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California Academy of Sciences

Tristemma mauritianum (A Madagascar Princess Flower) F. Almeda

Hello to our volunteers,

We celebrated a milestone this month. It has been 15 years since Deb Trock (Director of Collections and Botany Collections Manager) joined the Academy! We held a surprise party for her online--she was expecting a boring meeting and instead she was greeted with home-made signs saying congratulations (one of the fancier ones is below), many smiling faces, and speeches recognizing her contributions to the Academy collections and to the staff. We would have preferred sharing this special moment with her in-person, but we are adapting and enjoying the time that we can spend together virtually.

We hope you enjoy our second newsletter, and we hope you are all keeping well and busy.

With our best wishes from the Botany Department

Happy 15 year work-versary!

Time flies when you are a botanical boss lady!

A Walk Through the Orchids in San Francisco

Tom Daniel

During my walk home from the Academy through four or five different neighborhoods on the west side of San Francisco, I see several different large-flowered and brightly colored orchids that residents have in their yards, porches, and windows. For the past few years, I have been growing a beautiful orchid in a bark-filled pot in my backyard. Our department's research associate and orchid specialist, De Mally, gave Mary and me a cluster of pseudobulbs of *Maxillaria soconuscana* (recently transferred to a different genus, as *Psittacoglossum soconuscanum*), a native of Chiapas, Mexico that former botany curator Dennis Breedlove collected in 1986, and which she and Dennis described as new to science in 1989. After a year in the pot, our plant produced two flowers in succession. This year, after a good bit of neglect, it produced 11 flowers (simultaneously!) in early May (see figure with eight flowers). Because the flowers last for a couple of weeks, this plant has certainly been a gift that keeps on giving, and a ray of sunshine during our sheltering at home.

With at least 22,000 species, the orchid family (Orchidaceae) is the second largest family of flowering plants (after the sunflower family). Though most species occur in the tropics with many of them growing on other plants (epiphytes), there are more than 200 species in the United States and most of them grow in the ground (terrestrial). At least 34 species are native (i.e., occur naturally) or naturalized (i.e., non-natives that reproduce and spread on their own, essentially becoming established in the flora) in California.

Orchids: Maxillaria soconuscana from Chiapas (top), Piperia michaelii in SF (lower right), Epipactus helliborine in SF (top center), Corallorhiza striata in conifer forest south of SF (bottom center), and Piperia elegans in SF (lower left).

As some of you know, I've been involved for more than a decade with interns, students, colleagues, and volunteers in an effort to produce a new guide to the native and naturalized plants of San Francisco County. Some may not know that there are several orchids native to the smallest county in California. In 1958, Academy botanists (curator Tom Howell, research associate Peter Rubtzoff, and student collector Peter Raven) compiled a detailed list of the plants of San Francisco. They included six species of orchids as native (based on both historical and then current observations and herbarium specimens) in the county. Two of these were based on observations, grew only near gardens, and were doubtfully ever naturally occurring (i.e., native) in the city—*Epipactus gigantea*, the stream orchid, and *Corallorhiza striata*, the striped coralroot. Following taxonomic and nomenclatural renovations since 1958, exclusion of the two questionable occurrences outside of cultivation, and discoveries of two additional occurrences, we now recognize five species as native to or naturalized in San Francisco: *Epipactus helleborine*- broad-leaved helleborine, *Piperia elegans*- elegant piperia, *P. michaelii*- michael's rein-orchid, *Platanthera dilatata*- white-flowered bog orchid, and *Spiranthes romanzoffiana*- ladies tresses. Four of these are currently extant in San Francisco, though their occurrences are mostly restricted to a limited number of sites. *Epipactus helleborine* was not listed in the 1958 account, but was noted to occur in San Francisco in 1962 by Tom Howell. This species is native to Eurasia, but has become established (naturalized) throughout much of North America. It comes up in cultivated/disturbed areas of the county, and along trails in forests. *Piperia elegans* can form stands of several hundred individuals where it does occur on open grassy slopes. *Piperia michaelii*, was only recently discovered to occur in San Francisco—at one locality where there were fewer than five individuals. To the best of my knowledge at this time, *Platanthera dilatata* has not been seen in San Francisco for over a hundred years, and has probably been extirpated from the county. Fortunately, it is still known from other counties in the Bay Area.

