# Palms

Journal of the International Palm Society Vol. 56(1) Mar. 2012

# CONTENTS



## Features



The entire-leaf form of *Hydriastele beguinii* in the Hortus Botanicus collection at Nong Nooch Tropical Garden, Thailand, the exciting destination for this year's IPS Biennial. See article by L. Lai, p. 41. Photo by Paul Craft.

**FRONT COVER**

*Trachycarpus martianus* is known in the wild from Sikkim. See article by B.S. Kholia, p. 5. Photo by B.S. Kholia.

**BACK COVER**

Chestnut-colored fruits of *Calamus castaneus*. See article by N. Ruppert et al., p. 36.

# *PALM NEWS*


Late 2011 saw a **flurry of taxonomic papers in which a new genus, many new species and some new names** for existing species were published. Perhaps the biggest surprise is the **new genus *Lanonia***, which was published by Christine Bacon and Andrew Henderson (Systematic Botany 36: 883–895. 2011). It comes as a surprise because many of its species were described in 2008 in PALMS (52: 141–154) as dioecious species of *Licuala* from Vietnam. Bacon's molecular studies revealed that these Vietnamese species comprised a lineage distinct from that of *Licuala* (just as *Saribus* was found to be distinct from *Livistona*, as she reported in PALMS last year). *Lanonia* is very poorly represented in cultivation, but we hope that these attractive fan palms will soon find their way into collections around the world.

*Drymophloeus* has been down-sized as a result of a new molecular study of the subtribe Ptychospermatinae. Zona et al. transferred three species of *Drymophloeus* palms to the genus *Veitchia* and one to *Ponapea* (American Journal of Botany 98: 1716–1726. 2011). **The new names for the species now banished from *Drymophloeus* are *Veitchia subdisticha*, *V. pachyclada*, *V. lepidota* and *Ponapea hentyi*.** This publication also examined the geographic distributions of the species of Ptychospermatinae and found evidence of repeated radiations from New Guinea into the western Pacific and Australia. The study also confirmed that a palm from Biak Island represents a second, as yet unnamed species of *Adonidia*.

Three palm articles appeared recently in the new journal Phytotaxa. **The *Sabal* from Brazoria, Texas**, long suspected of being a hybrid, was examined by Doug Goldman et al. in an open-access article (www.mapress.com/phytotaxa/content/2011/f/pt00027p025.pdf). Using molecular tools, the authors found support for the hypothesis that the palm is of hybrid origin but – much to everyone's surprise – not involving *S. mexicana*. They formally named the palm *Sabal* × *brazoriensis*. Charlie Heatubun described **seven new species of *Areca***, five of them endemic to Borneo, one to Sumatra and one to Cambodia. Several of these new species would make attractive horticultural subjects. See a preview of the article at www.mapress.com/phytotaxa/content/2011/f/p00028p026f.pdf. Most recently, M.J. Sanín and G. Galeano produced a much-needed **revision of the genus *Ceroxylon***, the famous wax palms of the Andes. Download the article at www.mapress.com/phytotaxa/content/2011/f/pt00034p064.pdf.

Marc Jeanson and colleagues described **a new species of *Caryota*** from Sulawesi (Systematic Botany 36: 600–604. 2011). The species, christened *Caryota angustifolia*, is distinguished by having very narrow, strap-like leaflets at the bases of the secondary rachises. The new species is a large, solitary-stemmed species similar to *C. rumphiana* and is currently in cultivation in Bogor Botanical Garden, thanks to an earlier introduction of seeds by John Dransfield. The publication also includes a key to the five species of *Caryota* that occur east of Wallace's Line.

Finally, we note with pleasure that IPS member **José Antonio del Cañizo has brought out the third edition of *Palmeras***, his highly accessible Spanish-language guide to cultivated palms. The book was published by Ediciones Mundi-Prensa and is available through www.amazon.es. Instead of the almost 700 pages of the second edition, this new edition is a massive 1153 pages long and is correspondingly weighty. The substantial increase in size reflects the wealth of new palm information that the author has included. The book is beautifully produced and in full color throughout.

# Rediscovery of *Trachycarpus martianus* in the Sikkim Himalaya

B.S. Kholia
*Botanical Survey of India, Sikkim Himalayan Regional Center P.O. Rajbhawan Gangtok 737 103, Sikkim, India*

1. *Trachycarpus martianus* growing in front of workers' quarter at Temi Tea Garden, South Sikkim.

**The largely Himalayan genus of solitary fan palms, *Trachycarpus*, has always attracted plant lovers and nurserymen throughout the world, due mostly to its cold hardiness. During the time of the British Raj the genus was not fully understood in India, and only one (Brandis 1874, 1906), two (Griffith 1850; Gamble 1881; Beccari & Hooker 1894) or three (Blatter 1926) species were recognized from the Indian region, first in the genus *Chamaerops* and later separated off into the genus *Trachycarpus*. In his thorough study of Asiatic palms, Beccari (1931) provided taxonomy and distribution details of the genus as it was then known, and Martin Gibbons and Tobias Spanner (1998a) published an up-to-date version in 1998.**

At present, the number of species in the Indian Himalaya is five, including the extensively cultivated and now naturalized Chusan fan palm, *T. fortunei*. All of these species have a more or less restricted distribution; for example *T. takil* and *T. latisectus* are endemic to small areas of the Kumaon and Darjeeling Himalayas respectively. *Trachycarpus martianus* is reported from small areas of Nepal and the Khasia Hills (Gibbons 2003). The palm growing in tiny areas in Manipur and on the Naga Hills, introduced into cultivation variously as *Trachycarpus* sp. 'Manipur' or 'Naga Hills' (Kembrey 2004) and more recently described as *T. ukhrulensis* Lorek and Pradhan (Lorek 2004; Lorek & Pradhan 2006), has now been identified as the Thai mountain palm, *T. oreophilus* (Gibbons & Spanner 2009).

The Sikkim and Darjeeling Himalayas are the most extensively explored areas in the Indian Himalayan region. The *Trachycarpus* palms of this area at least have been well documented (Gamble 1881, Cowan & Cowan 1929, Beccari & Hooker 1894, Beccari 1931). Recently *T. latisectus,* a very beautiful species with marked taxonomic characteristics, was discovered here (Gibbons & Spanner 1998b; Spanner et al. 1997), and the old records of *T. martianus* from British Sikkim (i.e., present Sikkim State of India and the Darjeeling district of West Bengal) relate to this same species. On the other hand, Lorek (2007) reduced all the species with oval seeds growing in this Indian region to subspecies of *T. martianus,* and he named them as Khasyi form (subsp. *khasianus*), Nepal form (subsp. *martianus*) and Rissoom form (subsp. *latisectus*) according to the place of occurrence. He stated that "The locality in Sikkim [Rungbong] which was mentioned by Beccari (based on Indian classical taxonomic literature) has not been rediscovered up to now." He added, "Currently, it is not clear whether the 'Rissoom form' (= ssp. *latisectus)* has its origin at Rungbong or not. Maybe relocating the Rungbong locality could throw more light on this question." Perhaps Rissom and Rungbong are two different places. The need to establish this becomes essential to sorting out what is going on with the taxonomy and distribution of the ovoid-fruited species of *Trachycarpus*.

