OMB No. 0925-0001 and 0925-0002 (Rev. 11/16 Approved Through 10/31/2018)

BIOGRAPHICAL SKETCH

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NAME: Erin Mordecai

eRA COMMONS USER NAME (credential, e.g., agency login): MORDECAI.ERIN

POSITION TITLE: Assistant Professor, Biology Department, Stanford University

EDUCATION/TRAINING *(Begin with baccalaureate or other initial professional education, such as nursing, include postdoctoral training and residency training if applicable. Add/delete rows as necessary.)*

INSTITUTION AND LOCATION	DEGREE *(if applicable)*	Completion Date MM/YYYY	FIELD OF STUDY
University of Georgia, Athens, GA, U.S.A.	B.S.	05/2007	Mathematical Biology
University of California Santa Barbara, Santa Barbara, CA, U.S.A.	Ph.D.	12/2012	Ecology, Evolution, and Marine Biology
University of North Carolina, Chapel Hill, NC, U.S.A.	Postdoctoral Researcher	12/2014	Ecology of Infectious Disease
North Carolina State University, Raleigh, NC, U.S.A.	Postdoctoral Researcher	12/2014	Ecology of Infectious Disease
Stanford University, Stanford, CA, U.S.A.	Assistant Professor	1/2015-present	Ecology of Infectious Disease

A. Personal Statement

My research focuses on environmental drivers of infectious disease dynamics and their impacts on hosts. My work integrates empirical data with mathematical models, building on my training in mathematical biology and ecology as an undergraduate, graduate student, and postdoctoral fellow. My work follows two main themes: (i) the impact of the environment on vector-borne disease transmission in humans, and (ii) the impact of pathogens in plants and wildlife. I have been funded by the National Science Foundation (NSF) through a Doctoral Dissertation Improvement Grant, a Postdoctoral Research Fellowship, and an Ecology and Evolution of Infectious Diseases (EEID) grant. In my 11-year career I have published 31 peer-reviewed papers (16 lead-, sole-, or senior-authored). Through this work, I have gained experience developing, simulating, and parameterizing mathematical models of disease transmission using modern computational tools and statistical techniques, including Bayesian inference. Through interdisciplinary collaborations with mathematicians (Van Savage), statisticians (Leah Johnson), entomologists (Matt Thomas and Courtney Murdock), geographers (Eric Lambin and Sadie Ryan), public health researchers (Anna Stewart Ibarra), clinicians (Desiree LaBeaud), and economists (Taylor Ricketts and Matías Piaggio) I have applied a variety of quantitative approaches to experimental and observational data from the laboratory and the field, across several host – pathogen systems.

My lab at Stanford University focuses on the consequences of environmental change for human and wildlife health. My team of four PhD students, five postdocs, three co-terminal master's students, and 13 undergraduate researchers uses diverse empirical, statistical, and mathematical approaches to understand impacts of climate and land use on vector-borne disease, including dengue, chikungunya, Zika, malaria (*falciparum*, *vivax*, and *knowlesi*), yellow fever, and leishmaniasis in the Americas, Southeast Asia, and Africa. Capitalizing on and contributing to the vibrant, interdisciplinary, and solutions-oriented research environment at Stanford, I am a Leading Interdisciplinary Collaborations (LInC) Fellow, a Faculty Fellow in the Center for Innovation in Global Health, and a member of Bio-X, an interdisciplinary biosciences institute at Stanford.

1. **Mordecai, E.A.**, K. Paaijmans, C. Balzer, T. Ben-Horin, E. De Moor, L. Johnson, A. McNally, S. Pawar, S. Ryan, T. Smith, K. Lafferty. 2013. Optimal temperature for malaria transmission is dramatically lower than previously predicted. *Ecology Letters* 16: 22-30. http://dx.doi.org/10.1111/ele.12015

2. **Mordecai, E.A.** 2011. Pathogen impacts on plant communities: unifying theory, concepts, and empirical work. *Ecological Monographs* 81(3): 429-441. **Faculty of 1000 Recommended.** http://dx.doi.org/10.1890/10-2241.1

3. Shocket, M.S., Ryan, S.J., **Mordecai, E.A.** 2018. Transmission of Ross River virus peaks at intermediate temperatures. *eLife 7:e37762 https://doi.org/10.7554/eLife.37762.*