Unlike the orchids I see walking through neighborhoods, all of our native species have relatively small flowers that mostly lack striking colors, are terrestrial, and do not tend to be conspicuous where they occur. They are starting to come into flower now, and will be out for the next few months. If you see or know of sites for any of these in San Francisco, I would be very interested to hear about them. Although I've observed plants of *Spiranthes romanzoffiana* in the Presidio, I have not taken photos of that one and would like to do so at some point. It is a good time to get outside for walks (with all the protections and precautions for distancing, etc.) and see what nature is up to this spring. Hopefully, you will see some of the wonderful native plants that the Bay Area has to offer—and maybe, if you're lucky, a native orchid.

Southern Philippines expeditions: fantastic discoveries and more on the way

Jim Shevock

I have had the great opportunity to explore and conduct five plant biodiversity inventory activities in the Philippines. The first time was back in 2011 as part of the CAS Hearst Expedition. Then I was able to tag along via a grant awarded to Peter Fritsch and Darin Pennys to Mindanao. These Mindanao expeditions in 2014 and 2015 were also attended by the late CAS Research Associate and Fellow, Benito Tan. Together, Ben and I published six papers from those adventures including describing two mosses new to science and added almost 100 mosses as first records for Mindanao. In early 2019, Fritsch and Pennys were awarded a four year National Science Foundation grant to continue our activities in the southern Philippines and they added lichens to the taxonomic group to be studied along with vascular plants and bryophytes. I serve as the lead bryologist for these eight scheduled expeditions. Two month-long trips were conducted in 2019 under this grant. The first was conducted in May-June and the other in December. We were ready to return to Mindanao in May-June this year, but that trip has been

cancelled due to the covid-19 pandemic. The upcoming December trip this year may have the same fate.

Typical ‘mossy forests’ in cloud forest above 1600 m in Mindanao

So why all of this interest in the Philippines? Several scientists at CAS have worked there over the years, and basically, the Philippines are a remarkable hotspot of biodiversity, for both terrestrial and marine ecosystems. The location of the Philippines as well as its geologic history makes it a fantastic area to study. The land area known today as the Philippines is a large island complex and portions of the land masses of the country migrated from three different areas through the movement of the continents over geologic time. The Philippines is part of an area called ‘Malesia’, an the area that encompasses Indonesia, Malaysia as well as Papua New Guinea and nearby island chains. It has a remarkable flora and fauna and while much of it has affinities with Gondwana, it also has influences from Laurasia as species moved from the Northern Hemisphere to the Equator. The Philippines has species from both origins in its flora, especially the bryophytes. The other reason to do biodiversity inventories in the Philippines is due to its high rate of endemism coupled with conservation concern to retain as much of the remaining forests as possible in a country with a rapidly growing population.

Our in-country partners are stationed at Central Mindanao University (CMU) in Bukidnon Province. While the university has a herbarium, it is quite small and in need of much infrastructure support including herbarium cabinets and curatorial staff to mount specimens onto herbarium paper. Most of the specimens collected by CMU students and staff remain stored within the newsprint sheets they were collected in the field. During our current work in Mindanao we anticipate collecting around 12,000 specimens during the eight scheduled expeditions, and

therefore, we have sent herbarium paper, glue, archival paper for preparing labels, a rototrim to cut the labels, as well as hundreds of plant press corrugates. These supplies are hard to acquire in the Philippines or are not available at all.

