Zachary R. Lewis | Curriculum Vitae

Yale University, Ecology and Evolutionary Biology, New Haven, CT

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Academic positions

Postdoctoral Associate **2017 -**
Yale University, Advisor: Casey Dunn

Postdoctoral Associate **2016 - 2017**
Brown University, Advisors: Casey Dunn and Erika Edwards

Postdoctoral Associate **2016**
Harvard University, Advisor: James Hanken

Research Assistant II **2008 - 2009**
Oregon Health and Science University, Advisor: Alex Nechiporuk

Betty C. Liu Memorial Post-Baccalaureate Research Fellow **2007**
Reed College, Advisors: Robert Kaplan and Maryanne McClellan

Education

Harvard University **2009 - 2016**
PhD, Organismic and Evolutionary Biology
Advisor: James Hanken
Dissertation: “Causes and consequences of lung loss in salamanders.”

Reed College **2002 - 2006**
BA, Biology
Advisors: Robert Kaplan and Maryanne McClellan
Senior thesis: “Proliferation of primordial germ cells and sex differentiation in Threespine stickleback.”

Grants and fellowships

NSF Graduate Research Fellowship **2011 - 2015**
Title: “A developmental understanding of lung loss in salamanders.”

E.E. Williams Award, Society for the Study of Amphibians and Reptiles **2014**
For plethodontid transcriptome sequencing.

Barbour Award, Museum of Comparative Zoology **2014**
Support for plethodontid fieldwork and collection.

Robert G. Goelet Award, Museum of Comparative Zoology **2013**
For fieldwork and plethodontid embryo collection.

Sigma Xi Grant-in-Aid of Research **2013**
Support for next generation Sequencing.

Kenneth Miyata Award, Museum of Comparative Zoology **2012**
Support for fieldwork.

The William F. Milton Fund Award, Harvard Medical School **2011 - 2012**
To study the evolution and development of lung loss.

Betty C. Liu Memorial Biology Research Fellowship, Reed College **2007**
For the investigation of primordial germ cell proliferation in stickleback.

Reed College Summer Science Fellowship **2006**
To study endocrine disruption in stickleback.

Publications

Lewis ZR, Dunn CW. 2018. Genome evolution: we are not so special. eLife 2018;7:e38726

Lewis ZR, Dorantes JA, Hanken J. 2018. Expression of a novel surfactant protein gene is associated with sites of extrapulmonary respiration in a lungless salamander. *Accepted, Proceedings of the Royal Society B*. **Preprint:** https://doi.org/10.1101/261412

Lewis ZR, Hanken J. 2017. Convergent evolutionary reduction of atrial septation in lungless salamanders. Journal of Anatomy 230: 16-29. [Cover Article]

McCarroll MN, **Lewis ZR**, Culbertson MD, Martin BL, Kimelman D, Nechiporuk AV. 2012. Graded levels of Pax2a and Pax8 regulate cell differentiation during sensory placode formation. Development 139: 2740-2750.

Culbertson MD, **Lewis ZR**, Nechiporuk AV. 2011. Chondrogenic and gliogenic subpopulations of neural crest play distinct roles during the assembly of epibranchial ganglia. PLoS ONE 6(9): e24443.

Lewis ZR, McClellan MC, Postlethwait JH, Cresko WA, Kaplan RH. 2008. Female-specific increase in primordial germ cells marks sex differentiation in Threespine stickleback (*Gasterosteus aculeatus*). Journal of Morphology 269(8): 909-921. [Cover Article]

Work in preparation

Lewis ZR, Kerney R, Hanken J. Lung development in lungless salamanders. *In preparation*.

Lewis ZR, Mathewson B, Hanken J. Nesting notes on an indicator amphibian in central Massachusetts forests on the verge of losing a foundation overstory tree. *In preparation*.

Teaching experience

Sheridan Center for Teaching and Learning, Brown University, Teaching Certificate 1, Fall 2016. Pursued further training in learning design and inclusive pedagogy.

