

Dr. Mary “Molly” McLeod Rorick (White)

EDUCATION

Yale University

PhD, Genetics, May 23, 2011; MPhil, Genetics, May 25, 2009

Advisor: Dr. Günter P. Wagner, Dept. of Ecology & Evolutionary Biology and Systems Biology Institute

Research focus: Modeling the effects of genetic modularity on evolution. Theoretical work on the evolution of evolvability in genetic sequences. Comparative bioinformatics approaches to address the evolutionary consequences of modularity and robustness of protein tertiary structure. Mathematical modeling, computer simulation and comparative genetic approaches to address the evolutionary origins of multi-functional protein domains (e.g., HOX) and mixed-codon amino acid repeats.

Santa Fe Institute

June 1 – 27, 2008

Complex Systems Summer School

Research focus: Interdisciplinary (biophysics) models of evolution in hyper-dimensional genotype space. Theory for the interplay between ecological and evolutionary dynamics. Modeling co-evolution of host-pathogen systems. Comparisons between mathematical theory, simulation and field data.

Harvard University

Visiting Researcher, May – August, 2006

Harvard Program for Evolutionary Dynamics under Dr. Martin A. Nowak

Research focus: Mathematical modeling and computer simulation addressing robustness and modularity and their effects on natural selection. Evolvability of multi-loci epistatic networks.

Pomona College

BA, Phi Beta Kappa, May 16, 2004

Major: Biology; Minor: Studio Art; Advisor: Dr. Daniel E. Martínez

Research focus: Evolutionary genetics and evolution of development in cnidarians (gene cloning, molecular sequencing, *in situ* hybridization, genetic sequence analysis, comparative genetics). Field ecology relating to species area curves (mathematical modeling, field sampling of arthropod communities, data analysis).

POST-DOCTORAL RESEARCH POSITIONS

University of Utah

Visiting Scholar, 2017 – 2019

Dept. of Biology; Group of Dr. Frederick R. Adler

Research focus: Pathogen evolutionary genetics. Modeling pathogen evolution by recombination. Modeling and statistical analysis of epidemiological data.

University of Chicago

Postdoctoral Scholar, 2015 – 2016

Dept. of Ecology and Evolution; Group of Dr. Mercedes Pascual

Research focus: Pathogen population genetics, molecular evolution and disease ecology, with a focus on the hyper-diverse *PfEMP1* antigens of the malaria parasite *P. falciparum*. Development of network theoretical methods to detect protein functional groups within complex gene families. Inference of evolutionary dynamics driving and shaping pathogen strain diversity.

Howard Hughes Medical Institute and University of Michigan

Postdoctoral Scholar, 2011 – 2015

Dept. of Ecology and Evolutionary Biology; Group of Dr. Mercedes Pascual

Research focus: Interdisciplinary project development and grant writing for research projects spanning medical, biological and computational fields. Modeling disease progression, within-host dynamics and host immunity. Identifying clinically relevant genetic variation, including genetic predictors of severe (lethal) strains for the purpose of targeted vaccine design. Modeling evolution by recombination within complex transmission systems, and recombination as a means of innovation (e.g., immune evasion, drug resistance, emergence).

CONSULTING

EvoLive

Founder & Instructor, 2016 – Present

Various locations in Washington and Utah

EvoLive: “bringing science to life for kids”. A preK-12th grade outreach project providing hands-on science experiences that correct common misconceptions about evolution and other science topics. <https://www.evolve.org>

Vivint Smart Home

Data Science Consultant, 2018

Lehi, Utah

Worked on an interdisciplinary team, solving problems in prediction, modeling, AI and M2M technology.

Mercy Corps Nepal

Project Leader, 2010

Lalitpur, Nepal

Environmental and economic modeling for community-based disaster risk reduction in Kailali, Nepal.

PUBLICATIONS IN PEER-REVIEWED SCIENTIFIC JOURNALS

Zinder D, Rorick MM, Pascual M. *In prep.* Conservation of single amino-acid polymorphisms in *Plasmodium falciparum* erythrocyte membrane protein 1 and association with severe pathophysiology.

Rorick MM, Baskerville EB, Rask TS, Pascual M. 2018. Identifying functional groups among the diverse, recombining antigenic var genes of the malaria parasite *Plasmodium falciparum* from a local community in Ghana. *PLoS Comput Biology* 14(6): e1006174.

Rorick MM, Artzy-Randrup Y, Tiedje KE, Ruybal S, Rask T, Ghansah A, Agongo G, Anyorigiya T, Azongo D, Awine T, Aboriga R, Oduro A, Koram K, Day KP, and Pascual M. 2018. Signatures of competition and strain structure within the major blood-stage antigen of *P. falciparum* in a local community in Ghana. *Ecology and Evolution* 1;8(7):3574-3588.