Already during the first two expeditions in 2019 the team has discovered taxa new for the southern Philippines and several new species to describe too. One of the new mosses was named last fall as *Distichophyllum shevockii,* which is among the largest member of this genus of about 100 species. As with all plant collecting in the Philippines, there is no recently prepared vascular flora available to identify our collections. There are some newly developed web-based treatments, but we are always expecting to find species new for the southern Philippines from Papua New Guinea, Borneo and other Malesian islands. On the bryophyte front, there is a checklist of the mosses, liverworts and hornworts for the Philippines, but the only moss flora dates from 1939 and no floristic treatment of liverworts has yet been prepared. So one of our goals is to get as many specimens of bryophytes into the CMU Herbarium (with the Index Herbariorum code of CMUH) so a good reference collection can be readily available in-country.

While collecting we are also attempting to make detailed photographs from the field. These new digital cameras with stacking features are finally making bryophyte images of publication quality possible. It is still a lot of work and time to get the key features in focus especially if it is raining. These are generally very small plants and getting key diagnostic parts in focus is indeed a challenge. Nonetheless, we are getting good results and with practice the images of bryophytes will continue to be improved.

Distichophyllum shevockii; Dawsonia superba.
The genus Dawsonia (Polytrichaceae) contains 9 species with the center of its distribution in Australia. This species is the tallest free standing moss in the world where it is about knee high. It makes its northern station on Mindanao Island.

The bryophyte team on these Mindanao expeditions is comprised two USA bryologists and two members from CMU. The other USA bryologist is John Brinda at the Missouri Botanical Garden. One of the in-country bryologists is my former student, Aiman Yorong who graduated with his masters in Bryology from CMU in June 2019. It was great to be at his graduation ceremony and the second member of the team is Daryl Salas who is my current master's student. It is one of the real delights to see both Aiman and Daryl become the future of bryology in the Philippines and be active collectors on these expeditions. They already are making great collections and discoveries plus CAS receives a duplicate of all of their collections.

As you may be aware, Mindanao has some areas where we as foreigners are not permitted to go or our Philippine colleagues will not attempt to take us. Parts of Mindanao, especially the southwestern area, has ongoing rebel activities from those seeking succession from the Philippines and there is military action to control the region during the current martial law order. In addition, there are some rebel Communist bands that reside in mountainous terrain. So our CMU colleagues can only take us to areas where they feel our safety is not at risk. The next thing about this NSF project is there are several expeditions scheduled where only our Philippine colleagues will attend so they will venture into those areas where it is safe for them to go but where they would not take the foreigners. How I look forward to receiving the bryophyte collections from Aiman and Daryl for those mountains I will not be able to visit.

Jim Shevock & Daryl Salas; Jim Shevock collecting rheophytic mosses at Negros Island

One of the early indications from collecting in several cloud forest environments is that nearby mountains even at the same elevation band and basic forest vegetation is similar, there is a remarkable difference in the bryoflora both in species composition and which species are dominants. Some bryophyte species are reported from only one mountain in Mindanao. And even Distichophyllum shevockii is only known from two mountains. Some of this information is most likely a reflection of limited collections to examine. Perhaps the most specific moss to substrate is Spiridens reinwardtii. Spirdens is in the moss family Spiridentaceae, a monospecific genus of seven species worldwide with the greatest species diversity occurring in New Caledonia. Only one species of Spiridens occurs in the Philippines (and extends to its northernmost occurrence in southernmost Taiwan). This species is a large, showy, and distinctive moss and stems can easily be a foot long. It forms ‘tutu like rings’ nearly exclusively on tree fern trunks. I have only seen this moss once on a different substrate. How it selects only tree fern trunks 99.99% of the time is indeed a mystery.

