

Matthew L. Holding

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EDUCATION

Ph.D.	Ohio State University – Evolution, Ecology, and Organismal Biology <i>Advisor: H. Lisle Gibbs</i> <i>Interdisciplinary Minor: College and University Teaching</i>	2011 – 2017
M.S.	California Polytechnic State University – Biological Sciences <i>Advisor: Emily Taylor</i>	2009 – 2011
B.S.	Ball State University – Biology	2005 – 2009

PROFESSIONAL APPOINTMENTS

Research Investigator, Life Sciences Institute, University of Michigan	2024 – Pres.
Postdoctoral Research Fellow, Life Sciences Institute, University of Michigan	2021 – 2024
N.S.F. EPsCoR Postdoctoral Fellow, University of Nevada Reno	2020 – 2021
National Science Foundation Postdoctoral Fellow, Florida State Univ.	2018 – 2020
Postdoctoral Research Fellow, Biological Sciences, Clemson Univ.	2017 – 2018
Presidential Fellow, Ohio State University	2016 – 2017
Graduate Teaching Assistant – Ohio State University	2011 – 2012, 2014 – 2016
National Science Foundation Graduate Research Fellow – Cal Poly, Ohio State	2010 – 2014
Graduate Teaching Assistant – Cal Poly	2009 – 2011
Amphibian Research Technician, Green Diamond Resource Company, CA	2008
Avian Research Technician, Indiana Hardwood Ecosystem Experiment	2007

AWARDS & HONORS

Life Sciences Institute Outreach Award, University of Michigan	2024
Best Poster, Gordon Conference: Plasminogen Activation/Extracellular Proteolysis	2024
Postdoctoral Award for Exceptional Mentoring, University of Nevada Reno	2021
National Science Foundation Postdoctoral Fellowship	2017
Presidential Fellowship, Ohio State University	2017
Outstanding Undergraduate Research Mentor Award, OSU Undergrad. Research Office	2016

National Science Foundation Graduate Research Fellowship	2010 – 2014
Outstanding Graduate Student in Biological Sciences, Cal. Poly. State University	2011
Outstanding Thesis Award Nominee, Cal. Poly. State University	2011
Outstanding Senior in Wildlife Biology, Ball State University Biology Department	2009

RESEARCH FUNDING

Life Sciences Institute LSI Cubed Award - \$10,000	2024
National Science Foundation Postdoctoral Research Fellowship – \$138,000 <i>Use of Biological Collections Award #1711141:</i> <i>“Innovation, diversification, and complexity: The impact of venom evolution on the integrated venom delivery system of New World snakes”</i>	2018-2021
American Society of Naturalists’ Student Research Award – \$2000	2015
Ohio State Alumni Grants for Graduate Research – \$1990	2014
Jones-Lovich Grant in Southwestern Herpetology, Herpetologists’ League – \$1000	2014
Research Grant, Calif. Bureau of Land Management – \$4000	2014
Theodore Roosevelt Memorial Grant, American Museum of Natural History – \$2385	2013
Grant-in-Aid of Research, American Society of Mammalogists – \$1500	2013
Grant-in-Aid of Research, Sigma Xi – \$500	2013
Gaige Award, American Society of Ichthyologists and Herpetologists – \$500	2013
Graduate Student Research Grant, Chicago Herpetological Society – \$500	2013
The Sigma Xi Graduate Research Grant, OSU chapter of Sigma Xi – \$500	2012
Center for Life Sciences’ Laboratory Development Grant, Ohio State University – \$2,000	2011
NSF Travel Grant for International Research by Graduate Research Fellows – \$1500	2010
E.E. Williams Research Grant, The Herpetologists’ League – \$500	2010
Aryan I. Roest Memorial Grant, Cal Poly Department of Biological Sciences – \$2000	2010

PUBLICATIONS

**** mentored undergraduate; † joint lead author**

In review

Neilsen D, **Holding ML**, Matocq MD. Swapped diets reveal asymmetry in digestive system-wide response of detoxification gene expression and the microbiome in two vertebrate herbivores. *BMC Biology*, in revision

Published

- [51] Farleigh K, Highland DK, Alderman MG, Francioli Y, Hirst SR, Faber EM, Perry BW, **Holding ML**, Castañeda-Gaytan G, Borja M, Franz-Chávez H, Parkinson CL, Strickland JL, Margres MJ, Mackessy SP, Meik JM, Castoe TA, Schield DR. 2026. Evolution of genome-wide barriers to gene flow during complex speciation in rattlesnakes. *Proceedings of the National Academy of Sciences of the United States of America* 123: e2609058123.
- [50] **Holding ML**, Pontius MHH, **Ward MS, Akhtar J, Crowell HL, Svilar D, Keeler KM, Haynes LM, Ginsburg D, Shavit JA. 2026. Deconstructing cardiovascular and coagulation-related traits links dietary ecology to multi-functional snake venom specificity. *Evolution* 80: 1035-1046, qpag036.
- [49] **[†]Ward MS, [†]**Holding ML**, Haynes LM, Margres MJ, Matocq MD, Ginsburg D. 2025. Tandem duplication of serpin genes yields functional variation and snake venom inhibitors. *Molecular Biology and Evolution* 42: msaf290
- [48] Haynes LM, **Holding ML**, Woodard J, Siemieniak D, Ginsburg D. 2025. Thermodynamics and selection of the plasminogen activator inhibitor-1 latency transition. *Journal of Biological Chemistry* 301:110896.
- [47] [†]**Holding ML**, [†]Disharoon D, [†]Haynes LM, Chakravarthy Paruchuri B, Pontius MHH, Golden K, Shavit JA, Desch KC, Ginsburg D, Sen Gupta A, Cruz Y, [†]Drabek DH. 2025. Comparative microfluidic and enzymatic analyses reveal multifaceted snake venom resistance and novel VWF behavior in the opossum *Monodelphis domestica*. *PLoS One* 20: e0332686
- [46] Hogan MP, **Holding ML**, Nystrom GS, Lawrence KC, Broussard EM, Ellsworth SA, Mason AJ, Margres MJ, Gibbs HL, Parkinson CL, Rokyta DR. 2025. Life history and chromosome organization determine chemoreceptor gene expression in rattlesnakes. *Journal of Heredity*. 116: 617-631.
- [45] **Holding ML**, Kolora SRR, Smith JE, McDevitt SL, Sudmant PH, Tarvin RD. 2025. A genome assembly for a textbook mammalian study species, the California ground squirrel (*Otospermophilus beecheyi*). *Journal of Heredity* 2025: esaf045.
- [44] **Holding ML**, Coconis A, Connors PK, Matocq MD, Dearing MD. 2025. Ambient temperature and toxic diets constrain snake venom resistance in a desert rodent. *Biology Letters* 21: 20250068
- [43] Haynes LM, **Holding ML**, DiGiovanni HL, Siemieniak D, Ginsburg D. 2025. High-throughput amino acid-level characterization of the interactions of plasminogen activator inhibitor-1 with variably divergent proteases. *Protein Science* 34: e70088

