

Insect Epidemiology: Pests, Pollinators and Disease Vectors

(DRAFT syllabus from spring 2025, will change some for the Fall)

Michael Z. Levy

Professor of Epidemiology

mzlevy@pennmedicine.upenn.edu

phone: 215-746-8131

Office Hours: After class Tues & Thurs but I can also be available at other times. Please email me to schedule.

Course Description

Malaria, Chagas disease, the Plague—some of the most deadly and widespread infectious diseases are carried by insects. The insects are also pernicious pests; bed bugs have returned from obscurity to wreak havoc on communities, invasive species decimate agricultural production and threaten forests across the United States. At the same time declines among the insects on which we depend--the honeybees and other pollinators—threaten our food security, while general declines of insects threaten ecosystems. We will study the areas where the insects and humans cross paths and explore how our interactions with insects can be cause, consequence or symptom of much broader issues. This course is not an entomology course but will cover a lot about insects. It is not a traditional epidemiology course but will explore the approaches and study designs that epidemiologists use to uncover associations and evaluate interventions. It is not a history course but will cover past epidemics and infestations that have changed the course of the history and reversed advancing armies. Assignments will include midterm and final essays and presentations, a team project, and some shorter exercises.

Through this course I hope you will gain insight on:

- The roles of insects in the transmission of vector-borne diseases
- How to model an infectious disease: not being afraid to make mistakes, understanding what a model is for (just clarifying ideas), how to critique a model
- The nature of the associations between pests, pesticides and human health. Different epidemiological study designs and the strengths and weaknesses of each. How to think about associations, how to identify biases in studies, strategies to correct them.
- How to design a study to assess associations between exposures and disease
- The history and politics of insects, housing, and the environment

- Insects as agents of global climatic change; The effects of climatic change on insects and the species that depend on them.
- The limits of epidemiology and post-epidemiological inquiry
- How to write a good essay--form a thesis statement, search literature on a topic, structure paragraphs, be interesting

Assignments

Two Papers 5-7 pages double-spaced (30% & 30%)

- First on Insects as vectors of infectious Diseases
- Second on Insects, Insecticides, the Environment or Insects as causes and consequence of environmental, agricultural & climatic change
- Details, tips, etc. posted on Canvas
- In-class presentations (not graded) to get feedback before the papers are due
- First paper will be graded in parts (thesis statement, first paragraph will be turned in earlier)

One Team Project (20%)

Other Projects, Assignments, Short Essays & Participation including presentations (20%)

Attendance, Unforeseen difficulties & Extensions

If, for whatever reason, you are unable to make a class *please email me ahead of time*.

If you have having issues or problems during the semester, or whatever type, and need an extension on an assignment, please let me know.

Books and Book Chapters

Willoughby, Urmi Engineer *Yellow Fever, Race, and Ecology in Nineteenth-Century New Orleans* (LSU Press, 2017)

Shah, Sonia. *The Fever: how malaria has ruled humankind for 500,000 years*. Macmillan, 2010.

Mavhunga, C. Clapperton *The Mobile Workshop: The Tsetse Fly and African Knowledge Production* ([eBook via Penn Library](#))

Hernández, Daisy. *The Kissing Bug. A True Story of a Family, an Insect, and a Nation's Neglect of a Deadly Disease*

Biehler, D. (2013). *Pests in the city: flies, bedbugs, cockroaches, and rats*. University of Washington Press. ([library link](#))

Carson, Rachel. *Silent spring*. ([link to free version](#)[Links to an external site.](#))

Recommended (good place to look for essay topics): Berenbaum, May R. *Bugs in the system: insects and their impact on human affairs*. Basic Books, 1996.

Readings and alterations to the syllabus: The course is dynamic. Readings and other assignments will change as we go, especially for current topics. Please check Canvas regularly.

PART I. Insects as Vectors of Infectious Disease

Module 1 Colonialism and the Discovery that insects transmit disease

Southern cattle fever and ticks; Patrick Manson and the discovery of filarial worms in mosquitoes; Ronald Ross finally finds malaria parasites in mosquitoes; Carlos Chagas' intuition.

Yellow Fever in Philly, New Orleans, Cuba & the Panama canal. Carlos Finlay's hypothesis. Jesse Lazear lets a mosquito feed on the back of his hand. Walter Reed's human experiments.

Module 2 Malaria & The math of infectious diseases

Ross' model of malaria; the concept of R_0 ; the assumptions in the equations; control of malaria in the pre-DDT era. How to assess vaccines and design a trial, Bed nets and other interventions. What happened to Gates' 'Moonshot'? What is the role for the new malaria vaccine? 'Disease X' in the Democratic Republic of Congo.

Module 3: Plague, Quarantines, Globalization and the Law

The three historical Plague Pandemics and one from prehistory. Enzootic and epizootic transmission. Adding birth and death to the SIR models. How the bacteria increases biting rate. Plague foci around the world.

Globalism, Shipping, Rats & Fleas how the third pandemic spread. Racism, Quarantine & Fire-- Plague comes to the US. Travel restrictions and Vaccine requirements then and now.

Module 4. Emergence, spread and schemes to control the Arboviruses. Early attempts to eliminate *Aedes aegypti*, Oropouche expands from midges to Culex mosquitoes and sweeps out of the Amazon. The CDC, Puerto Rico and Zika. Oxitec, Wolbachia & Gene Drive. Who decides to release these technologies? Who assesses how well they work?

Module 5 (moved up). Chagas disease, migration, politics, and control

The city and the Bugs: Chagas disease in Arequipa, Peru. The Southern Cone Initiative (Argentina, Bolivia, Paraguay, Uruguay, Chile and sometimes Peru). More politics, regional migration, international migration, coups and auto-coups, economics, land tenure security, PAHO and the push to declare countries free of transmission.

Feb 13 -- Share topic ideas for the first paper

Feb 25 --in class workshopping of thesis statements and first paragraph

Presentations Feb 27, March 4, March 6

First paper due March 7th

*****SPRING BREAK*****

PART II. Insects, Insecticides, Health & Housing

Module 6 War, Postwar, Silent Spring: DDT enters the marketplace. Why were they spraying swimming pools? Why was Rachel Carson's writing so effective? How did the pesticide industry respond? Were the responses effective?

Module 7 Do Pesticides cause Cancer? ADHD? Epidemiological study designs. Associations, confounding and bias. Odds ratios, Regressions and other methods to assess association.

- *in class group project to write a proposal to investigate associations between insecticide and cancer.*

Module 8 Insects & Housing. PCOs--Don't call them exterminators. Social justice, HUD, Bed bugs, Philly's new bed bug law,

PART III. Insects as causes and consequence of environmental, agricultural & climatic change

Module 9. Insect Declines, Colony Collapse, and Pluralistic Reframing. First we noticed the honeybees dying and could not find the exact cause, and then multiple species of bees, then we noticed that almost all the insects were declining, quickly.

Module 10 Nonscalability

Module 11 The insects and us. The Ants; social biology & sociobiology, levels of selection and the concept of the 'superorganism'; what do the insects tell us about us? 'Insectization' of the other; why do aliens often look like insects?

Final Presentations 4/22, 4/24, 4/29

Final Paper due 5/2