One of my research focus areas involves those bryophytes that live in or are only found in riparian corridors where they are most often on boulders that are seasonally submerged. These bryophytes are called ‘rheophytic’. What makes them so exciting to me is they are poorly collected because part of the year they are underwater, or in swift white-water rapids making collecting difficult. And for some reason, botanists do not like to get their feet wet so aquatic vascular plants are also generally under-collected. The other interesting feature is these rheophytic bryophytes are mostly dioicous, meaning that there are separate male and female plants, and therefore, in such a habitat with fluctuating water levels, the likelihood of successful reproduction is rare and in fact for many rheophytic bryophytes sporophytes (the reproductive life cycle) remains unknown. On top of this, many rheophytes because of their specific habitat attributes have evolved similar morphological features (for example, thickened leaf margins to reduce abrasion during peak sediment loads or rather lanceolate shaped leaves) although they are not related.

Molecular insights have been fundamental to determine some of the family and generic placements for these rheophytes. For example, one of the rheophytic mosses I collected in Yunnan, China, I could not place in a family (although I had a couple of likely possibilities). Once the molecular data became available it was obvious that not only was my proposed family placement in error. Instead, it went into a family not known to have any rheophytic members, and therefore, it was determined to be a new genus that got coined by colleagues from Moscow who did the molecular work as Rheoshevockia fontana. Here in the Philippines I strive to collect rheophytes whenever I get to a rocky stream channel. Our last trip to the southern Philippines yielded two interesting rheophytes. On Negros Island, Daryl and I rediscovered Touwia negrosensis and we also obtained another rheophytic moss that in the field looks just like it but once the cells across the leaf surface could be examined in much greater detail under the microscope it proved to be something entirely different. This time it is in the rheophytic moss genus Pseudophysanthus nearest to P. touwii from Papua New Guinea. We will want to get molecular data from it too because it is most likely be new to science, and endemic to the

Philippines. However, the number of rheophytic collections I have made in Mindanao to date remains few because nearly all of the trails we have taken up into the cloud forests and our camp sites have been on ridges or on mid-slopes. I can see streams down in the canyons below but access to them is nearly impossible due to the dense vegetation and steep and rugged terrain.

Close-up of Touwia elliptica, new moss new for Mindanao

The nice thing about the cloud forest environments in Mindanao is that nearly all of them are within indigenous tribal areas so we need to acquire collecting permits from the various tribal leaders who are called Datus. Our Philippine colleagues need to visit each tribe and there is always a ceremony, blessing rituals to perform, and gifts that must be brought like a jar of coins, bags of rice, perhaps a few chickens and maybe even a pig to secure the permit. It is these lands that are in good condition and intact due to steepness of the mountains and heavy annual precipitation. At lower elevations where crops can be grown then the vegetation is always second growth or converted entirely. There are few low elevation forests in Mindanao that remain intact. Deforestation has played its part. Nonetheless, for bryophytes there is less likelihood of species extirpation compared to endemic flowering plants that generally have much reduced occurrences for the country although local bryophyte occurrences can easily be lost. Even in secondary growth forests bryophytes can re-colonize as habitat quality is improved. Bryophytes can, over long time periods, cross many land and ocean barriers due to movement of spores or fine vegetative propagules. The key to the distribution of bryophytes worldwide has been geologic time. Bryophytes predate the arrival of the flowering plants by many millions of years.

CAS has had a long interest working in the Philippines. These new expeditions to the southern Philippines will surely add significantly to our holdings of this botanical hotspot in Malesia. I can't wait for the covid-19 to be permanently resolved so I get back to Mindanao. I have no idea how many more international expeditions are in my future (hey I'm about to be 70 in a couple weeks!) but as long as I remain healthy I find these expeditions to be both rewarding physically and mentally challenging and it offers me opportunities to continue my research. Hoping that in

2021 international expeditions can resume. In closing I thought I'd add a charismatic flowering plant. Below is a member of Nepenthes (pitcher plants) with these remarkable leaf adaptations.

