**Lizard cold tolerance and extreme weather events: a scientist spotlight featuring Dr. Shane Campbell-Staton**

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**Course Information**

Department: Biology

Level: Lower undergraduate

Course type: Lecture

Students: Majors

Number of Students: 68 students in 2 sections

**Summary:** Students interpret experimental and observational data about patterns in cold tolerance in the green anole, including reading a short paper from the primary literature, while also reflecting on the experience and identity of the lead researcher based on the author’s discussion of his research in a video presentation and an interview.

**Overview:** The main purpose of this lesson is to explore how organisms adjust to variation in their environment and can respond to extreme environmental changes. Students examine data on cold tolerance in the green anole, a tropical species that colonized the southeastern US from Cuba, and thus faces wide variation in winter temperatures in different parts of its current range. Dr. Shane Campbell-Staton documented that variation among populations in cold tolerance has a genetic basis, while also showing that these lizards have the capacity to acclimate to cold temperatures. In this lesson, students interpret graphs and interpret experimental data in an online quiz or clicker question format, followed by reading a 3-page *Science* paper in which Dr. Campbell-Staton demonstrates rapid selection for increased cold tolerance in southern populations of green anoles in response to the extreme winter storm events associated with the 2014 polar vortex. Students work in groups to answer questions about the study. Context for this research is provided by a short video presentation and podcast by Dr. Campbell-Staton, which helps make the paper more approachable for students with limited experience with the primary literature. Students also view an interview with Dr. Campbell-Staton who is Black, and respond to some questions about the experiences and identity of this scientist. Part of this lesson was inspired by and adapted from the HHMI Biointeractive data point activity addressing some of the same findings (Kuhn 2019).

**Learning objectives:**

Quantitative learning objectives (from Clemmons et al. 2020)

1. Interpret informative graphs and other data visualizations
2. Interpret the biological meaning of quantitative results
3. Interpret, summarize, and evaluate evidence in primary literature
4. Relate conclusions to original hypothesis, consider alternative hypotheses, and suggest future research directions based on findings

Content learning objectives

1. Apply knowledge of ecological processes and develop models to explain ecological patterns and make predictions
2. Apply evolutionary theory to help explain ecological patterns

Social justice and/or diversity/equity/inclusion learning objectives

1. Identify and describe how systemic factors (e.g., socioeconomic, political) affect how and by whom science is conducted (Clemmons et al. 2020)
2. Adopt a more nonstereotypical description of who can be a scientist and increase ability to relate to scientists (Schinske et al. 2016).

**Lesson sequence:**

1. In one class period, the green anole study system and research documenting the latitudinal gradient in cold tolerance are introduced through a series of Powerpoint slides. Through either an online quiz or clicker questions, students interpret graphs and make predictions about experimental results based on figures from [Campbell-Staton et al. (2016)](https://onlinelibrary.wiley.com/doi/pdfdirect/10.1111/jeb.12935) and [Campbell-Staton et al. (2018)](https://onlinelibrary.wiley.com/doi/am-pdf/10.1111/mec.14580). See file: “Scientists Spotlights\_Campbell-Staton\_lizard cold tolerance\_quiz slides.pptx.”

2. Post an assignment for students to read the 3-page [Campbell-Staton et al. (2017)](https://lososlab.oeb.harvard.edu/files/lososlab/files/campbell-staton_et_al._science._2017.pdf) *Science* paper which documents a dramatic shift in cold tolerance of several populations of anoles in response to the 2014 polar vortex event. Students also view a short [6.5-minute video](https://www.youtube.com/embed/FLcLHyk-18k?feature=oembed) and listen to a [3.5-minute interview](https://www.scientificamerican.com/podcast/episode/cold-snap-shapes-lizard-survivors/%20) in which Campbell-Staton discusses his findings. For additional context, students can also read this 2-page commentary from Peter W. Grant, [“Evolution, climate change, and extreme events.”](https://static1.squarespace.com/static/55f2d2a7e4b0dbda5ff237ad/t/5997683ce58c62e2fe7f34b4/1503094845833/451.full.pdf)

See file: “Scientist Spotlights\_Campbell-Staton\_lizard cold tolerance\_group activity prep.docx.”