4. **Mordecai, E.A.**, Cohen, J.M., Evans, M.V., Gudapati, P., Johnson, L.R., Miazgowicz, K., Murdock, C.C., Rohr, J.R., Ryan, S.J., Savage, V., Shocket, M., Stewart Ibarra, A., Thomas, M.B., Weikel, D.P. 2017. Detecting the impact of temperature on transmission of Zika, dengue and chikungunya using mechanistic models. *PLoS Neglected Tropical Diseases* 11(4): e0005568. https://doi.org/10.1371/journal.pntd.0005568.

B. Positions and Honors

Positions and Employment

2013-14	NSF Postdoctoral Research Fellow, Department of Biology, University of North Carolina, Chapel Hill, NC and Department of Biological Sciences, North Carolina State University, Raleigh, NC.
2015-	Assistant Professor, Department of Biology, Stanford University, Stanford, CA.

Other Experience and Professional Activities

2018-	Guest Editor, *Philosophical Transactions of the Royal Society,* "Integrative approaches to understanding and predicting pathogen spillover"
2017-	Co-organizer, Working group "Land use, ecosystems, and health in Costa Rica"
2017-	Participant, Working group "Ecological Levers for Health", National Center for Ecological Analysis and Synthesis (NCEAS) and Science for Nature and People Partnership (SNAPP)
2017	Grant Panelist, National Science Foundation
2016-17	Member, American Society of Tropical Medicine and Hygiene
2016	Member, Society for Integrative and Comparative Biology
2016-	Member, Bio-X, Interdisciplinary Biosciences Institute at Stanford University
2015-	Member, Steering committee, NSF Research Coordination Network: "Vector BiTE"
2015-	Member, Jasper Ridge Biological Preserve Faculty Advisory Committee
2010-12	Leader, Working group "Malaria and Climate Change", NCEAS
2009, 2011	Participant, Workshop "Ecology and Evolution of Infectious Diseases"
2009-	Member, Ecological Society of America
2007-09	Participant, Working group "Parasites in Food Webs", NCEAS

Honors

2018-	Leading Interdisciplinary Collaborations (LInC) Fellowship
2017	Hellman Faculty Scholars Fellowship
2015-	Center for Innovation in Global Health Faculty Fellowship
2012-13	National Science Foundation Postdoctoral Research Fellowship in Biology
2012	University of California Santa Barbara Graduate Division Dissertation Fellowship
2011	Broida-Hirschfelder Award
2011	University of California Santa Barbara Dean's Fellowship
2011	Leal Ann Kerry Mertes Scholarship
2011	University of California Santa Barbara Affiliates Graduate Dissertation Fellowship
2010	Luce Foundation Environmental Science to Solutions Fellowship
2010	Susan Worster Award
2007	University of California Santa Barbara Department Fellowship
2005	University of Georgia Foundation Fellowship
2003	University of Georgia Bernard Ramsey Fellowship

