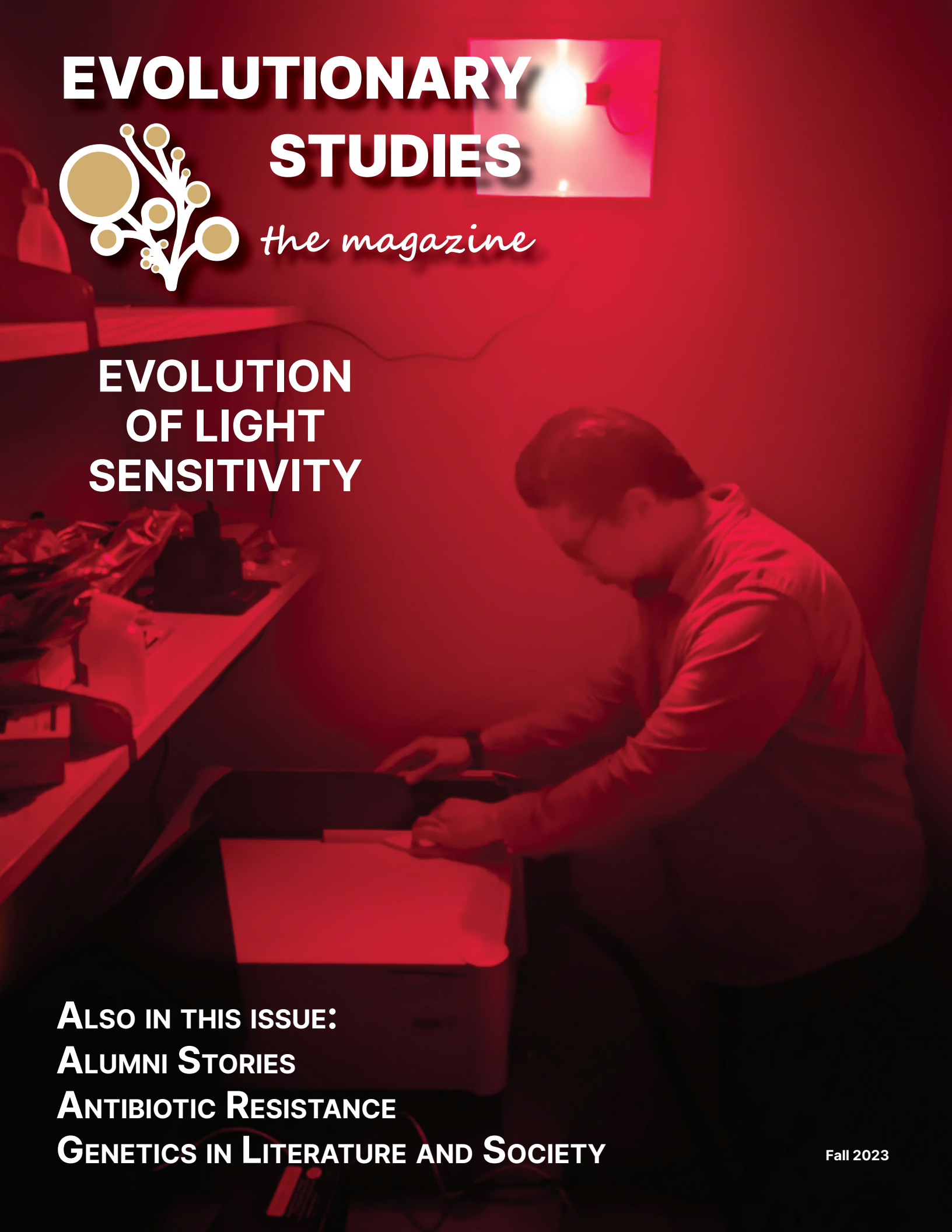
EVOLUTIONARY STUDIES

the magazine



EVOLUTION OF LIGHT SENSITIVITY

Also in this issue:
Alumni Stories
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Genetics in Literature and Society

Fall 2023

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EVOLUTIONARY STUDIES

VANDERBILT UNIVERSITY

VANDERBILT ESI

Greetings ESI Members, Alumni and Friends,

I hope this semester's magazine finds you well. As the fall semester and the year are ending, I can't help but feel very excited and proud with all that we have accomplished in 2023.

I will begin with pilot grants, which have been a soaring success this year. These grants are aimed at providing "seed" funding of cutting edge interdisciplinary evolutionary research. Of our previous trainee-awardees, three were awarded NSF GRFP fellowships. We were fortunate to be able to fund eleven applications this year in Biological Sciences (7), Earth and Environmental Sciences (3), and Medicine (1). These projects fund faculty (3), postdoctoral researchers (3), and graduate students (5). We have dedicated several pages in this issue to our pilot grant awardees (pages 16-21).

Back in late September, we successfully resubmitted our application to the National Institutes of Health to build our graduate program on computational evolutionary approaches for the study of disease. We are keeping our fingers crossed that this second submission will be the lucky one.

In October, we held our first-ever ES retreat. The more than 50 members of our community that took part enjoyed amazing talks by our three invited speakers, Prosanta Chakrabarty (LSU) and alumni Scott Egan (Rice) and Jen Mandel (Memphis), highly entertaining and very informative one-minute lightning talks from our trainees, staff, and faculty, and a wonderful social that included backyard games and a phenomenal coffee bar. You can read more about our retreat on page 15.

This fall, we were also incredibly fortunate to host Peter and Rosemary Grant (Princeton) for our inaugural Biodiversity Day Seminar. They spoke of their fundamental, decades-long work on the rapid evolution of the Galapagos Finches in front of a packed audience. Our trainees also had the honor of hosting Anne Stone (Arizona State), whose fascinating research focuses on ancient DNA and human adaptations and health. As we look into Spring 2024, we are gearing up for another three phenomenal events: our Darwin Day speaker (2/7) will be Neil Shubin (Chicago), whose type-specimen of Tik'taalik is currently on loan to the Academy of Natural Sciences in Philadelphia – much closer than its home in Canada! We also will host noted evolutionary biologist Carl Bergstrom (Washington) for our J.T. Scopes Lecture and noted evolutionary ecologist Sharon Strauss (UC Davis) for Earth Day.

We are thrilled by the strides we've made and the bright prospects for Evolutionary Studies at Vanderbilt. In this issue, you'll discover a wealth of exciting research conducted by our members and trainees. This edition features contributions from the Biological Sciences, Biochemistry, Medicine, Anthropology, English, and Earth and Environmental Sciences departments. We also have two new student writers, undergraduate Bryce Emanuel and graduate student Sarah Ward. We are grateful for your unwavering support and look forward to keeping you updated on our progress. Please feel free to contact us with any questions or ideas you may have.

Sincerely,
Antonis Rokas
Antonis Rokas, Director
Evolutionary Studies Initiative
Cornelius Vanderbilt Chair in Biological Sciences
Vanderbilt University

Photo credit Tracy Rokas

Dr. Antonis Rokas at The Evolution Store in NYC.

EVOLUTIONARY STUDIES the magazine

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SEMINAR SERIES '23/'24

Fall 2023

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Building Religious Cultural Competence for Effective and Inclusive Evolution Education

10/4 - Peter and Rosemary Grant
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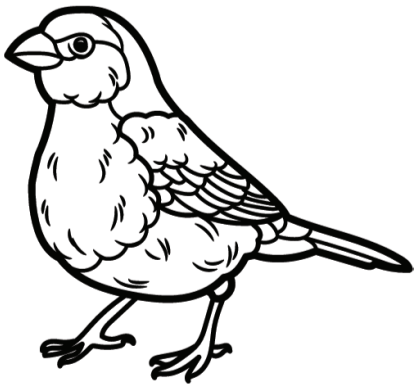
Biodiversity and the Evolution of Darwin's Finches



12/6 - Anne Stone
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TB and Leprosy: Insights into the Evolutionary History of Past (and Present) Mycobacterial Pathogens using Ancient DNA

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Darwin's Inner Fish

3/26 - Carl Bergstrom
University of Washington, Professor
Department of Biology
J.T. Scopes Lecture
Information Foraging in a Social Media World

4/3 - Sharon Strauss
University of California, Davis, Distinguished Professor Emerita
College of Biological Sciences
Earth Day
Evolution of Plant Communities

Find more information about our virtual seminar series on Vanderbilt.edu/evolution

*Photos submitted by the speakers

Welcome, Carlos Taboada!

Photo submitted by Carlos Taboada

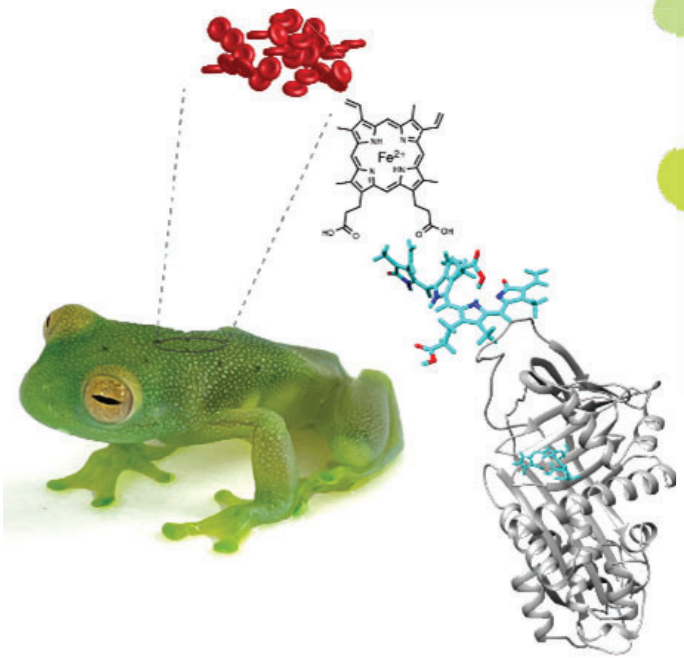
Carlos Taboada sporting his new ESI t-shirt!

Carlos Taboada is the newest member of the Vanderbilt University Evolutionary Studies Initiative. Taboada's research focuses on the evolutionary biochemistry of animal coloration.

In Taboada's words, "our lab lies at the interface of biochemistry, evolution, and visual ecology. We investigate the mechanisms that explain remarkable optical traits in amphibians, such as biological mirrors that amplify colored signals, the influence of fluorescence emission in the modulation of brightness, the convergent evolution of novel fluorescent proteins that make treefrogs green, and the physiological and metabolic mechanisms that make glassfrogs transparent."

Taboada started his journey in academia at the University of Buenos Aires, Argentina. He completed both a B.S. and a Ph.D. there. During graduate school, he joined the Herpetology Division of the Argentinian Museum of Natural Sciences. This is where he picked up a keen interest in amphibian biodiversity.

Taboada explained further, "I became increasingly interested in one aspect of the diversity: the origin of the striking variety of colors and color patterns in neotropical frogs. At the time, I had a colony of the polka dot treefrog, a species with a unique leaf-like color that allowed them to blend in with the vegetation where they lived. What I found exciting was that their blood plasma and lymph were blue and that depending on the distribution of their lymph, the animals could change colors, from blue, to green and even yellow."



A tree frog with a zoomed in view of blood and the proteins therein from the Taboada lab website.

While working on his Ph.D., he read Sönke Johnsen's book "The Optics of Life," which served as a catalyst for his research going forward.

According to Taboada, "I read it eagerly in a few days. After I finished it, I found myself thinking of many ideas to merge my passion for biochemistry, herpetology, and evolution and unify them in a visual ecology framework. I read his book during my second year of graduate school, and since then, I have been fascinated by optics in nature."

Taboada then earned a fellowship that allowed him to take on a postdoctoral position in Johnsen's lab at the Trinity College of Arts & Science at Duke University.

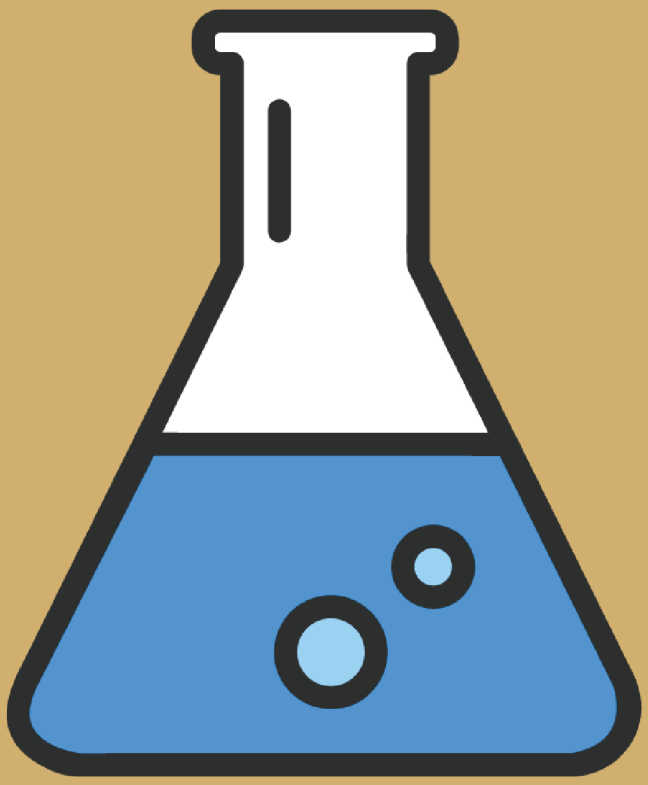
Taboada has made some interesting discoveries in his time studying the evolution of optics. One that he was really excited about was the ancestral function of a gene that now regulates leaf-like coloration in treefrogs.

