Investigating the Correlation Between Heart Rate and Growth Rate in Prairie Lizards

Project Description

We have documented latitudinal patterns among lizard populations consistent with compensatory evolution in response to the thermal gradient (Robbins and Hegdahl 2024). More energy is allocated to growth and reproduction in populations from northern, colder environments with shorter annual activity periods.

Understanding the geographic variation in the underlying physiology is crucial for explaining the ecological dynamics in response to thermal environments, especially with regard to climate change (De Frenne et al. 2013). Growth rate is a crucial trait in determining energy allocation, which affects how energy is constrained for other survival related traits, such as mating and reproduction (Congdon 1989). Differences in how shifts in growth rate are obtained might also show how these lizards have adapted to local environmental conditions.

Prairie lizards are ectotherms, which means they rely heavily on the environment to stay warm and function properly. Thermal gradients across different geographic regions can impact a lizard's behavior, morphology, and most importantly their physiological performance. By investigating how thermal sensitivity of heart rates may differ across prairie lizard populations from different latitudinal, and therefore thermal, locations we seek to gain insights into the adaptive significance of cardiovascular responses to temperature at both plastic and evolutionary scales. Understanding the relationship between thermally mediated physiology and growth in lizards is crucial for comprehending their adaptive strategies in response to varying environmental conditions (Angilletta et al. 2002). This research examines possible physiological mechanisms associated with greater growth efficiencies in populations adapted to colder environments. I hypothesize that faster heart rates should occur at warmer temperatures and correlate with faster growth both across individuals and across populations according to their latitude and energy use.

This experiment aims to test the geographic variation in heart rate sensitivity to temperature among prairie lizard populations from across the latitudinal thermal gradient in the United States. Measuring heart rate during three thermal challenges, I hope to test thermal sensitivity among the lizards and find correlations between the traits and geographic location. My objectives are:

1: Determine if there's a difference between heart rates in prairie lizards from different latitudinal populations.

2: Assess thermal sensitivity of heart rate across three short-term thermal environments.

3: Determine if heart rate correlates with growth rates among individuals and populations.

Methodology

We will be using lizards from three different latitudinal populations, using ten lizards from each group. The locations of the populations include Beavers Bend State Park in Oklahoma, and Lake Tawakoni State Park and Gus Engeling Wildlife Management Area in Texas. The lizards are currently in captivity at the UNO Animal Care Facility. We want to measure heart rates and growth rates during late spring because this is when we generally see greater divergence in physiological rates between populations of this lizard genus (Angilletta 2001).

We will measure growth rates of adult lizards via a common garden experiment where all lizards are cared for in identical environments with similar food and water availability. Each lizard will be individually marked, measured for snout-vent-length, and weighed for mass once a month and before each thermal challenge trial.

The lizards will be subjected to various thermal trials in an incubator (28, 32, and 36°C), during which we will measure heart rates over a seven-minute period. Heart rates will be measured with a doppler ultrasound apparatus set up in the incubators. At the end of the experiment, we will compare growth and heart rates among the lizard populations from across the latitudinal thermal gradient.

Student/Faculty Mentor Roles

I will be conducting this research as a part of Dr. Robbin's Lab. My student responsibilities will consist of data collection and measuring/comparing the heart and growth rates of prairie lizards. Dr. Robbins and I will meet weekly to ensure that everything is proceeding correctly and that IACUC regulations and standards are being upheld. Dr. Robbins will also assist me with the statistical analysis and writing of the manuscript. I will present my findings at the UNO Research and Creativity fair in 2026. There has been no previous internal funding received.

Project Timeline

2025	May	June	July	August
Prepare and setup	X			
Trials and data collection this	X	X		
Statistical analysis			X	
Writing of manuscript/poster			X	X

Budget and Justification

Item	Description	Cost
Doppler Supplies	General Doppler supplies and lizard restraint apparatus to place the flat Doppler probe in the correct position for measurement	$300.00
General Lab Supplies	Labelling tape, markers, rulers, weigh boats, lizard transport containers, etc.	$200.00
Student Stipend	10 hours a week for 18 weeks	$2,000.00
Total		$2,500.00

I am requesting a total of $2,500 to examine how prairie lizards' heart rates and growth rates may be related to their thermal environment at both short-term and long-term timescales. Of the $2,500 that is requested, $200 will be used for general lab supplies, $300.00 will be used for supplies associated with the Doppler heart rate measuring equipment (e.g. measuring platforms, sonogram gel), and the remaining $2,000.00 will be requested as a student stipend. Supplies may include, but are not limited to, small plastic tubs for temporary lizard transport and restraint while measuring ($60); markers ($40.00) for marking tubs and lizards for easy identification (temporary dorsal marks); nitrile gloves ($20.00) for lizard handling; labeling tape ($20.00) for tubs; rulers ($20.00) and weigh boats ($40.00) for measuring lizards and crickets. The student stipend ($2,000.00) will be paid over the summer while completing the proposed research project at a rate of $11 per hour for an estimated 180 hours total or ten hours per week for 18 weeks from May to August 2025.

