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2005 - 2025: Twenty Years of Phytotron Research

February 2025 marks 20 years of Phytotron research! Construction of the Science Complex and Phytotron facility began in 2002-2003.

The building was completed in phases, with the North Wing being completed first in late 2004. The Growth Facilities Committee was allowed to tour the facility in August 2004. Commissioning of the Phytotron was started in November 2004 and coincided with the final handover of the facility to University staff. By January 2005, the Phytotron facility poli-

cies were established and testing of greenhouse and growth room operation was under



Tagetes patula 'Petite Yellow', 2005 Phytotron greenhouse (Photo: M. Mucci)



Fireweed in the greenhouse - June 2005 (Photo: M. Mucci)

way. At the time, only the original 8 growth rooms were present in room 5107. The first set of planting supplies arrived in February 2005 and by February 24, the first seeds were sown in the greenhouse (*Tagetes patula* 'Petite Yellow'). These plants served as test

subjects for greenhouse environmental control operation and were later used at the old Axelrod greenhouse for a biological control 'trap plant' project.



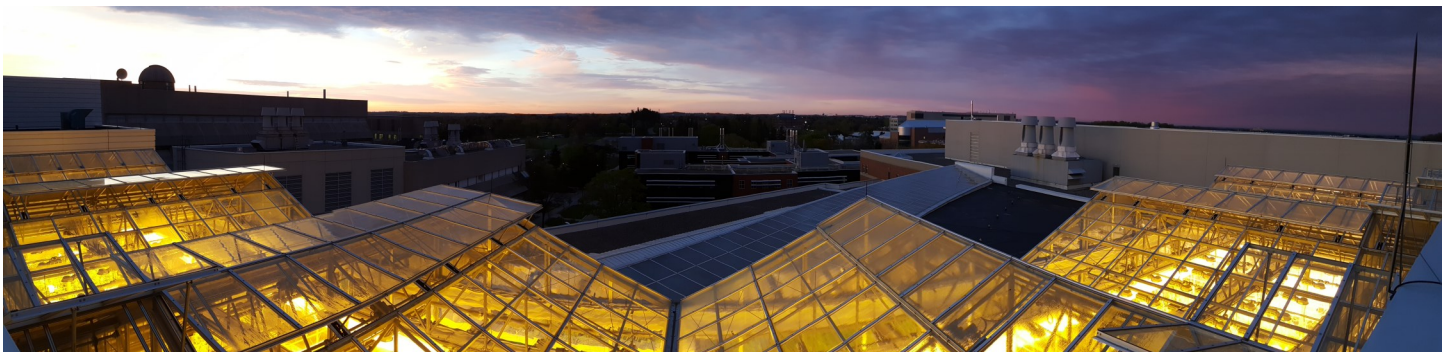
Corn in greenhouse 7 - June 2005, before construction of the west wing of the building (Photo: M. Mucci)

By March 2005, the first student orientation sessions were taking place and the first research projects were moving in. These included projects from the Husband lab (The significance of genome duplication for adaptation and phenotypic characters that influence reproductive isolation in *Chamerion angustifolium*), Colasanti lab (IDD genes in *Arabidopsis thaliana* and Analysis of *Zea mays* flowering time genes), and Nassuth lab

(Pepino mosaic virus in tomatoes).

By 2007, a second and third set of chambers had been moved over from the Axelrod building (E15 and E8) and the new PGC20 and PGV36 chambers had been installed. The final move from the old greenhouse was completed over the summer of 2007.

A lot has happened and a lot has changed over 20 years! The modifications will continue as we work through the fast paced changes in technology and try to keep up (ex/obsolescence of fluorescent lights and the move to LEDs!). We hope this newsletter will serve as a community building tool where we can highlight some of the research happening in the Phytotron. We also hope to highlight some lesser known facts about the facility that we hope will give someone an idea or insight into how the facility can help achieve their research goals. Finally, we also like to have a bit of fun and will occasionally highlight unique plants that have become fixtures of our small but mighty teaching collection!



The Phytotron greenhouse at dawn, May 16, 2017. (Photo: M. Mucci)

Phytotron Researcher Profile: Hannah Brazeau

Describe your education and career path that has led you to your current research.

I first trained as a lab technician through the Biotechnology program at St. Lawrence College in Kingston, Ontario. I then completed a BSc Honours in biology at Algoma University in Sault Ste. Marie, where my undergraduate thesis focused on the relationship between interspecific competition and plant species co-occurrence patterns in a former agricultural field. I then continued studying plant co-occurrence patterns during my MSc in biology at the University of New Brunswick in Fredericton, where I also designed and implemented a large field experiment to test how competition for pollinators impacts floral scent in fireweed (*Chamerion angustifolium*). I am currently in the 5th year of my PhD in the Department of Integrative Biology.

Describe your research. What are your primary research questions?

Widespread declines in pollinator abundance could alter the evolution of plants, as approximately 70-80% of flowering plant species rely on pollinators for reproduction. One way that flowering plants could adapt to pollinator decline is through the evolution of the “selfing syndrome” (smaller flowers with reduced distance between anthers and stigmas). The primary research questions for my dissertation are:

Do flowers evolve floral traits that improve self-pollination in response to pollinator decline?

Does adaptation to pollinator decline through selfing come at fitness cost when pollinator abundance increases?



Mimulus guttatus growing on the Phytotron flood bench (Photo: Hannah Brazeau)

Describe your work in the Phytotron along with a brief summary of results and potential discussion points or conclusions. What more needs to be done to complete your current research project?

