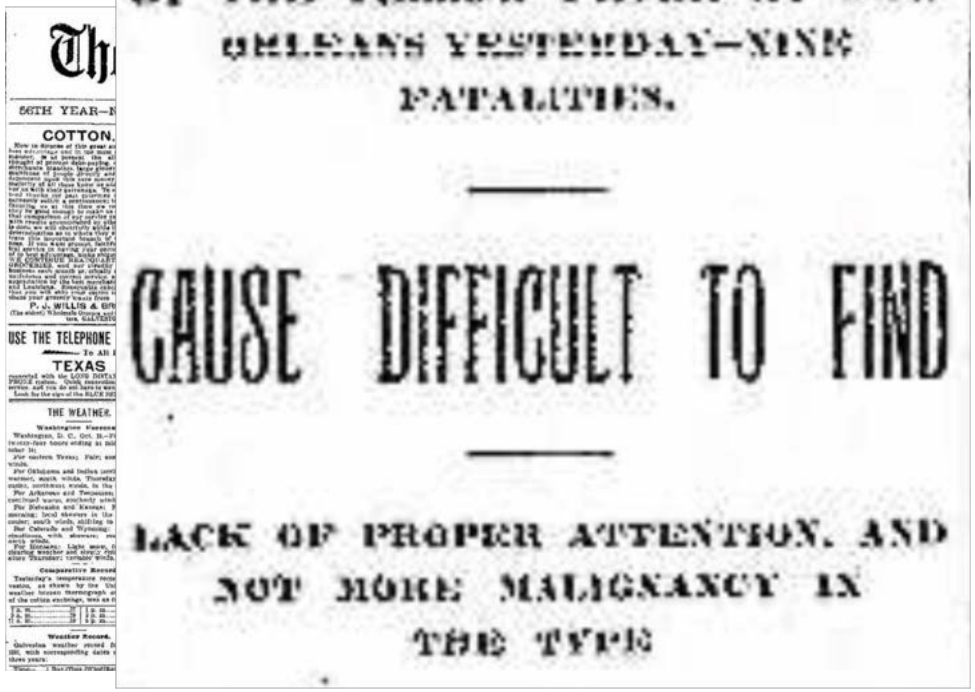
Know thy system
The ‘known knowns’ and the ‘known unknowns’ of VBD

Rebecca Christofferson

May 7, 2019

V

- lic health concerns



DEATH RECORD SMASHED

BY THE YELLOW FEVER AT NEW ORLEANS YESTERDAY—NINE FATALITIES.

CAUSE DIFFICULT TO FIND

LACK OF PROPER ATTENTION, AND NOT MORE MALIGNANCY IN THE TYPE

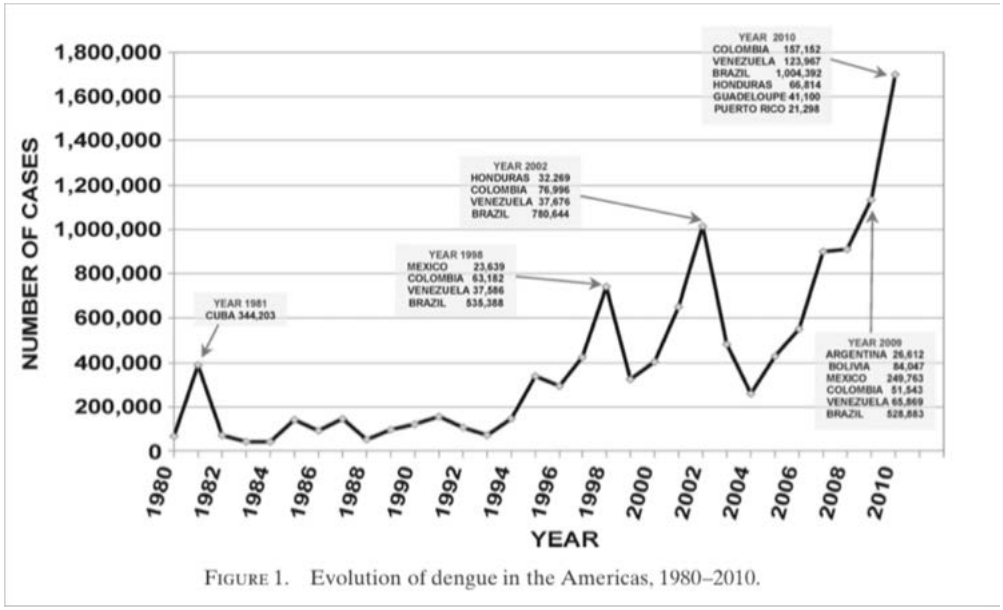
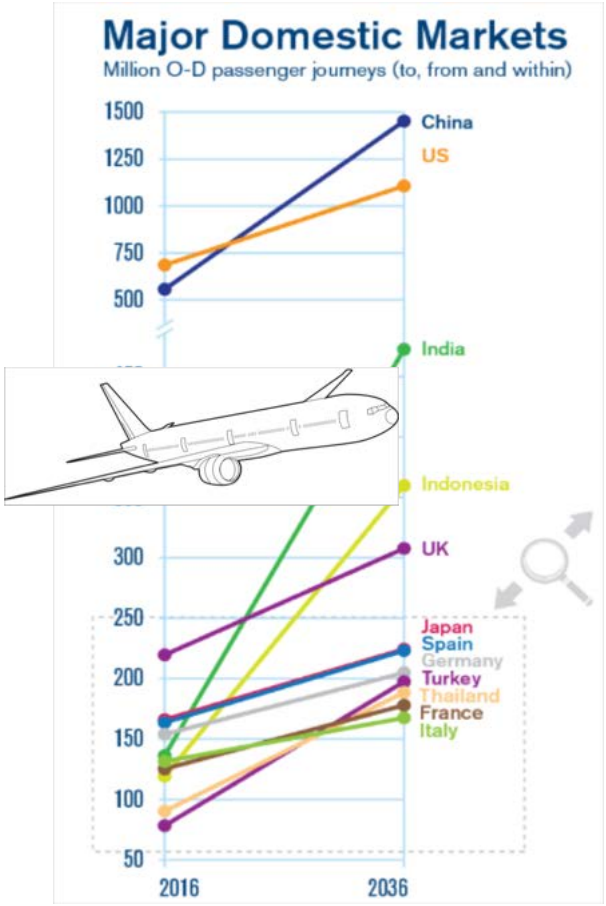
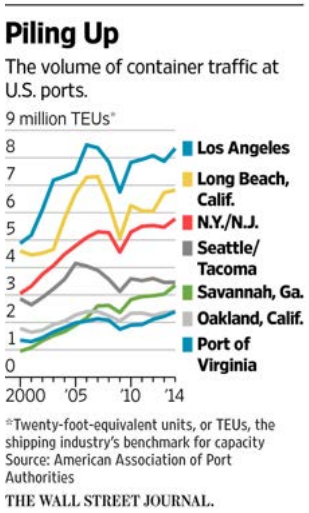


FIGURE 1. Evolution of dengue in the Americas, 1980–2010.