In the Philippines there are many endemic species of *Nepenthes*

Using DNA to trace maternal lines of evolution in cycads

Manuel Luján

Analyzing DNA sequences is probably the most powerful tool botanists have to understand relationships between species and how they are all connected in the tree of life. In plant cells, photosynthesis occurs in the chloroplasts. Something particularly interesting about chloroplasts is that they have their own DNA, called plastomes, and they are maternally inherited, that is from a female mother plant that only produces seed. Imagine a seed that was produced through pollination, chloroplasts present in that seed, and eventually in the entire plant, came from the cells that formed the ovary. Pollen grains usually lack chloroplasts. This means that when we study the plastomes in different plants, we are studying the maternal side of their evolutionary history. Something similar happens when we study the mitochondrial DNA in humans.

Before the SiP order, we were dedicated to obtaining DNA sequence data from a number of Australian species of *Cycas* in the Academy's Center for Comparative Genomics. Over the last few weeks I have been doing some bioinformatic work to assemble the plastomes from those data. This is a very computationally-demanding process and progress is slow; so far I have assembled the plastomes from five species. We will use plastomes to understand how species are related to each other, and compare that with the relationships recovered from genomic DNA, which is the chromosomal DNA contained in the nucleus of the cells.

Student training in Madagascar

Heritiana Ranarivelo

Academy botanists have been doing research and making vascular plant collections in Madagascar for over two decades, starting with a reconnaissance visit by Dr. Frank Almeda and friends in 1993. I'm sure some of you have mounted, entered data for, or seen some of our Malagasy specimens.

Madagascar is a unique place of incredible wildlife and biodiversity, but it is also a place where habitat destruction and biodiversity loss is very high. So starting in 2018, with one of our Research Associates, Dr. Vanessa Handley, we extended our activities in Madagascar to include conservation and capacity-building of local young scientists. And with the challenges we are now facing, we are keener than ever to get involved in the conservation of biodiversity around the world.

Subsequent to the recent fieldwork conducted by Vanessa in late 2018 in Madagascar, we chose an amazing area in the coastal southwest part of the island to start our project. Our study site consists of an area of spiny forest that is the natural habitat of many endemic species of plants, like the famous octopus tree in the family Didiereaceae (Fig .1). This area is also refuge to the Malagasy endemic radiated-tortoises (Astrochelys radiata). Unfortunately, not only are these animals gravely threatened by illegal poaching (and exported to Asia), but the spiny forest in which they live is also under severe pressure from human activities as well.

Fig. 1. Spiny forest with Didiereaceae (Photo credit: Rasolofoherisoa)

Fig. 2. Tahina Rasolofoherisoa (center) interviewing local people of Lavavolo (Photo credit: Iharimaka)

Fig. 3. Flower of *Alantsilodendron alluaudianum* (Photo credit: Rasoafaranaivo)

Fig. 4. Patch of patch of pristine dwarf littoral forest southwest of Madagascar (Photo credit: Almeda)

At the Madagascar Biodiversity Center in Antananarivo - the capital of Madagascar - we have been training a Master's student from the University of Antananarivo, Tahina Ny Aina Rasolofoherisoa. As part of her thesis, Tahina conducted a botanical inventory using plot surveys of the spiny forest area and carried out ethnobotanical research to quantify the local uses of wood in that locality (Fig. 2). She found that the spiny forest provides 100% of the wood needed by the local people in the nearby town of Lavavolo, and that there are four endemic tree species that are most used by the locals to build houses, furniture and fences: Alantsilondendron alluaudianum, Alluaudia montagnacii, Cedrelopsis gracilis, and Neobeguea mahafaliensis. Tahina is now working on a conservation assessment for Alantsilondendron alluaudianum (Fig. 3) using IUCN guidelines and criteria (International Union for Conservation of Nature) for the Red List of threatened species.

During this study we explored another patch of pristine dwarf littoral forest just inland from the coastal sand dunes on the Mozambique Channel that we feel should be protected (Fig. 4). Tahina, who successfully defended her Master's thesis in late 2019, continues to work with us as we prepare to propose a sustainable management plan for this remnant natural vegetation. This is an exciting project, as it promises to help conserve this unique ecosystem by engaging local people to help manage and protect it in a sustainable way.

