Personal Statement NSF-GFRP

My grandfather introduced my brother and I to beekeeping when I was 11 years of age. I was instantly fascinated by the processes associated with running and maintaining an apiary, notably, the constant need to manage and treat for the numerous honeybee-related pathogens. The first year I had a colony of my own, it died over the winter due to high parasite levels. Working in this system at a young age gave me an understanding for the importance of disease management and a respect for how difficult it is for beekeepers to maintain these important pollinators upon which we rely for one third of our food supply. The foundation for my goals of becoming a disease ecologist at a research university and a scientific communicator for pollinator health was already in place, however, it would not be a very direct or traditional path.

***Past experiences:*** I grew up in a large family with two brothers and two sisters. My father, a jeweler by trade, supported the family on a single moderate salary. I used to work with my dad in the summer, helping him machine components for a popular bracelet he had been commissioned to manufacture, instilling in me my passion for problem solving. My mother, originally from Costa Rica, was an amazing musician and imparted her love for music in our family. As a young adult, my two brothers and I would write and perform original music as well as covers of classic rock songs like, *Angie* by the Rolling Stones, or *The Ocean* by Led Zeppelin. When I was 16, our band “Burnham” was signed by a production studio in New York City and by the Age of 18, we had a major record deal from Island Def Jam Records. Only a year later, we had signed a publishing deal with EMI and were writing and recording in studios in Los Angeles, New York, Miami and Nashville with some of the top producers, songwriters and audio engineers in the world. This period was very disruptive for my supportive family. My mother, who had homeschooled us at various points throughout our lives, was hired by the record label to tutor us on the road. My sisters came to visit us in the studio and were able to travel to many exciting locations with us. During these years, I learned modern recording techniques and honed my skills as a music producer. In 2011 we opened for Justin Bieber for 20 shows during his “My World” arena tour. Completed a 20 state radio tour, walked red carpets and headlined two tours of our own. We played shows in 47 states and 4 Canadian provinces to hundreds of thousands of people during our carriers and three of our singles charted on Disney Radio’s top 10. However, in 2012, the industry shifted significantly and our label changed management. When we were dropped from Island Def Jam, I began perusing my love for the technical aspects of music. I continued recording and producing music from my bedroom studio and began a very small custom-design speaker cabinet business in 2012 called “Burnham Custom Amplification.” Over a three-year period, I built approximately fifty speaker cabinets for musicians all over the world. My passion for tinkering, problem-solving and understanding the mechanisms behind everyday things eventually drove me to pursue a degree in the sciences.

***Education:*** I was the first person in my family to attend college and receive a bachelor’s degree. In 2011, I began taking online classes from the Community College of Vermont. I took a broad selection of introductory science courses ranging from philosophy to archeology and human biology. The biological sciences resonated with me in a way that none of my other courses had. I took all of CCV’s biology offerings maintaining a 4.0 GPA while traveling with my band and running my owner-operated business. In 2014, I completed the first semester of my sophomore year and realized the need to transfer to a 4-year research university. After my first semester at the University of Vermont, I began looking for research opportunities. Alison Brody (Professor of Biology, UVM) advised me to apply for a job working with her Ph.D. student, Samantha Alger (NSF graduate fellow) on RNA viruses in bumble bees. I completed an undergraduate research project characterizing the prevalence and intensity of a microsporidian parasite, *Nosema bombi* in Vermont bumble bees. I was so enamored with the work that I applied to UVM’s Accelerated Master’s Program to build upon my undergraduate research by modeling *Nosema* prevalence through time and running competition experiments between two species of *Nosema* common to bumble bees. In 2017, I completed a BS in zoology with a focus in statistics and computational biology. I am currently in the last year of a joint Masters-BS program.

***Research experience:*** During the Fall of 2014 for my “Introduction to Archeology” class, I examined the differential complexity of gravestone morphology in Vermont during the periods before, during and after the American Civil War. In the Spring of 2015, I became an undergraduate field and lab technician for NSF graduate fellow, Samantha Alger. During the summer of that year, I assisted in the first North American survey of RNA viruses in native bumble bees, helping to sample bees and flowers from 30 sites across Vermont. I then conducted the RNA isolations and RNA virus assays (qPCR) for hundreds of the collected bumble bee and flower samples. I aided in rearing wild-caught bumble bee colonies for a field experiment looking at bumblebee health at different proximities to honeybee apiaries. In 2016, I assisted Samantha Alger in the experimental design, preparation, sample collection, virus assays and data analysis for a field experiment designed to test the proposed shared floral resource transmission route hypothesis between honeybees and bumble bees. For the last three years (2015-2017), I have been the assistant coordinator and sample collector for Vermont’s involvement in the National Honeybee Survey. I completed my undergraduate research work in 2016 on characterizing the prevalence and load of *Nosema bombi*,in Vermont bumble bees by surveying bees from 13 sites and counting Nosema spores in over 350 bee samples. Using my own empirical data as well as parameter estimates from the literature, I created an SIR-style model (ODE) predicting infection rate of Nosema during the growing season. My Accelerated Master’s work focuses on modeling competition between two species of *Nosema*, in bumblebees.