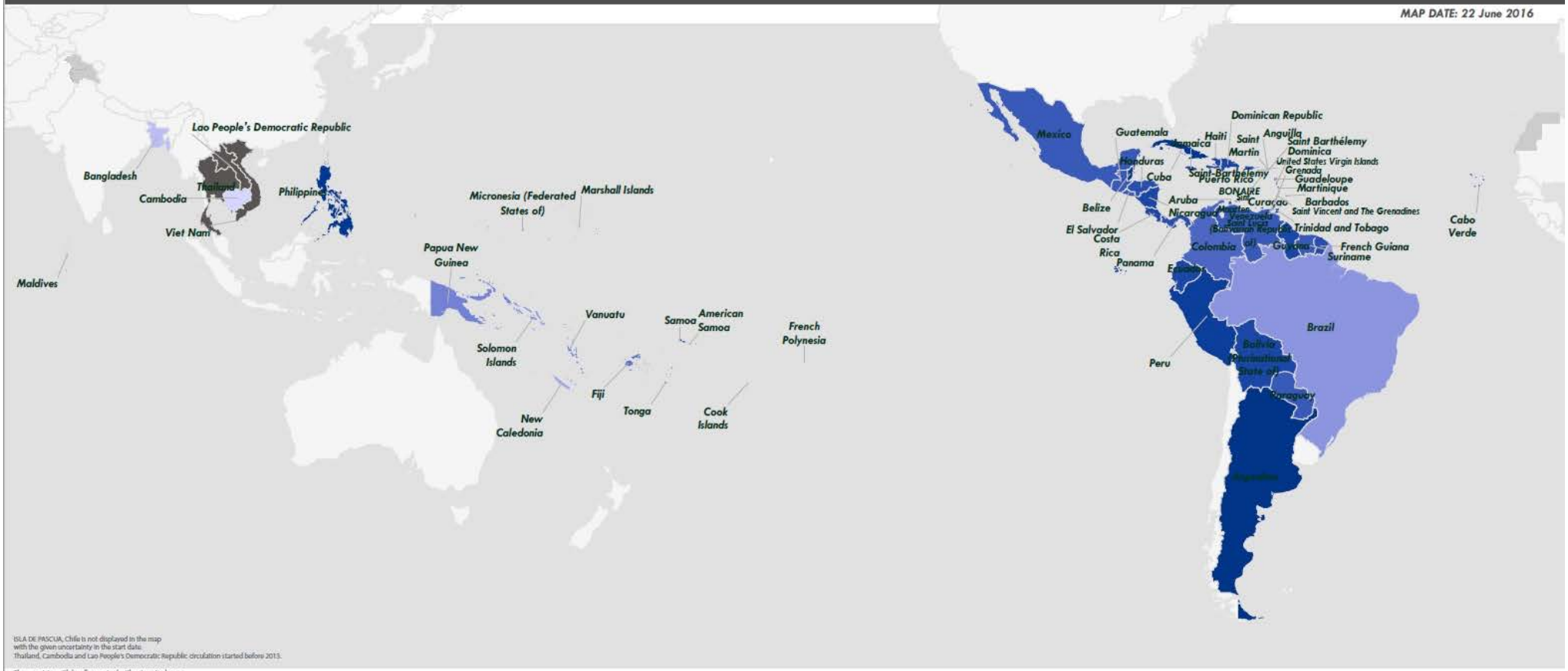
Dick et al. Am. J. Trop. Med. Hyg. 2012

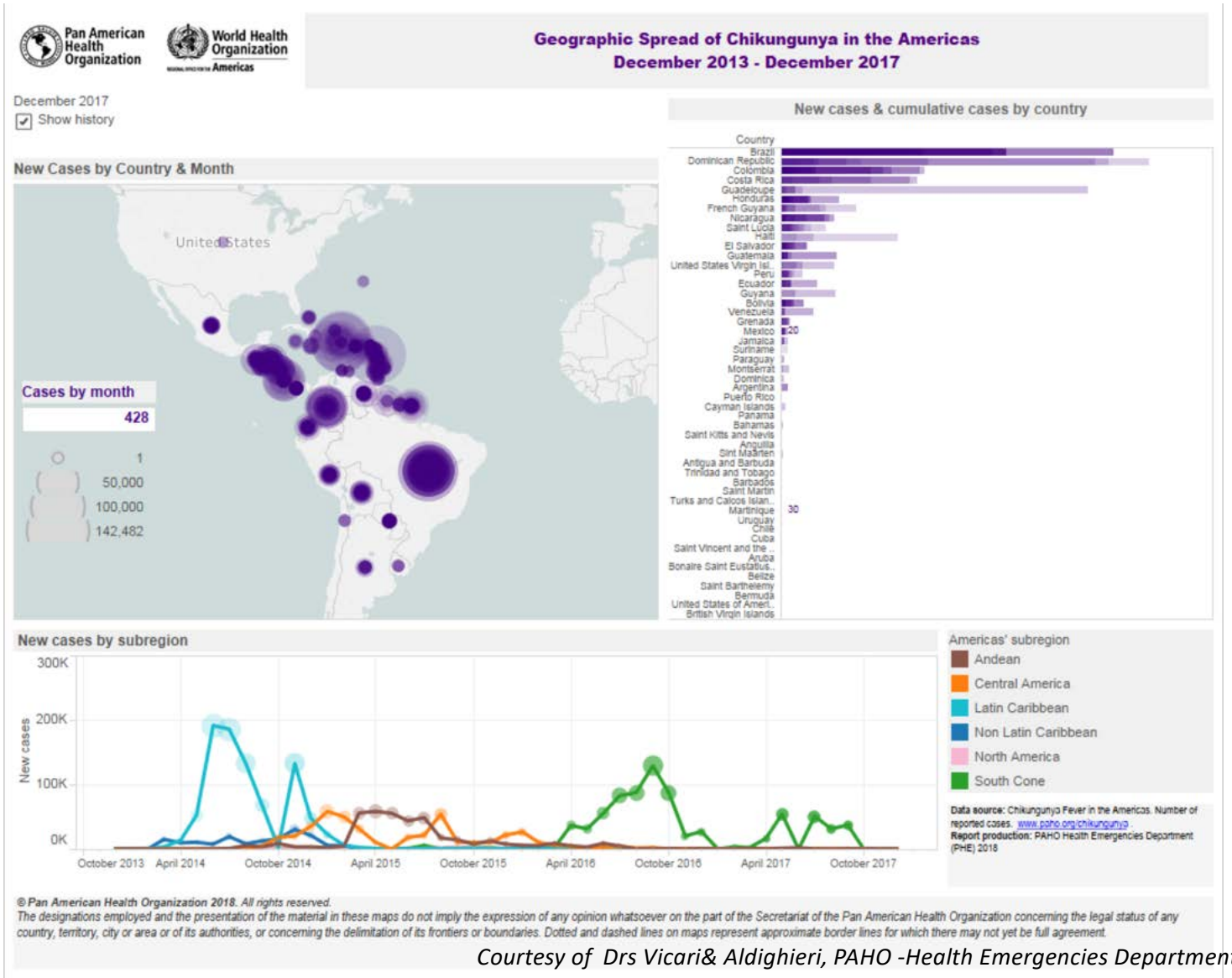

Major Domestic Markets
Million O-D passenger journeys (to, from and within)
1500
1250
1000
750
500
300
250
200
150
100
50
2016
2036
China
US
India
Indonesia
UK
Japan
Spain
Germany
Turkey
Thailand
France
Italy


Piling Up
The volume of container traffic at U.S. ports.
9 million TEUs*
8
7
6
5
4
3
2
1
0
2000
'05
'10
'14
Los Angeles
Long Beach, Calif.
N.Y./N.J.
Seattle/ Tacoma
Savannah, Ga.
Oakland, Calif.
Port of Virginia
*Twenty-foot-equivalent units, or TEUs, the shipping industry's benchmark for capacity
Source: American Association of Port Authorities
THE WALL STREET JOURNAL.

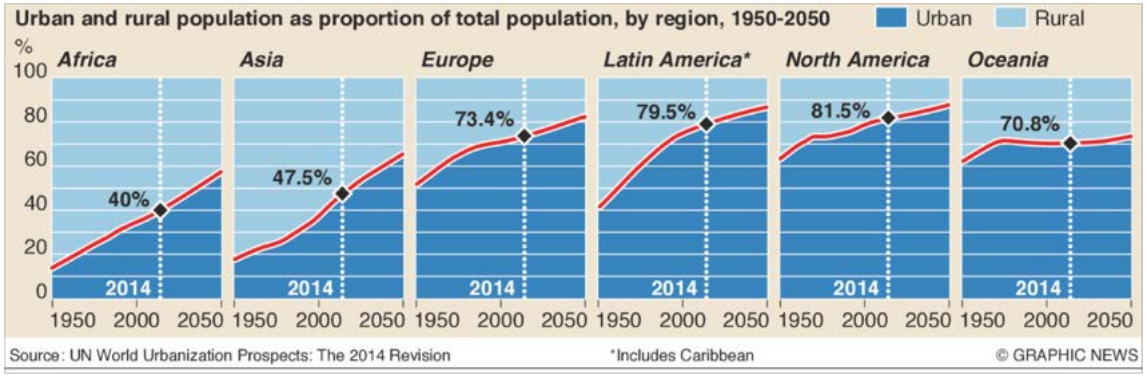
iata.org

Countries, territories and areas showing the distribution of Zika virus, 2013 - 2016





Courtesy of Drs Vicari& Aldighieri, PAHO -Health Emergencies Department


Urban and rural population as proportion of total population, by region, 1950-2050
Urban
Rural
%
100
80
60
40
20
0
Africa
Asia
Europe
Latin America*
North America
Oceania
40%
47.5%
73.4%
79.5%
81.5%
70.8%
2014
1950
2000
2050
Source: UN World Urbanization Prospects: The 2014 Revision
*Includes Caribbean
© GRAPHIC NEWS

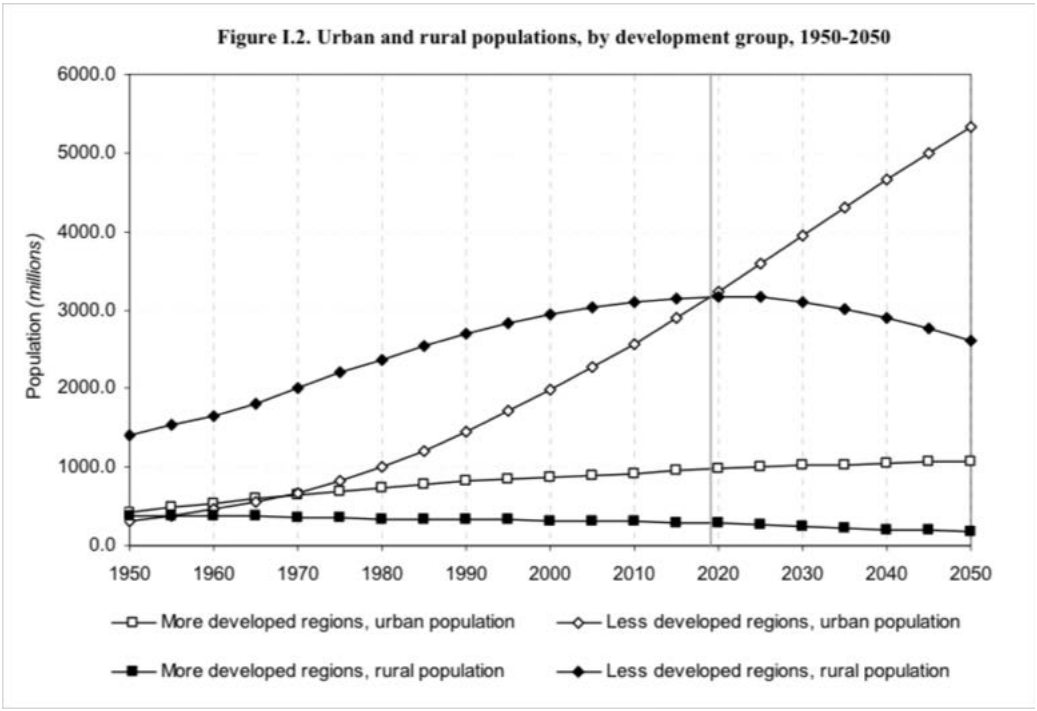
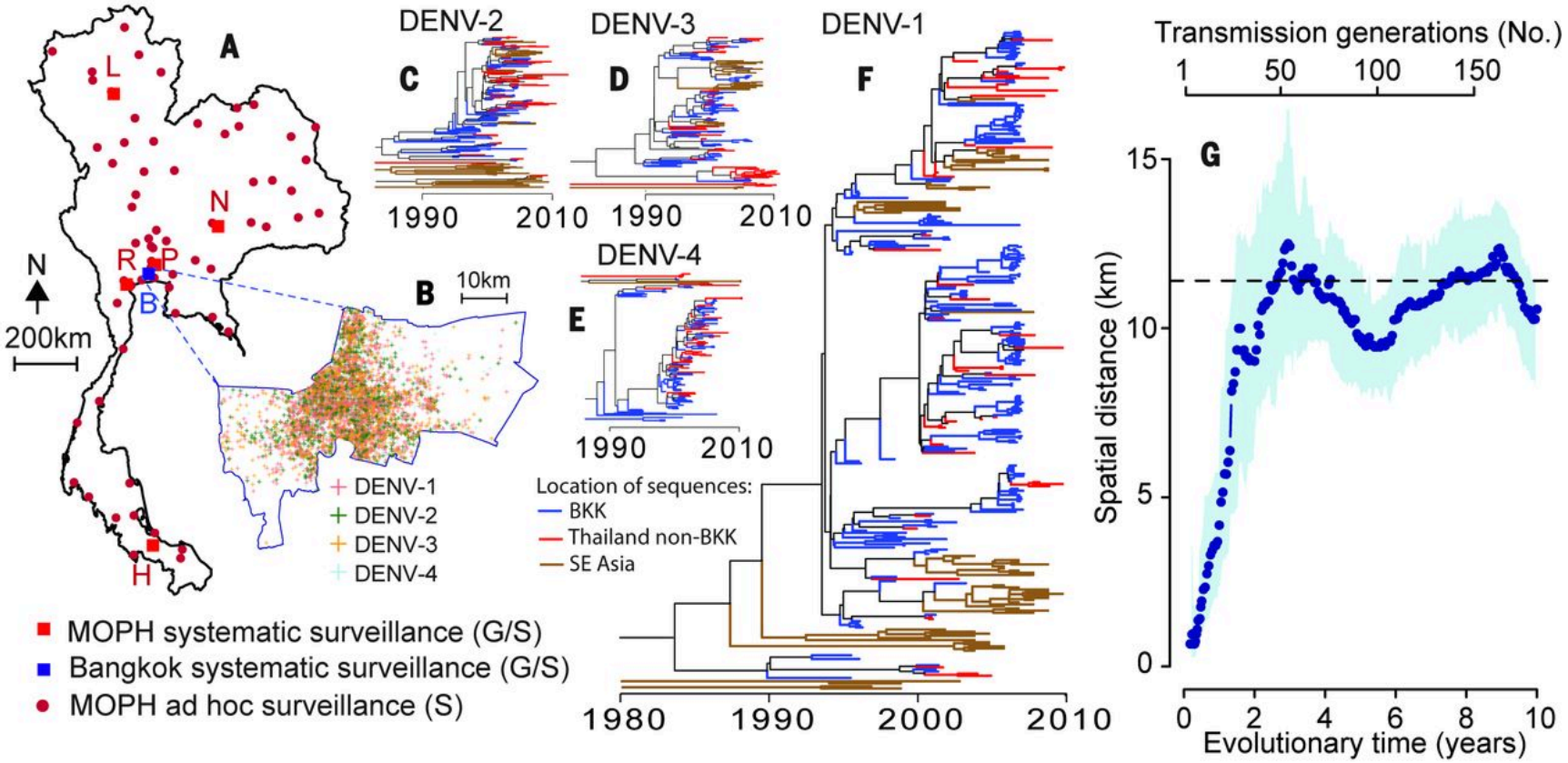


