biology update

CASE WESTERN RESERVE UNIVERSITY DEPARTMENT OF BIOLOGY

SPRING 2018

Bio[box]: Collaborative learning and Independent Research

Biology faculty members Deb Harris (left) and Dianne Kube (right) listen as bio[box] instrumentation is demonstrated.

The Department of Biology is opening a new, collaborative learning/research space called bio[box] in February 2018. Much like CWRU's makerspace think[box], bio[box] will provide undergraduate and graduate researchers with space, tools and instrumentation to facilitate collaborative learning and independent research under faculty supervision. It is a dedicated laboratory space, separate from the faculty's research labs, in which students will be encouraged to pursue authentic research questions that they may have initiated or participated in formulating, in areas ranging from field ecology to developmental biology to neurobiology and behavior. Again, like think[box], bio[box] is starting small; most of the current instrumentation and tools are aimed at supporting research using molecular techniques. All of the instruments are newly acquired and state-of-the-art, and in at least one case, an instrument is the only one of its kind on campus.

We believe that bio[box] will give our students a direct sense of ownership of the research questions they are working on. In addition, we want them to recognize a clear connection between the studies they conduct in bio[box] and the ideas and skills they are learning in their courses. By coordinating these projects with courses in the biology department's curriculum, we hope to create multiple opportunities for active learning in and out of class. In addition, we plan to create a common study area where students engaged in projects can talk to one another and forge strong collaborative relationships.

It is our hope that bio[box] will foster creativity by enabling students to experience what it is like to be a principal investigator.

INSIDE

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COLLEGE OF ARTS AND SCIENCES
CASE WESTERN RESERVE UNIVERSITY

Predicting future biodiversity: Insights from Cities and Citizens

By Dr. Sarah Diamond

Leonardo da Vinci once remarked that "nature is full of infinite causes." As scientists, we sort through these infinite causes to determine which are the most important, how they fit together and, mechanistically, how they work. The Diamond lab tackles these questions in the context of global change: our key mission is to uncover the mechanisms that govern which species will survive contemporary global change, and which will go extinct.

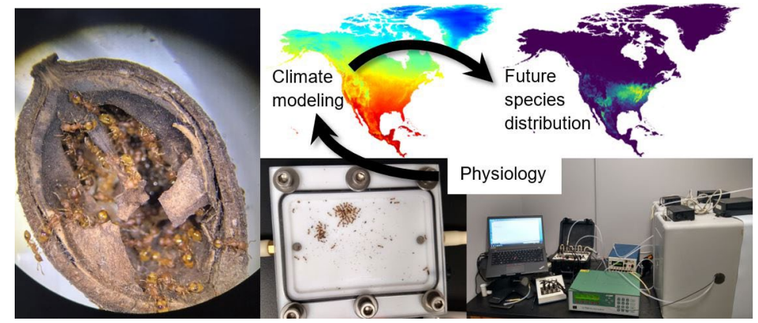
Without industrialization and unchecked burning of fossil fuels, we could have had thousands of years of relatively stable climate until the next ice age. But the climate is changing rapidly through human activities—more rapidly than it has ever changed over the Earth's history. Some scientists think we hit a point of no return (irreversible changes to global biological systems) when carbon dioxide levels exceeded 400 parts per million for the first time on May 9, 2013.

Our first climate forecasting models, which just turned 50 years old, have been remarkably accurate at predicting our current climate. But, whereas climate forecasts are relatively precise, the impacts of climate on biological systems are more challenging to predict. With these massive changes in climate, we are already beginning to see losses in biodiversity worldwide. Biodiversity loss can be mitigated to some degree by appropriate management and conservation planning, but first we need to know which species and geographic regions are most vulnerable. The key question, then, is this: How do we make accurate forecasts about biological communities as the world continues to change rapidly?

The Diamond lab takes a multifaceted approach to this question, using a combination of experiments and comparative work, both across latitudinal and elevational gradients in climate and across historical and contemporary climates. As a unifying theme, we focus on physiological performance and tolerance of temperature and other key climatic parameters. Most biological processes are sensitive to temperature change, from biochemical rate processes to individual performance to species interactions. As a consequence, we can examine the integrative impacts of temperature change from subcellular processes up to ecosystem functioning.