- [42] Heptinstall TC, Rosales García RA, Rautsaw RM, Myers EA, **Holding ML**, Mason AJ, Hofmann EP, Schramer TD, Hogan MP, Borja M, Castañeda-Gaytán G, Feldman CR, Rokyta DR, Parkinson CL. 2025. Dietary breadth predicts toxin expression complexity in the venoms of North American gartersnakes. *Integrative Organismal Biology* 7: obaf003
- [41] ****Beimfohr C, **Rivas Moreno L, **Anderson R, C**ardwell R, Seeman Z, Spry R, Holding M, Owens A, Denton R.** 2025. Characterizing population structure and documenting rapid loss of genetic diversity in Chiricahua Leopard Frogs (*Lithobates chiricahuensis*) with high throughput microsatellite genotyping. *Conservation Genetics* 26: 293-306.
- [40] Hogan, MP, **Holding, ML**, Nystrom, GS, Colston, TJ, Bartlett, DA, Mason, AJ, Ellsworth, SA, Rautsaw, RM, Lawrence, KC, Strickland, JL, He, B, Fraser, P, Margres, MJ, Gilbert, DM, Gibbs, HL, Parkinson, CL, Rokyta, DR. 2024. The genetic regulatory architecture and epigenomic basis for age-related changes in rattlesnake venom. *Proceedings of the National Academy of Science of the USA* 121: e2313440121.
- [39] Myers, EA, Rautsaw, RM, Borja, M, Jones, J, Grünwald, CI, **Holding, ML**, Grazziotin, F, Parkinson, CL. 2024. Phylogenomic discordance is driven by wide-spread introgression and incomplete lineage sorting during rapid species diversification within rattlesnakes (Viperidae: *Crotalus* and *Sistrurus*). *Systematic Biology* 73: 722-741.
- [38] Ellsworth SA, Rautsaw RM, Ward MJ, **Holding ML**, Rokyta DR. 2024. Selection across the three-dimensional structure of venom proteins from North American Scolopendromorph centipedes. *Journal of Molecular Evolution* 92: 505-524.
- [37] Brovkina, MV, Chapman, MA, **Holding ML**, Clowney, EJ. 2023. Emergence and influence of sequence bias in evolutionarily malleable, mammalian tandem arrays. *BMC Biology* 21: 179.
- [36] Westeen, EP, Escalona, M, **Holding, ML**, Beraut, E, Fairbairn, C, Marimuthu, MPA Nguyen, O, Perri, R, Fisher, RN, Toffelmier, E Shaffer, HB, Wang, IJ. 2023. A genome assembly for the southern Pacific rattlesnake, *Crotalus oreganus helleri*, in the western rattlesnake species complex. *Journal of Heredity* 2023: esad045.
- [35] Rosales-García, RA, Rautsaw, RM, Hofmann EP, Grünwald, C, Franz-Chavez, H, Ahumada-Carrillo, IT, Ramirez-Chaparro, R, Angel del Torre-Loranca, M, Strickland, JL, Mason, AJ, **Holding ML**, Borja, M, Castañeda-Gaytan, G, Myers, EA, Sasa, M, Rokyta, DR, Parkinson, CL. 2023. Sequence divergence in venom genes within and between montane pitviper (Viperidae: Crotalinae: *Cerrophidion*) species is driven by mutation-drift equilibrium. *Journal of Molecular Evolution* 91: 514-535.
- [34] **Holding ML**, Trevine, VC, Zinenko, O, Strickland, JL, Rautsaw, RM, Mason, AJ, Hogan, MP, Parkinson, CL, Grazziotin, FG, Santana, SE, Davis, ME, Rokyta, DR. 2022.

