Botany News #1 - April 22, 2020

California Academy of Sciences

Osbeckia octandra (a Princess Flower). Frank Almeda

Hello to our volunteers,

Happy Volunteer Week! Thank you for all that you do and we look forward to having you back with us. We all miss you dearly, so we have prepared this newsletter to let you know what we have been up to recently. Please enjoy reading these stories in our first newsletter, and we will keep you updated in the future. We hope that you are all well and safe during this challenging time. Please let us know if you need anything.

With our best wishes from the Botany Department

Making the Rounds

Deb Trock

The Collection Managers have been taking turns making rounds through all of the collection spaces each weekday. I have been fortunate enough to be able to make a couple of trips to the building to do rounds and check on the mail that is still coming in. I can tell you that the building is as empty as Emily describes in her update. I've encountered a couple of biologists on my rounds and they report that - for the most part - the animals are enjoying their little break from people. I think the penguins are a bit lonely, but Claude seems quite happy.

Pestec, our pest management contractor, has been working hard to help us monitor and reduce the number of rodent and insect pests that we are constantly dealing with in our unique building. They report that, with the absence of food and people in the building, the rodents are going into the traps much better, so we are getting a much better handle on what has been an ongoing problem. I'm happy to say that we have not had any other issues in the collection rooms (except a few clothes moths here and there).

Bryophyte component of the CAS herbarium in overdrive

Jim Shevock

As I have been sheltered at home identifying Gaoligongshan Meteroriaceae and working on manuscripts and as the English editor for a Chinese bryological journal with many manuscripts to prepare for publication, I also have had time to reflect on what our volunteer cadre has accomplished. Since we started the volunteer bryophyte cadre about a decade ago, collectively we have added over 90,000 new accessions into the herbarium. Next year we will have tripled the size of the CAS bryophyte herbarium in about a 10 year timeframe. This is simply remarkable and it is all attributable to the commitment and dedication of the bryophyte volunteers. We could not have achieved this milestone without your time and passion to enhance the scientific and research value of the CAS bryophyte herbarium.

As I work on finding new specimen exchange partners in parts of the globe where we could rapidly increase the number of taxa new for the herbarium, those curators are simply amazed by the volunteer program we have at CAS in developing the bryophyte component of the herbarium. Places like the Missouri Botanical Garden Herbarium (MO) wish they could even find even two volunteers to help them with their herbarium curation. So during 2021 CAS will hit the 150,000 mark of accessioned bryophytes. No doubt about it, CAS is among the fastest growing bryophyte herbaria in the world. And of course we have the Horton to incorporate along with lots more of my international expedition backlog. Next long range goal is to reach 200,000 bryophyte accessions.

Botany on Deck

Tom Daniel

About five years ago I moved my research collection of living plants (all members of the shrimp-plant family, Acanthaceae) from one of the greenhouses behind the Conservatory of Flowers in Golden Gate Park to the deck (and basement when the temperatures drop below 50 degrees) of my house in San Francisco. Acanths are generally very easy to grow from seed or cuttings, and they usually flower within a few months of germination. I began growing them when I was a graduate student, and I’ve cultivated about 300 species over the years since. Most of my plants are from seeds I collect in the field or that other folks send me. I make herbarium specimens from them to record (voucher) my studies, and take photos for use in publications (see photo of Mango assisting while I was taking photos of flowers of a new species I was describing; Mango decided to see if the flowers are edible; photos of the flowers appeared in the publication of that species—without Mango!). Several of the acanths I’ve cultivated from wild plants have been introduced into the ornamental horticultural trade from resulting seeds and cuttings.

Clockwise from upper left: deck with Acanthaceae, *Tetramerium glutinosum*, *Anisacanthus* sp., *Justicia zapotica* and Mango, *Justicia williamsii*, *Ruellia fulgida* (left) and *Justicia salviiflora* (middle).

I currently have about 40 species growing on the deck (see photos above of some currently flowering). On my trip to central Mexico last December, I collected seeds of several additional species that I've not previously grown. Now that it is getting warmer, in a week or so I will plant those and add them to "deck garden." Although I miss having herbarium specimens to work with during our time sheltering at home, there are lots of things I can do with these living plants that will potentially enhance my studies of shrimp plants. For example, I record several aspects of the floral biology of these plants, including: the floral life-cycle (when a flower opens, how long it lasts, and how it changes over the time it is open), nectar analyses (e.g., quantity and sugar concentrations), hand-pollinations to test compatibility (whether the flower is capable of self-pollinating and setting fruit), autogamy (whether they can automatically self-pollinate), and cross-pollinations (putting pollen from one species on the stigmas of another species and seeing if fruits/seeds are produced, and eventually testing whether those seeds can germinate). Some of these things involve having controls or isolating plants, all of which are relatively easy to do.

