

Anthropological Sciences 179, Human Biology 179
Environmental Change and Emerging Infectious Disease

Fall 2007

Instructors:

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Course Description:

This is a lecture course on the changing epidemiological environment, with particular attention to the ways in which human-induced environmental changes are altering the ecology of infectious disease transmission, thereby promoting their re-emergence as a major global public health threat. Organized by case studies of environmental change at (roughly) local to global scales, we focus on the role that environmental changes (such as deforestation and land-use conversion, urbanization, human migration, international commerce, and global warming) play in contemporary disease transmission. The diseases affected by these environmental changes include SARS, Avian Flu, Malaria, Dengue Fever, Chagas disease, Lyme, Influenza, Cholera, Hantavirus, BSE/vCJD, and West Nile Virus.

Expectations:

Attendance at lecture and discussion sections is mandatory. There is a take-home midterm and in-class final, for the 3-unit option, and the same midterm plus a 15-page research paper for the 5 unit option. The research paper may be on any related topic that is *approved by the instructors*. Paper proposals will be due during week 5 of the course (details TBA). Collaborative papers are welcome, subject to the requirement of roughly 15 pages per author.

Prerequisites:

One of the following: HUMBIO 2A & 2B, the Bio Core, the Earth Systems Core, or permission of the instructors.

Sections:

Discussion sections will meet for one hour weekly starting the second week of the course. Locations TBA. Sections are a required part of the class.

Grading:

Grades for 5-unit enrollment will be based on midterm (30%), section (10%), and the 15-page paper (60%). Grades for 3-unit enrollment will be based on midterm (30%), section (10%), and final (60%).

Readings:

There are four required texts for this class:

Collinge, S.K., and C. Ray, eds. 2006. *Disease ecology: Community structure and pathogen dynamics*. Oxford: Oxford University Press. (CR)

Garrett, L. 1995. *The Coming Plague: Newly Emerging Diseases in a World Out of Balance*. New York: Penguin Press.

Hart, T. 2004. *Microterrors: The Complete Guide to Bacterial, Viral and Fungal Infections That Threaten Our Health*. Buffalo, NY: Firefly Books

Yam, P. 2003. *The Pathological Protein: Mad Cow, Chronic Wasting, and Other Deadly Prion Diseases*. New York: Springer.

We will supplement these books with readings from the primary scientific literature throughout the quarter. All articles will be available on coursework.

Course Outline (Provisional)

Lectures are on Tuesday and Thursday from 11-12:30 in Building 200, room 002.

Week 1. Introduction: What EIDs are and R_0

- 09.25 SARS & Avian Flu: A Taste of the Future? (Jones)
Readings: Olsen et al. (2006); **Optional:** Mills et al. (2007); Gauthier-Clerc et al. (2007)
- 09.27 Epidemiology Meets Ecology: Some Tools (Jones)
Readings: Holt & Dobson, Ch. 2 in CR; Jones Lecture Notes: "On R_0 "

Week 2. Local Deforestation and Disease: Frontier Malaria in Rondônia

- 10.02 Colonization in Rondônia: How not to Change R_0 (Durham)
Readings: Vittor et al. (2006); Singer & Castro (2001), 184-222, skimming 210-212;
Optional: Guerra et al. (2006)
- 10.04 Vectors of Change and Vectorial Capacity (Durham)
Readings: Yasuoka & Levins (2007)

Week 3. When Disease Means Business, Agribusiness

- 10.09 Greasing Palms and Palm Oil: Mosquitoes and Malaria in Southeast Asia (Jones)
Readings: Rejmánková et al., Ch. 7 in CR; Chang et al. (1997); **Optional:** Fryauff et al. (1998); Yasuoka et al. (2006)
- 10.11 Run(s) for Your Life: Agricultural Conversion in Ecuador (Levy)
Readings: Eisenberg et al. (2006);

Week 4. Regional Plagues: Haunted by Hantavirus

- 10.16 Death in the Southwest: Hantavirus Pulmonary Syndrome (Jones)
Readings: Engelthaler et al. (1999); Garrett, ch. 15;
- 10.18 Hantavirus in Latin America (Durham)
Readings: Yates et al 2002, Armien et al 2004

Week 5. The Challenge of Chagas: Who's the Guinea Pig?

- 10.23 American Trypanosomiasis: Disease of Poverty (Durham)
Readings: Miles et al 2003, Aufderheide et al 2004
- 10.25 The Political Ecology of Landscape Transformation and R_0 (Durham)
Readings: Cohen and Gürtler (2001)

Week 6. Disruption of Community Processes and Disease Emergence

- 10.30 *Changes in the Land: Deflected Succession and the Emergence of Lyme Disease in New England* (Jones)
Readings: Ostfeld et al., Ch. 3 in CR; LoGiudice et al. (2003); Jones Lecture Notes: "Patterns of Species Diversity"
- 11.01 Bubonic Plague and the Structure of Small Mammal Communities
Readings: Ray & Collinge, Ch. 14 in CR; Duplantier et al. (2005)

