As a freshman eager to do research, I looked at my department's bulletin board for flyers looking for volunteers on a research project. The first flyer that caught my eye was from the Vandermeer lab and it detailed a project on identifying and recording the important insects found in the coffee farms of Chiapas, Mexico. After meeting with the project supervisor, I was handed thirty-eight vials containing specimens collected from different farms. With a heavy insect guide book on my lap, I poured the content of the vial in a petri dish and looked through the microscope lenses. There was a parasitoid wasp the size of a dust speck and floating nearby was a leafhopper vibrantly colored in ruby and turquoise. There were metallic-green bees and a treehopper shaped like a crescent moon. It was an extraordinary experience to witness such diversity that I wanted to pursue research on insects due to the important range of roles they play from agriculture pests and vectors of human diseases to invaluable agents of important ecosystem services. What was supposed to be a semester in the Vandermeer lab then turned into a four-year endeavor in pursuing research on how human effort in addressing social concerns such as food production can coexist with preserving insect biodiversity, environmental health, and sustainable agroecosystems.

RESEARCH CAREER: With their bizarre appearances and the macabre interactions they have with their hosts, the parasitoid wasps easily became my favorite insect group. However, it was their crucial role as biological control agents in agroecosystems that inspired me to pursue an independent project exploring how environmental variables at the local and landscape scale affect parasitoid distribution. I undertook the project because I saw the great benefits the study could have for the coffee farmers as augmenting the existing biocontrol population is more sustainable and environmentally safe than chemical control. Augmenting the local parasitoid population, however, is not only about increasing the abundance but the species richness as well because a diverse natural enemy assemblage is more effective in controlling pests. Therefore, I spent months identifying the wasps collected in Mexico at the family level and assigning the individuals to unique morphospecies for biodiversity analysis. At the end of the project, I had singlehandedly identified 422 parasitoid individuals of 164 morphospecies.

As there are few studies done on the distribution of neotropical parasitoid wasps in coffee agroecosystems, the fact that I reached significant results from my data analysis was exciting. By creating generalized linear mixed models in R, I found that it was not the number of shade trees but the presence of trees with larger biomass in the coffee farm that was a significant predictor of parasitoid distribution. This is because larger trees could provide more food resources and varying microclimate levels for refugia. This finding was important as the coffee farmers have direct control over the presence of shade trees on their farms. I also found that the interactions between the arboreal Azteca ants and the parasitoids to be more complicated than once thought. The Azteca ants are considered to have negative effects on biocontrol due to their protection of the coffee scales which are major pests that excrete honeydew for the ants to consume. However, I found that because the Azteca ants cluster the scales together, the parasitoids can actually reduce their host search time thus disproving the previous assumptions about the Azteca ants. My findings demonstrate that removing the shade trees will remove the Azteca ants thus curbing the effectiveness and stability of the parasitoid population. Finally, the major conclusion of my analysis was that a simplified landscape composed of highly intensified farms is detrimental to the local wasp population.

For future policies in agriculture management, I concluded that farmers should foster a shade tree canopy that includes large biomass trees which could ultimately create landscape complexity

for the persistence of effective biocontrol populations. I published my work **"Parasitoid wasps benefit from shade tree size and landscape complexity in Mexican coffee agroecosystems"** (Pak et al. 2015) in the journal *Agriculture, Ecology, and Ecosystems.* I won my department's **Travel, Research, and Internship Grant** (2014) which covered my expenses to present a poster at the **Ecological Society of America Conference** in Sacramento, California. After being exposed to the current research in multiple fields of ecology, I realized that I am interested in research projects which focus on the intersection of insects, disease, and the environment. Specifically, I want to pursue research on insect-pathogen systems and explore how anthropogenic impacts like climate change could affect such dynamics. Additionally, I plan to incorporate topics that I am interested in such as agroecosystems, spatial ecology, multi-trophic systems, and computational modeling. My research will be crucial for informing policy makers on implementing more effective biological control programs in the agricultural and forestry sectors and guiding ecologically sound integrated vector management in public health.

In my senior year, I continued my research exploring how vegetation structure can translate to effective control of leaf-miners, one of the most destructive coffee pests. After recording and identifying the parasitoids that emerged from the leaf-miner pupae collected in Puerto Rico, I used logistic regression analysis to understand how different variables of vegetation structure affect the parasitism rate. I found that the increasing complexity of vegetation structures across all forest strata greatly enhances the parasitism rate. I am currently writing my manuscript which further emphasizes how deforestation can reduce the natural enemies' ability to control for pests. This could lead to increased usage of chemical control that can drive the development of pesticide resistance in pests. I also pursued a similar secondary project to identify which local and landscape variables drive the incidence of rust, the most important disease in coffee agroecosystems. While my results were inconclusive, I realized the importance of looking at multiple taxon groups and other ecological factors to understand the complexity of disease dynamics. For future research on disease dynamics, I plan to incorporate interactions beyond the host-pathogen relationships to realistically capture ecological processes.