Figure I.2. Urban and rural populations, by development group, 1950-2050
Population (millions)
6000.0
5000.0
4000.0
3000.0
2000.0
1000.0
0.0
1950
1960
1970
1980
1990
2000
2010
2020
2030
2040
2050
More developed regions, urban population
Less developed regions, urban population
More developed regions, rural population
Less developed regions, rural population



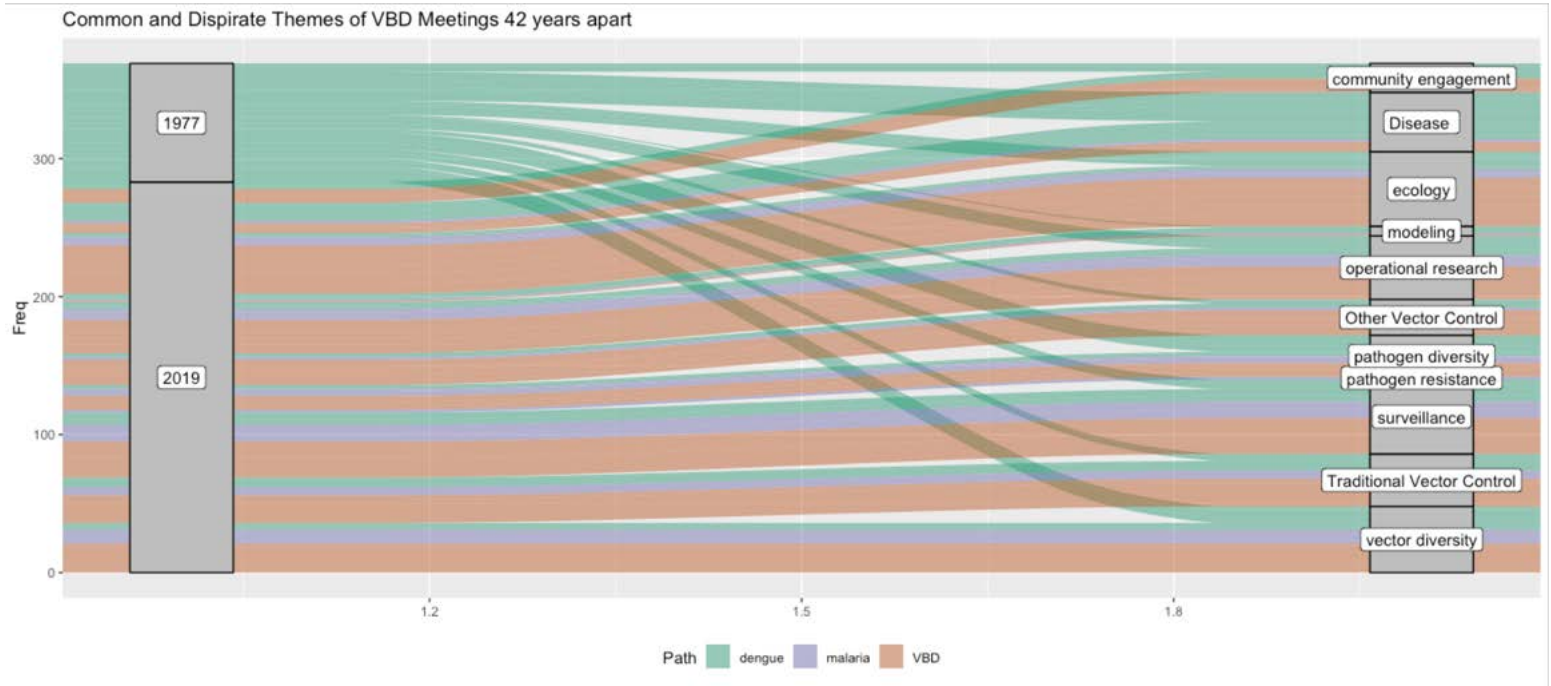
Salje et al. Science. 2017

Vector-borne diseases

- Known unknowns
  - VBD continue to be public health threats – what?
  - Interconnectivity of the global population means transmission /introduction is a flight away – where?
  - Urbanization and vector habitat suitability increasing worldwide – who?
  - Viral and vector pheno- and genotype diversity can be high – how?
    - Affects control efforts and efficacy testing of such – why?

Known Knowns and Known Unknowns

- 1977 meeting in SE Asia to discuss DENV research
- 2019 meeting in SE Asia to discuss DENV and other VBD research

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.com
Search ID: dhnn52
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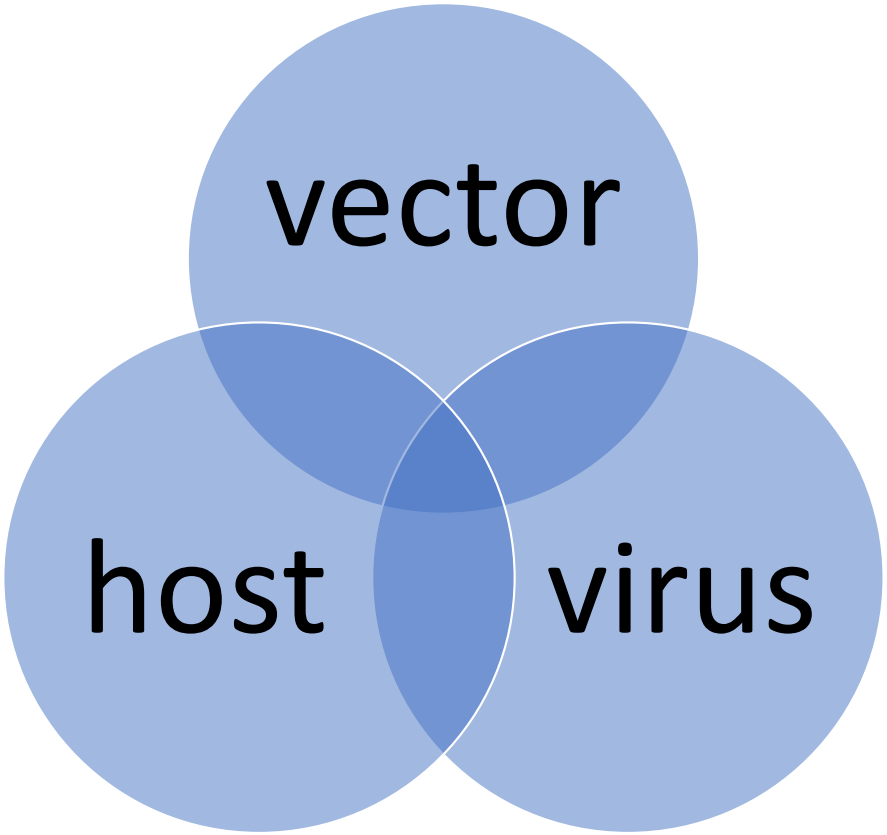
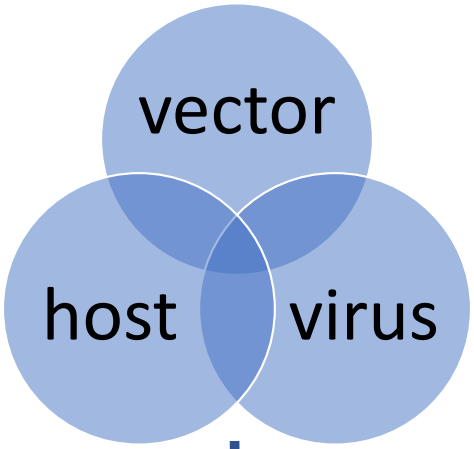
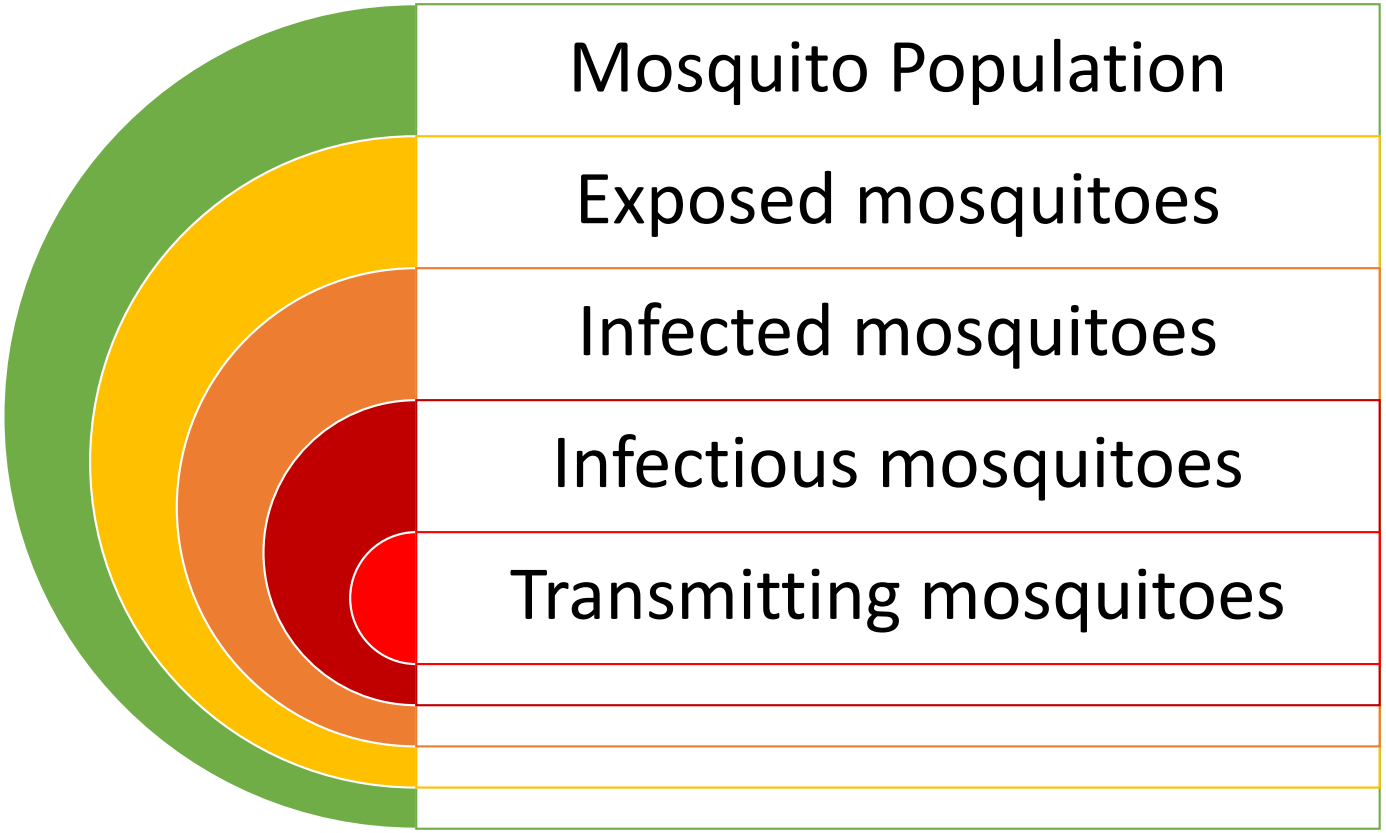
Vector-borne diseases