Congratulations to Maia

Nathalie Nagalingum

For the past two years we have been fortunate to spend our summers with undergraduate Maia Jones. She first joined us as a Summer Systematics Institute student in 2018, and last year returned to work on her senior thesis focussing on the conservation of an endangered Australian cycad using genomic DNA data. She recently received a PLANTS grant from the Botanical Society of America, which will provide with support to present her senior thesis at the newly virtual Botany 2020 conference.

Maia Jones and Nathalie Nagalingum during the Summer Systematics program.

Reflections on Restoration

Emily Magnaghi

While I have been systematically imaging the spurge family, Euphorbiaceae, many older specimens from the Dudley and Cal Academy herbaria are showing up weathered with time. Sometimes the mounting paper is non-archival, the acid in the paper turning it yellow and brittle, or the corners are dog-eared from traveling to another distant herbarium on loan, sometimes the glue has broken down and does not stick anymore so items are falling off. As I stop to repair these broken stems and loose leaves, gather floral bits to insert in the fragment packet and generally tidy up the specimens, I wonder, “How do we restore and repair these valuable specimens in a timely way with all the other herbarium housekeeping to do?” This is a question every herbarium has to address and plan for.

There are many techniques for repairing specimens which range from taking them off their original sheets and remounting them on new paper (time-intensive) to repairing them with linen tape and new glue (time-efficient). All original plant material and labels must be preserved so depending on what condition the plant and labels are in, the herbarium technician will determine which course of action to take. Currently, we set repair work aside in a special cubby and repair as needed. Since I have taken over the repair work, I may be enlisting your help in the future to assist with it. Examples of damaged specimens and repair work from the Edinburgh Herbarium can be seen here.

Every specimen is important and tells a story so preserving them for future research is very important, it is one of the reasons why herbaria exist. We want these specimens to be able to tell their stories for hundreds of years into the future. Botanical specimens are not only used for taxonomic purposes, as they were traditionally intended. As our landscape changes with human pressure and habitat restoration efforts increase throughout the world, herbaria are important repositories of plants from lost habitats and vanishing wilderness. Our collections are valuable to conservation biologists and restoration ecologists when recreating baseline species lists for habitat restoration or rewilding, as some are calling it now. An article describing these efforts was published in The South African Journal of Botany: Realising the potential of herbarium records for conservation biology.

Our herbarium restoration efforts will help preserve our specimens for other restoration efforts, two activities near and dear to my heart. My first job in San Francisco was with the Golden Gate Parks Conservancy’s Presidio Native Plant Nursery, collecting seeds for habitat restoration efforts in the park. That job led me to the Cal Academy herbarium where I now work on another side of the restoration front, collecting plant specimens to catalogue diversity and keeping our collections safe. I will continue to slowly chip away at repairing these Euphorbs while hoping for a future battalion of volunteers to help!

Madagascar’s Princess Flowers, Melastomataceae

Frank Almeda, Heritiana Ranarivelo & R. Douglas Stone

Madagascar, with its remarkable cradle of biodiversity, has intrigued natural historians for centuries. Research efforts on the island have accelerated exponentially in the past three decades to understand the forces that have molded the biological patterns of its flora and fauna, particularly with regard to origins, dispersal, and phylogeny (evolutionary relationships).

Just over 15 years ago now I was invited to write a chapter about princess flowers for a volume entitled “The Natural History of Madagascar” that was published in 2003 by the University of Chicago Press. Late in the Fall of 2019 one of the editors of that volume, Steven Goodman, wrote to me asking if I would revise that chapter for the forthcoming 2nd edition of that book. Since Heritiana, Research Associate at CAS, and Doug Stone, former Rose Postdoctoral Fellow

at the Academy, now also have active research programs focused on Princess Flowers in Madagascar, I asked them to join me in revising the chapter. It has been a fun little project that made us realize how much more important research lies ahead. We have only limited space here to provide a few of the highlights of our chapter; if you are interested in learning more about other topics and work in progress we can direct you to the volume when it is published later this year or early next year.

