

# ROBERT L. CIERI, PHD

## CURRICULUM VITAE

Department of Zoology  
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[ResearchGate](#) — [GoogleScholar](#)

### RESEARCH INTERESTS

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I am an evolutionary biologist broadly interested how animal evolution is constrained and guided by interactions with the physical world. I am currently an NSF postdoctoral fellow studying how lung structure and airflow biomechanics evolved with diving and explosive ventilation in marine mammals at the University of British Columbia. My PhD research investigated the evolution of **unidirectional pulmonary airflow** patterns in monitor lizards using open source **computational fluid dynamics** simulations. I also used **XROMM** to investigate the evolution of the axial skeleton and aspiration breathing in tetrapods. As a postdoc, I used **musculoskeletal models** to ask how biomechanical scaling drove locomotor innovations and adaptive evolution in Australian varanid lizards.

### EDUCATION

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#### The University of Utah

PhD, Biology 2019  
Blue Waters Graduate Fellow, NSF Graduate Research Fellow, TGLL NSF GK-12 Fellow  
Dissertation Project: *Pulmonary airflow patterns and ventilation mechanics in monitor lizards*  
Dissertation Advisor: Professor CG Farmer

#### Duke University

B.S., Biology; Biological Anthropology and Anatomy *with Distinction* 2011  
Thesis Topic: *Craniofacial feminization in Pleistocene Homo sapiens*  
Thesis Advisor: Professor Steven E. Churchill

### POSITIONS

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**NSF Postdoctoral Research Fellow** April 2022 - Present  
The University of British Columbia  
Supervisors: Robert Shadwick & William Milsom (UBC), Merryn Tawhai (University of Auckland)

**Postdoctoral Research Fellow** 2019 - 2022  
The University of the Sunshine Coast Supervisor: Christofer Clemente

### PUBLICATIONS

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#### Peer-reviewed journal articles

20. R Rockenfeller **RL Cieri**, J Schultz, R Maag, CJ Clemente. Coordinating limbs and spine: Pareto-optimal locomotion in theory, in vivo, and in robots. *Science Robotics, in review*.
19. **RL Cieri**, J Jevremov, JG Capano, CJ Clemente. Geometric morphometrics analysis reveals that long bone morphology depends on habitat and body size in varanoid lizards. *In Review*.
18. I Lindemann, **RL Cieri**, CJ Clemente, TJM Dick. Landmark-free statistical shape modelling reveals differing effects of age and sex on whole-muscle morphology among the triceps surae. *In Review*.
17. JG Capano, SM Boback, HI Weller, **RL Cieri**, CF Zwemer, EL Brainerd. [Modular lung ventilation in \*Boa constrictor\*](#), 2022 *Journal of Experimental Biology*. doi:10.1242/jeb.243119