- One of the focuses of my lab:
  - Extrinsic and intrinsic factors that affect transmission and risk of arbovirus (more broadly, VBD) infections. Specifically:
    - vector:virus interactions
    - vector:host interactions

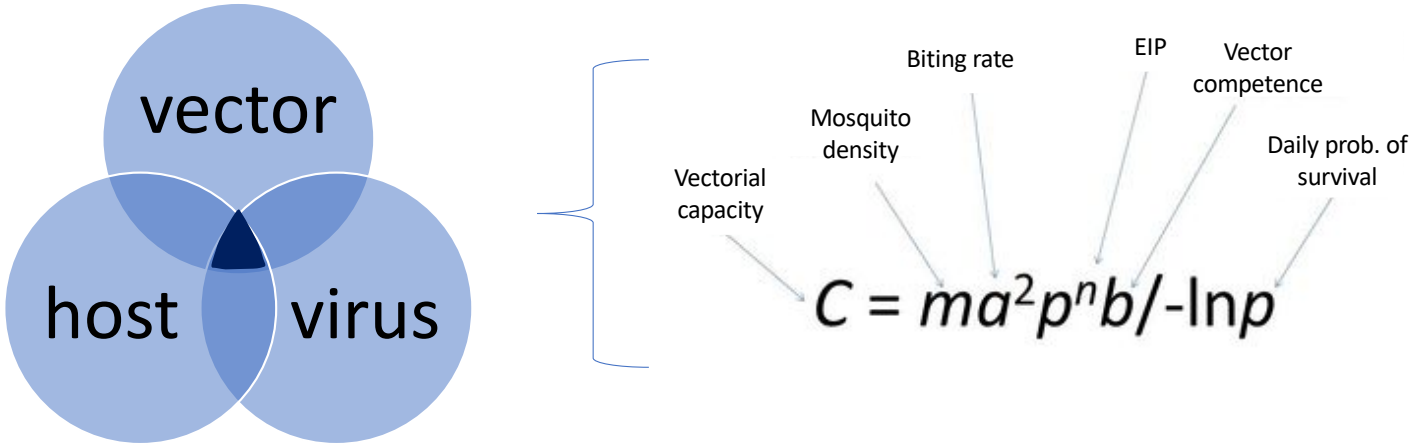




Filtering down to those mosquitoes that are actually transmitting.

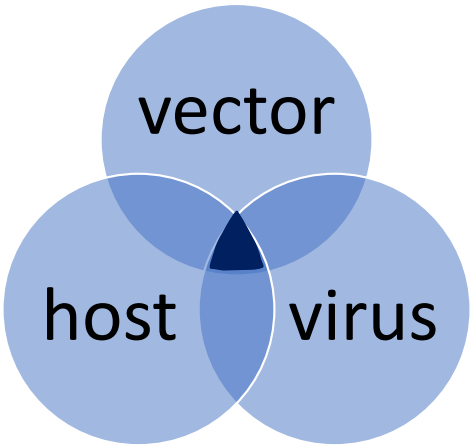


Vectorial capacity



Anderson, J.T., R., Rico-Hesse. 2006. Aedes aegypti vectorial capacity is determined by the infecting genotype of dengue virus. *American Journal of Tropical Medicine and Hygiene*. 75(5):886-892

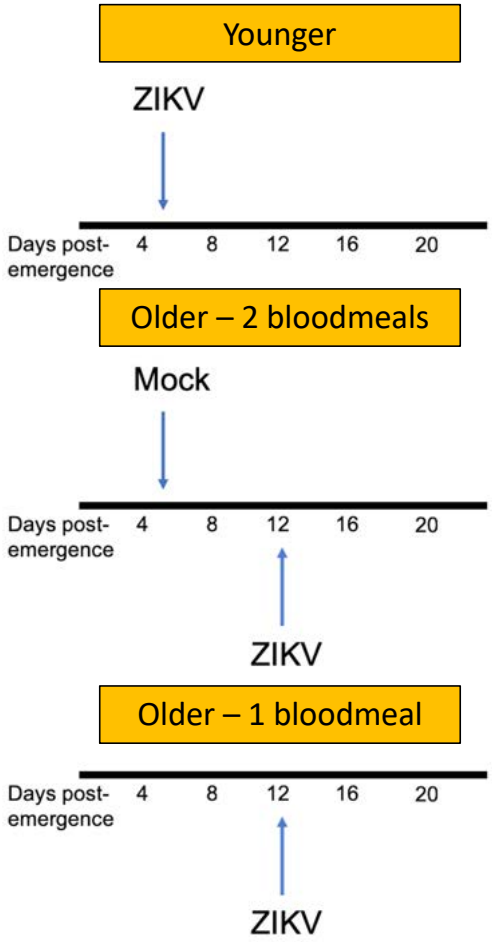
Vectorial capacity



1. Vector competence/ EIP
2. Mosquito mortality
3. Biting Rate

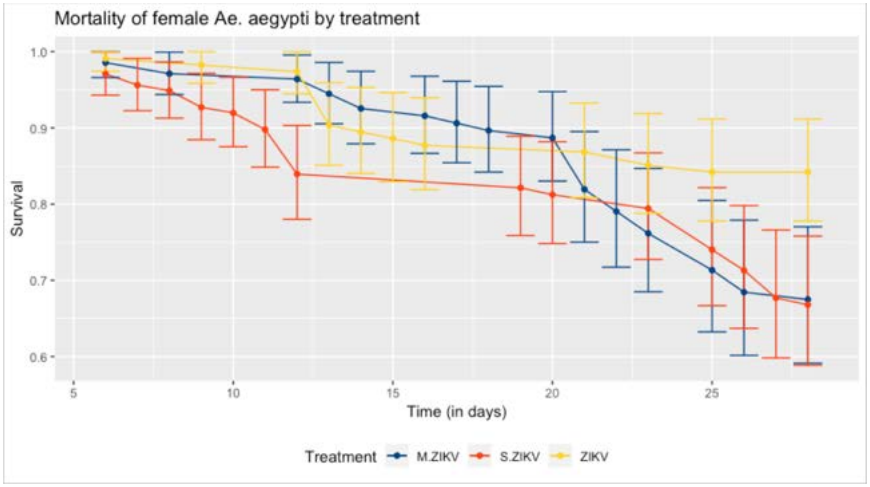
Question: What is the interplay between virus:vector kinetics and vector life traits?

- Affected mosquitoes at different day-post-emergence
- Difference in EIP50 among age groups?
- Difference in mortality between infected/uninfected?