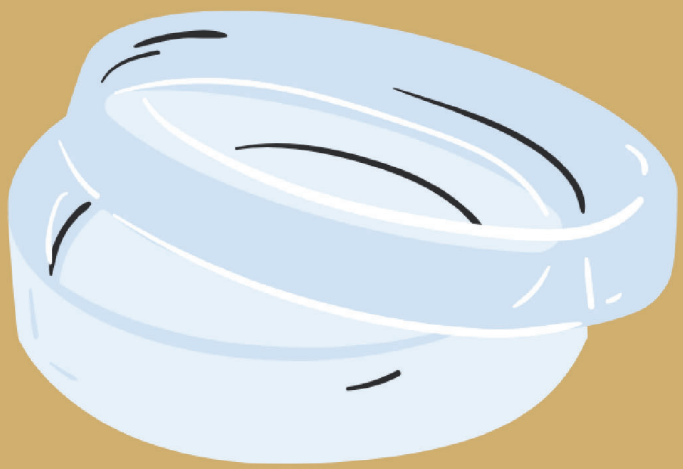
Taboada explained, "what was shocking was that their ancestral functions were related to the regulation of blood coagulation and inflammatory reactions and had nothing to do with color creation. But that's not all. I found that these proteins arose more than 40 times and even formed different gene copies. Also, they converged in their optical properties (they are blue/green and fluoresce in the infrared) but through other structural mechanisms. In my opinion, this is one of the most extreme cases of convergence in nature!"

Nashville is a great fit for Taboada as he joins us with a self-identified family of musicians. He also loves the nature available within a day trip around Nashville, specifically citing the mountainous countryside of middle Tennessee.

We are excited he is joining our group and can't wait to see where his research goes next here at Vanderbilt!

RESEARCH FEATURES





Behringer Lab

Researchers Reveal Insights into Bacterial Genome Evolution

In a study led by graduate student Carl Stone and his advisor, assistant professor of biological sciences, Megan Behringer, the team studied the effects of DNA repair pathways on genome-wide methylated DNA adenines (6mA). 6mA is a modification to DNA such that a methyl group is added on a nitrogen of adenine. This modification can influence various biological processes, including gene expression, DNA replication, pathogenesis and repair mechanisms.

According to Behringer, "*E. coli* uses 6mA to guide its mismatch repair system. When the DNA replication machinery makes a mistake and accidentally adds the wrong base causing a mismatch between the base pair, mismatch repair will replace the erroneous base with the correct one before it becomes a permanent mutation. There's a problem, though, how does the repair machinery know which base in the pair is the original base from the parent strand and which is the newly-added incorrect base? Well, when the DNA replication machinery synthesizes the new DNA strand, the newly added bases are not immediately methylated so during this time the parent strand is methylated but not the daughter strand."

This methylation allows the mismatch repair enzymes to correctly identify the parent strand to correct the other, mismatched base. Disabling mismatch repair enzymes, surprisingly, is not a lethal process to *E. coli* – it simply increases the volume of mutations or the mutation burden. As the primary purpose of 6mA is to guide mismatch repair, what happens to the methylations when the mismatch repair pathway is removed?

The team hypothesized that if they removed mismatch repair in *E. coli* and evolved the strains for several generations, they would see a reduction in these methylations.

Behringer followed up, "bacteria are very efficient, they don't want to waste anything; if they can shuttle that carbon somewhere else, they will. What we found neat was that we saw exactly that in these lines that we evolved. There was a global reduction in 6mA. That led us to our next question, are there specific bases that lose their methylation or is it a random process?"

The team found that for the most part the reduction in 6mA was more of a random process consistent with genetic drift. However, 6mA is involved in other processes such as gene expression, so the team does not expect it to disappear completely.

One application of this work is understanding the mutation process better. This process includes not just base mutations but epimutations as well. Epimutations occur when things like DNA methylations are changed and can lead to abnormal gene expression and even disease. Tracking 6mA mutations may provide a way to create a finer timescale to track evolution, which may already be the case in the field of plant evolution studies. Behringer expressed hope that using the tractability of 6mA evolution may be able to provide insights into future work in phylogenetics and systematics.

A second application comes in studying virulence of pathogens. Epimutations may increase or decrease the probability of turning on or off certain virulence factors, in other words, increasing or decreasing the probability of the pathogen becoming harmful.

Learn More >>

Photo submitted by Megan Behringer

Megan Behringer

Carl Stone digging for fossils at Coon Creek Science Center

Castiglione Lab

Vanderbilt Researcher Illuminates the Impact of Sunlight on Eye Function

A recent study by assistant professor of biology and ophthalmology Gianni Castiglione illuminates our understanding of eye diseases like macular degeneration. The paper, *Convergent evolution of dim light vision in owls and deep-diving whales,* was published in "Current Biology." Rhodopsin (RHO), a light-sensitive protein found in the rod cells of the retina in the eyes of vertebrates, produces a harmful by-product called all-trans retinal. Rod arrestin (Arr-1) helps eliminate it and may safeguard against toxic build-up.

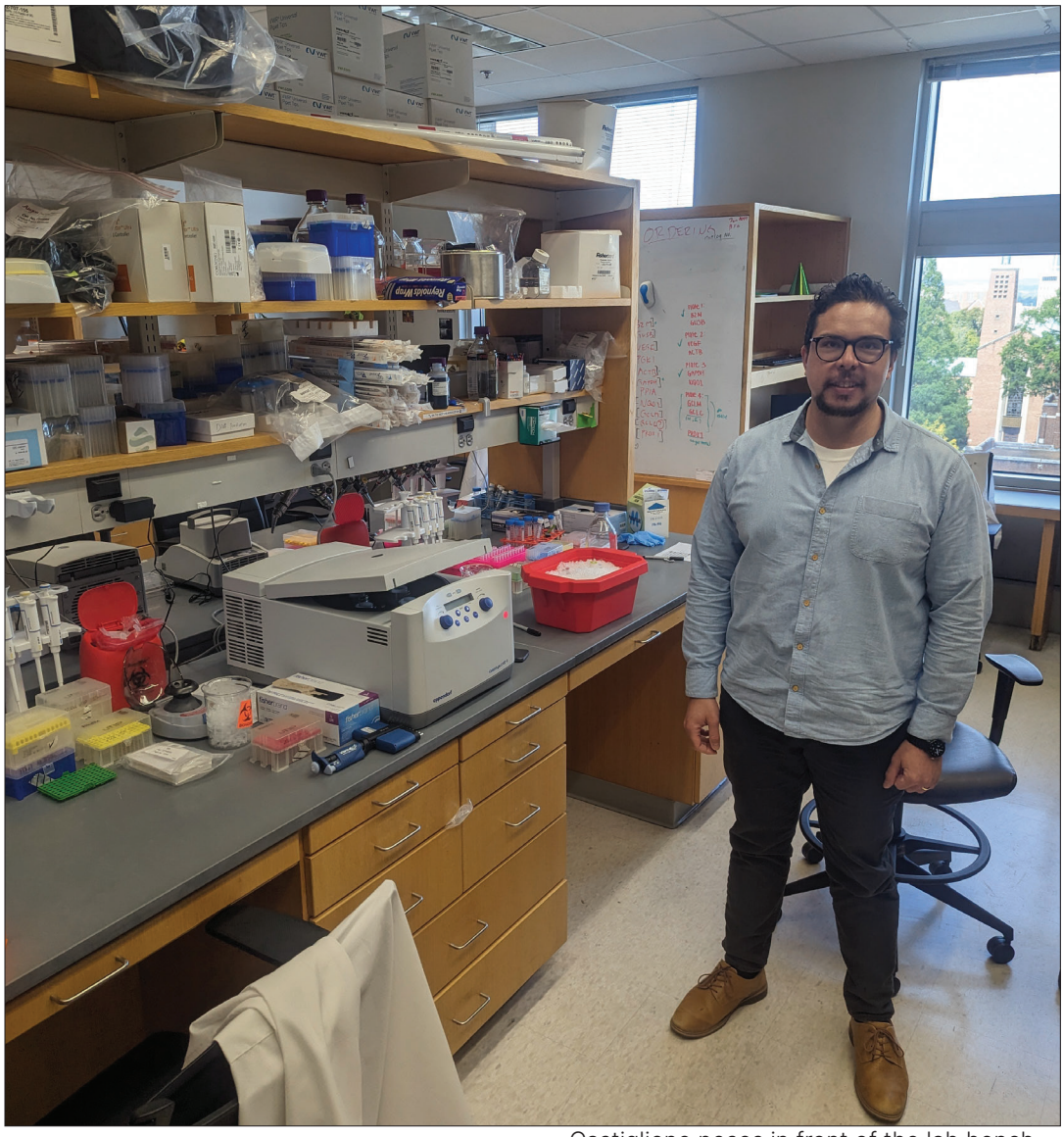
Photodamage risk from all-trans retinal varies among species, depending on dim-light sensitivity and light conditions. Nocturnal rodents are more vulnerable than primates, especially when exposed to sudden, intense light changes. The researchers predicted that animals facing high photodamage risk might have evolved Arr-1 to better handle all-trans retinal.

To test this prediction, the team of researchers looked at publicly available genetic data across species of mammals and birds. They found similar evolutionary trajectories in owls and deep-diving whales, creatures adapted for low light but sometimes exposed to intense light. Both groups of species showed an accelerated evolutionary change in Arr-1, sharing a common mutation. They then used lab studies to show that this mutation increased all-trans retinal sequestration by 30%.

Importantly, these groups of animals have independently evolved for 300-million years. This time between the species and the nearest common ancestor suggests that this is a case of convergent evolution, where the same genetic changes happen in two different lineages due to similar environmental pressures.

These findings extend beyond evolutionary biology, potentially helping us understand and treat eye conditions like macular degeneration and Stargardt disease, which is a rare genetic eye disorder.

Read more >>



Castiglione poses in front of the lab bench.

Merrikh Lab

New Avenue for Understanding Antibiotic Resistance Evolution

A new paper led by Houra Merrikh, showed that oxidative stress is a major factor in the evolution of antibiotic resistance in bacteria. The paper, *Oxidative stress drives mutagenesis through transcription-coupled repair in bacteria*, was published in the journal PNAS.

"Chemical reactions happen in our cells all the time. Most of them are controlled by the cell, and help it grow and perform its function. However, the byproduct of some essential reactions can be harmful for the cell. These reactions commonly involve oxygen since it is a very reactive molecule. When this molecule is present, it can cause oxidative stress. This type of stress caused by byproducts of oxygen metabolism can react with different parts of the cell, such as the DNA, RNA, or proteins, which will have both negative and sometimes positive consequences," explained Merrikh, Professor of Biochemistry and first author Juan Carvajal-Garcia's advisor.

The team tested the effects of oxidative stress on mutagenesis and the evolution of antibiotic resistance by exposing cells to different environments likely to reduce oxidative stress. They observed that mutagenesis and the evolution of antibiotic resistance were slower across diverse bacteria species.

Carvajal-Garcia used a metaphor to describe mutagenesis. Read the online version to see the metaphor!

Photo submitted by Houra Merrikh

Merrikh (left) and Carvajal-Garcia posing for a photo.

Clayton Group

Twenty Years of Understanding Genetics in Literature and Society

Jay Clayton, William R. Kenan, Jr. Professor of English, first received funding from the National Institutes of Health to study genetics in literature, film and popular culture in 2003. According to the application, this first grant funded, "a working group of scholars in literature, film, and media studies to examine the representation of genetics in literary and popular culture."

Twenty years later, it seems that Clayton has been extremely successful in developing a thorough understanding of this topic. In 2017, a group of researchers at Vanderbilt started the NIH-funded Genetic Privacy and Identity in Community Settings (GetPreCiSe).

According to Clayton, "this grant brought together a transdisciplinary working group at Vanderbilt to articulate best practices for genetic privacy in the age of big data."

Understanding how society views genetics has long been of interest to Clayton. In 2007, he published a single-authored paper (*Victorian Chimeras, or, What Literature Can Contribute to Genetics Policy Today*) about the passing of guidelines from the Institute of Medicine regarding DNA splicing. He showed how H. G. Wells had predicted such scientific developments in 1896 and foreshadowed some of the ethical concerns. He noted how several people, speaking at the guideline-development meeting, referenced scientific fictions including centaurs, minotaurs, and mermaids.

Since the GetPreCiSe program started, Clayton has showcased his commitment to mentorship by working with dozens of trainees under the program's umbrella.

According to Department of English chair, Jennifer Fay, "Clayton coordinates a research group varying in size between eight to twelve undergraduates, graduate students, and postdocs who work on multiple projects. Under Clayton's mentorship, numerous graduate students and undergraduates in the humanities have published as first-authors peer-reviewed papers (totaling more than 20 published to date)."