Evolutionary allometry and ecological correlates of fang length evolution in vipers. *Proceedings of the Royal Society B* 289: 20221132

- [33] Mason, AJ, **Holding, ML**, Rautsaw, RM, Rokyta, DR, Parkinson, CL, Gibbs, HL. 2022. Venom gene sequence diversity and expression jointly shape diet adaptation in pitvipers. *Molecular Biology and Evolution* 39: msac082
- [32] Schield, D.R., B.W. Perry, R.H. Adams, **Holding, ML**, Z.L. Nikolakis, S.S. Gopalan, C.F. Smith, J.M. Parker, J.M. Meik, S.P. Mackessy, and T.A. Castoe. 2022. The roles of balancing selection and recombination in the evolution of rattlesnake venom. *Nature Ecology & Evolution* 6: 1367–1380.
- [31] Greenhalgh, R., **Holding, ML**, Orr, TJ, Henderson, JB, Parchman, TL, Matocq, MD, Dearing, MD. 2022 Trio-binned genomes of the woodrats *Neotoma bryanti* and *N. lepida* reveal novel gene islands and rapid copy number evolution of xenobiotic metabolizing cytochrome p450 genes. *Molecular Ecology Resources* 22, 2713– 2731.
- [30] Ochoa, A, Hassinger, ATB, **Holding, ML**, and Gibbs HL. 2022. Genetic characterization of potential venom resistance proteins in California ground squirrels (*Otospermophilus beecheyi*) using transcriptome analyses. *J. Experimental Zoology B: Molecular and Developmental Evolution*. 10.1002/jez.b.23145
- [29] Huttinger ZM, Haynes LM, Yee A, Kretz CA, **Holding ML**, Siemieniak DR, Lawrence DA, Ginsburg, D. 2021. Deep mutational scanning of the plasminogen activator inhibitor-1 functional landscape. *Scientific Reports* 11:18827.
- [28] **Holding ML**, Strickland, JL, Rautsaw, RM, Mason, AJ, Hofmann, EP, Hogan, MP, Ellsworth, S, Nystrom, G, Margres, MM, Colston, TJ, Borja, M., Grünwald, C., Jones, J., Castañeda, G. Frietas-de-Sousa, .L, Moura-da-Silva, A, Azevedo, I, Grazziotin, FG, Gibbs, HL, Rokyta, DR, Parkinson, CL. 2021. Phylogenetic diet diversity predicts venom complexity in North American Pitvipers. *Proceedings of the National Academy of Science of the USA* 118, e2015579118.
- [27] Byer, NB, **Holding, ML**, Crowell, M., Pierson, TW, Dilts, TE, Shoemaker, KT, Matocq, MD. 2021. Adaptive divergence despite low effective population size in a peripherally isolated population of the pygmy rabbit (*Brachylagus idahoensis*. *Molecular Ecology* 30:4173–4188.
- [26] Robinson, KR, **Holding, ML**, Saviola, A, Whitford, MA, Clark, RC. 2021. Phenotypic and functional variation in venom and venom resistance of two sympatric rattlesnakes and their prey. *Journal of Evolutionary Biology* 34:1447–1465.
- [25] Claunch, NC, **Holding, ML**, Frazier, JA, **Huff, EM, **Schonour, RB, Vernasco, B, Moore, IT, Rokyta, DR, Taylor, EN 2021. Experimental manipulation of corticosterone does not affect venom composition or functional activity in free-ranging rattlesnakes. *Physiological and Biochemical Zoology*.
- [24] **†Schonour, RB, **†Huff, EM, **Holding, ML**, Claunch, NM, Ellsworth, SA, Hogan, MP, Wray, K, McGivern, J, Margres, MJ, Colston, TJ, Rokyta, DR. 2020. Gradual

and discrete ontogenetic shifts in rattlesnake venom composition and assessment of hormonal and ecological correlates. *Toxins* 12: 659.

- [23] **Holding, ML**, Sovic, MG, Colston, TC, Gibbs, HL. 2020. The scales of coevolution: comparative phylogeography and genetic demography of a locally adapted venomous predator and its prey. *Biological Journal of the Linnean Society*. doi.org/10.1093/biolinnean/blaa192
- [22] [†]**Holding, ML**, [†]Putman, BJ, ^{**}Kong, LM, Smith, JE, Clark, RW. 2020. Physiological stress integrates resistance to rattlesnake venom and the onset of risky foraging in California ground squirrels. *Toxins* 12: 617. doi.org/10.3390/toxins12100617
- [21] Gibbs, HL, Sanz, L, Pérez, A, Ochoa, A, Hassinger, ATB, **Holding, ML**, Calvete, JJ. 2020. The molecular basis of venom resistance in a rattlesnake-squirrel predator-prey system. *Molecular Ecology* 29: 2871-2888.
- [20] Freitas-de-Sousa, LA, Nachtigall, P, Portes-Jenior, JA, **Holding, ML**, Nystrom, GS, Ellsworth, SA, Guimarães, NC, Tioyama, E, Ortiz, F, Silva BR, Kunz, TS, Junqueira-de-Azevedo, ILM, Grazzitin, FG, Rokyta, DR, Moura-da-Silva, AM. 2020. Size matters: an evaluation of the molecular basis of ontogenetic modifications in the composition of *Bothrops jararacussu* snake venom. *Toxins* 12: 791
- [19] Rautsaw, RM, Hofmann, EP, Margres, MM, **Holding, ML**, Strickland, JL, Mason, AJ, Rokyta, DR, Parkinson, CL. 2019. Intraspecific sequence and gene expression variation contribute little to venom diversity in Sidewinder Rattlesnakes. *Proceedings of the Royal Society B: Biological Sciences* 286: 20190810.
- [18] Goetz SM, Piccolomini S, Hoffman M, Bogan J, **Holding ML**, Mendonca MT, Steen DA. 2019. Serum-based inhibition of pitviper venom by Eastern Indigo Snakes (*Drymarchon couperi*). *Biology Open*. doi: 10.1242/bio.040964
- [17] **Holding ML**, Margres MM, Mason AJ, Parkinson CL, Rokyta DR. 2018. Evaluating the performance of de novo assembly methods for venom-gland transcriptomes. *Toxins* 10: 10060249
- [16] Hofmann EP, Rautsaw RM, Stickland JL, **Holding ML**, Hogan MP, Mason AJ, Rokyta DR, Parkinson CL. 2018. Comparative venom-gland transcriptomics and venom proteomics of four Sidewinder Rattlesnake (*Crotalus cerastes*) lineages reveal little differential expression despite individual variation. *Scientific Reports* 8: 15534.
- [15] **Holding ML**, Margres MM, Rokyta DR, Gibbs HL. 2018. Local prey community composition and genetic distance predict venom divergence among populations of the northern Pacific rattlesnake (*Crotalus oreganus*). *Journal of Evolutionary Biology* 31: 1513–1528.
- [14] McCluskey EM, Matthew SN, Ligocki IY, **Holding ML**, Lipps GL Jr, Hetherington TE. 2018. The importance of historical land use in the maintenance of early successional habitat for a threatened rattlesnake. *Global Ecology and Conservation*. doi.org/10.1016/j.gecco.2017.e00370.