Most of my taxonomic work is based upon herbarium specimens—both those at the Academy and those I see at or on loan from other herbaria. But I find that I always learn something by growing and observing the species I am working on, at least when I have live plants to study. Information about their floral biology helps me to understand ecological relationships of the plants with their pollinators. Shapes, contours, fragrances, and colors of the flowers are not or not always preserved on dried herbarium specimens, and being able to study a fresh flower can help to identify important taxonomic characters that might otherwise go unnoticed. A recent comprehensive study of a very rare and unusual genus of acanths from Mexico and Central America (*Louteridium*) was published in the Academy's scientific journal (*Proceedings of the California Academy of Sciences*). In addition to the taxonomic and phylogenetic studies therein, I was able to grow several species of this genus and to include, as part of that study, detailed information on how these plants grow and on numerous aspects of their floral biology (nectar quantities and sugar chemistry, compatibility, autogamy, floral morphology and color, etc.)—all of which were informative in understanding how these rare plants fit into their ecosystems. It's also lots of fun to see these beautiful plants from the rear windows of my house; those that persist for several years seem to become old friends, just like our volunteers.

Meet *Rousseauxia*!

Heritiana Ranarivelo

Let me introduce you to a very interesting genus of Melastomataceae: *Rousseauxia*. It is named after the 18th century French philosopher Jean-Jacques Rousseaux as he was also passionate about botany. *Rousseauxia* is a genus endemic to Madagascar. You might see from the photos below that it presents several morphological similarities with the Asian genus *Osbeckia* (*Osbeckia octandra* is the photo shown at the beginning of this newsletter.) In fact, *Rousseauxia* and *Osbeckia* were treated as the same genus until recently when DNA studies revealed that they are two distinct genera.

Natural habitat of *Rousseauxia madagascariensis*- Marojejy Montane (Madagascar)

Rousseauxia marojejensis

Species of *Rousseauxia* are rare and some are known only from a single type specimen. However, my team managed to collect a fair number of specimens during recent fieldwork undertaken with Malagasy colleagues and students. With these specimens we are now analyzing DNA sequence data combined with morphological data from herbarium specimens to shed light on the relationship between this intriguing species and other Melastomataceae.

In other Melastomataceae news, Dr. Frank Almeda and I, together with another colleague, recently submitted a revised article about the Madagascar Melastomataceae in the book "The Natural History of Madagascar". Ricardo Pacifico, Frank's PhD student from Brazil, helped us with the plates. I have not yet seen an electronic version of the publication but if you locate one there is a lot to read about Madagascar biodiversity: ~1700 of pages of fascinating botanical facts.

During this quarantine period, volunteer Laura Goldman and I are lucky to be able to work remotely on updating data for about 1,400 Malagasy specimens that were collected between 2003-2010 in Madagascar. Thanks, Laura!

Careers in Science interns' research gone remote

Manuel Luján

Cycas calcicola is a species endemic to the Northern Territory in Australia. Previous work by Nathalie Nagalingum's former PhD student James Clugston suggests that some populations of this species are genetically distinct and may warrant recognition as a separate taxon. But before describing a new species, systematists want to find robust evidence to confirm that biological entities are actually distinct. That was the main motivation for us to come up with a research project to look at the morphological variation in *C. calcicola* specimens: we want to find out if some individuals within this species are distinct in their appearance (morphology), so they can be described as a separate taxon, and check if that correlates to what the DNA data is indicating.

Example of a Cycas calcicola specimen that Career in Science interns are analyzing

To this end, our five Careers in Science interns were set to meticulously measure a number of morphological traits on herbarium specimens we loaned from Australian herbaria. After shelter-in-place order was placed in San Francisco, our wonderful team of high school students shifted to work remotely on this project. Thanks to Nathalie's diligent work we obtained high-resolution images of the *C. calcicola* specimens that we were working on, and students quickly learned how to use a piece of software to take measurements of digital images.

For the past four weeks we have organized online working sessions to continue measuring traits on herbarium specimens and we record valuable data to answer our research questions. I have been fortunate enough to work with Kellan Warner from the Academy's Education team whose thoughtful work has been key to keeping our interns engaged with the project. Despite the difficult circumstances we are experiencing, we continue to explore, explain and sustain life, and we are doing it through innovation and more importantly through collaboration.

