

PHILLIP DAVID GRAYSON

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PROFESSIONAL EXPERIENCE

University of Manitoba	Postdoctoral Fellow	2019-Present
University of Manitoba	Sessional Instructor	Fall 2019

EDUCATION

Harvard University	Ph.D. Organismic and Evolutionary Biology	2019
University of Winnipeg	M.Sc. Bioscience, Technology and Public Policy	2013
University of Winnipeg	B.Sc.H. Biology (Gold Medal), B.Sc. Biochemistry	2011

RESEARCH FUNDING

Margaret F Docker, Colin J Garroway, Jason R Treberg, **Phil Grayson**, Nicholas S Johnson
Awarded 2020 (\$26,100)

“Body size, body condition, and reproductive potential in sea lamprey: nature or nurture?”
Great Lakes Fishery Commission, Sea Lamprey Research Program (Pilot Project)

Colin J Garroway, **Phil Grayson**

Awarded 2020 (33 CPU Years and 33.5 TB Storage on GREX Supercomputer)

“Genomics and population genetics of sea lamprey (*Petromyzon marinus*), urban grey squirrels (*Sciurus carolinensis*), beluga (*Delphinapterus leucas*), and bowhead (*Balaena mysticetus*)”
University of Manitoba Advanced Research Computing, Resource Allocation Competition

Margaret F Docker*, **Phil Grayson*** (* indicates co-lead investigators)

Awarded 2020 (Full cost of *de novo* whole genome sequencing for both species)

“Whole genome sequencing of the “paired” northern brook and silver lampreys, *Ichthyomyzon fossor* and *I. unicuspis*”

Canada’s Genomics Enterprise, Canada 150 Sequencing Program (CanSeq150)

SCHOLARSHIPS AND FELLOWSHIPS

Harvard University Graduate Fellowship	2013-2019
Natural Sciences and Engineering Research Council of Canada (NSERC)	2013-2016
Postgraduate Scholarship: PGS D	
NSERC Alexander Graham Bell Canada Graduate Scholarship: CGS D (Declined)	2013-2016
NSERC Alexander Graham Bell Canada Graduate Scholarship: CGS M	2012-2013
Manitoba Graduate Scholarship (Declined)	2012-2013
University of Winnipeg Graduate Scholarship	2011-2012

AWARDS AND HONOURS

Best Student Talk in the Division of Evolutionary Developmental Biology, The Society for Integrative and Comparative Biology	2019
Robert G. Goelet Summer Research Award, Harvard Museum of Comparative Zoology	2017
Competitive Youth Travel Award, Avian Model Systems 9: A New Integrative Platform	2016

Rosemary Grant Award, Society for the Study of Evolution 2015
Best Paper Presentation, University of Winnipeg Graduate Students Research Colloquium 2012
Student Conference Travel Grant, University of Winnipeg Student Association 2012

RESEARCH EXPERIENCE

University of Manitoba, Department of Biological Sciences 2019-Present
Supervisor: Drs. Margaret Docker, Colin Garroway, Alison Wright Winnipeg, MB, Canada
Postdoctoral Research: Genetic Basis of Sex Determination in Sea Lamprey

- Mentoring MSc and PhD students.
- Bioinformatics analyses of large-scale population genomic data.
- Long read sequencing using Oxford Nanopore and genome assembly for population genomics.
- Population genomics techniques including Genome Wide Associate Study (GWAS) to identify sex-linked regions in the parasitic sea lamprey genome.
- Experience with Compute Canada SLURM supercomputers.

Harvard University, Department of Organismic and Evolutionary Biology 2013-2019
Supervisor: Dr. Scott Edwards Cambridge, MA, USA
Doctoral Dissertation: The Comparative and Developmental Genomics of Flightlessness in Birds (Palaeognathae)

- Developmental biology of emu (*D. novaehollandiae*), chicken (*G. gallus*), duck (*A. platyrhynchos*), zebra finch (*T. guttata*), ostrich (*S. camelus*), Chilean tinamou (*N. perdicaria*) and greater rhea (*R. americana*) in the laboratory of Dr. Cliff Tabin.
- Experience with comparative avian embryology, *in situ* hybridization, enhancer screens, microscopy, and RNAi in the laboratory of Dr. Cliff Tabin.
- Whole genome library preparation and sequencing of 10 palaeognathous birds. Experience with Illumina Sequencing Platform, mate-pair and fragment DNA libraries, DNA extraction, Pippin Prep, Covaris, Aligent Bioanalyzer, qPCR, Qubit, Aligent Tape Station, Nanodrop, and Integen X Apollo 324.
- Coding experience in Python, Unix, Awk, Bash, Github, and R on local machines and SLURM supercomputers.
- Experience building in-house bioinformatics analysis pipelines.
- RNA-Seq library preparation and analysis with poly-A isolation from avian tissue.
- ATAC-Seq library preparation and analysis from avian embryonic tissue.
- Bioinformatic analysis of essential reproductive proteins (*Izumo* and *Juno*) and their protein families using MrBayes, RaxML, BLAST, Geneious, Mirror Tree, and PAML.

