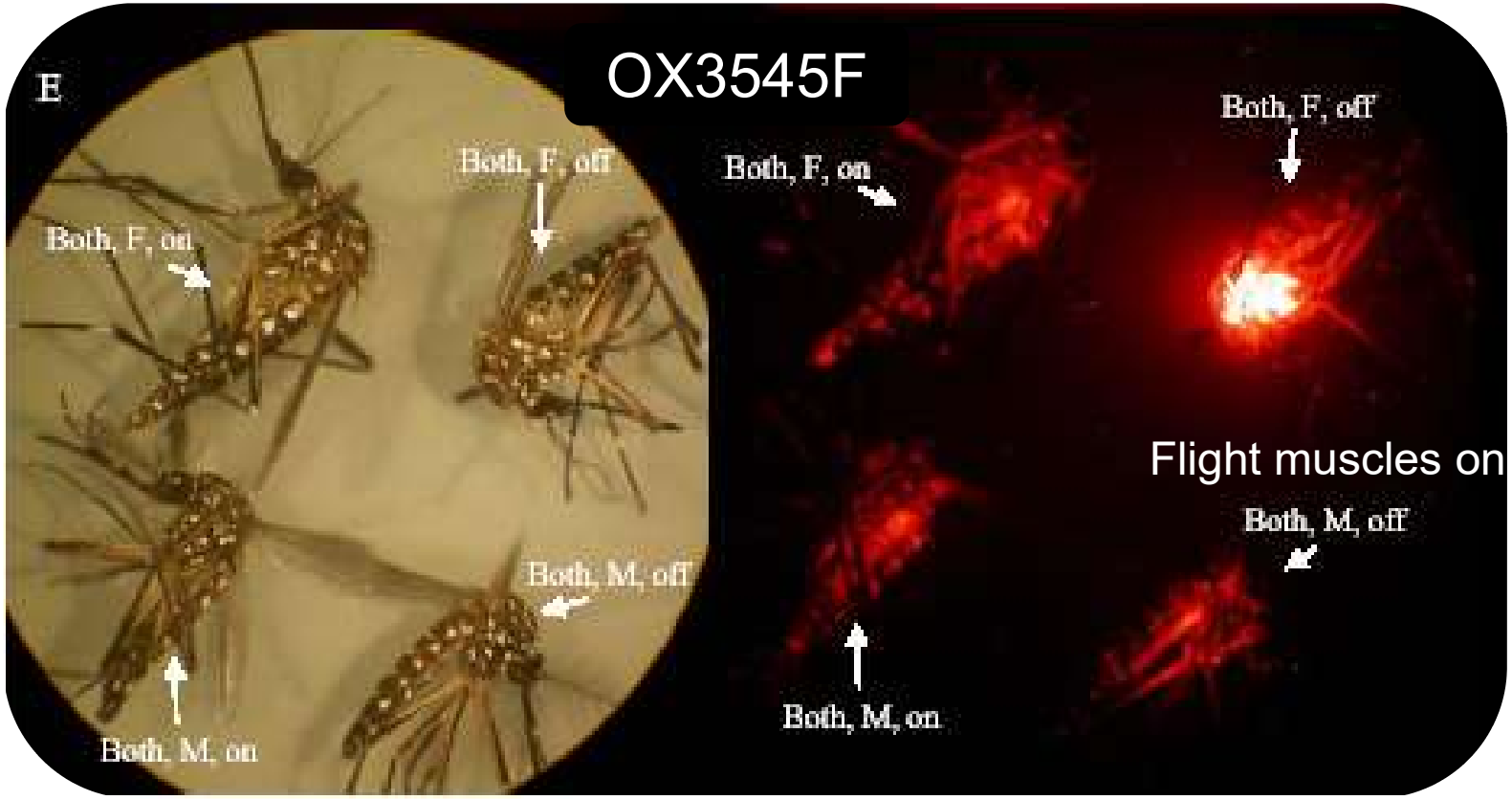


Female flight muscles + Red fluor



Act4 promoter

tetO + promoter



Fu *et al*. 2010 PNAS 107: 4550-4554

OX3604C RIDL mosquitoes

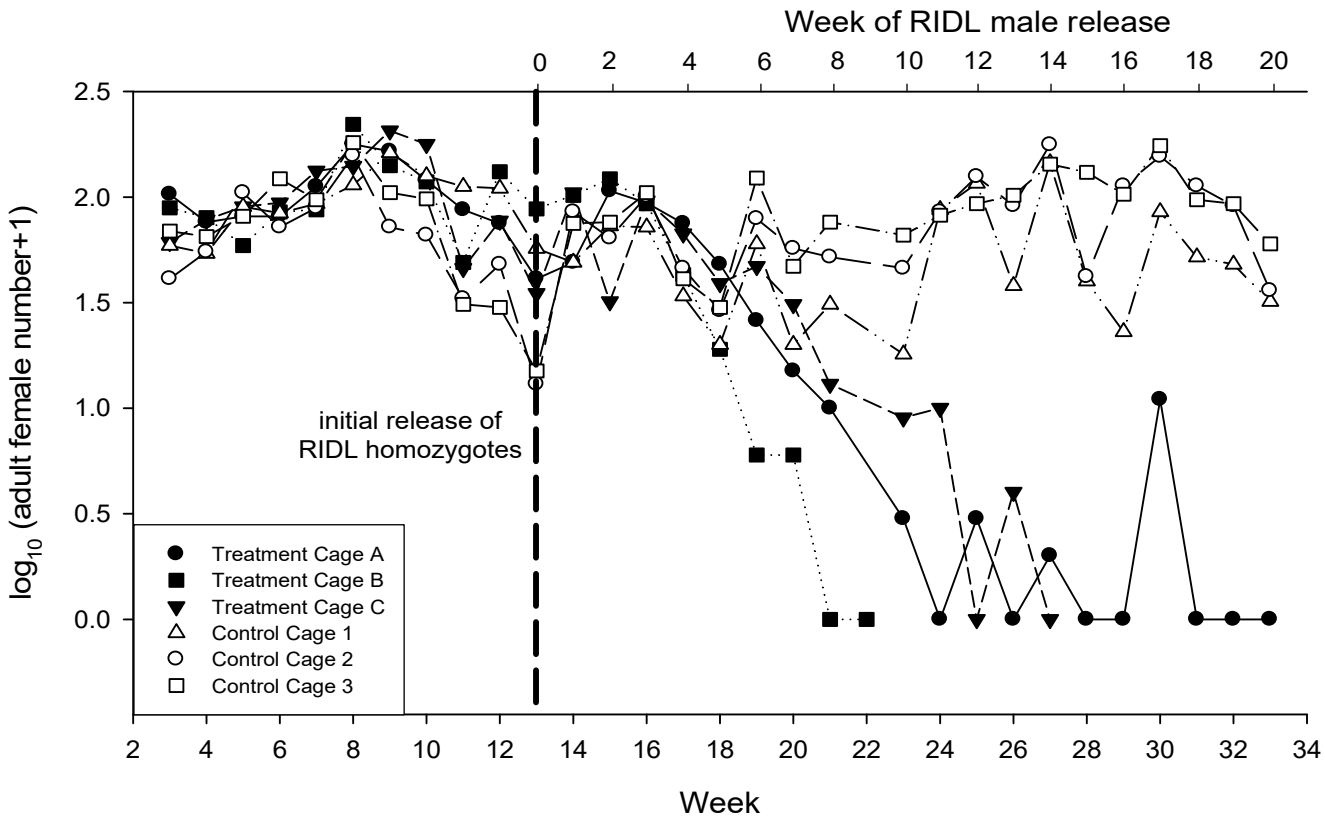
Males

Females

Flightless mosquitoes cannot survive in wild (or find hosts).