Citations

Angilletta, Jr, M.J., 2001. Variation in metabolic rate between populations of a geographically widespread lizard. Physiological and Biochemical Zoology, 74(1), pp.11-21.

Angilletta Jr, M.J., Niewiarowski, P.H. and Navas, C.A., 2002. The evolution of thermal physiology in ectotherms. Journal of thermal Biology, 27(4), pp.249-268.

Congdon, J.D., 1989. Proximate and evolutionary constraints on energy relations of reptiles. Physiological Zoology, 62(2), pp.356-373.

De Frenne, P., Graae, B.J., Rodríguez-Sánchez, F., Kolb, A., Chabrerie, O., Decocq, G., De Kort, H., De Schrijver, A., Diekmann, M., Eriksson, O. and Gruwez, R., 2013. Latitudinal gradients as natural laboratories to infer species' responses to temperature. Journal of Ecology, 101(3), pp.784-795.

Robbins, T.R. and Hegdahl, T.R., 2024. Latitudinal Clines in an Ectothermic Vertebrate: Patterns in Body Size, Growth Rate, and Reproductive Effort Suggest Countergradient Responses in the Prairie Lizard. *Ecology and Evolution*, 14(12), p.e70680.

University of Nebraska Omaha

Travis R. Robbins, Ph.D.

Department of Biology
Native American Studies

January 11, 2025

Dear Office of Research and Creative Activity (ORCA),

I strongly recommend Kayla Wycoff for a Fund for Undergraduate Scholarly Experience (FUSE) award. I have been studying the ecology and evolution of reptiles and amphibians for over 20 years, focusing on how populations adapt to environmental changes, such as those caused by invasive species and altered climates. My current research examines phenotypic evolution in reptile populations in response to changes in their thermal environments, focusing on life history traits such as growth, survival, and reproductive characteristics. Kayla has a strong research proposal to examine the thermal sensitivity of heart rates in lizard populations along a latitudinal thermal gradient. Kayla's project will also compare heart rates to growth rates across these populations. Her project is distinct from my general focus on life history because she will be focusing on flexibility within the cardiovascular system, which is beyond my current research focus. Examining how ectotherm populations have evolved to different thermal environments in the past will help us manage and predict how they will respond to our changing climate in the future.

Kayla has already proven herself as a dedicated undergraduate student and research assistant. She attended my lab's weekly herpetology journal club during the fall semester out of pure interest and enthusiasm for herpetological ecology. She assisted with ecological research in the Herpetology Lab on a project examining lizard locomotor performance that was presented at an international scientific conference in January 2024. For the current proposed FUSE project, Kayla has designed an experiment to examine heart rates for both plastic and evolutionary responses to thermal environments. She will measure lizard heart rates across three short-term thermal challenges to produce a thermal performance curve for each population that can then be compared among populations for trends along the latitudinal thermal gradient including correlations with other traits, such as growth rates. The lizards for these experiments are currently on-site at the UNO Animal Care Facility, ensuring the feasibility of this project. Kayla will be charged with setting up and running experiments, collecting the data on heart rates utilizing the Doppler, analyzing the data, and writing the manuscript to be submitted for publication. We will continue to meet weekly to go over project details and progress.

Kayla meets all of the FUSE program requirements of 1) being currently enrolled and paying fees at UNO through at least Summer semester, 2) having identified me as a mentor, 3) having proposed a scholarly experience, and is 4) planning on presenting her work at the UNO Research and Creative Activity Fair in March 2026. I have also verified her proposed budget and confirm that the project needs and costs are reflected and adequate to complete the project.

I wholeheartedly recommend Kayla Wycoff for the FUSE award. Her initiative, dedication, and enthusiasm make her the exact type of undergraduate student the Office of Research and Creative Activity should be looking to honor and award. If you have any questions please feel free to contact me at (813) 220-9684 or through any of the contact information listed below.

Sincerely,

Travis R. Robbins, PhD
Assistant Professor
Department of Biology