During the plant survey of the South District of Sikkim in 2008, the author came across five cultivated plants of a *Trachycarpus* palm in front of workers' quarters at Temi tea gardens (Fig. 1). They have denticulate petioles (Fig. 2) and bear white woolly hairs in the younger stage. They were without fruits. At first sight they looked quite different from either of the other palms growing in this part of the Himalaya, i.e., the commonly cultivated *T. fortunei* and the recently discovered *T. latisectus*. On the basis of the denticulate petiole and the general appearance, I presumed them to be *T. martianus*, but they could also possibly be members of the other group of *Trachycarpus* with reniform seeds, i.e., *T. oreophilus* or something closely related.

Intriguingly a local guide explained where these palms had come from and described a

2. *Trachycarpus martianus* showing denticulate petioles.

local population. I was determined to visit the place without delay. The next morning he and I left the Tandong Biodiversity Park at first light. We crossed the road that runs between Damthang and the Temi Tea Garden and that leads ultimately up to Gangtok, the capital city of Sikkim State. We climbed up about one and a half kilometers inside the forest and found ourselves on a narrow, gravelly and calm road between dense forest of large *Cupressus torulosa* other native broad leaved trees and dense patches of thicket fern, *Gleichenia gigantea*. At one point we left the road and followed a narrow path up into the forest. After a walk of 6 or 7 km, at 2000 m, we reached a clearing and enjoyed the beauty of a bright and sunny day and then climbed up the final 50 m to the summit. A beautiful landscape was waiting for us: the rays of the morning sun lit up the Teesta river and its wide valley a few kilometers to the east. We could see Rungpo, the gateway of Sikkim, at the confluence of the Teesta and Reshi Rivers, and in the southeast, the ridges of Kalimpong and other areas of Darjeeling formed the horizon. Just below us we could see our destination, the village of Rungbing, the very same Rungbong where C.B. Clarke collected *Trachycarpus* specimens more than a hundred years ago (Beccari 1931).

Presently we were on one of the historical routes between the Teesta valley and the Great Rangit valley, which were well connected with Darjeeling during the British time, before the development of motor roads in modern Sikkim. These days this route is almost abandoned and rarely used even by the villagers. After a short walk we left the road and started descending on a slanting connecting path, which was partly blocked with dense bushes and occasional big trees. After an easy 2 km walk down we entered the village. The locals there were very surprised to see us at this early hour, and assuming me to be a forest officer, half expected a raid. Fortunately we were able to reassure them of our good intentions. My colleague Krishna asked the people about *Pankha* or *Purbang* (vernacular names for the fan palm in the local Nepalese dialect), but we received largely negative answers.

We next made our way to where Krishna remembered having seen a large fan palm some ten or fifteen years ago. This magnificent palm, still there, is about 10 or 11 m tall, growing at the top of a steep, rocky bank and was heavy with seeds. It was overgrown with bushes and subtropical and temperate trees including *Castanopsis indica, Quercus lamellosa, Ficus cordifolia, F. neriifolia, F. hirta, Saurauia napaulensis, Erythrina arborescens, Engelhardtia spicata, Exbucklandia populnea, Macaranga denticulata, Echinocarpus dasycarpus* and *Alnus nepalensis*. Furthermore, the base of the trunk was completely hidden by steep rocks. In between bushes and under the large trees, 4 or 5 more, smaller palms were growing nearby. All had dry inflorescences.

Seed collection was very difficult due to the height of the big palm and the rocky terrain; a small slip could result in a fall of 60 meters. We considered carefully the easiest and safest

3. Seeds badly infected by insect larva.

way of collecting fruits. Krishna produced a sickle from his bag, and fixed it to a long bamboo cane using rope he made from grass. In the meantime the lady from a nearby house gave us valuable information about a wild population. She guided us along a suitable path, and after some effort we were at the base of a fruiting palm. Using the prepared sickle, we cut a small fruiting branch leaving the rest there because they were still not mature. We also cut a leaf from nearby smaller plant, and it, together with the round oval seeds, which were badly infected by insects (Fig. 3), allowed us to identify it as *T. martianus*, a palm that has not been seen in the wild in Sikkim for over 100 years!

We left the area and climbed upwards along a small footpath along the ridge in search of more plants. After ascending half a kilometer or so, we left the main footpath and started descending into the forest. After a descent of a kilometer in deep, southeast-facing forest, we began to follow a water supply pipe between shrubs and trees, continuing down between thorny bushes, prickly climbers and large trees, clearing a passage with the help of the sickle. Monkeys began jumping from one tree to another upon seeing these unexpected visitors. In a deep gully, between big trees, we found two fully grown palms. With great effort we reached them to try to take pictures, but no suitable angle was found due to the dense canopy. Alas there was no sign of fruits, seedlings or juveniles in the vicinity.

We decided to cross the small stream to check out the warmer and more exposed side of the gully. When we were about to cross it at 27°11′57.9″N; 88°25′28.0″E at 1680 m, we noticed three big trees of about 7 or 8 m tall growing some 30 m above us (Fig. 4), but they were also without fruits. Now we were confident that we were in the right place where the local guide had originally found the palms. We again found a small descending footpath perhaps used to visit the water tank, and we followed it for about one kilometer or so. Along the path and nearby we found up to a hundred different sized palms (Fig. 5), taking many pictures at 27°11′57.7″ N; 88°25′31.4″E. Many palms had died due to age, but some stumps were still remaining (Fig. 6). There seems to be no human interference with the palms, but even so we saw no seeds or seedlings. Monkeys are common in the forest, so we concluded that the fruits are taken by monkeys before they are ripe.

4. *Trachycarpus martianus* in its natural habitat at 27°11′59.9″N; 88°25′28.0″E.

Around 3 p.m., we left the area seeing many more individuals of *Trachycarpus martianus* growing below us on the southeast-facing slopes. We left with great satisfaction, returning to base via the old classical route running parallel to the top of Rangbing village. Since our visit, more cultivated palms have been reported from Sadam and other nearby villages in South Sikkim. These have all been collected from the nearby forests.

Gamble and Clarke found *Trachycarpus* palms in this area (Beccari 1931), however Brandis (1874) clearly stated that "No *Chamaerops* [*Trachycarpus*] has yet been reported from Sikkim," and in his later publication (Brandis 1906) does not record any *Trachycarpus* from Sikkim. Recently, during my visit to the Central National Herbarium in Calcutta (CAL) in June–July 2010, I was unable to find the *Trachycarpus* collections of Gamble and Clarke from British Sikkim. The Indian Liaison Officer at RBG Kew was unable to trace the missing collections of Clarke and Gamble. Could it be that all the sheets collected by these renowned botanists from British Sikkim were sent to Beccari and are still lying in the Beccari's palm herbarium in Florence, Italy?

5. *Trachycarpus martianus* at 27°11′57.7″N; 88°25′31.4″E.

After analyzing Gamble's (1881) lines – "In Sikkim, I have only once found it, on the hills east of Teesta river" – I am convinced that Gamble's locality ("Rissom mountain near Dumsong beyond Darjeeling") is definitely the Kalimpong area where *T. latisectus* was described. On the other hand a young plant collected by Clarke from "Rungbong at about 1,200 m" is definitely from the lower elevations of present day Rungbing village near Damthang in the south district of Sikkim, where *T. martianus* still grows. Thus Rissom and Rungbong are two different places; the first is on the east side of the Teesta River in Kalimpong in Darjeeling District where *T. latisectus* occurs; the second is on the western flank of the river in present day South District of Sikkim where *T. martianus* grows. The second locality has remained hidden or forgotten for more than a century. In any event, the rediscovery of *Trachycarpus martianus* in its historical location after a period of more than 100 years is an exciting event, and one that will be welcomed by all enthusiasts of the genus.