To understand how landscape simplification can affect the interactions of agricultural pests and their natural enemies, I was hired as a research assistant in the summer of 2015, to investigate how the dispersal ability of the organisms in a pest-pathogen-predator system could affect its survival. Specifically, our research group placed pea aphids and their natural enemies, lady beetles and a parasitic fungus, in a system of artificial patches. We then altered how well the organism could move between patches. Our hypothesis was that systems that could better facilitate dispersal between patches are less likely to face extinction. While we are still analyzing the results, this project gave me the unique opportunity to run empirical experiments on a multi-trophic system which is crucial for the success of my proposed research.

My current graduate research is exploring how increasing temperature leads to recurrent outbreaks of the tea tortrix in collaboration with Queens University, Canada and the National Institute for Agro-Environmental Sciences, Japan. Currently, this study only focuses on the tea tortrix system but I am working on how temperature can affect the moth's natural enemies to better understand the future of integrated pest management.

BROADER IMPACT: Due to my experience with parasitoid wasps, I have contributed my knowledge to projects pertaining to sustainable urban gardens. I helped analyze the distribution of parasitoid wasps in Ann Arbor's urban gardens and I have coauthored two posters that have been presented**: "Flying pests & natural enemy dispersal in an urban system"** (10th Early

Career Symposium, 2014) and **"Coupled Socio-ecology dynamics of urban garden"** (MCubed Symposium, 2014). For these projects, I worked closely with students in the ED-QUE2ST REU which is a University of Michigan research program for underrepresented students in Ecology and Evolutionary Biology. I taught the ED-QUE2ST students how to discern and identify the parasitoid wasps caught on sticky trap. In the summer of 2015, I had been working with both the lead of the project and the ED-QUE2ST students in getting the manuscript **"A meta-population approach to urban gardens"** (Ong et al. 2015) ready for publication. As a co-author, I identified parasitoid wasps, assisted with spatial-temporal data analysis, and wrote parts of the method and result sections. I am proud of my contributions to the project as we concluded that urban gardens could host a diverse invertebrate assemblage which is crucial for creating sustainable gardens that yield important benefits such as providing accessible produce in food deserts. Finally, this project gave me a fantastic opportunity to work with students from diverse backgrounds to contribute to the burgeoning urban agriculture movement.

My greatest strength as a researcher is that I am eager to collaborate by providing assistance in utilizing specific software, offering identified samples, and sending datasets to research groups that are interested in meta-analysis. For example, I analyzed the diversity of neotropical ants for a collaborator at UC Santa Cruz due to my experience in using EstimateS, a package for biodiversity estimation. I have also identified wasp samples for the El Colegio del Sur in Mexico. Finally, I have provided datasets on the neotropical parasitoid wasps identified in Mexican and Puerto Rican coffee farms (Approximately 900 individuals) to the Chaplin-Kramer Lab at Stanford University which are doing a meta-analysis on multiple taxon groups in different agroecosystems. I will continue to share my knowledge and data with other research groups. In order to disseminate knowledge to the broader public, I created a biology blog earlier this year entitled *"In the Deep End: A Biology Blog"* which has 344 pageviews as of October 2015. I have posted many of the R codes that I had used for my own projects and uploaded tutorials on topics ranging from structuring data for analysis to using the ggplot2 package to create graphs. I am also at work publishing photographs of parasitoid wasps I have taken and creating a guide for identifying these wasps.

OUTREACH: Due to the strong influence that my own mentors had in my career, I have been passionate about fostering younger students' interest in the sciences. After I graduated in 2014, I tutored middle-school students from Korea in science and mathematics and after entering graduate school, I have pursued various community outreaches. In late October, I volunteered to lecture on integrated pest management at a local elementary school and assisted running Haunted-U, an annual event that engages young students with scientific activities with a Halloween theme. I will continue to engage the general public with my research and advocate the importance of the public's support in the sciences.

In the future, I plan to get undergraduates in biology involved in programming with R. My colleagues and I will have workshops where students without programming backgrounds can immerse themselves in R. I want to emphasize the importance of coding for developing skills crucial for future researchers such as producing reproducible research to critical thinking and logical reasoning. Getting undergraduates especially those, from underrepresented groups, interested in R will give them the skill and confidence to address the challenges that we will face in our changing world. **Receiving the NSF fellowship will allow me the freedom to pursue impactful research that will broaden current knowledge and address social concerns while mentoring future scientists and communicating my research with the broader public.**