We typically use insects as model systems. As ectotherms (cold-blooded animals), insects are highly sensitive to small changes in temperature, and serve as good indicators of how entire biological communities will respond to global change. The lab has extensive experience using experimental warming approaches to simulate future climate change, and using "space-for-time" substitutions where geographic variation in climate (for example, from temperate regions to tropical regions and up mountainsides) can provide insight into future warmer environments. But these approaches carry important limitations due either to high infrastructure costs or non-climatic confounding variables. To get around these limitations, we have been harnessing the power of cities (urbanization is an accidental warming experiment, and one which has been replicated at a global scale) and of citizen scientists, who have contributed to historical ecological data sets stretching back decades. These strategies allow us to examine biological community responses to recent climate change in field settings.

Some members of the Diamond lab team: Dr. Sarah Diamond (top left), George B. Mayer Assistant Professor of Urban and Environmental Studies, in the field. Dr. Lacy Chick (bottom left), post-doctoral research associate, prepares urban acorn ant samples for gene expression analysis. Mr. Abe Perez (bottom right), fourth-year PhD student. Ms Yu Huan (top right), undergraduate student, collects acorn ants from the field.



The acorn ant, *Temnothorax cuvispinosus* (left), and the lab's general approach to forcasting future biodiversity by linking physiology with climate modeling to predict where and how abundant species will be with ongoing climate change (right).

Cities are windows into a future, warmer world. We have been exploring how the acorn ant (a species of ant that, remarkably, fits all 100–200 workers and multiple queens inside a single acorn) copes with rapid temperature rises in cities. Impervious surfaces like roads, sidewalks and buildings elevate environmental temperatures in cities above those of nearby undeveloped areas. By comparing the physiologies of ants from rural, undeveloped areas with those of ants from urbanized areas, we can evaluate whether insects will be able to withstand future warming at the global scale. We have found that ants from both rural and urban habitats have greater tolerance of high temperatures when acclimated to warmer climates, a result that is typical of many insects. Much more surprisingly, however, we have found evidence of evolutionary changes in the heat tolerance of city ants. These ants always have higher heat tolerance than rural ants, regardless of the temperature at which they're reared.

Many biodiversity forecasts do not include evolutionary change, as evolution is generally thought to occur over long time scales (millions of years). But we have found that, within only 100 years of urbanization, city ants in Cleveland, Ohio (and now more southerly locations as well, including Knoxville, Tennessee) evolved greater heat intolerance, suggesting we can no longer ignore evolution in the context of global change.

Because we work within the city limits and in nearby undeveloped areas, the lab has benefited tremendously from close connections with CWRU's Squire Valleevue Farm, the Holden Arboretum, the Cleveland Botanical Garden, Cleveland Metroparks and the Cleveland Museum of Natural History for collection sites and more long-term research plots. The lab is currently expanding its research directions to include capturing the mechanistic basis for rapid evolutionary changes in heat tolerance (looking at alterations to gene expression and subcellular processes), understanding the connections between heat tolerance and metabolism, and examining how changes in heat tolerance modify interactions between other ant species and the broader community in which they are embedded.

The scale and rapidity of global change presents a challenge beyond the scope of individual research labs. Citizen scientists can perform valuable data collection over the spatial and temporal timescales that we need to make robust forecasts of future biodiversity. The Diamond lab has collaborated with the Ohio Lepidopterists to examine how the timing of butterfly flight (a temperature-sensitive trait) is impacted by recent climate and by urbanization. We were able to identify tipping points in the timing of butterfly flight periods when conditions became too warm, leading to stress responses in butterfly populations. Our work continues in this area to understand how shifts in butterfly food resources and shifts in butterfly geographic ranges are related to changes in butterfly flight periods. In addition, the lab has started a new citizen science monitoring effort with ants in order to determine how temperature is impacting the competitive landscape among different species. Ultimately, these data will indicate how stable communities will be in warm environments.