His work looks in depth at single pieces, like the Orphan Black series, single genres, like medical dramas, and even all genres of movies and television over the past 100 years.

Much of Clayton's work is in the field of genetic privacy and he uses movies like the Blade Runner series to illustrate and study the intricacies of privacy. Along with first author Kendra Oliver (Ph.D. '16) and co-author Stephanie Higgs (MA '10, Ph.D. '16), the team published an article titled, *The End of Genetic Privacy in the Blade Runner Canon*. The team found that the Blade Runner series portrays a potential future where private information is collected and exploited with little regard for personal privacy rights, reflecting real-world trends.

When asked about the negative depictions of genetics in film, Clayton said, "some of the scary ways genetic data are handled in Blade Runner 2049 are easy to imagine coming to pass in our own society. Both the government and private corporations maintain vast databases that correlate every person's DNA with their health record, consumer habits, driver's license, criminal record, political and religious views, and more. Of course, the movie also has many science fiction elements too, like human clones created for work in toxic environments and off-world slave colonies!"

Steve Green / Vanderbilt University

'On the Edges' Art exhibit with works from Vanderbilt Department of Art Faculty & Staff on display at a reception in the Curb Center on 1801 Edgehill Ave. Jay Clayton welcoming Mel Ziegler.

Vanderbilt Photo / Daniel Dubois

Jay Clayton Illustrating a story for A&S Magazine where he said that he became interested in genetics in literature because of dinner conversation with his wife, Dr. Ellen Wright Clayton (MD and lawyer at VU in genetics and health policy).

Along with first-author Lauren Furman (BA, '20), Clayton published a piece titled, *Genetics in Television Medical Dramas*. This study looks at American medical dramas on primetime television, which have been popular since the 1950s. These shows have gradually incorporated genetics into their storyline, with a significant increase in the number of episodes involving genetics since 2010. The pair found medical dramas increasingly focus on helping their characters manage genetic conditions. More illnesses are being attributed to genetics which is enabling in-depth exploration of genetic nuances and shaping viewers' understanding of these issues in healthcare and society.

Clayton then took the research one step further with graduate student Ethan Gibbons (Ph.D., '22) and undergraduate researcher Isaac Stovall (BA, '21) to 100 years of television and movies across genres. Clayton and Gibbons were featured in a video created by Vanderbilt University Communications and Marketing and a story from Evolutionary Studies about the changing views on genetics in film and television. See the story to learn more about how popular format entertainment has evolved its use and understanding of genetics.

This work culminated with Clayton recently publishing an open access book, "Literature, Science, and Public Policy: From Darwin to Genomics." This book explores the role and changing voices of literature surrounding important scientific developments and how those changes influence public policy.

A quote in the final chapter reads, "but there is one pragmatic function of literature that this book has urged us to embrace, and that is the role that literature might play in dialogues about the values our societies hold dear at a time when the world needs such voices more than ever."

Clayton's expertise in understanding and interpreting literature, television, and films as the role they play in society with an eye toward bioethics and the sciences is vitally important in supporting this development.

Read more >>

Keith Lab

Researchers Root US Maternal Health Disparities in the Social Environment

Monica Keith, assistant professor of Anthropology, recently published insights into the complex factors contributing to maternal hypertension and health disparities in a paper titled, *Social Determinant Pathways to Hypertensive Disorders of Pregnancy Among Nulliparous U.S. Women* in the journal Women's Health Issues. This research, based on an analysis of observational cohort data from the "Nulliparous Pregnancy Outcomes Study: Monitoring Mothers-to-Be," sheds light on the alarming rates of hypertensive disorders of pregnancy (HDP) in the United States, particularly among Black mothers.

The study's findings reveal that embodied stress rooted in the social environment plays a pivotal role in driving maternal hypertensive disparities. This research emphasizes the need for a more comprehensive understanding of the social determinants of health and their impact on maternal and intergenerational outcomes.

Mulubrhan Mogos, assistant professor of nursing and Keith's future collaborator, studies ways to reduce cardiovascular disease risk among women.

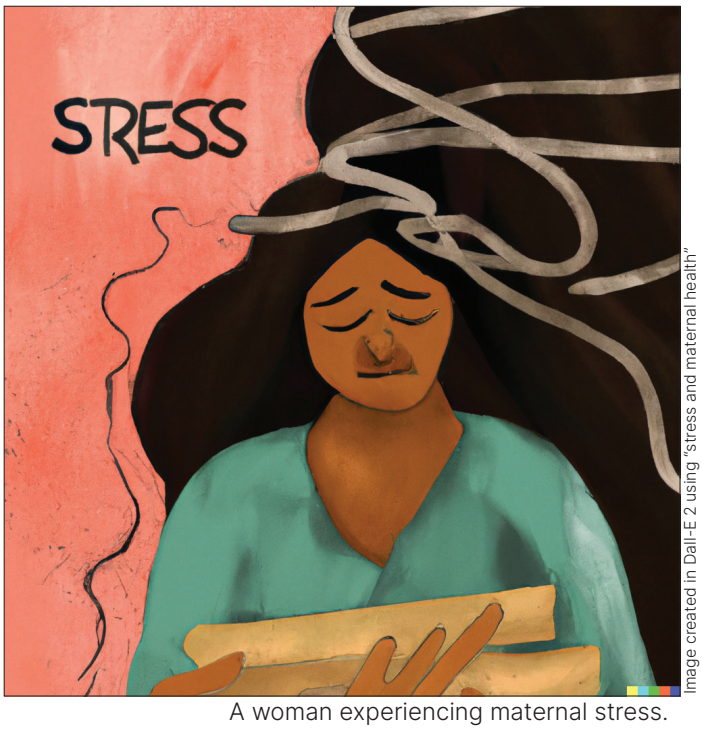
According to Mogos, "in the United States, hypertensive disorders of pregnancy (HDP) are documented in 31.6% of in-hospital deaths during childbirth. Innovative technology and data-driven approaches are vital for early HDP risk prediction and prevention, as well as mitigating long-term adverse outcomes. The application of wearable devices and telehealth solutions, as well as harnessing large datasets have the potential to lead to solutions that can reverse the disturbing trend in HDP-related maternal morbidity and mortality."

This study, conducted on a cohort of 6,501 participants, including 1,155 non-Hispanic Black mothers-to-be, revealed that non-Hispanic Black mothers exhibited significantly higher rates of hypertensive disorders of pregnancy (32%) compared to non-Hispanic White women (23%). Pathway modeling identified demographic aspects of the social environment, indexed by metrics such as household income and partnered status, as the most salient predictors of hypertensive risk, particularly among Black women.

Keith highlighted the critical findings from her research, "our study demonstrates that embodied stress rooted in the social environment is a major driver of maternal hypertensive disparities in the United States. Pre-pregnancy health also impacts the risk and severity of hypertensive outcomes. These disparities are deeply intertwined with systemic inequalities and underscore the significant impact of systemic stressors relative to individual health behaviors."

Read more >>

Monica Keith



A woman experiencing maternal stress.

Image created in Dall-E 2 using "stress and maternal health"

Rokas Lab

Postdoc Reveals Genomic Secrets of Ocean Sponges

By: Sarah Ward, Evolutionary Studies graduate communications assistant

Picture a thriving marine environment. Perhaps you envision a community as colorful and lively as "Finding Nemo," where massive schools of fish are flanked by sharks and sea turtles. What about sponges?

While perhaps less popular than their flamboyant counterparts, these organisms are the foundation of life in our oceans. Despite this, up until recently, we knew next to nothing about their genetic structure.

Research published by Vanderbilt post-doctoral fellow Karin Steffen this August 2023 in Genes, Genomes, and Genetics seeks to change that. Her paper, *Whole genome sequence of the deep-sea sponge* Geodia barretti *(Metazoa, Porifera, Demospongiae),* characterized the genome of the demosponge, *Geodia barretti*, via DNA sequencing. The paper was a result of her PhD work at Uppsala University in Sweden, and she plans to conduct similar work on Fungi during her time in the Rokas Lab at Vanderbilt.

According to Steffen, sponges emerged around 600 million years ago in the Ediacaran period, making them one of earth's earliest forms of life. A few years ago, scientists thought sponges could be the sister to all other organisms.

"Now we know that they're probably not," said Steffen, "but they still occupy an important position on the tree of life as one of its earliest branches."

As such, analyzing the DNA of sponges can provide clues as to which genetic traits are foundational to the evolution of complex organisms which contain more advanced adaptations such as nerve cells, multiple layers of tissue, and organs. When Steffen started this work, there were only nine published sponge genomes. For an organism this old, that leaves significant gaps (several million years of gaps) in its evolutionary journey.

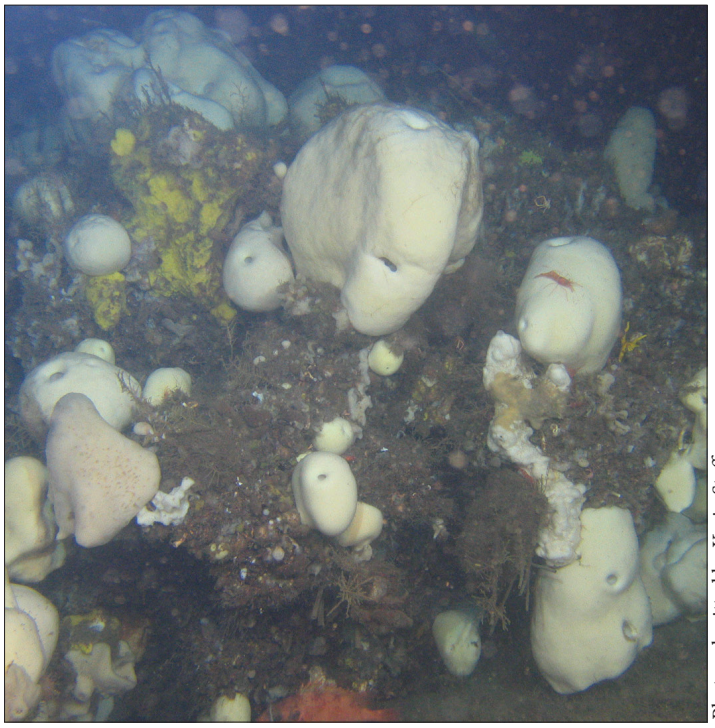


Photo submitted by Karin Steffen

Geodia barretti in their natural habitat.

To collect sponge samples for analysis, Steffen set sail on a research cruise off the coast of Sweden. Once she and her colleagues hit the continental shelf, which is where sponges like to attach themselves, Steffen and others sent a Remotely Operated Vehicle (ROV) underwater to search for samples. Using live video, Steffen would choose which sample she wanted the ROV to collect. This wasn't always easy.

"Sometimes, you would try to collect a sample and instead see it fall into the abyss," said Steffen.

Following sample collection, Steffen worked to sequence sponge DNA at her home institution in Sweden. This also came with challenges. For one, sponge DNA tends to be highly contaminated with microbes.

"It was the equivalent of sequencing DNA from a stool sample," said Steffen. Typically, scientists might remedy this issue by comparing their genome to others published in the literature. This helps to distinguish between DNA from the host and DNA from the microbes. Due to the lack of published data, for Steffen, this wasn't an option.

Read more >>

Photo submitted by Karin Steffen

Steffen with her research subject, the deep-sea sponge.

Boudko Lab

Collagen IV and the Aspirnauts

By: Bryce Emanuel, Evolutionary Studies undergraduate communications assistant

Sergei Boudko, a research assistant professor of Medicine in the Division of Nephrology and Hypertension, recently published a paper, *Collagen IV of basement membranes: IV. Adaptive mechanism of collagen IV scaffold assembly in* Drosophila. Boudko earned his Master's degree in Applied Physics and Mathematics from the Moscow Institute of Physics and Technology and a Ph.D. from the University of Basel in Switzerland.

Boudko's research focuses on a specific class of collagen, known as collagen IV, which plays a pivotal role in the intricate processes of kidney function. Collagen IV acts as a mesh, influencing the kidney's filtration abilities. Boudko aims to unravel the mysteries surrounding this collagen type, particularly its implications in various kidney diseases, including Alport syndrome, Goodpasture disease, and diabetic nephropathy, which may lead to kidney failure.