Mortality & Vector competence

- Average time to death ~ 25 days

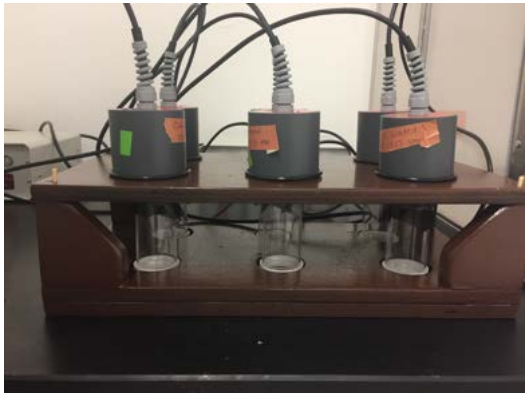


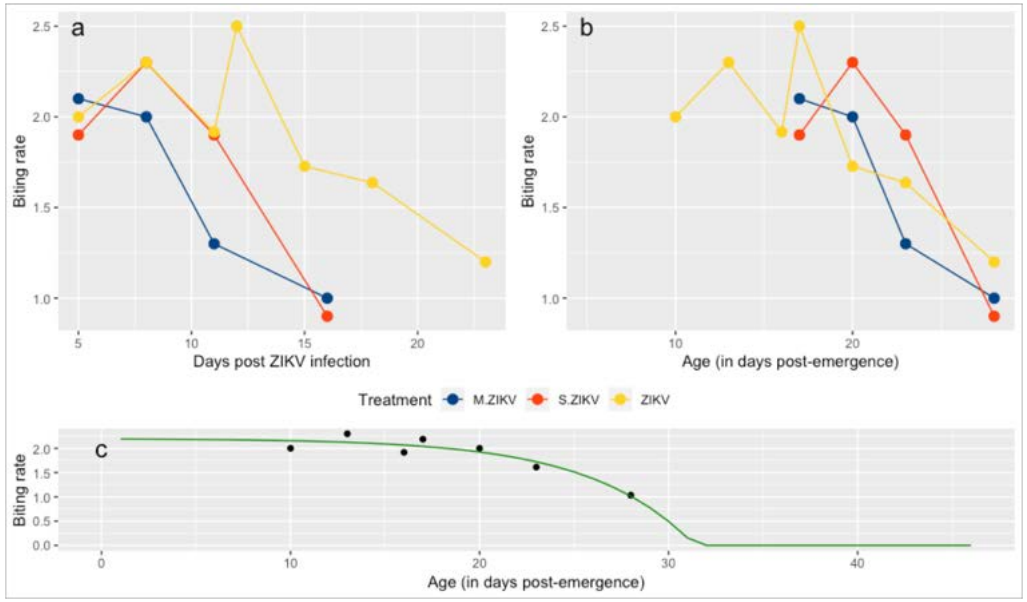
Treatment	dpi (Age)	% Transmission (n)
ZIKV	5 (10)	0 (10)
	8 (13)	0 (10)
	11 (16)	10 (10)
	12 (17)	10 (10)
	15 (20)	10 (10)
	18 (23)	60 (10)
	23 (28)	60 (10)
M.ZIKV	5 (17)	0 (10)
	8 (20)	0 (10)
	11 (23)	0 (10)
	16 (28)	0 (10)
S.ZIKV	5 (17)	0 (10)
	8 (20)	0 (10)
	11 (23)	10 (10)
	16 (28)	0 (10)

- No differences observed in EIP among treatments
- EIP_{50} ~ 18 days

Biting rate

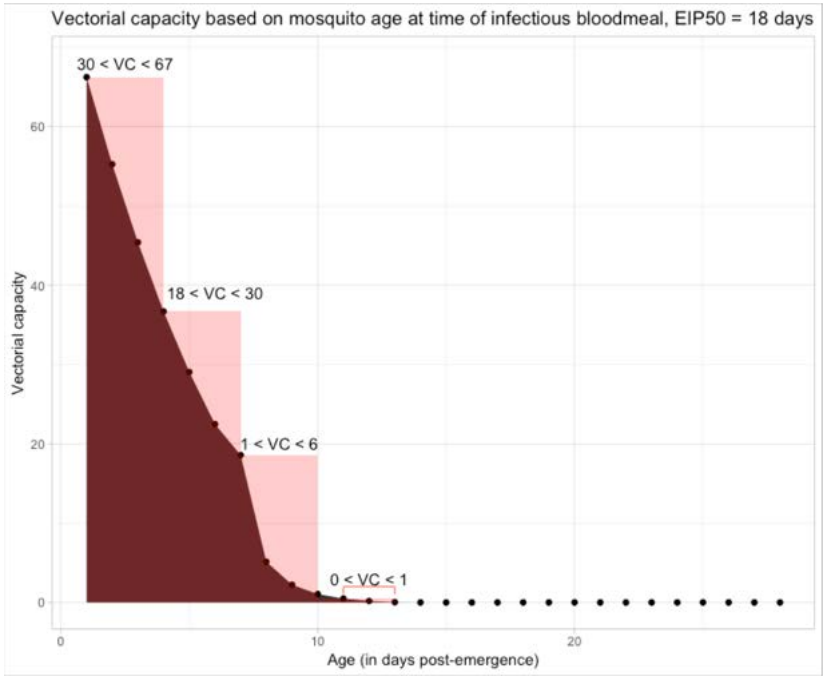
- No differences among treatments
- Apparent age effect



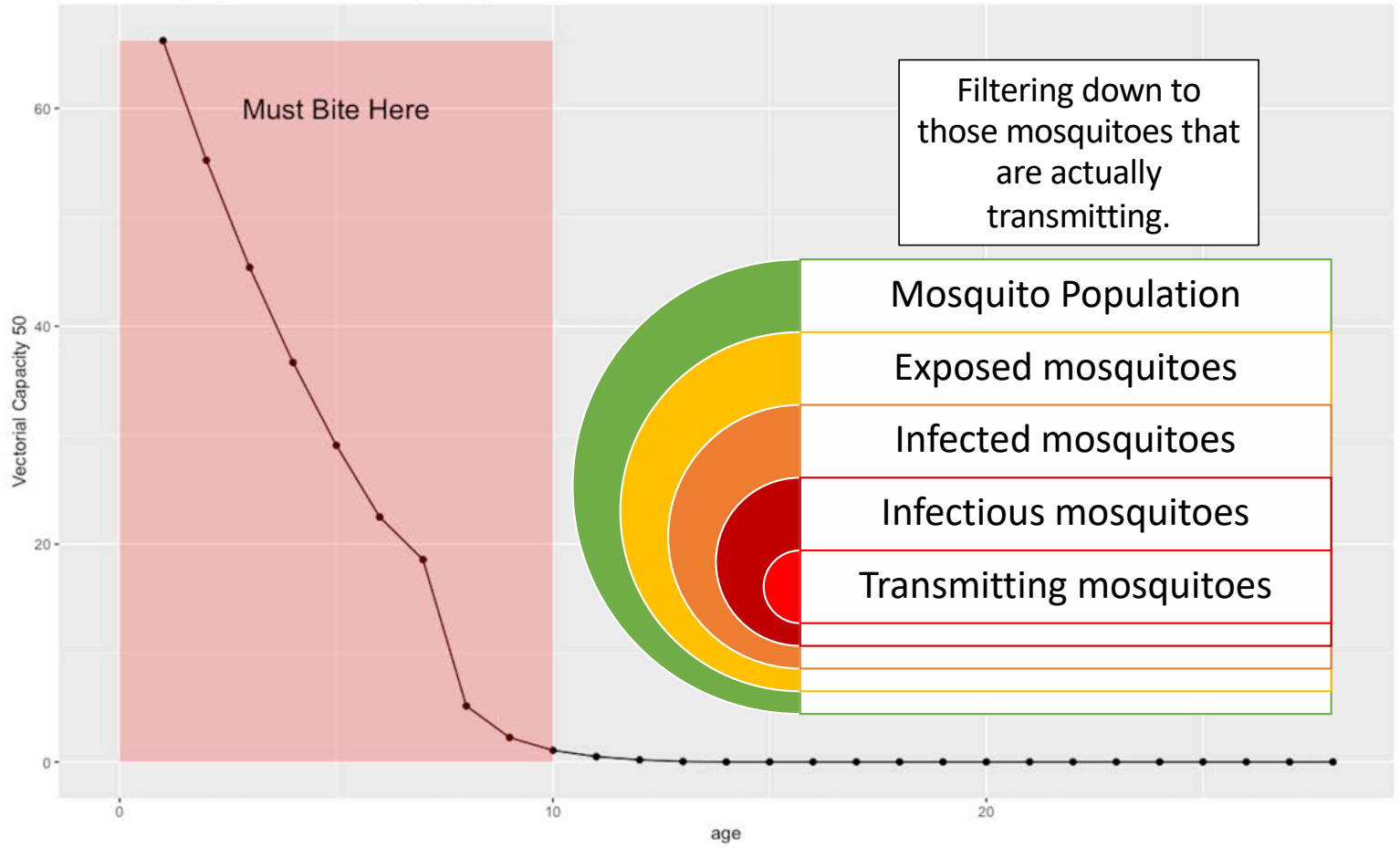


Age-structured vectorial capacity equation

$$VC_{age} = \frac{m\left(z_{age}a_{age} * z_i a_i\right) b \prod_1^i p_i}{-\ln(p_{age})}$$



Age-structured vectorial capacity equation



Age-structured vectorial capacity equation

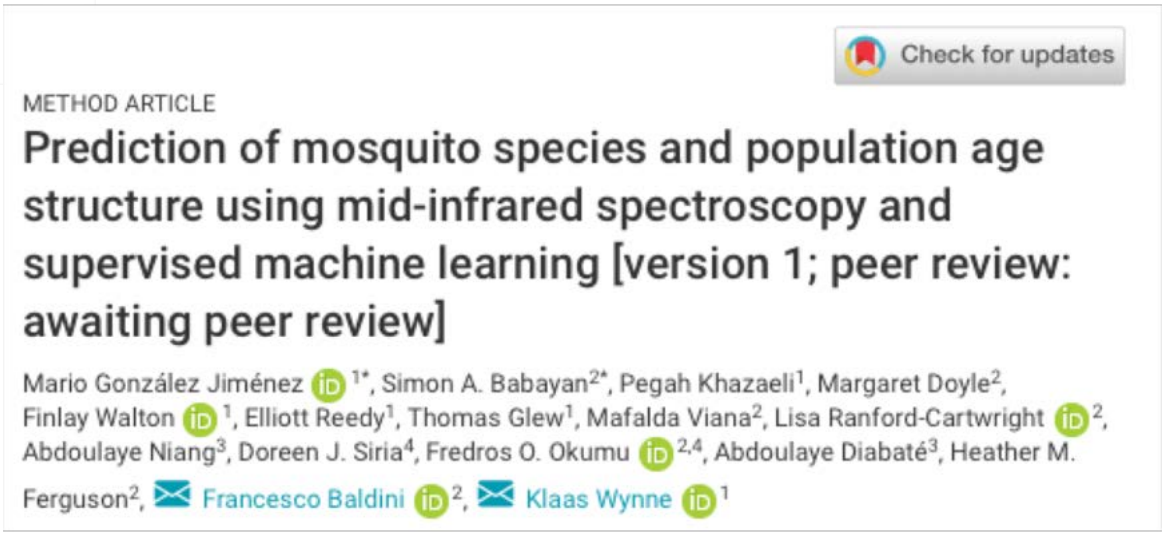
SCIENTIFIC REPORTS

OPEN

First report on the application of near-infrared spectroscopy to predict the age of *Aedes albopictus* Skuse

