Ecology & prevention of Chagas disease in northwest Argentina

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Chagas Disease Clinical and Translational Research Workgroup

Clinical Directors Network, New York

I am Abby Rockefeller Mauzé Professor of Populations at the Rockefeller University, with joint appointments at Columbia University and the University of Chicago.

Laboratory of Populations at RU started in 1975.

Sample of research topics:

- estimates and projections of human and non-human populations, including births, deaths, and migrations;
- infectious diseases, including Chagas disease and COVID-19;
- farms, fisheries, forests, wildlife, food webs, and weather;
- bacterial, cellular, and molecular populations involved in immunology, hearing and DNA transcription;
- development of methods and models using mathematics, computation, statistics.

Collaborations cross disciplinary, institutional, and national boundaries.

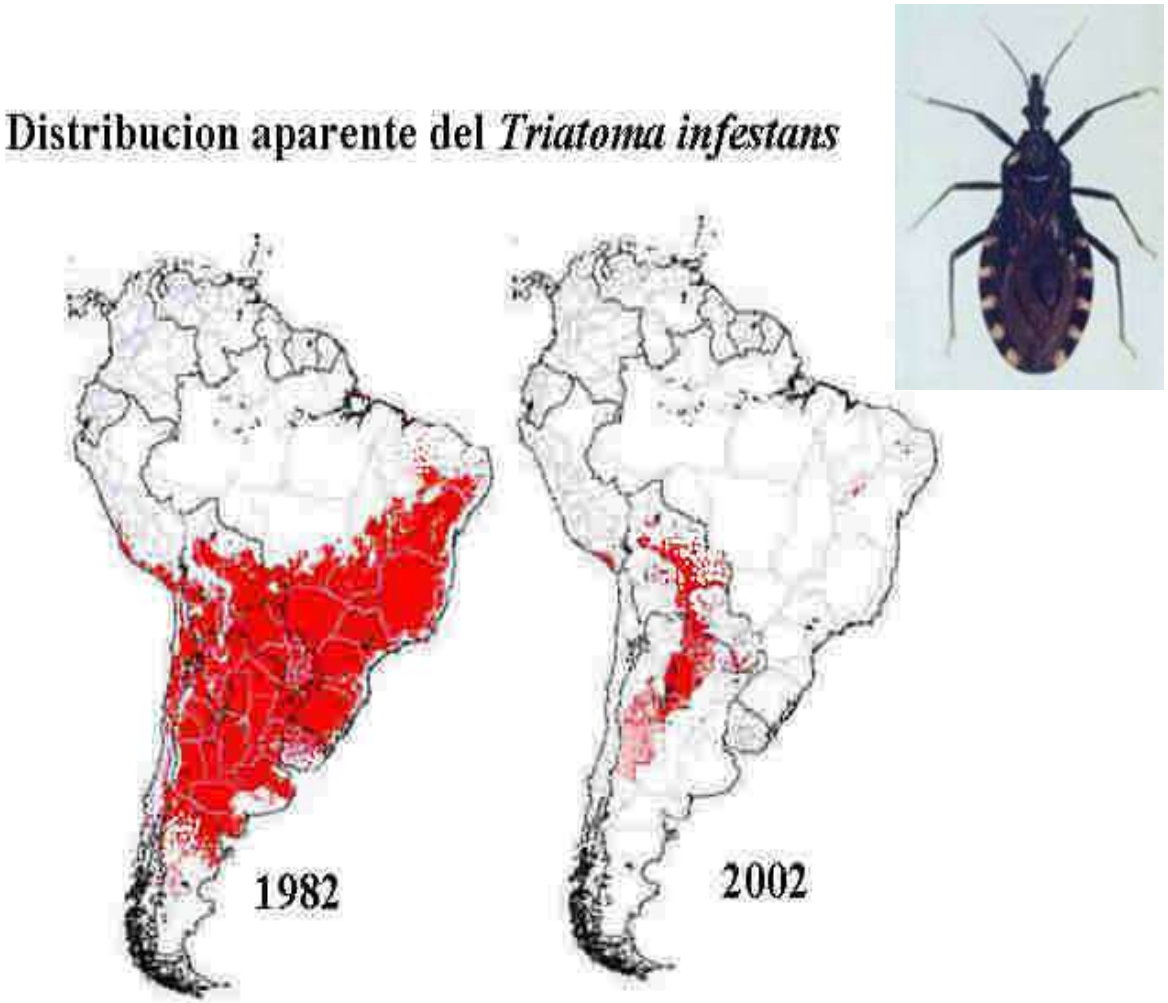
Chagas work/experience/interest

23 papers with **Ricardo E. Gürtler** and colleagues on Chagas disease in Argentina (1996-2019). Examples:

1. J. E. Cohen, Ricardo E. Gürtler (2001) Modeling household transmission of American trypanosomiasis. *Science* 293(5530):694-698
2. Ricardo E. Gürtler, Uriel Kitron, M. Carla Cecere, Elsa L. Segura, J. E. Cohen (2007) Sustainable vector control and management of Chagas disease in the Gran Chaco, Argentina. *PNAS USA* 104(41):16194–16199
3. (J. E. Cohen, Lucía Rodríguez-Planes, María S. Gaspe, María C. Cecere, Marta V. Cardinal, Ricardo E. Gürtler (2017) Chagas disease vector control and Taylor's law. *PLoS Neglected Tropical Diseases* 11(11):e0006092