Unable to mate even in laboratory. Males have normal flight ability, as have females given antidote as larvae.

Fu *et al*. 2010 PNAS 107: 4550-4554

Aedes aegypti cage suppression



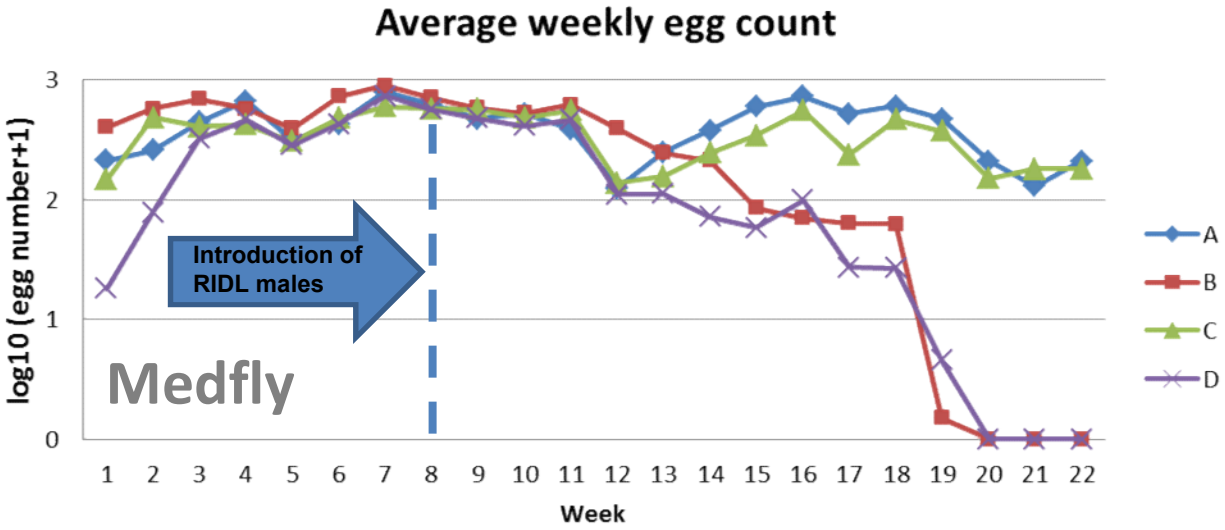
Colorado State University experiment in indoor cages

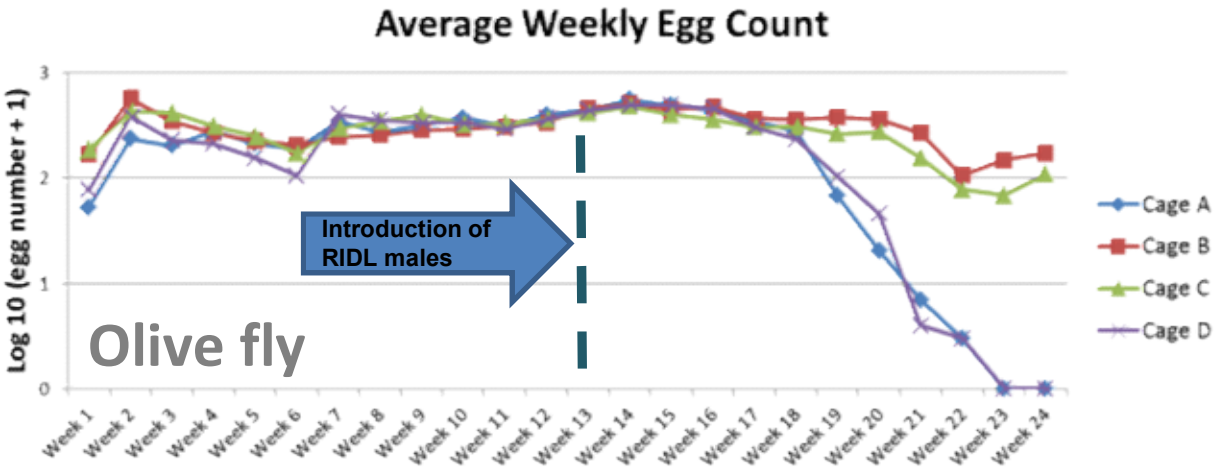
Control from RIDL was as predicted in simulation model

