2016 Undergraduate Research Award - Essay

You don't have to go far to get great information. Sometimes it's not about making an epic journey to the ends of the world to get the information you want, but talking to the right people. The right people at UGA are in abundance. People such as librarian Ms. Holdsworth are extraordinarily helpful in aiding me in find resources and new methods to search for information. Professionals like her are essential to the success of projects like mine.

The project I have worked on for the past nine months is developing soybeans that are resistant to soybean mosaic virus (SMV). While soy is important because it is the second most grown crop in the United States worth $40.3 billion in 2014 (USDA, 2015), SMV, a RNA virus, is concerning because it reduces yield and its symptoms range from nuisance to harvest ending. The virus can reduce yield up to 94% and causes an assortment of other negative effects, such as reductions in nitrogen fixation, reduction in yield quality, stunting of the plant, mottling of the leaves, and of course mosaicking (Hill and Whitham, 2014). Even greater amounts of damage can occur when other viruses co-infect the soybean plants that are already infected with SMV (Hill and Whitham, 2014; Quiniones et al., 1971). As no single soy cultivar is resistant to all strains of the disease in the United States, there was a clear need for research regarding resistance to SMV (Ma et al., 2004).

Knowing the importance of finding a solution, I then set out investigating how to combat the disease, where I learned the importance of preliminary research and attention to detail. One of the premier technologies in the field of molecular biology, CRISPr/Cas9, was an appealing tool to combat the disease. I spent the 2015 spring break at home using GALILEO, Science Direct, and Google Scholar to immersing myself in the literature of soybean viruses and molecular biology. After a week of extensive research and paper writing, my literature review,

materials, and methods appeared to be reaching a conclusion. For Cas9 (an enzyme that cuts DNA/RNA) to be functional it needs to be localized to the nucleus of the cell to combine with guide RNA (a molecule that guides the Cas9 enzyme to its target, which it cuts) that is necessary for providing disease resistance. However SMV is localized to the cytoplasm (not the nucleus), meaning they would never interact (Mali et al., 2013). Without a full investigation of the literature and picking through the useful articles, my well-intended project would be doomed from the inception. I may have lost a dedicated week of my efforts, but I was saved from making a far greater blunder: beginning a project that just wouldn't function as designed. I ended up using a far superior option for combating SMV. The tool was tasiRNA or transacting silencing RNA. TasiRNA did not have problems with being localized to another part of the cell. In fact other siRNA's in plants, including soy, provide virus resistance naturally (Chen et al., 2015). The experience, however, drove home the point that though there may be stumbling blocks along the way, if research was easy it would just be called search.

Now I had ample information but I was lacking several key elements. That's where meeting with Ms. Holdsworth came in. Our research conference was very productive and something I will do again. She showed me how to extract more information from articles by feeding them back into Web of Science and going to the paper's citations and citers. In addition to introducing me to the Web of Science, she also introduced me to the USDA statistics website and the ACSESS DL search engine, both of which I used to immediately to find and add information to my literature review. She was able to answer questions I had about difficult-to-cite materials. She also had great advice for doing exhaustive research and keeping citations consistent when in doubt in the future.

A paper from ACSESS DL that Ms. Holdsworth directed me to was a publication from 1971 in the journal of Crop Sciences titled "Performance of three soybean varieties inoculated with soybean mosaic virus and bean pod mottle virus" (Quiniones et al., 1971). As the title suggests the paper investigated soy yield loss when infected with SMV and BPMV. I was excited to get a historical view of research on the disease, but was disappointed to learn I could not access the full article online. With Ms. Holdsworth's help we discovered that UGA had the article in print! The article was exceptional in that it had explicit and concise methods that, compared to some modern papers, was quite tenable. Most memorably, an oddity in the results (less seed discoloration in co-infected plants) was striking and I would love to begin another experiment with current technology to investigate the cause. It was also intriguing to learn the 1970's strains of SMV were named according to their location of isolation. This was before genetic sequencing was available so a location's strain might be genetically identical to differently denoted strain; they had no way to differentiate them! The historical perspective on the disease was impelling and it had parallels to my own work, even forty years later.

I immediately included the information from the 1971 paper; I used the search tools and websites Ms. Holdsworth showed me to ameliorate my current citations. She also gave me the tools to find "that one perfect paper" I had forgotten to cite and was otherwise impossible to relocate. I would adamantly recommend everyone who wants to do research talk to Ms. Holdsworth immediately after starting research as it would multiply their efforts and prevent grief. Without the tools and resources, including people, that the University of Georgia provides, I would not have even known where to begin. I am exceptionally grateful that they are available to us.

Abstract:

Soybeans, as one of the largest crops in cultivation, are constantly under attack by diseases. One of the most common diseases affecting soybeans internationally is the soybean mosaic virus. Food supply safety is a growing concern that must be addressed through new solutions as old techniques falter in the face of evolving diseases and increasing demand. Gene silencing is a powerful tool that many plants use to regulate their own gene expression. In this case, if gene-silencing could turn off the genes of the invading virus, the plant would be resistant. Even before the causal mechanism was known, genetic engineers have used gene silencing to combat viral disease. With a greater understanding of these silencing mechanisms, genetic engineers can create more efficient ways to induce gene silencing. One such method is using a specific type of miRNA pathway known as tasi-RNA, which is found within crop plants and using it to induce the desired silencing. By placing a tasi-RNA 22 DNA recognition site in front part of the viral DNA, resistance to soybean mosaic virus should be achievable. Accordingly, vectors for silencing the positive sense, negative sense, and a combination of the two strands of the virus were constructed. These events were introduced into Jack soybean tissue to generate transgenic lines for each vector. Events will be phenotyped for disease resistance upon reaching 20 cm in height. It is expected that not only can this approach impart viral resistance to soybean mosaic virus, but also to all other related viruses.

