

Ministério da Saúde

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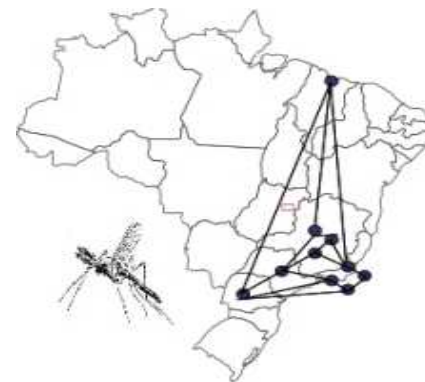
Fundação Oswaldo Cruz

Models of dengue fever and their contributions to public health

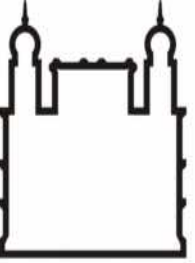
Cláudia Torres Codeço

codeco@fiocruz.br

Aguas de Lindoia, CNMAC, Setembro de 2012



Pronex Dengue



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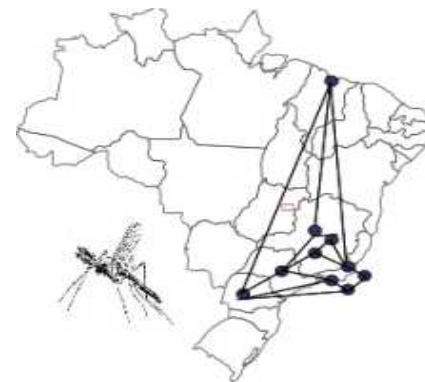
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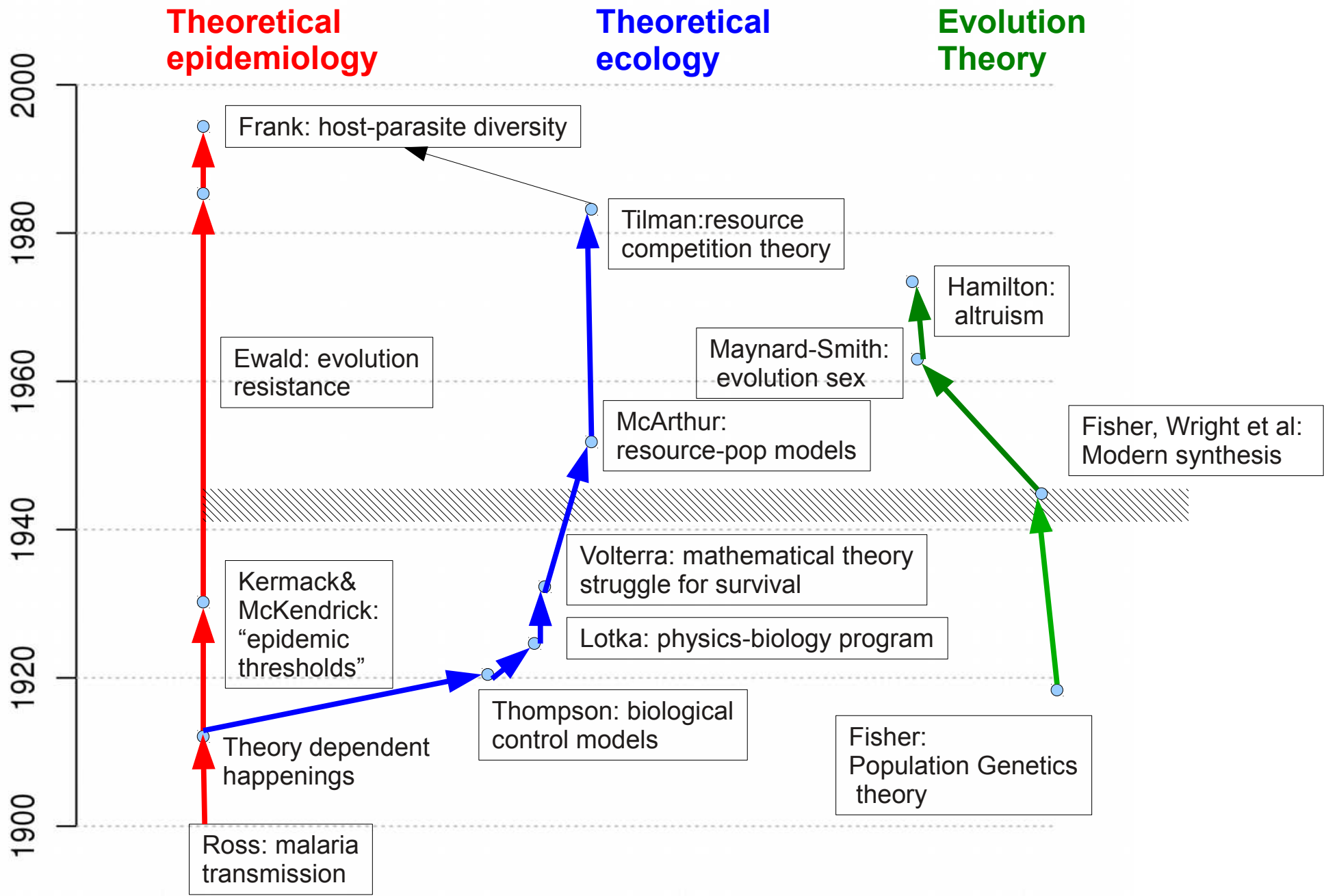
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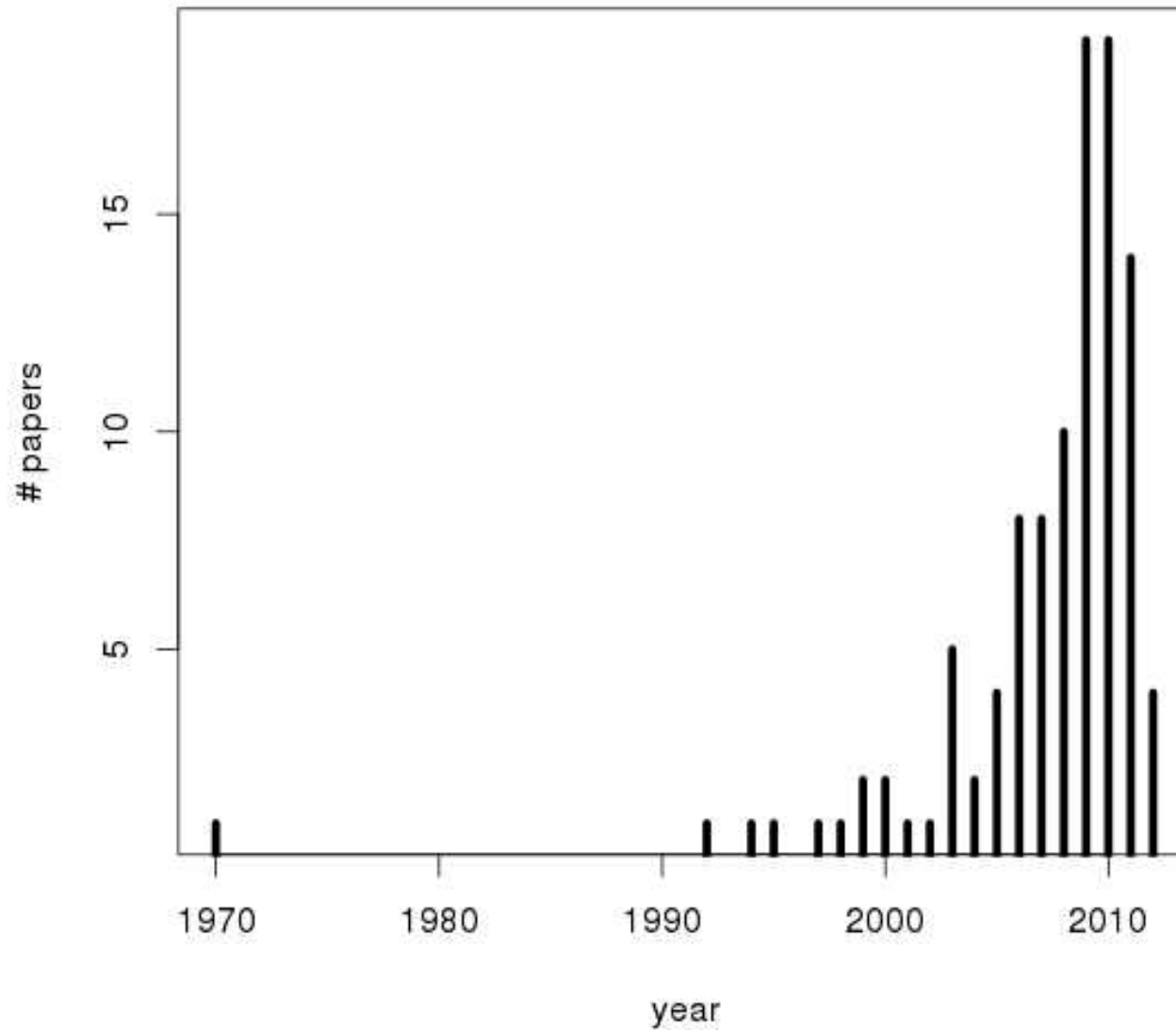