Received: 27 October 2017
Accepted: 12 June 2018
Published online: 25 June 2018

Maggy T. Sikulu-Lord[1,2], Gregor J. Devine[1], Leon E. Hugo[1] & Floyd E. Dowell[3]



Check for updates

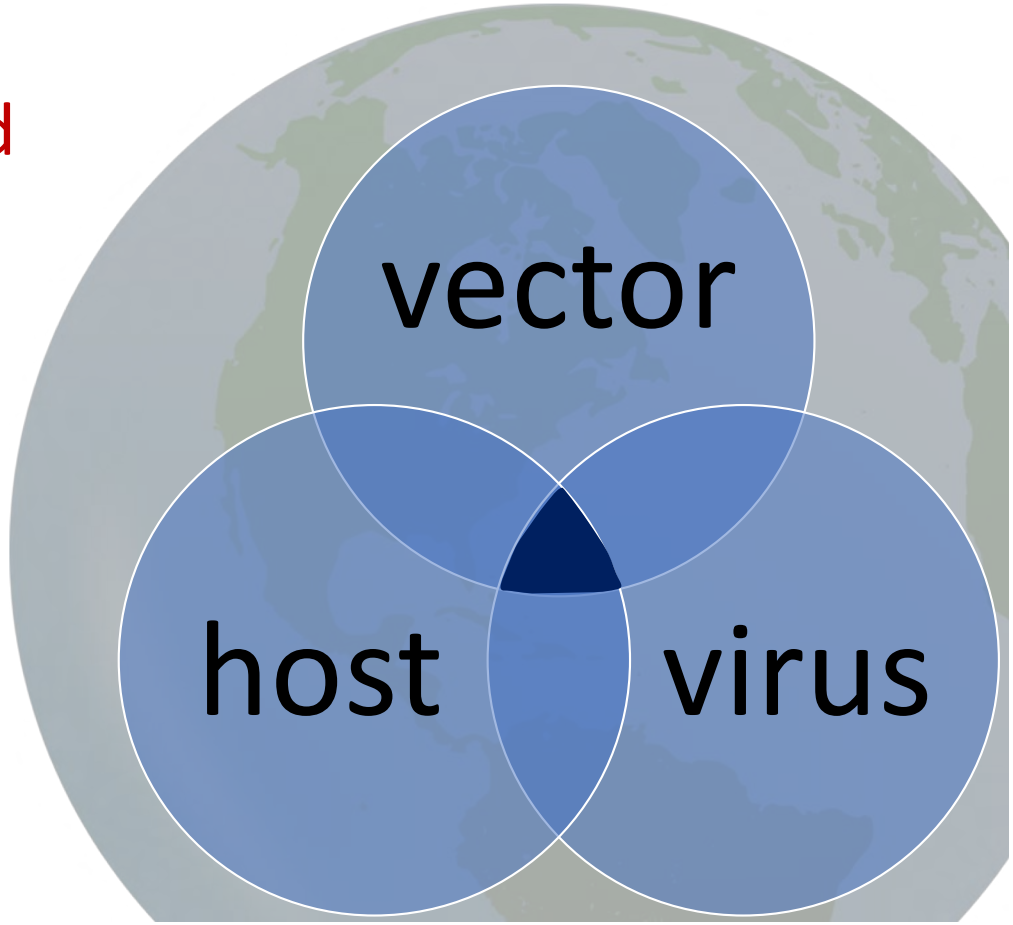
METHOD ARTICLE

Prediction of mosquito species and population age structure using mid-infrared spectroscopy and supervised machine learning [version 1; peer review: awaiting peer review]

Mario González Jiménez [1*], Simon A. Babayan[2*], Pegah Khazaeli[1], Margaret Doyle[2], Finlay Walton [1], Elliott Reedy[1], Thomas Glew[1], Mafalda Viana[2], Lisa Ranford-Cartwright [2], Abdoulaye Niang[3], Doreen J. Siria[4], Fredros O. Okumu [2,4], Abdoulaye Diabaté[3], Heather M. Ferguson[2], Francesco Baldini [2], Klaas Wynne [1]

Vector-borne diseases

How will climate change add to the unknown?



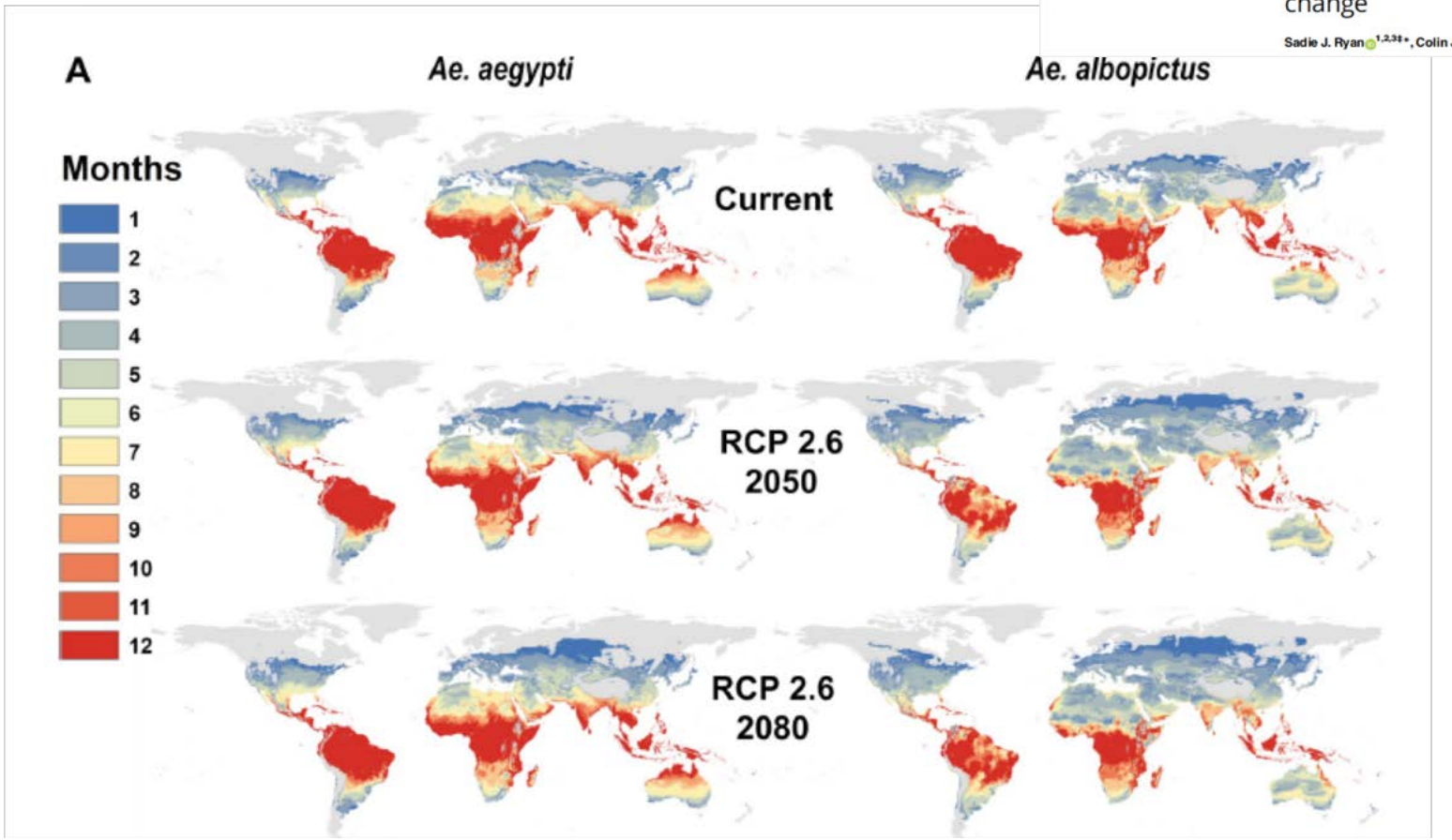
Climate Change

PLOS | NEGLECTED TROPICAL DISEASES

RESEARCH ARTICLE

Global expansion and redistribution of *Aedes*-borne virus transmission risk with climate change

Sadie J. Ryan[1,2,3‡*], Colin J. Carlson[4,5‡], Erin A. Mordecai[6], Leah R. Johnson[7]

