

Kathleen Morrill-Pirovich, PhD

Computational biologist with a keen focus on comparative and evolutionary genomics, rooted in my dissertation on the genetic determinants of canine health and behavioral disorders that have parallels to human conditions. My rigorous approach to project management, enriched by cloud-based computational workflows, is evident from my pivotal roles in Darwin's Ark, a community science project on companion dogs, and the Dog Aging Project, a longitudinal study of healthy aging. These endeavors not only highlight my expertise in managing and analyzing expansive, multi-omic biobanks but also underscore my dedication to public-engaging scientific initiatives. As a senior scientist in genome analysis at Colossal Biosciences, I spearheaded approaches to modeling and predicting effects of non-coding, regulatory DNA sequence variants from data-constrained species, including ancient DNA from extinct taxa.

Education

Bates College, Lewiston, ME, 2011 – 2015

Bachelor of Science in Biological Chemistry, minor in Mathematics, with distinction

University of Massachusetts Chan Medical School, Worcester, MA, 2016 – 2023

PhD in Biomedical Sciences at the Morningside Graduate School of Biomedical Science

Department of Bioinformatics and Integrative Biology | Program in Neuroscience

Experience

Research Roles

Senior Scientist

Colossal Biosciences, Dallas, TX

Computational Sciences Team

kathleen@colossal.com

2023 – present

The genetic basis for key phenotypes of long-extinct species is elusive. My role as senior scientist in genome analysis at Colossal Biosciences is to provide expertise on phenotypes and enable genotype-to-phenotype inference in target species through cross-species comparative genomics and transfer learning approaches.

Doctoral Student

University of Massachusetts Chan Medical School, Worcester, MA

Department of Bioinformatics and Integrative Biology

Research Advisor: Elinor Karlsson (*elinor@broadinstitute.org*)

2017 – 2023

The behavior of domestic dogs can be utilized as a natural neurogenetic system for human neuropsychiatric conditions. Dogs exhibit similar behavioral disorders of similar clinical presentation and therapeutic response, and behavioral selection in canine lineages has increased the prevalence of high effect, behavior-associated variants amenable to genomic investigations. My dissertation research focuses on the behavioral genetics of dogs and its relevance and utility towards human conditions.

Graduate Intern

Cold Spring Harbor Laboratory, Cold Spring Harbor, NY

Neuroscience Program

Research Advisor: Josh Dubnau (*joshua.dubnau@stonybrook.edu*)

2015 – 2016

The transposon storm hypothesis postulates that unregulated retrotransposon activity contributes to accumulation of DNA damage. By modeling the human neurodegenerative disease of amyotrophic lateral sclerosis (ALS) in *Drosophila*, we explored mechanisms behind impairment of siRNA silencing, retrotransposon activation, DNA damage, and non-cell autonomous death. When human TDP-43, a protein implicated in ALS, was over-expressed in glial cells, flies showed motor defects, early death, increased activity of endogenous retrovirus "Gypsy", and DNA damage-signaled apoptosis.

Undergraduate Research Student

Bates College, Lewiston, ME

Undergraduate Senior Thesis in Biological Chemistry

Research Advisor: Larissa Williams (lwillia2@bates.edu)

2014 – 2015

Since 1996, the coverage of eelgrass (*Z. marina*) in the Frenchman Bay, ME, has declined from 3,174 to <200 acres. In 2013, major restoration areas disappeared. Genetic diversity was considered in explaining differences in survival between populations and resistance to disturbance. I isolated genomic DNA of 90 individual plants, amplifying and sizing six microsatellite loci, and quantified the genetic diversity of six distinct populations on the coasts of the Frenchman Bay and Mount Desert Island, ME. I correlated population genetics with factors of loss and resistance measured in field.

Summer Research Intern

National Cancer Institute, Frederick, MD

Molecular Control and Genetics Section

Research Advisor: Donald Court (courtd@mail.nih.gov)

2014 and 2015

The lambda phage Rex functions (*rexA* and *rexB* and their products) have been implicated in phage replication in and induction from *E. coli* hosts. I studied these functions and the induction of *rexB*'s separate promoter, *P_{LIT}*, during DNA damage. I found this promoter dependent on host SOS response repressor protein, LexA, and confirmed this by mutation of the suspected binding site. This presents evidence of *RexB* having a role during prophage induction, perhaps in balance with *RexA* to temper the response of lambda to the degree of DNA damage in the host.