## Acknowledgments

Grateful thanks are due to Martin Gibbons of England and Tobias Spanner of Germany for providing literature, constant guidance and support and for improving the manuscript. I am most thankful to Dr. M. Sanjappa, Director and Dr. D.K. Singh Add. Director, Botanical Survey of India for providing the necessary facilities. Mr. Krishna caretaker of Tandong Biodiversity Park, Sikkim is also acknowledged for his assistance in the field.

### Literature Cited

Beccari, O. 1931. Asiatic Palms – Corypheae. Ann. Roy. Bot. Gard. Calcutta 13: 1–356.

Beccari, O. and J.D. Hooker. 1894. Order CLXIII. Palmae. In J.D. Hooker, Flora of British India, vol. VI. L. Reeve & Co. London.

Blatter, E. 1926. The Palms of British India and Ceylon, Oxford University Press, London.

Brandis, D. 1874. The forest flora of north-west and central India. W.H. Allen and Co. Ltd., London.

Brandis, D. 1906. Indian Trees, Archibald Constable and Co. Ltd, London,

Cowan, A.M. and J.M. Cowan. 1929. The trees of Northern Bengal. Calcutta.

Gamble, J.S. 1881. A Manual of Indian Timbers: An Account of the Structure, Growth, Distribution, and Qualities of Indian Wood, Office of the Superintendent of Government Printing, Calcutta,

Gibbons, M. 2003. A Pocket Guide to Palms, Chartwell Book Inc, New Jersey.

Gibbons, M. and T. Spanner. 1998a. Palms for Southern California. Part Thirty: *Trachycarpus*. The Palm Journal 138: 8–17.

Gibbons, M. and T. Spanner. 1998b. *Trachycarpus latisectus*: The Windamere palm. Principes 42: 24–29.

Gibbons, M. and T. Spanner. 2009. *Trachycarpus takil* – lost and found, for now. Palms 53: 96–101.

Griffith, W. 1850. Palms of British East India, Charles A. Serrao, Calcutta.

Kembrey, N. 2004. *Trachycarpus* sp. Manipur or Naga Hills. Chamaerops 49, published online, visited July 2010.

6. Stump of a dead palm.

LOREK, M. 2004. *Trachycarpus ukhrulensis*, the survivor palm. The Palmateer 24(2): 13, 22, 23.

LOREK, M. 2007. A taxonomic review of *Trachycarpus martianus* (Wall.) H. Wendl. Curr. Sci. 92: 1678–1679.

LOREK, M. AND K.C. PRADHAN. 2006. A new species of *Trachycarpus* (Arecaceae) with remarks on its unusual habitat. Bot. Jahrb. Syst. 126: 419–426.

SPANNER T., H.J. NOLTIE AND M. GIBBONS. 1997. *Trachycarpus latisectus*. Edinburgh J. Bot. 54: 257–259.

# In Search of *Juania australis* with a Few Observations of *Jubaea chilensis* along the Way

Donald R. Hodel
*University of California*
*Cooperative Extension*
*4800 E. Cesar Chavez Ave.*
*Los Angeles, CA 90022 USA*
*drhodel@ucdavis.edu*

1. At the Hacienda de las Palmas de Cocalán south of Santiago, Chile, the extensive population of *Jubaea chilensis* inhabits the flat valley bottom and is semi-managed for the bountiful crop of edible seeds called *coquitos*.

**One of the most mysterious, enigmatic and fascinating palms must be *Juania australis*. Its isolated habitat alone, on Robinson Crusoe Island (Juan Fernández) off the coast of Chile, is more than sufficient to conjure up images of a remote, far away, mysterious land, while the name of the island itself and its past role in literary lore add immeasurably to this mystique. I visited Chile in November, 2010 with Marianne Hodel and Steve Daugherty, my former college roommate, to explore for the rare *J. australis* in its isolated, island habitat and to observe the famous and well known *Jubaea chilensis* in the wild.**

After the all-night flight from Los Angeles to Santiago, Chile, we rented an auto and drove to our hotel where we checked in and relaxed for awhile before meeting Steve's friend, Eva Ochoa, for lunch. Over a traditional Chilean seafood extravaganza, we planned our activities for the next two weeks. Our plan was to spend about 10 days in and around Santiago, making day trips to several locales to see the famous Chilean wine palm, *Jubaea chilensis*, in the wild and cultivated around the city. We would then make a four-day trip to Robinson Crusoe Island to see *Juania australis* after which Marianne and I would travel to Easter Island for a few days before returning to Los Angeles.

### *Jubaea chilensis*

Like California, central Chile, including Santiago, has a Mediterranean climate characterized by cool, moist winters and warm, dry summers. November is late spring in Santiago, and typically the weather is mostly pleasant with warm, sunny days and cool nights although we experienced several unusually cool days with clouds and rain. We were amazed at the similarity of the terrain and vegetation around Santiago with that of southern California. The rocky hillsides were variously covered with xerophytic shrubs, small trees, cacti and, at this time of year, seasonal wildflowers, just like our chaparral in California. It was all the more amazing, though, to see some of these hills and valleys covered densely with vast stands of *Jubaea chilensis*.

We visited three areas with *Jubaea chilensis*, including Quebrada Siete Hermanas near the port and tourist destinations of Valparaiso and Vina del Mar west of Santiago, the Hacienda de las Palmas de Cocalán south of Santiago (Fig. 1), and Parque Nacional La Campana north of Santiago. The last two sites have the largest populations of *J. chilensis*, 35,000 and 62,500 adults each, respectively. While this palm is most abundant in valley bottoms, where soil is deep and moisture is more plentiful and available, it frequently inhabits or even thrives on dry, well drained, rocky hilltops and ridges (Fig. 2). I was surprised and had a difficult time understanding how this palm could grow in such a harsh environment. At the Hacienda de las Palmas de Cocalán, where the palms are semi-managed for the bountiful fruits containing the edible seeds, called *coquitos* (small coconuts), we observed several, still-living and healthy-appearing specimens with burned-out trunks, evidence of the occasional fires that ravage the palms and surrounding area. Some were burned so extensively that only a perimeter layer of

2. While *Jubaea chilensis* is most abundant in valley bottoms, where soil is deep and moisture is more plentiful and available, it frequently inhabits or even thrives on dry, well drained, rocky hilltops and ridges, as here at Parque Nacional La Campana north of Santiago, Chile.

sound tissue about 10 cm (4 inches) thick remained and, in some cases, only partially enclose the trunk, easily enabling a person to step inside. These burned-out trunks still supported a healthy, full canopy of leaves.