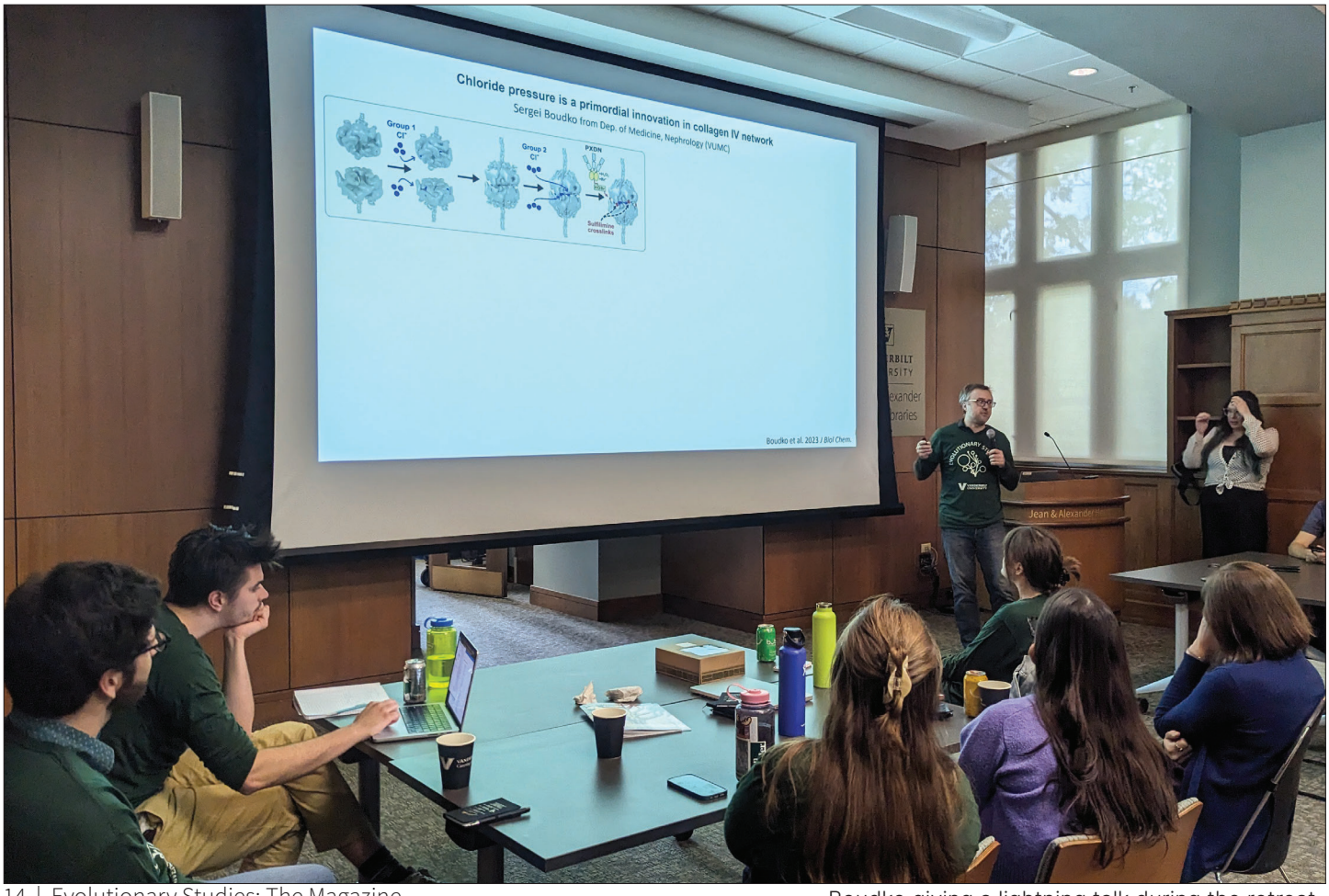
Budko's research is novel in that he uses evolution as a lens to examine the kidney. Boudko's team found that collagen IV is found in a wide variety of organisms, leading to a better understanding of the relationship between humans and other species. Boudko used two methods to understand how collagen IV manifests. The first is through characterization of the manner by which collagen IV links to form a mesh. Boudko's collaborator, research assistant professor Elena Pokidysheva, examines the manner by which collagen IV has assembled through evolution. This is in service to understanding where the individual components of collagen IV appeared in evolution.

A noteworthy aspect of Boudko's project is the collaborative effort with "Aspirnauts," a group of 25 high school students passionate about science. These students, who were in high school during the paper's publishing, actively contributed to the project's success.

Read more >>

Photo submitted by Sergei Boudko

Sergei Boudko



Boudko giving a lightning talk during the retreat.

ESI First Annual Retreat

Evolutionary Studies hosted our first annual retreat this fall. On the first night, trainees had dinner with our honored guest-speakers, Prosanta Chakrabarty, curator of fishes at the LSU Museum of Natural Sciences, Scott Egan, associate professor at Rice University and Ph.D. alumnus of VU's Daniel Funk, and Jennifer Mandel, associate professor at the University of Memphis and Ph.D. alumna of VU's late David McCauley.

On day two, the action picked up with a morning of interesting talks from our featured speakers. We heard about the evolution of fish - we're all fish, after all - the evolution of sunflowers, and the evolution of gall-forming insects.

After a lunch break, we came back with ESI-member lightning talks. These talks were one minute, one slide (loosely defined) and featured over 40 of our members - including trainees, faculty, and staff. These quick hitters provide a nice overview of everyone's work and helped our group - which spans five colleges - get to see some of the connecting threads that run through everyone's research.

Next, we had a sort of scientific blind dating where folks spent a few minutes getting to know others in different departments they may not normally get to interact with. This opportunity sparked some new collaborations and we look forward to the research outputs ahead. Finally, we ended with a happy hour, a coffee cart from the Proverbial Cup, and yard games.

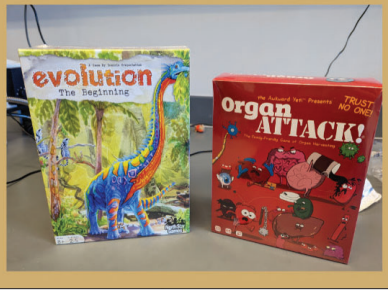
We can't wait for next year!

Right: feedback from our post-retreat survey. Below: left, cornhole tournament from the retreat social hour and right, evolution-themed game nights!

• TRAINEE-FOCUSED FUN •

ESI GAME NIGHT

MONTHLY EVOLUTION-THEMED GAMES



PILOT GRANTS

2023 a Boon for Pilot Grant Applicants

Over the past 2 years, we've given out more than 20 pilot grants to graduate students, postdoctoral researchers, and faculty. These grants help motivate cross-disciplinary collaborations and open up labs and students to new areas on inquiry. Each grant provides around $5,000 for research support. In our first year, Spring 2022, we gave out seven pilot grants. In Fall 2022, we gave out just four pilot grants. This past Spring, we were lucky enough to fund all eleven applicants. Over the next several pages, you will learn about the current 11 awardees and what research projects they are up to.

Full versions of stories written by our student writers will be available here >>

Submitted photo

Jamisha Francis

Uropathogenic Bacterial Evolution

Jamisha Francis is a new Ph.D. student in the lab of Maria Hadjifrangiskou. Her pilot grant topic is *Does the urobiome or recurrent infection affect UPEC pathogenic potential evolution?*

Francis hopes to accomplish two aims with this grant. First, she will investigate the effects of *A. schaalii* on uropathogenic *E. coli* (UPEC) evolution, metabolism, and biofilm formation. She will use electron and confocal laser scanning microscopy to visualize the interactions.

"Our findings have the potential to... open avenues for probiotic therapy discoveries."

She will then define the evolution of UPEC during an acute urinary tract infection. The Hadjifrangiskou lab frequently uses a murine urinary tract infection model to discover UTI dynamics. Francis will rely on this method to investigate UPEC evolution over time and use next generation sequencing to identify mutations.

According to Francis, "this work is significant, because it will be the first to determine how uropathogens respond to the presence of urinary microbiota and how such interactions influence pathogen evolution. Our findings therefore have the potential to change current paradigms in UPEC pathogenesis and open avenues for probiotic therapy discoveries."

Francis' past experiences leave her well-equipped to tackle such a project. She earned her B.S. (cum laude) in Biology from the University of the Virgin Islands with a minor in Psychology. She then completed a M.S. in Microbe-Host Interactions here at Vanderbilt where she studied *Streptococcus agalactiae* pathogenicity. In 2022, she also spent some time with Pfizer in Pearl River New York where she gained skills in isolating genomic DNA, next generation sequencing, and analysis of sequence data. This year, she even earned a Scientific Leadership Certificate from the Owen Business School Executive Education Program.

We're excited to see where this research goes!

Triassic Marine Reptile Evolution

Submitted photo

Neil Kelley

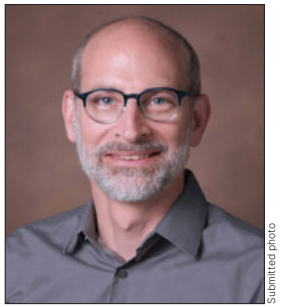
Neil Kelley, Assistant Professor in the Department of Earth and Environmental Sciences, will embark on a project titled "Finding and Digitizing 'Forgotten Gems' of Triassic Marine Reptile Evolution." This project focuses on exploring previously collected but understudied fossils to gain critical insights into the early evolution of reptiles in Mesozoic oceans.

Over the 2023 / 2024 academic year, Kelley plans to visit collections in Boston, California, and Canada, where he will study Triassic ichthyosaur and thalattosaur fossils. The institutions involved in the project include the Museum of Comparative Zoology at Harvard University, the University of California Museum of Paleontology, the California Academy of Sciences, and the Royal Tyrell Museum of Natural History. Kelley also aims to involve Samir Cancel-Matos, a first-year PhD student in EES, in this venture, providing him with exposure to key questions in marine reptile evolution and practical experience in working with museum collections.

Goals and Hypotheses:

While many paleontological endeavors prioritize fieldwork for new discoveries, Kelley's proposal takes a unique approach by using museum collections filled with overlooked and neglected fossils. The primary goals include lost and forgotten fossils and creating digital assets, such as 3D models through photogrammetry and microCT scanning, to share these valuable resources with the international scientific community.

Unlocking the Secrets of Genome Maintenance



Submitted photo

Brandt Eichman

William R. Kenan, Jr. Chair of Biological Sciences, professor Brandt Eichman, is researching the atomic-level molecular structures and mechanisms of enzymes involved in genome maintenance. This project investigates the fundamental processes of DNA replication and repair; essential for the proper functioning and evolution of all living organisms.

"One ongoing project involving a structural evolution approach is aimed at understanding how DNA repair proteins serve as self-resistance mechanisms for the production of DNA-damaging toxins by antibiotic-producing bacteria," said Eichman. This research not only contributes to understanding cellular function but also addresses the broader implications of specialized DNA repair proteins in secondary metabolite production, particularly in antibiotic-producing bacteria.

Understanding the self-resistance mechanisms of DNA repair proteins can pave the way for novel biological and biochemical insights, potentially leading to the discovery of new mechanisms in enzyme function. Moreover, this research has implications for increasing the yield of natural products from re-engineered producing organisms, offering promising avenues for the development of antimicrobial and anticancer drugs.

Goals of the Research:

The overarching goal is to decipher the molecular structures of enzymes involved in genome maintenance, providing a framework to understand the outcomes of evolution at the amino acid and structural levels. By combining structural information with phylogenetic and genomic analysis, the team seeks to explore how genes related to genetic information exchange evolve and impact cellular function.

PILOT GRANTS

Horsing Around with Sea Horses

Gianni Castiglione

Gianni Castiglione, Assistant Professor of Biological Sciences, is set to lead an innovative research project titled "Exploring Metabolic Evolution in Horses (Equus) using Seahorse Assays." Representing a new direction for the Castiglione lab, this study delves into the metabolic networks of horses, aiming to unravel how these majestic creatures have evolved to cope with oxygen-starved environments during endurance running.

According to Castiglione, "horses, with their exceptional endurance, present a unique opportunity to explore how the body adapts to extreme physiological demands. Our research suggests that HIF-1 is hyperactive in horse cells and muscle tissues, revealing potential insights into enhanced glycolysis. This not only expands our understanding of equine physiology but may also shed light on how horses have evolved to thrive in oxygen-deprived conditions."

Goals and Hypotheses:

Building on their prior research in avian metabolic adaptation related to flapping flight, the Castiglione lab is now turning its attention to Equus, investigating the physiological adaptations that enable horses to achieve unparalleled endurance running. The research focuses on understanding how horses cope with periods of oxygen starvation during their demanding physical activities and if the transcription factor HIF-1 plays a central role in their hypoxic response.

Uroprotective Traits in Bladder Commensal Bacteria

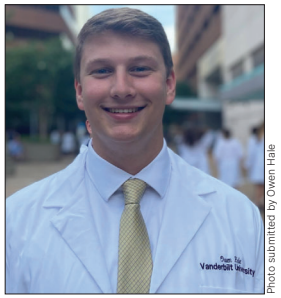


Photo submitted by Owen Hale

Owen Hale

Owen Hale, under the guidance of Dr. Megan Behringer, assistant professor of biological sciences, is spearheading a research project to understand the diversity of uroprotective traits in bladder commensal bacteria. This endeavor holds promising implications for uncovering novel insights into urinary tract health and the adaptive landscape of uropathogenic *Escherichia coli* (*E. coli*).

According to Behringer, "the complexity of interactions between uropathogenic *E. coli* and commensal lactobacilli is a fascinating puzzle that we aim to solve through cutting-edge techniques such as RB-TnSeq."

A crucial aspect of the research involves understanding the tradeoffs associated with resistance mutations. By validating knockout phenotypes identified by RB-TnSeq and measuring the fitness of select mutants in coculture with each *Lactobacillus* strain, the team aims to explore potential tradeoffs in resistance mutations.