Pronex Dengue



Classic mechanics, demography(Malthus), statistical epidemiology
 Darwin's theory

Dengue modeling literature



N = 105

DIANA B. FISCHER*
SCOTT B. HALSTEAD**

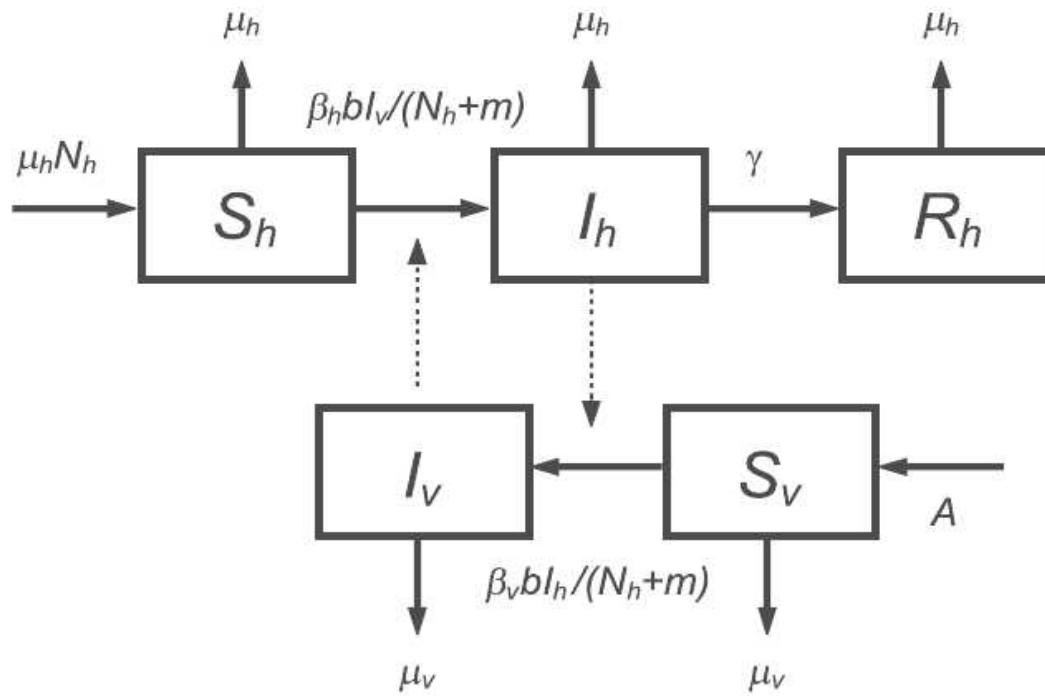
*Yale Arbovirus Research Unit,
60 College Street,
New Haven, Connecticut 06510*

**OBSERVATIONS RELATED TO PATHOGENESIS OF DENGUE HEMORRHAGIC FEVER.
V. EXAMINATION OF AGE SPECIFIC SEQUENTIAL INFECTION RATES
USING A MATHEMATICAL MODEL†**

Two models of dengue infection patterns are examined: 1) the *double sequential model* and 2) the *triple sequential model*.

