NECTANDRA INSTITUTE

Feb 2019, Vol. 19 No.1

Supernova Among Bromeliads

I was about 8 years old at the time, when my grandmother finally trusted me with a sharp knife to carve my first pineapple ever. It was the Lunar New Year. Every Asian household was preparing for its annual Open House when good cheer, food and gifts were exchanged. We were expecting friends and members of our large extended family to drop in during the three days of festivities. In previous years, I was only allowed to watch all the women in the family frantically prepare food for days in advance for the onslaught of visitors. This particular year, without ceremony, I became one of them.

Grandmother first showed me how to remove the spiny crown, then the base of the fruit. She had me carefully cut off 1/8 in. (0.5 cm) of the outer rough rind all around the fruit, just deep enough to reveal the many small "eyes" without sacrificing the yellow juicy flesh. "Inspect the way the eyes spiral around the fruit" Grandma instructed me. "Do you see two different spirals, one going to the right and one to the left? They are circling the fruit like threads of a screw. The longer spiral has a finer pitch than the shorter one with the wider pitch. Always remove the eyes along the longer spiral because they line up in a straighter line than the eyes on the shorter spiral."

Without knowing it, my unschooled grandmother was showing me (at the time) the not-yet-recognized manifestation of the Fibonacci numbered curves formed by the eyes in the pineapple. These spirals, of course, did not go unnoticed by workers in the pineapple industry either. In fact, in 1933 M.B. Lindford of the Experiment Station of the Association of Hawaiian Pineapple Canners used the numbers of eyes and spirals to rank the quality of the pineapples, the greater the number of eyes and spirals, the larger the fruits. He also noted that the fruits conveniently came mostly in 5, 8 or 13 spirals, but can include some with 3 or 21 spirals. By multiplying the number of eyes per spiral, he could estimate with fair precision the total number of eyes without having to count them individually. Mr. Lindford did not make the association of the 3,5,8,13,21 spiral numbers with the Fibonacci series (in which any number in the series is the sum of the previous two numbers). A colleague of his, P.B. Onderdonk at the Maui Pineapple Company did, years later, about the time I was cutting my first pineapple. Interestingly, subsequent breeders searched for the existence of potentially larger fruits with 13,21,34 spirals, but never found them.

The pineapple has intrigued me since childhood, but the vague recognition that it is different and unusual stayed dormant until my exposure to its close relatives in the Bromeliaceae family at Nectandra. Everything I have learned since confirmed my early suspicion that it's a rare fruit structurally, and that the plant is quite special among its 3000 relative species.

The bromeliads are almost all indigenous to tropical and subtropical Americas, with the exception of one isolated branch in West Africa. Phylogenetically, the bromeliads are distantly related to the grasses, and sedges.

At Nectandra, nearly all of the bromeliads species are epiphytic, growing densely on tree branches and trunks. The leaves form striking rosettes of varying sword-shaped leaves, of color ranging from green to maroon, with intense rose speckling and patterns. They can grow to immense density. One study in Columbian montane forest found 4400 bromeliads in a 0.1 ha site. Fig 1A suggests that the density at Nectandra may be equally high in certain area.

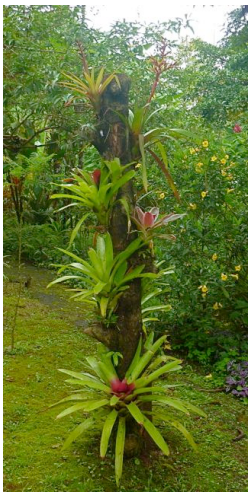

Fig1B Exhibit of native bromeliads at Nectandra

Fig 1A Cloud forest epiphytic bromeliads tangle

Fig1C Plantation pineapple in Costa Rica

There is no mistaking a pineapple (*Ananas comosus*) plant for anything but a bromeliad, with its rosette of pale green, spiky, waxy leaves (Fig 1C). Early domesticated pineapples had sharply barbed, serrated leaf margins, but the spikes have been bred out of existence in the modern cultivars. Unlike most of the 2000 epiphytic bromeliads species in Costa Rica, however, the pineapple is a terrestrial perennial. It can tolerate a wide range of soil and growth conditions. Of all the bromeliads, only the *Ananas* genus (8-10 species, depending on who's counting) have edible fruits. Of the ten, only *A. comosus* has been in continuous domestication, selection and hybridization for its large, juicy, yellow 2-5 pound fruits.

Geographically, *Ananas comosus* can be traced to two regions in South America. Historical records showed that pineapples were cultivated by the Maipure Indians long before Columbus set eyes on the golden fruits on his second voyage in 1493 to Guadeloupe. Several varieties of pineapples recorded by a Spanish government official in 1513 and other early explorers (including Sir Walter Raleigh in 1595) were seedless, compared to the wild pineapples at the time, suggesting that the pineapples had already undergone selection and domestication for some time. Today wild forms of *Ananas* species, but not *A. comosus*, can still be found inland of the Orinoco River in

Brazil (ancestral home of the Maipures) and further south in Paraguay.