Day KP, Tiedje KE, Ruybal S, Rask T, Artzy-Randrup Y, Rorick MM, Pascual M. 2017. Evidence of strain structure in *Plasmodium falciparum* var gene repertoires in children from Gabon, West Africa. *Proceedings of the National Academy of Sciences* 114(20): E4103–E4111.

Ruybal-Pesántez S, Tiedje KE, Rorick MM, Amenga-Etego L, Ghansah A, Oduro A, Koram K and Day KP. 2017. Lack of geospatial population structure yet significant linkage disequilibrium in the reservoir of *Plasmodium falciparum* in Bongo District, Ghana. *American Journal of Tropical Medicine & Hygiene* 97(4): 1180–1189.

Rorick MM. Review of Githinji G and Bull PC. 2017. A re-assessment of gene-tag classification approaches for describing var gene expression patterns during human *Plasmodium falciparum* malaria parasite infections. *Wellcome Open Research* 2: 86. DOI: 10.21956/wellcomeopenres.13039.r26465.

Rorick MM, Rask TS, Baskerville EB, Day KP, Pascual M. 2013. Homology blocks of *Plasmodium falciparum* var genes and clinically distinct forms of severe malaria in a local population. *BMC Microbiology* 13: 244.

Foster DV, Rorick MM, Gesell T, Feeney L, Foster JG. 2013. Dynamic landscapes: a model of context and contingency in evolution. *Journal of Theoretical Biology* 334: 162-72.

Rorick MM, Pascual M. 2013. Influenza evolution navigates stability valleys. *eLife* 2: e00842.

Artzy-Randrup Y, Rorick MM, Day KP, Chen DC, Dobson AP, Pascual M. 2012. Population structuring of multi-copy, antigen-encoding genes in *Plasmodium falciparum*. *eLife* 1: e00093.

Rorick MM. 2012. Quantifying protein modularity: a comparison of different techniques. *Biosystems* 110(1): 22-33.

Rorick MM, Wager GP. 2011. Protein structural modularity and robustness are associated with evolvability. *Genome Biology and Evolution* 3: 456-475.

Rorick MM, Wagner GP. 2010. The origin of conserved protein domains and amino acid repeats via adaptive competition. *Journal of Molecular Evolution* 70(1): 29-43.

Bridge DM, Ha CT, Nemir A, Renden A, Rorick MM, Shaffer A, Underkoffler DM, Wills AE, and Martínez DE. 2004. Variations on a theme? Polyp and medusa development in *Podocoryna carnea*. *Hydrobiologia* 530-531(1-3): 299-307.

PUBLICATIONS IN TECHNICAL REPORTS

Rorick MM, Wagner GP. Structural Robustness Confers Evolvability in Proteins. 2010. "Complex Adaptive Systems: Resilience, Robustness, and Evolvability" AAAI Technical Reports.

White B, Rorick MM. 2010. Cost-Benefit Analysis for Community-Based Disaster Risk Reduction in Kailali, Nepal. Mercy Corps.

Rorick MM, Wagner GP. 2009. Emergence of ultra-conserved protein domains and amino acid repeats: Adaptation, competition and thresholds. "Complex and Adaptive Systems and the Threshold Effect: Views from the Natural and Social Sciences" AAAI Technical Reports.

Drown D, Rorick MM, Mills R, Moffett A. 2008. Modularity in Coevolving Host-Pathogen Systems. Santa Fe Institute publication.

Feeney L, Foster DV, Foster JG, Gesell T, Millner A, Rorick MM. 2008. Dynamic Landscapes: A Model of Context and Contingency in Evolution. Santa Fe Institute publication.

ACADEMIC AWARDS

NSF Graduate Fellowship Honorable Mention	2005
Yale MCGD Director's Fellowship	2004
Phi Beta Kappa (Pomona College)	2004
Beckman Scholarship for Undergraduate Research	2003 - 2004
Flintridge Award (Pomona College)	2004
President's Prize in Women's Studies (Pomona College)	2004
Honors in Senior Project in Biology (Pomona College)	2004
Class of 2004 Vaile Prize in Biology (Pomona College)	2004
President's Prize in Women's Studies (Pomona College)	2003
1st Place Award for the Sigma Xi Poster Competition (Harvey Mudd College)	2002
Pomona College Scholar Award (6 semesters)	2001 - 2004

MEMBERSHIP IN SCIENTIFIC ORGANIZATIONS & HONOR SOCIETIES

International Society for Evolution, Medicine, and Public Health
American Society of Naturalists
Society for Integrative and Comparative Biology
Sigma Xi Scientific Research Honor Society
Phi Beta Kappa Academic Honor Society for Liberal Arts and Sciences

