

Research Interests

My lab's research interests range from plant systematics, field biology, ethnobotany to evolutionary and community genomics. The versatility of phylogenetics in elucidating plant evolutionary relationships, dating origins and understanding the mechanisms that have produced current plant distributions (biogeography), as well as its application in teasing out ecological mechanisms of community assembly make it indispensable to my research. The Philippines, with over 7,000 islands of varying sizes and geological histories and home to disproportionately high levels of species richness, provides limitless opportunities to understand drivers of evolution in a tropical setting and offers a potentially far more insightful and rewarding venue for my questions than any other island system.

The Philippine tropics as a model system

Biological diversification achieves its zenith in tropical biomes, making them the ideal systems for deciphering the gamut of evolutionary and ecological factors that stimulate speciation and allow these species to coexist in seeming harmony vis-à-vis relentless competition. With over 7000 islands, the Philippines surpasses Hawaii and the Galapagos in species biodiversity and endemism, and would be the perfect model system to understand why it is a cauldron of evolution. Species richness in islands is not only influenced by the interplay of colonization and extinction, but that phylogenetic diversification—phylogenesis—maybe an equally important factor. This redefines the pervasive thinking of equilibrium in island biogeography pioneered by Wilson and McArthur in 1969. This improved recipe for explaining island species diversity has not been evaluated in Philippine plants, which is deplorable in spite the fact that at least half of its 15000 plant species—found nowhere else in the world—are gravely endangered by habitat destruction. My dream is to call attention to the Philippines as a new model island study system in the same way that science has brought prestige and protection to Hawaii and the Galapagos.

Phylogenetics and Biogeography of Philippine plants. I am interested in understanding how the Philippine islands, almost all of oceanic origin, have been colonized by plant taxa throughout its geological history and how much phylogenesis has contributed to current species richness. This may be addressed through a comparative phylogeographic approach wherein phylogenies from multiple endemic plant taxa are compared, with topological congruence to suggest that similar geological and environmental processes shaped species' phylogenetic history. Do the phylogenies reflect the chronology of geological changes in the Pacific including differential island uplift and movement during the Tertiary (65-2 mya)? Or did the Pleistocene glaciations (2 mya-12000 years ago), characterized by repeated fragmentation and coalescence of islands due to fluctuating sea levels left more of a phylogenetic imprint? Pleistocene speciation was found not to be the case with endemic Philippine mammals, but has not been tested in plants.

Phylogenetic Community Structure of Philippine forests. In collaboration with the Smithsonian's Center for Tropical Science and University of the Philippines, we are collecting DNA barcodes—sequences from chloroplast genes that molecularly

distinguish species—to reconstruct the phylogeny of the lowland forest community in the Palanan Forest Dynamics Plot to understand the determinants of community assembly in Philippine lowland forests, one of the most biodiverse but highly threatened ecosystems in the world. A phylogenetic framework is essential in answering these questions. Do habitat idiosyncrasies filter for a set of traits that only phylogenetically related members possess thus resulting in phylogenetic clustering of tree species within the habitat? Or are coexisting species more unrelated than expected by chance due to competitive exclusion of closely related taxa with similar traits? It could also be that phylogenetic clustering of tree species may result from adaptive radiation, which has allowed related species to evolve dissimilar traits that exploit different niche spaces.

Genomics of Rafflesia. *Rafflesia* is one of the rarest plants in the world, found only in the Southeast Asian tropics. It produces the biggest blooms, which can be at least 3 feet in diameter, which has landed it a title in the Guinness Book of World Records. It is also a parasite, with no stems, leaves nor roots, just a massive flower, shamelessly feeding off the hapless tropical vine *Tetrastigma* and nothing else. More than a third of the 28 *Rafflesia* species are unique to the Philippines. In collaboration with New York University, Southern Illinois University, and the Philippine Genome Center, we are sequencing the whole genome of two Philippine endemics *Rafflesia manillana* and *R. leonardi* to gain a better understanding of the genes that have been involved in the evolution of parasitism and floral size increase, two traits that *Rafflesia* had acquired in the last 65 million years, which make it spectacular compared to its closest relatives, the non-parasitic small-flowered spurges.

Ethnobotany and Genomics of Native Philippine Medicinal Plants. Many herbal products sold in the Philippine market are not derived from native plants, like ampalaya (*Momordica charantia*) and bayabas (*Psidium guajava*). With over half of Philippine plant species unique to the country, and an incredibly diverse indigenous population who have intimate knowledge of the many uses of these plants, we have a natural pharmacopoeia waiting to be scientifically transcribed. Documentation of ethnobotanical knowledge coupled with field-based rapid assays can help us identify new medicinal plants. I am trying to liaise with the Global Bioexploration Institute (Rutgers University, NJ) to bring their knowledge and expertise in natural product research to UP. I am interested in conducting transcriptome characterization of plants with medicinal value discovered in the field. This will elucidate the genetic and biochemical pathways involved in production and regulation of plant medicinal compounds, which can empower researchers with new ways of producing drugs that are originally difficult or impossible to synthesize in the lab.