

Thank you for submitting an application for the MU-MUSE Program. Below is your submission.

**Student Name**

**Major** Biology (BS)

**Overall GPA** 3.83

**GPA in Major** 3.74

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**Faculty Mentor**

**Faculty Department**

**Faculty MU Email**

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**Project Title** University herbaria as a rich source of new floristic discoveries

**Starting Date** 02/01/2018

**Ending Date** 04/30/2020

**Other Funding for this project**

SGRCA

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**Project Abstract:**

The Millersville University Herbarium's collection of ~20000 preserved plant samples, collected over the last 150 years, is a small herbarium by most accounts when compared to larger universities with hundreds of thousands of samples. This research will test the idea the small herbaria are valuable sources of information about the local flora by using new county records as a proxy for novel data stored in the herbarium. An analysis of the herbarium's database has so-far revealed approximately 200 unpublished new county records for Lancaster and surrounding counties. This research will further identify new county records in Lancaster and surrounding counties from the Millersville Herbarium. Each county record will be relocated in the wild to confirm that each county record is a wild population which is still extant and the the herbarium data is accurate. I will also analyze the trends in the expansion of native and exotic species using our herbarium's dataset and others.

This resear

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**Attached:**

Grant Uploaded

Project Narrative

Faculty Letter of Endorsement

cc: Faculty Mentor

MUSE Committee

**From:** Carol Hepfer  
**Sent:** Wednesday, March 28, 2018 11:07 AM  
**To:** kefacen@millersville.edu  
**Cc:** Christopher Hardy  
**Subject:** Keever Student Research Award Recommendation

Dear Kevin:

I am pleased to inform you that the Keever Award Committee is recommending an award of \$300 for your proposal entitled "New Floristic Finds in the Wetland Flora of Pennsylvania". Feedback from the committee follows.

Your plans to mine the herbarium, identify new specimens, and verify their current presence is very worthwhile and ambitious. The proposal was very informally written, and the committee recommends that you review your proposal carefully with your advisor so that your future applications are enhanced. Funds being awarded should enable you to begin the process of discovery and determine exactly what you will need to accomplish your goals. When specific herbarium items have been found, you will have a much better idea of the miles you'll need to travel and the supplies you will require. At that time, additional grant applications (e.g., Neimeyer-Hodgson) would be appropriate and sufficient justifications for your requests could be provided.

We wish you well with the completion of your project.

Sincerely,  
Carol Ely Hepfer, Ph.D.  
Professor, Department of Biology  
Chairperson, Keever Student Research Award Committee

## **Student Statement**

My proposed project of working with the Millersville Herbarium's plant collection has been somewhat long running. My involvement with the herbarium started in 2017 when I began contributing plant specimens, curating the herbarium, and identifying more difficult types of plants such as grasses and sedges. Since then I have spent many a day working with in the herbarium and improving our database to the point where it is research quality. I have now reached a point where I am comfortable enough with plant identification to undertake a serious research project involving relocation of herbarium specimens in the wild. Last summer I was planning on starting work on this project but I was accepted into a NSF REU internship at Eastern Kentucky University and was off campus for most of the summer. While at my REU I learned more about plant ID and data analysis which has prepared me even more for this project. I have also taken the plant systematics course at Millersville which taught me many plant identification skills and after this semester ends I will have completed a computer science minor which will be a major advantage for the coding and data analysis part of this project.

This grant will help very significantly with my goal of having a published paper produced shortly after I graduate. Working with my mentor (Dr. Chris Hardy) will allow me to develop skills in writing and data analysis that I may not otherwise be able to develop. The stipend will allow me to focus on this research full time and to not have to worry about working and will further allow me to get improved equipment including a camera to photograph plants in the wild and improved plant pressing materials to allow me to make excellent samples of the plants that I collect. This grant will also allow me to log more miles and travel to more sites for plant relocation than I otherwise would be able to.

## **Narrative**

**Introduction:** Nothing is more critical to the study and conservation of biodiversity than accurate and precise data on the composition and distribution of flora and fauna (Niemiälä 2000;

Kim and Byrne 2006; Guralnick et al. 2007; Buhlmann et al. 2009; Buchanan et al. 2011; Telenius 2011). Such data inform organizations such as the Pennsylvania Natural Heritage Program not only as to which species are found in the Commonwealth, but also which species are common and which are endangered or otherwise rare and in need of protection. Historically, the basis of such knowledge has come from the organismal occurrence data and databases gleaned from the millions of preserved plant and animal specimens housed in the world's major museums and herbaria such as the Smithsonian Institution and the Field Museum of Natural History. Such collections were made by scientists as part of scientific expeditions sponsored by these institutions over the last two centuries.

Recently, however, Hardy & Hardy (2018) conducted an analysis of 1,500 recent course-project-related plant collections made by BIOL 325 students at Millersville University between 2010 and 2015 and found 31 new state and country records among them. New county records or state records are those which document, for the first time, the presence of a species in the wild for a county or state. Furthermore, nearly two-thirds of these new state and country records were for non-native or invasive species – thereby providing evidence that these species may be spreading through Pennsylvania and threatening to displace populations of valuable native species. Thus, out of data generated by undergraduate students as part of routine class projects came valuable new discoveries about our flora and how it may be changing. All of these discoveries have obvious conservation implications. Yet there is nothing particularly unique about the recent students and their projects that produced these new discoveries since 2010. In fact, the Millersville herbarium is home to more than 20,000 preserved plant collections that have largely been accumulated from similar activities by students of botany courses offered annually at