3. Group activity during class (could be online or in person) in which students collaborate in groups in answering questions about the Campbell et al. (2017) study in a Google doc after a very brief Powerpoint introduction. See file “Scientist Spotlights\_Campbell-Staton\_lizard cold tolerance\_intro slide.ppt” and “Scientist Spotlights\_Campbell-Staton\_lizard cold tolerance\_group activity questions.docx.” Contents of Word file can be copied into Google Doc for sharing with students.

4. Submission of a personal reflection based on an [interview with Dr. Campbell-Staton](https://www.youtube.com/embed/bqCoIbiPlWs?feature=oembed). Students respond to three questions posted on the learning management system. The full interview is 35 minutes, but students were only required to view the first 14 minutes. See file: “Scientist Spotlights\_Campbell-Staton\_lizard cold tolerance\_reflection post.docx.”

**Pre-lesson activities:** Students have had experience in interpreting graphs, identifying independent and dependent variables, inferring experimental treatments or groups from graphs, and understanding the meaning of a p-value from a statistical analysis. Through previous course material students were exposed to concepts related to how organisms cope with environmental variation, including phenotypic plasticity, acclimation, local adaptation, and common garden experiments to distinguish plastic responses from those with a genetic basis. Students also learn about the four postulates of natural selection: the conditions that must be satisfied for evolution via natural selection to occur.

**Implementation notes:** I implemented this activity in an online-only sophomore-level ecology course in spring 2021. Every week we would have two synchronous meetings, one in which students carried out some individual assignment, and one in which students worked in groups. The first component exploring the cold tolerance data and responding to quiz questions was our individual activity for the week, and then students answered questions in groups for our weekly group synchronous session, which used breakout rooms in Zoom. The data overview and quiz could be an individual homework assignment instead of being conducted in class. It could also be omitted and students could simply read the Campbell-Staton et al (2017) *Science* paper. Alternatively, the lesson could just focus on the latitudinal gradient in cold tolerance and not include the paper about the lizards’ response to the polar vortex episode. The group activity could be performed in a 50-min class in person. In person, I would probably still have students collaborate on a Google Doc in class on their laptops (we have a required laptop rule). Or students could answer the questions individually or on paper handouts during class. This lesson does require additional out-of-class time for students to do the readings and view videos, and for them to provide individual responses to the question prompts relating to the scientist’s identity and social justice learning objectives. Students could respond to these questions in an online discussion forum in which they see and comment on each other’s responses. While I originally required that students only view the first 14 minutes of the interview (because they had so much other video content to view), I think they would get much more insight from the full interview (particularly at 30:00 when Dr. Campbell-Staton addresses being a person of color in biology).

**References and additional resources:**

Campbell‐Staton, S. C., Bare, A., Losos, J. B., Edwards, S. V., & Cheviron, Z. A. (2018). Physiological and regulatory underpinnings of geographic variation in reptilian cold tolerance across a latitudinal cline. *Molecular Ecology*, 27(9), 2243-2255.

Campbell-Staton, S. C., Cheviron, Z. A., Rochette, N., Catchen, J., Losos, J. B., & Edwards, S. V. (2017). Winter storms drive rapid phenotypic, regulatory, and genomic shifts in the green anole lizard. *Science*, 357(6350), 495-498.

Campbell‐Staton, S. C., Edwards, S. V., & Losos, J. B. (2016). Climate‐mediated adaptation after mainland colonization of an ancestrally subtropical island lizard, Anolis carolinensis. *Journal of Evolutionary Biology*, 29(11), 2168-2180.

Clemmons, A., J. Timbrook, J. Herron, & A. Crowe. (2020). BioSkills Guide. Core Competencies for Undergraduate Biology, (Version 5.0). QUBES Educational Resources.

<https://doi.org/10.25334/156H-T617>

Kuhn, B. 2019. Lizards in the cold. HHMI Biointeractive Data Point Activity. Available from: <https://www.biointeractive.org/classroom-resources/lizards-cold>

Schinske, J.N., H. Perkins, A. Snyder, and M. Wyer. 2016. Scientist spotlight homework assignments shift students’ stereotypes of scientists and enhance science identity in a diverse introductory science class. *Life Sciences Education* 15(3):1-18. 2017 online publication. <https://doi.org/10.1187/cbe.16-01-0002>