C. Contributions to Science

1. **Nonlinear impacts of temperature on vector-borne disease transmission.** As a graduate student, I became interested in how climate change would impact vector-borne diseases like malaria. Despite fears that warmer temperatures would cause widespread increases in transmission, I hypothesized that warming beyond the thermal optimum could slow transmission in some warmer regions. I independently obtained funding for and led a collaborative working group to investigate the impact of temperature on malaria transmission by measuring its impacts on the relevant mosquito and parasite traits. Surprisingly, we found that the optimal temperature for malaria transmission is 25°C, 7°C cooler than all previous models had predicted but aligned with field transmission patterns (Mordecai et al. 2013). As the climate warms, we expect climate suitability for transmission to shift, rather than broadly increasing (Ryan et al. 2015). I have continued to lead this collaborative research group during my postdoc and faculty position and have obtained major NSF funding (EEID) as lead PI. We have used this trait-based approach to show that the thermal optimum for transmission of dengue, chikungunya, Zika viruses is 29°C (Mordecai et al. 2017), and for Ross River virus is 26°C (Shocket et al. 2018), implying important nonlinear impacts of climate and climate change on disease transmission.
    a. **Mordecai, E.A.**, Cohen, J.M., Evans, M.V., Gudapati, P., Johnson, L.R., Miazgowicz, K., Murdock, C.C., Rohr, J.R., Ryan, S.J., Savage, V., Shocket, M., Stewart Ibarra, A., Thomas, M.B., Weikel, D.P. 2017. Detecting the impact of temperature on transmission of Zika, dengue and chikungunya using mechanistic models. *PLoS Neglected Tropical Diseases* 11(4): e0005568. https://doi.org/10.1371/journal.pntd.0005568.
    b. **Mordecai, E.A.**, K. Paaijmans, C. Balzer, T. Ben-Horin, E. De Moor, L. Johnson, A. McNally, S. Pawar, S. Ryan, T. Smith, K. Lafferty. 2013. Optimal temperature for malaria transmission is dramatically lower than previously predicted. *Ecology Letters* 16: 22-30. http://dx.doi.org/10.1111/ele.12015
    c. Ryan, S.J., McNally, A., Johnson, L.R., Ben-Horin, T., **Mordecai, E.A.**, Paaijmans, K., Lafferty, K.D. 2015. Mapping physiological suitability limits for malaria in Africa under climate change. *Vector-Borne and Zoonotic Diseases* 15(12): 718-725. http://dx.doi.org/10.1089/vbz.2015.1822.
    d. Shocket, M.S., Ryan, S.J., **Mordecai, E.A.** 2018. Transmission of Ross River virus peaks at intermediate temperatures. *eLife* 7:e37762 https://doi.org/10.7554/eLife.37762.
2. **Environmental drivers of infectious disease transmission.** Environmental and social factors, including climate, land use, urbanization, and poverty, combine to drive infectious disease dynamics—another major area of my research. As part of the U.S. Government Interagency Dengue Forecasting Challenge, my team successfully used climate drivers and machine learning to forecast dengue dynamics in San Juan, Puerto Rico and Iquitos, Peru (Johnson et al. 2018). An undergraduate researcher I supervised developed a mathematical model that showed that mean and seasonal temperature interact to determine dengue dynamics, and that large outbreaks can occur both in tropical environments that are warm year-round and in temperate, seasonal environments (Huber et al. 2018). I led an undergraduate class in synthesizing environmental and social drivers and consequences of the Zika epidemic in the Americas (Ali et al. 2017), which received press coverage at Stanford and nationally. As part of an interdisciplinary working group at Stanford, I helped to develop a mathematical framework for socio-ecological feedbacks between infectious disease and the environment (Garchitorena et al. 2017), which we will apply to case studies of win-win environment and health solutions.
    a. Johnson, L.R., Gramacy, R.B., Cohen, J., **Mordecai, E.A.**, Murdock, C.C., Rohr, J.R., Ryan, S.J., Stewart-Ibarra, A.M., Weikel, D.P. 2018. Phenomenological forecasting of disease incidence using heteroskedastic Gaussian processes: a dengue case study. *Annals of Applied Statistics* 12(1): 27-66. https://doi.org/10.1214/17-AOAS1090.
    b. Huber, J.H., Childs, M.L., Caldwell, J.M., **Mordecai, E.A.** 2018. Seasonal temperature variation influences climate suitability for dengue, chikungunya, and Zika transmission. *PLOS Neglected Tropical Diseases* 12(5): e0006451. https://doi.org/10.1371/journal.pntd.0006451.
    c. Ali, S., Gugliemini, O., Harber, S., Harrison, S., Houle, L., Ivory, J., Kersten, S., Khan, R., Kim, J., LeBoa, C., Nez-Whitfield, E., O'Marr, J., Rothenberg, E., Segnitz, R.M., Sila, S., Verwillow, A., Vogt, M., Yang, A., **Mordecai, E.A.** 2017. Environmental and social change drive the explosive emergence of Zika virus in the Americas. *PLoS Neglected Tropical Diseases* 11(2): e0005135. http://dx.doi.org/10.1371/journal.pntd.0005135.
    d. Garchitorena. A., Sokolow, S.H., Roche, B., Ngonghala, C.N., Jocque, M., Lund, A., Barry, M., **Mordecai E.A.**, Daily, G.C., Jones, J.H., Andrews, J.R., Bendavid, E., Luby, S.P., LaBeaud,

A.D., Seetah, K., Guégan, J.F., Bonds, M.H., De Leo, G.A. 2017. Disease ecology, health and the environment: a framework to account for ecological and socio-economic drivers in the control of neglected tropical diseases. *Philosophical Transactions of the Royal Society* 372: 20160128. https://dx.doi.org/ 10.1098/rstb.2016.0128.