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REPORTS
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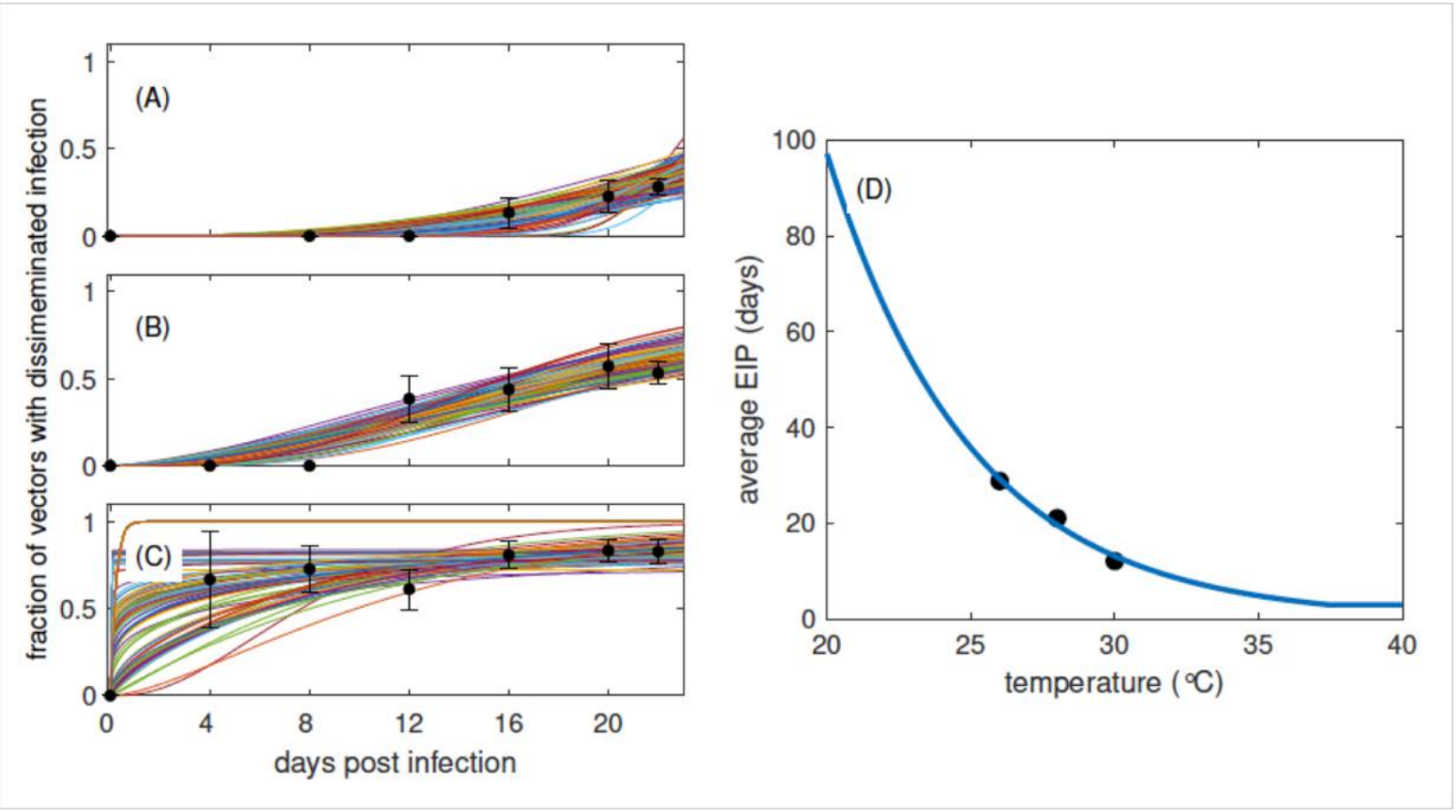
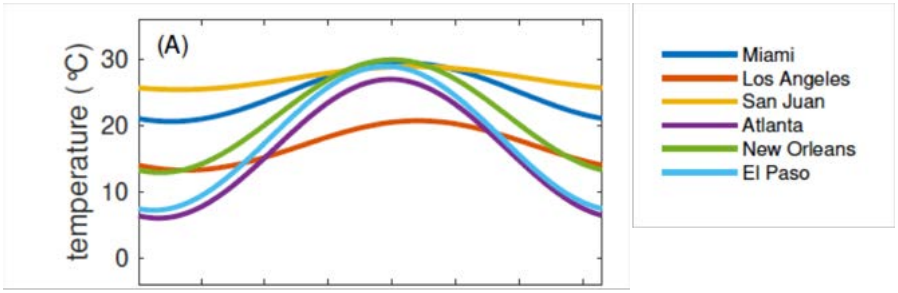
The Intergovernmental Panel on Climate Change
The Intergovernmental Panel on Climate Change (IPCC) is the United Nations body for assessing the science related to climate change.
PREVIOUS WEBSITE
GLOBAL WARMING OF 1.5°C
WMO
UNEP
Nobel
2007 PEACE PRIZE