16. **RL Cieri**, TJM Dick, JS Morris, CJ Clemente. [Scaling of fibre area and fibre glycogen concentration in the hindlimb musculature of monitor lizards: implications for locomotor performance with increasing body size](#), 2022 *Journal of Experimental Biology*. doi:10.1242/jeb.243380
15. **RL Cieri**, M Turney, R Carney, ... CG Farmer. [Virtual and augmented reality: new tools for visualizing, analyzing, and communicating complex morphology](#), 2021 *Journal of Morphology*. doi:10.1002/jmor.21421
14. **RL Cieri**, JT Schultz, T Proost, R Pilai, M Hodgson, F Plum, CJ Clemente. [Tail base deflection but not tail curvature varies with speed in lizards: results from an automated tracking analysis pipeline](#), 2021 *Integrative and Comparative Biology*. doi:10.1093/icb/icab037
13. **RL Cieri**, RJ Irwin, D Rumsey, TJM Dick, CJ Clemente. [Ground reaction forces in monitor lizards and the scaling of locomotion in sprawling tetrapods](#), 2021. *Biology Letters*. doi:10.1098/rsbl.2020.0612.
12. **RL Cieri**, TJM Dick, CJ Clemente. [Monitoring muscle over three orders of magnitude: widespread positive allometry among locomotor and body support musculature in the pectoral girdle of varanid lizards \(\*Varanidae\*\)](#), 2020 *The Journal of Anatomy*. doi:10.1111/joa.13273.
11. **RL Cieri**, SH Hatch, JG Capano, EL Brainerd. [Locomotor rib kinematics in two species of lizards and a new hypothesis for the evolution of aspiration breathing in amniotes](#). 2020 *Scientific Reports*. doi:https://doi.org/10.1038/s41598-020-64140-y.
10. **RL Cieri** and CG Farmer. [Computational fluid dynamics reveals a unique net unidirectional pattern of pulmonary airflow in the savannah monitor lizard \*Varanus exanthematicus\*](#), 2019 *The Anatomical Record*. doi: 10.1002/ar.24293.
9. ER Schachner, RB Irmis, AK Huttenlocker, K Sanders, **RL Cieri**, SJ Nesbitt. [Osteology of a late triassic bipedal archosaur \*Poposaurus gracilis\* \(Archosauria: psuedosuchia\) from Western North America](#), 2019, *The Anatomical Record*, **482**, 1-10, doi: 10.1002/ar.24298
8. **RL Cieri**. [Pulmonary smooth muscle in vertebrates: A comparative review of structure and function](#), 2019, *Integrative and Comparative Anatomy*, **482**, 1-10, doi: 10.1093/icb/icz002
7. JG Capano, S Moritz, **RL Cieri**, L Reveret, EL Brainerd. [Rib Motions Don't Completely Hinge on Joint Design: Costal Joint Anatomy and Ventilatory Kinematics in a Teiid Lizard, \*Salvator merianae\*](#), 2019, *Integrative Open BIology*, doi:10.1093/iob/oby004  
*Contributions*: Contributed varanid biomechanics data and contributed to MS.
6. **RL Cieri**. [The axial anatomy of monitor lizards \(\*Varanidae\*\)](#), 2018, *Journal of Anatomy*, **233:5**, 636-643, doi: 10.1111/joa.12872
5. **RL Cieri**, S Moritz, JG Capano, EL Brainerd. [Breathing with floating ribs: XROMM analysis of lung ventilation in savannah monitor lizards](#), 2018, *Journal of Experimental Biology* **221:22**, doi: 10.1242/jeb.189449  
*Contributions*: Developed questions and collected data, led analysis, wrote paper
4. **RL Cieri**, CG Farmer. [Unidirectional pulmonary airflow in vertebrates: a review of structure, function, and evolution](#), 2016 *Comparative Physiology, B* **186:5**, 541-552, doi: 10.1007/s00360-016-0983-3
3. **RL Cieri**, B Craven, ER Schachner, CG Farmer. [New insight into the evolution of the vertebrate respiratory system and the discovery of unidirectional airflow in iguana lungs](#), *Proceedings of the National Academy of Sciences of the United States of America* (2014) **11:48**, 17218-17223, 10.1073/pnas.1405088111  
*Contributions*: Collected and analyzed data, collaboratively wrote MS as a research technician.
2. **RL Cieri**, SE Churchill, RG Franciscus, J Tan, B Hare. [Craniofacial Feminization, Social Tolerance, and the Origins of Behavioral Modernity](#), *Current Anthropology* (2014) **55:4**, 419-443, doi: 10.1086/677209  
*Contributions*: Collected data and led analysis, wrote MS collaboratively.
1. ER Schachner, **RL Cieri**, PJ Butler, CG Farmer. [Unidirectional pulmonary airflow patterns in the savannah monitor lizard](#), *Nature* (2013) **506**, 10.1038/nature.12871  
*Contributions*: Collected and analyzed data, collaboratively wrote MS as a research technician.

## Book Chapters

1. CJ Clemente **RL Cieri**. Quadrupedal locomotion in arboreal reptiles, *Functional morphology and biomechanics of arboreal locomotion in tetrapods*, In Press

## Non-peer-reviewed journal articles

1. **RL Cieri**, S Gutman, D Henry, D Marx, L Kruger, A Gardiner. The influence of habitat rugosity on limb length: the size-grain hypothesis applied across taxa, 2011, *Vertices*, Spring, 1-6  
*Contributions*: Collected and analyzed data, wrote MS.

