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Hanon McShea

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Education:

Stanford University, Stanford, CA 2018 –
Ph.D. in Earth System Science, **GPA:** 3.98/4.00
Harvard University, Cambridge, MA 2014 – 2018
A.B. *magna cum laude* in Integrative Biology, secondary in Microbial Sciences, **GPA:** 3.86/4.00

Awards:

Stanford Bio-X Travel Award 2024
Stanford School of Sustainability McGee and Levorsen Graduate Research Grant 2021, 2023
Training Program in Biophysical and Structural Analysis of Biological Macromolecules 2023 –
National Science Foundation Graduate Research Fellowship 2018 – 2023
Stanford Enhancing Diversity in Graduate Education Fellowship 2018 – 2020
Harvard Origins of Life Initiative Undergraduate Research Fellowship 2017
Harvard Life Sciences Conference Presentation Grant 2017
Weissmann International Research Fellowship 2016
University of Pittsburgh Training and Experimentation in Computational Biology Fellowship 2015

Publications:

1. **McShea, H.**, Weibel, C., Wehbi, S., Goodman, P., James, J., Wheeler, A., and Masel, J. The effectiveness of selection in a species affects the direction of amino acid frequency evolution. bioRxiv 2023. https://doi.org/10.1101/2023.02.01.526552. Under revision at *Genome Biology and Evolution*.
2. Weibel, C., Wheeler, A., James, J., Willis, S., Hernández, U., **McShea, H.**, and Masel, J. A new codon adaptation metric predicts vertebrate body size and tendency to protein disorder. https://doi.org/10.7554/eLife.87335.1. Under revision at *eLife.*
3. Dang, C.C., Bui, M.Q., **McShea, H.**, Masel, J., James, J.E., Le, V.S., and Lanfear, R. nQMaker: estimating time non-reversible amino acid substitution models. 2022. *Systematic Biology* 71(5): 1110-1123. https://doi.org/10.1093/sysbio/syac007
4. Garcia, A.K., **McShea, H.**, Koaczkowski, B., and Kacar, B. Reconstructing ancestral nitrogenases suggest Mo-specific ancestry. 2020. *Geobiology* 18(3): 394-411. https://doi.org/10.1111/gbi.12381
5. Laird, M.K., **McShea, H.**, Murphy, C.R, McAllan, B.M., Shaw, G., Renfree, M.B., and Thompson, M.B. Desmosomal remodeling is required for non-invasive embryonic attachment in the marsupials *Macropus eugenii* (Macropodidae) and *Trichosurus vulpecula* (Phalangeridae). 2018. *Molecular Reproduction and Development* 85(1): 72-82. https://doi.org/10.1002/mrd.22940
6. Laird, M.K., **McShea, H.**, McAllan, B.M., Murphy, C.R., and Thompson, M.B. Uterine remodelling during pregnancy and pseudopregnancy in the brushtail possum (*Trichosurus vulpecula*; Phalangeridae). 2017. *Journal of Anatomy* 231(1): 84-94. https://doi.org/10.1111/joa.12610

Publications in preparation:

1. **McShea, H.**, Viens, R., Olagunju, B., Giner, J., and Welander, P. Evolutionary and biochemical analysis of triterpenoid cyclases. *[Experiments complete, manuscript drafted, collaborators revising]*
2. **McShea, H.**, de Anda, V., Brocks, J., Baker, B., and Welander, P. A diterpenoid cyclase from the Asgard archaea. *[Experiments complete, drafting manuscript]*

Presentations:

3rd Joint Congress on Evolutionary Biology (Upcoming talk, virtual) 2024
Archaea Power Hour (Invited talk, virtual) 2024
Northern California Geobiology Conference (Talk, Stanford, CA) 2024
Geobiology Gordon Research Conference and Seminar (Poster, Ventura, CA) 2024
Bay Area Population Genetics Conference (Talk, Stanford, CA) 2023