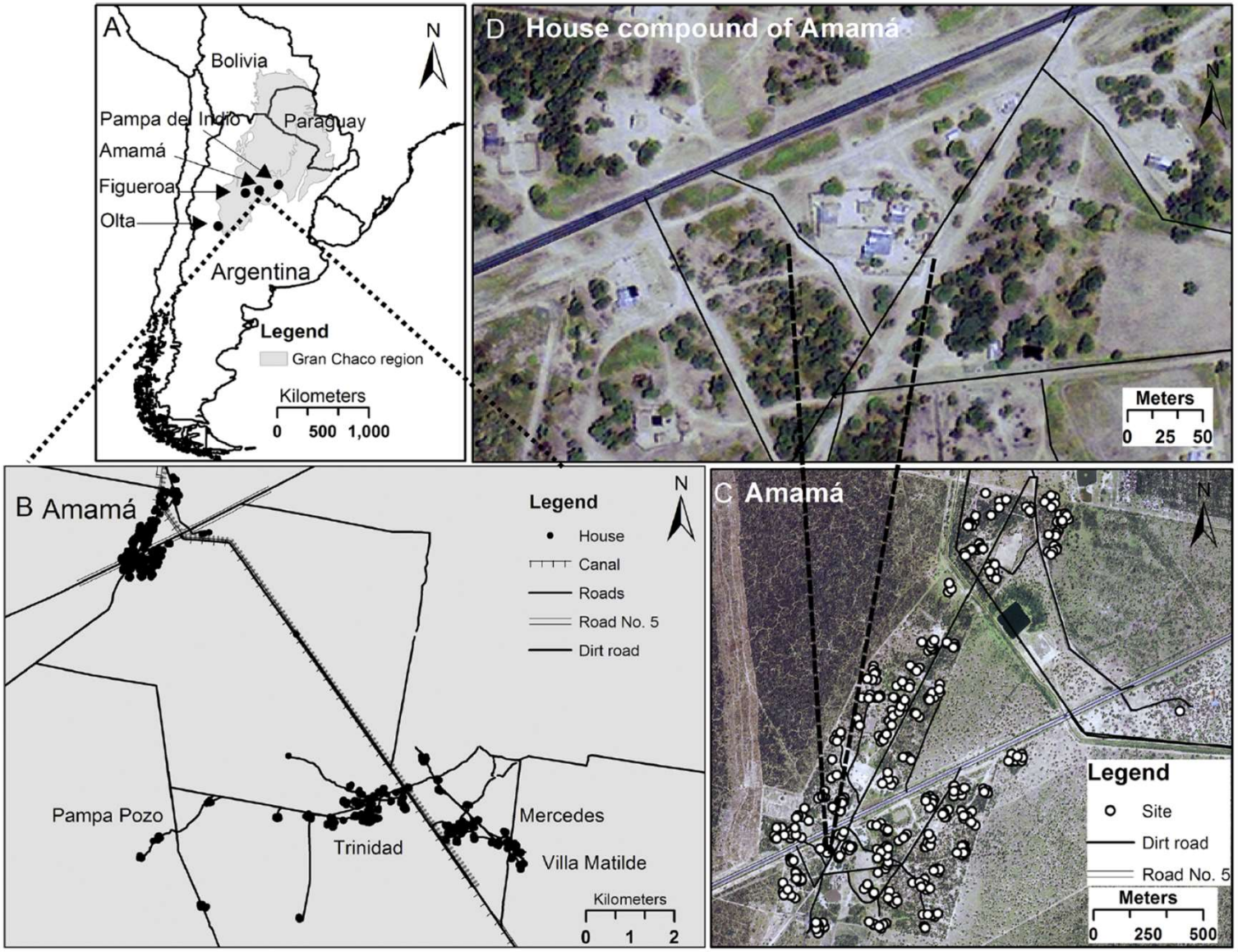
Our work on Chagas' disease won the Fred L. Soper Prize of the Pan American Health Organization, Washington, DC, April 1998.