### *Juania australis* and Robinson Crusoe Island

After spending a few days in Santiago visiting several of the well known tourist sites, many of them with exemplary specimens of *Jubaea chilensis*, we were ready and excited to visit Robinson Crusoe Island (otherwise known as Juan Fernández) in our quest to see *Juania australis*. Unfortunately, our plans unraveled slightly when the day before our departure the travel agent who had made our arrangements for Robinson Crusoe Island (air, lodging and local guide), e-mailed me to say that the regularly scheduled airline on which we were booked had decided not to fly to Robinson Crusoe Island that week! We were stunned because we were locked-in to our departure to Los Angeles and Marianne and I still had our short trip to Easter Island, precluding us from adjusting our schedule. This discouraging news reminded me painfully what others had told me about travel to Robinson Crusoe Island: it is not an easy place to get to, the airline that serves it is unreliable and flights are frequently cancelled or rescheduled with little or no notice.

Fortunately, our savvy and resourceful travel agent quickly, at no additional coast, chartered a small, two-engine aircraft to take us to Robinson Crusoe Island. On the morning of November 9, when Steve, Eva, Marianne and I arrived at one of the charter hangers at the airport, an agent met and told us that one additional passenger would be accompanying us to Robinson Crusoe Island. As it turned out, the additional passenger was none other than Michelangelo Trezza, the owner of the hotel where we would be staying for three nights on the island. At the time of our visit there was only one hotel operating on Robinson Crusoe

3. Cultivated specimens of *Juania australis* in San Juan Bautista on Robinson Crusoe Island typically are better looking than their wild counterparts and have a fairly robust, smooth, lime-green, conspicuously and densely ringed trunk supporting a compact, nearly spherical canopy of 25 to 35, stiffly ascending to spreading to drooping, dark green, pinnate leaves.

4. The congested leaf bases of *Juania australis*, deeply split opposite the petiole, are loosely overlapping, do not form a crownshaft, and, like the petioles, are densely covered with grayish to tan or even rusty brown, felt-like indumentum.

Island because the tsunami spawned by the powerful earthquake that struck Chile in February 2010 devastated San Juan Bautista, the only village on the island. The tsunami killed over 20 people and destroyed nearly half the small village, including all the hotels except one. We were the first tourists to visit Robinson Crusoe Island since the tsunami.

The flight from Santiago to Robinson Crusoe was uneventful but as we neared the island the skies suddenly became cloudy and we would not see the sun again until we returned to Santiago in three days. Once our plane had landed and we had collected our gear, we learned that the pilot would be staying with us for our three nights rather than making another trip back to Santiago and then back to the island again. From the airport we took a short truck ride down to a small bay that was home to several hundred noisy sea lions frolicking in the rough surf or lying contentedly on the mossy rocks. From the small bay we took a rough, wet, two-hour, 18-km (11-mile) ride in a small, open boat to San Juan Bautista. If not for the rain coverings we were given upon boarding the salt spray would have thoroughly soaked us and our gear.

Prior to the tsunami about 500 people lived on Robinson Crusoe Island, nearly all in San Juan Bautista on Cumberland Bay, and they were engaged in fishing, primarily lobster, and a budding eco-tourism industry. Now about 350 people live on the island and, while fishing is still the primary source of income, there is hope that tourism can get back on its feet with reconstruction of hotels and other necessary infrastructure.

Formerly known as Juan Fernández Island or Más a Tierra, the Chilean government renamed the island Robinson Crusoe Island in 1966 to reflect is purported literary past. Many people theorize that Daniel Defoe based his 1719 novel, *Robinson Crusoe*, on the experiences of a Scottish castaway, Alexander Selkirk, who voluntarily asked to be left on the island in 1704 because of doubts of the seaworthiness of the vessel on which he sailed. After four years on the island he was rescued in 1709 and returned to Europe to tell his tale. However, several other real-life incidences may very well have served as Defoe's inspiration.

About 675 km (415 miles) west of Chile, Robinson Crusoe Island is the largest of three that make up the Juan Fernández Islands archipelago (Alexander Selkirk and Santa Clara are the other two islands in the archipelago). The island covers 93 km$^2$ (36 miles$^2$) and rises very precipitously to 916 m (3005 feet) at the

5. *Juania australis* clings tenaciously to a cliff near Mirador de Selkirk above San Juan Bautista on Robinson Crusoe Island.

top of El Yunque, the highest point. The remains of an ancient volcano, Robinson Crusoe Island is extremely mountainous and spectacularly eroded with steep valleys and narrow, razor-like ridges and is reminiscent of some of the picturesque, older islands in Hawaii or the South Pacific.

Like the Chilean mainland, Robinson Crusoe Island has a Mediterranean climate but the cold Humboldt Current sweeping up from Antarctica provides significant modifications. Thus, it has a more moderate climate, not as warm or cold as Valparaiso at roughly similar latitude on the Chilean coast, and with little seasonal variation. However, because of the cold Humboldt Current, the weather is frequently cool, cloudy, misty or drizzly, and windy, and reminded me much of San Francisco on the central California coast. Daytime high and nighttime low temperatures in January, the warmest month, average 22ºC (71ºF) and 16ºC (61ºF), respectively, while in August, the coolest month, they are 15ºC (60ºF) and 10ºC (50ºF). A low -2ºC (29ºF) has been recorded in October. Rain averages 170 mm (7 inches) in July, the wettest month, and 26 mm (1 inch) in February, the driest month. Humidity is always high and the rainiest months of June and July average about 15 days per month of rain or drizzle while the driest months of December and January average about six days per month of rain or drizzle. These records are for San Juan Bautista at sea level but certainly the higher parts of the island, which are frequently hidden in clouds, experience cooler temperatures and higher rainfall and humidity.

Pasture land and disturbed forest with many invasive, weedy exotic species, like *Eucalyptus*, *Cupressus* and *Pinus*, occur from sea level to about 200 meters elevation. Lower montane forest ranges from 200 to 400 meters elevation. Upper montane forest occurs above 400 meters elevation. *Juania australis* is restricted to montane forest and is most common in upper montane forest. Upper montane forests on some of the higher mountains, which are nearly always enveloped in clouds, support an intriguing cloud forest. Robinson Crusoe Island is rich in endemics, with 101 of the 146 native plant species (nearly 70%) found nowhere else. Most of the plants have relatives in South America, New Zealand and Australia. Several members of the sunflower family, whose relatives are typically herbs in other locations, are trees on Robinson Crusoe Island. The entire island was designated a World Biosphere Reserve in 1977 because of its unique and endangered flora and fauna.

As our small boat pulled up to the wharf at San Juan Bautista, the destruction from the tsunami was stunning. The lower half of the village adjacent to Cumberland Bay was gone, as if a giant hand had simply wiped it from the earth's surface. Only a few very large and old trees and house foundations remained. As we waited for the ride to our hotel, I looked up to the steep and narrow ridgelines towering over the village and here and there I was just able to pick out a few specimens of *Juania australis* clinging precariously to nearly vertical cliffs not too far above San Juan Bautista. Seeing the palms above and so near to San Juan Bautista was encouraging but, being an eternal pessimist and somewhat experienced in searching for palms in difficult-to-access places, I checked my optimism because I knew that what seemed like a rather easy walk up to the palms could easily be just the opposite.

After checking into the hotel and eating lunch, we discussed our plans for the next two days with Michelangelo, who would also serve as our guide in our search for *Juania australis*. The next day we would take a walk up a trail behind San Juan Bautista to Mirador de Selkirk, a viewpoint at the top of the ridge overlooking the village and bay near to the *J. australis* I had seen upon our arrival. Our second day's activities would take us on a much longer walk over several ridges to the southeast of San Juan Bautista. We spent the remainder of the afternoon exploring the steep hillsides around the hotel, looking at ferns and admiring the views of the ocean crashing into the base of the precipitous slopes.