## HONORS, AWARDS AND GRANTS

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### Research Awards and Fellowships

Holsworth Wildlife Research Endowment, Ecological Society of Australia	2020
NSF Postdoctoral Research Fellowship in Biology	2021 - 2024
Blue Waters Graduate Fellowship (NCSA)	2018 - 2019
NSF Graduate Research Fellowship	2014 - 2017
NSF GK-12 Teaching Fellowship (TGLL)	2013 - 2014
George R. Riser Award for Outstanding Graduate Research (U of Utah)	2020
Blue Waters Graduate Fellowship : 1.6m CPU hours on Blue Waters	2018 - 2019

### Symposium/Workshop Funding

NSF Small Meeting Support Grant (ViRTMORPH)	2019
Company of Biologists Meeting Support Grant (ViRTMORPH)	2019

## ADDITIONAL TRAINING AND RESEARCH SKILLS

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### Graduate Coursework

Exploring Human Behavior (Anthropology)  
Computational Fluid Dynamics, Intermediate Fluid Dynamics (Mechanical Engineering)  
Muscle Physiology, Biomechanics (Exercise and Sport Science)  
Physiological Basis of Behavior, Human Anatomy, Computational Paleophysiology (Biology)

### Short Courses

DeepLabCut Machine Learning Video Tracking (Mathis Lab)	2020
Scanning Electron Microscopy (Utah NanoFab Institute)	2018
Image Based Biomechanical Modeling in FEBio (Utah Scientific Computing Institute)	2015

### Research Skills

Biomechanical modelling in OpenSim Computational Fluid Dynamics (CFD) modeling in open-source OpenFOAM software  
3D modelling (3D PFD, etc) Generation from Volumetric, Surface, and Simulation Data  
Data visualization and analysis in ParaView  
XROMM Analysis and animation: XMA Lab, Maya by Autodesk  
CT and MRI Image data analysis software: Horos, Avizo, 3D Slicer, Seg3D  
Vertebrate dissection and soft-tissue surgery  
Finite element analysis and modeling in open-source FEBio  
Open-source metabolic analysis  
3D photogrammetry, LiDAR, open-source modeling  
High performance computing environments: LINUX, NSF XSEDE and Blue Waters architecture  
Field herpetology: Identification, Capture, Collection

## PRESENTATIONS AND PUBLISHED ABSTRACTS

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### Symposia and Panels

Rib kinematics in lizards provide insight into the evolution of ventilation and locomotion: Taking a breath: The mechanics and evolution of tetrapod ventilation. Aerodigest 2023. UBC, Vancouver, Canada. Nov. 2023

Rib kinematics in lizards provide insight into the evolution of ventilation and locomotion: Taking a breath: The mechanics and evolution of tetrapod ventilation. International Congress of Vertebrate Morphology. Cairns QLD, Australia. Jul. 2023

VIRTMORPH: Using virtual reality (VR) to visualize and analyze vertebrate morphology (organizer of symposium and associated workshop). International Congress of Vertebrate Morphology. Prague, Czech Republic. Jul. 2019

Tactile teaching toolboxes for blind students. Diverse Approaches to Paleo Outreach Programs: Ideas, Strategies, and Logistics. Society of Vertebrate Paleontology, Salt Lake City, UT. Sep. 2016