***Broader impacts associated with my past and current work:*** During my time as an undergraduate researcher and an accelerated master’s student, I was able to oversee two undergraduate researchers and help train and manage six others. In addition, I was able to disseminate my findings to the scientific community, beekeeping community, as well as the general public as a whole. I have given talks on improving beekeeping management practices informed by my native bee and honeybee pathogen work. Venues ranged from various north east honeybee organizations, including the Vermont Beekeeper’s Association to the UVM beekeeping club. In February of 2016, I gave a talk at the Vermont State House to the Pollinator Protection Committee on the current state of disease in Vermont’s honeybee and bumble bee populations. I have given workshops on how to identify and quantify detrimental honeybee pathogens like Nosema and Varroa, giving beekeepers the tools and knowledge to manage their disease levels from the point of view of a scientist. In addition, I gave a talk to South Burlington High School’s Big Picture students on applied experimental design in honeybee research.

***Ongoing collaborations:*** I am currently an active collaborator on many different projects with research groups that bridge disciplines, professions and academic institutions. I am currently a collaborator on Samantha Alger’s dissertation work on determining the roll of shared floral resources in the RNA virus transmission route between managed honeybees and native bumble bees. In addition, Samantha Alger, Leif Richardson (environmental consultant and leading bee researcher) and Zac Lamas (local commercial beekeeper) and I are working on an experiment.com crowd-funded project that examines the roll of migratory beekeeping on the spread of disease. Along with Lauren Ash (UVM graduate student), Erin Keller (UVM graduate student) and Samantha Alger, I am a founding member of UVM’s disease ecology reading group. Our 2018 goal is to write review paper that characterizes the experimental and statistical methods required to address proposed gaps in our knowledge on co-infection. I am collaborating with my Masters Advisor, Alison Brody, on project that looks at the effects of pollen thievery on the fitness of gynodioecious flowers. Finally, Herman Lehman (Professor of Biology, Hamilton College), Andre Burnham (Molecular Biology BS student at Hamilton College) and I are currently working on two different projects. Firstly, we have experimentally shown that locally-bred honeybees are more pathogen resistant in their own local environment than honeybees imported from large breeders. Secondly, we are examining how the natural tree resin-based product, propolis, might be a viable treatment for Nosema infection in honeybees.

***Publications and conference talks:* 1)**Burnham P.A. & Alger S.A. (2017). Vermont 2015 National Honeybee Survey results. Vermont Pollinator Protection Committee Report. 30-39. **2)** Alger, S. A., Burnham, P. A., Richardson, L., & Lamas, Z. (In Review). How does migratory beekeeping affect the spread of infectious disease in *Apis melifera*. PLoS One.

**3)** P. Alexander Burnham. (Abstract accepted for 2018 conference talk). RNA viruses and Varroa mites: Temporal variation in honeybee pathogens influences patterns of coinfection. National Honeybee Federation Conference.

***Intellectual merit (future):*** Recently, experts in infectious disease, in a series of review papers, have pointed out the lack of understanding we currently have for the mechanisms behind co-infection (multiple pathogens in one host) and how multiple infection affects host functions. The study of infectious disease is primarily concerned with the transmission, dissemination and clinical signs associated with a pathogen, while disease ecology primarily focuses on interactions between the host, environment and pathogen. In my Ph.D. work, I aim to bridge these two fields by examining how community level interactions, like competition, might work in a host-pathogen system. Previous work has shown that co-infection can lead to so-called “synergistic effects” that increase mortality or reduce host fitness in some way. Very little work has been done from the angle of the parasite community and the potential competition for resources that could be responsible, in part, for increased pathogen virulence.

***Broader impacts (future work):*** In my time as a Ph.D. student, I will continue to develop myself as a scientific communicator in addition to pursuing my academic goals. I will speak at conferences, beekeeping and government organizations in addition to publishing my findings in academic journals. I will include both high school and undergraduate researchers in my work, allowing students to pursue individual research. I will continue to work closely with beekeepers and other stakeholders like the Vermont Beekeepers Association and the local agricultural community through workshops, seminars and policy recommendations. ***Receiving the honor of becoming an NSF graduate fellow would drastically improve my ability to peruse my goals of becoming disease ecologist in an academic position and a scientific communicator.*** I am currently on a Teaching Assistantship, and the experience gained from teaching undergraduate laboratories has proven invaluable. However, the ability to spend more time pursuing scientific research and disseminating my findings, which this fellowship allows, will better enable me to reach my goals. I believe scientific communication (in its similarities to stage performance) has drawn me to scientific communication. The time I have spent on biological research has strengthened my drive to add to the body of knowledge in disease ecology. I am an applicant who would maximize the opportunity afforded by this prestigious award and honor this distinguished fellowship. I thank you for your consideration.