University of Winnipeg, Department of Biology 2011-2013
Supervisor: Dr. Alberto Civetta Winnipeg, MB, Canada
Master's Thesis: Testing selection during the evolution of mammalian male reproductive proteins

- Phylogenetic and molecular evolutionary analysis for sperm and testes expressed *Adam* genes across the *Mus* genus following primer development and PCR optimization. Isolating selective pressures and their potential association with relative testes weight.

- Examination of mutational prevalence in genomic regions surrounding positively selected reproductive genes.
- Bioinformatic analysis of *izumo* sperm-egg fusion gene family across mammalia and identification of bouts of positive selection not linked to sexual selection.

University of Winnipeg, Department of Biology 2009-2010
Research Supervisor: Dr. Scott Forbes Winnipeg, MB, Canada

Undergraduate Honours Thesis: Determinants of paternal care in red-winged blackbirds

- Theoretical work on the evolution of biparental care (the presence of a brood parasite pushes this highly polygynous species toward monogamy).
- Field work, including marsh and nest surveys, handling of red-winged blackbird (*Agelaius phoeniceus*) eggs and nestlings for data collection, and set-up of videography equipment for behavioural observations at nests.
- Dataset assembly through collation and analysis of 18 years of feeding and begging behaviours recorded on videotape (one of the longest running studies on any wild bird).

PUBLICATIONS

JOURNAL ARTICLES:

Alison Cloutier, Timothy B Sackton, **Phil Grayson**, Scott V Edwards, Allan J Baker. "First nuclear genome assembly of an extinct moa species, the little bush moa (*Anomalopteryx didiformis*)." Available at *bioRxiv*. doi.org/10.1101/262816

John J Young*, **Phil Grayson***, Scott V Edwards, Clifford J Tabin. "Attenuated Fgf signaling underlies the forelimb heterochrony in the emu *Dromaius novaehollandiae*." *Current Biology*, 29:1-11. 2019. doi.org/10.1016/j.cub.2019.09.014. ***Indicates co-first author**

Luohao Xu, Simon Yung Wa Sin, **Phil Grayson**, Daniel E Janes, Scott V Edwards, Timothy B Sackton. "Evolutionary dynamics of sex chromosomes of palaeognathous birds." *Genome Biology and Evolution*, 11(8):2376-2390. 2019. doi.org/10.1093/gbe/evz154

Sangeet Lamichhaney, Daren C Card, **Phil Grayson**, João FR Tonini, Gustavo A Bravo, Kathrin Näpflin, Flavia Termignoni-Garcia, Christopher Torres, Julia A Clarke, Frank Burbrink, Timothy B Sackton, Scott V Edwards, "Integrating natural history collections and comparative genomics to study the genetic architecture of convergent evolution." *Philosophical Transactions of the Royal Society B*, 374(1777). 2019. doi.org/10.1098/rstb.2018.0248

Alison Cloutier, Timothy B Sackton, **Phil Grayson**, Michele Clamp, Allan J Baker, Scott V Edwards. "Whole-genome analyses resolve the phylogeny of flightless birds (Palaeognathae) in the presence of an empirical anomaly zone." *Systematic Biology*, syz019. 2019. doi.org/10.1093/sysbio/syz019

Timothy B Sackton, **Phil Grayson**, Alison Cloutier, Zhirui Hu, Jun S Liu, Nicole E Wheeler, Paul P Gardner, Julia A Clarke, Allan J Baker, Michele Clamp, Scott V Edwards, "Convergent regulatory evolution and loss of flight in paleognathous birds." *Science*, 364(6435):74-78. 2019. doi.org/10.1126/science.aat7244

John J Young, **Phil Grayson**, Clifford J Tabin. "Developmental biology: *Hox* timing determines limb placement." *Current Biology*, 29(2):R52-R54. 2019. doi.org/10.1016/j.cub.2018.11.068

Phil Grayson, "Izumo1 and Juno: the evolutionary origins and coevolution of essential sperm-egg binding partners." *Royal Society Open Science*. 2: 150296. 2015. doi.org/10.1098/rsos.150296