TEACHING EXPERIENCE

Science Club Teacher, ASB School	2022 - Present
Founder and Instructor, EvoLive (K-12 Science Outreach)	2016 - Present
Writing Coach, Yale Writing Center	2008 - 2011
ESL Writing Coach, Yale Writing Center	2009 - 2010
Graduate Affiliate, Davenport College, Yale University	2009 - 2011
Education Group Leader, Yale HealthCORE (Public Health Outreach in El Salvador)	2008 - 2009
Teaching Assistant (Section Instructor), Human Genetics, Yale Medical School	2008 - 2009

Teacher, Neutral Networks Tutorial, Santa Fe Institute	2008
Mentor, Genetics, Pomona College	2003
Laboratory Teaching Assistant, Developmental Biology, Pomona College	2003
Tutor, Genetics for Non-majors, Pomona College	2002
Biology Department Student Liaison, Pomona College	2000 - 2004
Teacher, science workshops, Northshore School District	1998 - 2006

COMMUNITY SERVICE

Public Health Committee Member, Temple Beth Am	2020 - 2022
Referee, BioEssays	2019
Referee, Journal of Computer-Aided Molecular Design	2018
Referee, Wellcome Open Research	2017
Reviewer, <i>Proceedings B</i>	2013
Reviewer, <i>BMC Evolutionary Biology</i>	2012
Reviewer, <i>Journal of Molecular Evolution</i>	2011 - 2012
Reviewer, <i>Theoretical Population Biology</i>	2011
Reviewer, <i>PLoS Computational Biology</i>	2010 - 2017
Organizing Committee Member, AAAI Complex Adaptive Systems Symposium	2010
Analyst (environmental and economic modeling), Mercy Corps	2010
Vice President, Scientists & Engineers for America Yale Student Chapter	2009 - 2010
Chapter Advisory Board Representative, Scientists & Engineers for America	2009 - 2010

INVITED TALKS/PRESENTATIONS AT SCIENTIFIC MEETINGS

Ecology and Evolution of Infectious Diseases. Montpellier, France. June 14-17, 2021. “Scientific Teaching Methods for Evolution Outreach in Schools”

Pomona College Invited Speaker, Departments of Chemistry and Biology. Claremont, CA. November 8, 2019. “The antigenic genes of the malaria parasite *Plasmodium falciparum* and implications for vaccine design”

Annual Meeting of the International Society for Evolution, Medicine & Public Health. Park City, UT. August 1-4, 2018. “Evidence of niche partitioning within the antigenic genes of the malaria parasite *P. falciparum* and implications for malaria vaccine design”

University of Utah Mathematical Biology Seminar. Salt Lake City, UT. December 6, 2017. “The Story of a Well-Adapted Parasite: Malaria Vaccines and Antigenic Diversity in *Plasmodium falciparum*”

Evolution Meeting. Portland, OR. June 23-27, 2017. “Evolution under competition: signatures of strain structure within the major blood-stage antigen of the malaria parasite *P. falciparum*”

American Society of Tropical Medicine and Hygiene Annual Meeting. Philadelphia, PA. Oct 25-29, 2015. “Modularity and strain structure in *var* antigenic gene repertoires of *P. falciparum* malaria in a high transmission region of the Bongo District, Ghana”

Ecology and Evolution of Infectious Diseases. State College, PA. May 20-23, 2013. “Identifying rapidly recombining parasite gene segments associated with severe malaria phenotypes”

Keystone Symposium on Malaria. New Orleans, LA. January 20-25, 2013. “Using homology blocks to identify functional groups in the *var* sequence diversity sampled from local populations”

Great Lakes Bioinformatics Conference 2012. Ann Arbor, MI. May 15-17, 2012. “Why do hyper-variable malaria *var* genes rely on recombination (as opposed to mutation) and what are the consequences?”

Eighth Annual Early Career Scientists Symposium: Biodiversity Informatics. Ann Arbor, MI. March 25, 2012. “Dynamics of hyper-variability: modeling evolutionary genetics and analyzing sequence diversity in malaria *var* genes”

Mathematical Biosciences Institute Symposium on Robustness. Ohio State University, Columbus, OH. February 6-10, 2012. “Dynamics of hyper-variability: modeling evolutionary genetics and analyzing sequence diversity in malaria *var* genes”

AAAI Fall Symposium on Complex Adaptive Systems: Robustness, Resilience and Evolvability. Arlington, VA. November 10-13, 2010. “Protein Modularity, Robustness and Evolvability”

Yale University Department of Genetics Research In Progress 2008 Seminar Series. New Haven, CT. February 23, 2010. “Protein modularity, robustness and evolvability”

The Society for Integrative & Comparative Biology Annual Meeting. Seattle, WA. January 4-7, 2010. “The origin of modularity and evolvability”