Michelangelo was full of confidence the next morning as he, Eva, Steve, Marianne and I set out for Mirador de Selkirk. He was sure we would find our quarry, *Juania australis*. As we walked toward the village we passed through groves of the Australian native *Eucalyptus globulus*, the blue gum, which reminded me much of the central and northern California coasts. Much to our surprise as we passed through San Juan Bautista, we found several cultivated specimens of *J. australis* adorning a few dooryards. Known locally as *chonta*, it is an unusual palm, not likely to be confused with any other. The fairly robust, smooth, lime-green, conspicuously and densely ringed trunk supports a compact, nearly spherical canopy of 25–35, stiffly ascending to spreading to drooping, dark green, pinnate leaves with relatively short petioles (Fig. 3). Leaf scars on the lower part of the trunk, which were produced when the palm was young and growing more vigorously and or perhaps shaded, are frequently uneven and asymmetrical, with one side higher than the other, reminding me of those of *Howea forsteriana*. In contrast, leaf scars near the top of the trunk just below the leaves are severely close set and congested, reminding me of those of *Rhopalostylis baueri* or *R. sapida*. The stiff pinnae are glossy dark green above and grayish below. The congested leaf bases, deeply split opposite the petiole, are loosely overlapping, do not form a crownshaft, and, like the petioles, are densely covered with grayish to tan or even rusty brown, felt-like indumentum (Fig. 4). Simply looking at the leaf bases easily reminds one of its relatives *Ceroxylon*, *Oraniopsis appendiculata* and even *Ravenea*. Unfortunately, none of the plants had flowers or fruits although they looked sufficiently large and old to be mature. Michelangelo was delighted, jauntily declaring that we had attained our objective for the trip. His spirits were not in the least bit dampened when I reminded him that I had come to see these

6. Above Mirador de Selkirk on Robinson Crusoe Island *Juania australis* is exposed and, with its wind-battered, torn and frayed leaves, is not nearly as handsome as its cultivated counterparts in San Juan Bautista.

7 (left). A thrifty, wind-battered staminate plant of *Juania australis* in lower montane forest is exposed above the surrounding vegetation at El Cordon Piedra Agujereada, Robinson Crusoe Island. 8 (right). Old staminate inflorescences of this *Juania australis* at El Cordon Piedra Agujereada on Robinson Crusoe Island are held among the leaves.

palms in the wild, and he assured me that we would soon see them at Mirador de Selkirk.

The trail to Mirador de Selkirk, like all the other trails on the island, was unusually steep but afforded spectacular views of San Juan Bautista and adjacent Cumberland Bay. We zigzagged up the steep slope, passing through moist forests with short trees heavily laden with epiphytic ferns and a dense groundcover of shrubs and other ferns. As we neared the top of the ridge *Juania australis* seemed tantalizing close as they clung tenaciously to the near vertical slopes 25–50 meters above us (Fig. 5). Finally we arrived at the top of the ridge and Mirador de Selkirk where we enjoyed panoramic views of the village and bay on one side and the western end of the island on the other. Unfortunately we realized that we would be unable to access the palms from this site because the razor-sharp ridges leading away to the north and south to the palms were simply too steep to negotiate without being a goat or professional mountain climber, neither of which applied to us. Thus, I had to be content with viewing the palms from a distance and trying to take a few shots with a telephoto lens (Fig 6). Despite the distance it was easy to see that these palms, with their wind-battered, torn and frayed leaves, were not nearly as handsome as their cultivated counterparts we had just admired in San Juan Bautista. These wild palms had a hemi-spherical canopy of many fewer leaves with necrotic, gray- to brown-tipped pinnae. I am sure that my disappointment at not being able to reach the palms was clear because Michelangelo confidently assured me that we would reach them the next day.

Like everyday during our stay on the Robinson Crusoe Island, the next day dawned cloudy, drizzly, cool and windy. Eva and Steve decided to remain at the hotel, but the pilot and one of the hotel's gardeners would join Michelangelo, Marianne and me for our arduous trek to the southeast to see *Juania australis*. We zigzagged up a very steep ridge directly behind the hotel and then crossed two small valleys and ridges before finally arriving, several hours later, on a grassy, windswept plateau and large ridge overlooking a deep

9 (left). Infructescences of *Juania australis* are showy when heavily laden with bright, red-orange fruits. Cultivated, Los Canelos, Viña del Mar, Chile. 10 (right). The showy infructescences of *Juania australis* are mostly held below the leaves and typically retain several, large, thick-papery, tan bracts that persist over the cluster of fruits. Cultivated, Los Canelos, Viña del Mar, Chile.

valley, an area known as El Cordon Piedra Agujereada. Across this valley and higher up we could see extensive lower and upper montane forest with numerous *J. australis* poking their leaves above the canopy. Excitedly down we went into the deep valley and up the other side, passing through lower montane forest and panting heavily from the exertion of the climb before finally gaining access to upper montane forest. This dense, mossy, high-elevation forest was a delightful place, supporting an extensive understory of the cycad-like fern *Blechnum cycadifolium* and several, handsome tree ferns. The moss and leaf litter on the forest floor formed a spongy layer 30–60 cm (1–2 feet) deep and gave us a bouncy sensation as we maneuvered our way through the dense undergrowth. Scattered here and there were several *J. australis* that we could actually touch and look right up the trunk into their wind-battered canopies! However, these palms were difficult to photograph because of the densely encroaching forest and not much better looking than the palms we had seen from a distance the day before. They had the same wind-torn and shredded leaves with gray-and brown-tipped pinnae. Because we could examine these palms closely, though, we could see that some type of insect predator was also severely ravaging the leaves.

*Juania australis* is dioecious, meaning there are separate staminate (male, pollen-bearing) and pistillate (female, seed-bearing) plants. We were fortunate to find one staminate plant with old inflorescences emerging among the leaves but hanging below them in nearby lower montane forest that was sufficiently clear to photograph (Figs. 7 & 8). In upper montane forest we found a pistillate plant with torn, tattered and ravaged leaves that was in young fruit. Unfortunately we found no plants with mature fruit. We also noticed that during the developmental phases from seedling to adult plant the palms display saxophone-type establishment growth and produce a “heel,” like other palms including *Chamaedorea radicalis*, *Ravenea xerophila*, *Rhopalostylis* spp. and *Sabal* spp.

We were in a special place, one in which we wanted to linger and were in no hurry to leave. We simply wanted to “soak up” the ambiance

11. The bright orange, spherical fruits of *Juania australis* are about 2 cm (0.8 inch) in diameter. Cultivated, Los Canelos, Viña del Mar, Chile.

of the moment. But the day was getting late and we had a strenuous, four-hour walk to return to the hotel. We were a happy group as we descended and then ascended a seemingly never-ending series of valleys and ridges. However, our happiness was tempered somewhat when Michelangelo twisted his ankle descending into one of the valleys, necessitating a 45-minute hiatus to recover before he was able to continue on. We were relieved finally to stagger into the hotel, take a warm shower, enjoy a lobster dinner, and share our day's adventures with Eva and Steve.