Like organisms facing global change, research approaches must adapt in order to cope with the unprecedented scale of environmental perturbation we are experiencing and will continue to experience far into the future. By harnessing the power of cities and citizen scientists, we hope to improve our forecasts about future biological communities—not only to conserve as many plants and animals as possible, but also to safeguard our own future.

visit the Diamond lab at http://www.diamond-lab.org/

Undergraduate Feature

By: Brian Lerch

Research was a key factor in my decision to come to CWRU, so I knew before I arrived on campus that I would be looking for a lab. But I did not realize what a huge impact my research experience would have on my college career. During the second week of my freshman year, I sent out emails to professors whose research interested me. I was shocked and grateful to see the willingness of the faculty to take on an undergraduate with no prior research experience or college coursework.

I spent my first semester working in the lab of Dr. Karen Abbott, and the research drew me in. The Abbott lab focuses on theoretical ecology. Roughly speaking, this means that we use mathematical models to uncover general ecological phenomena that may be hard to observe or detect in an experiment.

Despite my lack of experience, Dr. Abbott allowed me not only to lead a project during my first semester in college, but also to devise my own project. With the help of former postdoc Ben Nolting, I developed a model of African wild dog populations, with a particular focus on their pack structure. Although it is well established that small packs are less successful than large ones, we were able to show that small populations are not necessarily less successful, We also uncovered the mechanism behind this disconnect between the pack level and the population level. Since then, we have generalized the project to encompass more species and turned it into a manuscript that is currently under review.

In a second project, I have worked with former postdoc Chris Stethia on a model that analyzes plant-herbivore dynamics in systems in which plants drive population dynamics by responding to herbivory. I have since moved into the realm of evolutionary biology and am studying the implications of my previous project for the evolution of cooperative groups.

Joining the Abbott lab was the best decision I have made at CWRU. I am extremely fortunate to have amazing opportunities and mentorship. I hope to make the most of my research experience by going to graduate school and ultimately continuing to conduct academic research. I am especially interested in further developing theory regarding the ecology and evolution of cooperation.

Recent Alumni Feature - by Mahima Devarajan (CWRU 17)

While the statistics vary somewhat from year to year, biology majors make up close to 50 percent of all pre-medical students at CWRU. I used to say that I liked science, at least enough that I didn't mind identifying with that overwhelming demographic. Now, having had experiences as a biology major at CWRU and as a research assistant at the Children's Hospital of Philadelphia (CHOP) Research Institute, I'm closer to saying I'm a scientist.

This transition was largely facilitated by my time in Dr. Radhika Atit's lab at CWRU. Before joining the lab in my sophomore year, I had spent a summer in another lab, studying the role of Hox genes in limb development. During my interview with Dr. Atit, she asked what interested me about Hox genes. In an attempt to plausibly and creatively link my response to the main focus of her lab, I told her I was interested in the role of Hox genes in facial development. She then pointed out that
the face is actually *Hox*-negative, and I sat there, substantially embarrassed for several minutes, thinking, "Well, there goes that job." Luckily, I was hired, but this wouldn't be the first time I said something comically inaccurate during my 2.5 years in the Atit lab.

Over the next few years, I began to engage with science in a way that forced me to think more critically than I ever had before. As a member of Dr, Atit's research group, I studied the epigenetics regulating craniofacial development, which, if dysregulated, can lead to many well-known congenital conditions, such as craniosynostosis (changes in the growth pattern of the skull). This piqued my interest in the origin and whole-body effects of other congenital conditions, such as those in the heart, which I study now at CHOP. We are investigating white matter brain injury that occurs when, as a consequence of congenital heart defects, the oxygen demands of the brain during fetal development are not met. The really novel aspect of the work comes from the use of diffuse optics to assess brain health in vivo. Diffuse optical spectroscopy can be effectively used to measure brain oxygen saturation with excellent temporal resolution, while being non-invasive and non-ionizing.

Now that I work in a more clinical environment, I'm observing science from an entirely different perspective, but am still consistently seeing the application of hypothesis-driven research. As a result, I am slowly coming to see research and medicine not as two distinct worlds, but as interdependent fields. I'd like to work as a physician-scientist in the future, a career that will allow me to contribute to the advancement of science as well as to its application.