Sweets in the Europe of Columbus days were rare treats, as enormously expensive refined cane sugar had to be imported from Asia. Fresh fruits were available but only briefly during the seasons. The arrival of Columbus' tangy, sweet, juicy pineapples created a sensation, triggering two hundred years of intense effort among horticulturists and speculators to grow the fruits. It became a symbol of prestige, wealth and extravaganzas. King Charles II of England posed in a royal portrait with it, society hostesses used it in lavish dinner party center decorations. Those that could afford it ate them afterward, those that couldn't rented them by the day.

Success in growing from seeds or plants to fruiting only came with the development of artificial heating of hot houses in Holland about 1690. That advent triggered an explosion of interest on the growing of pineapples among gardeners and horticulturists by the 1800's, to such an extent that it is now a challenge for the modern growers to sort and trace the ancestry of 'Cayenne', the mother of the Hawaiian pineapple cultivars.

The manner of pineapple fruiting is truly a testament to Mother Nature's whimsy. Let's take a look at the distinct difference between typical seeds of the epiphytic bromeliads at Nectandra and the terrestrial pineapple (Fig 2). In the former, small brown seeds are attached to the tip of fine hair-like appendages for wind dispersal. During the fruiting season at Nectandra, millions of the fluffy seeds literary permeate the air to land and stick to rough surfaces in its flight path. At right are the hard seeds from a local market pineapple.

Fig 2. Seeds. Left, *Vriesea*, Right, pineapple

Fig 3. Pineapple inflorescence *(Photo by Andy Kass)*

Growth from pineapple seed to fruit takes about 2.5-3 years. As the herbaceous plant matures and gets ready to flower, the center stem elongates. The tip enlarges to form a tight head of small purplish red flowers (Fig 3), the base of which would become the eyes of the fruit.

In its native South America, *A.comosus* is pollinated primarily by hummingbirds. After pollination, individual berries develop from the flowers and eventually fuse into a single large fruit that we call pineapple. The final fruit of the modern cultivars average 100-150 berries. Pollination, oddly enough, produce fruit of inferior quality — smaller fruit, more seeds. As result, a great deal of effort went into *preventing* pollination to boost yield in the early Hawaiian plantations. It is the reason why hummingbirds were banned on the Hawaiian Islands and why the Hawaii pineapples that I remembered were almost completely seedless.

A. comosus has another trait. It is self-incompatible, meaning that pollen from one plant cannot be used by its own flower. Self-crossed progenies are sterile. This is a natural mechanism to prevent inbreeding. At the same time, fruit development does not require fertilization. Hence, propagation of pineapple crop plants depends, not on seeds, but from vegetatively produced plantlets, which are the suckers growth from the mother plants after fruiting of (seedless) fruits. Sexual reproduction is used strictly for plant breeding programs. In Costa Rica, banning hummingbirds from the country is not an option. To minimize pollination, synchronized flower formation is induced by gassing the plants with ethylene oxide in plantation plots, where segregation of different cultivars is strictly observed to prevent seeded fruit production. Nevertheless, I chuckle with glee each time I find seeds in my pineapple. For each seed hails a good meal for some lucky hummingbird.

The chart below is a simplified flow chart showing the effort in 1950 by J.L. Collins of the Department of Genetics, Pineapple Research Institute of Hawaii to trace the ancestry of 'Cayenne' . From Europe, where the climate is distinctly unsuited for pineapples, the trail of pineapple cultivation arrived in Hawai'i (circa 1813), when cultivars from 11 countries were introduced and tested in Hawai'i. The 'Cayenne' variety emerged as the favorite because of its cylindrical shape, a desirable attribute for the canning industry initiated by James D. Dole in 1898.

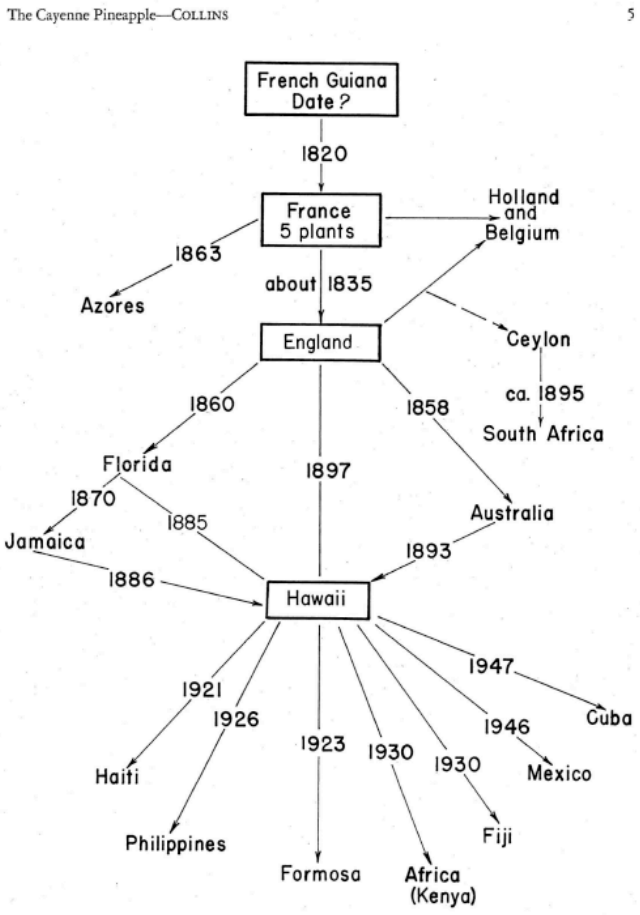

FIG. 1. Distribution of Cayenne following its introduction into France in 1820. Two major centers for distribution appear: first England and then Hawaii.