Hale plans to apply for an NIH F31 fellowship for further support in completing the project. Additionally, the research groups of Dr. Behringer and Dr. Sysoeva are part of a consortium developing an application for an NIH Program Project grant, reflecting the collaborative and impactful nature of their work.

Project Objectives:

The adaptive landscape of uropathogenic *E. coli* is intricately linked to the native bladder microbiota, predominantly composed of lactobacilli associated with urinary health. The project seeks to unravel the mechanisms by which lactobacilli inhibit E. coli growth and explore the adaptive gene loss landscape in the presence of different commensal *Lactobacillus* species.

Unlocking the Mysteries of mtDNA 6mA in Eukaryotes

Submitted photo

Lantana Grub

Lantana Grub, graduate student in Maulik Patel's lab, will work on an exploration of mitochondrial DNA (mtDNA) epigenetics. Grub and the Patel Lab are diving into the role of N6-methyldeoxyadenosine (6mA) in eukaryotes, particularly in the model organism *C. elegans*. Eukaryotes, including humans, trace their origins back to an ancient endosymbiotic event, marking the birth of the mitochondria, which have retained their semi-autonomous status over billions of years. The retention of a small but essential mtDNA has long intrigued scientists, and the Patel Lab aims to unravel this mystery by investigating the presence and function of 6mA, an epigenetic modification commonly found in prokaryotes.

"Ultimately, this research will provide essential information about how mtDNA epigenetics is affected by environmental stress and the role it has in adaptation to metabolic stress." said Patel.

The project led by graduate student Grub, will also get valuable assistance from rising junior Marleigh Carter, an undergraduate in the Molecular and Cellular Biology program at Vanderbilt.

Goals and Hypotheses:

Leveraging Nanopore sequencing, the team aims to identify 6mA sites in wildtype C. elegans with unparalleled single-base resolution. This cutting-edge technique will unveil the distribution of 6mA sites, offering critical insights into its potential functions, such as marking sites of replication initiation.

A Glimpse into the Dietary Evolution of Sabertooth

Photo submitted by Jay Pardo

Jay Pardo

In a quest to unveil the dietary secrets of *Smilodon fatalis*, (the sabertooth cat), graduate student Jay Pardo and Professor Larisa DeSantis embark on a research project titled "The Changing Menu of Sabertooth Cats: Dietary Ecology of *Smilodon* During Glacial and Interglacial Periods of the Pleistocene."

Rancho La Brea, home to the largest collection of *S. fatalis* specimens globally, provides a rich archaeological backdrop for this investigation. By leveraging previously collected stable isotopes and dental microwear data, the team aims to select individuals spanning glacial and interglacial periods, as well as the arrival of humans.

The study is poised to address a pivotal evolutionary question: How did the arrival and expansion of human populations in North America influence the interactions between *Smilodon*, an apex predator, and its prey? The integration of sulfur isotopes in the analysis of Smilodon's mandibular bones promises to shed light on the potential changes in home range sizes and the utilization of coastal habitats in response to environmental and anthropogenic factors.

According to Pardo, "the ESI pilot grant allows me to conduct a comprehensive study on the dietary ecology of *Smilodon*. This funding allows me acquire cutting-edge technology for dental microwear and stable isotopes lab work analyses. The significance of this funding extends beyond my research and will contribute to the broader scientific community's understanding of prehistoric ecosystems and ecological dynamics."

PILOT GRANTS

Exploring the Harmonies of Evolution

Kate Snyder

A team of researchers led by Dr. Kate Snyder, with guidance from advisor Prof. Nicole Creanza, is set to unravel the intricate melodies of bird song and its evolutionary implications. The project, funded by a Pilot Research Grant in Evolutionary Studies, delves into the relatively unexplored realm of female bird song and its connection to complex reproductive behaviors.

"One of our goals is to understand how sexual selection for song complexity is altered in species with cooperative breeding behaviors," said Snyder.

Using songbirds as a model system, the team leverages the diversity of life history strategies and songs across species to investigate the evolutionary consequences of complex reproductive behaviors. Preliminary data suggests that approximately 10% of songbird species frequently exhibit cooperative breeding social behaviors, offering a rich dataset to explore the interplay between cooperative breeding, sexual selection, and the evolution of bird song.

Goals and Hypotheses:

Bird song, traditionally considered a primarily male trait, plays a crucial role in mate attraction, species recognition, and social interactions. Dr. Snyder's research challenges existing paradigms by investigating the occurrence, functions, and selection pressures on female bird song. The project aims to understand the influence of female preferences on male song complexity and the broader implications for evolutionary processes.

Evolutionary Mismatch in Human Populations

Photo submitted by Marina Watowich

Marina Watowich

Postdoctoral researcher Marina Watowich of the Lea Lab, in collaboration with the Turkana Health and Genomics Project (THGP) and the Tsimane Health and Life History Project (THLHP), embarks on a journey to investigate clonal hematopoiesis of indeterminate potential (CHIP) and its potential links to cardiometabolic health across two populations undergoing rapid lifestyle transitions—the Turkana of Kenya and the Tsimane of Bolivia.

The study will integrate genomic and biometric data, focusing on two populations. Both groups are undergoing rapid transitions from traditional to urban lifestyles.

Clonal hematopoiesis, an over-representation of blood cells derived from a single clone, has emerged as a critical area of study, particularly when mutations occur in cancer-associated 'driver' genes. This project will explore the prevalence of CHIP and its potential role in cardiovascular diseases, stroke, and coronary heart diseases. By investigating CHIP prevalence and its association with cardiometabolic health, the team will study environmental mismatch and the molecular-level manifestations of this phenomenon.

Recognizing the importance of community engagement, the team will communicate the results of the study with respect and transparency. The project is not just a scientific endeavor; it is a collaborative effort to advance understanding and improve health outcomes.

According to Watowich, "The funding from the ESI pilot grant allows me to quantify the prevalence of specific somatic mutations among individuals from small-scale, subsistence-level societies. As one of the first datasets of its type, this will yield important insights into the rates of somatic mutations throughout aging in these populations."

Preserving Tennessee's Unique Ecosystem

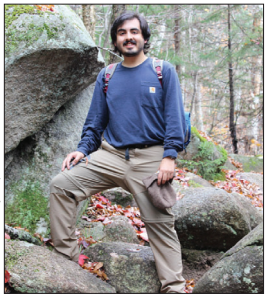


Photo submitted by Alejandro Prieto

Alejandro Prieto

Limestone cedar glades, a distinctive and fragile ecosystem, are primarily located within the Central Basin of middle Tennessee. Dr. Elsie Quarterman, a pioneering figure in Biological Sciences at Vanderbilt, laid the foundation for understanding the ecology of these glades. The glades, characterized by Lebanon limestone and a karst topography resulting from water erosion, face seasonal variations that pose unique challenges to the flora inhabiting them.

Photo submitted by Dante Hernandez

Dante Hernandez

In an effort to safeguard the unique limestone cedar glades of middle Tennessee, a team of researchers led by Alejandro Prieto, a PhD student in Earth and Environmental Sciences, is conducting a study.

According to Prieto, "the Pilot Grant offers us the ability to work with others outside of Vanderbilt University, like Metro Parks, and perform meaningful research that can be applied in real management plans for Cedar Glade ecosystems in Tennessee."

We look forward to seeing their progress!

Impact of Air Pollution on Plant Phenology

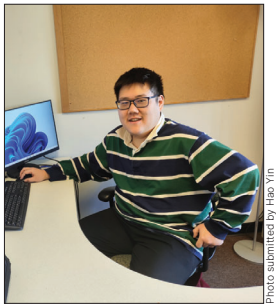


Photo submitted by Hao Yin

Hao Yin

Hao Yin, a Postdoc in Earth and Environmental Sciences, will investigate the relationship between air pollution and plant phenology. As atmospheric pollution continues to rise, posing threats to both the environment and human health, understanding its impact on plant life becomes increasingly important.

According the grant, over the past few decades, rapid industrialization and urbanization have led to a surge in atmospheric pollution, with pollutants such as nitrogen oxides, sulfur dioxide, ozone, carbon monoxide, and particulate matter reaching alarming levels. While the detrimental effects of these pollutants on air quality and human health are well-documented, their impact on plant life remains a lesser-explored area. The team will bridge this gap with comprehensive understanding of how air pollutants influence plant phenology, contributing insights to environmental conservation and agricultural management.

The study has three objectives: 1) investigate potential correlations between air pollutants and plant spring phenology, 2) identify key atmospheric pollutants with the greatest influence on spring phenology, and 3) determine if there is a pollutant concentration threshold that triggers substantial changes in spring phenology.

According to Hao Yin, "while the detrimental effects of these pollutants on air quality and human respiratory systems are well-documented, their impact on plants is less explored. This ESI grant will allow us to understand the responses of vegetation phenology to air pollution, in order to develop strategies for conservation and management in the face of climate change."

New Student Writers

Sarah Ward - Volcanologist

Sarah Ward, a current Ph.D. student at Vanderbilt University in Earth and Environmental Sciences (EES), has a passion for volcanic hazards mitigation, a fascination that took root during an internship with the USGS Volcano Cascade Society in Vancouver. Growing up in Washington, D.C., where both of her parents work in the government (her father as a lawyer and her mother for the National Park Service), Ward developed a keen interest in the natural world, particularly volcanoes.

Drawn to the field after witnessing the eruption of Fuego volcano in Guatemala, Ward found a kindred spirit in her mutual love for pumice and joined the lab of Kristen Fauria at Vanderbilt. Fuego's eruption served as a catalyst for her dedication to understanding and mitigating volcanic hazards.

Ward's educational journey began at Carlton College outside Minneapolis, where she pursued her undergraduate degree. She graduated in 2019 with a bachelor's degree in Geology. She published an integrated comprehensive exercise titled *Textural Characteristics of Pumice from a Postglacial Plinian Eruption at Laguna del Maule, Southern Chile: Implications for Magma Ascent Dynamics*.

Along with her interest in geology, she also spent time as a Carleton Knightingale, singing in the oldest a cappella group at Carleton College. You can even find a solo of hers on YouTube!

Ward also spent time in the Maloof lab at Princeton University where she was a laboratory technician. She primarily worked on sample processing using carbon isotope mass spectrometry to understand climate data from sedimentary rock deposits.

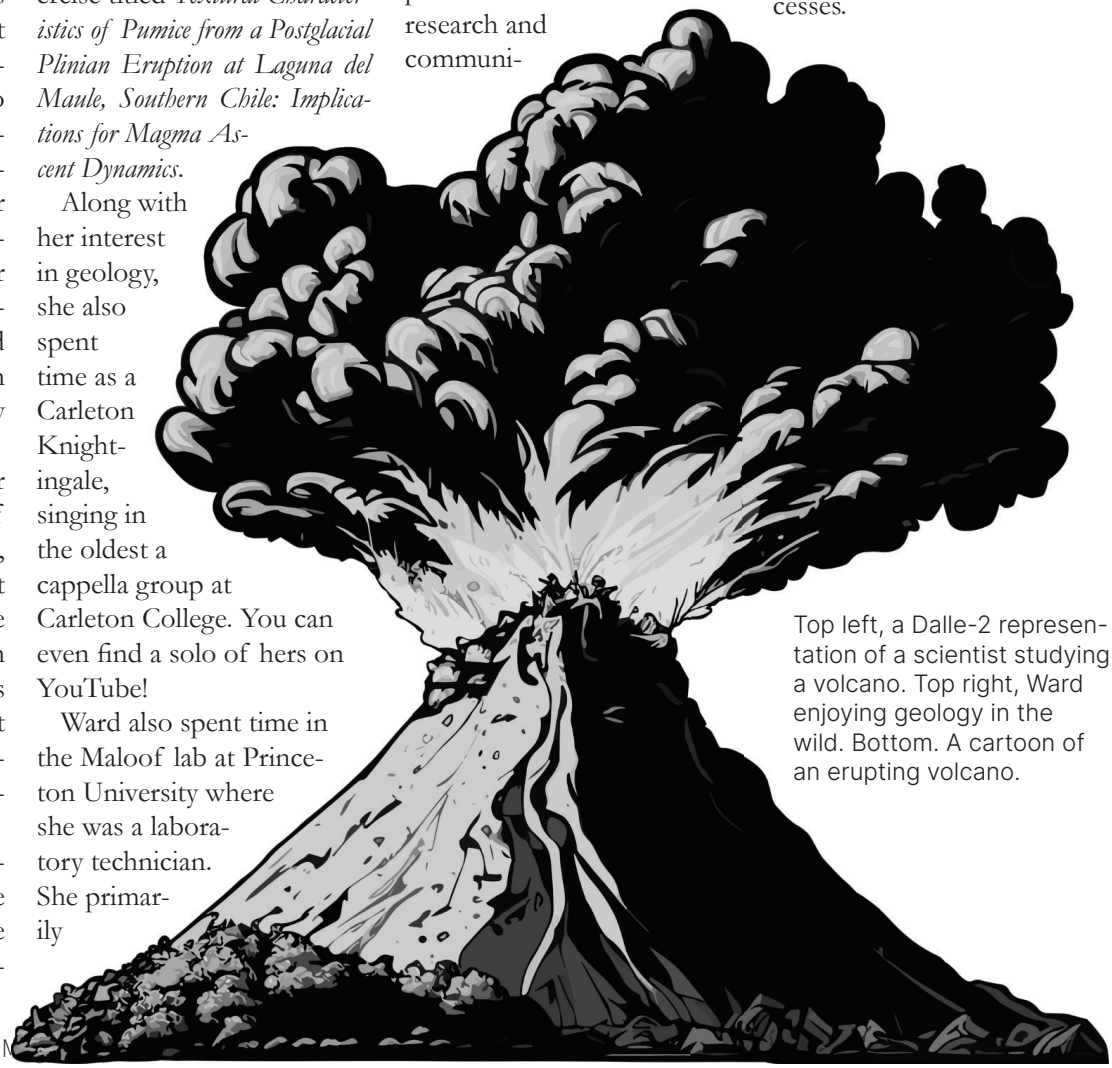
After Princeton, she joined the Vanderbilt community where her decision to pursue her Ph.D. was influenced by the university's exceptional EES program.

