The University of Miami's Gifford Arboretum, a resource for research and outreach within our community

By Olga Tserej, PhD student at the University of Miami Biology Department

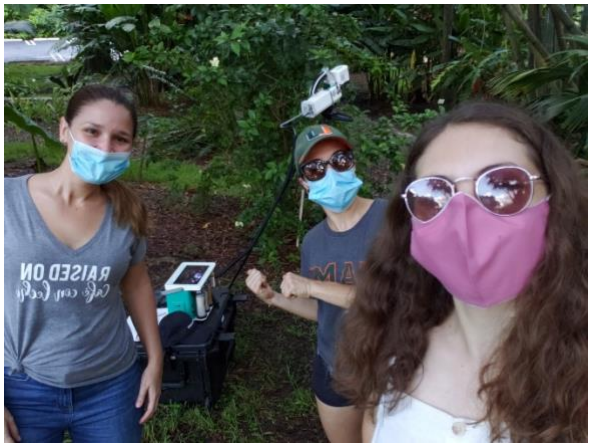

Figure 1. Data collection at the Gifford Arboretum by "Jungle Biology" laboratory PhD students

As temperatures increase due to climate change, it is increasingly important to understand how hot temperatures influence plant performance and survival. Many scientific studies assume that a plant's performance is directly related to air temperature. However, other studies have shown that plants have a variety of mechanisms and physical traits that cause a plant's leaf temperatures to be hotter or cooler than the surrounding air temperature. In other words, different species of plants that grow in the same location and in the same climate may have very different leaf temperatures. Since leaf temperature is a better predictor of plant performance than air temperature, climate change may therefore have different effects on the performances of different species depending on leaf characteristics. To study leaf temperatures of tropical trees while minimizing the potential influences of other environmental factors like soil, topography and climate, it is best to work with species grown under controlled environmental conditions. Typically, scientists use greenhouses to maintain these conditions but this is not possible for large adult trees so instead, I used the Gifford Arboretum, which serves as a common garden for hundreds of tropical trees. The vast number of exhibits and plant species available in this arboretum, together with its proximity to our laboratory facilities, allows for multiple ongoing studies. For this specific project, we were able to measure leaf morphological traits and temperatures on more than 50 tropical and subtropical tree species representing 28 plant families with a wide variety of leaf sizes and shapes.

Results from our research show that leaf temperatures are strongly influenced by leaf properties like leaf size and the amount of water in the leaf – in general, larger leaves get hotter, and "drier" leaves with less water in their tissues heat up faster. The connection between simple leaf traits and temperatures raises the possibility that some plant species may be able to offset rising air temperatures by changing these leaf properties.

For example, some species may be able to respond quickly to rising air temperature by rapidly adjusting leaf traits like leaf angle or even leaf area. Over time, some species may be able to adjust other morphological traits such as leaf shape, thickness and water content. By assessing which leaf "thermoregulatory traits" are most important, and how these traits change between and even within species, we can potentially identify the processes that plants can use to protect themselves against climate change, allowing us to better predict the effects of global warming on our natural world.

Outreach day at the Gifford Arboretum

In order to expand the scope of this project beyond data collection and models, I created a citizen science program in collaboration with the Fairchild Tropical Botanic Garden. As part of this project, students learn about plants and climate change while they simultaneously collect real data on leaf thermoregulatory traits. The Gertrude K. Edelman Sabal Palm Elementary School is one of the 60+ schools participating in this exciting project. The students and their teacher (Dr. Hadassah Weiner Friedman) are highly invested in the program and have hosted PhD students from our laboratory as guest speakers multiple times (even by Zoom during coronavirus times!).

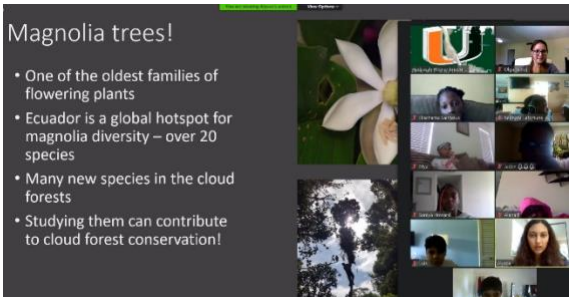

Figure 2. Virtual lesson on Magnolia Trees by PhD student Alyssa Kullberg

Figure 3. GKE Sabalm Palm students visiting the "Jungle Biology" laboratory

The elementary students were very excited to visit UM and to learn more about our ongoing research projects. To help encourage the growth of these budding scientists, our "Jungle Biology" laboratory, in collaboration with the UM Biology Department, invited the students o Gertrude K. Edelman Sabal Palm Elementary School for a special day where they had the chance to visit the University, meet our team of scientists, perform some experiments, and tour the Gifford Arboretum. Students were welcomed by Dr. Kenneth Feeley and were given an overview about how tropical forests are being affected by climate change and deforestation.