38. **Talk:** Cieri RL, Clemente CJ, Dick TJM, Bishop PJ, Hutchinson JR. Locomotor joint moments in Varanid lizards and the scaling of locomotion in sprawling tetrapods. International Congress of Vertebrate Morphology, Cairns QLD, Australia. Jul. 2023
37. **Poster:** Cieri RL, Shadwick RE, Tawhai M, Piscitelli M. Structure and function in the cetacean pulmonary airway tree. International Congress of Vertebrate Morphology, Cairns QLD, Australia. Jul. 2023
36. **Talk:** Cieri RL, Shadwick R. Lung structure and pulmonary airflow patterns in cetaceans. Society of Integrative and Comparative Biology, Austin TX. Jan. 2023
35. **Talk:** Cieri RL, Shadwick R. Lung structure and pulmonary airflow patterns in cetaceans. British Columbia Marine Mammal Symposium. Nov. 2022
34. **Talk:** Cieri RL, Dick TJM, Clemente, CJ. Musculoskeletal modelling of Australian monitor lizards and the scaling of locomotion in sprawling tetrapods. Comparative Physiology Seminar, University of British Columbia. Nov. 2022
33. **Talk:** Cieri RL, Dick TJM, Clemente, CJ. The scaling of ground reaction forces and the musculoskeletal system in monitor lizards: implications for locomotion in large sprawling tetrapods. Society of Experimental Biology, Montpellier France. Jul. 2022
32. **Talk:** Cieri RL, Dick TJM, Clemente, CJ. The scaling of ground reaction forces and the musculoskeletal system in monitor lizards: implications for locomotion in large sprawling tetrapods. Society of Integrative and Comparative Biology, Phoenix AZ. Jan. 2022
31. **Talk:** Cieri RL, Dick TJM, Clemente, CJ. The scaling of ground reaction forces and the musculoskeletal system in monitor lizards: implications for locomotion in large sprawling tetrapods. Society of Experimental Biology, Virtual Meeting. Jul. 2021
30. **Poster:** Cieri RL, Dick TJM, Clemente CJ. Ground reaction forces and muscle allometry in monitor lizards (Varanidae) with implications for the scaling of locomotion in sprawling tetrapods. Evolutionary Biology, Virtual Meeting. Apr. 2021
29. **Talk:** Schultz JT, Cieri RL, Proost T, Clemente, CJ. Comparative biomechanics of lizard tails during level walking and vertical climbing. Society of Integrative and Comparative Biology, Virtual Meeting. Jan. 2021
28. **Talk:** Cieri RL, Dick TJM, Clemente CJ. Ground reaction forces in monitor lizards (Varanidae) and the scaling of locomotion in sprawling tetrapods. Society of Integrative and Comparative Biology, Virtual Meeting. Jan. 2021

