Personal Statement, Background and Future Goals

When my grandfather introduced me to beekeeping at age 11, I was instantly fascinated with running and maintaining an apiary, notably, the ever-changing environment, the troubleshooting, and 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 as a beekeeper at a young age gave me an understanding for the importance of disease management and a respect for how difficult it is 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, mine would not be a very direct or traditional path.

Past experiences: I grew up with two brothers and two sisters. My father, a jeweler by trade, supported our family of seven on a moderate salary. As a child, I spent my summers working with my dad, 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 a talented musician and imparted her love for music in our family. As a young adult, my two brothers and I wrote and performed 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 time I was 18, we had a major record deal from Island Def Jam Records and a publishing deal with EMI Music Publishing. We began writing and recording in Los Angeles, New York and Nashville with some of the top producers, songwriters and audio engineers in the world. At a young adult, I found myself deeply involved in contract negotiations with some of the most powerful presidents and CEOs in the music industry, allowing me to develop communication skills that would serve me later in life. This period was very disruptive, yet exciting, 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 radio tour throughout 20 states, walked red carpets and headlined two tours of our own. We played in 47 states and four Canadian provinces to hundreds of thousands of fans 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 pursuing 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 inspired me to pursue a degree in the sciences.

Education: I am 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 (CCV). I tackled 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 developed an interest in pursuing a career in medicine. I transferred to the

University of Vermont and after my first semester, 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 quickly became involved in multiple bee-related research projects, leading me away from the medical field and towards a career in disease ecology. I applied to UVM's Accelerated Master's Program (AMP) and in 2017, I completed my BS in zoology with a focus in statistics and computational biology. I am currently in the last year of this joint MS-BS program.

Research experience: In 2015, I became a research technician for Samantha Alger and assisted in both field and laboratory work for the first comprehensive North American survey of RNA viruses in native bumble bee species. That same year, I assisted in a field experiment examining bumble bee health at different proximities to honeybee apiaries. In this work, I reared wild-caught bumble bee colonies, monitored colony health, and analyzed bees for diseases using both microscopy and quantitative PCR. In 2016, I co-led one of the first investigations testing if bee viruses are transmitted between bee species through the shared use of flowers. I assisted in all aspects of this field experiment including experimental design, sample collection, molecular assays to detect viruses and data analysis. Every year since 2015, I have helped lead Vermont's involvement with the National Honey Bee Survey, a nationwide effort to gather baseline data on bee disease. Results from this work represent the only standardized honeybee disease data Vermont has to date. As assistant survey coordinator and sample collector, I am responsible for recruiting beekeeper participants, collecting samples from apiaries, data analysis and reporting findings to beekeeping organizations throughout the state. I completed my undergraduate research work in 2016, quantifying the prevalence and load of *Nosema bombi* in Vermont bumble bees. Using my empirical data as well as parameter estimates from the literature, I developed a model to predict infection rate of *Nosema* during the growing season. My AMP work focuses on modeling competition between two species of *Nosema* in bumble bees. This year I conducted a crowd-funded project with Samantha Alger, Leif Richardson (environmental consultant and leading bee expert) and Zac Lamas (local commercial beekeeper) to examine the role of migratory beekeeping on the spread of disease. For all of these projects, our manuscripts are either in preparation or recently submitted.

Broader impacts associated with my past and current work: During my time as an undergraduate researcher and an AMP student, I have been the primary mentor for two undergraduate researchers and helped to train and advise six others. In addition, I have presented my findings to the scientific and beekeeping communities, as well as the general public. I have lectured on my research and sound beekeeping practices to numerous beekeeping organizations, including Vermont Beekeepers Association (VBA), Southern Adirondack Beekeepers Association and UVM Beekeeping Club. In February of 2016, I was invited to the Vermont State House to present our findings on bee disease to the Pollinator Protection Committee (PPC), a legislative committee charged with improving bee health in Vermont. Our report was included and published in the PPC report to the Vermont Legislature. I have designed and presented hands-on bee disease workshops, providing beekeepers with the tools and knowledge to manage bee disease from the point of view of a scientist. In addition, I was invited to South Burlington High School to teach experimental design to students in the Big Picture Learning program. In January 2018, I will be speaking at the American Beekeeping Federation Conference, one of the nation's largest honeybee research conferences, on my newest research project "RNA viruses and Varroa mites: Temporal variation in honeybee pathogens influences patterns of coinfection".

Ongoing collaborations: I am currently an active collaborator on numerous projects with research groups that bridge disciplines, professions, and academic institutions. I am collaborating with Samantha Alger to examine the prevalence of bee viruses on field-collected flowers and the propensity for bees to leave behind viruses while foraging. Along with three other graduate students, I am a founding member of UVM's disease ecology reading group. We are currently working on a review paper that characterizes the experimental and statistical methods required to address proposed gaps in our knowledge on co-infection. I am assisting a beekeeper who has limited formal scientific training, analyze data and interpret results for his research project that examines the efficacy of natural Varroa controls (SARE grant: FNE16-840). I am collaborating with my advisor, Alison Brody, to investigate the effects of pollen thievery on the fitness of gynodioecious plants. Finally, I am collaborating with Herman Lehman (Professor of Biology, Hamilton College) and Andre Burnham (Biology BS, Hamilton College) on two projects: one to examine the environmental context of pathogen resistance in honeybees, and two, to examine if the natural tree resin-based product, propolis, might be a viable treatment for *Nosema ceranae*.

Intellectual merit: In my previous work, I have characterized *Nosema* prevalence in native bees, investigated beekeeping practices, educated beekeepers with the aim to reduce disease spread, examined a proposed, but largely untested virus transmission route, and helped to provide the first standardized data our state has on honeybee disease. Now, as an early career scientist, I will continue to aid in efforts to improve pollinator health while also contributing to broader infectious disease research as a disease ecologist. Recently, experts in infectious disease have pointed out the lack of understanding we currently have for the mechanisms driving co-infection (multiple pathogens in one host) and how multiple infections affect host functions (1,2). To address this gap, particularly in the field of pollinator disease research, I believe a multidisciplinary approach is necessary. The study of infectious disease is primarily concerned with the transmission, dissemination and clinical signs associated with a pathogen, while ecology primarily focuses on interactions between organisms and their environment. To address this gap, in my Ph.D. work, I will bridge these two fields as a disease ecologist and examine how community level interactions, like competition, operate in a host-pathogen system.

Broader impacts (future work): I will continue to develop myself as a scientific communicator and work closely with beekeepers and other stakeholders like the VBA and the local agricultural community through workshops and seminars. I will continue to speak at conferences, advocate at the state government level by providing policy recommendations to improve pollinator health, and publish my findings in academic journals. I will include both high school and undergraduate students in my work, allowing them to pursue individual research. Receiving the honor of becoming an NSF graduate fellow would drastically improve my ability to pursue 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.

References: 1) Hébert-dufresne, L., & Althouse, B. M. 2015. Complex dynamics of synergistic coinfections on realistically clustered networks. PNAS. *112*(33): 1–6. **2)** Johnson, P. T. J., et al. 2016. Why infectious disease research needs community ecology. Science. *349*(6252): 1-20.