Globally, the Princess Flower family (Melastomataceae) consists of about 150-155 genera and 5680+ species. It is among the 10 largest families of flowering plants. The family has a distribution that is largely pantropical, with relatively few members found in temperate zones (e.g., *Rhexia* with 13 species in eastern North America). One can almost always recognize a princess flower by its opposite leaves and distinctive foliar venation in which two or more main veins arise at, or close to, a common point at the blade base and converge in arcuate fashion toward the apex. Additional distinguishing features include elongate tubular anthers that release their pollen from terminal pores, and fruits that are dry capsules or fleshy berries.

Left to right; *Warneckea sansibarica* showing typical leaf venation (D. Stone); *Dichaetanthera hirsuta* showing tubular anthers that have apical pores (F. Almeda).

On Madagascar the 346 native species of princess flowers are grouped into two subfamilies, four tribes, and 12 genera. In addition, three other non-native species from Africa, SE Asia, and tropical America respectively have become naturalized in lowland sites along the Madagascar's east coast. The assemblage of princess flowers in Madagascar is notable for several reasons. Seven of the 12 native genera belong to a single tribe, the Melastomateae, which is well represented in Africa and tropical America. All three endemic genera of princess flowers (*Amphorocalyx*, *Dionycha*, and *Rousseauxia*) in Madagascar also belong to this tribe. Considering the family as a whole, ca. 80% of the Malagasy species belong to just three genera – *Gravesia* with 110 species, *Medinilla* with 70 species, and *Memecylon* with 96 species. Interestingly, Madagascar is a major center of diversity for each of these genera. At the species level, 99% of the Malagasy princess flowers (344 of 346 species) occur only on Madagascar. This is notably higher than the figure of 82% for the vascular flora of the island as a whole. For princess flowers, Madagascar harbors a higher incidence of species-level endemism than any area of comparable size anywhere in the world.

Left to right, *Amphorocalyx rupestris* (F. Almeda)*; Dionycha bojeri* (F. Almeda); *Rousseauxia dionychoides* (R. Letsara).

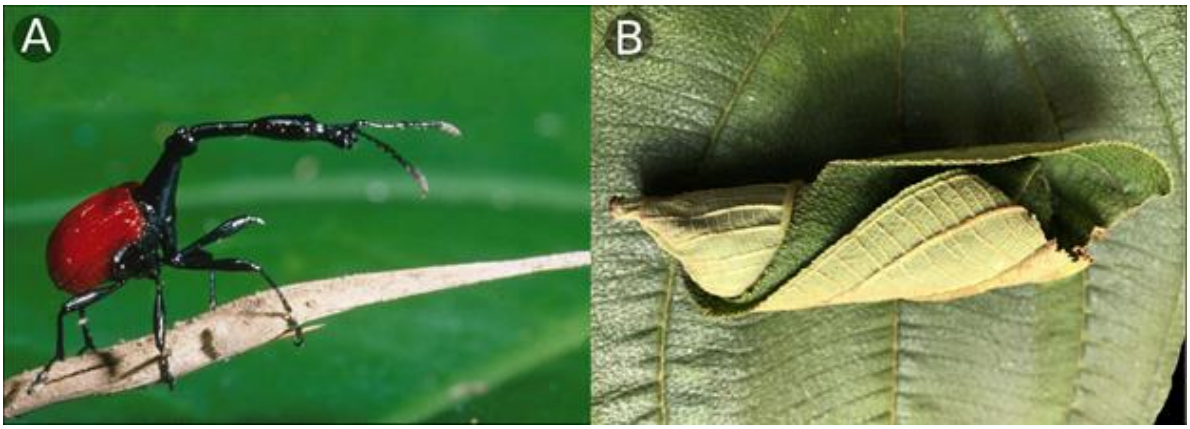
Left to right, *Medinilla humbertiana* (F. Almeda); *Memecylon galeatum* (A. Randrianasolo)*; Gravesia laxiflora* (F. Almeda).

