



UNIVERSITY OF
GEORGIA

Center for the Ecology
of Infectious Diseases



ANNUAL REPORT

FY 2022

SEEKING TO
UNDERSTAND THE
HOST-PARASITE
RELATIONSHIP
IN NATURE



LETTER FROM THE DIRECTOR

As I write this, the world continues to navigate a global pandemic. In 2022, the Center for the Ecology of Infectious Diseases (CEID) found that continuous adaptation was needed to meet the needs of our community, country, and planet. Over the course of this year, UGA faculty, staff, and student members of CEID sought to cultivate and foster a research community that both seeks to understand the interactions of hosts and parasites as part of the natural order of things, but is also capable of addressing the global challenges that infectious diseases create for our society. While we have come a long way since the start of the COVID-19 pandemic, our work is far from over.

By mapping, forecasting, and analyzing data on infectious diseases, our faculty, staff, and students worked to promote UGA as a leader in infectious disease research. In the last year, our members submitted a Predictive Intelligence for Pandemic Prevention (PIPP) grant to the National Science Foundation; published a monograph on animal behavior and parasitism; collaborated with other organizations like the Centers for Disease Control and Prevention (CDC) with our COVID-19 and Flu Forecasting models; and developed maps so that we could be better informed about potential disease impacts. Through the Global Infectious Disease Intelligence Consortium, we engaged with industry and other non-academic partners to better understand how our research and models can be used to inform their decisions and to improve the quality of our academic research.

The spillover and spread of infectious diseases as well as the need for more intelligence about emerging threats challenges us daily to pursue our research and engage the communities around us. The COVID-19 pandemic has provided numerous insights. But the pandemic has also illustrated that our infectious disease research is extremely important and has real-world implications. As we go into 2023 and beyond, the CEID will continue to strive to improve our understanding of infectious diseases, to conduct the most cutting-edge research, and to develop new tools for monitoring and forecasting endemic diseases, emerging threats, and a wide range of transboundary pathogens.



John M. Drake
- John M. Drake, Director

BY THE NUMBERS



146

PEER REVIEWED
ARTICLES



47

FACULTY AND STAFF
COLLABORATORS



90

MEMBERS



3

WORKING GROUPS



6

SEMINARS



205

ACTIVE PARTICIPANTS



1

DISEASE MAPPING
WEEKEND WORKSHOP

WORKING GROUPS

FORECASTING

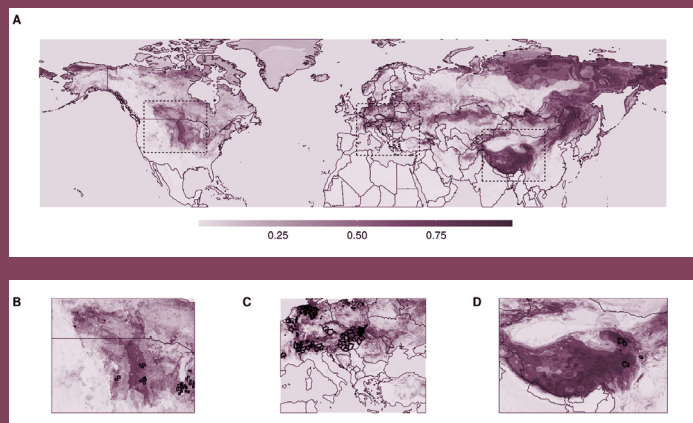
With leadership from John Drake, Éric Marty, and Avranil Basu, the **Forecasting Working Group** continued its efforts in forecasting ongoing disease outbreaks of COVID-19 and Influenza, and developing state-of-the-art modeling tools for epidemic forecasting, prediction, inference, and scenario analysis.

Working group members Eamon O'Dea and John Drake published their next-generation semiparametric model in the *Journal of the Royal Society Interface*. A semiparametric, state-space compartmental model with time dependent parameters for forecasting COVID-19 cases, hospitalizations and deaths,” demonstrates the new modeling procedure and forms the basis for the **Forecasting Working Group's** operationalization of the model for COVID-19 in the 50 U.S. states. This novel modeling architecture enables efficient, high performing forecasts incorporating explicit observation modeling, large numbers of covariates, and a latent process to capture unknowns. These methods are expected to be applicable to a wide range of diseases.