3. **Community ecology of infectious disease.** My work seeks to understand the role of infectious disease in natural ecosystems as well as human populations. During my PhD, I published a single-authored paper developing a conceptual framework that is now widely used in the field (Mordecai 2011) to understand how pathogens affect the diversity of ecosystems. Building on this framework, I have published papers that combine field and lab experiments and mathematical models to understand how species diversity is maintained in parasite and host communities. I found that shared fungal pathogens promote coexistence of native and exotic grasses (Mordecai 2013), that coinfection and vector generalist-specialist tradeoffs promote coexistence of vector-borne viruses in plants (Mordecai et al. 2016a), and that tradeoffs between competitive ability and colonization promote coexistence of trematode parasites in estuaries (Mordecai et al. 2016b).
    a. **Mordecai, E.A.** 2011. Pathogen impacts on plant communities: unifying theory, concepts, and empirical work. *Ecological Monographs* 81(3): 429-441. http://dx.doi.org/10.1890/10-2241.1.
    b. **Mordecai, E.A.**, Gross, K., Mitchell, C.E. 2016a. Within-host niche differences and fitness tradeoffs promote coexistence of plant viruses. *American Naturalist* 87(1): E13-E26. http://dx.doi.org/10.1086/670190.
    c. **Mordecai, E.A.,** Jaramillo, A.G., Ashford, J.E., Hechinger, R.F., Lafferty, K.D. 2016b. The role of competition – colonization tradeoffs and spatial heterogeneity in promoting species coexistence in a diverse guild of California salt marsh trematodes. *Ecology* 97 (6), 1484-1496. http://dx.doi.org/ 10.1890/15-0753.1.
    d. **Mordecai, E.A.** 2013. Despite spillover, a shared pathogen promotes native plant persistence in a cheatgrass-invaded grassland. *Ecology* 94:2744–2753. http://dx.doi.org/10.1890/13-0086.1.

4. **Ecological impacts of natural enemies.** Pathogens, herbivores, and other natural enemies may be important for regulating host population dynamics in natural ecosystems. My research has measured these ecological impacts, showing that natural enemies can affect host survival and reproduction in at seed and adult stages (Mordecai 2012; Spear & Mordecai 2018), in single and coinfection (Mordecai et al. 2015), and across a range of systems and experimental approaches in a meta-analysis (Viola et al. 2010). This body of work demonstrated that fitness consequences for individuals and populations can be strong but variable, and that not all pathogens have major consequences for their hosts.
    a. Viola, D.V., **E.A. Mordecai**, S.A. Sistla, A.G. Jaramillo, G.S. Gosnell, L.K. Albertson, B.J. Cardinale, and J.M. Levine. 2010. Competition–defense tradeoffs and the maintenance of plant diversity. *Proceedings of the National Academy of Sciences* 104(40): 17217-17222. http://dx.doi.org/10.1073/pnas.1007745107.
    b. **Mordecai, E.A.**, Hindenlang, M., Mitchell, C.E. Differential impacts of virus diversity on biomass production of a native and an exotic grass host. 2015. *PLoS ONE* 10(7): e0134355.
    c. **Mordecai, E.A.** 2012. Soil moisture and fungi affect seed survival in California grassland annual plants. *PLoS ONE* 7(6): e39083. http://dx.doi.org/ 10.1371/journal.pone.0039083.
    d. Spear, E.R., **Mordecai, E.A.** 2018. Foliar pathogens of California grasses are multi-host and spatially widespread: implications for grassland diversity. *Ecology* (in press) https://doi.org/10.1002/ecy.2427.