If I had to give some advice to other biology undergraduates, it would be to constantly ask questions, even at the risk of being wrong (or comically inaccurate). Every question you ask and every statement you make, as ignorant as it may be, is worth saying because it will allow you to learn and benefit from the expertise that surrounds you. I found this expertise came from many members of the Department of Biology, but I give special thanks to Dr. Atit, Dr. Burden-Gulley, Dr. Drushel, and members of the Atit lab: James, Gregg, Trizi, Anna, Sai, Nate Mullins, and Mia. Though you are a biology major now (one of many), over time this questioning mindset could lead you to define yourself less as someone with a mere interest in science, and more as a scientist yourself.

Senior Alumni Feature : Lee Benison Price

by: Katie Bingman

Lee Benison Price, Director of Scientific Immigration, Immigration Law Assoiates P.C., Skokie, Illinois.

People do not always take a clear and direct path to their destination.. Lee Benison Price (CWR '75), who graduated with a BA in biology, found that her interest in biology and her love of the elegance of biological systems did not translate directly into a scientific career. However, she thinks that her experience at CWRU, and the circuitous route by which she became the director of scientific immigration at a law firm, may offer lessons for other biology majors.

After earning her degree from CWRU, Price worked in a research laboratory in the CWRU School of Medicine and decided she had a limited aptitude for bench science. She did know that she was a good
She did know that she was a good writer, so she pursued a master's degree in journalism from Northwestern University. She did not want to be a traditional journalist, and her abiding love of biology caused her to gravitate toward writing jobs that had biological or technical content. For a time, she wrote promotional materials and proposals for pharmaceutical companies. She eventually put her considerable writing talents to work for the Illinois branch of the Kidney Foundation. In this role, she created newsletters and promotional pieces, using her creativity to translate complicated issues into terms that a lay audience could easily understand. For example, she created a comic book explaining the dangers of high blood pressure and the effects of diet and smoking on this condition.

After raising two daughters, Lee took a position as a writer in a law office. (She says the transition was easy because there are many lawyers in her family; in fact, her great-grandmother graduated from CWRU's School of Law.) Her boss liked the way she wrote and gave her the opportunity to produce technical legal drafts. This, together with her experience in biology, led to her current position. As the director of scientific immigration, Lee assists foreign scientists who want to study, work, or live permanently in the U.S. She provides written explanations to U.S. Citizenship and Immigration Services about what these scientists do, and why they are qualified for a particular visa category. The scientist she helped in her first case is now a faculty member at CWRU. Finally, Ms. Price's career-long dedication to biology has led her to work as a volunteer in the Division of Mammals at the Field Museum in Chicago, where she recently became an author on her first scientific paper.

We asked Ms. Price to answer a few questions about her experiences in the Department of Biology.

Q: What did you learn as a biology major that helped you in your career?

A: I learned that there is a beautiful order [to things] that has guided me ever since.

Q: Was there a particular faculty or staff member in the biology department who inspired or influenced you and your development?

A: During my time in the department, Drs. Dave Murrish and Mits Teraguchi influenced me. They were both supportive, but always very demanding. I was not always a particularly dedicated student and did not always do my best work. But despite this, I felt they neither judged me, on the one hand, nor lowered the standards they wanted me to meet, on the other.

Q: What kind of advice would you give to our pre-med or pre-health care undergraduates?

A: I would aim this toward those who are struggling: Try not to let it worry you too much, because the struggle allows for some wiggle room, and a lack of achievement can ultimately be very forgiving.

Letter from the Chair:

Hello Everyone,

I am happy to report another excellent year for the Department of Biology at CWRU. Our recent accomplishments include the arrival of a new faculty member (Sarah Bagby), the promotion of two current faculty members (Radhika Atit and Rebecca Benard) and a successful national search for another new faculty member who will start next fall. One of our senior instructors, Rich Drushel, received the 2017 Wittke Award for Excellence in Undergraduate Teaching; he is the department's second award winner in three years.
Finally, we have developed bio[box], the department's first-ever central research facility, to support undergraduate researchers and the faculty members with whom they are working. A detailed description of bio[box] is featured on the first page of this newsletter.