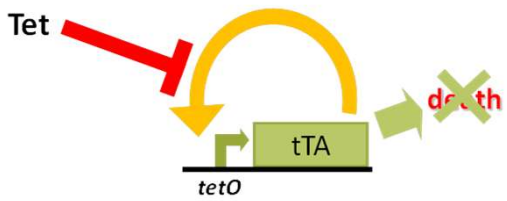
Cage populations eradicated in under 20 weeks

Wise de Valdez et al (2011) PNAS 108: 4772-4775

cage suppression trials: fruit flies







Leftwich *et al.* Proc Roy Soc B 2014 281:20141372

Ant *et al*. 2010 BMC Biology 10: 51

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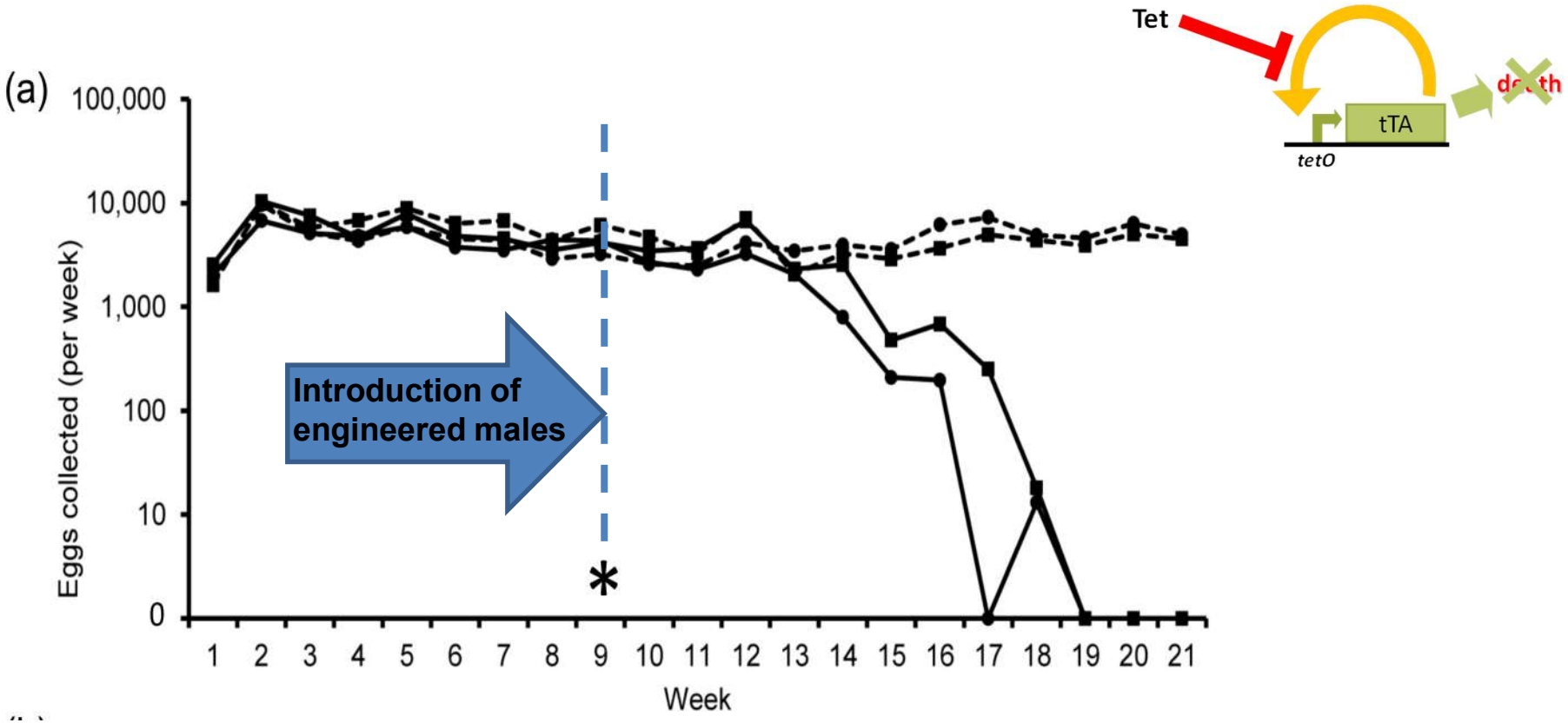
cage suppression trials: moths



Diamondback moth

Harvey-Samuel *et al.* 2015 BMC Biology 13:49

phased testing

contained

- Molecular characterisation
- Genetic and phenotypic stability
- Bionomic characteristics
- Mating competitiveness
- Mating compatibility
- Insecticide resistance
- Suppression trials