Floating cycads: a dispersal survey

Jian Liu

Cycads have restricted distributions with limited dispersal ability. However, the subsection *Rumphiae* from the genus *Cycas* is a morphologically unique group, having evolved a thick spongy layer inside the seed, which makes them float in water. It is widely acknowledged the buoyant seeds of this group may account for their wide distribution along the coastal SW Pacific as well as Indian Ocean. The biogeographical pattern of this group is not yet fully understood, and we are keen to know how and when seed dispersal happened, possibly via sea currents.

In order to address these questions, I carried out the sampling in 2018, under the tremendous help of Anders Lindstrom, a cycad expert from Nong Nooch Tropical Botanical Garden in Thailand. We sequenced the DNA from the chloroplast genome for all 10 species from this group, with a total of 47 samples from multiple islands/continental coasts from Indian/SW Pacific Ocean. Using these data, we can reconstruct the evolutionary history of the chloroplastic lineages which are inherited from the maternal (seed) side in *Cycas*. During the quarantine in China, I surveyed the geological literature on SE Asian plate tectonics (for someone who may be interested: here are plenty of slides and videos simulating continental drift since 55 million years ago). The mail goal of this project is trying to combine the evidence from SE Asia tectonic history, glaciation, and chloroplast DNA data to elucidate the cycad transoceanic travelling story. Thanks to the Cal Academy's high performance computer server "Alice", I was able to analyze the genomic data.

Megasporophylls and the abnormal “seeds” of *Cycas edentata* (*Cycas* section *Rumphiae*) collected from Myanmar. The top rright is a cross section of an unfertilized but still floatable seed.

Making Labels

Deb Trock

A project that both Susan and I have been working on is making labels for yet-to-be-mounted specimens. I’m sure that all of you plant mounters will be thrilled to know that I was able to make about 100 labels for Thai and Cambodian plants (I know how much you love mounting those!). I’ve got another 100 or so labels to do on this project.

Susan has been working from field notebooks to put data into a spreadsheet from which we can make labels for some of the Diana Horton vascular plant specimens that came along with the big acquisition of bryophytes that he got a few months ago. Most of those specimens are from North America, with a lot of them being plants from wet places like bogs and fens.

Images L to R: *Calotropis gigantea, Mesua ferrea, Bauhinia tomentosa, Trichosanthes cucumeriana,* Sri Lanka (Frank Almeda)

Cancelling/Planning Meetings

Deb Trock

Another, and rather sad project that I’ve been engaged in for the past few weeks has to do with the fact that we were forced to cancel our annual meeting of the Society for the Preservation of Natural History Collections (SPNHC), which was to have been held in Edinburgh, Scotland. This is the big international meeting that is specifically geared toward the people who care for collections,

with lots of information shared each year about Best Practices and unique specimens in our museums. The Academy was slated to be hosting this meeting next year, but at the present time, that is up in the air as well.

The good news is that we have an ad hoc committee of people from all over the world (Israel, Germany, Scotland, Australia, Taiwan and several from the U.S.), who are meeting each week to try to put together a “Virtual” SPNHC meeting. The committee is planning to try to have plenary speakers, several talks and to conduct our annual business meeting and Council meetings - all virtually. We are calling it the “un-conference”. The only problem with getting this group together is that we meet at 6 a.m. (our time)! It’s pretty hard to be ready for a meeting at that time of the morning - but it’s gotten better since I realized that I did not have to turn the camera on :-}

Specimen Imaging in a Very Quiet Workspace

Emily Magnaghi

Over the past few weeks, I have been lucky enough to go into the Botany department three times a week to take pictures of specimens that are then transcribed into the database, remotely. I am photographing specimens from Euphorbiaceae (the spurge family, see photos below) for the Endless Forms grant project and for California databasing. May, Alisa, and Rose are transcribing specimen label data from these images at home and putting the records directly into Specify through the Academy's VPN (Virtual Private Network). It's working pretty well, so far. We have almost 2,500 entries in the database and made over 1,300 images.

Images L to R: *Acalypha umbrosa, Acalypha wigginsii, Acalypha wilkensiana*

Training the Next Generation of Plant Systematists

Frank Almeda

As some of you may know all of us in Botany continue to train and mentor graduate students as they pursue advanced degrees in Botany. Although I am officially retired I still have the honor and pleasure of being able to conduct research, plan field expeditions, and actively participate in the important training of graduate students.

