

COLSA Awards Outstanding Work at 2021 URC

Funds from Jack '55 and Pat Weeks make recognition possible

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in Female Breeding Tidal Marsh Sparrows

Undergraduate Researcher: Julia Squillace | Co-Authors: Andrew Wiegardt, Emily Patterson & Adrienne Kovach
Department of Natural Resources and the Environment, University of New Hampshire, Durham, NH 03824

Introduction

- To persist, organisms must adapt, especially as climate change creates more dynamic environments.
- Adaptation results from changes in DNA and in gene expression via epigenetic processes like DNA methylation. Some populations are better able to adapt to change than others, making them more resilient.
- The tidal marsh is a model system to study the epigenetic basis of adaptation; it has been colonized by few vertebrates and features major stressors like cyclical saltwater inundation.
- Tidal marsh sparrows display nesting adaptations to these stressors such as nesting in tall/dense grasses at higher elevations and synchronizing their nesting cycle to the lunar tidal cycle to avoid nest flooding. This synchronization may be linked to the regulation of circadian rhythm genes.

Research Questions and Hypotheses

Questions

- Is there an epigenetic basis underlying the differences in nest-timing phenotypes of breeding female sparrows?
- Do clutch size, nest height, and nest initiation time affect nest fate?

Hypotheses

- There will be different levels of DNA methylation in the genomes of females that display different nest timing phenotypes, potentially on circadian rhythm genes.
- Females with smaller clutch sizes, taller nest heights, and quicker nest initiation time will be more likely to avoid flooding.

Methodology

Data Collection: June-August 2020

- Nest searching and monitoring for nest characteristics and status
- Mist netting to catch females for DNA blood samples and to match females to nests.

Reduced Representation Bisulfite Sequencing (RRBS)

- Prepare DNA for sequencing methylated sites (n=22)

Bioinformatics

- Yield sequences of interest

Data Analysis in R with MethyKit

- Analysis of differential methylation

Tidal Marsh Sparrows

Figure 1. Adult saltmarsh sparrow (*Arenoscoptes cinnabecus*)

Figure 2. Adult Nelson's sparrow (*Arenoscoptes nelsoni*)

Results

Figure 3. Methylation levels for Nelson's and Saltmarsh sparrows at the top 200 differentially methylated sites. Darker colors indicate higher levels of methylation. (n=22)

Figure 4. Methylation levels for sparrows with different nest initiation timing, measured in days after the full moon high tide. Darker colors indicate higher levels of methylation. (n=22)

Figure 5. Methylation levels for sparrows with different nesting intervals measured in days between nest failure due to flooding and subsequent nest initiation. Darker colors indicate higher levels of methylation. (n=6)

Nest Timing

- Sparrows will synchronize their nest timing with the lunar tidal cycle, which is approximately 28 days.
- Females must fit egg laying, incubation, and chick brooding within the window of the lunar cycle to avoid intense flooding during the full moon "spring tides".
- If chicks are old enough by the time of a flooding event, they can climb out of the nest to avoid drowning.

Figure 6. The lunar tidal cycle is an important regulating factor in the nesting cycle of tidal marsh sparrows. Source: Jillian Brown

Conclusions

- Probability of fledging increases with nest height, but a larger sample is needed to determine the effect of initiation on nest fate. Clutch size has no significant effect on nest fate.
- Many gene regions showed significant differential methylation between the species and nest timing phenotypes. Although there were no consistent patterns, subtle methylation differences are present.
- Methylation is tissue specific, but blood samples are less invasive than brain tissue sampling, which may show stronger methylation patterns. High individual variation suggests that blood samples show promise as a tissue for detecting differential methylation.
- This is exploratory research in a novel epigenetics topic. Future research should identify genes in the differentially methylated regions and whether they are circadian rhythm genes.

Acknowledgements

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JULIA SQUILLACE'S WINNING URC POSTER

For the first time in the 30-year history of the [UNH Undergraduate Research Conference](#), the College of Life Sciences and Agriculture has recognized 10 students with monetary awards totaling \$3,000.

COLSA Dean Anthony S. Davis announced eight \$250 prizes for excellence and two \$500 prizes, one for outstanding oral presentation and one for outstanding poster presentation, during a virtual awards ceremony following the conference. The students' work was reviewed by a diverse group of 68 COLSA postdoctoral researchers and graduate students. The judges ranked posters and presentations based on criteria that included visual appeal, overall clarity and the presenter's ability to frame their research in a real-world context.

The eight recipients of awards of excellence were Lillian Delgado '21, Donnelly Hutchings '21, Troy LaPolice '21, Lauren McDowell '24 and Cate Wardinski '21 (joint project), Elizabeth Miller '21, Robyn Parker '21, McKenna Wells '21 and Emily Williams '21. Hayleigh Hildebrand '21 won the outstanding poster award for her research on agricultural nutrient cycling titled How Does Agricultural Management Affect the Distribution of Organic Nitrogen Into Different Soil Pools? and Julia Squillace '21 won outstanding oral presentation for her research titled Linking Nest Timing Phenotypes to DNA Methylation of Circadian Rhythm Genes in Female Breeding Tidal Marsh Sparrows.

"Winning this award has made me very proud of the hard work I have accomplished as an undergraduate," says Squillace, a [wildlife and conversation biology major](#) and budding bird researcher. "This experience has shown me a potential career path that I can pursue."

For Hildebrand, an environmental sciences and Russian dual major, the URC represents an extension of her broader UNH education.

"I think events like the URC are important because they help students prepare for the future while learning about something that they love, and it gives students a chance to really demonstrate the skills that all of their classes have been helping them develop," she says.

The awards were made possible by the generosity of Jack Weeks, Jr. '55 and his wife Pat, who established the Weeks Family Fund at UNH in support of COLSA. Weeks was a member of the Alumni Association Board of Directors, a founding member of the UNH Foundation Board of Directors, and an alumni representative to the University System Board of Trustees. The Weeks family also established the Herbert C. "Dinty" Moore Memorial Fund at UNH in honor of a favorite professor and are avid supporters of 4-H. In 1990, Weeks received the Alumni Association's Meritorious Award and in 2002, he received the UNH Profile of Service Award.

"This past academic year has been one of many challenges and added hurdles — especially to conduct and complete these projects," says [Jesse Stabile Morrell](#), principal lecturer in the department of agriculture, nutrition and food systems and a member of COLSA's URC committee and the awards subcommittee. "We are so grateful that the

Weeks' support helped us acknowledge the resiliency, perseverance, hard-work and creativity displayed by our COLSA students.”

COLSA's URC committee also includes Andre Brito, Leslie Curren, Molly Doyle, Jessica Ernakovich, Vicki Jeffers, Subhash Minocha, and Paul Tsang and co-chairs Pamela Wildes and Wil Wolheim. Curren, Jeffers and Ernakovich joined Morrell on the awards subcommittee that coordinated the poster and presentation evaluations, recruited judges and organized the results.

This year's COLSA URC showcased the work of 81 undergraduate students, representing roughly 60 academic advisors. The URC was originally founded as a science-based conference in 1991 and has expanded in the 30 years since, evolving into a university-wide display of undergraduate research across numerous disciplines. It is the oldest and one of the largest undergraduate research conferences in the country.

- WRITTEN BY:
[Benjamin Borgmann-Winter](#) | UNH College of Life Sciences and Agriculture

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