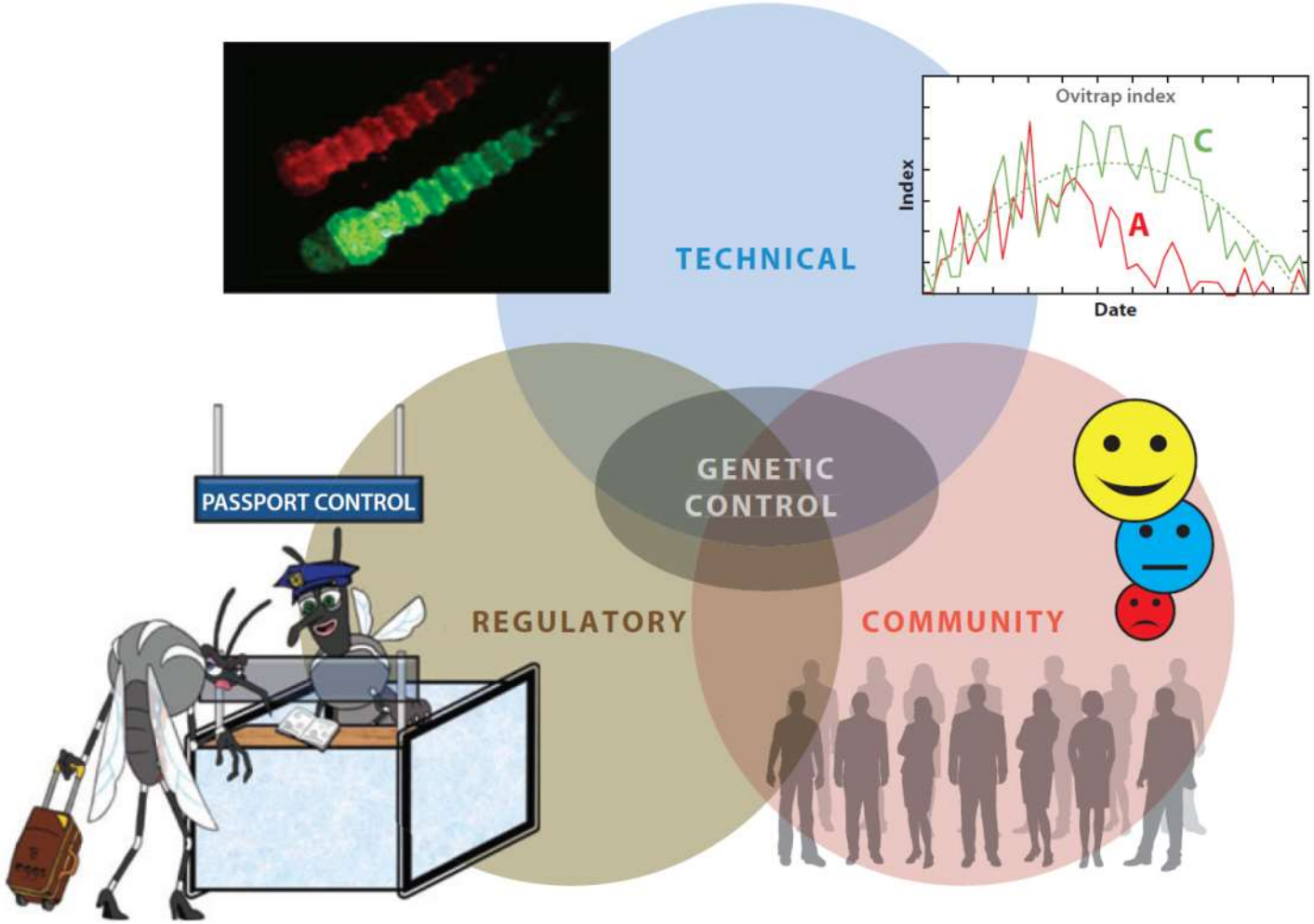
semi-field

- Mating competitiveness in semi-natural conditions
- Cage suppression trials

open field population suppression

- Validation in field conditions

bringing new technology to the field



presentations

Projeto Aedes Transgênico









TV and radio