It is the purpose of this paper to utilize the above observations in a study of mathematical models which permit prediction of age specific secondary or tertiary infection rates in populations exposed to three or four different dengue viruses. Results from models have been compared with available

The Canonical Model



$$\frac{dS_h}{dt} = \mu_h (N_h - S_h) - \frac{\beta_h b}{N_h + m} S_h I_v,$$

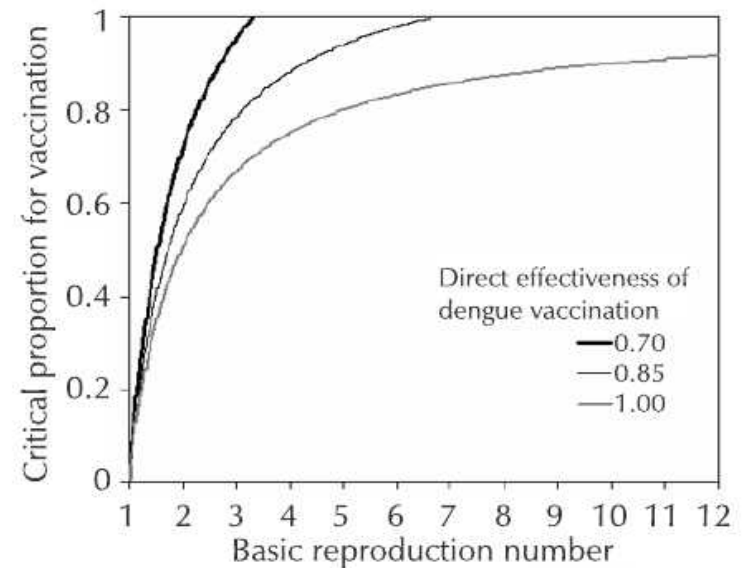
$$\frac{dI_h}{dt} = \frac{\beta_h b}{N_h + m} S_h I_v - (\mu_h + \gamma) I_h,$$

$$\frac{dR_h}{dt} = \gamma I_h - \mu_h R_h,$$

$$\frac{dS_v}{dt} = A - \frac{\beta_v b}{N_h + m} S_v I_h - \mu_v S_v,$$

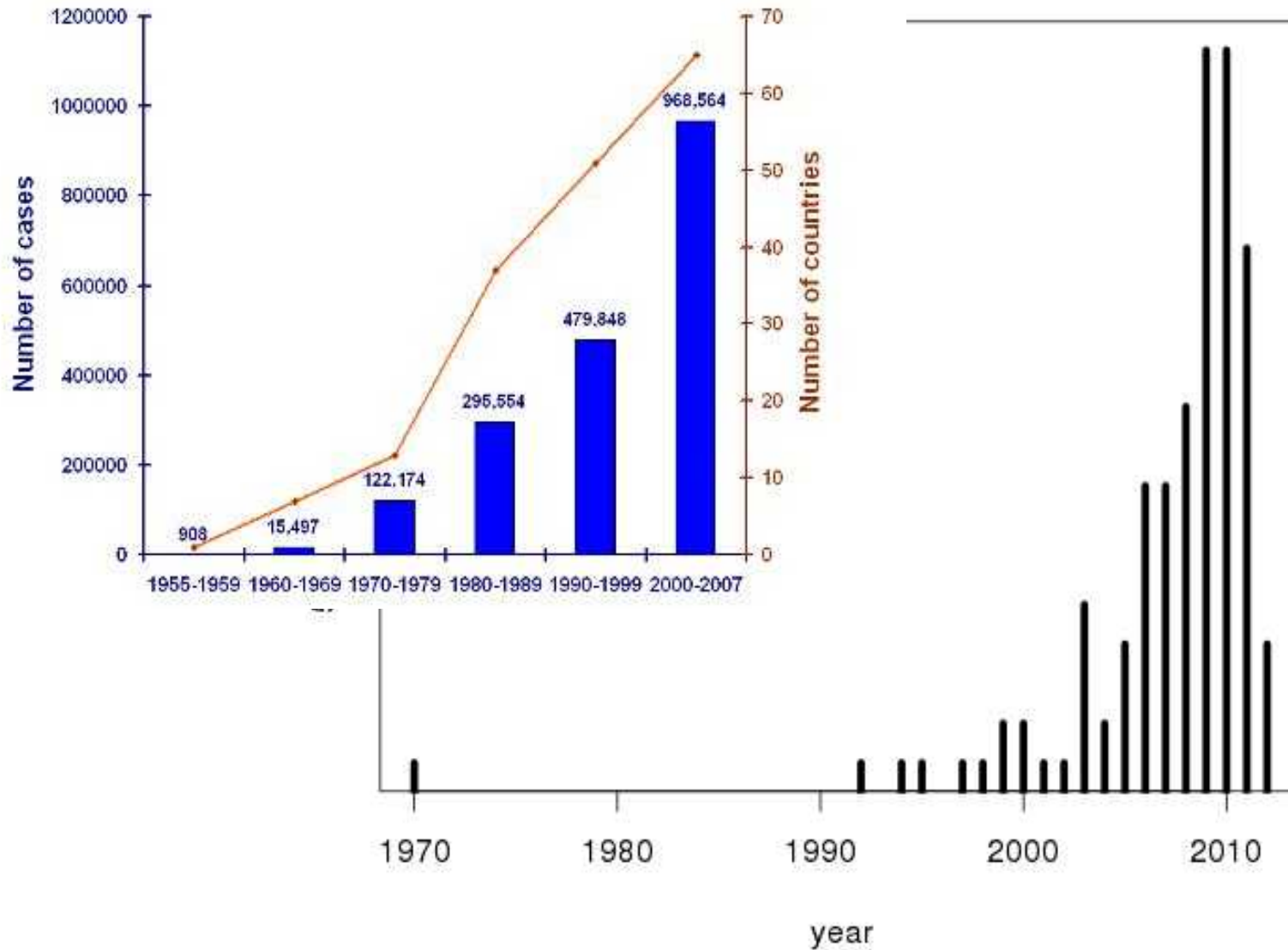
$$\frac{dI_v}{dt} = \frac{\beta_v b}{N_h + m} S_v I_h - \mu_v I_v,$$

$$R_0 = \sqrt{\frac{b^2 \beta_h \beta_v N_h A / \mu_v}{(N_h + m)^2 \mu_v (\gamma + \mu_h)}} > 1$$