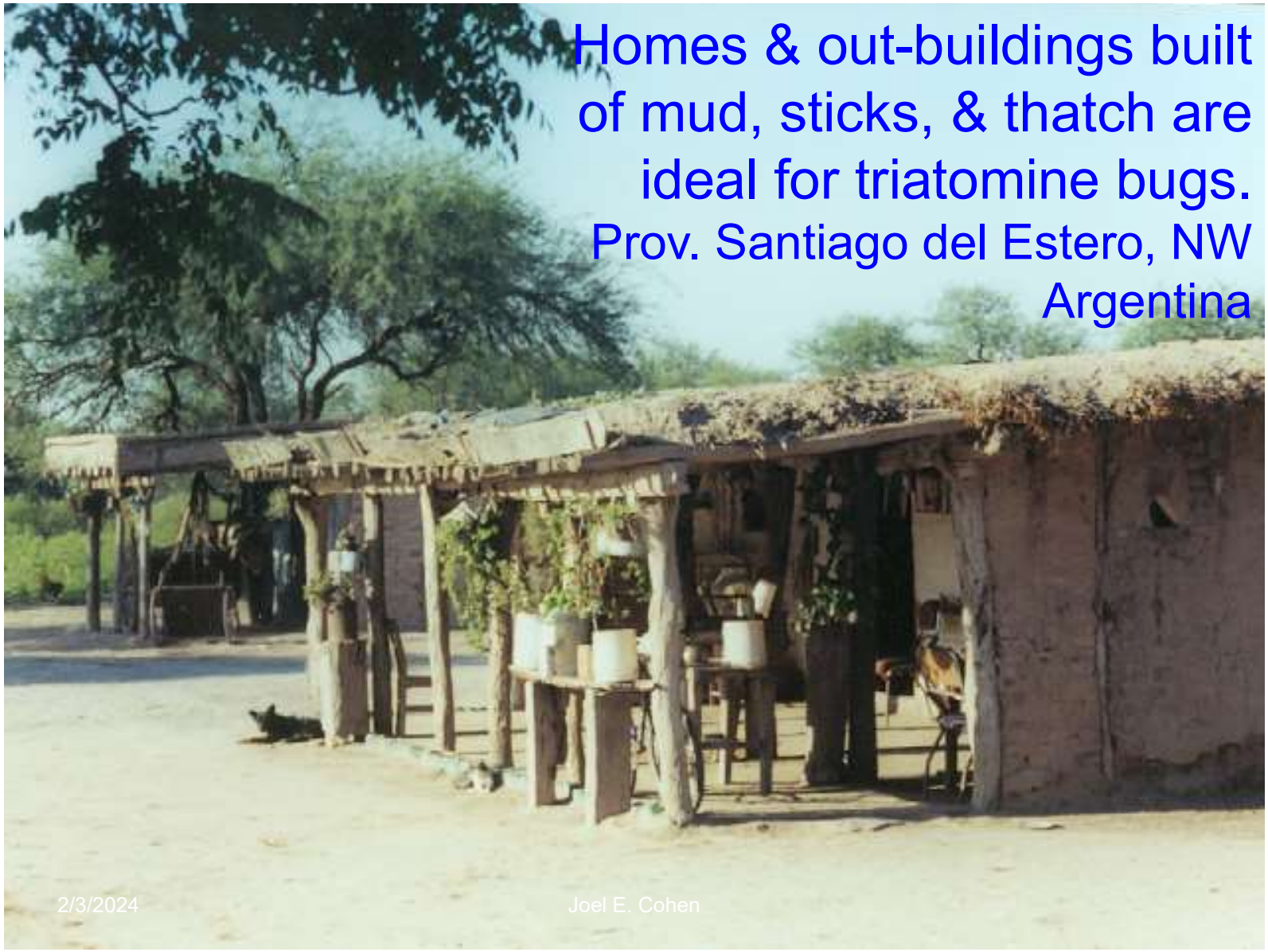
Ricardo E. Gürtler, Professor, Head of Laboratory of Eco-Epidemiology, Department of Ecology, Genetics, & Evolution, Universidad de Buenos Aires



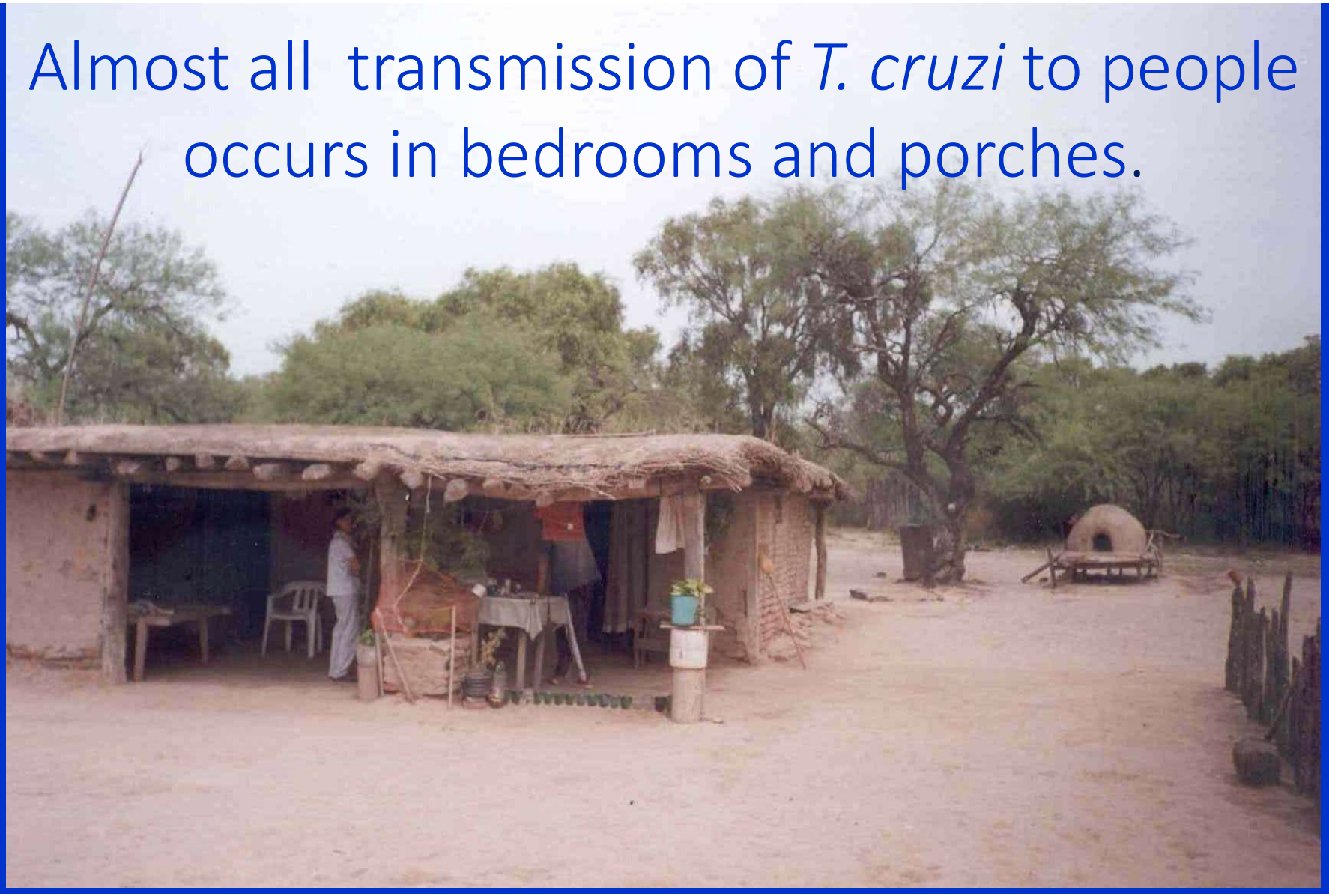
Schofield CJ, Jannin J, Salvatella R, 2006. Trends in Parasitol 22: 583-588.