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local festivals

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PAT

leaflets

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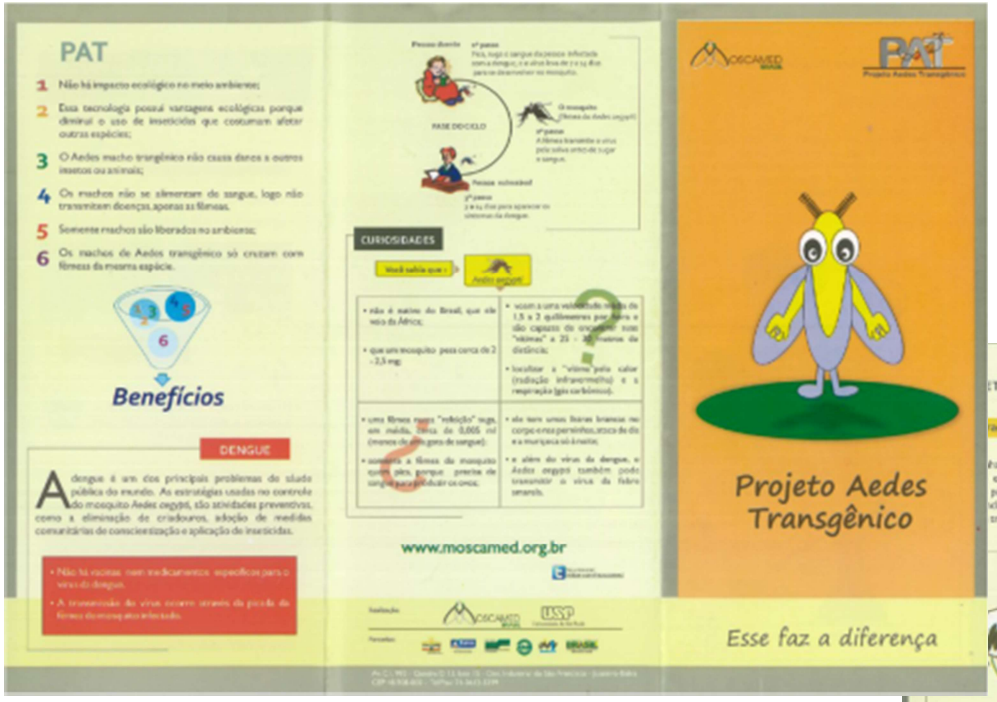
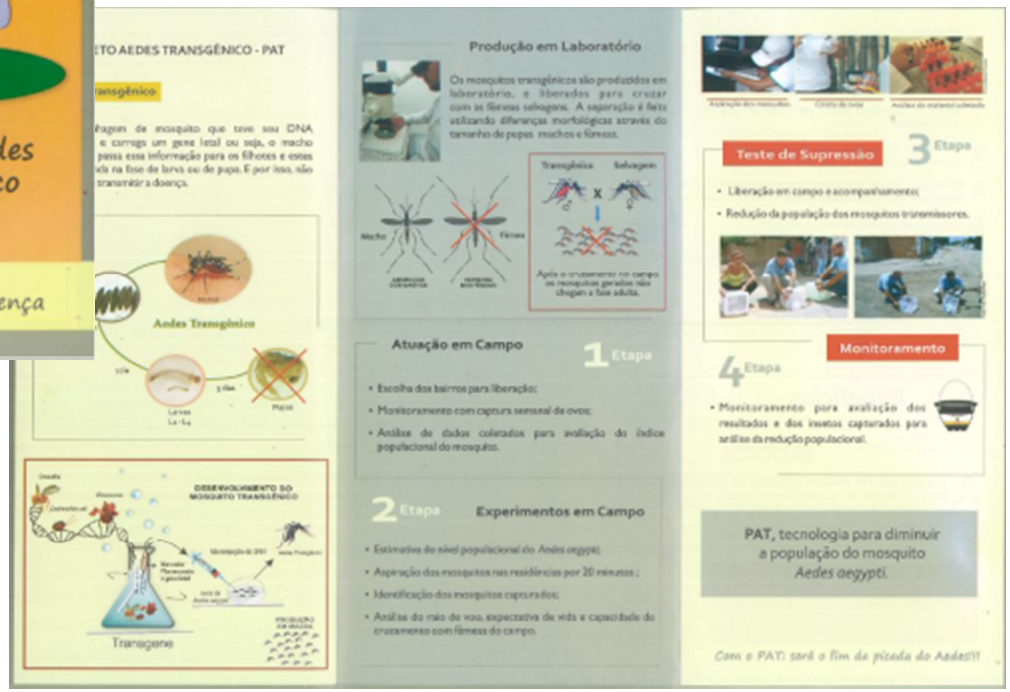
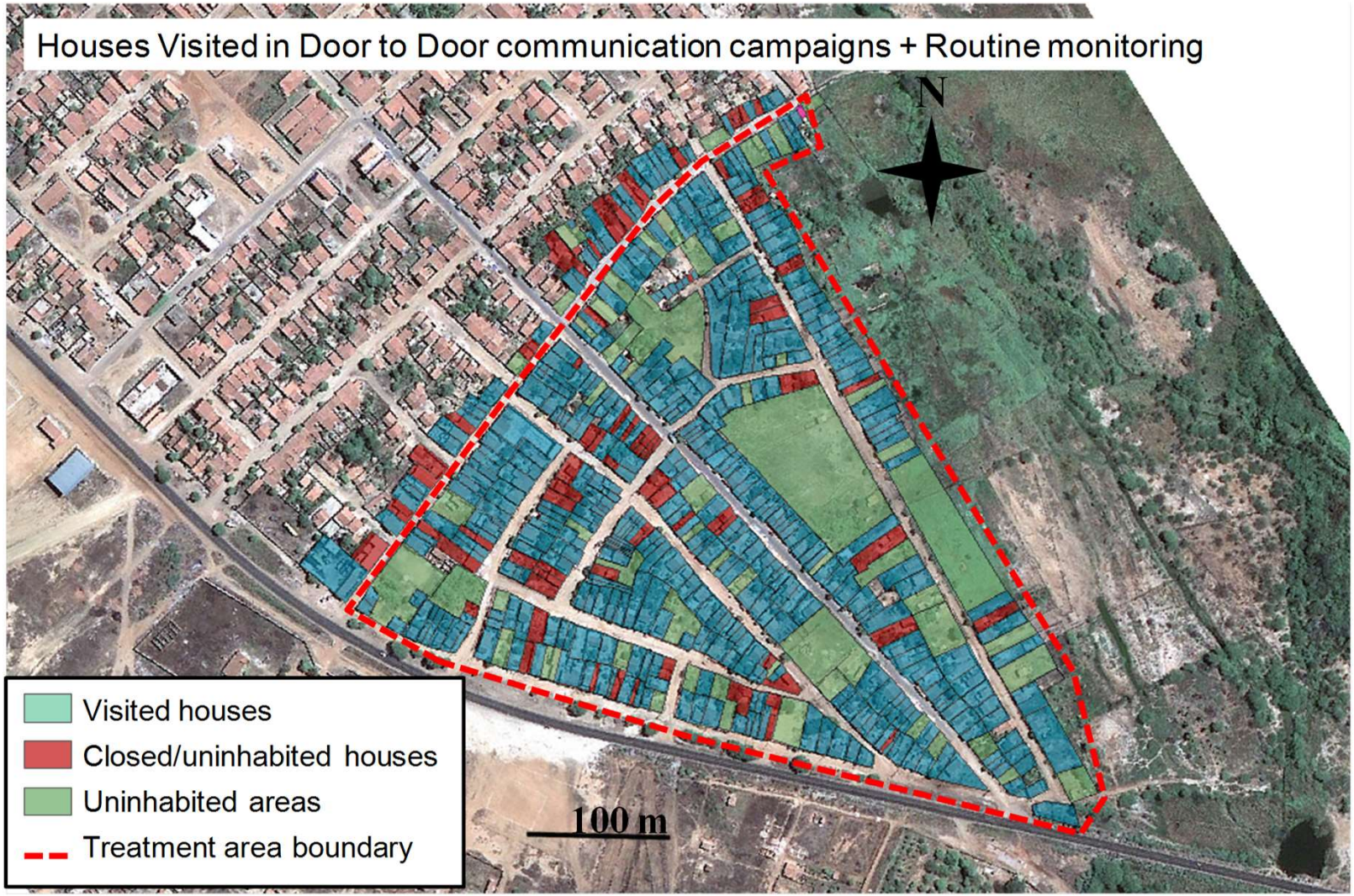