Other Roles

Darwin's Ark, Team Member (darwinsark.org)

Dog Aging Project, Project II: Genetics, Team Member (dogagingproject.org)

Awards and Honors

Harold M. Weintraub Graduate Student Award, 2023

International Society of Psychiatric Genetics Early Career Investigator Program, 2022

Dean's Award for Outstanding Mid-Thesis Research, 2022

Diane M. Riccio Morningside Graduate School of Biomedical Sciences Travel Award, 2022

Anne D. Williams Family Prize in Population or Environmental Studies, 2015

Cancer Research Training Award, 2014 & 2015

Publications

ORCID: 0000-0002-9139-453X

Morrill, K., Chen, F., and Karlsson, E.K. Comparative neurogenetics of dog behavior complements efforts towards human neuropsychiatric genetics. (2023). *Human Genetics*.

Christmas, M.J., and 75 other authors, including **Morrill, K.** Evolutionary constraint and innovation across hundreds of placental mammals. (2023). *Science*.

Moon, K.L.†, Huson, H.J.†, **Morrill, K.†**, Wang, M., Li, X., Srikanth, K., Zoonomia Consortium, Svenson, G.J., Karlsson, E.K., Shapiro, B. Comparative genomics of Balto, a famous historic dog, captures lost diversity of 1920s sled dogs. (2023). *Science*.

Megquier, K., Turner-Maier, K., **Morrill, K.**, Li, X., Johnson, J., Karlsson, E.K., London, C.A., Gardner, H.L. The genomic landscape of canine osteosarcoma cell lines reveals conserved structural complexity and pathway alterations. (2022). *PLOS One*.

Morrill, K., Hekman, J., Li, X., McClure, J., Logan, B., Goodman, L., Gao, M., Dong, Y., Alonso, M., Carmichael, E., Snyder-Mackler, N., Alonso, J., Noh, H., Johnson, J., Koltokian, M., Lieu, C.,

Megquier, K., Swofford, R., Turner-Maier, J., White, M.E., Weng, Z., Colubri, A., Genereux, D.P., Lord, K.A., Karlsson, E.K. Ancestry-inclusive dog genomics challenges popular breed stereotypes. (2022). *Science*.

Thomason, L., **Morrill, K.**, Murray, G., Court, C., Shafer, B., Schneider, T., Court, D. Elements in the λ immunity region regulate phage development: beyond the ‘Genetic Switch’. (2019). *Mol. Microbiol.*

Megquier, K., Genereux, D., Hekman, J., Swofford, R., Turner-Maier, J., Johnson, J., Alonso, J., Li, X., **Morrill, K.**, Anguish, L., Koltookian, M., Logan, B., Sharp, C., Ferrer, L., Lindblad-Toh, K., Meyers-Wallen, V., Hoffman, A., Karlsson, E. BarkBase: Epigenomic Annotation of Canine Genomes. (2019). *Genes*.

Krug, L., Chatterjee, N., Borges-Monroy, R., Hearn, S., Liao, W.-W., **Morrill, K.**, Prazak, L., Rozhkov, N., Theodorou, D., Hammell, M., Dubnau, J. Retrotransposon activation contributes to neurodegeneration in a *Drosophila* TDP-43 model of ALS. (2017). *PLoS Genetics*.

Morrill, K., Farrel, A., Dirks, A., Badger, M., Disney, J., Williams, L. Role of genetic diversity and water quality in the 2013 decline of eelgrass (*Zostera marina*) populations of the Upper Frenchman Bay, ME coastlines. (2015). *MDIBL Bulletin*.