In FY22, the working group began developing a scalable, modular forecast architecture to facilitate rapid development and deployment of models. CEID contributed weekly forecasts to the CDC's Flu and COVID-19 Forecast Challenges (covid19forecasthub.org) using their next generation and baseline models.



MAPPING



Through collaborative projects, the **Mapping Working Group** provides disease mapping resources to promote infectious disease intelligence. Led by IDEAS student, Daniel Suh, and composed of graduate students, the Mapping Working Group leads workshops and modeling events throughout the year to improve others' mapping and modeling capabilities. The **Mapping Working Group** also established a wastewater surveillance map to depict the impact of wastewater on public health.

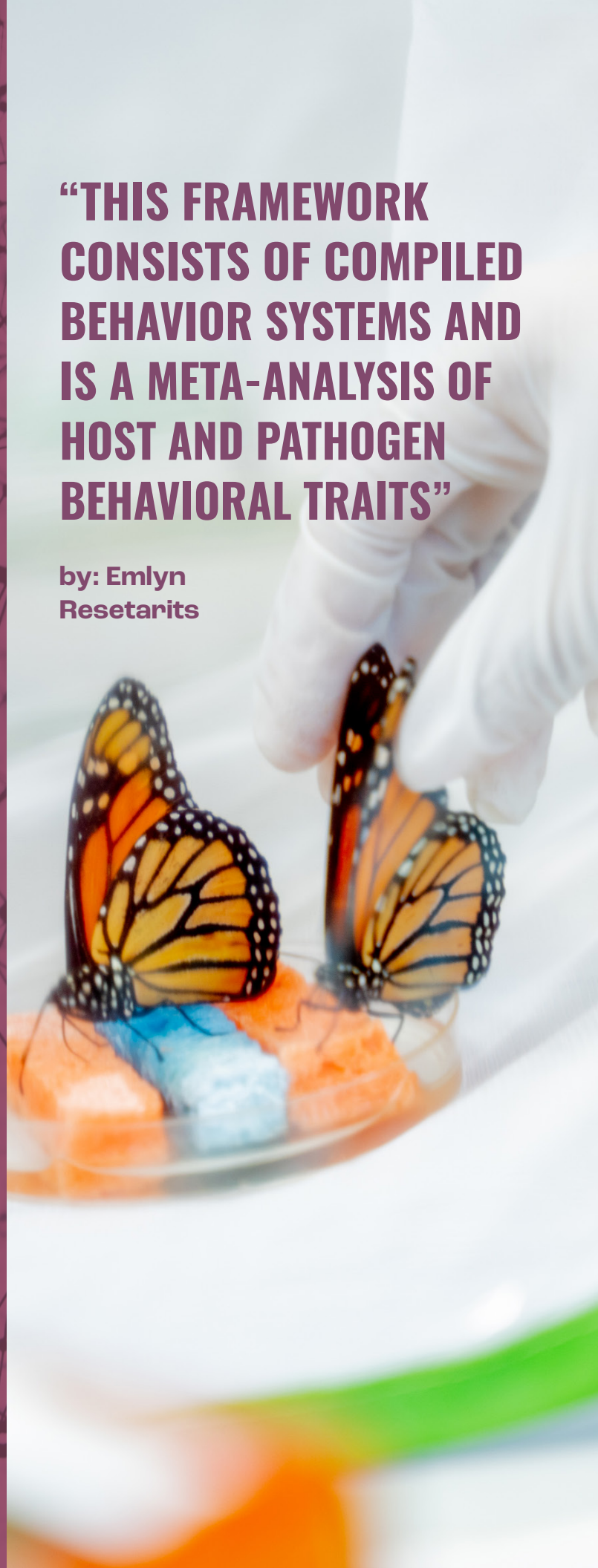
BEHAVIOR AND INFECTIOUS DISEASE

The **Behavior and Infectious Disease Working Group** examines behavioral traits of hosts, parasites, and pathogens both for a better understanding of infectious diseases and as behavioral ecology study of systems. Formed in 2021, the **Behavior and Infectious Disease Working Group** is the newest working group within CEID. In its first year, the working group authored the final chapter in *Animal Behavior and Parasitism* (2022), edited by CEID members Vanessa Ezenwa, Sonja Altizer, and Richard Hall. The book is the third in CEID's Oxford University Press series on the "Ecology and Evolution of Infectious Diseases."