Foundations of Biodiversity (Organismic and Evolutionary Biology 10), Harvard University, Fall 2015. Graduate teaching fellow leading lab exercises, writing exams and grading assignments. I began each class with active review of lecture material using group exercises such as think-pair-share and review games such as Jeopardy. Labs focused on hypothesis generation and testing related to ecological and genetic concepts. I integrated the specific lab exercises with the concepts from lecture by encouraging students to consider how experiments similar to the ones that they performed are utilized to generate biological knowledge.

Herpetology (Organismic and Evolutionary Biology 167), Harvard University, Spring 2014. Graduate teaching fellow in charge of two laboratory sections. I incorporated specimen-based morphological and evolutionary inquiry, tapping into the vast resources of the Museum of Comparative Zoology herpetology collections. I created new laboratory exercises emphasizing higher order analytic and synthetic capabilities. I led group field exercises in Costa Rica and locally. I helped to implement several alternative approaches to final projects including generating species webpages on the En-

cyclopedia of Life, Wikipedia, creating outreach videos or pursuing independent research projects.

Genetics, Genomics, and Evolution (Life Sciences 1b), Harvard University, Spring 2013. Graduate teaching fellow for an introductory genetics course. I primarily ran laboratory exercises. I began labs with a presentation reviewing how lecture topics relate to the day's lab, then spent time working through practice problems using a variety of small group work and whole-class interaction. Lab exercises began with discussions of hypotheses and experimental design and were followed by interpretation of results. Data analysis was conducted as small groups in real time when possible.

From Egg to Embryo to Organ (Molecular and Cellular Biology 118), Harvard University, Fall 2010. Graduate teaching fellow responsible for facilitating discussion sections focused on critical reading of seminal papers in experimental developmental genetics. I wrote and graded exams and problem sets. I gave one course lecture on evolution and development.

Invited talk

Lewis ZR, Hanken J. "A transcriptional and morphological investigation of lung loss in salamanders." Canadian Society of Zoologists annual meeting, Calgary, AB. May 2015.

Selected scientific presentations

Lewis ZR, Dorantes JA, Hanken J. "Neofunctionalization of a lung gene paralog may facilitate respiration in lungless salamanders." Society for Integrative and Comparative Biology annual meeting, Portland, OR, Jan. 2016.

Lewis ZR, Hanken J. "A salamander model for atrial septal defects and cardiopulmonary evolution." American Association of Anatomists annual meeting, Boston, MA. Mar. 2015.

Lewis ZR, Hanken J. "Take Another Little Piece of my Heart: Convergent heart evolution in independent lineages of lungless salamanders." 6th Conference on the Biology of Plethodontid Salamanders, Tulsa, OK. May 2014.

Lewis ZR, Hanken J. "Co-evolution of heart and lung development in lungless salamanders." Society for Integrative and Comparative Biology annual meeting, Austin, TX. Jan. 2014.

Lewis ZR, Kerney RK, Dorantes JA, Hanken J. "Lung loss: Molecular and morphological Consequences." International Congress of Vertebrate Morphology, Barcelona, Spain. July 2013.

Lewis ZR, Kerney RK, Dorantes JA, Hanken J. "Extrapulmonary expression of surfactant proteins in lungless salamanders" Keystone Symposium: Lung Development, Cancer and Disease, Taos, NM. Feb. 2013.

Lewis ZR, Kerney RK, Dorantes JA, Hanken J. "Genetic and morphological vestiges of lost lungs in plethodontid salamanders." Society for Integrative and Comparative Biology annual meeting, San Francisco, CA. Jan. 2013.

Lewis ZR, Kerney RK, Dorantes JA, Hanken J. "Pulmonary surfactant proteins are expressed in lungless salamanders." Society for Integrative and Comparative Biology annual meeting, Charleston, SC. Jan. 2012.

Lewis ZR, Kerney RK, Hanken J. "Lung development in lungless salamanders!" Society for Developmental Biology annual meeting, Chicago, IL. Jul. 2011.