Gran Chaco region of northwest Argentina & neighbors, & four study areas (Amamá, Olta, Figueroa, Pampa del Indio)

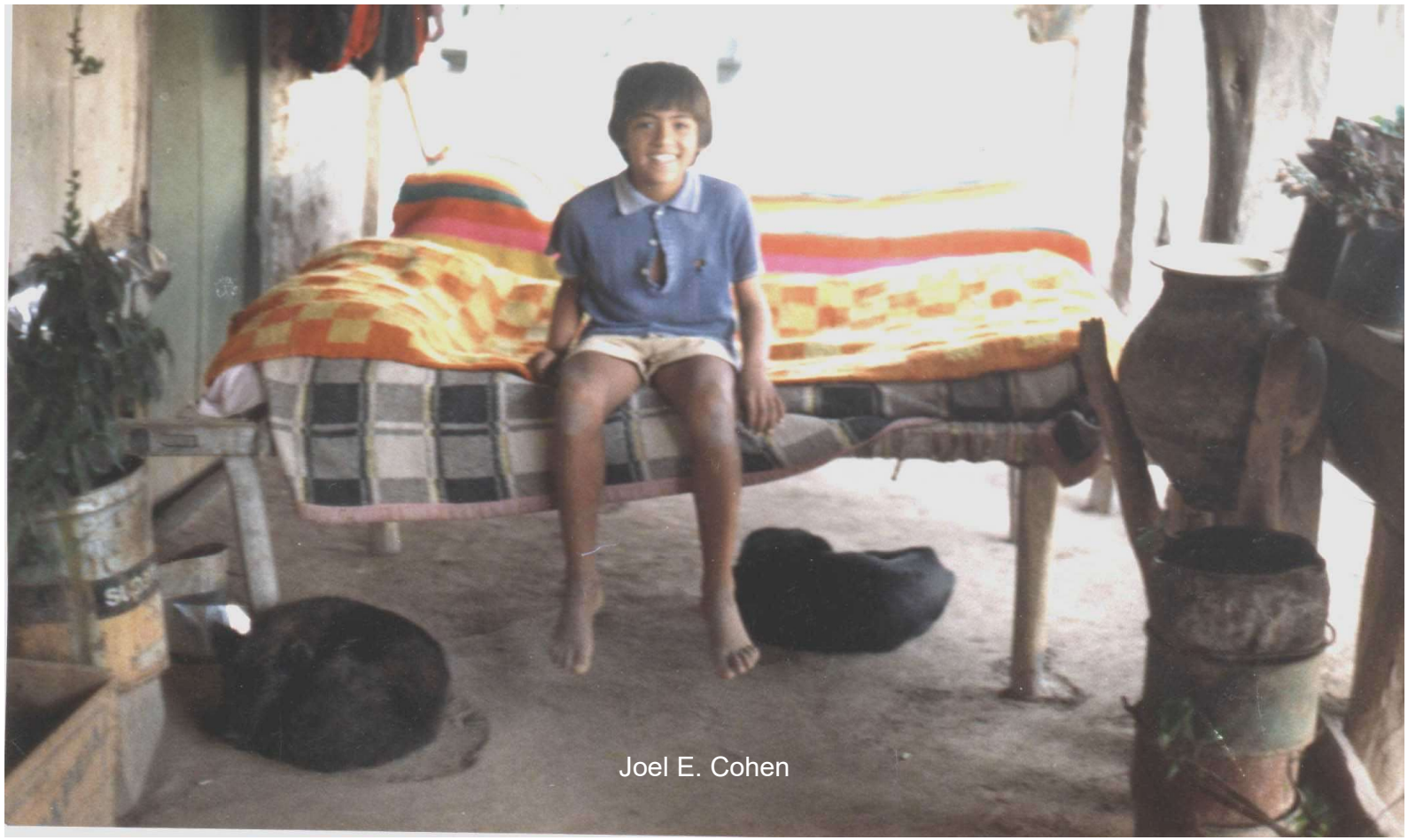



Homes & out-buildings built of mud, sticks, & thatch are ideal for triatomine bugs.
Prov. Santiago del Estero, NW Argentina