She noted, "the culture of EES is awesome!" while emphasizing the supportive and collaborative environment that has played a pivotal role in shaping her academic pursuits.

Looking forward, Ward aspires to combine her research and communication skills to contribute to volcanic hazards mitigation. She envisions a career that involves both scientific research and science journalism, recognizing the importance of effectively communicating scientific findings to the broader public.

Submitted photo

With a focus on volcanic hazards mitigation, Ward is dedicated to making impactful contributions to the field and fostering public understanding of geological processes.



Top left, a Dalle-2 representation of a scientist studying a volcano. Top right, Ward enjoying geology in the wild. Bottom. A cartoon of an erupting volcano.

New Student Writers

Bryce Emanuel - CSET and Beyond

CSET Storytelling

Bryce Emanuel, with interest in Communication of Science and Technology was part of a group who collaborated on an immersive writing challenge. The challenge involved making sophisticated science, technology, engineering, and math (STEM) topics compelling for fourth graders through storytelling. Working on the "Who Me? I'm a … Now!" book series, targeted at fourth and fifth graders, Emanuel expressed their love for science and the opportunity the project provided to delve into new research while using their creative side.

The series, initiated by Professor David Weintraub, focused on the inspiring origin stories and professional lives of Vanderbilt STEM professors. Emanuel highlighted their motivation for participating in the project, stating, "And if I can make a child feel like they can do something cool when they grow up, I feel like I've accomplished my job." The students involved in the project, including Emanuel, had to think like 10-year-olds, incorporating stories about the professors' childhoods and using special readability software to ensure age-appropriate content.

One notable aspect of the project was the students' exploration of real-life issues faced by the professors, discussing how to sensitively address topics in the professors' research and lives. In particular, Emanuel mentioned the impact of interviewing paleobiologist Larisa DeSantis, who shared her journey growing up with epilepsy. Additionally, Emanuel highlighted the significance of discussing mental health, as demonstrated by Professor Sandy Rosenthal, known for her breakthrough work in nanocrystals and quantum dot chemistry. Rosenthal openly shared her experiences with bipolar disorder, emphasizing the importance of embracing one's personal story and overcoming challenges.

Emanuel and the other students appreciated the professors' willingness to showcase their humanity alongside their groundbreaking work. The hope is that these personal stories will resonate with elementary readers, inspiring them to see scientists as real people with diverse experiences and encouraging them to pursue STEM fields.

Read more of the original story by Amy Wolf here >>

Vanderbilt University

Carly Stewart (left) and Bryce Emanuel collaborate in David Weintraub's CSET class.

Beyond CSET:

Emanuel, pursuing a Bachelor of Arts at Vanderbilt University with a major in Human Computer Interaction and a minor in Neuroscience, is set to graduate in May 2024. Their academic journey has been enriched with coursework in Systems Engineering, Neuroscience, Python, Technology Strategy, and Rapid Prototyping. Fluent in French and professionally proficient in Spanish, Emanuel possesses strong language skills.

Emanuel served as a User Experience Content Design Intern for the PocketLab team, enhancing the website while conducting usability testing, writing digital content, and presenting insights

Vanderbilt University

for potential improvements to the overall UI design. Additionally, Emanuel has been an invaluable asset to the Vanderbilt Department of Computer Science STIR Lab, working as an undergraduate research assistant. Their contributions include analyzing Instagram direct messages to design a user-centered interface promoting adolescent safety, and assisting in usability testing for digital interfaces tailored to adolescents' needs.

Emanuel's commitment to research is demonstrated through their involvement in the SyBBURE Searle Undergraduate Research Program since December 2019. This four-year commitment involves part-time research during the academic year and full-time research in the summer, with Emanuel receiving individualized mentorship and training. Noteworthy projects include Doresto-Doors, a website promoting disability inclusivity on Vanderbilt's campus, and "The role of CaMKIIα in tactile behaviors and autism," a research endeavor exploring the impact of a novel mutation on sensory and social phenotypes related to Autism Spectrum Disorder.

Beyond academia, Emanuel engages in diverse interests such as poetry, photography, science communication, digital design, and social activism. ESI is lucky to have Emanuel as our undergraduate student writer!

Outreach Efforts

The Dismas House and Coon Creek Science Center

In 2023, ESI has focused on two outreach activities. The first, spearheaded by postdoctoral researcher in the Rokas lab, Kyle David, brings men from the Dismas House residential re-entry program into Vanderbilt for lab tours and a hands-on lab experience. This past semester, the hands-on lab was led by graduate student Nadir Dbouk of the Castiglione lab.

Submitted photo

According to Dbouk, "my hope is that through our interactions, the guys gain a sense of accomplishment and a tangible connection with the science they're exploring. Engaging them in hands-on activities like transfections to observe GFP (green flourescent protein) under a fluorescent microscope, and extracting DNA from strawberries that they can take home, I aim to provide a real and interactive experience."

Our second outreach activity has turned into an annual trip originally funded by a regional outreach grant from the Society for the Study of Evolution to take metro Nashville high school students to the Coon Creek Science Center to do fossil digging and learn about evolution. This year, four students and three postdocs dug for fossils while getting to know the high school students. After lunch, the ESI crew explained a bit about their academic journies and their evolution-focused research in short presentations. Finally, the ESI group worked with small groups of students to create food webs based on the fossils they found and compare those food webs to extant food webs - or in one case - a food web of the distant future.

Katie McCormack, graduate student in the Benn Torres lab, joined our inaugural trip last year and this year's trip. According to McCormack, "both the high school students and everyone from Vanderbilt were equally excited to make their own fossil discoveries after getting to know a bit about the site, which made it a really fun and positive environment to learn as a group with different science backgrounds and interests."

She is hopeful the diversity of paths from ESI folks showcases that there is no one right way to pursue science. She also hopes that by talking about her specialty - biological anthropology - she might be able to reach curious students that had never had exposure before.

Photo submitted by Deasree Williams

Above: Nadir Dbouk headshot. Bottom Left: From left, Dismas residents Jace Sharp, Crossifico McCleary, and Heath Pack, and case manager Deasree Williams get a Vanderbilt tour and interactive lab with postdocs Thomas Sauters and Kyle David. Bottom Right: David explains that the "March of Progress" evolutionary diagram is not the best way to think about our ancestors. Opposite: Postdoctoral researchers Karin Steffen, Sauters, and Sarah Worthan; graduate students Katie McCormack, Audrey Arner, and Christina Chavez; and research technician Zeer Cen spoke to high school students at Coon Creek Science Center about evolution and academia. They also worked on creating fossil food webs. A fossil mollusk is shown along with a fossil ID guide.


Karin
Katie & Audrey
Thomas & Christina
Sarah & Zeer
FOSSILS OF THE COON CREEK FORMATION
MOLLUSKS
SCAPHOPODA
Dentalium
BIVALVIA
CLAMS
Veniella
Corbula
Nucula
SCALLOPS
Nelthea
Cucullaea
Pterotrigonia
Crassatella
Teredo rectus
OYSTERS
Pecten
Exogyra
Ostrea
Anomia
Paranomia
GASTROPODA
SNAILS
Volutomorpha
Longoccncha
Mesorytis
Drilluta
Turritella
Bellifusus
Pyrifusus
Omopsis
Pugnellus
Laxispira
Euspira (Polynices)
CEPHALOPODA
Baculites
Gyrodes
CRUSTACEANS
Callianassa Claw
Coon Creek Science Center

Undergraduate Research Fair Participants

Lilian Baker ‘25
Medicine, Health and Society; Anthropology

Using Stable Oxygen Isotope Analysis to Reconstruct Middle Horizon (600-1000 CE) Migration Patterns in the Central Peruvian Highlands
Mentor: Professor Tiffiny Tung, Anthropology

Zeer Cen ‘23
Molecular and Cellular Biology

The Impact of Lamboid Phage φ80 Lysogen on the Fitness of *E. coli* ΔFhuA Mutants
Mentor: Professor Megan Behringer, Biological Sciences

Ikenna Chukwu ‘23
Neuroscience; Medicine, Health and Society

Distribution of Inhibitory Neurons in Cortex
Mentor: Professor Jon Kaas, Psychology

Jiulin (Zoe) Dai ‘23
Child Development; Ecology, Evolution and Organismal Biology

Unique and Shared Mechanisms of Reading Skill and Anxiety Symptoms in Children
Mentor: Professor James Booth, Psychology and Human Development

Toluwa David ‘23
Biological Sciences

Genetic and Linguistic Admixture in Caribbean Creole Populations Show Complex Correlations
Mentor: Professor Nicole Creanza, Biological Sciences

Ralph Francois ‘25
Psychology

Examining Childhood Diet of Ancient Andean Site of Auquimarca through Stable Carbon Isotope Analysis
Mentor: Professor Tiffiny Tung, Anthropology

Robert McCarthy ‘23
Molecular and Cellular Biology; Medicine, Health and Society

Global Regulator Alleles Alter Metabolism and Increase Survival in Experimentally Evolved *E. coli* Populations
Mentor: Professor Megan Behringer, Biological Sciences

Adi Peres ‘23
Psychology

Calcium-binding Protein Immunohistochemistry Reveals Laminar Distribution of Inhibitory Neurons in Primary Sensory Areas of Prosimian Galagos throughout Development
Mentor: Professor Jon Kaas, Psychology

Henry Pliske ‘23
Ecology, Evolution and Organismal Biology

Impact of Human Recreation on Mammal Activity Patterns
Mentor: Professor Malu Jorge, Earth and Environmental Sciences

Saksham Saksena ‘25
Molecular and Cellular Biology; Medicine, Health and Society

Temperature and Age Shape the Body Size of Mosquitoes and Impact how they Respond to Infection
Mentor: Professor Julian Hillyer, Biological Sciences

Undergraduate Research Fair Participants

Rabia Shaban ‘23
Medicine, Health and Society

Preperation of a Human Factor XII Variant Lacking the Cys340-Cys467 Disulfide Bond
Mentor: Dr. David Gailani, Pathology, Microbiology and Immunology

Estelle Shaya ‘23
Latin American Studies; Earth and Environmental Sciences

Predictors of Mammalian Biodiversity in the Nashville Urban Landscap
Mentor: Professor Malu Jorge, Earth and Environmental Sciences

Isra Shuster ‘24
Biochemistry and Chemical Biology; Chemical Biology

Machine Learning Guided Discovery of Bioactive Natural Products from *Amycolatopsis azurea*
Mentor: Professor Allison Walker, Chemistry

Katherine Zhong ‘23
Medicine, Health and Society; Molecular and Cellular Biology

Negative Regulation of Immunity
Mentor: Professor Ann Tate, Biological Sciences

Tiffany Zhou ‘24
Biochemistry and Chemical Biology; Medicine, Health and Society

Exploring Copper Acquisition and Detoxification in *Acinetobacter baumannii*
Mentor: Professor Eric Skaar, Pathology, Microbiology and Immunology

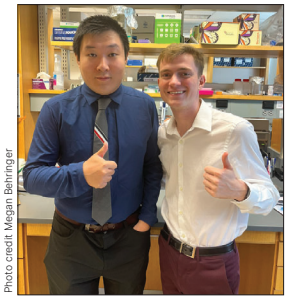


Photo credit Megan Behringer

Zeer Cen (left) and Robert McCarthy of the Behringer lab.

Toluwa David of the Creanza lab.

Photo submitted by Toluwa David

Submitted photo

Ralph Francois of the Tung lab.

Isra Shuster of the Walker lab.