- [13] Claunch NC, **Holding ML**, Escallon C, Vernasco B, Moore IT, Taylor EN. 2017. Good vibrations: Assessing the stability of snake venom composition after researcher-induced disturbance in the laboratory. *Toxicon* 133: 127-135.
- [12] **Hudson P, Denton RD, **Holding ML**, Gibbs HL. 2017. Repeatability of locomotor endurance in the Smallmouth Salamander (*Ambystoma texanum*). *Herpetological Review* 47: 583-586.
- [11] [†]**Holding ML**, [†]Drabeck DH, Jansa SA, and Gibbs HL. 2016. Venom resistance as a model for understanding the molecular basis of coevolutionary adaptations. Invited review for *Integrative and Comparative Biology* 56: 1032-1043.
- [10] **Holding ML**, Biardi JE, Gibbs HL. 2016. Coevolution of venom function and prey resistance in a rattlesnake predator and its squirrel prey. *Proceedings of the Royal Society B: Biological Sciences* 283:28-41.
- [9] **Saccucci M, Denton RD, **Holding ML**, Gibbs HL. 2016. Polyploid unisexual salamanders have higher tissue regeneration rates than diploid sexual relatives. *Journal of Zoology* 300: 77-81.
- [8] **[†]Pomento AM, **[†]Perry BW, Denton RD, Gibbs HL, **Holding ML**. 2016. No safety in the trees: Local and species-level adaptation of an arboreal squirrel to the venom of sympatric rattlesnakes. *Toxicon* 118:149-155
- [7] **Holding ML**, **Kern EH, Denton RD, Gibbs HL. 2016. Fixed prey cue preferences among Dusky Pigmy Rattlesnakes (*Sistrurus miliarius barbouri*) raised on different long-term diets. *Evolutionary Ecology* 30:1-7.
- [6] [†]**Holding ML**, [†]Denton RD, Kulesza A, Ridgway JS. 2014. Confronting scientific misconceptions by fostering a classroom of scientists in the introductory biology lab. *The American Biology Teacher* 76: 218-523.
- [5] **Holding ML**, Owen DAS, Taylor EN. 2014. Evaluating the thermal effects of translocation in a large-bodied pitviper. *Journal of Experimental Zoology A* 321, 442-449.
- [4] Owen DAS, Carter E, **Holding ML**, Islam K, Moore IT. 2014. Roads are associated with a blunted stress response in a North American pit viper. *General and Comparative Endocrinology* 202:87-92.
- [3] **Holding ML**, Frazier JA, Pollock N, **Dorr SW, et al. 2014. Wet- and dry-season steroid hormone profiles and stress reactivity of an insular dwarf snake, the Hog Island Boa (*Boa constrictor imperator*). *Physiological and Biochemical Zoology* 87:363-373
- [2] **Holding ML**, Frazier JA, **Dorr SW, Henningsen SN, Moore IT, and Taylor EN. 2014. The physiological and behavioral effects of repeated handling and short-distance translocation on free-ranging Northern Pacific rattlesnakes (*Crotalus o. oreganus*). *Journal of Herpetology* 48: 233-239.

- [1] **Holding ML**, Frazier JA, Taylor EN, Strand CR .2012. Experimentally-altered navigational demands induce changes in the cortical forebrain of free-ranging Northern Pacific Rattlesnakes (*Crotalus o. oreganus*). *Brain, Behavior, and Evolution* 79:144-154.

PRESENTATIONS

Invited Oral Presentations

Holding, ML. Genomic footprints and environmental context of biochemical warfare between rodents, plants, and rattlesnakes – *2026 Hitchcock Center for Chemical Ecology Symposium, University of Nevada Reno – Lake Tahoe Campus.*

Holding, ML. Characterizing coevolution and toxin-target interactions – *2026 Gordon Conference on Venom Evolution, Function, and Biomedical Applications, Barcelona, Spain.*

Holding, ML. Genomic and environmental context of rodent resistance to two chemical challenges: toxic diets and toxic predators– *2026 Seminar Series, Eastern Michigan University, Dept. of Biology*

Holding, ML. Molecular warfare between rodents and rattlesnakes – *2025 Fall Seminar Series, Biology Department, Ball State University, Muncie, IN, USA*

Holding, ML. Characterizing molecular warfare between pitvipers and rodents – *2025 Biology of the Pitvipers 5 Conference, Rodeo, NM, USA*

Holding, ML. Toxic relationships: The genomic and phenotypic outcomes of molecular warfare between predators and prey – *2024 Fall Seminar Series, Dept. of Biology, University of Virginia*