The Dengue modeling literature

Average annual number of DF/DHF cases reported to WHO & average annual number of countries reporting dengue

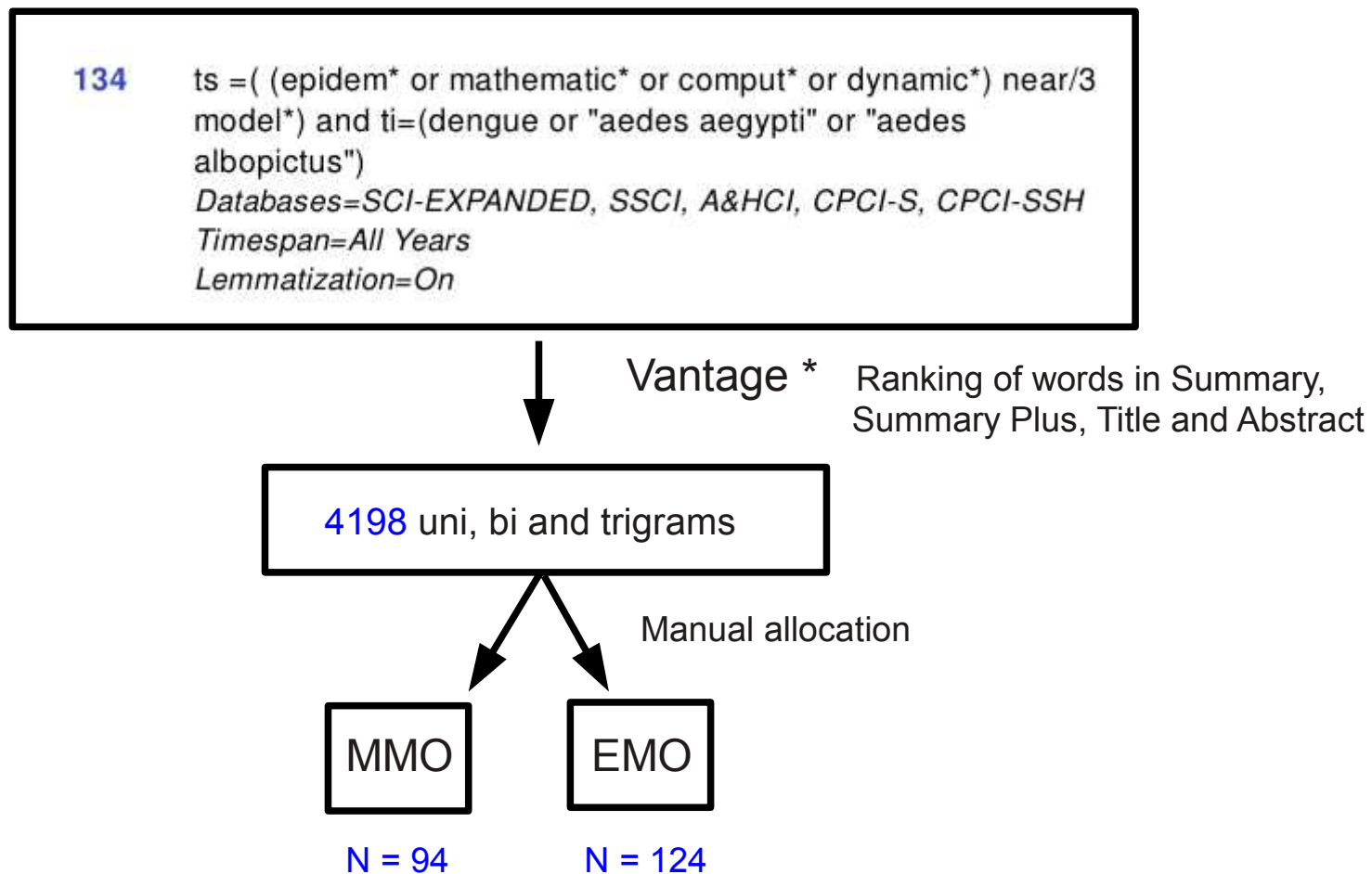


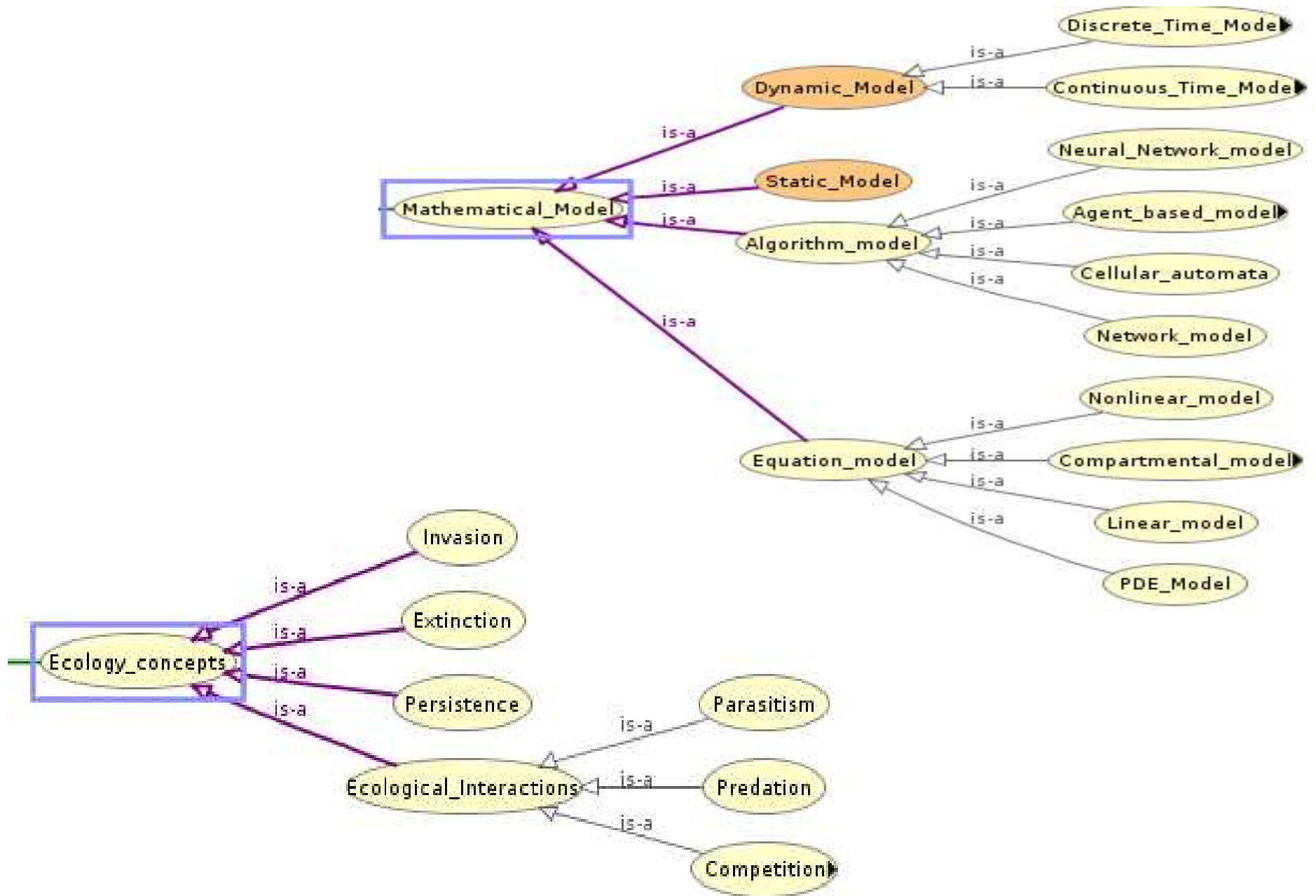
How to observe the contributions to Public Health?