27. **Talk:** Cieri RL, Farmer CG. Net-unidirectional airflow patterns vary with pulmonary anatomy in monitor lizards (Varanidae): insights from a multi-species computational fluid dynamics investigation.  
Society of Integrative and Comparative Biology, Austin, TX. Jan. 2020
26. **Talk:** Cieri RL, Farmer CG. Net-unidirectional airflow patterns vary with pulmonary anatomy in monitor lizards (Varanidae): insights from a multi-species computational fluid dynamics investigation.  
Society of Integrative and Comparative Biology, Austin, TX. Jan. 2020
25. **Talk:** Capano JG, Cieri RL, Weller HI, Brainerd EL. Modular Lung Ventilation in Snakes .  
Society of Integrative and Comparative Biology, Austin, TX. Jan. 2020
24. **Poster:** Cieri RL, Hatch ST, Capano JG, Brainerd EL. The similarity of locomotor and ventilatory kinematics in two species of lizard suggest a locomotor origin for rib mobility and aspiration breathing in tetrapods .  
International Congress of Vertebrate Morphology. Prague, Czech Republic. Jul. 2019
23. **Talk:** Cieri RL, Farmer CG. Breathing life into digital anatomy using virtual reality: Interactive anatomy and computational fluid dynamics (CFD) simulations of pulmonary airflow in monitor lizards (*Varanidae*).  
International Congress of Vertebrate Morphology. Prague, Czech Republic. Jul. 20
22. **Invited Talk:** Cieri RL, Farmer CG. Computational fluid dynamics modelling reveals a unique net-unidirectional pulmonary airflow pattern in in monitor lizards (*Varanidae*). Blue Waters Symposium, Sun River, OR Jun. 2019
21. **Talk:** Cieri RL, Hatch ST, Brainerd EL. Breathing as bilateral walking: Locomotor and ventilatory rib kinematics in monitor lizards.  
TGIF Departmental Seminar, Salt Lake City, UT Nov. 2019
20. **Poster:** Delgado S, Battaglioli S, Howell M, Cieri RL, Farmer CG. 2019. Microfluidics and gas exchange in reptilian parenchyma.  
Society of Integrative and Comparative Biology, Tampa, FL Jan. 2019
19. **Poster:** Cieri RL, Farmer CG. 2019. Computational fluid dynamics modeling of pulmonary airflow in monitor lizards (Varanidae).  
Society of Integrative and Comparative Biology, Tampa, FL Jan. 2019
18. **Talk:** Farmer CG, Cieri RL 2019. A tesla valve in the turtle lung.  
Society of Integrative and Comparative Biology, Tampa, FL Jan. 2019
17. **Talk:** RL Cieri, CG Farmer. Computational fluid dynamics modeling of pulmonary airflow in monitor lizards (Varanidae).  
Society of Integrative and Comparative Biology, San Francisco, CA Jan. 2018
16. **Poster:** Hatch, SH, Cieri RL, Brainerd EL. XROMM analysis of axial skeletal kinematics during terrestrial locomotion in the savannah monitor lizard, *Varanus exanthematicus*.  
Society of Integrative and Comparative Biology, San Francisco, CA Jan 2018
15. **Poster:** Mason T, Tilt LL, Cieri RL, Farmer CG. The pulmonary anatomy of the Gray Parrot (*Psittacus erithacus*) studied by computed tomography.  
Society of Integrative and Comparative Biology. San Francisco, CA. Jan. 2018
14. **Poster:** Sowards SH, Cieri RL, Farmer CG. Computational fluid dynamics modeling of pulmonary airflow in a (*Python regius*).  
Society of Integrative and Comparative Biology. San Francisco, CA. Jan. 2018
13. **Poster:** Ridge NC, Cieri RL, Farmer CG. Computational fluid dynamics modeling of pulmonary airflow in *Pogona vitticeps* (Bearded dragon).  
Society of Integrative and Comparative Biology. San Francisco, CA. Jan. 2018
12. **Talk:** Cieri RL, Munns S, Farmer CG. Two and a half goanna stories.  
The Australia and New Zealand Society for Comparative Physiology and Biochemistry Annual Meeting. Daintree Forest Observatory, QLD, Aus. Dec. 2017
11. **Talk:** Cieri RL, Moritz S, Brainerd EL. Ventilatory rib kinematics in the savannah monitor, *Varanus exanthematicus*: an XROMM Study.

- Society of Integrative and Comparative Biology. New Orleans, LA. Jan. 2017
10. **Talk:** Cieri RL, Farmer CG. Computational fluid dynamics modeling of unidirectional pulmonary airflow in the savanna monitor lizard. Utah Bioengineering Conference. Salt Lake City, UT. Nov. 2016
  9. **Poster:** Cieri RL, Moritz S, Brainerd EL. Ventilatory rib kinematics in the savannah monitor, *Varanus exanthematicus*: an XROMM Study. Society of Vertebrate Paleontology. Salt Lake City, UT. Sep. 2016
  8. **Talk:** Cieri RL, Moritz S, Brainerd EL. Ventilatory rib kinematics in the savannah monitor, *Varanus exanthematicus*: an XROMM Study. International Congress of Vertebrate Morphology. Washington, DC. Jul. 2016
  7. **Talk:** Cieri RL, Moritz S, Brainerd EL. Ventilatory rib kinematics in the savannah monitor, *Varanus exanthematicus*: an XROMM Study. FUSION Departmental Seminar, Salt Lake City, UT. Feb. 2016
  6. **Poster:** Cieri RL, Huttenlocker AK, Farmer, CG. Traveling tactile toolboxes for teaching evolutionary biology to blind students. Society of Integrative and Comparative Biology. West Palm Beach, FL. Jan. 2015
  5. **Poster:** Cieri RL, Farmer CG. Pulmonary air flow patterns in diapsids: computational and experimental fluid dynamic investigations. Utah Bioengineering Conference. Salt Lake City, UT. Nov. 2015
  4. **Poster:** Cieri RL, Farmer, CG. Airflow patterns in the lungs of *Xenopus laevis*, *Varanus exanthematicus*, and *Iguana iguana*: The phylogeny of unidirectional ventilation. Society of Integrative and Comparative Biology. Austin, TX. Jan. 2014
  3. **Talk:** Cieri RL. Craniofacial feminization in Pleistocene *Homo sapiens*: testosterone, social tolerance, and the origins of behavior modernity. Evolution. Snowbird, UT. Jul 2013
  2. **Talk:** Cieri RL, Churchill SE. Craniofacial feminization in Pleistocene *Homo sapiens*: insights into the origin of modern human behavior. TGIF Departmental Seminar, Salt Lake City, UT Oct. 2013
  1. **Talk:** Cieri RL, Churchill SE. Craniofacial feminization in Pleistocene *Homo sapiens*: testosterone, social tolerance, and the origins of behavior modernity. ACC Meeting of the Minds. Miami, FL. Apr. 2011