Holding, ML. Hunting for the molecular basis of predator-prey coevolution between snakes and rodents – *2024 Gordon Research Conference: Venom Evolution and Biomedical Applications, Portland, ME, USA*

Holding, ML. Investigating functional evolution of serine protease inhibitors by comparative genomics and ancestral sequence resurrection – *2024 Spring Colloquium, University of Michigan, Life Sciences Institute*

Holding, ML. Evolution of snake venom and mammalian venom resistance through the lens of undergraduate-led research efforts – *2024 Spring Seminar Series, Department of Biological Science, California Polytechnic State University*

Holding, ML. Phylogenetic diversity is a shared driver of complexity in toxin-mediated species' interactions – *2022 Fall Seminar Series, Department of Ecology, Evolution, and Behavior, University of Minnesota*

Holding, ML. Evolution of complexity in two molecular weapons systems: Viper venoms and rodent phytochemical detox genes– *2021 Departmental Seminar, Utah State University, Department of Biology*

Holding, ML. Snake venoms and rodent chemical detox genes give shared insights on the evolution of molecular trait complexity – *2021 Departmental Seminar, University of Michigan, Department of Ecology and Evolutionary Biology*

Holding, ML. Snake venoms and rodent phytochemical detox genes share adaptive drivers of complexity – *2021 Departmental Seminar, California Polytechnic State University, Department of Biological Science*

Holding, ML. Evolving Complex Traits in Darwin’s Tangled Riverbank – *2021 Departmental Seminar, University of Nevada Reno, Department of Evolution, Ecology, and Comparative Biology*

Holding, ML. Viper venoms and rodent phytochemical detox genes give shared insights on the evolution of molecular trait complexity – *2021 Departmental Seminar, Ohio State University, Department of Evolution, Ecology, and Organismal Biology*

Holding, ML. Phylogenetic diet diversity predicts venom complexity in North American pitvipers – *2020 Virtual Presentation Series, Instituto Butantan, Brazil.*

Holding, ML. Adaptive Variation in Viper Venom and the Venom Delivery System Spanning the Scales of Biodiversity – *2019 Departmental Seminar, Florida State University, Department of Biological Sciences*

Holding, ML. Drivers of diversity in pitviper venoms – *2018 MVZ Lunch – University California Berkeley, Museum of Vertebrate Zoology*

Holding, ML. Drivers of diversity in pitviper venoms – *2018 Departmental Seminar Series – University of North Carolina Charlotte, Biology Department – Charlotte, NC*

Holding, ML, Sovic, MG, Gibbs, HL. Demographic factors predict local adaptation in populations of a venomous snake and its venom resistant prey – *2017 Venom Biology, Biochemistry, and Evolution Symposium – Instituto Butantan – Sao Paulo, Brazil*

Holding, ML. Coevolution of snakes and their venom resistant prey – *2017 Departmental Seminar Series – Ohio Wesleyan University – Delaware, OH.*

Holding, ML, Biardi, JE, Gibbs, HL. Coevolution of venom function and prey resistance in a rattlesnake and a squirrel: Is it an arms-race? – *2016 Meeting of the Society for Integrative and Comparative Biology – Portland, OR*

Holding, ML, Biardi, JE, Gibbs, HL. Adaptive variation in a complex chemical phenotype: Northern Pacific rattlesnake local adaptation to venom resistance in ground squirrels. Symposium entitled

“Transforming Chemical Ecology” – 2015 Joint Meeting of Ichthyologists and Herpetologists – Reno, NV, USA

Holding, ML. Northern Pacific Rattlesnakes at the Cutting Edge of Biology Research – *2014 Meeting of the Northern California Herpetological Society – Sacramento, CA*

Holding, ML and Denton, RD. Tackling Scientific Misconceptions by Fostering a Classroom of Scientists – *2013 OSU Center for Life Sciences Education’s Seminar Series – Columbus, OH*

Select Contributed Presentations at Professional Meetings

Holding ML, Haynes, LM, Pajares-Herrera, D., DiGiovanni, H, Pajares-Herrera, D., Ginsburg, D. – Functional evolution of PAI-1 across species and time – *2024 Gordon Conference on Plasminogen Activation and Extracellular Proteolysis – Ventura, CA.*

Holding ML, Coconis A, Matocq MD, Dearing MD. Environmental constraints on mammalian venom resistance – *2024 Society for the Studies of Amphibians and Reptiles Meeting –MI, USA.*

Holding ML, Pontius, H, Haynes, LM, Ginsburg, D, Shavit, J. – Fluorescent fish shed light on the adaptive evolution of snake venom coagulotoxicity - Oral Presentation – *2023 Evolution – Albuquerque, NM*

Holding ML, Pontius, H, Haynes, LM, Ginsburg, D, Shavit, J. – Fluorescent fish shed light on the adaptive evolution of snake venom coagulotoxicity - Oral Presentation – *2023 Joint Meeting of Ichthyologists and Herpetologists – Norfolk, Virginia*

Holding ML, Hogan, M, Rokyta, DR. – Adaptive role of gene duplication in the evolution of snake venom serine proteases. Oral Presentation – *2022 Joint Meeting of Ichthyologists and Herpetologists – Spokane, WA*

Holding ML, Coconis A, Adkins C, Galla S, Byer N, Striluk M, Connor E, Himer A, Jahner J, Greenhalgh R, Dearing D, Shapiro M, Forbey J, Simison B, Henderson M, Matocq M. Evolution of gene islands in the cytochrome p450 detox genes of rodents in relation to dietary diversity – *2021 American Society of Mammalogists Meeting, Virtual Conference*