The next day we said our goodbyes to the attentive hotel staff and, after braving the wet, two-hour boat ride back to the west end of the island and the airport, we departed on our charter flight to Santiago. After saying fond farewells to the pilot and Michelangelo in Santiago, we dropped Eva off at her house and Steve, Marianne and I returned to our hotel.

**Easter Island**

The next day Marianne and I departed for Easter Island. While we both wanted to see the famous remnants of the ancient Polynesian civilization that once thrived on the island, I was keen to see the *Jubaea chilensis* that had been transported from the Chilean mainland by boat a few years ago in an attempt to "reforest" Easter Island, which is a sensitive subject in Chile. In 1984 John Dransfield and others published the name *Paschalococos disperta* for an extinct palm that once inhabited Easter Island. The name was based upon some fruit endocarps (shells) found in a cave and that indicated the extinct palm was related to *Jubaea chilensis*. It is thought that the Polynesians deforested Easter Island and in the process drove *P. disperta* to extinction. They may have cut the palms for food or shelter, and or used the trunks as rollers to move the large and heavy *moais* (giant statues) from the quarries to various sites around the island.

A small controversy is raging in Chile about *Paschalococos disperta* and *Jubaea chilensis*. One group believes that these two species are one and the same and, thus, has made an effort to reestablish *J. chilensis* on Easter Island. The other group believes that the two are distinct and, thus, there should be no efforts to reforest Easter Island with *J. chilensis*. At least one initial planting of *J. chilensis* has been made, though, and small, still trunkless plants to 2 meters (6 feet) overall height can be seen at the agriculture department arboretum and the airport. It seems unlikely that the two species are the same, though, because the climate on

Easter Island is mildly tropical and coconuts are widely planted there. *Jubaea chilensis* does not grow well in a tropical climate and rather performs best or thrives in a Mediterranean climate. It will be interesting to track the progress of the few *J. chilensis* on Easter Island and see how well they grow in the years to come. Tour guides would like to have real live palms to show the tourists because of the critical role the palm might have played in the development and demise of the Polynesian culture on Easter Island. All they could show us now were purported palm trunk lava molds on the walls and ceilings of a few caves.

**Cultivated *Juania australis***

After two days enjoying the sites on Easter Island Marianne and I returned to Santiago. Our departure for Los Angeles was late the next evening, meaning we had a full day left in Santiago. We decided to visit the private garden Los Canelos in the scenic and touristy Viña del Mar near Valparaiso on the coast west of Santiago. Eduardo Sone, curator of the garden, showed us several, old, mature, and heavily fruiting specimens of *Juania australis*. Pistillate plants are showy when carrying several infructescences with bright, red-orange fruits (Fig. 9). While emerging within the leaves, the relatively short but showy infructescences are mostly held below them in fruit and typically retain several, large, thick-papery, tan bracts that persist over the cluster of fruits (Fig.10). The spherical fruits are about 2 cm (0.8 inch) in diameter (Fig. 11). Seedling eophylls are strap-like (Fig. 12). Other than these specimens, the only other cultivated *J. australis* I had ever seen were in the Lakeside Palmetum in Oakland, California near San Francisco and in Dick Endt's fabulous garden near Auckland, New Zealand. The plants in California, which are growing steadily but slowly, have yet to form trunk but the one at Dick Endt's garden had a short trunk in 2005. Larger specimens, which I have not seen but are perhaps mature, are at Illeifa, a small island in Lago Ranco, Valdivia in southern Chile.

After seeing *Juania australis* in the wild and the few cultivated specimens on the Chilean mainland, and in California and New Zealand, I can understand and appreciate how rare this palm is in cultivation and how slowly it grows. The rather narrow and exacting environmental parameters in which it grows, with little daily or even seasonal variance, make it one of the most difficult palms to cultivate. There are few places in the world of palm cultivation that have the same or similar climate as that of Robinson Crusoe Island, and the narrow environmental parameters are difficult to duplicate artificially.

12. Seedling eophylls of *Juania australis* are strap like. Cultivated, Los Canelos, Viña del Mar, Chile.

We hurried back to Santiago to do our final packing, gather our luggage, check out of the hotel, and head to the airport for our return to Los Angeles. Because I dislike hasty departures, we were much relieved and content finally to settle into our seats for the long flight to Los Angeles and fondly remember Chile's two endemic and very different palms.

**Acknowledgments**

Several people and institutions facilitated our travel and visits to see palms in Chile and all have my sincere thanks. These include Veronica Lopez of Hacienda las Palmas de Cocalán; Patricio Novoa of the Jardín Botánico Nacional at Viña del Mar; Mauricio Moreno of the Reserva Ecológica Oasis de la Campana; and Eduardo Sone of Los Canelos, Renaca, Viña del Mar. Ceci Salas of Latin Trip and Michelangelo Trezza, owner of Hotel Pangal, made our trip to Robinson Crusoe Island possible and pleasurable.

# In Search of *Juania australis* with a Few Observations of *Jubaea chilensis* along the Way

DONALD R. HODEL
*University of California
Cooperative Extension
4800 E. Cesar Chavez Ave.
Los Angeles, CA 90022 USA
drhodel@ucdavis.edu*

1. At the Hacienda de las Palmas de Cocalán south of Santiago, Chile, the extensive population of *Jubaea chilensis* inhabits the flat valley bottom and is semi-managed for the bountiful crop of edible seeds called *coquitos*.

**One of the most mysterious, enigmatic and fascinating palms must be *Juania australis*. Its isolated habitat alone, on Robinson Crusoe Island (Juan Fernández) off the coast of Chile, is more than sufficient to conjure up images of a remote, far away, mysterious land, while the name of the island itself and its past role in literary lore add immeasurably to this mystique. I visited Chile in November, 2010 with Marianne Hodel and Steve Daugherty, my former college roommate, to explore for the rare *J. australis* in its isolated, island habitat and to observe the famous and well known *Jubaea chilensis* in the wild.**

After the all-night flight from Los Angeles to Santiago, Chile, we rented an auto and drove to our hotel where we checked in and relaxed for awhile before meeting Steve's friend, Eva Ochoa, for lunch. Over a traditional Chilean seafood extravaganza, we planned our activities for the next two weeks. Our plan was to spend about 10 days in and around Santiago, making day trips to several locales to see the famous Chilean wine palm, *Jubaea chilensis*, in the wild and cultivated around the city. We would then make a four-day trip to Robinson Crusoe Island to see *Juania australis* after which Marianne and I would travel to Easter Island for a few days before returning to Los Angeles.

### *Jubaea chilensis*

Like California, central Chile, including Santiago, has a Mediterranean climate characterized by cool, moist winters and warm, dry summers. November is late spring in Santiago, and typically the weather is mostly pleasant with warm, sunny days and cool nights although we experienced several unusually cool days with clouds and rain. We were amazed at the similarity of the terrain and vegetation around Santiago with that of southern California. The rocky hillsides were variously covered with xerophytic shrubs, small trees, cacti and, at this time of year, seasonal wildflowers, just like our chaparral in California. It was all the more amazing, though, to see some of these hills and valleys covered densely with vast stands of *Jubaea chilensis*.