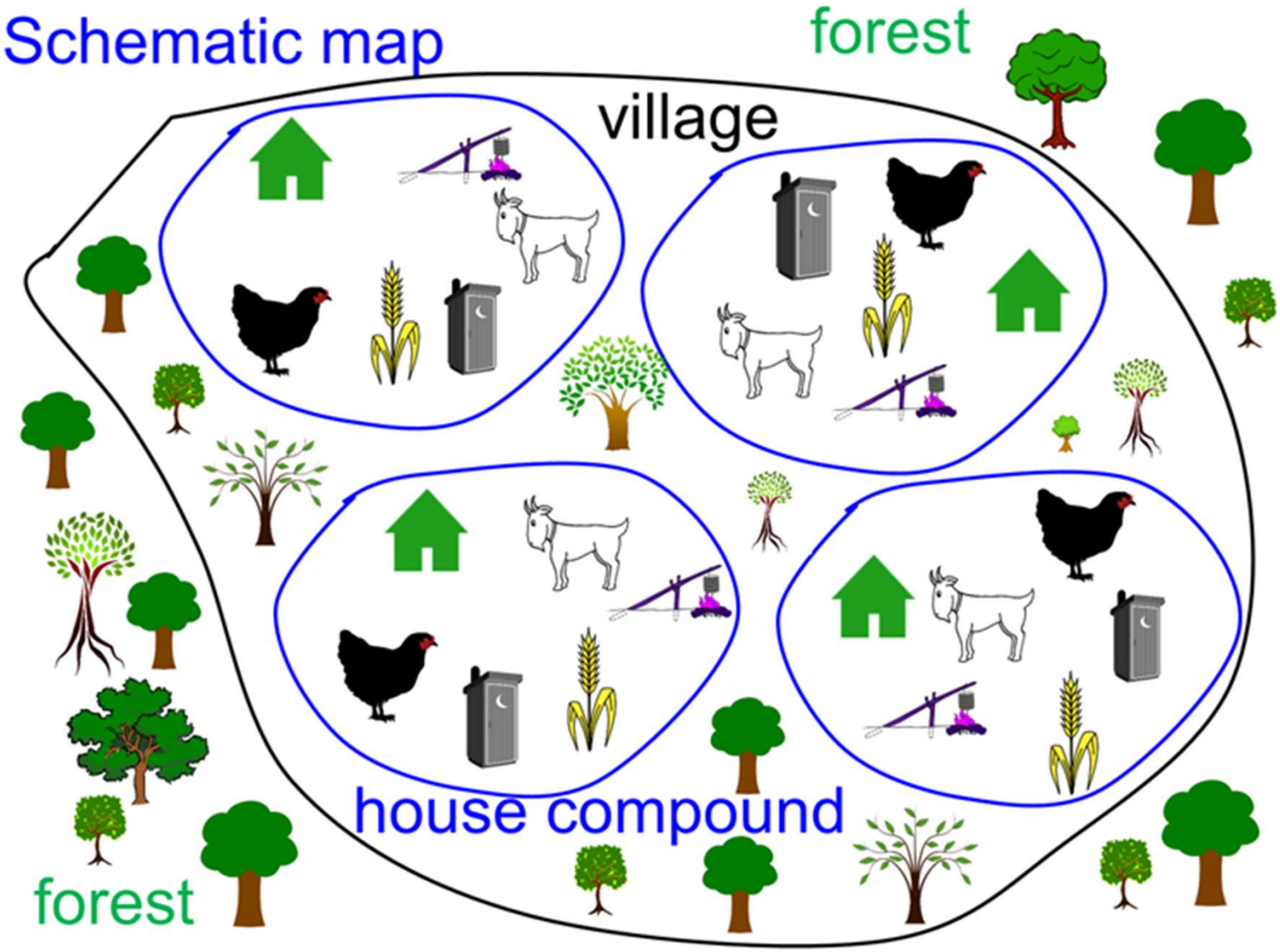
Almost all transmission of *T. cruzi* to people occurs in bedrooms and porches.



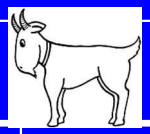
Bug bites dog infected with *T. cruzi.* Infected bug bites boy.



Outbuildings surrounding domiciles are frequently infested with triatomine bugs. Pampa del Indio, 2007-2011


Schematic map
forest
village
house compound
forest

Each habitat (domicile, chicken coop, goat corral, granary) defines one sample.

Habitat→				
Bug population density (per hour of search) in exemplars of this habitat	x_{11}	x_{12}	x_{13}	$x_{...}$
	x_{21}	x_{22}	x_{23}	…
	x_{31}	x_{32}	x_{33}	…
		x_{42}	x_{43}	…
		x_{52}		…
Mean	m_1	m_2	m_3	m…
Variance	v_1	v_2	v_3	v…

"Taylor's law" *Nature* 1961:

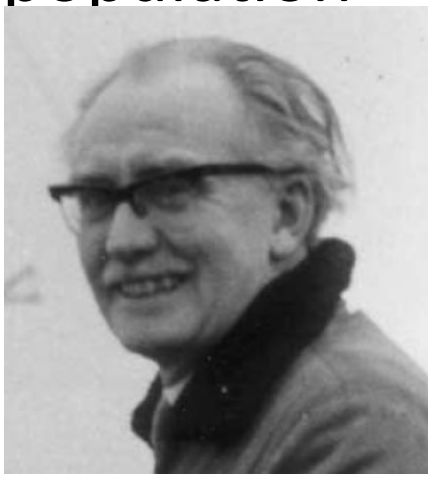
empirical pattern, not universal

In multiple sets of samples, the variance of population density is proportional to a power of the mean population density.

$$\text{variance} = a(\text{mean})^b, a > 0.$$

$$\log(\text{variance}) = \log(a) + b \cdot \log(\text{mean}).$$

$$\text{variance}/(\text{mean})^b = a, \quad a > 0.$$



L. Roy Taylor
1924-2007

$b \approx$ % change in variance for 1% change in mean

b = "elasticity of variance with respect to mean" (in economists' use of "elasticity").

Amamá core (sustained surveillance & control): *T. infestans* obeys spatial TL in 13 surveys 1993-2002.