The working group focused on the feedback between host behavior and parasite behavior, which enables host-pathogen coevolution and alters disease characteristics. While a majority of infectious disease research examines the impact of parasites on the evolution of hosts and their behaviors, their chapter in *Animal Behavior and Parasitism* explores the other side of this relationship—the influence of hosts on parasite biology and behaviors. The working group also drafted a publication on their novel framework, based on a meta-analysis of host and pathogen behavioral traits. The framework elucidates host-pathogen behaviors and interactions while answering key questions pertaining to infectious disease spread. The new publication will seek to address various questions related to host-pathogen systems to better understand pathogen dynamics and host-parasite interactions.

**"THIS FRAMEWORK
CONSISTS OF COMPILED
BEHAVIOR SYSTEMS AND
IS A META-ANALYSIS OF
HOST AND PATHOGEN
BEHAVIORAL TRAITS"**

**by: Emlyn
Resetarits**



PROFILES

POSTDOCTORAL FEATURE: EMLYN RESETARITS



Dr. Emlyn Resetarits' interest in disease ecology was sparked after taking an undergraduate course in conservation medicine at Columbia College in New York. She had originally intended to study Latin at Columbia, but found herself drawn to ecology after taking this course, which focused on the relationships between humans, wildlife, and environment. As she pursued her passion for ecology, she enrolled in a Ph.D. program at the University of Texas at Austin. This program primarily focused on community ecology, and she became interested in eusocial parasite colonies.

During her time in Athens, Resetarits served as a Chair for the **Behavior and Infectious Disease Working Group** at CEID. The group, created in 2021, focuses on the behavioral traits of hosts and their pathogens. The goal of this group is to study interactions among hosts

and parasites in infectious disease systems in order to better understand disease dynamics. Resetarits' current research focuses on the indirect effects of parasites on the local environment at the University of Georgia Marine Institute on Sapelo Island, where she works as the resident scientist. She is currently examining the impact of parasites on eastern mudsnail behavior and on eastern oyster filtration.

Dr. Resetarits is concerned with how parasite colonies infect mudsnails, and how infections influence the snails' dietary choices, which in turn impacts the resources available to other species in the area. To identify specific host-parasite associations, mudsnails are exposed to light in the lab, prompting the release of a free-swimming stage of the parasite, allowing Resetarits and her colleagues to easily identify it. In her research with eastern oysters, Resetarits examines the effects of disease on the ability of the oyster to filter water, an essential factor in the maintenance of water quality in estuaries.

As a member of CEID, Dr. Resetarits has participated in disease ecology symposia with speakers from around the world; **"I like that there are opportunities to try to collaborate with people who care about disease across all sorts of disciplines,"** she said.

Resetarits' often combines her love of working in the field with her passion for teaching undergraduate students. Resetarits teaches introductory ecology, giving many students their first exposure to field work, where they are often knee-deep in mudflats. She works hands-on with students to show them how to conduct scientific research and to educate them on the coastal ecosystems of Georgia.

In addition to her research on Sapelo Island, Dr. Resetarits is involved in outreach projects that allow her to engage with the public. Resetarits is one of the hosts of the **"STEM Fatale"** podcast, which highlights women in science history.

FACULTY FEATURE: ALEX STRAUSS



Dr. Alex Strauss studies the intersection of community and disease ecology, focusing on host-parasite interactions in both terrestrial and aquatic systems. Strauss has several active research undertakings in his lab, including terrestrial projects investigating the effects of pathogens on tall fescue and a collaboration with a global research network known as DRAGNet, examining how the removal of fungi impacts the community composition of grasses recovery from disturbance and ecosystem disturbance.

In the aquatic sphere of his research, Dr. Strauss studies the effects of temperature on parasite's ability to infect zooplankton and how community composition and other related factors might mediate this relationship.