Holding ML, Strickland, JL, Rautsaw, RM, Mason, AJ, Hofmann, EP, Hogan, MP, Ellsworth, S, Nystrom, G, Margres, MM, Colston, TJ, Borja, M., Grünwald, C., Jones, J., Castañeda, G. Frietas-de-Sousa, .L, Moura-da-Silva, A, Azevedo, I, Grazziotin, FG, Gibbs, HL, Rokyta, DR, Parkinson, CL. Comparative analysis of venom complexity and diet diversity in rattlesnakes using a novel, genome-wide phylogeny – *2020 Society of Integrative and Comparative Biology Meeting, TX, USA*

Holding ML, Trevine, VC, Zinenko, O, Strickland, JL, Rautsaw, RM, Mason, AJ, Hofmann, EP, Hogan, MP, Parkinson, CL, Grazziotin, FG, Santana, SE, Davis, ME, Rokyta, DR. The beak of the snake: fang length evolution is predicted by diet. – *2020 Society of Integrative and Comparative Biology Meeting – Austin, TX.*

Holding ML, Strickland, JL, Rautsaw, RM, Mason, AJ, Hofmann, EP, Hogan, MP, Ellsworth, S, Nystrom, G, Margres, MM, Colston, TJ, Borja, M., Grünwald, C., Jones, J., Castañeda, G. Frietas-de-Sousa, .L, Moura-da-Silva, A, Azevedo, I, Grazziotin, FG, Gibbs, HL, Rokyta, DR, Parkinson, CL. Diet and venom complexity it rattlesnakes. – *2019 Biology of Pitvipers 3 – Rodeo, NM*

Holding ML, Trevine, VC, Zinenko, O, Strickland, JL, Rautsaw, RM, Mason, AJ, Hofmann, EP, Hogan, MP, Parkinson, CL, Grazziotin, FG, Santana, SE, Davis, ME, Rokyta, DR. Evolutionary matching of fang length to diet in vipers. – *2019 Biology of Pitvipers 3 – Rodeo, NM*

Holding ML, Strickland, JL, Rautsaw, RM, Mason, AJ, Hofmann, EP, Hogan, MP, Ellsworth, S, Nystrom, G, Margres, MM, Colston, TJ, Borja, M., Grünwald, C., Jones, J., Castañeda, G. Frietas-de-Sousa, .L, Moura-da-Silva, A, Azevedo, I, Grazziotin, FG, Gibbs, HL, Rokyta, DR, Parkinson, CL. Assessing the relationship between diet and venom complexity it rattlesnakes using a novel, genome-wide phylogeny. – *2019 Joint Meeting of Ichthyologists and Herpetologists – UT, USA*

Holding ML, Trevine, VC, Zinenko, O, Strickland, JL, Rautsaw, RM, Mason, AJ, Hofmann, EP, Hogan, MP, Parkinson, CL, Grazziotin, FG, Santana, SE, Davis, ME, Rokyta, DR. Evolutionary matching of fang length to diet in vipers. – *2019 Joint Meeting of Ichthyologists and Herpetologists – Snowbird, UT, USA*

Parkinson, C.L, **Holding, ML** J.L. Strickland, R.M. Rautsaw, A.J. Mason, E.P. Hofmann, M. Borja, C.I. Grünwald, J.M. Jones, G. Castañeda, and D. Rokyta. El árbol de la vida de las serpientes de cascabel: una perspectiva de genoma amplio – 2nd Congreso Nacional de Viperidos Mexicanos y Ofidismo – Aguascalientes, Mexico.

Holding, ML, Margres, MM, Rokyta, DR, and Gibbs, HL. Local prey community composition and genetic distance predict venom divergence among populations of the northern Pacific rattlesnake (*Crotalus oreganus*) – *2018 Joint Meeting of Ichthyologists and Herpetologists – Rochester, NY*

Holding, ML, Sovic, MG, Gibbs, HL. Demographic differences predict patterns of local adaptation in a venomous snake and its resistant prey – *2017 Evolution Meeting – Portland, OR*

Holding, ML, Gibbs, HL. Migration, drift, and the outcomes of coevolution between a rattlesnake and its squirrel prey – *2016 Joint Meeting of Ichthyologists and Herpetologists – New Orleans, LA*

Holding, ML, Biardi, JE, Gibbs, HL. Coevolution of venom function and prey resistance in a rattlesnake predator and its squirrel prey – *2016 Evolution Meeting – Austin, TX*

****Pomento, AM, **Perry, BW, Denton, RD, Gibbs, HL, Holding, ML.** No safety in the trees: Local and species-level adaptation of gray squirrels to the venom of sympatric rattlesnakes – *2016 Evolution Meeting – Austin, TX – Poster*

Holding, ML, Gibbs, HL, Biardi, JE. Testing for local adaptation of pitviper venoms to resistant prey: Interactions between Northern Pacific Rattlesnakes and California Ground Squirrels – *2014 Biology of the Pitvipers Conference – Tulsa, OK*

Denton, RD, **Holding, ML**, Ridgway, JS, Mollohan, K, Kulesza, A. Improving students' perceptions of the scientific method by showing them 'How Real Science Works' – *2013 National Association of Biology Teachers Meeting – Atlanta, GA*

Holding, ML. Snakes living the island life: Sex steroid concentrations and stress reactivity of the Hog Island Boa (*Boa constrictor*) – *2012 World Congress of Herpetology, Vancouver, CA*

Holding, ML. Altered navigational demands induce changes in the cortical brain region of free-ranging Northern Pacific Rattlesnakes (*Crotalus o. oreganus*) – *2011 Joint Meeting of Ichthyologists and Herpetologists – Minneapolis, MN*