Cohen, Rodríguez-Planes, Gaspe, Cecere, Cardinal, Gürtler, *PLoS Neglected Tropical Diseases* 2017

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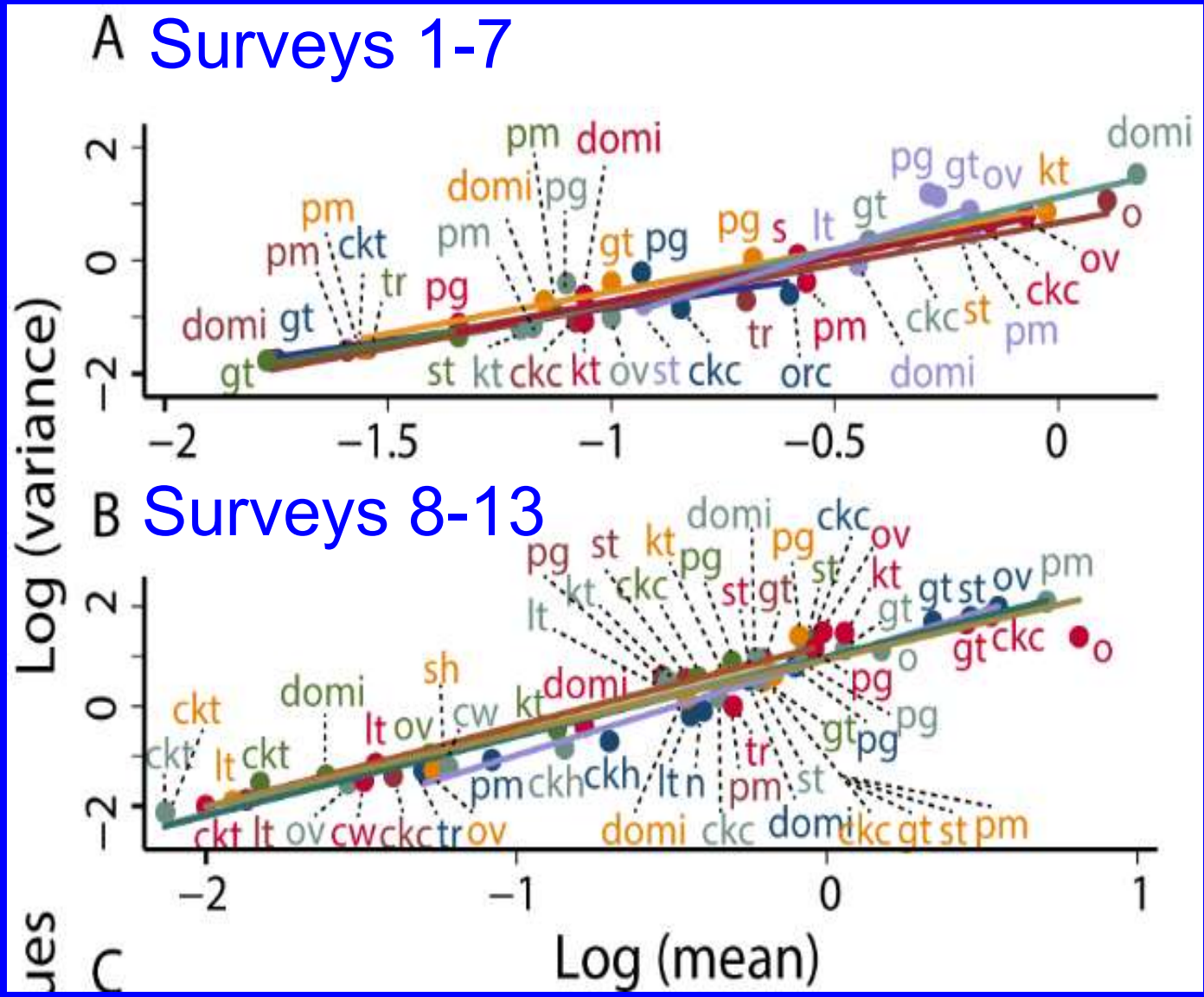
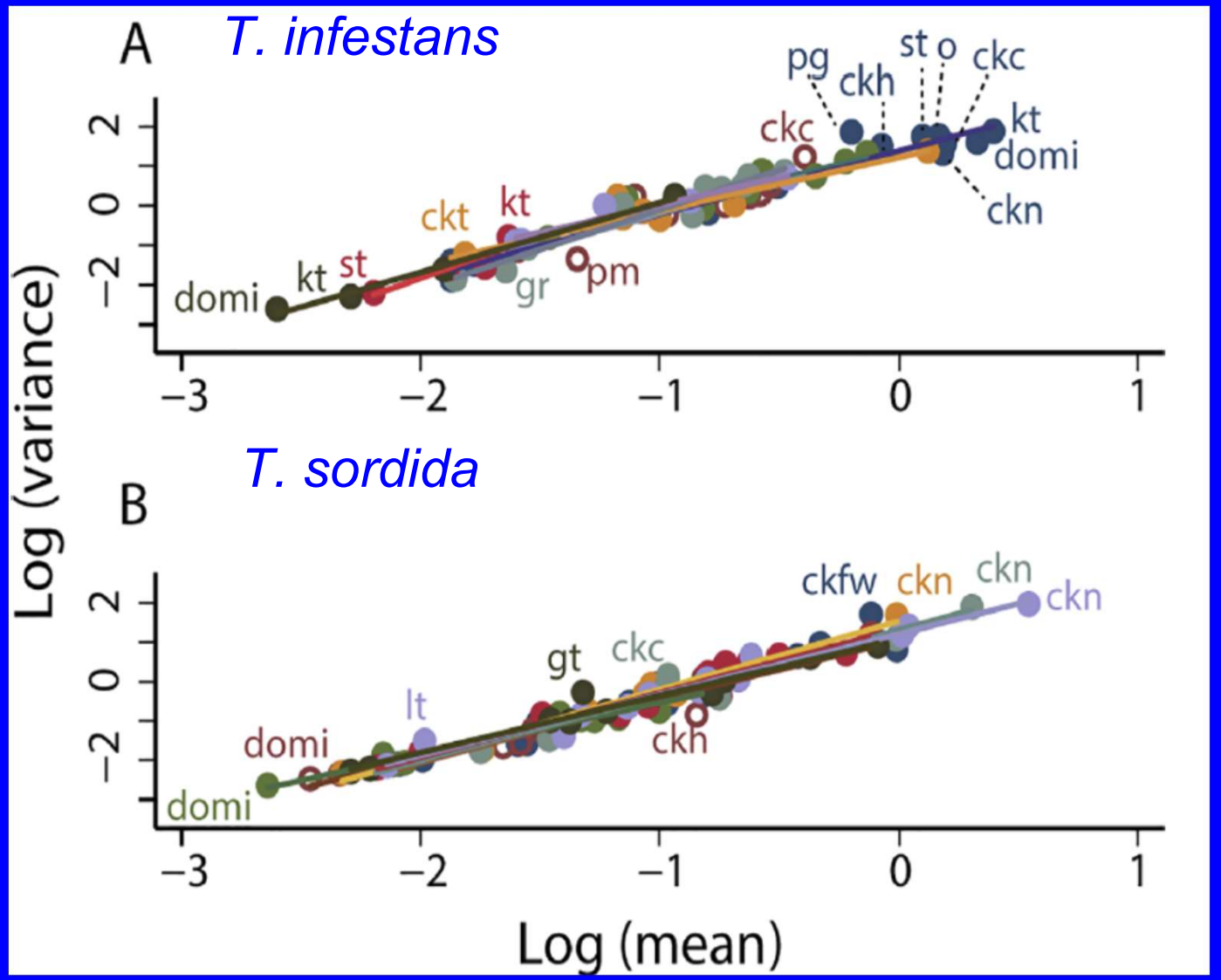