Society for Molecular Biology and Evolution (Poster, Ferrara, Italy) 2023
Northern California Geobiology Conference (Poster, Stanford, CA) 2023
Geobiology Gordon Research Conference and Seminar (Poster, Ventura, CA) 2022
Stanford Advanced Seminar in Microbial Molecular Biology (Talk, Stanford, CA) 2022
American Society for Microbiology Microbe (Poster, Virtual) 2020
Stanford Biochemistry Annual Research Conference (Invited breakout talk, Santa Cruz, CA) 2019
Northeast Geobiology Conference (Poster, Woods Hole, MA) 2018
Harvard Microbial Sciences Initiative (Invited chalk talk, Cambridge, MA) 2018
Harvard Origins of Life Initiative (Chalk talk, Cambridge, MA) 2017
Earth Life Science Institute (ELSI) Origins Network Universal Biology workshop, (Talk, Tokyo, Japan) 2017
Geobiology Conference (Poster, Banff, Canada) 2017

Research Projects:

Biophysical implications of sterol demethylation Sept. 2023 –
Welander and Boxer Labs, Stanford University Departments of Earth System Science and Chemistry
Physical properties of membranes are sensitive to small differences in sterol molecular structure, such as exocyclic alkyl group length, position, and stereochemistry. To systematically approach these effects on membrane condensation, fluidity, and phase, we are investigating a series of four sterols that each differ by one methyl group.

Evolutionary history of terpenoid cyclases Sept. 2018 –
Welander Lab, Stanford University Department of Earth System Science
Terpenoid cyclases perform an exquisitely controlled cyclization cascade to synthesize diverse products including sterols. My work involves experimental characterization of divergent cyclases of unknown function, as well as theoretical investigation of the evolutionary forces that produced such diversity.

- Heterologous expression in *E. coli*, especially of proteins from environmental metagenomes and uncultured organisms (metagenome-assembled genomes, including Asgard archaea)
- Molecular cloning to engineer *E. coli* strains to produce new substrates for *in hetero* cyclase activity
- Lipid extraction, purification, and analysis by gas- and liquid-chromatography mass-spectrometry
- Protein purification and *in vitro* biochemistry to determine cyclase substrates and products
- Phylogeny estimation under a variety of evolutionary models, statistical hypothesis testing
- Development of new methods for phylogeny estimation and analysis

Evolutionary trends in proteome composition May 2020 – June 2023
Masel Lab, University of Arizona Department of Ecology and Evolutionary Biology
Nearly neutral theory predicts evolutionarily significant variation among species in the ability of selection to purge weakly deleterious mutations. This work investigated whether and how this variation in the effectiveness of selection affects the direction of protein evolution. We found strong preferences for some amino acids under more effective selection, specifically those with fewer rotational degrees of freedom, suggesting selection for greater ΔG of folding.

Detecting adaptive events in the evolutionary history of nitrogenase using ancestral protein reconstruction Dec. 2016 – Mar. 2018
Kaçar and Edwards Labs, Harvard University Department of Organismic and Evolutionary Biology
Global nitrogen fixation is performed by the enzyme nitrogenase. I used ancestral protein reconstruction to determine how the enzyme adapted to Earth surface redox change. I found that mutations arising in the stem lineages of aerobic nitrogenase clades are clustered in protein domains implicated in protecting nitrogenase from oxygen in their respective taxa – suggesting perhaps global selective pressure, such as Precambrian oxygenation.

Desmosome-mediated uterine remodeling for noninvasive implantation in the marsupial *Trichosurus vulpecula* June – Aug. 2016
Thompson Lab, University of Sydney Department of Zoology
Placentation in mammalian pregnancy is a site of parent-offspring conflict, and as such has evolved diverse physiologies across marsupials and eutherian mammals. Within marsupials, it is yet unclear how non-invasive placentation evolved from an invasive ancestor. We studied changes in the uterine epithelial distribution of cell-cell adhesion protein desmoglein-2 over the course of non-invasive pregnancy in the brushtail possum *Trichosurus vulpecula* and found that their patterns did not differ from either eutherian or marsupial invasive placentation.