- Method: *Culturomics* studies human behavior and cultural trends through the quantitative analysis of digitized texts.
- Application to dengue modeling literature:
 - Cultural Trends
 - Biological complexity
 - Mathematical complexity

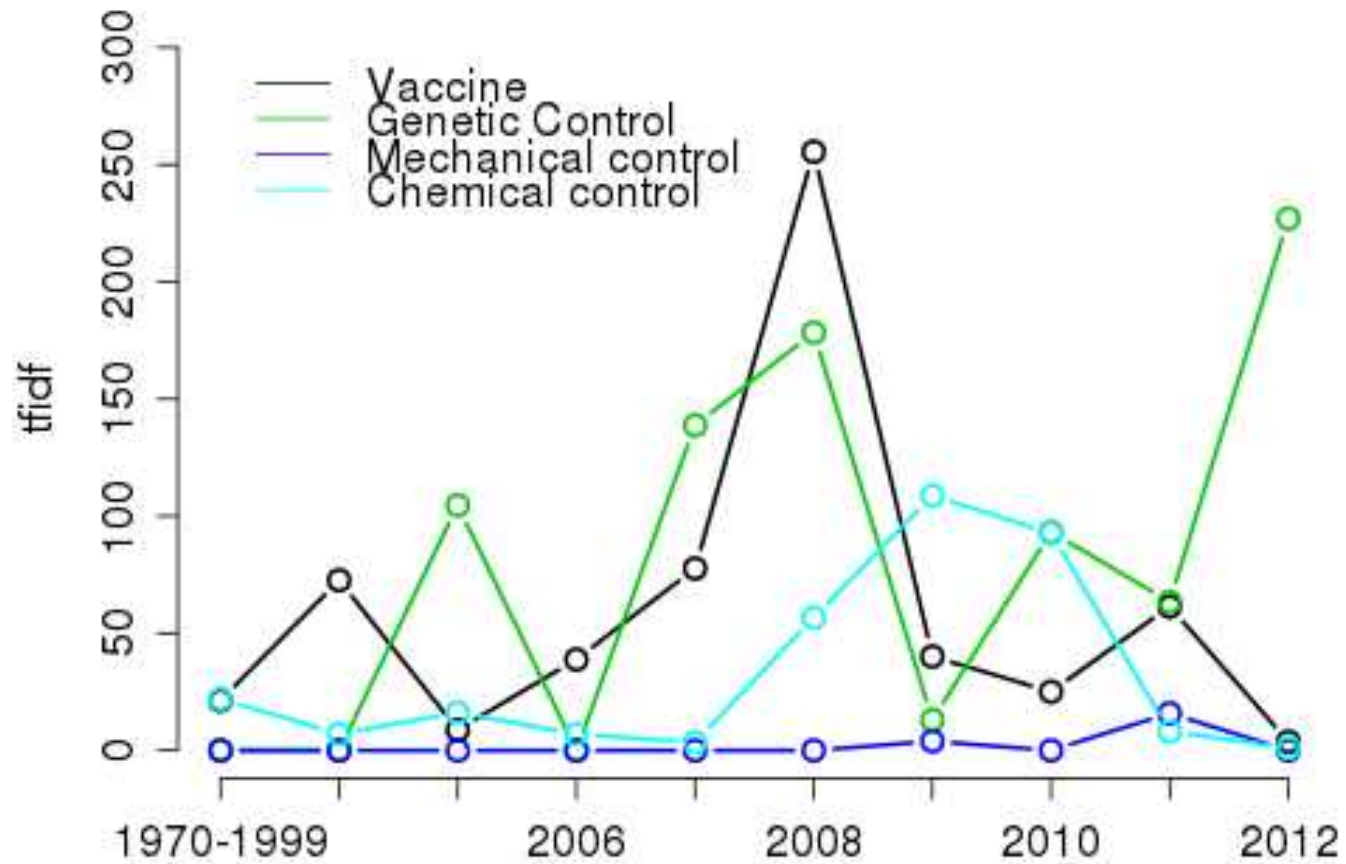
Method

Literature Harvesting – *focused on Dengue Fever Modeling*

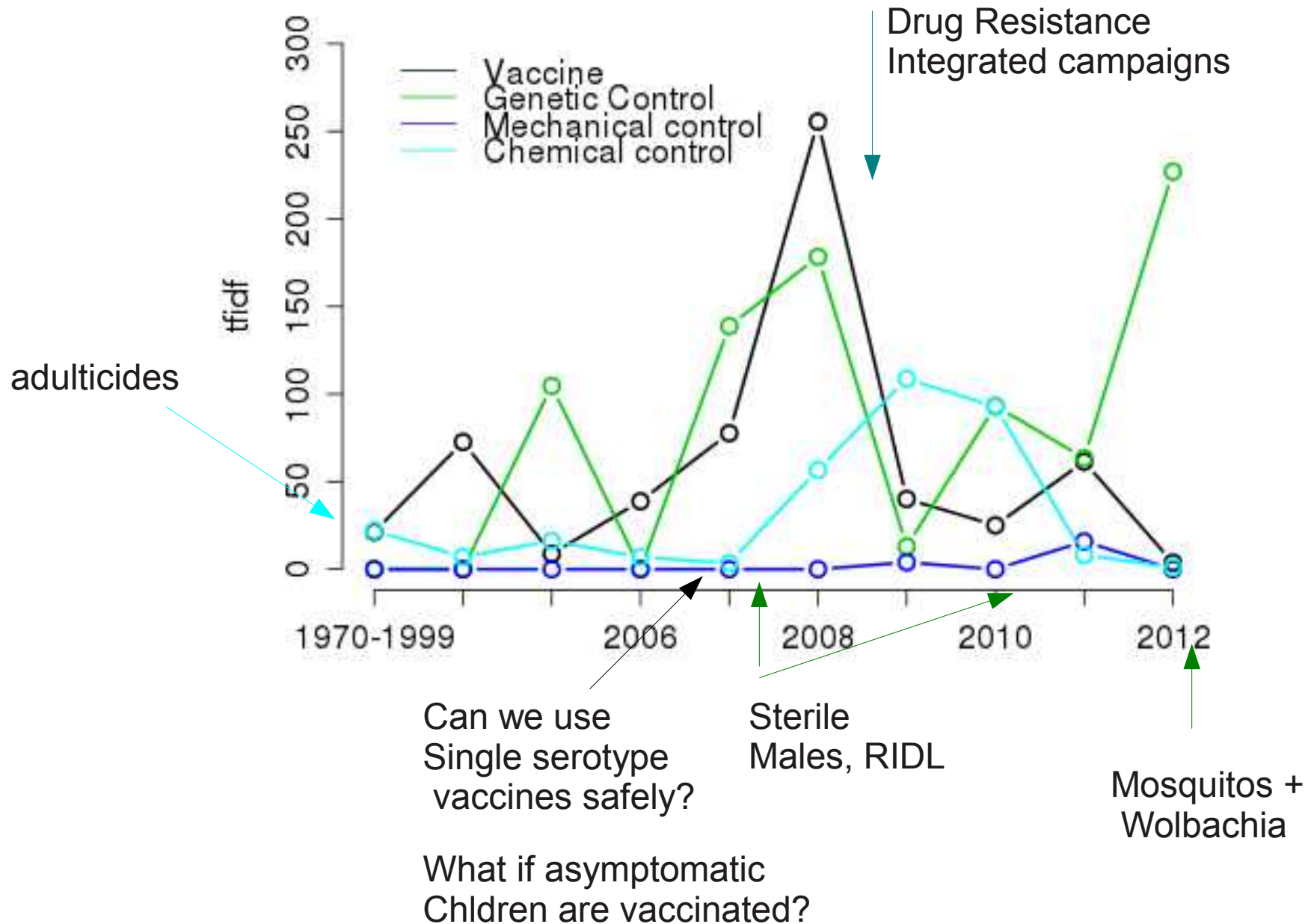




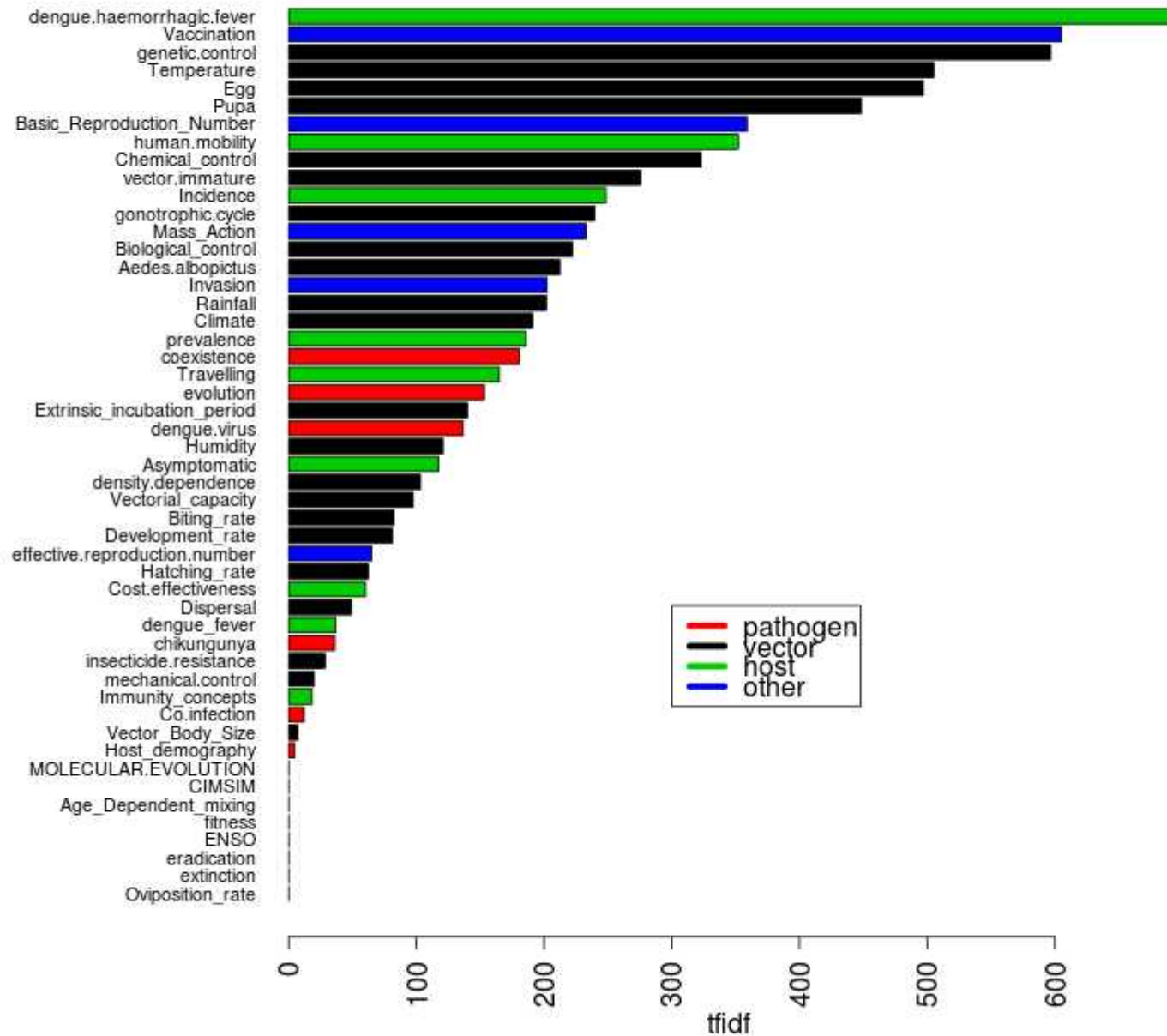
Results: Dengue models follow trends in technology