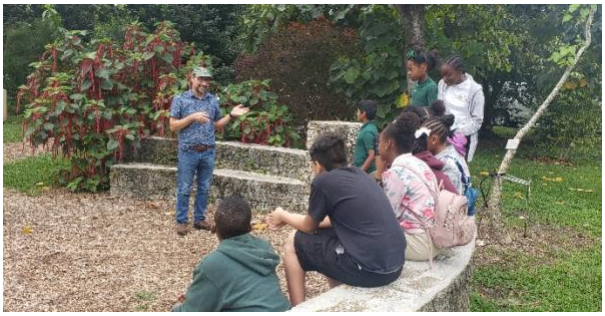

Figure 4. Dr. Mauro Galetti welcoming students to the Gifford Arboretum

As part of the day's activities the students visited the Gifford Arboretum where the director, Dr. Mauro Galetti, provided a brief presentation of the Arboretum's collections. Dr. Galetti talked about how this tropical arboretum is maintained for education and research purposes, and its importance as a place where our community can interact with nature and grow their interest in tropical trees.

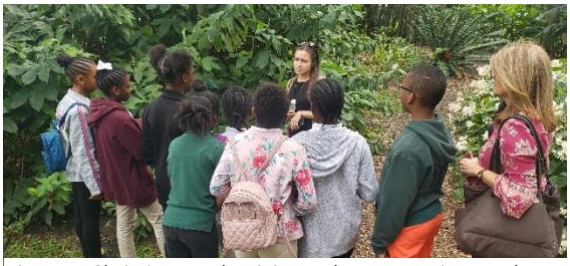

Figure 5 Christine Pardo giving a demonstration on the use of the MultispeQ

Not only were students able to visit the Gifford Arboretum but they also participated in some ongoing experiments being performed by graduate students from our laboratory. With Christine Pardo (former Aldridge Curator and PhD student in the UM Abess Center), students learned how to measure photosynthetic efficiency, chlorophyll content, leaf angle, and leaf temperature among other variables using a new tool called the "MultispeQ". This state of the art instrument is not only used by scientists, but also by farmers to make help them decisions about crop health and performance.

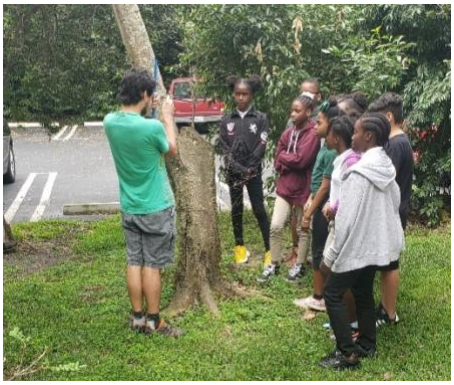

Figure 6. Manuel Bernal giving a demonstration on tree coring

The "Jungle Biology" laboratory also uses wood cores and measurements of tree ring ("dendrochronology") to study the long-term effects of climate change on the growth rate of tropical trees. The students were able to participate in several stages of wood core collection and measurement with the help of our tree ring expert, Manuel Bernal (PhD student in UM Biology).

With leaf samples collected from trees in the Gifford Arboretum, students then moved to our laboratory in the Cox Science Center to complete a set of experiments. Perhaps one of the most interesting experiences for the students was working with Catherine Bravo (PhD student in UM Biology) to use a LI-COR 6800 portable photosynthesis system to look at how fast plants can take up carbon dioxide from the air and how photosynthesis is being changed by temperature, humidity, and rising CO2 levels.

Figure 7. Catherine Bravo demonstrating the functionalities of the LI-COR 6800

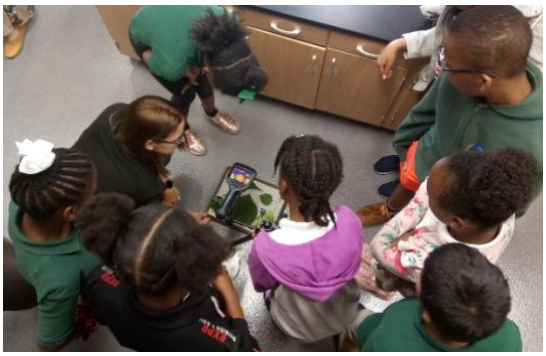

Figure 8. Olga Tserej demonstrating the use of a thermal camera

The Gertrude K. Edelman Sabal Palm Elementary School students had already participated in our citizen science project measuring leaf temperature for different plant species at their homes and school. However, while at UM they had the chance to use a thermal camera to analyze the relationship between leaf traits and temperature. While taking thermal videos, students were amazed by the rapid changes of leaf temperature as they were moved from the sun to the shade. The students realized that not all kinds of leaves are able cool off at the same rate or reach the same temperature in the sun.

Hosting these kinds of educational visits not only increases environmental literacy in our younger generation but also empower underserved communities and builds bridges between scientists and the general public. In addition, these projects are also important for UM's graduate students since they allow us to improve our science communication and teaching skills directed at a broader (and younger) audience. The elementary school students, teachers, and administrators have expressed their gratitude and have recognized the benefits of this experience for science education. The students are excited to return to UM and the Gifford Arboretum again to become scientists for a day – and hopefully for a lifetime!

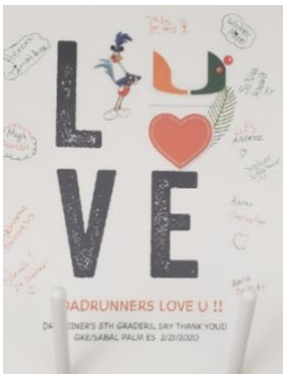

Figure 9. Thank you card