Phil Grayson, Alberto Civetta, "Positive selection in the adhesion domain of Mus sperm Adam genes through gene duplications and function-driven gene complex formations." *BMC Evolutionary Biology*, 13(217):8 pages. 2013. doi.org/10.1186/1471-2148-13-217

Phil Grayson, Barb Glassey, Scott Forbes, "Does brood parasitism induce paternal care in a polygynous host?" *Ethology*, 119(6):489-495. 2013. doi.org/10.1111/eth.12086

Phil Grayson, Alberto Civetta, "Positive selection and the evolution of *izumo* genes in mammals." *International Journal of Evolutionary Biology*, 2012 (Article ID 958164):7 pages. 2012. doi.org/10.1155/2012/958164

BOOK CHAPTERS:

Alexandria Digiacomio, Alison Cloutier, **Phil Grayson**, Timothy B Sackton, Scott V Edwards. "Flightless birds and the unfinished synthesis of comparative genomics and phylogenetics." *In revision*.

Phil Grayson, Simon YW Sin, Timothy B Sackton, Scott V Edwards, "Comparative genomics as a foundation for evo-devo studies in birds," in *Methods in Molecular Biology: Avian and Reptilian Developmental Biology*. Editor: Guojun Shen. Humana Press. 2017. doi.org/10.1007/978-1-4939-7216-6_2

TEACHING EXPERIENCE

Evolutionary Biology 2019 (F)

Instructor, University of Manitoba

41 undergraduate students for primary lectures and discussion/activity-based laboratories

Genetics and Genomics 2018 (W)

Teaching Fellow, Harvard University

17 undergraduate and graduate students for discussion sections

Awarded Harvard University Certificate of Distinction in Teaching

Molecular Ecology and Evolution 2016 (F)

Teaching Fellow, Harvard University

6 undergraduate and graduate students for computational laboratories with lectures

Awarded Harvard University Certificate of Distinction in Teaching

Evolution, Ecology, and Biodiversity 2012 (W)

Laboratory Instructor, University of Winnipeg

41 undergraduate students for laboratories with pre-lab lectures

Cells and Cellular Processes

2011 (F)

Laboratory Instructor, University of Winnipeg

41 undergraduate students for laboratories with pre-lab lectures

GUEST LECTURES

Phil Grayson. 2020. Enhancer Discovery and Evolution. University of Manitoba. PhD Course.

INVITED SEMINARS

Phil Grayson. 2019. From flightless birds to jawless fish: Evolutionary analyses through comparative genomics and developmental biology. University of Winnipeg, Biology Seminar.

CONFERENCE PRESENTATIONS

Phil Grayson. 2019. Like a needle in a haystack: How to identify sex chromosomes through comparative genomics. *University of Manitoba 2020 Darwin Day Symposium*. Oral Presentation.

Phil Grayson, Alison Wright. 2019. Genetic basis of sex determination in sea lamprey. *International Lamprey Genomics Workshop*. Oral Presentation.

Phil Grayson, John J Young, Scott V Edwards, Clifford J Tabin. 2019. Regulatory evolution and wing reduction in the convergent loss of avian flight. *EMBO Workshop: Limb Development and Regeneration: New Tools for a Classic Model System*. Poster.

Phil Grayson, Scott V. Edwards. 2019. Regulatory evolution and forelimb heterochrony in the flightless birds. *Boston Area Bird Meeting*. Oral Presentation.

Phil Grayson, John J Young, Scott V Edwards, and Clifford J Tabin. 2019. Convergent regulatory evolution and forelimb heterochrony in flightless birds. *Society for Integrative and Comparative Biology*. Oral Presentation. **Best Student Talk in the Division of Evolutionary Developmental Biology.**

Phil Grayson, John J Young, Clifford J Tabin, and Scott V Edwards. 2018. Limb development in the large flightless birds and their volant relatives. *Society for Integrative and Comparative Biology Northeast Regional Meeting*. Oral Presentation.

Phil Grayson, John J Young, Scott V Edwards, and Clifford J Tabin. 2017. The developmental basis of forelimb reduction in the emu (*Dromaius novaehollandiae*). *Pan American Society for Evolutionary Developmental Biology*. Poster.

Timothy B Sackton, **Phil Grayson,** and Scott V Edwards. 2017. Convergent regulatory evolution and the origin of flightlessness in palaeognathous birds. *Boston Evolutionary Genomics Supergroup*. Chalk talk.

