UMD Strategic Plan Initiative: Community Partnership Grants
Final Grant Report: January 15, 2014

Rediscovering Duluth's Heritage Apple Resources: community partnerships to identify and map heritage apple varieties (*Malus* x *domestica*) using genetic markers.

Summary: This project was designed to genetically identify apple trees in Duluth using genetic markers, and to map existing apple trees in the region. Over 300 apple samples were gathered from the UMD Seedling Trial Orchard and public spaces or from contributions from interested community members. Of these, 184 were genotyped and 140 of them could be analyzed for varietal identity. Twelve of these were matched to known cultivars, and an additional 21 samples matched at least one other sample in the dataset. This project provided training for six UMD undergraduates (two of whom worked extensively on the project), and put the Biology Department and the SAP in direct contact with a large number of Duluth community members who submitted apples to be identified. Although we did not complete all of the stated goals for the project, we have created a solid base for future work in the lab and with the community, and we plan to pursue additional funding to continue the project and completely document the apple diversity in the Duluth region.

Project outcomes and impacts:

- Identification of grafted trees in the UMD Seedling Trial Orchard and genotyping of volunteer seedlings (note that volunteer seedlings will be unique and are not expected to have a match among known cultivars in the USDA collection).

We achieved our goal of collecting and genotyping 34 of the approximately 40 known, grafted trees from the UMD Seedling Trial Orchard. Only two matches were found for the grafted trees; one was identified as 'Charlamoff' (a heritage variety from the former USSR, first recorded in the 1700s) and one as 'Jewett Red' (a heritage variety from the US, first recorded in 1842). Several of the grafted trees have tentative identifications based on fruit types; we are continuing to pursue these tree IDs to determine whether they can be confirmed using genetic data. We did not accomplish the goal of genotyping all the volunteer seedlings this year. There are roughly 200 volunteer trees in the orchard, and we decided to direct our resources to identifying community trees rather than focusing on these volunteer trees; this allowed us to focus more squarely on the community outreach aspect of the project. Leaves from these volunteer trees will be collected in the summer of 2014 and genotyped in the coming year.

- Genotyping of older community trees of unknown varieties to identify described cultivars and document potentially un-described varieties; the results of which will be combined into a comprehensive survey of apple diversity in the Duluth area.

We received 221 samples from interested community members, and collected samples from 57 public (unclaimed) trees. Of these, 127 have been genotyped (along with 21 standards provided by the USDA national collection), and ten were matched to known varieties in the USDA national collection. The most common match was to 'Haralson', a variety that was developed by the University of Minnesota in 1913; six of the ten identified samples were 'Haralson'. The other described varieties matched 'Honeygold', 'Oriole', 'Redwell', 'Redfree' (one identified sample for each variety). In addition, there were ten genotypes that did not match any known varieties,

but were repeated at least once within the Duluth community samples; these might represent locally adapted varieties that are unique to the area.

- Identification of locally adapted cultivars that will provide hardy, high-yielding trees for households and orchards in northern Minnesota. Recommendations will be compiled in a brochure available at future outreach events, and will be accessible from websites of the Gross lab, the SAP and our community partners.

The most common local variety, by far, is 'Haralson'; it appeared six times in the dataset (i.e., it makes up 4.3% of the successfully genotyped trees). The variety was developed by breeders in Minnesota, and appears to be well suited to the cold climate of the Duluth region. Several other heritage varieties, including 'Honeygold', 'Oriole', 'Redwell', 'Redfree', and 'Jewett Red' were also identified in the dataset and are therefore promising as local cultivars. The nationally unidentified, but locally repeated genotypes are also of interest. Most of these trees belong to community members (i.e., are private property), but we hope to work with the owners to find out more about their history and origin. The brochure production is underway, but is not yet complete; we are working with Stacy Stark in the Geospatial Analysis Center to compile detailed maps of the public apple trees available in Duluth.

- Training undergraduate researchers in relevant genetic techniques and data analysis, as well as providing a direct connection between UMD students and the community through collection of apple tissue followed by identification and propagation of unique cultivars.

Two undergraduates have been trained in apple sample collection, DNA extraction, PCR, and data analysis (see attached self-reports), and they have completed the bulk of the work associated with this project. Both will continue to work on the apple ID project in the Gross lab during the spring of 2014. At least four other undergraduate employees or volunteers have learned how to extract DNA from apple leaves or collect samples as a part of their training in the Gross lab. Duluth area community members showed a strong interest in the project, as demonstrated by the >200 samples we received over the course of the summer. All of the community members who submitted samples have been updated regarding the identity of their samples (if genotyped) or have been informed that their samples are on a waitlist to be genotyped in the future.

- Introducing the public to the science of apple breeding and genetics, increasing their understanding and appreciation for the role of science in their lives.