Princess flowers generally provide pollen, less commonly nectar or fatty oils, as pollinator rewards. The type of reward, in turn, determines the pollinator spectrum of a species and is correlated with morphological features that facilitate pollen extraction and deposition on a receptive stigma. About 98% of princess flowers studied to date rely on pollen as the pollinator reward. While nectar-producing flowers among princess flowers are much less common, nectar production has evolved in a diverse group of New World lineages. Floral nectar collectors include birds, bats, rodents, and bees, but most nectar-flowers in the family appear to be pollinated by hummingbirds in the New World tropics. None of the Malagasy princess flowers are pollinated by birds or mammals because there appear to be no nectar producing species on the island. In Madagascar, birds and some mammals (lemurs) are believed to be important dispersal agents for the 184 species of princess flowers that produce fleshy fruits. This is an area of research that is still in its infancy so much more field work is needed to determine the spectrum of effective dispersal agents.

Malagasy princess flowers have other interesting symbiotic relationships with ants, mites, and weevils that are just beginning to get research attention. At least two species of *Gravesia* have hollow internodal stem chambers that harbor unidentified species of ants. These stem chambers are apparently used as nest sites by the ants. The ants, in turn, appear to defend their host plants from herbivore attack. The two species of *Rousseauxia* that have a relationship with mites produce specialized pocket or hair-tuft chambers (called acarodomatia) in the vein axils on the under surface of leaves. These acarodomatia serve as egg nurseries and help to shelter the mites from predators, while the mites benefit the plants by feeding on fungal spores and the eggs of predatory insects.

One of the most fascinating interactions between Malagasy princess flowers and insects involves the relationship between two species of *Dichaetanthera, D. arborea* and *D. cordifolia,* and the giraffe-necked weevil. The life cycle of this weevil is totally dependent on these two species. A female giraffe-weevil rolls the *Dichaetanthera* leaves into a cone in which she lays a single egg. The leaf is then severed and falls to the ground. Adult male and female weevils subsequently eat the rolled leaves as do the maturing larvae. The weevil/plant relationship as we currently understand it appears to be commensalistic since *Dichaetanthera* leaves provide both egg nurseries and a source of food for the weevils. (Commensalism is where one organism

benefits while the other is generally unaffected). Additional field work is needed to determine if there is any direct benefit to the two species of *Dichaetanthera*.



A. Giraffe-necked Weevil (F. Almeda), B. Rolled leaf of *Dichaetanthera cordifolia* (H. Ranarivelo)

Conservation Concerns

Because the lion's share of princess flower diversity in Madagascar is centered in Madagascar's moist evergreen forests, the long-term survival of this family will depend on critical habitat protection. Madagascar has arguably lost 80-90% of its original forest cover. Of the 261 native species of princess flowers known to Henri Perrier de la Bâthie, a pioneering student of the family in Madagascar, 170 were recorded from a single locality, 82 species had been collected from several sites (two to six localities) and only seven species were known to have wider ranges. If these figures are representative of the original ranges of most Malagasy princess flowers, one can only surmise that many species have gone extinct as the native forests have been cleared. Unlike the New World tropics, where there are many colonizing species that can survive in marginal habitats with high insolation and nutrient-poor soils, a much larger number of Malagasy species seem to require the microenvironments that only an intact tropical forest can provide.


Pristine Moist Evergreen Forest at Mantadia National Park, Madagascar (F. Almeda)

A closer look at flowers: a botany mini-class

Nathalie Nagalingum

It’s springtime! Learn about the anatomy of flowers, behold incredible variation you didn’t know existed, and get a blast of beauty on your screen thanks to some freshly picked co-hosts. You can watch my mini-class on flowers on YouTube. And, there are past and upcoming breakfast club mini-classes on the Academy’s website.

Some of the flowers you’ll see “up close” in the flowers mini-class.