Holding, ML. The physiological ramifications of short-distance translocation in reptiles: a case study using the Northern Pacific Rattlesnake (*Crotalus o. oreganus*) – *2011 Joint Meeting of Ichthyologists and Herpetologists – Minneapolis, MN*

Holding, ML, **KM Buskirk,, EN Taylor, and CR Strand. Experimentally altered navigational demands affect neuroplasticity in the rattlesnake brain – *2011 International Symposium on Amphibian and Reptilian Endocrinology and Neurobiology, Ann Arbor, MI*

Holding, ML. The physiological effects of short-distance translocation on Northern Pacific rattlesnakes – *2011 Biology of the Rattlesnakes Symposium – Tucson, AZ*

TEACHING EXPERIENCE

Instructor of Record

EEOB 3194: Evolution and Ecology of Amphibians and Reptiles, Ohio State	Su 2015
Field Herpetology, American Museum of Nat. History's Southwest Res. Station	2011 – 2013, 2016 – 2024

Guest Lectures

Cal State Long Beach – Ecology – “Field Study of Predator-prey Interactions”	Fa 2024
Texas AM Kingsville – Venom Biochemistry – “Proteomic of rodent venom resistance”	Fa 2024
Univ. Nevada Reno – Bioinformatics – “Transcriptomic Data Analysis”	Fa 2022
Univ. Minn. Morris – Bioinformatics – “Reduced-representation sequencing”	Sp 2019

Graduate Teaching Assistant

EEOB 4220: Evolution and Ecology of Mammals, Ohio State	Sp 2015, Sp 2016
EEOB 3320: Organismal Diversity, Ohio State	Fa 2015
EEOB 3310: Evolution, Ohio State	Fa 2014
EEOB 2510: Introductory Anatomy, Ohio State	Fa 2012, Su 2012
EEOB 3410: Ecology, Ohio State	Sp 2012
BIOL 1113: Energy Transfer & Development, Ohio State	Fa 2011
ZOO 341: Herpetology, Cal Poly	Sp 2011
BIO 162: Introduction to Organismal Form and Function, Cal Poly	Fa 2010, Sp 2010
BIO 160: Diversity and History of Life, Cal Poly	Fa 2009

SERVICE AND MENTORSHIP

Leadership Positions

Elected co-Chair – Gordon Conference <i>Gordon Conference on Venom Evolution, Function, and Biomedical Applications</i>	2028, 2030
Elected Member – ASIH Board of Governors, <i>The American Society of Ichthyologists and Herpetologists Board of Governors votes changes to society function to improve the Society</i>	2022- Pres.
Member – ASIH Diversity, Equity, and Inclusion, and Belonging Committee <i>The American Society of Ichthyologists and Herpetologists DEIB Committee acts to promote belonging and a culture of inclusivity in the Society</i>	2022- 2025
LSI Trainees Committee Member – University of Michigan <i>Organize career development, networking, and social events for the Graduate students and postdoctoral trainees at the Life Science Institute.</i>	2021- 2024
Social Media Manager and Member – Florida State Postdoctoral Association <i>Contribute at association meetings and promote postdoc achievements</i>	2019 – 2020
Co-founder and Graduate Student Advisor – OSU Evolution and Ecology Club <i>Advised undergraduate officers on how to run a university organization, organized field trips and workshops each year</i>	2013 – 2016
Elected Student Representative – EEOB Dept. Chair's Advisory Committee <i>Represented graduate students at bi-weekly meetings discussing topics of importance to my department</i>	2014 – 2015
Elected Departmental Delegate – Ohio State Council of Graduate Students.	2012 – 2013

Represented EEOB graduate students at monthly meetings discussing issues relevant to graduate students at Ohio State University

President – Ball State University Student Chapter of The Wildlife Society 2008 – 2009
Lead bi-weekly meetings, organized workshops and community service events, and facilitated visits from guest speakers

Other Department and University Service

Mentor – U. Michigan Undergrad Research Opportunity Program (UROP) 2021-Pres.
UROP Mentor for 4 undergraduate student researchers

Mentor – U. Michigan Perrigo Fellows Research Program 2023, 2025
Summer research mentor for 2 Perrigo undergraduate researchers

Mentor – U. Michigan Aspinaut Program 2022, 2023, 2024
Research mentor for 5 Aspinaut program high school senior researchers

Judge – Michigan Undergraduate Research Symposium 2022, 2024
Scored and provided feedback on student research posters

Mentor – Florida State Undergrad Research Opportunity Program (UROP) 2018-2020
UROP Mentor for 7 undergraduate student researchers

Student Representative – OSU College of Arts & Sciences Curriculum Committee 2016
Present student views on curriculum issues at monthly meetings

Judge – Ohio State Fall Undergraduate Research Week's Student Poster Forum 2014
Scored and provided feedback on student research posters

Judge – Ohio State Graduate Associate Teaching Award Committee, 2013
Evaluated and scored applications for this award

Elected Student Representative – EEOB Department Seminar Committee. 2012 – 2013
Scheduled graduate student interactions with invited speakers for the weekly EEOB departmental seminar series and facilitated speaker's visit

Symposium Organizer – Ohio State Dept. of EEOB's Darwin Award Presentations 2012
Organized sessions of short talks given by EEOB graduate students

Other Society and Professional Service

Undergraduate Mentor – Evolution Meetings 2026
Mentor in Society for the Study of Evolution Cleveland Conference for undergraduate student attendees