Phil Grayson, Timothy B Sackton, Alison Cloutier, John J Young, Michele Clamp, Clifford J Tabin, Scott V Edwards. 2017. Comparative genomics, epigenomics, and developmental biology uncover convergent acceleration in putative regulatory regions associated with repeated losses of avian flight. *Society for Integrative and Comparative Biology*. Oral Presentation.

Phil Grayson, Timothy B Sackton, Alison Cloutier, John J Young, Michele Clamp, Clifford J Tabin, Scott V Edwards. 2016. Comparative genomics and developmental biology suggest a strong role for gene regulation in the evolution of flightless birds. *Evolution*. Oral presentation.

Phil Grayson, Timothy B Sackton, Alison Cloutier, John J Young, Michele Clamp, Clifford J Tabin, Scott V Edwards. 2016. Insights into convergent losses of flight via comparative genomics and developmental biology. *Avian Model Systems 9: A New Integrative Platform*. Poster.

Phil Grayson. 2016. The developmental genomics of ratite flight loss. *Boston Area Bird Meeting*. Oral presentation.

Phil Grayson, Timothy B Sackton, Michele Clamp, Clifford J Tabin, Scott V Edwards. 2015. Genomic, developmental, and functional genetic analysis of convergent avian flight loss. *The Past, Present, and Future of DNA – Radcliffe Institute of Advanced Study*. Poster.

Phil Grayson, Timothy B Sackton, Michele Clamp, Clifford J Tabin, Scott V Edwards. 2015. Genomic, developmental, and functional genetic analysis of convergent avian flight loss. *Pan American Society for Evolutionary Developmental Biology*. Poster.

Phil Grayson. 2015. Examining flight loss in ratites through genomics and developmental biology. *Boston Area Bird Meeting*. Oral presentation.

Phil Grayson, Alberto Civetta. 2012. Differential bouts of selection during the evolution of *izumo* genes. *Evolution*. Poster.

Phil Grayson. 2012. Bouts of positive selection at *izumo* gene family members are driven by protein subfunctionalization. *The University of Winnipeg Fourth Annual Graduate Students Research Colloquium*. Oral presentation. **Best Paper Presentation**.

Phil Grayson. 2010. Daddy wasn't there: Determinants of paternal care in red-winged blackbirds. *Prairie University Biological Symposium*. Oral presentation.

WORKSHOP AND PROGRAM DEVELOPMENT

Phil Grayson. 2017-2018. Soaring to New Heights or Stuck on the Ground: The Evolution of Flightless Birds. *Harvard Summer School*. Invited to return to present my program for the Harvard Summer School classes of 2017 and 2018. Presented three times per summer.

Phil Grayson. 2016. Soaring to New Heights or Stuck on the Ground: The Evolution of Flightless Birds. *Harvard Summer School*. Developed a 90-minute program for high school students integrating up-to-date research from my dissertation with museum and collection tours alongside Q&A. Presented the program three times throughout the summer.

PUBLIC OUTREACH

Phil Grayson. 2020. Skype a Scientist. This program matches scientists with classrooms and families to facilitate a Q & A about their region of interest and life as a scientist to inspire the next generation of citizen scientists and researchers.

Evolution Researchers. 2017. Science AMA Series: We are evolution researchers at Harvard University, working on a broad range of topics, like the origin of life, viruses, social insects,

cancer, and cooperation. Today is Charles Darwin's birthday, and we're here to talk about evolution. AMA! www.reddit.com/r/science. Interactive Q&A on the Reddit Science website. Archived at doi.org/10.15200/winn.148690.07449.

Phil Grayson. 2015. Avian flight loss and island life. *Harvard Museum of Natural History*. Oral presentation.

Phil Grayson. 2014. Ancient DNA from ancient birds: A tale of two Palaeognathae papers. EvoBites website. https://evobites.com/2014/10/25/grayson_birdphylogeny/

RELATED PROFESSIONAL EXPERIENCE

Freshman Resident Academic Advisor: Harvard University, 2014-2017. Met with and advised students on academic and extracurricular opportunities. Guided students through any challenges that arose during their personal transitions to college life.

Freshman Proctor: Harvard University, 2014-2017. Lived in freshmen dormitory and worked alongside Resident Dean to ensure student safety and standards of community living. Managed three-member team of Peer Advising Fellows (upper-class advisors). Planned weekly social events throughout the year and engaged students in the dorm community.

PEER REVIEWS

I have reviewed for the following journals and granting agencies. If I have conducted more than one review for that agency or journal, the number is contained within parentheses.

PLOS Biology, Great Lakes Fisheries Commission (Sea Lamprey Research Program), PLOS One, Ethology, Mechanisms of Development (2), Scientific Reports, PeerJ.

REFERENCES

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