A large number of community members interacted with project representatives at the UMD and Duluth Farmer's Markets. The majority of the community members were enthusiastic about the project, interested in identifying their favorite apple trees, and asked a variety of questions about apple breeding and genetics.

Description of how the project outcomes will be assessed, including how it will help undergraduate students meet specific UMD Learning Goals and Student Learning Outcomes:

- Success of genotyping and cultivar identification program will be assessed via a survey of community participants to estimate the value of this service to them and how it affects their perceptions of and relationship with UMD.

This survey is currently being administered; results to date indicate that:

- 66% of respondents answered 'yes' to the question "Did the UMD Apple ID Project improve your knowledge of the use of genetics to answer practical questions?"
- The project generally increased the awareness of and attitude towards both the Biology Department and the UMD Sustainable Agriculture Project - the average rating was 2.5 out of 5 before the project began and 3.9 out of 5 after the results were returned (with 0 being "nothing" and 5 being "high")

- This project will provide undergraduates with interdisciplinary experiences involving ongoing genetic research in the Gross lab and practical applications of sustainable agricultural practices with SAP. Moreover, the project allows a direct connection between UMD students and the community, as well as fostering an understanding of how university research and programs can benefit the local community. Students gain specific knowledge of genetics and sustainability while actively engaging the community, contributing to two of the six main UMD learning goals (knowledge and social responsibility) and providing learning outcomes in these areas as students see the impact of their work benefiting the community. Assessment of learning goals and student learning outcomes will be assessed via self-reporting from undergraduate researchers and participants as a required element of participating in the project with either the Gross lab or SAP.

See attached self-reports from Abby DeVita and Marshall Wedger, the two main undergraduates working on the project.

Undergraduate self-report: Abby DeVita

During my time as a student researcher with the UMD Strategic Initiative Community Partnership Grant, I have been dedicated to fulfilling two of the six main UMD learning goals: social responsibility and knowledge. In this position, I focused largely on community outreach, from designing and distributing promotional flyers to collecting apple leaf samples at the Duluth Farmers' Market every Saturday. By interacting with a variety of community members and UMD faculty, I was able to communicate the importance of sustainability and demonstrate the meaning of social responsibility. Coming from a social sciences perspective, I thrived on making these connections and keeping them up via email and farmers' market interactions. I demonstrated the knowledge learning goal by weighing out and organizing apple leaf samples, extracting DNA, running PCR, and maintaining Excel spreadsheets. Since I had no prior experience in a research lab, it was a challenge to learn entirely new concepts and procedures in conducting genetic research. I learned these skills with the help and support of my peers, lab tech, Briana Gross, and Cindy Hale.

This experience has provided me with a variety of new skills that I used in an effort to connect genetic research and sustainability with the community. While communicating with community members at the Duluth Farmers' Market, it was rewarding to hear how nearly everyone had a connection to the project. These connections ranged from having an interest in sustainability or biology to having memories of an apple tree in their yard currently or years ago. I enjoyed working on this project because it was relatable on such a basic level, yet provided me with the opportunity to learn the scientific processes behind identifying apple varieties. After collecting hundreds of apple leaf samples and going through the steps to identify the specific variety, it was fascinating to see the results of our research that shows the range of apple varieties specific to the Duluth area. This project has many beneficial outcomes including an improved relationship between UMD and the community, a resource for learning about Duluth apple varieties, and a starting point for future research in identifying, mapping, and cataloging apple trees in Northeastern Minnesota.

Undergraduate self-report: Marshall Wedger

Going into the project I had mid-level expectations for educational objectives. I thought I was going to learn procedures I needed without being taught the theory or science behind the results. Coming out of the project I see that I have far overshot what I thought I would learn from Dr. Gross. Not only did she teach me genetics, but let me design and run my own experiment (within limits of course), teaching me what techniques are good or bad in the experimental process. She gave me papers to read and manuals to learn from instead of just telling me what to do, so I learned how to access information myself. She let me struggle with new programs and protocols so that I learned the ins and outs instead of just what I needed. I learned so much from her not only in this field but in science as a whole. The experience and knowledge gained in the project is invaluable, and nothing I could have learned in a traditional undergrad lab class. Networking is another very important part of moving on in academics, and this project has put me in touch with other professors at UMD, many different organizations within Duluth, and plenty of community members with all of their networks. In summary my undergraduate educational experience is tenfold richer because of this project.

If it has not already been made clear, I thoroughly enjoyed my work on this project. As an undergrad I thought most of what I would be doing was attending lectures and doing previously worked out experiments in general labs. This is fine in its own way; I learn technique and theory and generally increase my knowledge of the subject. I have always known I wanted to go to some sort of grad school, med-school, or something of the sort. This project was my first taste of what it is like to work in a real genetics research lab, and I love it. I know now what I want to do with my biology degree after I graduate; I want to go to grad school and work in exactly the same situation as I have done here.