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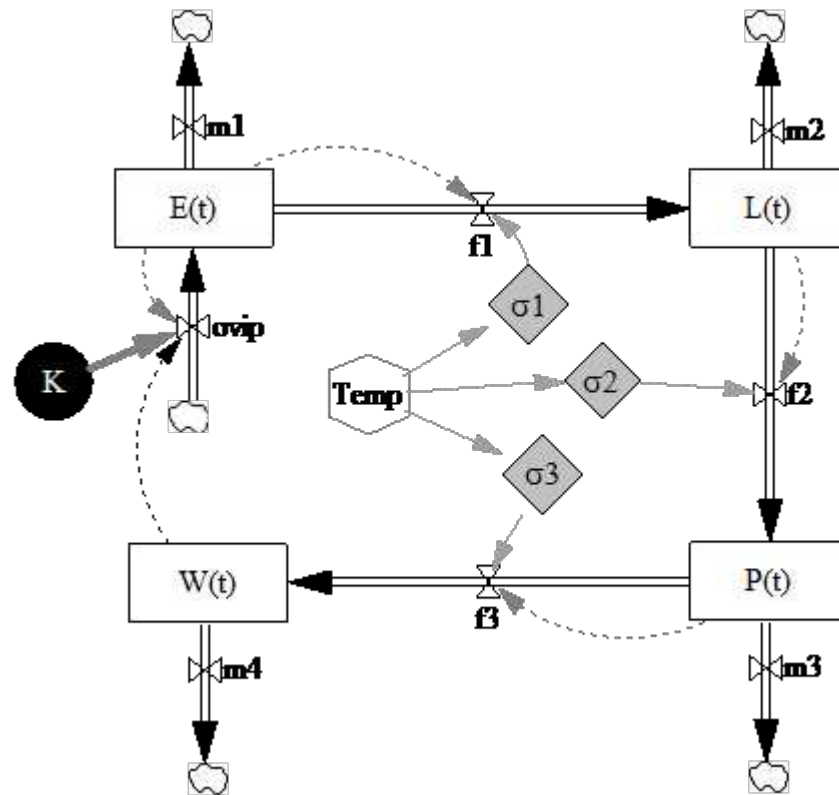
Biological complexity still very biased towards the mosquito compartment



What is missing...

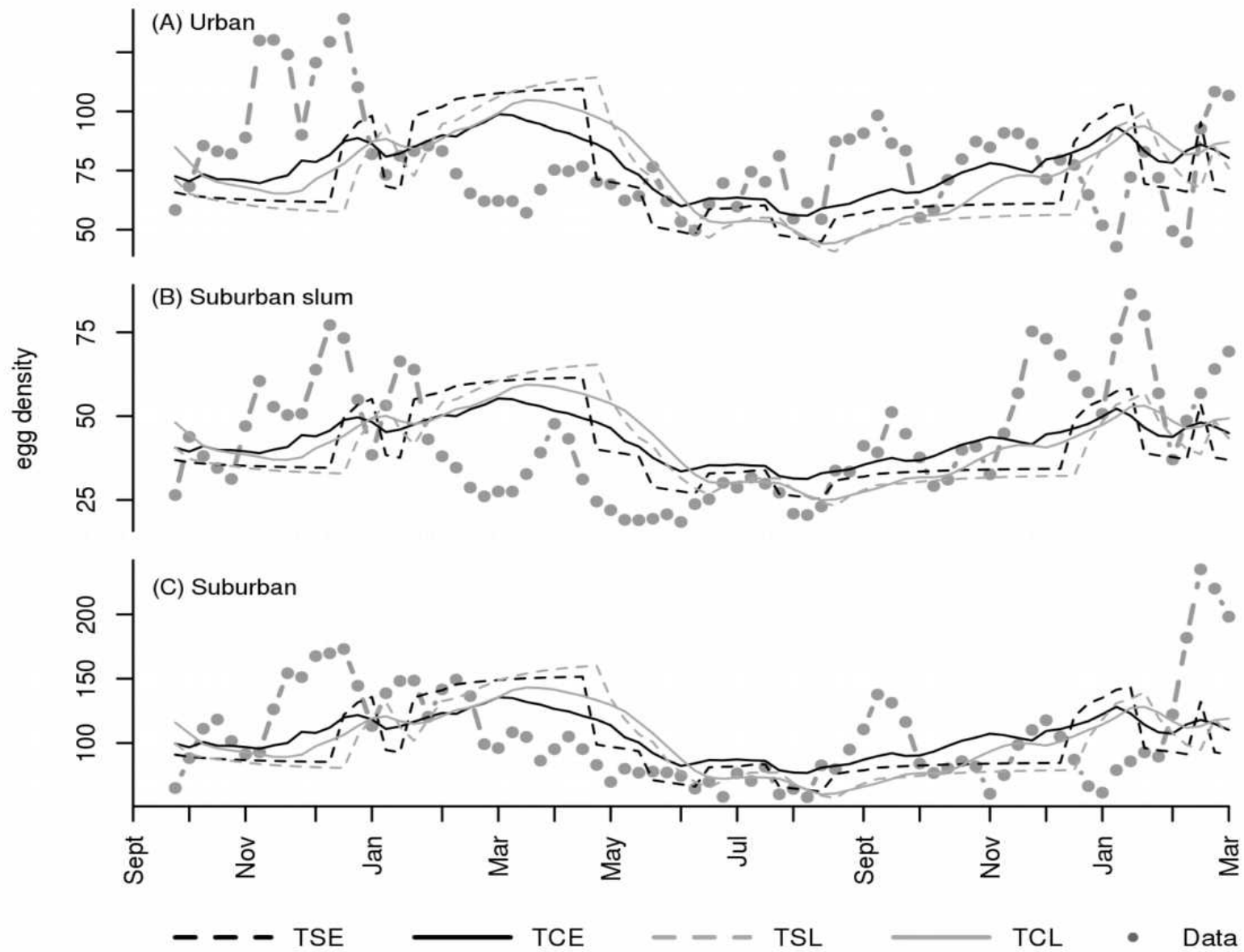
- Asymptomatic dengue infections (2)
- Co-infection (1)
- Age structure (1)