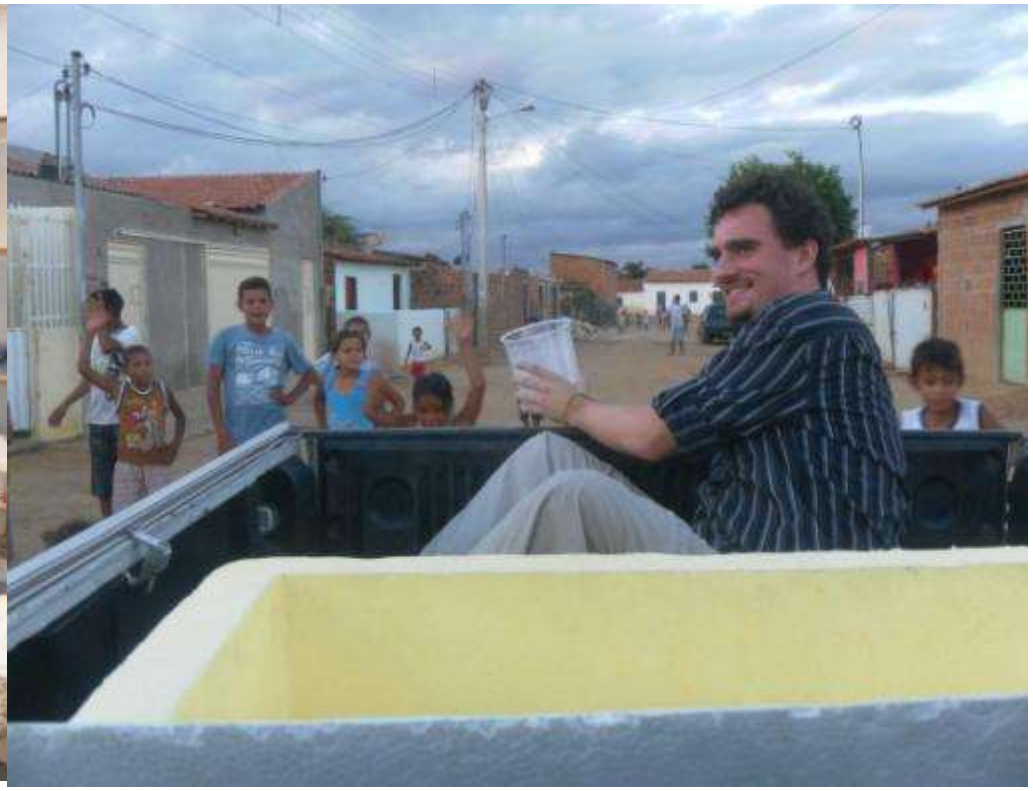
house visits

Projeto Aedes Transgênico

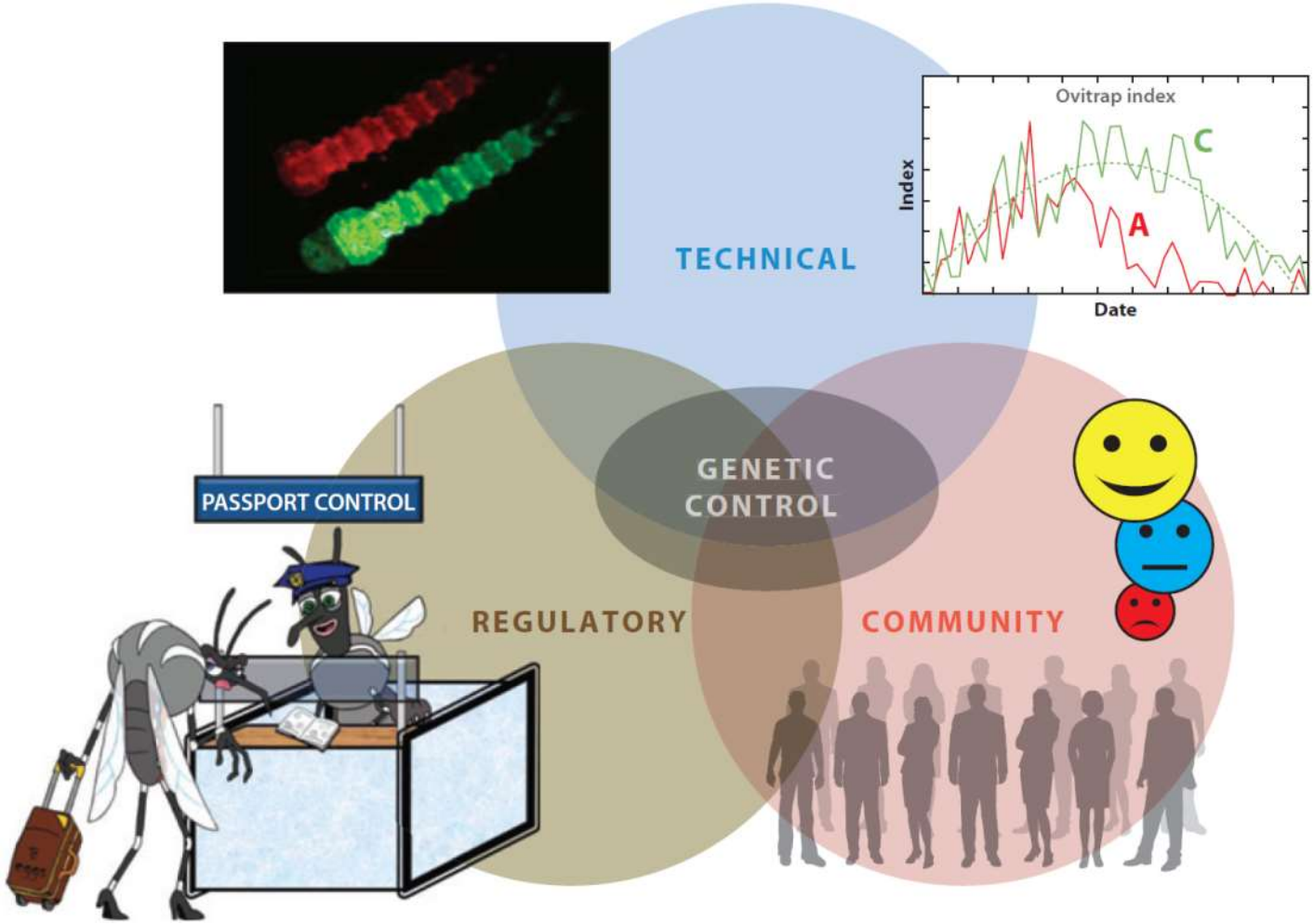


operations

Projeto Aedes Transgênico

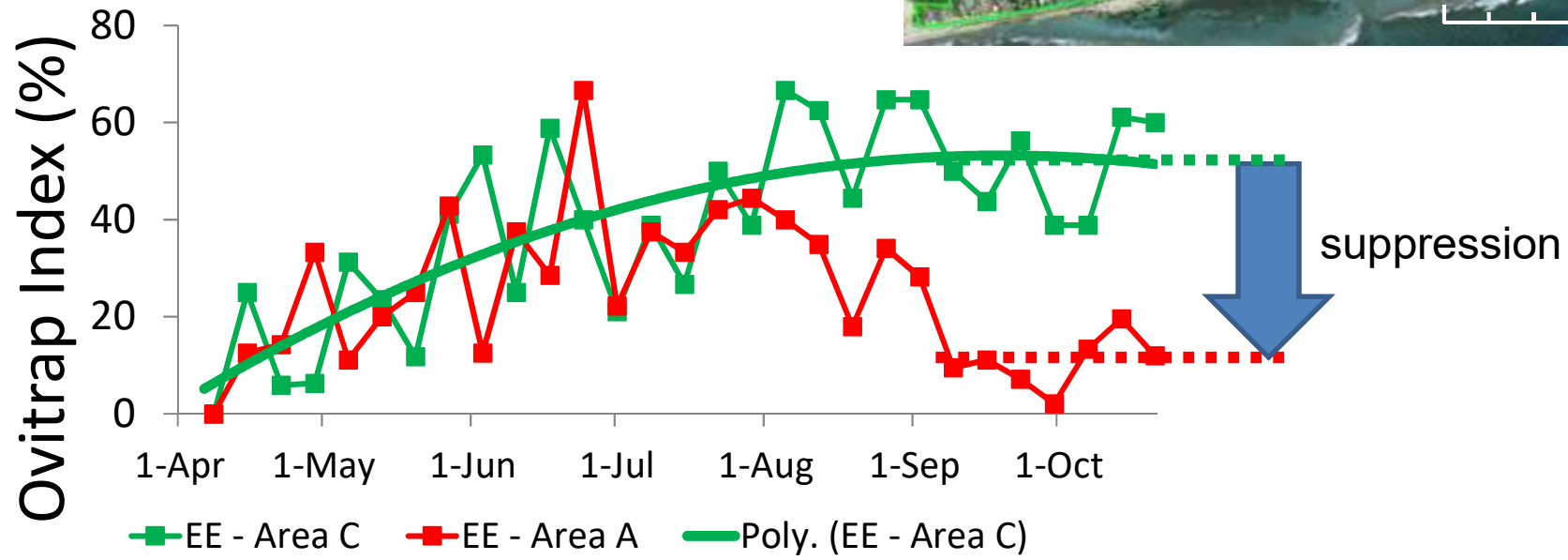


bringing new technology to the field



Cayman field trial 2010

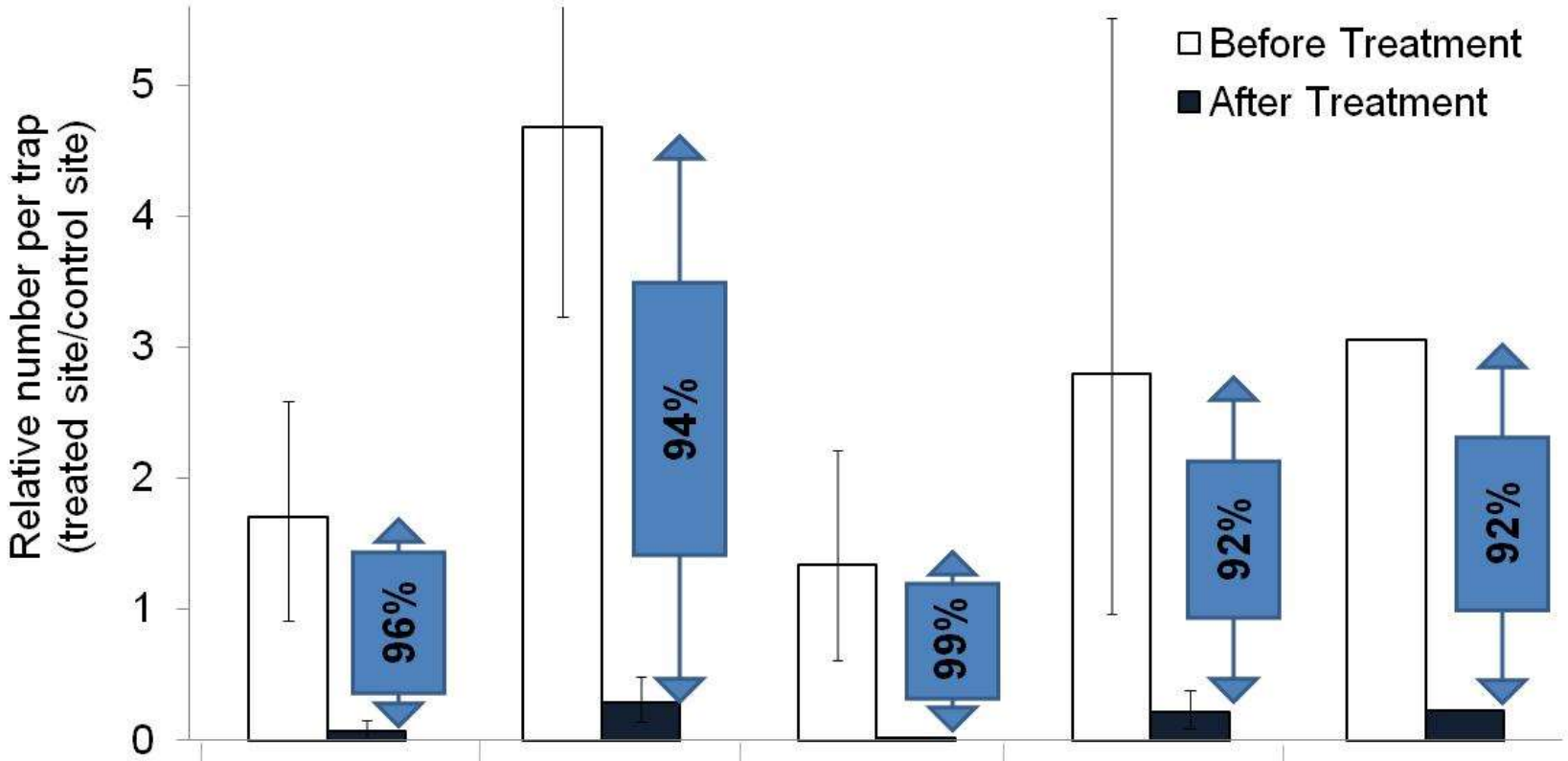
OVITRAP INDEX treated (A) & non-treated (C)



- Trial was complete success; all endpoints met
  - Clear suppression from early August
- Sustained release of RIDL OX513A males can suppress a field population of *Aedes aegypti* mosquitoes
  - Maximum degree of suppression limited by immigration
- GM mosquitoes can perform successfully in the field

Harris *et al.* 2012
Nat. Biotech. 30:828-30

RIDL is effective in multiple settings



Treated Site	East End	Itaberaba	Mandacaru	Pedra Branca	Nuevo Chorillo
Control Site	East End	Itaberaba	Carnaiba	Jacobina	Princesa Mia
Country	Cayman Islands	Brazil	Brazil	Brazil	Panama

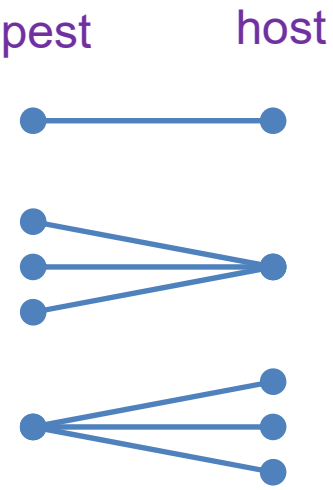