Lewis ZR, Nechiporuk AV. "Origins of the epibranchial placodes and ganglia in zebrafish." RIKEN CDB Symposium 2010 "Frontiers in Organogenesis," Kobe, Japan. Mar. 2010.

Honors and awards

Honorable Mention, Brian K. Hall Award **2015**
From the Canadian Society of Zoologists. Runner up for best student talk.

First prize, Harvard Integrated Life Sciences Gallery Night **2013**
For scientific photography.

Harvard University Certificate of Distinction in Teaching **2014**
For Herpetology course.

Class of '21 Award **2007**
Awarded by Reed College upon graduation for "creative work of notable character."

Phi Beta Kappa **2007**
Reed College

Professional activities and memberships

The Society for Integrative and Comparative Biology
American Association of Anatomists

Service activities and outreach

Peer Review: PNAS, Transactions of the Royal Society of South Africa
Curator and content contributor for the Encyclopedia of Life **2010 -**
Oral presentation, Shore Collaborative Henry Owens School, Chelsea, MA **2015**
Oral presentation, Science at the Seashore, Cape Cod National Seashore **2013**
Oral presentation, Pioneer Charter School of Science, Everett, MA **2013**
Volunteer for Harvard Life Sciences Outreach and Gradwagon **2010 - 2015**

Research experience

Postdoctoral Associate, Dunn Lab **2016 -**
Brown University and Yale University

- Sequenced the 3 Gbp genome of the Portuguese man o' war (*Physalia physalis*) to understand the genetic basis for UV-radiation tolerance. The *Physalia* genome represents the first sequenced genome from the order Siphonophora.
- Developed a method to analyze spatial gene expression from frozen tissue sections by generating spatially tagged transcriptome libraries.
- Sequenced the genome of the ctenophore *Mnemiopsis leidyi* using SMRT sequencing and Hi-C scaffolding.

Postdoctoral Associate, Edwards Lab **2016 - 2017**
Brown University

- Developed protocols to perform the first ever *in situ* hybridization and immunohistochemistry experiments in the succulent plant *Portulaca oleracea*.
- Determined the gene expression patterns of two paralogs of the photosynthesis enzyme PEPC that are associated with the evolution of C_4–CAM metabolism in *P. oleracea*.
- Found that when CAM respiration is induced in *P. oleracea*, carbon fixation occurs in the same cells that fix carbon during C_4 respiration.

PhD Research, Hanken Lab **2009 - 2016**
Harvard University

- Demonstrated that lungless salamanders develop a transient embryonic lung rudiment using morphological and molecular approaches.
- Used transcriptome sequencing and chemical genetic experiments to demonstrate that Tgf-β plays a roll in lung loss in lungless salamanders.
- Discovered a novel salamander-specific gene associated with cutaneous and buccopharyngeal respiration in lungless salamanders. Found ultrastructural evidence that lungless salamanders produce lung-like surfactant secretions in their skin.
- Investigated the morphology and development of the atrial septum in lungless salamanders. Determined that lungless salamanders from two independent lineages have convergently lost a portion of the atrial septum related to pulmonary respiration.
- Developed a plethodontid salamander field collection program to reliably obtain embryos.

Research Assistant II, Nechiporuk Lab **2008 - 2009**
Oregon Health and Science University

- Investigated the morphogenesis of the peripheral nervous system in zebrafish by single cell labeling and fate-mapping.
- Developed a fine-scale fate-map of the otic and epibranchial placodes.
- Helped coordinate a multi-lab mutagenesis screen and generate new transgenic reporter lines.

Undergraduate and post-baccalaureate, Kaplan and McClellan Labs **2005 - 2007**
Reed College

- Researched gonadal sex differentiation in threespine stickleback.
- Determined that female fish undergo a rapid proliferation of primordial germ cells as the first morphological indicator of sexual differentiation.
- Found population-specific differences in sex differentiation, which may correspond to different life history strategies.