Proper validation of the mosquito compartment

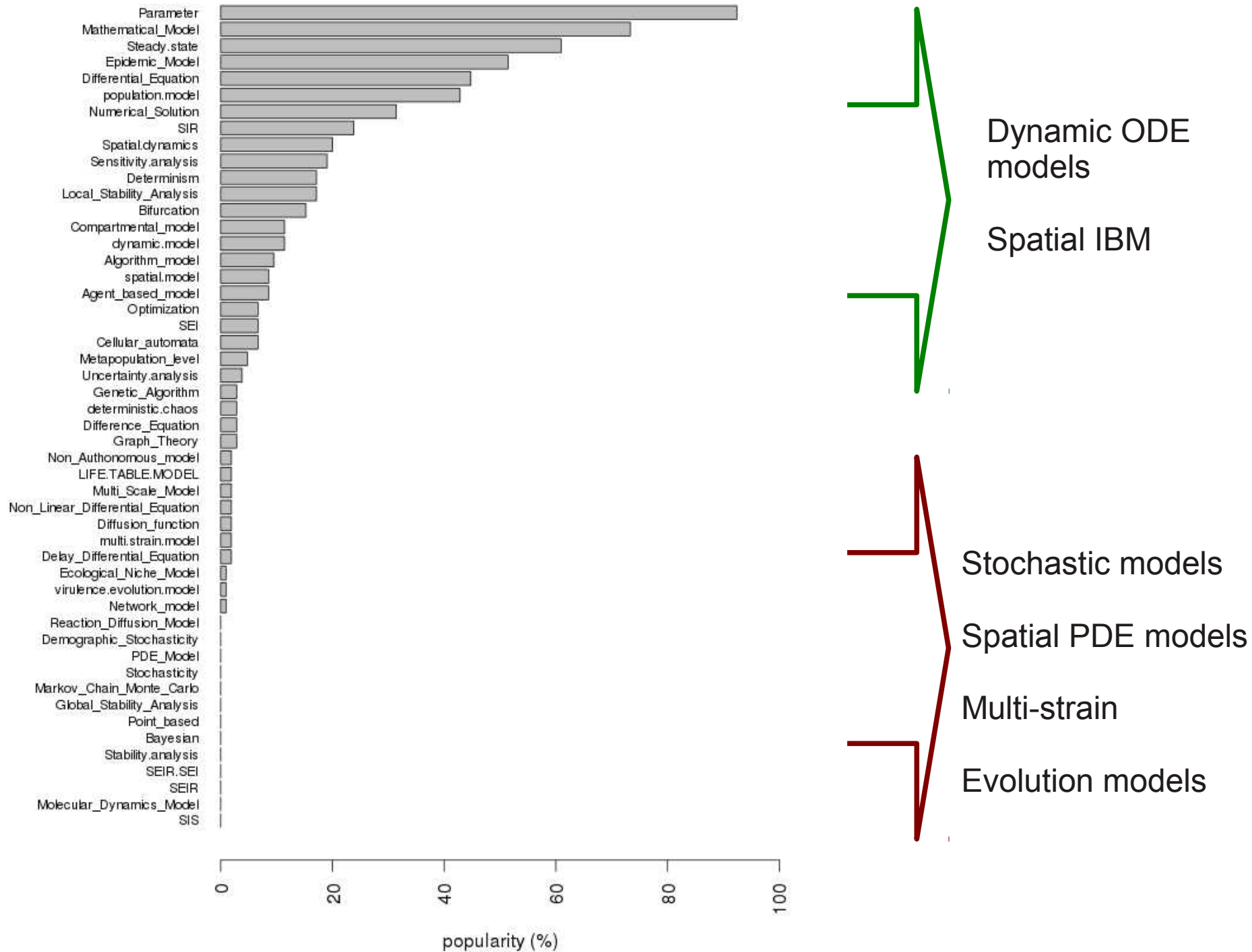


Climate, carrying capacity, detailed life history

Temperature-dependent mosquito dynamics



Mathematical complexity is comparatively low



Main messages

- There are many models, but far from enough!
- Need to think 'out of the box': stochasticity, multi-strains, evolution.
- Model comparison may be more important than model development, there are data out there!
- In Brazil, more and more companies are bringing new 'silver bullets' for dengue. We need to be aware and model them!

Acknowledgments

Entomology, Fiocruz:

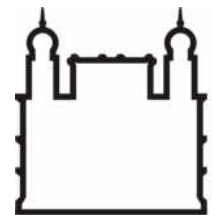
- Nildimar Honório, Ricardo Lourenço, Denise Valle, Rafael de Freitas,

Modeling, Fiocruz e UFOP:

- Claudio Struchiner, Paula Luz, Arthur Weiss, Flavio Coelho, Raquel Lana, Tiago Carneiro
- **ICICT Fiocruz e FGV:** Flavio Coelho, Renato Rocha, Simone Alencar
- **Rede Pronex Modelagem em Dengue CNPq**



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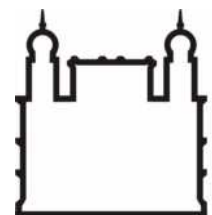
IV: Flavio
cha, Simone

elagem em

**Temos vagas para
Alunos e posdocs interessados em modelagem
Da dengue**

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