## TEACHING EXPERIENCE

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### The University of British Columbia

Lead Instructor Biology 325: Principles of Animal Locomotion Fall 2023

### The University of Utah

Guest Instructor Biology 5445: Computational Paleophysiology Summer 2023

Lead Instructor Biology 2420: Human Physiology Lecture Fall 2016

Tutor, High Performance Tutoring 2017 - 2019

Guest Lecturer Biology 1010: Biology in the 21st Century Fall 2015

T.A. Biology C1403: Computational Paleophysiology Summer 2014

NSF GK-12 Teaching Fellow: 5th and 6th Grade Science Teacher 2013

## SELECTED ACTIVITIES AND SERVICE

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Organized Evolutionary Biology Graduate Reading Group 2016 - 2017

Graduate Student Invited Speaker Organizer 2016 - 2017

### Students Supervised and Outreach

Joshua Jevremov\*†, Alexa Pappas, Gabriel Deniro, Taylor Baker\*, Jacob Graham, Giuliana Gigliotti\*, Kristen Meredith, Lewis Tam\*, Timothy Mason\* †§, Samuel Hatch\* †§, Lindseylee Anne Tilt\* †§,

Staffan Sowards †§, Mason Pearse-Clawson, Nick Ridge\* †§, Carson Gifford, Samuel Gomez Delgado †§, Isaac Christianson, Gurleen Jammu\*‡, Caleb Quayle\*‡, Christina Elton‡ \*Received course credit for the supervised research

† Published or Presented at a Scientific Meeting

§ Received Undergraduate Research Opportunities Program Funding (U of Utah)

‡ Biology Undergrad Diversity in Research (UBC)

### Scientific Outreach

NSF Postdoctoral Fellowship - Broadening Participation of Underrepresented Groups in Biology 2021 - present

TGLL Teaching Fellowship (NSF GK-12 Program) 2013-2014

Science Ambassador Program (Natural Hist. Museum of Utah) 2017 - 2018

TOUCH Science Project (Tactile teaching toolboxes for the blind) present - 2012

STEM Ambassador Program (outreach about animal breathing to yogis) Present - 2016

### Organising Symposia and Workshops

ViRTMORPH: Using virtual reality to visualize and analyze vertebrate morphology. International Congress of Vertebrate Morphology, July 2013, Prague Czechia

Proposed session, designed hands-on workshop, garnered funding, organized collaborative manuscript

### MEDIA

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Nova: The Violence Paradox (2019)

### REFERENCES

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Professor Emeritus RE Shadwick  
The University of British Columbia shadwick@zoology.ubc.ca (604) 827-3149

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The University of the Sunshine Coast cclement@usc.edu.edu +61 7 5459 4535

Professor CG Farmer, University of Utah cg.frmr@gmail.com (801) 581-4236

Professor EL Brainerd, Brown University brainerd@brown.edu (401) 863-9261

Professor SE Churchill, Duke University churchy@duke.edu (919) 660-7314