We visited three areas with *Jubaea chilensis*, including Quebrada Siete Hermanas near the port and tourist destinations of Valparaiso and Vina del Mar west of Santiago, the Hacienda de las Palmas de Cocalán south of Santiago (Fig. 1), and Parque Nacional La Campana north of Santiago. The last two sites have the largest populations of *J. chilensis*, 35,000 and 62,500 adults each, respectively. While this palm is most abundant in valley bottoms, where soil is deep and moisture is more plentiful and available, it frequently inhabits or even thrives on dry, well drained, rocky hilltops and ridges (Fig. 2). I was surprised and had a difficult time understanding how this palm could grow in such a harsh environment. At the Hacienda de las Palmas de Cocalán, where the palms are semi-managed for the bountiful fruits containing the edible seeds, called *coquitos* (small coconuts), we observed several, still-living and healthy-appearing specimens with burned-out trunks, evidence of the occasional fires that ravage the palms and surrounding area. Some were burned so extensively that only a perimeter layer of

2. While *Jubaea chilensis* is most abundant in valley bottoms, where soil is deep and moisture is more plentiful and available, it frequently inhabits or even thrives on dry, well drained, rocky hilltops and ridges, as here at Parque Nacional La Campana north of Santiago, Chile.

sound tissue about 10 cm (4 inches) thick remained and, in some cases, only partially enclose the trunk, easily enabling a person to step inside. These burned-out trunks still supported a healthy, full canopy of leaves.

### *Juania australis* and Robinson Crusoe Island

After spending a few days in Santiago visiting several of the well known tourist sites, many of them with exemplary specimens of *Jubaea chilensis*, we were ready and excited to visit Robinson Crusoe Island (otherwise known as Juan Fernández) in our quest to see *Juania australis*. Unfortunately, our plans unraveled slightly when the day before our departure the travel agent who had made our arrangements for Robinson Crusoe Island (air, lodging and local guide), e-mailed me to say that the regularly scheduled airline on which we were booked had decided not to fly to Robinson Crusoe Island that week! We were stunned because we were locked-in to our departure to Los Angeles and Marianne and I still had our short trip to Easter Island, precluding us from adjusting our schedule. This discouraging news reminded me painfully what others had told me about travel to Robinson Crusoe Island: it is not an easy place to get to, the airline that serves it is unreliable and flights are frequently cancelled or rescheduled with little or no notice.

Fortunately, our savvy and resourceful travel agent quickly, at no additional coast, chartered a small, two-engine aircraft to take us to Robinson Crusoe Island. On the morning of November 9, when Steve, Eva, Marianne and I arrived at one of the charter hangers at the airport, an agent met and told us that one additional passenger would be accompanying us to Robinson Crusoe Island. As it turned out, the additional passenger was none other than Michelangelo Trezza, the owner of the hotel where we would be staying for three nights on the island. At the time of our visit there was only one hotel operating on Robinson Crusoe

3. Cultivated specimens of *Juania australis* in San Juan Bautista on Robinson Crusoe Island typically are better looking than their wild counterparts and have a fairly robust, smooth, lime-green, conspicuously and densely ringed trunk supporting a compact, nearly spherical canopy of 25 to 35, stiffly ascending to spreading to drooping, dark green, pinnate leaves.

4. The congested leaf bases of *Juania australis*, deeply split opposite the petiole, are loosely overlapping, do not form a crownshaft, and, like the petioles, are densely covered with grayish to tan or even rusty brown, felt-like indumentum.

Island because the tsunami spawned by the powerful earthquake that struck Chile in February 2010 devastated San Juan Bautista, the only village on the island. The tsunami killed over 20 people and destroyed nearly half the small village, including all the hotels except one. We were the first tourists to visit Robinson Crusoe Island since the tsunami.

The flight from Santiago to Robinson Crusoe was uneventful but as we neared the island the skies suddenly became cloudy and we would not see the sun again until we returned to Santiago in three days. Once our plane had landed and we had collected our gear, we learned that the pilot would be staying with us for our three nights rather than making another trip back to Santiago and then back to the island again. From the airport we took a short truck ride down to a small bay that was home to several hundred noisy sea lions frolicking in the rough surf or lying contentedly on the mossy rocks. From the small bay we took a rough, wet, two-hour, 18-km (11-mile) ride in a small, open boat to San Juan Bautista. If not for the rain coverings we were given upon boarding the salt spray would have thoroughly soaked us and our gear.

Prior to the tsunami about 500 people lived on Robinson Crusoe Island, nearly all in San Juan Bautista on Cumberland Bay, and they were engaged in fishing, primarily lobster, and a budding eco-tourism industry. Now about 350 people live on the island and, while fishing is still the primary source of income, there is hope that tourism can get back on its feet with reconstruction of hotels and other necessary infrastructure.

Formerly known as Juan Fernández Island or Más a Tierra, the Chilean government renamed the island Robinson Crusoe Island in 1966 to reflect is purported literary past. Many people theorize that Daniel Defoe based his 1719 novel, *Robinson Crusoe*, on the experiences of a Scottish castaway, Alexander Selkirk, who voluntarily asked to be left on the island in 1704 because of doubts of the seaworthiness of the vessel on which he sailed. After four years on the island he was rescued in 1709 and returned to Europe to tell his tale. However, several other real-life incidences may very well have served as Defoe's inspiration.

About 675 km (415 miles) west of Chile, Robinson Crusoe Island is the largest of three that make up the Juan Fernández Islands archipelago (Alexander Selkirk and Santa Clara are the other two islands in the archipelago). The island covers 93 km$^2$ (36 miles$^2$) and rises very precipitously to 916 m (3005 feet) at the

5. *Juania australis* clings tenaciously to a cliff near Mirador de Selkirk above San Juan Bautista on Robinson Crusoe Island.

top of El Yunque, the highest point. The remains of an ancient volcano, Robinson Crusoe Island is extremely mountainous and spectacularly eroded with steep valleys and narrow, razor-like ridges and is reminiscent of some of the picturesque, older islands in Hawaii or the South Pacific.

Like the Chilean mainland, Robinson Crusoe Island has a Mediterranean climate but the cold Humboldt Current sweeping up from Antarctica provides significant modifications. Thus, it has a more moderate climate, not as warm or cold as Valparaiso at roughly similar latitude on the Chilean coast, and with little seasonal variation. However, because of the cold Humboldt Current, the weather is frequently cool, cloudy, misty or drizzly, and windy, and reminded me much of San Francisco on the central California coast. Daytime high and nighttime low temperatures in January, the warmest month, average 22ºC (71ºF) and 16ºC (61ºF), respectively, while in August, the coolest month, they are 15ºC (60ºF) and 10ºC (50ºF). A low -2ºC (29ºF) has been recorded in October. Rain averages 170 mm (7 inches) in July, the wettest month, and 26 mm (1 inch) in February, the driest month. Humidity is always high and the rainiest months of June and July average about 15 days per month of rain or drizzle while the driest months of December and January average about six days per month of rain or drizzle. These records are for San Juan Bautista at sea level but certainly the higher parts of the island, which are frequently hidden in clouds, experience cooler temperatures and higher rainfall and humidity.