summary

Widespread use against dengue depends on efficacy, and public and regulatory approval

- **Efficacy:** periodic release of RIDL males suppressed wild target population
  - No conventional control for *Aedes aegypti*
  - Full suppression in 2-3 months
  - Target population recovered only slowly post-release
- **Public approval:** initial indications positive at trial sites
  - Intended goal of dengue control recognised as desirable
  - May vary by country (culture, prior experience of GMOs, etc)
- **Regulatory approval:** independent regulatory authorities have approved use
  - Field use in Cayman Islands, Malaysia, Brazil (& USA for pink bollworm)
  - Import permits in many additional countries

where to use?

- **Species-specific:** released insects mate only with own species
  - Aggressive gene drive systems may penetrate species complex with incomplete reproductive isolation
  - Environmentally friendly
  - How many pest species?
- **Case-by-case environmental analysis**
  - Native or invasive species?
- **Self-dispersing and target-seeking:**
  - Based on mating behaviour and mobility of insect
  - Need to consider reproductive behaviours and ecology
- **Other issues:**
  - Generation time, artificial diet, dispersal/mobility
- **Sterile males – simple precise suppression**
- **Gene drive systems – population- or species-level genetic modification**



Oxitec's portfolio

Agriculture

Target		Crop
	Diamondback moth	Brassicas
	Medfly/ Mexfly	Citrus/pome /stone fruit
	Olive fly	Olive
	Pink bollworm	Cotton
	*Tuta absoluta*	Tomato
	Spotted wing *Drosophila*	Soft fruit

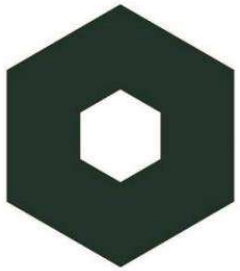
Public health

Target		Vector of
	*Aedes aegypti*	Dengue
	*Aedes albopictus*	Chikungunya & dengue
	*Anopheles stephensi*	malaria

Other (sericulture)

Target		Purpose
	silkworm	Improved silk production

Thank you



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