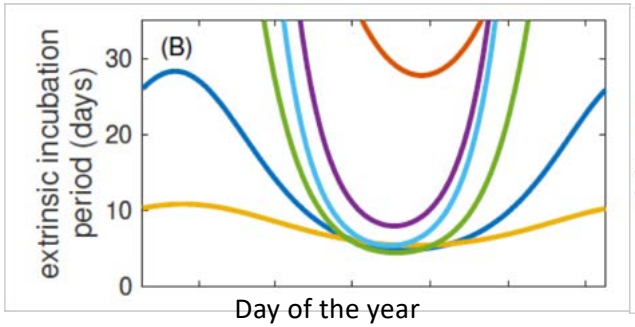
Climate change and DENV transmission



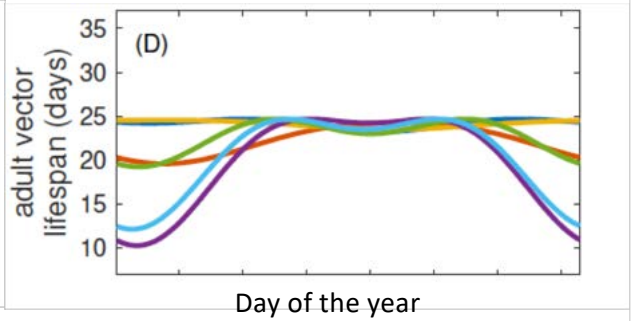
Climate change and DENV transmission



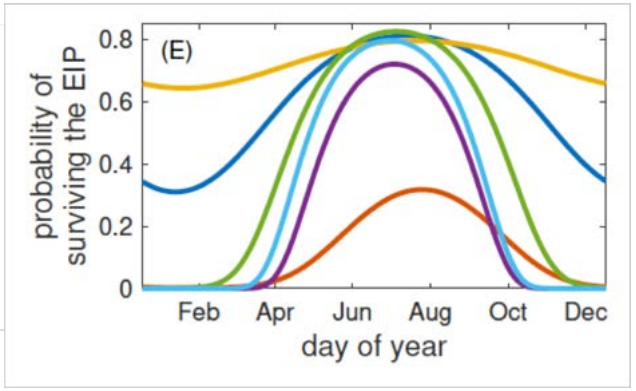
Day of the year



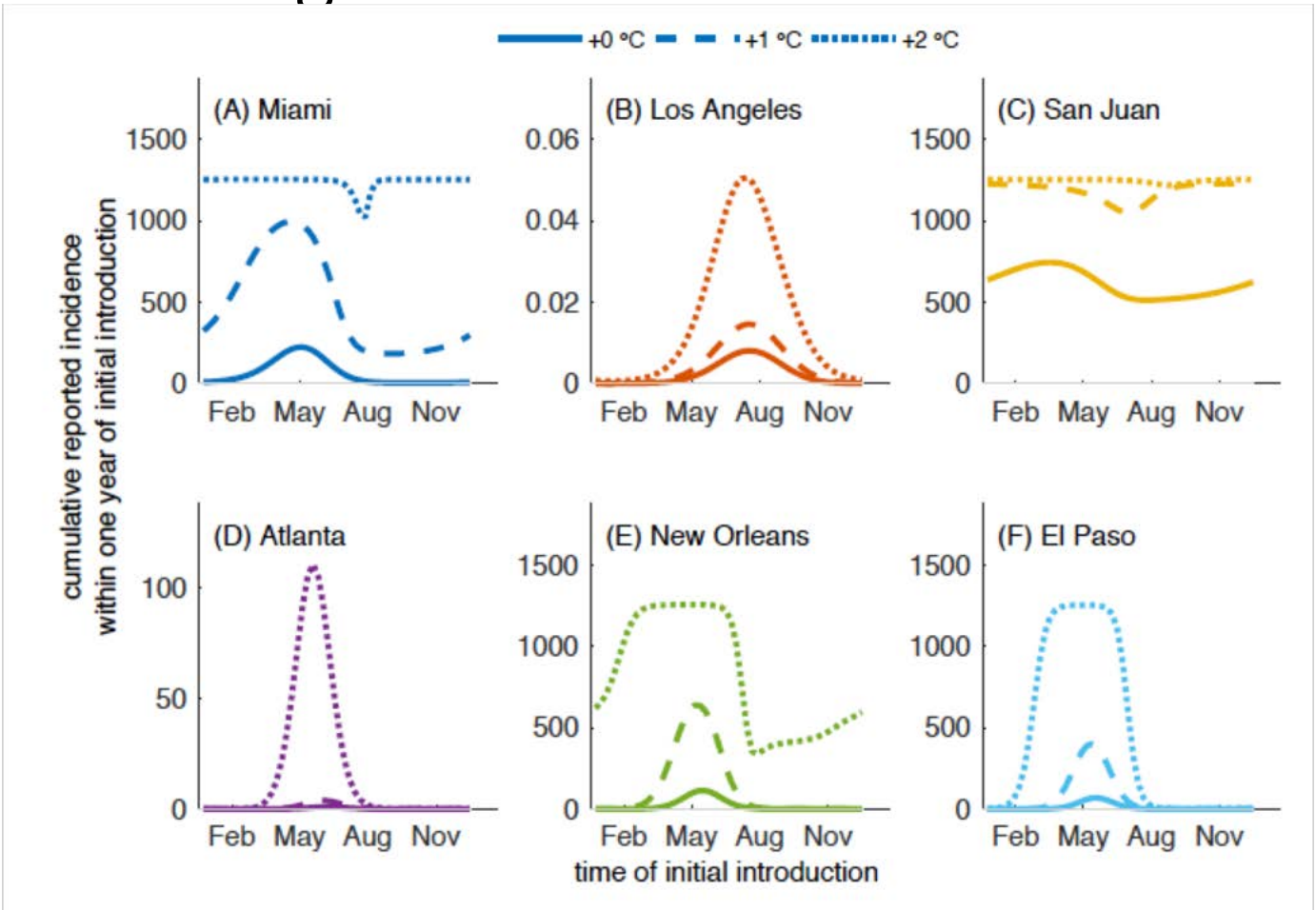
Day of the year



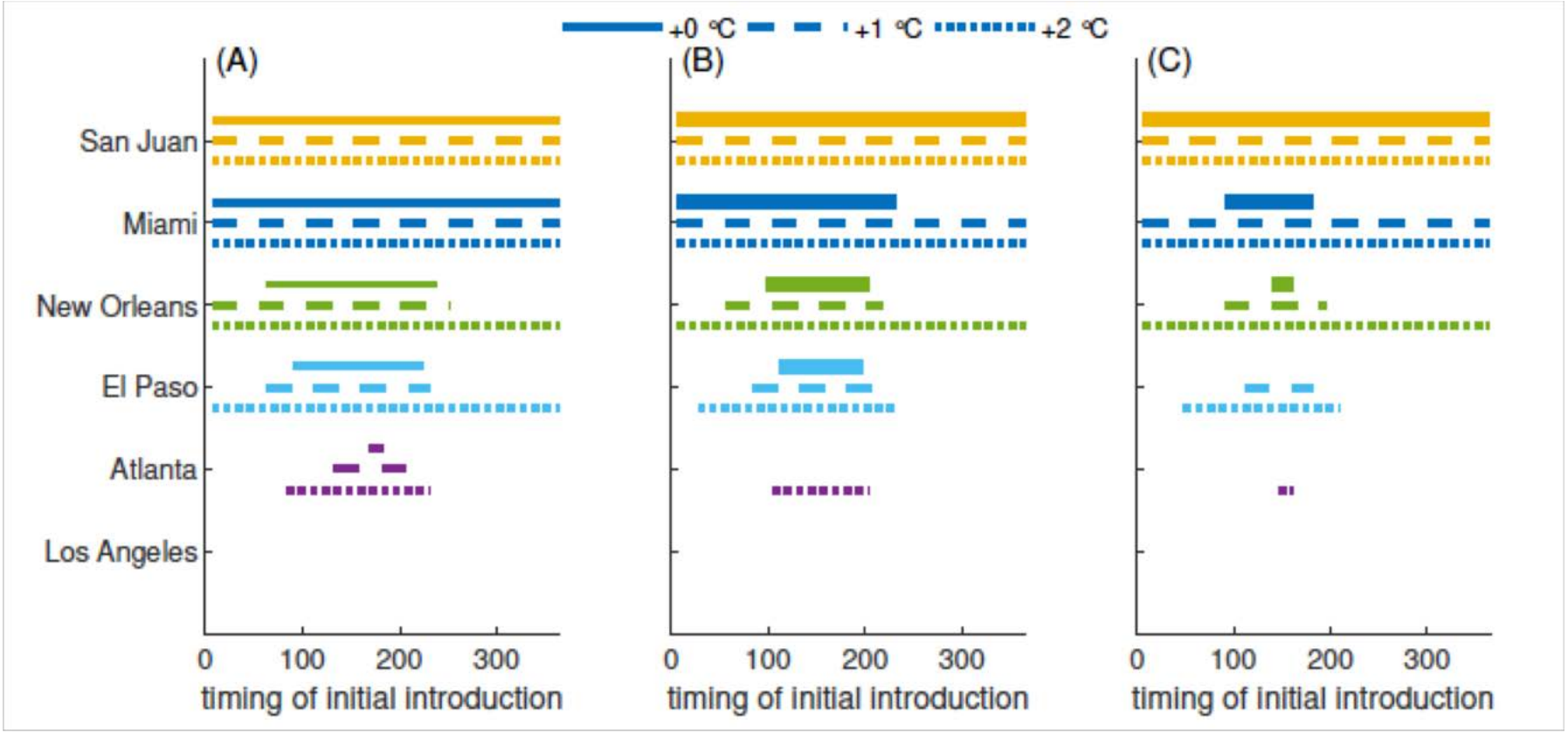
Day of the year



Climate change and transmission



Climate change and transmission



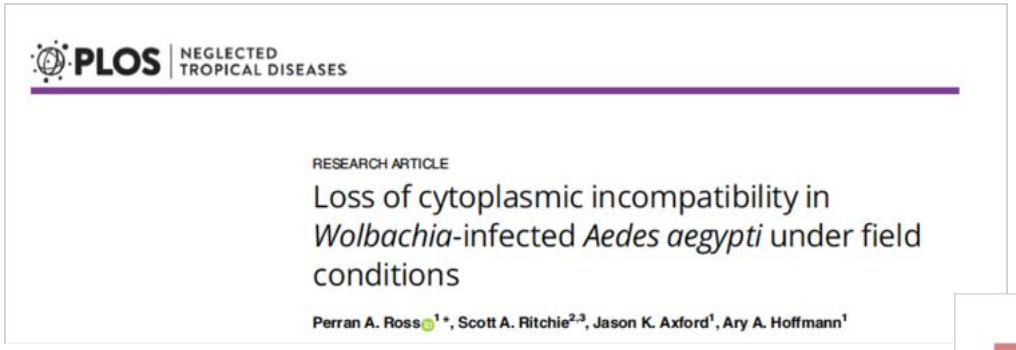
Climate change and transmission

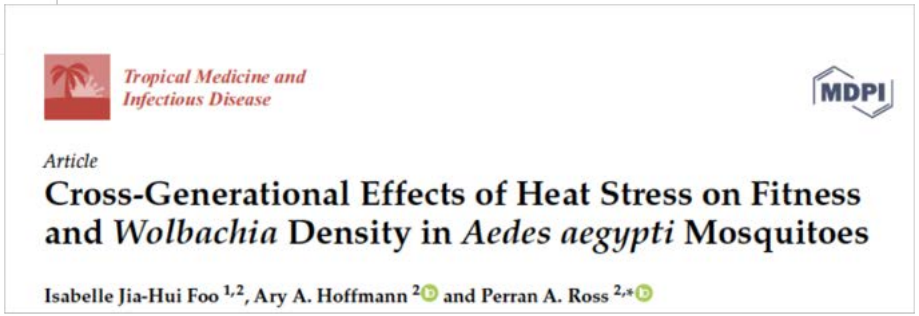
- Assumptions (selected):
  - No phenotypic diversity in either mosquito or virus
  - Biting Rate not age-specific
  - No age-structure in the model

- Meaning:
  - We have *an idea* of what could happen

Climate Change

- Other effects



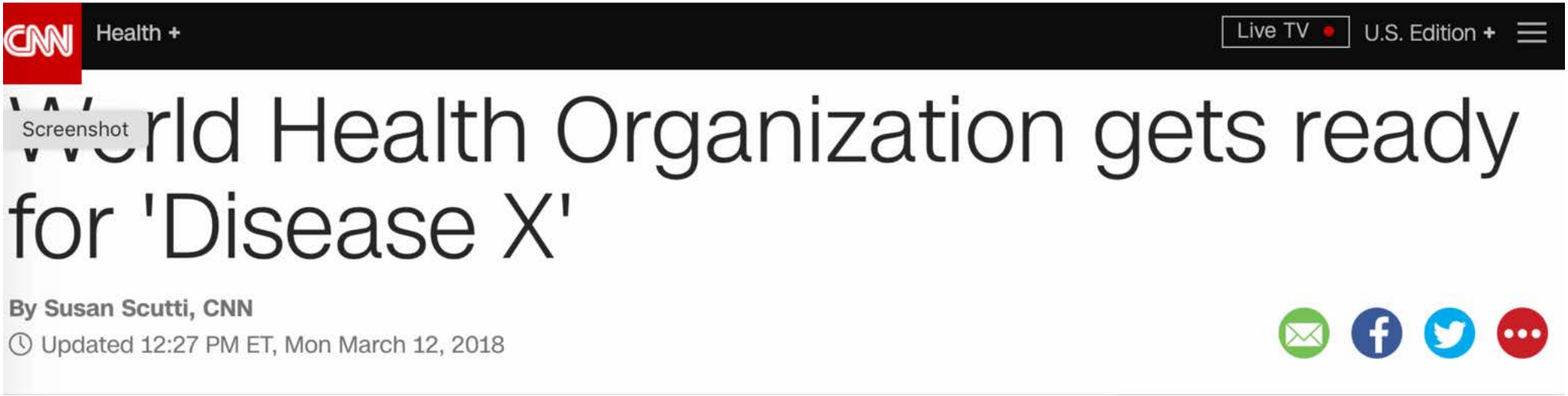


Summary

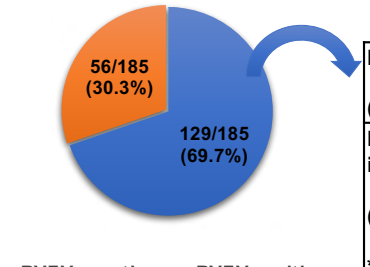
- What do we know?
  - We know what the threats are
  - We know (some of) the drivers of risk
  - We know the challenges
- What do we know we do not know?
  - Actual transmission rates
  - Nuances of effectors
  - Technicalities of how to address

Summary

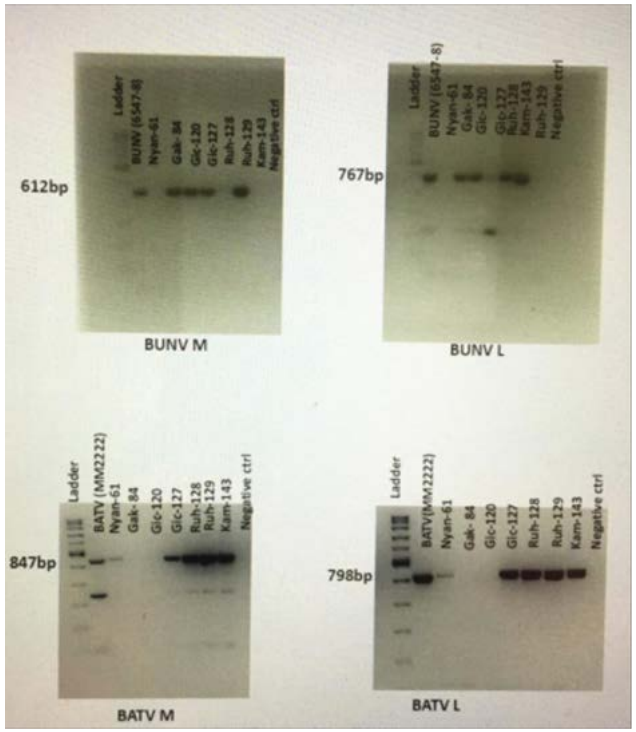
- Unknown unknowns
  - The one everybody wants to know: What's next?



Orthobunyaviruses in RVFV negative samples



BUNV infection **2/129** **(Gak, Gic)**
BATV & BUNV infection **3/129** **(Gic, Ruh,Ruh)** ***can't rule out triple co-infection (with NRIV)**
BATV infection **2/129** **(Nyanz,Kam)**



		RVFV + (56)	BUNV + (2)	BATV + (2)	BUNV-BATV co+ (3)
Species	Cattle (157)	44	2	2	3
	Goats (28)	12	0	0	0
Clinical symptoms	Abortion (153)	41	2	2	3
	Hemorrhagic fever* (15)	15	0	0	0

*all cases of hemorrhagic fever were fatal

Thank you:

- Lab Members
- E. Handly Mayton
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- A. Ryan Tramonte
- Austin Barnes

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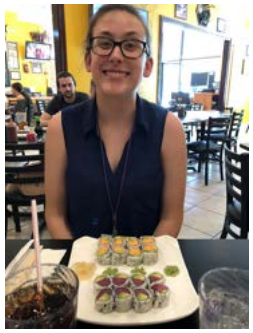

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Dad

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