Agent-based modeling of the relationship between oscillatory calling and spatial cluster formation in an Anuran mating chorus June – Aug. 2015
Ermentrout Lab, University of Pittsburgh Department of Mathematics

Mentorship and Outreach:

Undergraduate Research Mentor (Stanford University) 2024 –
- Mentored computer science student Minh Tu in heterologous expression, lipid extraction and analysis, and experimental design

Enhancing Diversity in Graduate Education Mentor (Stanford University) 2023 –
- Mentored three Ph.D. students through their first year of graduate research
- Organized group lunches with EDGE mentees, mentors, and faculty mentor

Earth System Science Department Mentor (Stanford University) 2020 – 2021
- Mentored two Ph.D. students through the first year of graduate research, in the midst of pandemic

Sustainability and Earth Summer Undergraduate Research Mentor (Stanford University) 2019 – 2020
- Mentored biology student Robb Viens in heterologous expression of squalene-hopene cyclases, hopanoid extraction and analysis, and experimental design for a summer project and ongoing work in the Welander lab
- Helped the student successfully apply for a job in the biotechnology industry
- Co-authored a paper with the student (in prep)

Graduate Research Mentor (Stanford University) 2018 –
- Brought new computational knowledge to the Welander lab (molecular structure visualization, phylogeny estimation, navigating HPC systems), trained lab mates interested in using these tools and helped troubleshoot

Teaching:

Teaching Assistant, Research Proposal Development and Delivery (Profs. Paula Welander and Page Chamberlain, Stanford University) 2023
- Met with students and provided detailed feedback on assignments and final proposals
- Organized grading system
- *What aspects of this instructor's teaching were most helpful to you?* “Caring, good feedback, honest,” “Humor, candor, patience and thoughtful, detailed feedback,” “Friendliness, availability, and willingness to clarify doubts,” “Direct comments, positive, and intentional,” “Clear communication, great feedback, approachable and offered helpful perspectives.”

Teaching Assistant, Coevolution of Earth and Life (Prof. Andrew Leslie, Stanford University) 2022
- Held weekly office hours and met with students to study
- Edited and graded course materials and exam problems
- *What aspects of this instructor's teaching were most helpful to you?* “Kindness and engagement,” “Willingness to find answers even when they didn't originally have an answer, friendliness, direct explanations,” “Kindness, understanding, compassion.”

Workshop, Phylogenetic Theory and Analysis (Stanford University) 2019
- Designed and led workshop on estimating phylogeny
- Materials available at https://github.com/cyclase/skillshare

Pamphlet, Critical pedagogy for graduate student teachers in STEM (Stanford University) 2019
- Created a short teaching guide for the Diversity and Inclusion in the Geosciences seminar
- Available at bit.ly/2HuSmLr

Teaching Assistant, Geobiology and the History of Life (Prof. Andrew Knoll, Harvard University) 2018
- Assisted Teaching Fellow Anna Waldeck in the preparation and leading of weekly lab sections

Service:

Convener, Symposium on Causation in Protein Evolution (Ferrara, Italy) 2022 – 2023
- Organized symposium at Society for Molecular Biology & Evolution Meeting
- Recruited co-convener, invited keynote speakers, solicited and selected abstracts
- Organized dinner for invited speakers and networking session for attendees

Session co-chair, Northern California Geobiology Meeting (Stanford, CA) 2023
Co-chair, Student-invited Seminar Committee (Stanford Earth System Science Department) 2021 – 2022
Member, Diversity, Equity, and Inclusion Working Group (Stanford School of Earth) 2020 – 2021
Member, Gender Inclusive Housing Committee (Stanford University) 2019 – 2020
Treasurer, Scientists Speak Up (Stanford University) 2019 – 2020

Graduate-Level Coursework:

Stanford: Fundamentals of geobiology, Diversity and inclusion in the geosciences, Topics in geobiology, Geomicrobiology, Environmental microbiology I, Modern statistics for modern biology, Microbial genomics, Understanding Kinetics for Biologists and Biology

Harvard: Geobiology and the history of life, Low temperature geochemistry I & II, Analytic and field methods in geobiology, Oxygen and life, Stable isotope fractionation in multiple isotope systems, Genetics, Ecology, Herpetology, Vertebrate viviparity, Biochemistry of membranes, Microbial sciences: chemistry, ecology, and evolution, Molecular ecology and evolution, Systematics, Phylogenetics and phylogeography in the era of genomics

Else: **Workshop on Molecular Evolution**, Marine Biological Laboratory, Woods Hole, MA, 2022
Rapidata 2024: Practical Course in Macromolecular X-ray Diffraction Measurement, Stanford Synchrotron Radiation Light Source, SLAC National Accelerator Laboratory, Menlo Park, CA, 2024

References:

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Professor Daniel Herschlag, Stanford University, *Collaborator*
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Professor Joanna Masel, University of Arizona, *Collaborator*
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