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Abstract

Hurricanes have the potential to produce mega mass casualty and mass fatality events in addition to catastrophic structural damage. The state of Georgia is located in an area vulnerable to hurricanes originating in both the Atlantic Ocean and the Gulf of Mexico; however, Georgia's response to a major hurricane has not yet been tested. While forecasting and emergency planning have greatly improved over the past few decades, recent history demonstrates that hurricanes still have the potential to result in catastrophic loss of life. The successful evacuation of coastal healthcare facilities in response to an impending hurricane requires advanced notice, timely decision making, and an unprecedented coordination effort between coastal and inland facilities. However, government planning assumptions do not accommodate the additional challenges faced by coastal healthcare facilities during severe weather evacuations, specifically, the advanced timelines needed, and the limitations of early hurricane forecasting models.

Elizabeth Hardister

UGA Libraries' Undergraduate Research Award

Hurricane Forecasting and Coastal Healthcare Facility Evacuations

When I began my research my freshman year, I scheduled a meeting with Ian Thomas in order to learn more about the resources the library provides that would enhance prospective research in the health sciences. He provided me with an introduction to GALILEO, Web of Science, PubMed, and Google Scholar. He recommended that I use these search engines to find review articles for accessible and comprehensive overviews of potential research areas. When I began my research with the Institute for Disaster Management, I used Web of Science's "most cited" filter to browse for influential articles concerning the ethics of disaster medicine. I came across an article reporting the story of Dr. Anna Pou, a physician that faced criminal charges for the deaths of several patients awaiting rescue from a New Orleans hospital during Hurricane Katrina. After discussing this case with my research mentor, I began a project evaluating Georgia's emergency plans for evacuations of coastal healthcare facilities threatened by hurricanes.

My research assesses the feasibility of Georgia's evacuation plans with regard to the accuracy of current hurricane forecasting models. The evacuation of hospitals, nursing homes, hospices and other healthcare facilities is complicated by the medical and access needs of their patients and residents. These evacuations require a number of complex tasks such as coordinating transportation, matching patients to beds in inland healthcare facilities and special shelters, and transferring medical records, medications, and any necessary equipment. Because of the vulnerability of patients and the complexity of these evacuations, facilities are expected to evacuate far in advance of the general population. My review of Georgia's current emergency management planning revealed that healthcare facilities are expected to begin preparations for an evacuation more than four days in advance of the predicted landfall of a hurricane. However, as the amount of time in advance of a

hurricane increases, the likelihood of having an accurate forecast of its future location and intensity decreases. My project examines the implications of the reliability of early hurricane forecasts on coastal healthcare facilities' compliance with evacuation plans.

I started my research project by looking for data on hurricane forecasting. My search of GALILEO's Weather and Climatology databases led me to the U.S. National Oceanic and Atmospheric Administration (NOAA) Storm Events Database, which I used to confirm that Georgia has not faced a major hurricane in the past twenty years. Continuing my search with NOAA resources, I found the National Hurricane Center's official error trends for Atlantic Basin storms and hurricanes. This data indicated that forecasts several days in advance had large margins of error in predicting a hurricane's path and intensity. Current methods of forecasting hurricanes are not accurate enough to consistently support Georgia's healthcare evacuation plans.

After characterizing the imprecision of early hurricane forecasts, I wanted to examine the consequences of the failure to evacuate in advance of a hurricane. With the case of Dr. Anna Pou in mind, I decided to search for lawsuits involving healthcare providers following hurricanes. I visited the Law Library in order to learn more about legal sources that could aid me in my research. There, I was instructed to try the Lexis Nexis database. With some help from the reference team at the law library, I found several lawsuits involving healthcare facilities and hurricanes. One case was a wrongful death suit involving the owners of a New Orleans nursing home in which many patients died during Hurricane Katrina. Another was a class action lawsuit against the City of New York for violating the Americans with Disabilities Act for failing to accommodate for the needs of medical patients and other disabled residents in the city's response to Hurricane Sandy, during which officials failed to evacuate healthcare facilities prior to the storm. These cases provided me with extensive, detailed records of incidents that demonstrated the results of healthcare facilities not adhering to evacuation plans.

After finding these cases, I wanted to see if I could find any information on recent healthcare evacuations specifically in Georgia. The last major evacuation was in 1999 for Hurricane Floyd, a storm that ultimately spared the state. My online searches for information on this evacuation yielded few results, and little that pertained to the evacuations of healthcare facilities. I had a breakthrough when I visited the microfilm section of the Main Library in order to view newspapers published in coastal areas of Georgia around the time of the hurricane. When I viewed microfilms of the *Savannah Morning News* from the week of the evacuation for Hurricane Floyd, I found several articles that described the evacuations of area nursing homes and hospitals. I discovered one major detail about the evacuation that I had previously missed: the only fatalities in the state of Georgia attributed to Hurricane Floyd were those of two nursing home residents who died during the evacuation, which was greatly prolonged due to a failure to depart prior to the evacuation of the general population.

Going forward, I plan to interview healthcare providers about their emergency plans and their awareness of hurricane forecasting error. Also, I am working to identify specific examples of hurricanes whose forecast inaccuracies would violate the assumptions of current evacuation timelines. With my research, I aim to draw attention to the gaps in Georgia's current hurricane plans. I hope to develop recommendations on how to improve the evacuations of healthcare facilities in order to increase their resilience in the face of disasters, and most importantly, the safety of their patients.

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