We are proud of our success in increasing the visibility and stature of the Department of Biology, and we will continue to move forward in 2018. As the first step toward encouraging undergraduate students to engage more actively with the department, we have initiated an undergraduate Chair's Advisory Committee. This committee, made up of students representing sophomores, juniors and seniors in the major, will educate me on how best to tap into the enthusiasm, expertise and perspectives of our undergraduate majors for the department's benefit.

In our last newsletter, I closed my message by saying that we want to learn how you have developed since you graduated, and how your experiences in the Department of Biology helped you on your way. The more I talk with our alums, recent or more distant, the more I discover the breadth of career opportunities for which an undergraduate degree in biology from CWRU prepared them. Please write to Katie Bingman (krb28@case.edu) or me (maw27@case.edu) about your professional and personal achievements so we might share them with your fellow alums and our current students. We will use this feature to illustrate the amazing range of possibilities and heights of success open to students with a biology degree from CWRU. Imagine how seeing the life experiences and successes of fellow biology majors could have helped you when you were a junior or senior trying to figure out which path to take once you graduated. I look forward to hearing from you and hope that you will visit our website regularly to learn the most recent news from the department (biology.case.edu).

It is always my goal to help our faculty and students continue our upward trajectory by building on our excellent reputation and enhancing our impact nationally, internationally, and in the local Cleveland area. Thanks very much for all of your help and support as we go forward.

Faculty Highlights

Christopher Cullis has been published in the Journal of Experimental Botany:
Christopher Cullis1 and Karl J. Kunert (2017) Unlocking the potential of orphan legumes J. Exp. Bot.
Y Kim and Christopher Cullis. (2107) A novel inversion in the chloroplast genome of marama (Tylosema esculentum) J. Exp.Bot.

Dr. Valerie Haywood has been invited to share her findings on biology education research at several prominent events, including the Gordon Research Conference on Undergraduate Biology Education Research, the National Association of Biology Teachers (NABT) Professional Development Conference, and the annual conference of the American Society of Plant Biologists (ASPB) She was also elected to the Education Committee for the ASPB in 2015 and serves in an executive position on the OH-PKAL Governing Board.

Rich Drushel received the Carl F. Wittke Award for Excellence in Undergraduate Teaching for 2017.

Jean H. Burns joined the COMPADRE Core Committee, whose mission is 'facilitating comparative analysis of plant and animal demography through provision of data infrastructure, tools and open-access data.'
She also was published in Ecology: Michelle E. Afkhami*, D. Luke Mahler*, Jean H. Burns*, Marjorie G. Weber, Martin F. Wojciechowski, Janet Sprent and Sharon Y. Strauss*. in press. Symbioses with nitrogen-fixing bacteria: nodulation and phylogenetic data across legume genera. Ecology. doi: 10.1002/ecy.2110
*indicates authors contributed equally

The interdisciplinary team behind CWRU's recent biohybrid sea slug robot, including mechanical engineering faculty members Drs. Akkus, Gurkan and Quinn, Professor of Biology Dr. Chiel, and post-doctoral fellow Dr. Webster-Wood, have published a new review in the journal Science Robotics. This review discusses how organic materials can be used for the four fundamental components in robotic systems: Structure, Actuation, Sensing, and Control.
Arnold Caplan received a Lifetime Achievement Award at the International Joint Preservation Congress in Warsaw, Poland on September 14, 2017 (www.jointpreservation.pl).

Robin Snyder's paper with Steve Ellner, "Pluck or luck: does trait variation or chance drive variation in lifetime reproductive success?" is in press at the American Naturalist. Snyder also gave a talk on this subject at Penn State. They also received the American Society of Naturalists Presidential Award for the best paper published in the journal "American Naturalists" for this paper.

Radhika Atit was promoted from Associate Professor to Professor

Graduate Student Highlights

Bonnie Baird, Austin Leeds, and Laura Bernstein-Kurtycz all presented talks at the Third International Symposium on Zoo Animal Welfare at Brookfield Zoo, October 8-10, 2017.