In the aquatic realm, Dr. Strauss studies microsporidian infections of *Daphnia* in local

populations and attempting to discern what could be driving the size of these epidemics in different ponds and the variation in species that become infected.

Dr. Strauss is excited to collaborate with others through the **Behavior and Infectious Disease Working Group** as a group leader and other opportunities provided by CEID.

His interest in examining the relationships between disease and community ecology was ignited during his undergraduate years at Washington University in St. Louis when he assisted with a research project comparing the community composition of ponds with and without amphibian chytrid fungus.

Though he had always found the ability of small organisms to shape entire ecosystems fascinating, the project showed him how he could combine community and disease ecology in his research.

"I've always been really intrigued by the idea that little organisms, the parasites and pathogens, can have such big impacts on their host and ecosystem dynamics like nutrient cycling or trophic cascades," Strauss said.

Strauss joined the faculty of the Odum School of Ecology and the Center for the Ecology of Infectious Diseases in 2020, and works closely with CEID's **Behavior and Infectious Disease Working Group**. This working group asks questions at the forefront of behavior and disease ecology research, using multiple study systems to study these questions. Strauss serves as an expert in the *Daphnia* system and contributes additional expertise on aphids as disease vectors. He enjoys working with CEID because **"it's a great place to do disease ecology and brainstorm collaborations."**

PROFILES

STUDENT PROFILE: DANIEL SUH



Ph.D. student Daniel Suh's interest in infectious diseases began during undergraduate fieldwork, which examined the rates at which invasive crayfish and native dragonfly nymph species consume mosquito larvae. Although this research wasn't directly related to disease dynamics, it prompted Daniel to begin thinking about disease vectors and how diseases and ecosystems mutually shape each other.

In his dissertation, Suh uses mathematical models and data from previous studies to examine the relationship between biodiversity and disease transmission. He is interested in understanding how the ability of generalist parasites to persist in a population can vary based on the biodiversity of the host community. He also studies the impacts on this relationship of biotic factors such as relative host abundance and distribution and abiotic factors such as precipitation and temperature.

In his role as **Interdisciplinary Disease Ecology Across Scales (IDEAS) program representative from 2020 to 2021**, Suh served on the IDEAS steering committee, organized interest meetings for IDEAS program students, and hosted an invited speaker.

Suh serves as chair of the CEID Disease **Mapping Working Group**, which is creating an interactive map-based application to visualize COVID-19 wastewater data.

"This project will help to visualize the COVID-19 wastewater surveillance data in another, more intuitive way," he said. **"Scatter plots and trendlines are useful visualizations, but maps are often easier for communicating data to a broader audience."**

Suh also contributed to the working group's development of a global distribution model for the tapeworm *Echinococcus multilocularis*, which is responsible for alveolar echinococcosis disease in humans and other animals. Passionate about education, Suh coordinated and taught the **"Mapping in R Weekend Workshop"** on working with spatial data in the R programming language.