Week 7. Bound by the Food Chain: Prions

- 11.06 Careful What You Eat: The Tragic Case of Kuru (Durham)
Readings: Yam (2003), Durham (forthcoming)
Paper Topic Proposals Due (5-unit option only)
- 11.08 How Now Mad Cow: Environmental Influences on the TSE's (Durham)
Readings: Smith and Bradley (2003), Prusiner (2004)
Take-home Midterm Exam Passed Out

Week 8. Global Environmental Change: Climate and Cholera

- 11.13 Environment and Endemism in South Asia: The Case of Cholera
Guest Lecture: Gary K. Schoolnik
Readings: Cottingham & Butzler, Ch. 8 in CR; Garrett, ch.16
Take home Midterm Exam Due
- 11.15 Coping with Copepods & El Niño: The Peruvian Cholera Epidemic (Durham)
Readings: Faruque, et al. (2005), Lipp, Huq, & Colwell (2002), Gil et al. (2004)
- 11.20-11.22 Thanksgiving

Week 9. National & International Change: Viral Encephalopathies on the Move

- 11.27 Paper or Plastic? Climate Change and Urban Refuse as Drivers of Epidemic Dengue Fever (Jones)
Readings: Patz et al. (2000); Favier et al. (2006)
- 11.29 Dropping Like Crows: West Nile Virus in North America (Durham)
Readings: Glaser (2004), Epstein (2001), Mackenzie et al. (2004)

Week 10. Wrap-Up: Humanity's Changing Epidemiological Environments

- 12.04 Lessons for Control: How Can Human Ecology Help? (Jones)
Readings: Daily & Ehrlich (1996); Galvani (2003)
- 12.06 Concluding Remarks (Durham, Jones)

Readings:

- Armien, B. et al. 2004. High Seroprevalence of Hantavirus infection on the Azuero Peninsula of Panama. *American Journal of Tropical Medicine and Hygiene* 70 (6): 682–687.
- Aufderheide, A.C. et al. 2004. A 9000-year record of Chagas disease. *Proceedings of the National Academy of Sciences* 101 (7): 2034-2039.
- Chang, M. S., J. Hii, P. Buttner, and F. Mansoor. 1997. Changes in abundance and behaviour of vector mosquitoes induced by land use during the development of an oil palm plantation in Sarawak. *Transactions of the Royal Society of Tropical Medicine and Hygiene* 91 (4):382-386.
- Cohen, J.E., and R.E. Gürtler. 2001. Modeling Household Transmission of American Trypanosomiasis. *Science* 293:694-698.
- Daily, G. C., and P. R. Ehrlich. 1996. Global change and human susceptibility to disease. *Annual Review of Energy and the Environment* 21:125-144.
- Durham, W.H. forthcoming. When culture affects behavior: A new look at Kuru. IN: M. Brown, ed. *Explaining Culture Scientifically*. University of Washington Press.
- Duplantier, J. M., J. B. Duchemin, S. Chanteau, and E. Carniel. 2005. From the recent lessons of the Malagasy foci towards a global understanding of the factors involved in plague reemergence. *Veterinary Research* 36 (3):437-453.
- Eisenberg, J. N. S., W. Cevallos, K. Ponce, K. Levy, S. J. Bates, J. C. Scott, A. Hubbard, N. Vieira, P. Endara, M. Espinel, G. Trueba, L. W. Riley, and J. Trostle. 2006. Environmental change and infectious disease: How new roads affect the transmission of diarrheal pathogens in rural Ecuador. *Proceedings of the National Academy of Sciences of the United States of America* 103 (51):19460-19465.
- Engelthaler, D. M., D. G. Mosley, J. E. Cheek, C. E. Levy, K. K. Komatsu, P. Ettestad, T. Davis, D. T. Tanda, L. Miller, J. W. Frampton, R. Porter, and R. T. Bryan. 1999. Climatic and environmental patterns associated with hantavirus pulmonary syndrome, Four Corners region, United States. *Emerging Infectious Diseases* 5 (1):87-94.
- Epstein, P.R. 2001. West Nile Virus and the Climate. *Annals of the New York Academy of Sciences* 78 (2):367-371.
- Favier, C., N. Degallier, P. D. T. Ribeiro Vilarinhos, M. D. L. de Carvalho, M. A. Cavalcanti Yoshizawa, and M. B. Knox. 2006. Effects of climate and different management strategies on *Aedes aegypti* breeding sites: a longitudinal survey in Brasilia (DF, Brazil). *Tropical Medicine & International Health* 11 (7):1104-1118.
- Fryauff, D. J., S. Tuti, A. Mardi, S. Masbar, R. Patipelohi, B. Leksana, K. C. Kain, M. J. Bangs, T. L. Richie, and J. K. Baird. 1998. Chloroquine-resistant *Plasmodium vivax* in transmigration settlements of West Kalimantan, Indonesia. *American Journal of Tropical Medicine and Hygiene* 59 (4):513-518.

