Ecology & prevention of Chagas disease in northwest Argentina

Joel E. Cohen
cohen@rockefeller.edu
2024-01-08

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:


Our work on Chagas' disease won the Fred L. Soper Prize of the Pan American Health Organization, Washington, DC, April 1998.
Distribución aparente del *Triatoma infestans*

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

<table>
<thead>
<tr>
<th>Habitat</th>
<th>$x_{11}$</th>
<th>$x_{12}$</th>
<th>$x_{13}$</th>
<th>$x_{...}$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$x_{21}$</td>
<td>$x_{22}$</td>
<td>$x_{23}$</td>
<td>$...$</td>
</tr>
<tr>
<td></td>
<td>$x_{31}$</td>
<td>$x_{32}$</td>
<td>$x_{33}$</td>
<td>$...$</td>
</tr>
<tr>
<td></td>
<td>$x_{41}$</td>
<td>$x_{42}$</td>
<td>$x_{43}$</td>
<td>$...$</td>
</tr>
<tr>
<td></td>
<td>$x_{51}$</td>
<td>$x_{52}$</td>
<td></td>
<td>$...$</td>
</tr>
</tbody>
</table>

Bug population density (per hour of search) in exemplars of this habitat

<table>
<thead>
<tr>
<th>Mean</th>
<th>$m_1$</th>
<th>$m_2$</th>
<th>$m_3$</th>
<th>$m_{...}$</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Variance</th>
<th>$v_1$</th>
<th>$v_2$</th>
<th>$v_3$</th>
<th>$v_{...}$</th>
</tr>
</thead>
</table>
“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.

\[ \text{variance} = a(\text{mean})^b, \ a > 0. \]
\[ \log(\text{variance}) = \log(a) + b \cdot \log(\text{mean}). \]
\[ \frac{\text{variance}}{(\text{mean})^b} = a, \ a > 0. \]

\( b \approx \% \text{ change in variance for 1\% change in mean} \)

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

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

2/3/2024

Cohen, Rodríguez-Planas, Gaspe, Cecere, Cardinal, Gürtler, *PLoS Neglected Tropical Diseases* 2017
Figueroa: Vectors of Chagas disease obey spatial TL.
Cohen, Rodríguez-Planes, Gaspe, Cecere, Cardinal, Gürtler, *PLoS Neglected Tropical Diseases* 2017

![Graphs showing vectors of Chagas disease](image)
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?

cohen@rockefeller.edu

Chicken coop

Goat corral

Pig corral

Kitchen