Pampa del Indio: *T. infestans* & *T. sordida* obey spatial TL in 8 surveys 2007-2010.

Cohen, Rodríguez-Planes, Gaspe, Cecere, Cardinal, Gürtler, *PLoS Neglected Tropical Diseases* 2017



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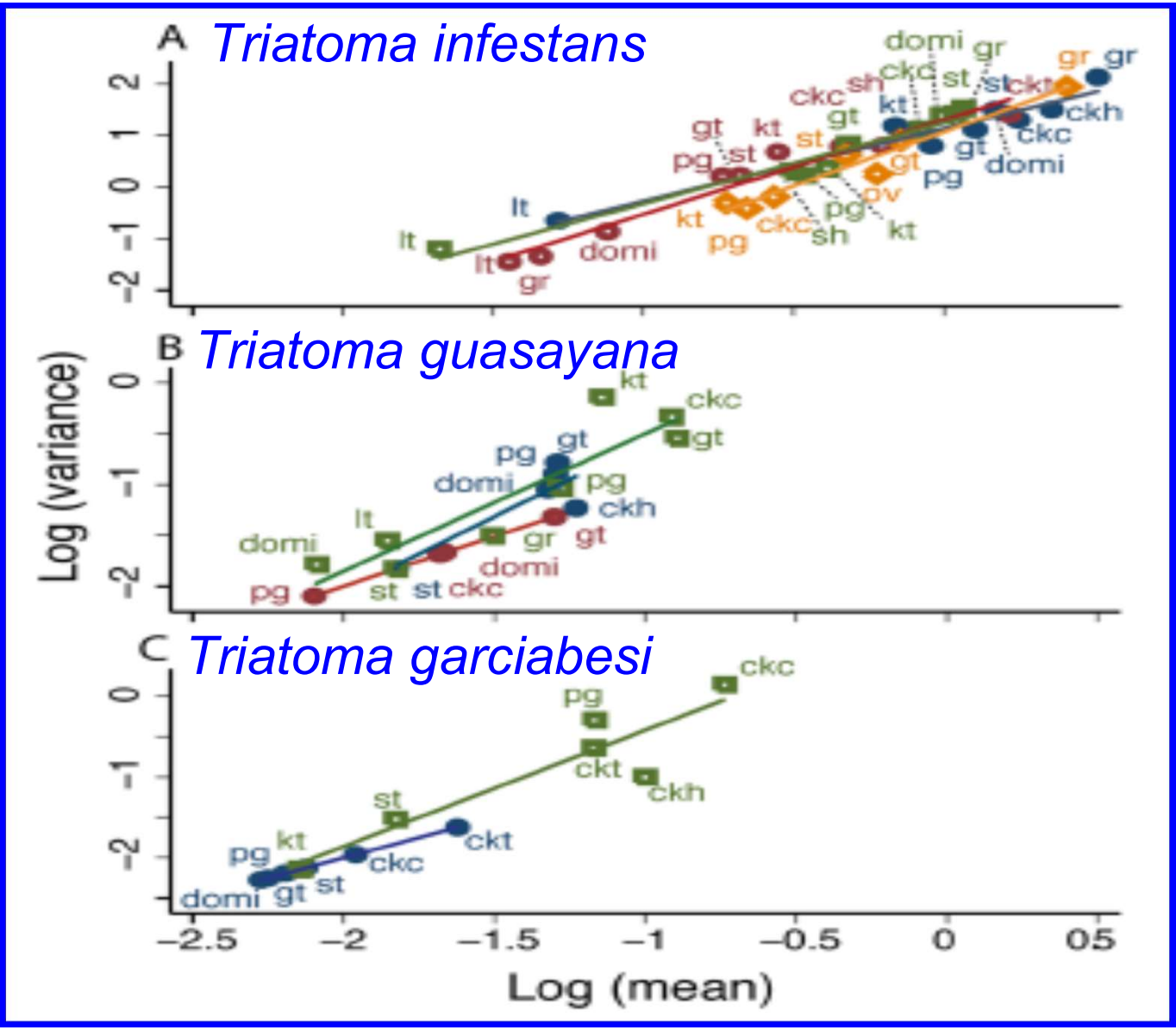
Figueroa: Vectors of Chagas disease obey spatial TL.

