Sitting in class alone. Breathing deeply to push back tears. Dreading the weekend because I did not have any social plans or friends to spend time with. On the whole, my transition to college was deeply difficult. I have always been an introverted person, close to my family and with a small, tight-knit group of friends. Lifted out of that community and resettled on campus, my first months at New College upended everything. Even in class, I had to redirect my attention towards lectures on the cell cycle and away from an anxious inner voice that pointed out how much I didn't feel the sense of community that college had seemed to promise. Instead, I felt achingly alone.

Myakka River State Park was one place I could go to escape that feeling. Hiking through the scrubby flatwoods, I was surrounded by saw palmetto, polygala, and oak toads– not alone at all. My hikes became a form of walking meditation. Over countless solo visits, just myself and a camera, I started noticing patterns in the landscape around me. A few inches of elevation change resulted in totally different plant communities, with predictable assemblages across the park. Long-headed toothpick grasshoppers perfectly mimicked the wiregrass on which they sat, sometimes green, sometimes tan. Oak toads blended into the sandy Myakka soils. While I had entered college intending to go to medical school, **my experiences in nature and desire to understand the natural world drew me in a different direction**, towards classes like Ecology, Entomology, and Conservation Biology.

Long-headed toothpick grasshopper; polygala; oak toad; Myakka River SP. Photos: M. Barkdull

Intellectual Merit: The peaceful escape of the Myakka scrub got me through two very tough years. But over time, I found my human community at New College as well. I'm sure my ecology professor, Dr. Emily Heffernan, had no idea how she was changing my life when we bumped into each other one Saturday at the New College bayfront. She had noticed my engagement in her class, and asked if I would like to join a **January independent study project** she was sponsoring– three students, working closely with her to screen tissue samples from the threatened Dakota skipper butterfly (*Hesperia dacotae*) for *Wolbachia*, a reproductive parasite that decimates small populations when first establishing infection. We found that one of three study populations was infected with *Wolbachia*, allowing conservation managers to better plan *ex situ* breeding programs. Through this experience in Dr. Heffernan's lab, I saw for the first time how genetic tools might let me understand the natural patterns I had observed at Myakka. I could rephrase my observations as questions– *how* and *why* had the long-headed toothpick grasshopper evolved to mimic grasses?– and evolutionary genetics would provide answers.

But her lab did more than open my eyes to the power of scientific inquiry: it also gave me the gift of community. After the January independent study period ended, I asked Dr. Heffernan if I could continue working in her lab– I was hooked on my research experiences alongside her and her students. To quote her email response: "Score! Yes, I have more *H. dacotae* samples!" I spent the next semester collaborating with a thesis student, amplifying microsatellite loci for a conservation genetics study of *H. dacotae*, and the next year **wrote my own honors senior thesis on the conservation genetics of the rare Florida duskywing (*Ephyriades brunnea*)**. I found that duskywing populations act as a metapopulation, with each sampled population harboring unique genetic diversity. Through my collaborations in the lab, the students I worked with became my colleagues, but also some of my closest friends.

Over the course of that first semester working in Dr. Heffernan's lab, I really fell in love with research– that's hard to deny when you find yourself talking about STRUCTURE analyses at the beach with friends! I also realized that there were some techniques I could not learn, and questions I could not explore on New College's 800-student campus, so **I decided to apply for NSF REU programs**. That

was another life-changing decision: working at the American Museum of Natural History, I learned that museums are more than dioramas and taxidermy; they are also hotbeds of innovative research. For my REU project, I sequenced 12S rDNA from 761 leech guts to determine which barcoding loci are most informative for invertebrate-ingested DNA biodiversity surveys. I found that the 12S locus identified a greater diversity of vertebrates than the typically used 16S locus. **Having finished the lab work for the project much faster than my mentors expected, I tackled a second project to assess the diversity of trypanosomal parasites** harbored by the leeches in our dataset. I was also invited to return two years later for a project using bloodmeal DNA to ascertain the origin of smuggled, internationally-protected leeches, which we determined were illegally collected in Central Russia.

Upon graduating, **I contacted several scientists at Cornell University inquiring about research positions,** and moved to Ithaca, NY for my gap year. I was interested in building on my conservation genetics background, and so I asked Dr. Kelly Zamudio if her lab could use a volunteer. Instead, she offered me a job as a postbaccalaureate intern. In that role, I worked with graduate students on several projects, using molecular techniques to study amphibian ecology. Most significantly, **I collaborated with a visiting scholar from Brazil, Dr. Fábio de Sá,** to elucidate the mating system of the frog *Cycloramphus boraceiensis*. This was an excellent example of the power of community and collaboration in science: I had more extensive lab experience, and so taught him lab techniques, while he had expertise in reproductive ecology, and taught me how to derive meaning from our data. We found that the frogs tended to share mates with more related individuals, suggesting the presence of kin selection; we are now working together to prepare our results for publication.