To determine how flowers evolve in response to pollinator decline, I have conducted a large multi-generation experimental evolution study in the Phytotron, using *Mimulus guttatus* as a model species. I exposed 6 popula-

tions of *M. guttatus* to either high and low abundances of *Bombus impatiens* workers in flight cages in a growth chamber for multiple generations and measured the size of their flowers, the distance between their anthers



Bombus impatiens worker on a *Mimulus guttatus* flower in the growth chamber (Photo: Claire Bruner-Prime)

and stigmas, and the number of seeds produced in pollinator-free, low-pollinator, and high-pollinator abundance environments.

My results show that pollinator decline does not drive changes in flower size but does result in decreased anther-stigma distance and increased selfed seed production. Additionally, although evolution under low pollinator abundance does increase selfed seed production, it does not come at a cost to outcrossed seed production under high pollinator abundance. Overall, my research shows

that although plants can adapt to pollinator decline through increased selfing, this does not necessarily have to come at a cost to pollinator attraction (through smaller flowers) or the production of outcrossed seeds when pollinator abundance increases.

To complete my current research, I am collecting additional data on the quality and quantity of pollen in evolved plants, as well as the quality of selfed seeds.

What is your favorite research tool or piece of scientific equipment that helps you carry out your research? Would your work be impossible without this equipment?

My favourite research tool is the ebb/flood bench in the Phytotron. *Mimulus guttatus* has very high water demands, so having a custom-made automated watering system has saved me an immense amount of time. In addition to the flood bench, digital calipers for measuring floral traits have been an essential piece of equipment for my research.

If you had access to unlimited time, funding and equipment, where would you like to take your research? What questions would you like to tackle?

If I had unlimited time, funding, and equipment, I would incorporate chemical ecology and electrophysiology into my current work. Specifically, the questions I would like to tackle are:

1) Do the volatile organic compounds that make up floral scent change in response to

pollinator decline?

2) Are bumblebees able to detect these changes in floral VOCs, and does it impact foraging behaviour?

What is your favorite plant?

My favourite plant is *Aconitum delphinifolium* (Monkshood). The flowers have such a beautiful colour and distinctive shape, and chemical defenses in plants fascinates me.

Share something unique about yourself that isn't related to your research.

When I'm not focused on science, I'm focused on music and have been playing bass guitar for over 20 years.



Measuring flower size in the greenhouse (Photo: Claire Bruner-Prime).

Hannah Brazeau is a PhD student in the Caruso lab in the Department of Integrative Biology.

Plant Profile: *Synsepalum dulcificum*

Synsepalum dulcificum (Sapotaceae) is a small, tropical West African shrub, growing to a height of 2 – 6m with leathery, obovate leaves approximately 10 – 15cm long. The clustered axillary flowers are small, 5 lobed and whitish. The fruit is a bright, glossy red 2cm long fleshy berry containing one seed. At

first glance, this plant would seem rather unremarkable. However, the properties of the berry from this plant have earned it the common name “Miracle fruit”.

The plant was first described in the eighteenth-century during a West African exploration by French explorer Chevalier de Marchais



Leaves of the Miracle Fruit (Photo: M. Mucci)

who noted that locals would chew the berries before meals. The berries themselves have very little flavour. What makes the Miracle fruit special is the effect it has on your taste-buds. After chewing on a Miracle fruit berry, consuming anything sour will result in deliriously sweet sensations on your tongue. Lemons are said to taste like lemonade. Limes become as sweet as oranges. Shots of vinegar can be consumed without the slightest puckering of your lips. The West African locals still use the berry today to sweeten a number of incredibly sour traditional foods.

The miraculous effect of the Miracle fruit is achieved thanks to a glycoprotein compound (glyco = sugar) found in the berry called miraculin. The mechanism of miraculin's taste altering properties are still not entirely understood; however, it has been hypothesized that the glycoprotein molecule sits on the tongue with the sugars just out of reach of your

sweetness receptors. When an acidic compound encounters the glycoprotein (i.e.: when you consume something sour), the sugar part of the molecule is allowed to make contact with the sweetness receptors on the tongue sending a rush of sugary sensations to your brain. The molecule is then "reset" and the sugar part of the glycoprotein waits to be re-activated again by more acidity. None of the sugar is actually ingested. The effect is reported to last anywhere from 15 to 60 minutes, so you'll have plenty of time to ingest all varieties of sour foods and beverages and marvel at the taste altering properties. Unfortunately, that's where the miracle ends...you'll have to deal with the repercussions of taking vinegar shots on your own –



Unripe miracle berry (Photo: M. Mucci)

your stomach will not appreciate the trickery as much as your taste-buds.

All joking and novelty aside, the miracle fruit's properties have been seriously investigated by numerous researchers as a sugar substitute for diabetics and an alternative to sugar altogether. During the 1970s a researcher and independent business person, Bob Harvey, created a company called Miralin and developed a line of sugar-free products only to be essentially put out of business by the FDA under shady circumstances.

Greenhouse curators interested in growing the plant should note that the seed is not easy to germinate, with many people reporting low germination success. The plant grows best in low pH (~4.5 – 5.8) in partial shade and high humidity. Plants will begin producing fruit in approximately 2 – 3 years. Frozen fruits are available in North America as several nurseries and numerous distributors have begun growing and selling Miracle fruit for its novel taste-altering properties. Some nurseries even offer small plants for sale.

A fascinating story like that of the Miracle fruit is certainly one that should grab the attention of students and hopefully get them hooked on the many wonders of the plant world!



Ripe miracle berry (Photo: M. Mucci)

References

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This article was originally published in the Association of Education and Research Greenhouse Curators newsletter, Winter 2009, Volume 21, Number 4. Miracle Fruit seeds were first planted in the Phytotron in November 2016.