AAAI Fall Symposium on Complex and Adaptive Systems and the Threshold Effect: Views from the Natural and Social Sciences. Arlington, VA. November 5-7, 2009. “Emergence of Ultra-Conserved Protein Domains and Amino Acid Repeats: Adaptation, Competition and Thresholds”

Yale University Department of Genetics 2009 Seminar Series. New Haven, CT. May 5, 2009. “The origin of conserved protein domains and amino acid repeats via adaptive competition for control over amino acid residues”

Society for Integrative & Comparative Biology Annual Meeting. Boston, MA. January 5, 2009. “The origin of conserved protein domains and amino acid repeats via adaptive competition for control over amino acid residues”

Santa Fe Institute Complex Systems Summer School 2008. Santa Fe, NM. June 27, 2008. (1) “Modularity in Coevolving Host-Pathogen Systems”; (2) “Dynamic Landscapes: A Model of Context and Contingency in Evolution”

Yale University Department of Genetics 2008 Seminar Series. New Haven, CT. March 11, 2008. “A model for the origin of the homeodomain”

Yale University Computational Biology & Bioinformatics Journal Club, hosted by Gerstein Lab. New Haven, CT. December 6, 2006. “Molecular Modularity & evolvability”

Workshop on Cnidarian Development and Evolution, University of California at Irvine, July 2002. “The expression of *Hydra orthopedia* in I-cell derivatives-- nerve cells?”

Southern California Conference for Undergraduate Research, California Institute of Technology, Pasadena, CA. November 23, 2002. “The expression of *Hydra orthopedia* in I-cell derivatives—nerve cells?”

International Conference on Coelenterate Biology. Lawrence, KS. July 6-11, 2003. “The expression of *Hydra orthopedia* in I-cell derivatives—nerve cells?”

International Workshop on Hydra and the Evolution of Signaling Pathways, Evangelische Akademie Tutzing, Germany. September 15-18, 2003. “Variations on a theme? Polyp and medusa development in *Podocoryna carnea*”

Pomona College Summer Research Poster Session. Pomona College, Claremont, CA. September 2003. “Variations on a theme? Polyp and medusa development in *Podocoryna carnea*”

Pomona College Summer Research Poster Session. Pomona College, Claremont, CA. September 2002. “The expression of *Hydra orthopedia* in I-cell derivatives-- nerve cells?”

Sigma Xi Scientific Poster Session. Harvey Mudd College, Claremont, CA. November 6, 2002. “Where is the head of a jellyfish?”

Southern California Conference for Undergraduate Research (SCCUR). California Institute of Technology, Pasadena, CA. November 23, 2002. “Where is the head of a jellyfish?”

RESEARCH EXPERIENCE PRIOR TO DISSERTATION RESEARCH

Graduate Research Rotations, Yale University. (1) March to August 2005: Department of Ecology and Evolutionary Biology, under Dr. Günter Wagner. Modeling coevolution of epistatic genes and defining statistical signatures of epistasis “modules” in comparative genomic/proteomic databases. (2) January to February 2005: Department of Genetics, under Dr. Michael Stern. Modeling processes of cell fate specification and cell migration involved in *C. elegans* development. (3) September to December 2004: Department of Genetics, under Dr. Kevin White. Characterization of *Drosophila* transcription factor binding sites *in vivo* using Chromatin Immuno-Precipitation and DNA micro-array techniques.

The Beckman Scholarship, Pomona College (research funding for two summers and one academic year). Department of Biology, under Dr. Daniel Martinez, May 2003 to August 2004. Characterization of *budhead* and *Cn-NK2* expression in *Podocoryna* through whole-mount *in situ* hybridization.

Independent Research, Harvey Mudd College. Department of Biology, under Dr. Brian Hudgens, May to December 2002. Field and statistical research to characterize species-area curves.

Independent Research, Pomona College. Department of Biology, under Dr. Daniel Martinez, May 2002 to May 2003. Characterization of the *orthopedia* expression pattern in *Hydra* through whole-mount *in situ* hybridization. Cloning and probe construction for *Podocoryna budhead*, a gene associated with metazoan organizers. Characterization of *budhead* expression in *Podocoryna* through whole-mount *in situ* hybridization.

NSF Research Experience for Undergraduates, Pomona College. Department of Biology, under Dr. Daniel Martinez, September 2001 to May 2002. Cloning of *orthopedia*—a CNS gene—from *Hydra* genome, and construction of RNA *in situ* hybridization probe.

Research Assistant, University of Hawaii at Manoa. Department of Plant and Soil Sciences, under Dr. Mitiku Habte, May to August 2001. The effect of mycorrhizal fungi on crop health and yield.

Research Intern, University of Washington. Department of Engineered Biomaterials, under Dr. Cecilia Giachelli, June to July 1999. Characterization of the calcification of implanted artificial heart valves.