BOOK RELEASE

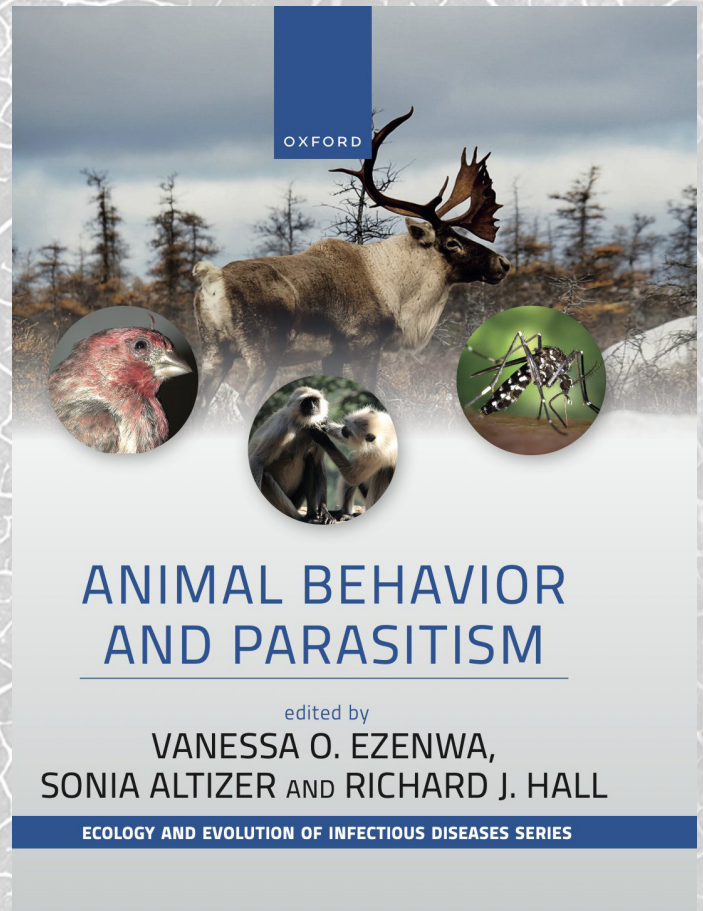
ANIMAL BEHAVIOR AND PARASITISM

Animal Behavior and Parasitism is the third book in CEID's series "**Ecology and Evolution of Infectious Diseases**", published by Oxford University Press. The book was released as an ebook in Summer 2022, and in print on November 30, 2022.

Edited by CEID scientists **Vanessa Ezenwa, Richard Hall, and Sonia Altizer**, *Animal Behavior and Parasitism* explores the complex relationships between parasites and their hosts that can lead to system-wide alterations in an ecosystem.

Parasites can influence a host's social behavior, defensive tactics, sexual selection, mating behavior, and movement patterns. And shifts in an infected host's behavior can affect disease transmission.

As illustrated by the COVID-19 pandemic, human concerns about SARS-CoV-2



infections and the onset of clinical disease have shaped our hygienic behaviors and where and when we gather in groups. Similarly, when a person becomes infected by a parasite, this can alter their personality, memory, cognitive behavior, and bodily function.

Animal Behavior and Parasitism additionally describes how animal behavior impacts parasite biology and has influenced parasitic evolution.

Authors emphasize that the development of sophisticated modeling and tracking techniques to identify an animal's location and follow its movements and interactions with other animals allows scientists to make more accurate predictions about parasite transmission and disease outbreaks than was previously possible.



Pej Rohani, John Drake, Richard Hall and Sonia Altizer at the book release of *Animal Behavior and Parasitism* along with their books

PUBLIC-PRIVATE PARTNERSHIP



The Global Infectious Disease Intelligence Consortium (**GIDIC**) is a collaboration between the Center for the Ecology of Infectious Diseases (CEID), academia, industry, government, and NGOs designed to help members identify, prepare for and respond to emerging disease threats.

In June 2021, CEID was contracted by the Swine Health Information Center (**SHIC**) to collaborate on a project to estimate the spillover risk of pathogenic bacteria from wild mammals into domestic pigs.

SHIC, a non-profit industry group, was chartered to protect and enhance the health of the US swine herd through coordinated global disease monitoring, targeted research investments, and analysis of swine health data.

In phase I of the project, a CEID data-driven horizon scan model identified 127 potential North American wild mammalian hosts for 102 bacteria species with a measurable chance of infecting domestic pigs. The trait-based machine learning model identified 37 bacteria with high probability of being able to infect swine, but which were previously undocumented in pigs.

In phase II, CEID and **SHIC** conducted a survey of subject matter experts (swine veterinarians, veterinary pathologists, etc.) to assess the potential impacts resulting from a spillover of each of the 102 pathogens on swine health and the swine industry.



“This project will assist SHIC in identifying and assessing risks to animal and human health, pork industry vulnerabilities to these pathogens, and possible actions [to] mitigate risk,” said Paul Sundberg, SHIC executive director. **“The outcome of the project could lead to enhanced diagnostic capabilities for high-risk bacteria to ensure their early detection to support cost-effective management and control.”**

In addition to sponsored projects, **GIDIC** delivered webinars on Pluralistic Modeling and Infectious Disease Intelligence, as well as roundtables with industry partners on emerging agricultural threats, and on the potential impact of Japanese Encephalitis Virus on the pork industry and humans. **GIDIC’s** first annual Horizon Report, providing an overview of the most important infectious disease threats in the year to come and beyond, was released in October 2021.