5. **Theory of infectious disease transmission.** I have developed theory to understand infectious disease dynamics in complex systems, uncovering unexpected effects of infectious disease. I developed theory showing that pathogens can interact with environmental variation to promote host species coexistence (Mordecai 2015), can promote dominance, exclusion, or coexistence of invasive species with native species as a result of pathogen spillover (Mordecai 2013), and can competitively suppress other pathogens within co-infected hosts (Seabloom et al. 2015). The working group that I built and led used models to quantify uncertainty in the relationship between malaria transmission and temperature, identifying the most important targets for future empirical research (Johnson et al. 2015); in response to this paper, entomologists have conducted the suggested experiments and updated our models (Murdock, Miazgowicz, and Mordecai in prep).
    a. **Mordecai, E.A.** 2015. Pathogen impacts on plant diversity in variable environments. *Oikos* 124: 414-420. http://dx.doi.org/10.1111/oik.01328.

b. **Mordecai, E.A.** 2013. Consequences of pathogen spillover for cheatgrass-invaded grasslands: coexistence, competitive exclusion, or priority effects. *American Naturalist* 181(6): 737-747.
c. Seabloom, E.W., Borer, E.T., Gross, K., Kendig, A., Lacroix, C., Mitchell, C.E., **Mordecai, E.A.**, Power, A.G. 2015. The community ecology of pathogens: Coinfection, coexistence, and community composition. *Ecology Letters* 18: 401-415. http://dx.doi.org/ 10.1111/ele.12418.
d. Johnson, L.R., Ben-Horin, T., Lafferty, K.D., McNally, A., **Mordecai, E.A.**, Paaijmans, K.P., Pawar, S., Ryan, S.J. 2015. Understanding uncertainty in temperature effects on vector-borne disease: A Bayesian approach. *Ecology* 96:203-213. arXiv:1310.5110.

Complete List of Published Work in my Bibliography:

https://www.ncbi.nlm.nih.gov/myncbi/browse/collection/53149883/?sort=date&direction=ascending

D. Additional Information: Research Support and/or Scholastic Performance

Ongoing Research Support

NSF Ecology and Evolution of Infectious Diseases 1518681 Mordecai (PI) 9/2015-8/2020
"Effects of temperature on vector-borne disease transmission: integrating theory with empirical data"
We aim to use laboratory experimental data and mathematical models to estimate the temperature-dependent transmission of 13 vector-borne diseases, validate the models with field transmission data, and measure local thermal adaptation in two globally important mosquito vector species, *Aedes aegypti* and *Ae. albopictus*.
Role: Principal Investigator

NSF RAPID 1640780 Murdock (PI) 5/2016-10/2018
"Environmental drivers of Zika transmission and control"
We aim to understand how viremia and temperature affect Zika infection dynamics in *Ae. aegypti* and *Ae. albopictus*, and to model Zika transmission across climate and control strategies.
Role: Investigator

Stanford Woods Institute for the Environment Mordecai (PI) 9/2016-2/2019
"Predicting Dengue Transmission in a Changing Climate to Improve Mosquito Control"
We aim to integrate climate-driven models of dengue transmission, field data on mosquito abundance, human infection, and climate in multiple sites in Kenya and Ecuador, and remote sensing data to predict dengue transmission, and to communicate results to policymakers and stakeholders in both countries.
Role: Principal Investigator

Hellman Faculty Scholars Award Mordecai (PI) 10/2017-9/2018
"Predicting the influence of land use change and climate on the transmission of Dengue, Zika, and Chikungunya"
We aim to survey *Ae. aegypti* and *Ae. albopictus* mosquitoes across land-use and climate gradients in Costa Rica, to assess implications for transmission of dengue, chikungunya, and Zika.
Role: Principal Investigator

Completed Support

Stanford Center for Innovation in Global Health Seed Grant Mordecai (PI) 1/2016-1/2017
"Predicting Dengue Transmission in a Changing Climate"
We aimed to develop mechanistic models of temperature-driven dengue transmission to predict *Ae. aegypti* abundance and infection rates with arboviruses and human dengue seropositivity in Kenya.
Role: Principal Investigator

NSF Postdoctoral Research Fellowship in Biology Mordecai (PI) 1/2013 – 12/2014
"Community ecology of infectious diseases: mechanisms maintaining pathogen and host diversity"
I aimed to model competition and coexistence of multiple vector-transmitted plant viruses, using 40 years of empirical data, and to conduct laboratory experiments on the impacts of disease and coinfection.
Role: Postdoctoral Research Fellow