- Award Nominating Committee Member – ASIH Stoye Award** 2026
Judged for best student presentation of American Society of Ichthyologist and Herpetologists Stoye Award in Genetics, Development, and Morphology
- Workshop Organizer – NSF EPSCOR Workshop on Genome Annotation** 2020, 2021
Developed and led a full day Zoom workshop on genome annotation combining command-line basics, analysis, and manual curation of gene annotations.
- Judge – DCPB Wake Award for Best Student Presentations** 2020
Judged student presentation competitions at the 2020 Society of Integrative and Comparative Biology Meeting in Austin, TX.
- Judge – ASIH Stoye Award** 2018, 2019, 2022, 2023
Judged for best student presentation of American Society of Ichthyologist and Herpetologists Stoye Award in Genetics, Development, and Morphology
- Student Mentor – Joint Meeting of Ichthyologists and Herpetologists** 2018, 2019
Mentor in Society for the Study of Amphibians and Reptiles New Member Mentorship Program for undergraduate students
- Graduate Student Committee Member – The Herpetologists' League.** 2014 – 2016
Represent graduate students at annual business meeting of the society, coordinate society fundraisers that provide funds for student travel
- Workshop Organizer – Joint Meeting of Ichthyologists and Herpetologists** 2015
Organized a workshop and expert panel discussion on field work basics and public engagement during research for the graduate students
- Grant Reviewer – E. E. Williams Graduate Student Research Grant.** 2014
Served on the review committee in charge of deciding the grant recipients

Peer Reviewer for the Following Journals

Current Biology • Proceedings of the National Academy of Sciences USA • Molecular Biology and Evolution • Evolution Letters • Journal of Molecular Evolution • Ecology Letters • Systematic Biology • Proceedings B • Molecular Ecology • Genome Biology and Evolution • BMC Evolutionary Biology • PLoS One • Journal of Proteomics • Toxicon • Toxins • Journal of Herpetology • Conservation Physiology • Experimental Biology and Medicine • American Biology Teacher

OUTREACH AND PUBLIC ENGAGEMENT

Public Presentation , Public talk at Oak and Otter Brewing Company, 87 attendees <i>"The Best Offense is a Good Defense: the Dual Roles of Color and Venom in Snake Evolution"</i> San Luis Obispo, California. Invited oral presentation	2024
Public Presentation , Public talk for the Channel Islands Conservancy, 43 attendees <i>"The Chemical Weapons in Snake/Mammal Warfare"</i> Ventura, California. Invited oral presentation.	2023
Classroom Career Day Visit , Radio Park Elementary, State College, PA. <i>Held a virtual Zoom visit to Mrs. Pantall's 4th grade class's career day to talk with her students about how to become a scientist, and what herpetologist.</i>	2021
Museum Display Contribution , Tallahassee Museum of Natural History. <i>Contributed large display of Florida's viperid snake diversity including 3D printed snake fangs and panel on importance of biodiversity museum collections</i>	2020
Social Media Manager , NSF Dimensions of Biodiversity Scales Project group. <i>Posted weekly content through the @scalesproject Twitter account that showcases Project research findings in publicly-accessible format</i>	2018 – 2019
Content Presenter , Ohio State Museum of Biological Diversity's Open House <i>Designed and presented interactive displays showcasing scientific research and live animal handling, servicing over 2,000 people per event</i>	2012 – 2016
Program Organizer , Univ. of California Santa Barbara's Sedgwick Reserve <i>Led a six hour "Walking Ecology" program for the staff and docents, which highlighted current research on rattlesnakes via a guided nature walk</i>	2014
Public Presentation , June Meeting of the Santa Ynez Natural History Society <i>"Rattlesnake Research in California: Unlocking the Secrets of a Symbol of the American West"</i> Los Olivos, California. Invited oral presentation	2013
Event Organizer , K-12 University Field Trips <i>Planned and oversaw a reptile and amphibian research exhibit during multiple K-12 school field trips to the Cal Poly Biological Sciences Department</i>	2011
Presenter , San Luis Obispo, CA, Cub Scouts <i>Talk on how and why we do research to conserve snakes for Cub Scout group</i>	2010

WORKSHOPS AND TRAINING

Biomedical Data Sciences Summer Academy –University of Michigan	2025
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- Michigan Institute for Data and AI in Society 1 week workshop on key concepts of machine learning, artificial intelligence and implementation for biological data*
- Symposium on Inclusion in Research and Teaching** – Florida State 2018
Two-day series of lectures, round-table discussions, and break-out working groups on issues of diversity, inclusion, equity in academic workplace
- Open Doors, Diversity and Implicit Bias Training** – Ohio State Office of Student Life 2016
Training on the challenges and solutions to implicit bias in the university, empathetic listening, helping people in distress. Became an “Open Doors Partner”
- Mobile Summer Institute on Undergraduate STEM Education** – Ohio State 2016
Received training on planning courses that facilitate student learning via backward design and student-centered active learning.
- Invited Participant in “Catalysis Meeting”** – National Evolutionary Synthesis Center 2014
Participated in a 3 day meeting in Raleigh, NC, that brought 25 venom biologists from 7 countries together to solve current challenges venom biology
Title: “Integrating Organismal and Applied Perspective on Animal Venom Diversity”
- Professional Development Conference** – National Association of Biology Teachers 2013
Attended presentations and workshops devoted to novel, research-based methods for teaching biology topics.

PROFESSIONAL SOCIETIES

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| Society for Molecular Biology and Evolution | 2022 – Present |
| American Society of Naturalists | 2014 – Present |
| Society for the Study of Evolution | 2012 – Present |
| American Society of Ichthyologists and Herpetologists | 2009 – Present |