I am currently a co-advisor to Ricardo B. Pacifico who is a Ph.D. candidate at the State University of Maringá in the state of Paraná, Brazil. I brought Ricardo to CAS for six months in 2017 to begin research on his Ph.D. His thesis involves phylogenetic relationships in the Princess Flower tribe Microlicieae using DNA sequence data. His work with this group will facilitate the circumscription of resolved genera and help us to gain an understanding of the evolution of morphological characters. The Microlicieae appear to be a monophyletic (a group of species descended from a common ancestor and including all the descendants from that ancestor) fire-adapted branch of the family tree that consists of 300+ species whose major diversification coincided with the origin of the Cerrado biome hotspot in Brazil and the rise to dominance of flammable C4 grasses within the past 10 million years.

One of the regions (Chapada Diamantina National Park) where we did field work in Bahia in search of the Princess Flower tribe Microlicieae

In Brazil, the major center of diversity for the tribe is the state of Minas Gerais with a largely endemic secondary center in the northeastern state of Bahia. The composition of the tribe has had a long and complex history. Seven genera (*Chaetostoma, Lavoisiera, Microlicia, Poteranthera, Rhynchanthera, Stenodon*, and *Trembleya*) are currently recognized but none of these has yet to be tested for monophyly in a phylogenetic context. Ricardo was initially interested in studying the systematics of Trembleya but it soon became evident that an understanding of this genus would necessitate a close look at the entire tribe Microlicieae.

During the first half of 2017 Ricardo spent three months in the field in Minas Gerais collecting fresh foliar material of some 61 species of Microlicieae for molecular analyses. This sampling was augmented with other DNA sequences of another 60 taxa generated by a former postdoctoral fellow at CAS, Darin Penneys, from materials I had collected in southern Brazil in the course of several field expeditions. Ricardo's initial work in our Center for Comparative Genomics (CCG) employed Sanger sequencing based on two nuclear genes and three chloroplast genes. Sanger sequencing techniques and the genes we targeted have been used to study many other tribes of Princess Flowers in the last couple of decades. Ricardo's 2017 work in our CCG laboratory confirmed the monophyly of Microlicieae and reduced the composition of the tribe from 11 to seven genera which corroborated the results of two recent studies based on much smaller sample sizes. Unfortunately, Ricardo's initial results showed significant discrepancies between the phylogenetic trees generated with nuclear DNA and chloroplast DNA sequences so it became clear that a Plan B was in order.


Microlicia chrysantha and Ricardo in the field.

In order to accomplish Plan B we launched a 3½ week expedition to the state of Bahia, Brazil in the spring of 2019 that generated material of another 60 species that are known only from that state. We felt that this additional sampling would be important for his continued studies using Next Generation Sequencing (NGS) techniques, especially Restriction site associated DNA sequencing (RADseq) markers. RADseq has yielded highly resolved, strongly supported phylogenetic hypotheses for relationships within and across genera of higher plants. To date, no other lineages of Princess Flowers have been sequenced using RADseq.

Ricardo returned to the Academy for a seven and a half month stay (August, 2019-March, 2020) to continue this work in our CCG laboratory. Ricardo and I are hoping that this enhanced study of the Microlicieae will add to the growing body of literature documenting the utility of RADseq for phylogenetic studies. As I write, Ricardo is beginning analyses of the RADseq results from his home base in Brazil.

Hypotheses about the relationships among plants continue to be revised (sometimes substantially and sometimes not) when we use molecular data as part of our research toolbox. It can also inform us about how morphological characters have evolved. We want our taxonomic groups (in this case genera of the Microlicieae) to reflect evolutionary relationships. Ricardo's data will ultimately tell us whether we should recognize seven or fewer genera in the tribe Microlicieae. Stay tuned for an update.

We thank the M. Stanley Rundel Charitable Trust and the Lakeside Foundation for grant support that made Ricardo's training visits to the Academy possible.

Fern mini-class

Nathalie Nagalingum

Ever wonder how to become invisible? If you found a fern seed, you could! In this talk, I take you on a search for fern seed: Be transported back in time to the Victorian age, when fern fever gripped the world; join expeditions to deserts, jungles, and mountains around the world to collect ferns; and learn about the latest research discoveries. From the science to the folklore of these ancient plants, just bring your curiosity! You can watch my mini-class on YouTube. And, there are past and upcoming breakfast club mini-classes on the Academy's website.