Cohen, Rodríguez-Planes, Gaspe, Cecere, Cardinal, Gürtler, *PLoS Neglected Tropical Diseases* 2017



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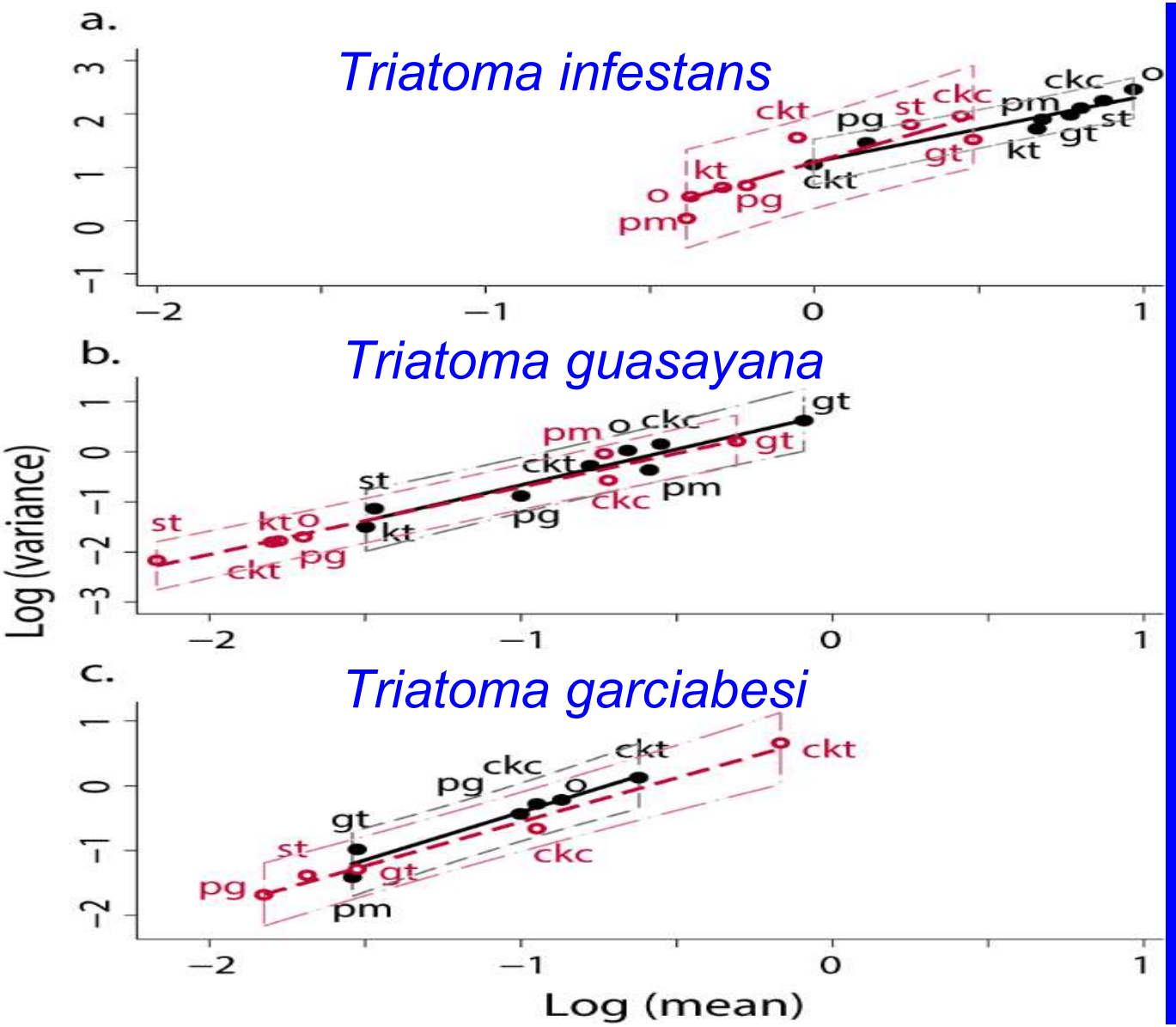
Olta: Vectors of Chagas disease obey spatial TL before (black) & after (red) community-wide spraying

Cohen, Rodríguez-Planes, Gaspe, Cecere, Cardinal, Gürtler, *PLoS Neglected Tropical Diseases* 2017



What use is Taylor's law in Chagas disease vector control?

1. Improve efficiency of sampling to achieve fixed precision.
2. Identify habitats of exceptional variability, high or low, as sources of outbreaks or endemic infestation.
3. Assess impact of control measures (spraying, environmental alteration) before & after intervention.
4. Point out errors in data.

Thank you! Questions?

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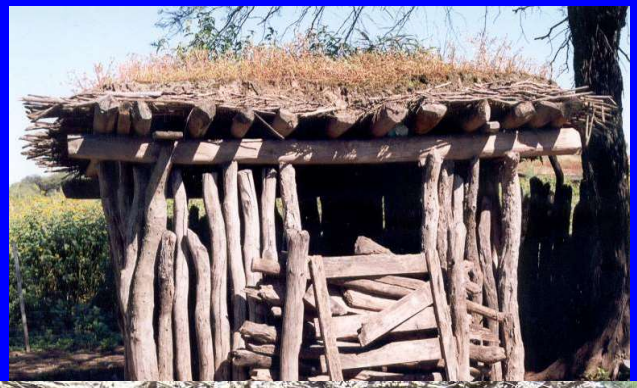
Chicken coop



Pig corral

Goat corral

Kitchen