GIDIC’s research collaboration and outreach efforts help to advance knowledge and capabilities in Infectious Disease Intelligence for prediction, estimation, inference, scenario analysis, and synthesis of infectious disease threats, with a view to preventing and preparing for the next global pandemic.

RESEARCH EXPERIENCE FOR UNDERGRADUATES

The Odum School of Ecology's Population Biology of Infectious Diseases **Research Experience for Undergraduates** (REU) program is a 9-week NSF-funded site program that has run at UGA's main campus since 2013. Students from across the country work with UGA faculty, postdocs and graduate students to develop research experiences at the intersections of quantitative and experimental studies in infectious disease biology. **The goal of this program is to catalyze a new generation of interdisciplinary infectious disease scientists by facilitating cross training in both computational and life science approaches.**

Faculty co-directors were Sonia Altizer and John Drake, and PhD student Nicole Solano served as program coordinator. Summer highlights included a kick-off dinner reception, field trip to the Georgia Aquarium, weekly journal club discussions, and bi-weekly dinners with faculty. During the last week of July, the 2022 program wrapped up with a poster symposium and closing luncheon to celebrate the 13 students who joined the program this year. Projects ranged from modeling the dynamics of immune escape in pertussis to quantifying parasite biodiversity declines in salamanders. Congratulations to the student-mentor teams for developing and presenting exciting infectious disease projects!

2022 PopBio REU Program participants: Sarah Blankespoor (Cuesta College), Annika Cleven (St. Olaf College), Annalise Cramer (Westfield State University), Sierra Felty (Radford University), Jonah Giermann (College of St. Scholastica), Helen Gloege (Mount Holyoke College), Jacob Glover (Franklin College), Emily Landolt (St. Norbert College), Sofia Markiewicz (Scripps College), Samantha O'Keefe (Jacksonville University), Madeline Sheppard (Eckerd College), Jenevier Tejada (Denison University), and Gowri Vadmal (Stanford University).



MEMBER ACCOMPLISHMENTS



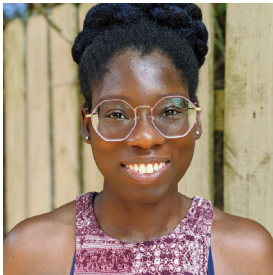
Jeb Byers

Elected as **Fellow of the American Association for the Advancement of Science (AAAS)**.



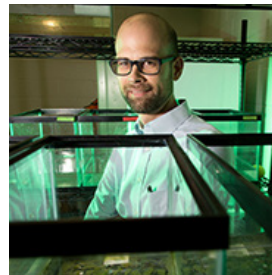
Anna Willoughby

Awarded the **Beverly Hirsh Frank Graduate Fellowship for Women in Science** from the UGA Graduate School.



Anecia Gentles

Received a research grant from **Bat Conservation International**.



John Drake

Named **Regents' Professor** to recognize the national and international reach of his scholarship.



Daniel Suh

Was awarded a Spring 2022 **Retention and Inclusion Grant** of \$5,000 for a graduate student retreat.



Cali Wilson

Was awarded a Spring 2022 **Retention and Inclusion Grant** of \$5,000 for a graduate student retreat.



Emlyn Resetarits

Winner of the award for **Best Postdoctoral Talk** at the Southeastern Population Ecology and Evolutionary Genetics (SEPEEG) conference.



Sonia Hernandez

Was awarded the section ASA new member for **"University's Women's Leadership Fellows Program"**



Kailah Massey

Winnner of the award for **Best Undergraduate Poster** at the Southeastern Population Ecology and Evolutionary Genetics (SEPEEG) conference.



Alex Strauss

Received and **Interdisciplinary Seed Grant** for "Bloom and Doom: Is Increasing Risk of Harmful Algal Blooms an Inevitable Consequence of Global Change? Assessing Risk and Exploring Strategies in Georgia from Biological and Social Perspectives."



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JOHN M. DRAKE, DIRECTOR
203 D.W. BROOKS DRIVE | ATHENS, GA 30602
CEID@UGA.EDU