My research experiences prior to graduate school used genetic tools to measure parameters of ecological interest, like genetic differentiation and alpha diversity. However, the observations at Myakka that first drew my interest centered on adaptation: the grass-mimicking grasshopper, the cryptic oak toad. As I considered these observations through the lens of evolutionary genetics, I wanted to know: how are pigmentation genes regulated to produce the oak toad's camouflage? Are the variably-colored toothpick grasshoppers simply polymorphic, or might they be phenotypically plastic? **To explore these kinds of questions, I joined Dr. Corrie Moreau's lab at Cornell University.**

In my first year as a graduate student, I have initiated a project to assess the effects of ant worker reproduction on patterns of molecular evolution, using publicly available genomes to determine what genetic changes are associated with worker sterility vs. reproduction. My question and hypotheses first got me excited about the project, but as I have developed methods I have become nearly as excited by the computational tools I am mastering. During undergraduate studies at my small liberal arts college, I did not have the resources to learn computational skills; since entering graduate school, **I have gained proficiency in R, Python, Bash and Git**, using these skills in a comparative genomics framework to implement tests for selection, gene family expansions, etc. These skills are a critical complement to my wet-lab expertise, and together facilitate the research I propose in my Graduate Research Plan.

Intellectual Merit Summary: My research has resulted in **two publications**[1,2], **two manuscripts in prep**, and has **contributed to a fifth paper** currently in preprint[3]. Through my REU research, I developed **novel methods** for biodiversity surveys, demonstrating that the shorter 12S rDNA locus identifies a greater range of vertebrates than the longer 16S rDNA locus, the historic locus of choice in iDNA research. I presented the results of this research at the AMNH, and the Cornell Ecology & Evolutionary Biology Winter Symposium, winning the department's **Book Award**.

This past spring and summer, I **developed a novel workflow** for comparative genomic analyses, and tested it in an investigation of the molecular basis of reproductive systems in ants. My workflow, and accompanying documentation, are available on my Github[4] for public use, allowing any researcher to more quickly and easily conduct a comparative genomic analysis in their study system of interest. My ongoing graduate research helps unravel the processes underlying caste differentiation in ants, which will advance our understanding of the evolution of phenotypic plasticity and sociality (*see Research Statement*).

Broader Impacts:

Outreach & communication: Concrete conservation goals drove my undergraduate research. **Minnesota Zoo conservation professionals** are using my work on the disease ecology and population genetics of the Dakota skipper **to plan *ex situ* conservation programs**[5]. My colleagues and I also **presented our findings to the Imperiled Butterflies of Florida Work Group**[6], speaking to an audience of scientists, land managers, educators and citizens interested in butterfly conservation. While my past work was conservation oriented, moving forward I plan to focus on outreach through collaborations with high school and college educators, bringing computational skills to students early in their educational trajectories (*see Research Statement*).

Mentoring & leadership: While completing my honors senior thesis, I mentored another undergraduate in Dr. Heffernan's lab, collaborating with her on lab work and analyses. This fall, I am mentoring 4 undergraduates as we work together to digitize the ant holdings in the Cornell University Insect Collection. As I have immersed myself in computational biology, I have seen that the field sorely lacks representation of women and scientists of color, which motivates my ongoing mentorship activities. For example, I worked as a workshop volunteer and mentor through Cornell's 2020 **Diversity Preview Weekend**, a program created and run by graduate students to provide pre-doctoral students from underrepresented backgrounds with the skills needed to apply to graduate school.

Since June 2020, **I have served in a leadership role as the Ecology and Evolutionary (EEB) Biology Graduate Student Association co-president.** In this role, I collect input and data on graduate student concerns and liaise with faculty leaders to achieve progress on issues including diversity, equity and inclusion; teaching; and departmental climate and graduate student wellbeing. This service role has brought me personal satisfaction, and I plan to purse such roles at the departmental level as a future faculty member.

Diversity, Equity & Inclusion: Because scientific community has played such an important role in my own life, I am committed to making science a place where everyone can find that kind of belonging. To achieve this goal, we must critically re-evaluate existing systems to understand how they act as barriers to equity in science. As a first year student, I joined my department's seminar series committee, which solicits speaker nominations and assembles the schedule for each semester. Looking through past speaker lists and recalling the seminars I attended during my gap year, I noticed a striking lack of diversity. To confirm my hunch, I compiled and analyzed data on the race and gender of invited speakers from 2014-2020. I found that the series had been **just 20% non-white, 36% women, and 8% women of color**. Clearly, this was a problem: we had not been highlighting the research of scientists from underrepresented backgrounds, which furthers inequities in EEB. To address the problem, **I proposed that the committee include an explicit request for diverse nominations** in our solicitation email. We implemented this change, and **as a result our speakers for Fall 2020 are 60% non-white, 60% women, and 20% women of color.** I am also engaged in ongoing efforts to improve diversity in EEB as a member of my department's Graduate Student Recruitment DEI Working Group, working with faculty, postdocs and other graduate students to re-imagine departmental recruitment and admissions policies.

Future goals: GRFP support will help me pursue my goal of a career as a **museum scientist with dual affiliation as faculty** at a research university. I know from my own experiences that museum science remains poorly understood by the general public, and I am passionate about communicating the importance of biodiversity collections to society. This career path will allow me to marry this passion for museum-based biodiversity science with my desire to continue mentoring students. In addition to conducting high-quality research, it is my goal as a scientist and educator to increase equity in the natural sciences, building a world in which all people can be a part of the scientific community.

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