Submitted photo

Undergraduates

Summer 2022

- Andres Alejandro Concepcion - Bachelor of Science in Educational Studies and Ecology, Evolution & Organismal Biology

Spring 2023

- Zeer Cen - Bachelor of Arts in Molecular & Cellular Biology
- Jiulin Dai - Bachelor of Science in in Child Development and Ecology, Evolution & Organismal Biology (*magna cum laude*, Honors)
- Toluwani Star Osaiyanah David - Bachelor of Arts in Biological Sciences
- Nicholas Dean Edwards - Bachelor of Musical Arts in Composition (Musical Arts) and Ecology, Evolution & Organismal Biology
- Hale Nobuo Weil Masaki - Bachelor of Arts in Climate Studies and English
- Robert Donald Pivar McCarthy - Bachelor of Arts in Medicine, Health & Society and Molecular & Cellular Biology (*cum laude*, Honors)
- Truman James McDaniel - Bachelor of Arts in Ecology, Evolution & Organismal Biology and Political Science
- Andrei Olaru - Bachelor of Arts in Ecology, Evolution & Organismal Biology (Highest Honors)
- Henry David Pliske - Bachelor of Arts in Ecology, Evolution & Organismal Biology
- Kayla Prowell - Bachelor of Arts in Psychology
- **Carly Meredith Stewart** - Bachelor of Arts in Communication of Science & Technology and Molecular & Cellular Biology (*cum laude*, Honors)
- Madison Alise Toonder - Bachelor of Arts in Anthropology and Ecology, Evolution & Organismal Biology and Medicine, Health & Society
- Aaron Yeh - Bachelor of Arts in Chemistry and Molecular & Cellular Biology
- Veronica Joy Zancho - Bachelor of Arts in Ecology, Evolution & Organismal Biology (Highest Honors)
- Katherine Y. Zhong, - Bachelor of Arts in Medicine, Health & Society and Molecular & Cellular Biology (*magna cum laude*, Highest Honors)

Featured Undergrad

Carly Stewart worked as a Buchanan Library Fellow in the Spring of 2023 on the History of Evolution at Vanderbilt project. Her project focused on Claude Chadwick, a professor in the 1960s. He was as well-known for his square dancing lessons as he was his genetics lessons. Carly was also the president of Hillel Vanderbilt and gave a short speech during the Graduates Day festivities. She is currently pursuing the next stage of her career in the Medical Scientist Training Program at the University of Cincinnati College of Medicine.

Graduates

Summer 2022

- Souhrid Mukherjee (Biological Sciences) Kolkata, India Ph.D. Dissertation: Machine-Learning-Based Interpretation of Rare Disease Variants Leveraging Genomics and Computational Structural Biology

Fall 2023

- Sarah Lihua Fong (Human Genetics) Oakland, Calif. Ph.D. Dissertation: Dissecting the Evolution of Human Enhancer Sequences
- Timothy Wade Thoner, Jr. (Microbe-Host Interactions) Ashland City, Tenn. Ph.D. Dissertation: Defining Influences on Packaging and Reassortment of the Segmented Reovirus Genome

Spring 2023

- Cody Nicholas Heiser (Chemical and Physical Biology) Houston, Texas Ph.D. Dissertation: Molecular Cartography Uncovers Evolutionary and Microenvironmental Dynamics in Sporadic Colorectal Tumors
- **Katherine Tuuri Snyder** (Biological Sciences) Novelty, Ohio Ph.D. Dissertation: Drivers of Birdsong Evolution on Micro- and Macroevolutionary Scales
- Tyler John Hansen (Biochemistry) Nashville, Tenn. Ph.D. Dissertation: Identifying Gene Regulatory Activity Divergence in Cis and Trans with ATAC-STARR-seq

Featured Grad

Kate Snyder earned her Ph.D. in the lab of Nicole Creanza after completing her B.S. in Ecology and Evolutionary Biology at Rice University. Kate was a frequent attendant of ESI journal clubs and is now a postdoctoral researcher. She is pictured here after a great day of learning about the history of the ecology, environment, and the animal communities of middle Tennessee at the Coon Creek Science Center and finding her own fossils to take home. We wish her the best of luck as she pursues her future endeavors!

Alumni Update

Jennifer Mandel: A Journey in Plant Ecology, Evolution, and Biodiversity

Dr. Jennifer Mandel earned her Ph.D. in Biological Sciences under the guidance of the late Dr. David McCauley. Graduating in 2008, Dr. Mandel is now an Associate Professor of Biological Sciences at the University of Memphis, where her research focuses on plant ecology, evolution, and biodiversity.

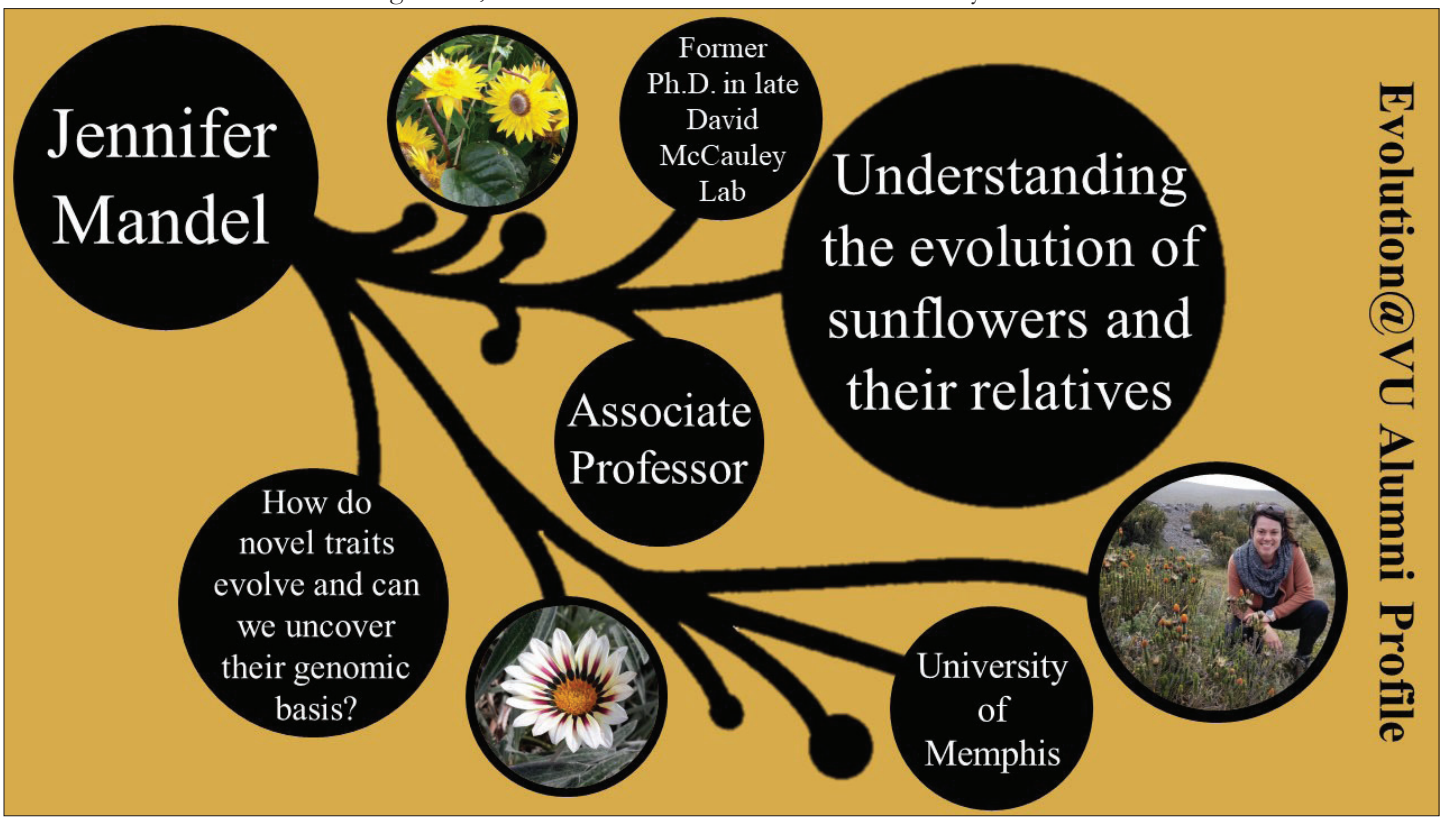
When asked about her decision to choose Vanderbilt, Mandel emphasized the allure of world-class faculty and facilities. The research and teaching experience she gained at Vanderbilt significantly shaped her personal and professional trajectory, fostering lasting connections with mentors who have become collaborators and friends. Reflecting on her time as a graduate student, Mandel regards it as a defining period in her career. She appreciated the encouragement to delve deeper into scientific questions independently while benefiting from thoughtful guidance, particularly from McCauley.

A pivotal achievement was the publication of the sunflower family phylogeny in the Proceedings of the National Academy of Sciences. This accomplishment not only represented a significant stride in her research but also allowed her work to reach a broad audience. Mandel's journey illustrates how the *research bug*, as termed by McCauley, became a driving force, cultivated in the supportive environment at Vanderbilt.

Speaking on achievements, Mandel added, "I think getting a faculty position was a huge milestone and I just remember how proud Dave was when he first visited to see me sitting behind my new office desk."

Acknowledging the inherent challenges in science, Mandel highlighted the resilience required when experiments do not go as planned. During her Ph.D., a setback in her research led to the restructuring of her dissertation's third chapter. What initially seemed like a disappointment turned into a crucial contribution—helping to list the sunflower species she studied as a federally endangered species. This experience taught her the value of adaptability and resourcefulness in navigating the unpredictability of scientific exploration.

Beyond academic achievements, Mandel cherishes personal moments at Vanderbilt, including meeting her husband, who was a biology major and research technician. Their shared Vanderbilt experience laid the foundation for enduring support in both personal and professional aspects of life. As Mandel continues her impactful journey at the University of Memphis, her roots at Vanderbilt remain an integral part of her success in plant ecology and evolutionary research.



Alumni Update

Scott Egan: From Genes to Ecosystems

Dr. Scott Egan, a distinguished scientist and Associate Professor of BioSciences at Rice University, reflects on his journey from earning his Ph.D. at Vanderbilt University under Daniel Funk in 2010 to becoming a recognized leader in the field of ecology and evolution.

"I was inspired to choose Vanderbilt because of the lab I joined, the wonderful and creative faculty I met during my interview visit, the community of graduate and undergraduate students, and the University as a whole," said Egan. "My time in Nashville shaped my journey in many ways. Professionally, it gave me the foundation to pursue my goal of becoming a professor and scientist – first at the University of Notre Dame and now at Rice University."

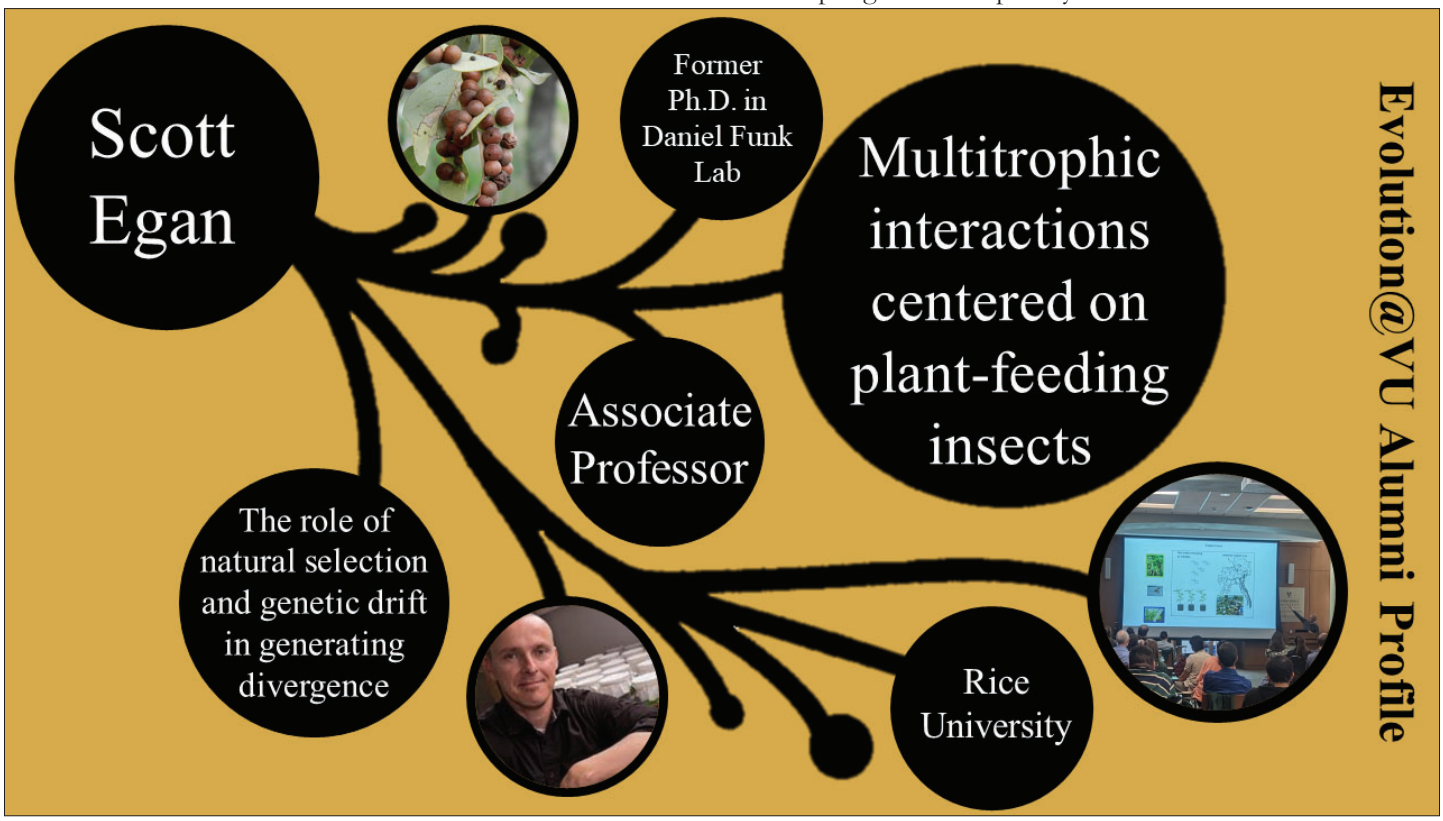
The lab's work has been published in leading journals such as *Science*, *Nature Ecology & Evolution*, *PNAS*, and *Current Biology*. Egan's research has also garnered public attention, being featured in outlets like the New York Times, Wall Street Journal, The Atlantic, National Geographic, and even as a clue on Jeopardy!