Michael Moore gave an oral presentation at the Society for Integrative and Comparative Biology in January and was awarded a $2000 grant from the Theodore Roosevelt Memorial Fund (through the American Museum of Natural History) for his research on color evolution in dragonflies.
He also had a paper accepted to the prestigious peer-reviewed journal "Ecology" on how predators affect dragonfly development: http://onlinelibrary.wiley.com/doi/10.1002/ecy.2056/full)

Russell Engelman, CAS 2015, had a paper published, entitled "New palaeothentid marsupials (Paucituberculata) from the middle Miocene of Quebrada Honda, Bolivia, and their implications for the palaeoecology, decline and extinction of the Palaeothentoidea". This paper won second place in the department's Outstanding Paper Award and was featured in the Case Daily. https://www.eurekalert.org/pub_releases/2017-04/cwru-crd041117.php

Iulien Ghergel coauthored a paper published in Molecular Phylogenetics and Evolution (http://www.sciencedirect.com/science/article/pii/S1055790316302329) He also organized and lead a half a day workshop on "Modeling species distributions using Maxent" as a part of the 15th International Symposium in Geographical Information Systems and Teledetection this past September in Romania.

Sydney Brannoch received the Cleveland Museum of Natural History Outstanding Student Award in 2017 for her doctoral research. She also led a study that standardized praying mantis morphological terminology, specimen preparation, and measurement data capture, which was recently published: Brannoch, S.K, Wieland, F., Rivera, J., Klass, K-D., Béthoux, O. Svenson, G. (2017). Manual of praying mantis morphology, nomenclature, and practices (Insecta, Mantodea). ZooKeys. 696: 1–100. https://doi.org/10.3897/zookeys.696.12542

Riley Tedrow received the Health Services Collegiate Program Scholarship in Medical Entomology from the US Navy in April.

Abe Perez won best poster at the CWRU Biology graduate research symposium and recieved the Ecological Society of America 2017 Springer Travel Award, Urban Ecosystem Ecology Section

Alexandra Yarger, CAS 2011, (won the Case Western Department of Biology Outstanding Paper Award. and the Graduate Research Symposium Oral Presentation Competition.

David Dimitrie presented a poster at the Midwest Partners in Amphibian and Reptile Conservation 2017 Meeting titled "Response of Post-metamorphic American Toads (Anaxyrus americanus) to Experimental Soil Liming in Deciduous Forests of Northeastern Ohio".

New Faculty Member: Sarah Bagby

Dr. Sarah Bagby joined the Department of Biology in 2017 as an assistant professor. She earned her undergraduate degrees at the University of Chicago and at Oxford, and her PhD at MIT. "Microbial processes underlie life as we know it. Microbes power the carbon and nitrogen cycles; nearly 3 billion years ago, microbes drove the rise of molecular oxygen in our atmosphere.
The metabolic processes that allow these tiny creatures to have a global impact all arose as ways of solving the problems presented by the physical environment: How do you thrive at high pressure? at high, or low, or fluctuating temperatures? in bright, energy-rich, deadly light, or in total darkness? in turbulent flow, or in still waters? How do you survive when you're starving, and how do you outcompete other cells when food is abundant? The ways microbes answer these questions, and the ways their solutions spread from community to community, continue to shape our world today. Dr. Bagby has studied microbial physiology and evolution in the oligotrophic ocean, in lakes in the thawing Arctic permafrost, in the seafloor, and in groundwater. The Bagby lab uses fieldwork and bioinformatics to describe microbial communities and processes in situ; lab experiments to identify and characterize the molecular innovations that mark these communities; and ecoinformatics to understand the impact of these communities on the Earth system."

We want to hear from you!

We are proud of the accomplishments of our faculty, students and alumni. Let us know about job changes, awards, honors and life events. Please email your news and contact information updates to contact-cas@cwru.edu

Support the Department of Biology

You can contribute to our on-going success by making a gift to the department. Your gift will allow us to continue to offer opportunities for our students to excel academically and to conduct cutting edge research. You can give online at giving.cwru.edu/biology

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