Why the interest? Because pineapple, from the time it first set root in Europe to the present, continues to be a prized crop. By 2016 they were worth $15 billion dollars globally and the demand has not been met. Our insatiable appetite for the golden fruit increases at an annual rate of 3.3% with no end in sight. Information on small details of its genetic background enables hybridizers to find genetic modifications, which in turn may lead to large profits.

Hawaii's three companies (Dole, Del Monte, and Maui Pineapple Co.) dominated the pineapple canning and fresh fruit production between 1900 – 1992, capturing 80% of the world's market, but competition was fierce. To capitalize on cheaper labor, Del Monte moved its canning operation to the Phillipines in 1962 and another later to Thailand. As the Hawaiian canning industry waned due to foreign competition, a consortium of the three companies invested heavily into the development and breeding program for the fresh fruit sector, resulting in MD2, today's king of cultivars. Any supermarket purchase in the US today would likely be MD2, aka Del Monte Gold. As result, MD2 and its derivatives have swept through the entire globe.

MD2 is exceptionally and uniformly sweet, medium size, has high yield, more vitamin C, less fibers, good storability (important in shipping), and consistent fruit quality. By sheer luck of timing, Costa Rica was the first testing ground for MD2. Del Monte fresh fruit operation moved there in the late 1970's to be closer to the Eastern US and European markets. MD2 tested and grew well there. Overnight this country became the first and biggest beneficiary of decades of research and labor. Production expanded and hasn't stopped. In the meantime, the last canning plant in Hawaii closed in 2007. Del Monte and Maui Gold now grow fruits in Hawaii only for the local and tourist market.

Costa Rica is now the world's number one producer of fresh pineapples, outcompeting Brazil, Philippines, Indonesia, India, China, Thailand, Mexico and Angola. Pineapple is only second to banana in the country's fruit production. US and Europe are its biggest customers. China, a potential large client, has just signed up this year for the Costa Rican golden fruit. Needless to say, this huge scale of pineapple production is causing havoc in this small country. Its environmental impact on land use, water use, ecosystem wide toxic contaminations from herbicides, insecticides, nematocides, heavy use of soil supplements, and human health has been and will continue to be enormous.

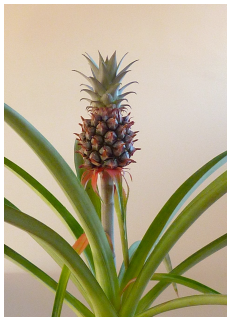

Fig 4. Pineapple grown in the author's kitchen

In the meantime, my curiosity about the star of the Bromeliaceae has not waned, both gastronomically and botanically. Some years ago, to learn about its growth habit, I took the top of a local market fruit, immersed and grew the tuft in pure water, and parked it on the sunlit top of my refrigerator. At left is the outcome of five years of waiting. That it grew and produced fruit attest to its hardiness, its astounding efficiency in extracting nutrients from just water and sunlight, its capacity to adapt, to survive and flourish.

— *Editor* —

News Highlights

Our community Outreach Program

• Nectandra Institute (NI) signed loan number 14 with FEDAPRO, a federation of 14 community water management associations in the upper Chayote watershed. The loan was instrumental in the purchase of a 20 ha (50 acres) partially forested cattle ranch. The spring on the property supplies water to many of the communities in the federation. This loan is the second ecoloan for FEDAPRO. In exchange for their pledge to regenerate and monitor forest on the entire property, NI will provide technical assistance to help the communities reforest and manage their watershed. The partnership with FEDAPRO has worked seamlessly to date on the previous land purchase.

• The annual Water Month (September) celebration was delayed to October due to the country-wide month-long strike. While attendance was slightly down from last year, the spirit of the attendees for the outdoor activities was very high. In the left photo below, the organizers were setting up the festivities tent for one of multiple events at Pueblo Nuevo ecoloan property. The right photo shows one of the beauty pageant participants proudly showing off her evening gown fashioned with recycled and disposable materials. The evening indoor event is the leading fundraising venue for the water associations to buy more land for water security and conservation.

At the Nectandra Reserve

University Studies Abroad Program interns Ben Camper and Evan Klumpp began a two-term long herpetofaunal survey . Ben's photo shows his first capture and release snake, the fire-bellied snake *Liophis epinephelus.*

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Huntleya burtii orchids at the Nectandra Cloud Forest Reserve

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