Presentations

World Congress on Psychiatric Genetics, Oral Presentation (invitee), 2022, Florence, Italy

Available online: <https://youtu.be/8SnauFP1cUQ>

The Biology of Genomes, Poster Presentation, 2022, Cold Spring Harbor Laboratory, NY

Society for Molecular Biology & Evolution, Poster Presentation (virtual), 2021

Medical and Population Genomics, Primer Lecture, 2021, Virtual Broadcast

Available online: <https://youtu.be/Yq1m1BJQbto>

Medical and Population Genomics, Group Presentation, 2019, Broad Institute of MIT & Harvard

2nd Annual Food Allergy Science Initiative Symposium, Poster Presentation, 2019

42nd Maine Biological and Medical Sciences Symposium, Oral Presentation, 2015, MDIBL, ME

Summer Poster Day, Poster Presentation, 2014 & 2015, National Institutes of Health, Bethesda, MD

Activities

Outreach

“Every dog is an individual”, Data Visualization Dashboard, 2022.

<https://darwinsark.org/muttomics>

“Envisioning Dogs in the Cloud” for Terra.bio, Blog Post, 2022.

<https://terra.bio/envisioning-dogs-in-the-cloud/>

“Dog and Human Genetics: Similarity and Difference” for Dog Aging Project, Blog Post, 2022.

“Using Genetics to Predict Physical Traits” for Dog Aging Project, Blog Post, 2021.

“July Pack Appreciation Event” for Dog Aging Project, Virtual Broadcast, 2020.

<https://youtu.be/0vdsuO9K2VM>

Education

Sacred Heart Upper School, Greenwich, CT | Scientist Mentor, 2021 - 2022

Students placed 1st in the Team category of the 2021 CT-STEM science fair in (ctstemfoundation.org) and 3rd in the 2022 Connecticut Science & Engineering Fair.

Broadie for a Week, Cambridge, MA

“GWAS Gene Hunt” Module Developer and Mentor

Experimental Design and Data Analysis Bootcamp, Worcester, MA
Teaching Assistant, 2017 & 2019 | Course Instructor, 2020

Interviews

Jeffrey M. Perkel, “Terra takes the pain out of ‘omics’ computing in the cloud”, *Nature*
<https://www.nature.com/articles/d41586-021-03822-7>

Katherine J. Wu, “Humans Can’t Quit a Basic Myth About Dog Breeds ” , *The Atlantic*
<https://www.theatlantic.com/science/archive/2022/04/dog-breed-personality-characteristics/629707/>

Jack Tamisiea, “Dogs’ Personalities Aren’t Determined by Their Breed” , *Scientific American*
<https://www.scientificamerican.com/article/dogs-personalities-arent-determined-by-their-breed/>

Illustration

Illustrations for print page summary. Christmas, M.J. *et al.* Evolutionary constraint and innovation across hundreds of placental mammals. (2022). *Science*.

Illustrations for figures. Chan, F. *et al.* Advancing genetic selection and behavioral genomics of working dogs through collaborative science. (2021). *Frontiers in Veterinary Science*.

Events

2021 NIH Health Disparities Codeathon, “Cancer disparities through a genomic epidemiology lens”

Skills

Project Management. Writing standard operating procedures (SOPs), designing workflows, workgroup leadership, research participant engagement (e.g., developing genomic report returns)

Writing and Editing. Experience writing SOPs and SOWs, L^AT_EX Typesetting Language

2D and 3D Illustration. Adobe Creative Suites, Corel Painter, Blender 3D, Autodesk Fusion 360

Languages, Statistics, and Computing. Python, R, Unix / Bash, workflow definition language (WDL), cloud-based computing (Terra.bio, Google), MATLAB, Maple Mathematics, GraphPad Prism, SigmaPlot

Genomics and Bioinformatics. Genome-wide association studies (GWAS), fine-mapping, heritability, global and local ancestry inference, GATK, PLINK, GCTA, VCFtools, SAMtools, BCFtools

Molecular Biology. DNA/RNA, PCR/qPCR, fragment analysis, next generation sequencing, protein chromatography, traditional and high-throughput Western blotting

Cellular Biology. reporter & activity assays (β -galactosidase, luciferase, GFP), genetic recombineering, cloning, FLP/FRT mitotic recombination, fluorescent imaging, confocal microscopy

Model Organisms and Cell Culture. Bacteria (*E. coli*), worm (*C. elegans*), fly (*D. melanogaster*), mammalian cell culture (primary and immortalized, mouse and human, cancer and non-cancer)