- Galvani, A. P. 2003. Epidemiology meets evolutionary ecology. *Trends in Ecology & Evolution* 18 (3):132-139.
- Gauthier-Clerc, M., C. Lebarbenchon, and F. Thomas. 2007. Recent expansion of highly pathogenic avian influenza H5N1: a critical review. *Ibis* 149 (2):202-214.
- Gil, A. I., V. R. Louis, I. N. G. Rivera, E. Lipp, A. Huq, C. F. Lanata, D. N. Taylor, E. Russek-Cohen, N. Choopun, R. B. Sack, and R. R. Colwell. 2004. Occurrence and distribution of *Vibrio cholerae* in the coastal environment of Peru. *Environmental Microbiology* 6 (7):699-706.
- Glaser, A. 2004. West Nile virus and North America: An unfolding story. *Revue Scientifique et Technique De l'Office International Des Epizooties* 23 (2):557-568.
- Goldfarb, L. G. 2002. Kuru: the old epidemic in a new mirror. *Microbes and Infection* 4 (8):875-882.
- Guerra, C. A., R. W. Snow, and S. I. Hay. 2006. A global assessment of closed forests, deforestation and malaria risk. *Annals of Tropical Medicine and Parasitology* 100 (3):189-204.
- Jones, C. G., R. S. Ostfeld, M. P. Richard, E. M. Schaubert, and J. O. Wolff. 1998. Chain reactions linking acorns to gypsy moth outbreaks and Lyme disease risk. *Science* 279 (5353):1023-1026.
- Lipp, E. K., A. Huq, and R. R. Colwell. 2002. Effects of global climate on infectious disease: the cholera model. *Clinical Microbiology Reviews* 15 (4):757-770.
- LoGiudice, K., R. S. Ostfeld, K. A. Schmidt, and F. Keesing. 2003. The ecology of infectious disease: Effects of host diversity and community composition on Lyme disease risk. *Proceedings of the National Academy of Sciences of the United States of America* 100 (2):567-571.
- Mackenzie, J.S., D. J. Gubler, and L.R. Petersen. 2004. Emerging flaviviruses: the spread and resurgence of Japanese encephalitis, West Nile and dengue viruses. *Nature Medicine* 10 (12):S98-S109.
- Miles, M.A., M. D. Feliciangeli, A. Rojas de Arias. 2003. American trypanosomiasis (Chagas' disease) and the role of molecular epidemiology in guiding control strategies. *British Medical Journal* 236: 1444-1448.
- Mills, C. E., J. M. Robins, C. T. Bergstrom, and M. Lipsitch. 2006. Pandemic influenza: Risk of multiple introductions and the need to prepare for them. *PLoS Medicine* 3 (6):769-773.
- Olsen, B., V. J. Munster, A. Wallensten, J. Waldenstrom, Adme Osterhaus, and R. A. M. Fouchier. 2006. Global patterns of influenza A virus in wild birds. *Science* 312 (5772):384-388.
- Patz, J. A., D. Engelberg, and J. Last. 2000. The effects of changing weather on public health. *Annual Review of Public Health* 21:271-307.

- Peterson, A. T., J. T. Bauer, and J. N. Mills. 2004. Ecologic and geographic distribution of filovirus disease. *Emerging Infectious Diseases* 10 (1):40-47.
- Prusiner, S.B. 2004. Detecting mad cow disease. *Scientific American* (7):86-93.
- Randolph, S. E. 2001. The shifting landscape of tick-borne zoonoses: tick-borne encephalitis and Lyme borreliosis in Europe. *Philosophical Transactions of the Royal Society of London Series B-Biological Sciences* 356 (1411):1045-1056.
- Singer, B. H., and M. C. de Castro. 2001. Agricultural colonization and malaria on the Amazon Frontier. *Annals of the New York Academy of Sciences* 954:184-222.
- Smith, P. G., and R. Bradley. 2003. Bovine spongiform encephalopathy (BSE) and its epidemiology. *British Medical Bulletin* 66:185-198.
- Vittor, A. Y., R. H. Gilman, J. Tielsch, G. Glass, T. Shields, W. S. Lozano, V. Pinedo-Cancino, and J. A. Patz. 2006. The effect of deforestation on the human-biting rate of *Anopheles darlingi*, the primary vector of falciparum malaria in the Peruvian Amazon. *American Journal of Tropical Medicine and Hygiene* 74 (1):3-11.
- Yasuoka, J., and R. Levins. 2007. Impact of deforestation and agricultural development on anopheline ecology and malaria epidemiology. *American Journal of Tropical Medicine and Hygiene* 76 (3):450-460.
- Yasuoka, J., R. Levins, T. W. Mangione, and A. Spielman. 2006. Community-based rice ecosystem management for suppressing vector anophelines in Sri Lanka. *Transactions of the Royal Society of Tropical Medicine and Hygiene* 100 (11):995-1006.
- Yates, T.L. et al 2002. The Ecology and Evolutionary History of an Emergent Disease: Hantavirus Pulmonary Syndrome. *Bioscience* 52(11): 989-998