Recently elected as a Fellow of the Royal Entomological Society, an organization that once included Charles Darwin as a member, Egan has been named the Director of the Environmental Futures Initiative within the School of Natural Sciences at Rice. In this role, he is tasked with nurturing collaborative environmental research across departments.

Egan reflected on the challenges he faced in his career, particularly during graduate school. "You get pulled in many different directions, you're not sure exactly where your path will lead, and you must do it on a shoestring budget. Learning to balance work and life, and to work efficiently and effectively with the time I had was a challenge that I had to overcome, and what I learned from that challenge still benefits me today," he said.

Egan's experiences at Vanderbilt have significantly influenced his path, especially in adopting interdisciplinary approaches to address important questions. He emphasized the impact of his time at Vanderbilt, where a vibrant graduate program focused on ecology, evolution, and behavior inspired and challenged him. The connections forged with fellow students, faculty, and postdocs continue to influence his career as he engages in conferences and meetings.

Egan's journey from Vanderbilt to Rice University exemplifies a commitment to excellence, interdisciplinary approaches, and a passion for addressing significant questions in the realm of ecology and evolution. We can't wait to see where his research goes next!



Awards

Faculty

- Ken Catania - Elected to the American Association for the Advancement of Science
- Julián Hillyer - Centennial Endowed Chair
- Amanda Lea - 2023 Pew Scholar
- Lin Meng - 2022 Green Talents Award from the German Federal Ministry of Education and Research
- Eric Skaar - 2023 Faculty Mentor of the Year
- Keivan Stassun - Elected to the American Academy of Arts and Science

Postdoctoral Researchers

- Juan Carvajal-Garcia - Helen Hay Whitney Postdoctoral Fellowship
- Kyle David - NSF Postdoctoral Research Fellowships in Biology
- Karin Steffen - Swedish Pharmaceutical Society Postdoctoral Research Fellowship

Graduate Students

- Audrey Arner - Outstanding Student Presentation Award at American Association for Biological Anthropologists 2023 Conference
- Tyler Hansen - Leon W. Cunningham Graduate Biochemistry Award
- Marie-Claire Harrison - 2023 Brighter Ventures Student Award
- Ismail Kurun - Novack Award from Acton Institute
- Ximena Leon - NSF GRFP
- Chiamaka Okoye - Best Graduate Student Oral Presentation at the 2023 VIRAL Research Symposium
- Seth Reasoner - Best poster at Collaborating for the Advancement of Interdisciplinary Research in Benign Urology (CAIRIBU) conference
- Rosseirys de la Rosa - NSF GRFP
- Sam Schaffner - NSF GRFP
- Kat Turk - Fulbright Research Award to Germany
- Taiye Winful - NSF DDRIG

Undergraduate Students

- Jiulin (Zoe) Dai - Best Research Fair Poster, Public Health, Social Sciences, Humanities
- Kayla Prowell - Casey Carter Bonar Award
- Tiffany Zhou - Best Research Fair Poster, Basic and Natural Sciences

ESI Quick Facts

The Evolutionary Studies Initiative was founded in 2019 by Antonis Rokas with the help of the Advisory Board (Jada Benn Torres, Larisa DeSantis, Suzana Herculano-Houzel, Owen Jones, Houra Merrikh, and Betsey Robinson).

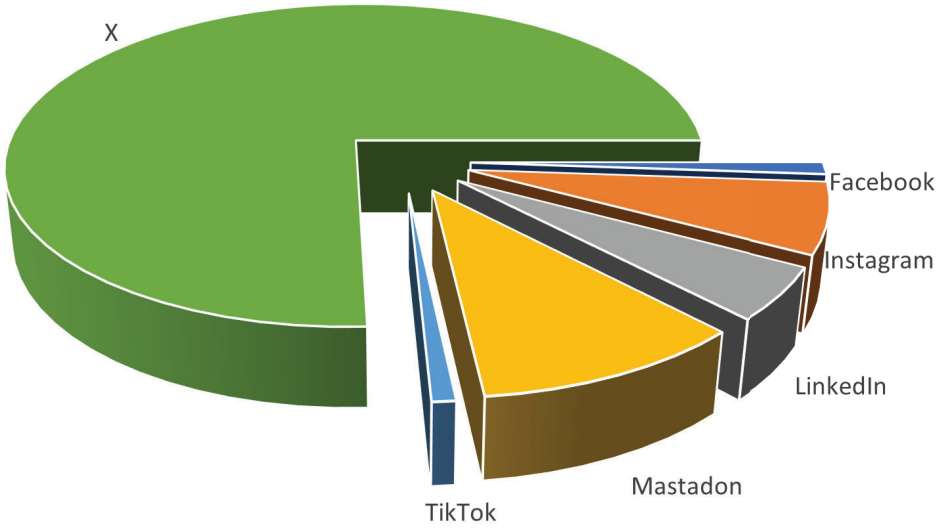
In 2021, ESI began a Pilot Grant Program with the aim of funding collaborative research projects across not just labs, but also departments. To date, we have given out 22 grants to fund research in Biological Sciences (BSCI), Earth and Environmental Science (EES), Anthropology, and Medicine. We have started new collaborations between BSCI and EES as well as BSCI and Medicine.

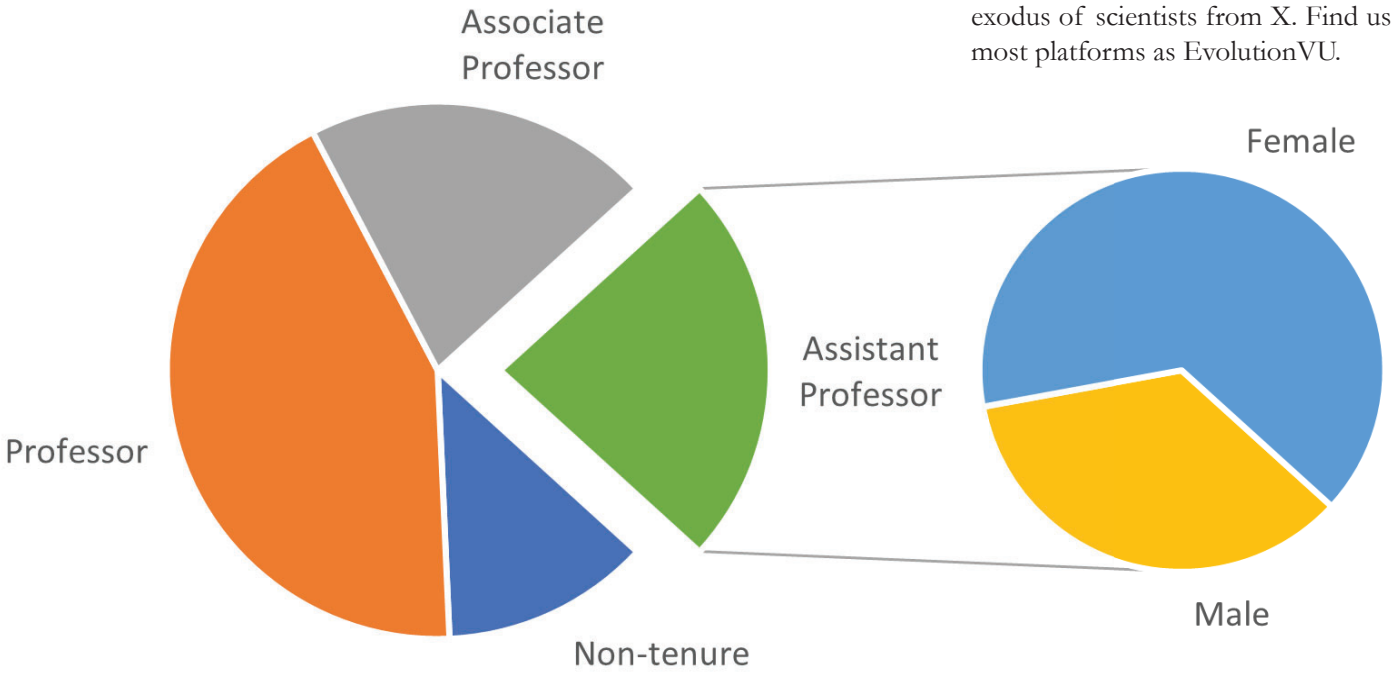
Projects led by graduate students have already had a massive return on investment. Of the 22 grants given out, ten have been to graduate students. Those students have received three NSF GRFPs, one NSF DDIG, one DoD NDSEG, and one SSE Rosemary Grant Graduate Research Excellence Award.

We have directly recruited four new faculty, two in BSCI (Castiglione and Taboada), one in EES (Meng), and one in Anthropology (Keith). We also have expanded our membership from the original 50 faculty members to now include 73 faculty across five colleges (Arts & Science, Medicine, Peabody, Engineering, and Law). While 63% of our total faculty are male, 65% of our assistant professors are female. See the pie chart below for a breakdown of faculty ranks.

We engage in several outreach activities, with our two major projects consisting of teaching high school students about evolution while digging for fossils at Coon Creek Science Center and working with the Dismas House residential re-entry program to produce hands-on labs the residents can do during a campus tour.

We also engage with the community on many social media platforms. We have a total of 994 followers across all platforms and are expanding our social media presence as new media formats are created and gain public traction. Our pie chart to the left breaks down our followers by social media type. We have been on X (formerly Twitter) since 2019 and have the biggest following there. We were able to capture about 20% of our X followers on Mastodon during the mass exodus of scientists from X. Find us on most platforms as EvolutionVU.





RECRUITING NOW

Brian O. Bachmann (Biochem)
Biosynthesis, Secondary Metabolites, Directed Evolution, Drug Discovery

Megan Behringer (BSCI)
Population genetics, genomics, microbiology, *E. coli*

Rachel Bonami (PMI)
B cell evolution, *T* cell, autoimmunity, type 1 diabetes, arthritis, microbiome

Benjamin Bratton (PMI)
Bacterial evolution, microscopy, cell shape, quantitative biology

Gianni Castiglione (BSCI)
Molecular evolution, vision, oxidative stress, evolutionary medicine

Larisa DeSantis (BSCI)
Vertebrate paleontology, paleoecology, paleoclimates

Ivelin Georgiev (PMI)
Immunology, virology, vaccines, antibodies, computational, disease

Monica Keith (Anthro)
Biological anthropology, data science, Bayesian modeling, maternal health disparities

Amanda Lea (BSCI)
Gene regulation, biological anthropology, genotype x environment interactions, early life effects

Lin Meng (EES)
Climate change, plant ecology, remote sensing, light pollution

Maulik Patel (BSCI)
Mitochondria, adaptive evolution, genetic conflict, selfish DNA, female reproduction, disease inheritance

Antonis Rokas (BSCI)
Evolutionary genomics, molecular evolution, phylogenomics, fungi, mammals, fungal diversity

Eric Skaar (PMI)
Bacteria, host-pathogen interactions, biochemistry, molecular biology, cell biology

Carlos Taboada (BSCI)
Treefrogs, camouflage, biochemistry, protein evolution, animal fluorescence, visual ecology, optics

Ann Tate (BSCI)
Immune system, virulence, systems biology, coinfection, host-parasite coevolution, life history evolution

UNIVERSITY POSITIONS

Research Assistant Professors:
Physics & Astronomy

Professor of the Practice:
Computer Science

Senior Lecturer:
Climate Science
Medicine, Health & Society

Assistant Professor:
Biomedical Informatics
Cell & Developmental Biology
Pharmacology
Sustainability, Energy & Climate

Support our mission to **create a world-class center for evolutionary studies** at Vanderbilt! Our researchers conduct groundbreaking evolutionary research across the disciplines, while offering the highest quality education to our trainees. Your donation supports cross-disciplinary research, student travel grants, and helps us bring in the world's best speakers to our seminar series.

Donate today at tinyurl.com/29tycx3p or

https://vanderbilt.alumniq.com/giving/to/GrandChallengeEvolutionaryStudies?appealcode=CFE12

EVOLUTIONARY STUDIES

VANDERBILT UNIVERSITY