Millersville since its founding in 1855. Largely accrued prior to the digital age, however, most of these student collections and their associated, potentially valuable data were simply filed away and forgotten about in herbarium cabinets after the close of each semester. Since 2008, efforts by Dr. Hardy and myself to serialize and database these historical collections has led to a database of more than 18,000 specimens. Building on the findings of Hardy & Hardy (2018) that looked at just a small component of the more recent 1,500 specimens housed in the university herbarium, I am proposing to, and I have already began work on mining the data associated with the additional 17,000 specimens housed in the university herbarium in search of a proportionately commensurate number of additional discoveries about the flora of Pennsylvania. Where new discoveries are made from the historical collection, fieldwork will be used to determine whether or not the populations that the collections voucher still exist or whether they have been extirpated (extinguished) by factors such as development and land-use change. Using the Millersville herbarium as a test case, the broader hypothesis I am testing is that herbaria in teaching universities can be valuable, heretofore overlooked sources of new information about a regional flora. In fact, I believe that it is the very nature of the herbaria of smaller teaching universities like Millersville, wherein collections are accrued largely in one place (e.g. Lancaster County) repeatedly from annual, course-related projects, which makes them especially valuable for monitoring dynamic, ever-changing local floras.

**Methodology:** During the previous winter break and into the beginning of this semester I compared all of the specimens in the Millersville Herbarium's database to the BONAP (Kartesz 2011) dataset which contains the most complete county level checklists for the United States. I found 846 specimens in the Millersville Herbarium which can be considered new county records.

Approximately 200 of these are from southeastern Pennsylvania. Each of those 846 specimens need to manually have their identities confirmed with modern identification keys to make sure they are correctly identified; this process will take a considerable amount of time. I will attempt to relocate each of the 200 records which are in southeastern PA as focusing my relocation efforts locally will allow me to gather the most data in the least amount of time. Relocating a plant specimen involves traveling to the location described on the label and investigating suitable habitat to attempt to find a wild population. Some newer specimens have GPS coordinates with high accuracy which makes relocation easy. Other, older records just give a general area such as “Pinchot State Park” or “Holtwood Pennsylvania” and these will be more difficult to find as there is simply a larger area which has to be searched. Once I find a population of the plant in the wild I will collect a sample for permanent preservation in the Millersville herbarium and also photograph it as further documentation of the condition and number of plants in the population. Relocating these samples is important to prove the legitimacy of the county record and lend credibility to Millersville as being a valuable and accurate source of botanical information. Permits have already been obtained from the DCNR to collect plants which are state listed as endangered or threatened.

**Data analysis:** For each plant specimen which is determined to be new county record the USDA Plants database (USDA NCRS 2019) will be referenced to determine whether the species is a native, or non-native species. Using that information a ratio of native county records to non-native county records can be computed and that ratio can be compared to the historical ratio of native vs non-native plants known to occur in PA. If the modern ratio of is significantly different than the historical we know that the flora is changing and which nativity status is generally

expanding throughout the state. It is predicted that the proportion of non-native plants will be higher than that of the native plants given my first hand experience and the work of Hardy and Hardy (2018)

**Dissemination:** This work will be turned into my Departmental Honors Thesis and published in a peer-reviewed journal following the completion and defense of the thesis. This work will be presented in Made in Millersville in both 2019 and 2020. The new county records will be given to BONAP to add to their dataset.

**Timeline:**

This research is ongoing, having started in 2017, and will continue after the MUSE grant expires.

- Week 1-2: Confirm identities of herbarium specimens representing new county records focusing on the plants from southeastern PA. Gather background research on introduced and native plant trends and the history of county record checklists.
- Weeks 3-8: Relocate plant specimens in the wild from Lancaster and surrounding counties. Confirm identities of relocated plants. Continue to confirm the identities of plants which are not in southeast PA
- Weeks 9-10: Mount specimens of plants collected during relocation effort for permanent storage in the herbarium. Do preliminary data analysis and statistics to determine if non-native plants represent larger proportion of the new county records than is expected.

Relocation of plants will continue for the rest of the summer so the analysis of that cannot be done finished during the MUSE period.

## Literature Cited

Buhlmann KA, Akre TSB, Iverson JB, Karapatakis D, Mittermeier RA, Georges A, Rhodin AGJ, van Dijk PP, Gibbons JW (2009) A global analysis of tortoise and freshwater turtle distributions with identification of Priority Conservation Areas. *Chelonian Conservation and Biology* 8:116-149.

Guralnick RP, Hill AW, Lane M (2007) Towards a collaborative, global infrastructure for biodiversity assessment. *Ecology Letters* 10:663-672.

Hardy, C. R., & Hardy, N. W. (2018). Adapting Traditional Field Activities in Natural History Education to an Emerging Paradigm in Biodiversity Informatics. *The American Biology Teacher*, 80(7), 501-519.

Kartesz, J. T. (2011). The biota of North America program (BONAP). *North American Plant Atlas*.

Kim KC, Byrne LB (2006) Biodiversity loss and the taxonomic bottleneck: emerging biodiversity science. *Ecological Research* 21:794-810.

Niemalä J (2000) Biodiversity monitoring for decision-making. *Annals Zool. Fennici* 27:307-317.

Telenius A (2011) Biodiversity information goes public: GBIF at your service. *Nordic Journal of Botany* 29:378-381.

USDA, NRCS (2019). The PLANTS Database (<http://plants.usda.gov>, 8 February 2019). National Plant Data Team, Greensboro, NC 27401-4901 USA.