Pasture land and disturbed forest with many invasive, weedy exotic species, like *Eucalyptus*, *Cupressus* and *Pinus*, occur from sea level to about 200 meters elevation. Lower montane forest ranges from 200 to 400 meters elevation. Upper montane forest occurs above 400 meters elevation. *Juania australis* is restricted to montane forest and is most common in upper montane forest. Upper montane forests on some of the higher mountains, which are nearly always enveloped in clouds, support an intriguing cloud forest. Robinson Crusoe Island is rich in endemics, with 101 of the 146 native plant species (nearly 70%) found nowhere else. Most of the plants have relatives in South America, New Zealand and Australia. Several members of the sunflower family, whose relatives are typically herbs in other locations, are trees on Robinson Crusoe Island. The entire island was designated a World Biosphere Reserve in 1977 because of its unique and endangered flora and fauna.

As our small boat pulled up to the wharf at San Juan Bautista, the destruction from the tsunami was stunning. The lower half of the village adjacent to Cumberland Bay was gone, as if a giant hand had simply wiped it from the earth's surface. Only a few very large and old trees and house foundations remained. As we waited for the ride to our hotel, I looked up to the steep and narrow ridgelines towering over the village and here and there I was just able to pick out a few specimens of *Juania australis* clinging precariously to nearly vertical cliffs not too far above San Juan Bautista. Seeing the palms above and so near to San Juan Bautista was encouraging but, being an eternal pessimist and somewhat experienced in searching for palms in difficult-to-access places, I checked my optimism because I knew that what seemed like a rather easy walk up to the palms could easily be just the opposite.

After checking into the hotel and eating lunch, we discussed our plans for the next two days with Michelangelo, who would also serve as our guide in our search for *Juania australis*. The next day we would take a walk up a trail behind San Juan Bautista to Mirador de Selkirk, a viewpoint at the top of the ridge overlooking the village and bay near to the *J. australis* I had seen upon our arrival. Our second day's activities would take us on a much longer walk over several ridges to the southeast of San Juan Bautista. We spent the remainder of the afternoon exploring the steep hillsides around the hotel, looking at ferns and admiring the views of the ocean crashing into the base of the precipitous slopes.

Michelangelo was full of confidence the next morning as he, Eva, Steve, Marianne and I set out for Mirador de Selkirk. He was sure we would find our quarry, *Juania australis*. As we walked toward the village we passed through groves of the Australian native *Eucalyptus globulus*, the blue gum, which reminded me much of the central and northern California coasts. Much to our surprise as we passed through San Juan Bautista, we found several cultivated specimens of *J. australis* adorning a few dooryards. Known locally as *chonta*, it is an unusual palm, not likely to be confused with any other. The fairly robust, smooth, lime-green, conspicuously and densely ringed trunk supports a compact, nearly spherical canopy of 25–35, stiffly ascending to spreading to drooping, dark green, pinnate leaves with relatively short petioles (Fig. 3). Leaf scars on the lower part of the trunk, which were produced when the palm was young and growing more vigorously and or perhaps shaded, are frequently uneven and asymmetrical, with one side higher than the other, reminding me of those of *Howea forsteriana*. In contrast, leaf scars near the top of the trunk just below the leaves are severely close set and congested, reminding me of those of *Rhopalostylis baueri* or *R. sapida*. The stiff pinnae are glossy dark green above and grayish below. The congested leaf bases, deeply split opposite the petiole, are loosely overlapping, do not form a crownshaft, and, like the petioles, are densely covered with grayish to tan or even rusty brown, felt-like indumentum (Fig. 4). Simply looking at the leaf bases easily reminds one of its relatives *Ceroxylon*, *Oraniopsis appendiculata* and even *Ravenea*. Unfortunately, none of the plants had flowers or fruits although they looked sufficiently large and old to be mature. Michelangelo was delighted, jauntily declaring that we had attained our objective for the trip. His spirits were not in the least bit dampened when I reminded him that I had come to see these

6. Above Mirador de Selkirk on Robinson Crusoe Island *Juania australis* is exposed and, with its wind-battered, torn and frayed leaves, is not nearly as handsome as its cultivated counterparts in San Juan Bautista.

7 (left). A thrifty, wind-battered staminate plant of *Juania australis* in lower montane forest is exposed above the surrounding vegetation at El Cordon Piedra Agujereada, Robinson Crusoe Island. 8 (right). Old staminate inflorescences of this *Juania australis* at El Cordon Piedra Agujereada on Robinson Crusoe Island are held among the leaves.

palms in the wild, and he assured me that we would soon see them at Mirador de Selkirk.

The trail to Mirador de Selkirk, like all the other trails on the island, was unusually steep but afforded spectacular views of San Juan Bautista and adjacent Cumberland Bay. We zigzagged up the steep slope, passing through moist forests with short trees heavily laden with epiphytic ferns and a dense groundcover of shrubs and other ferns. As we neared the top of the ridge *Juania australis* seemed tantalizing close as they clung tenaciously to the near vertical slopes 25–50 meters above us (Fig. 5). Finally we arrived at the top of the ridge and Mirador de Selkirk where we enjoyed panoramic views of the village and bay on one side and the western end of the island on the other. Unfortunately we realized that we would be unable to access the palms from this site because the razor-sharp ridges leading away to the north and south to the palms were simply too steep to negotiate without being a goat or professional mountain climber, neither of which applied to us. Thus, I had to be content with viewing the palms from a distance and trying to take a few shots with a telephoto lens (Fig 6). Despite the distance it was easy to see that these palms, with their wind-battered, torn and frayed leaves, were not nearly as handsome as their cultivated counterparts we had just admired in San Juan Bautista. These wild palms had a hemi-spherical canopy of many fewer leaves with necrotic, gray- to brown-tipped pinnae. I am sure that my disappointment at not being able to reach the palms was clear because Michelangelo confidently assured me that we would reach them the next day.

Like everyday during our stay on the Robinson Crusoe Island, the next day dawned cloudy, drizzly, cool and windy. Eva and Steve decided to remain at the hotel, but the pilot and one of the hotel's gardeners would join Michelangelo, Marianne and me for our arduous trek to the southeast to see *Juania australis*. We zigzagged up a very steep ridge directly behind the hotel and then crossed two small valleys and ridges before finally arriving, several hours later, on a grassy, windswept plateau and large ridge overlooking a deep

9 (left). Infructescences of *Juania australis* are showy when heavily laden with bright, red-orange fruits. Cultivated, Los Canelos, Viña del Mar, Chile. 10 (right). The showy infructescences of *Juania australis* are mostly held below the leaves and typically retain several, large, thick-papery, tan bracts that persist over the cluster of fruits. Cultivated, Los Canelos, Viña del Mar, Chile.

valley, an area known as El Cordon Piedra Agujereada. Across this valley and higher up we could see extensive lower and upper montane forest with numerous *J. australis* poking their leaves above the canopy. Excitedly down we went into the deep valley and up the other side, passing through lower montane forest and panting heavily from the exertion of the climb before finally gaining access to upper montane forest. This dense, mossy, high-elevation forest was a delightful place, supporting an extensive understory of the cycad-like fern *Blechnum cycadifolium* and several, handsome tree ferns. The moss and leaf litter on the forest floor formed a spongy layer 30–60 cm (1–2 feet) deep and gave us a bouncy sensation as we maneuvered our way through the dense undergrowth. Scattered here and there were several *J. australis* that we could actually touch and look right up the trunk into their wind-battered canopies! However, these palms were difficult to photograph because of the densely encroaching forest and not much better looking than the palms we had seen from a distance the day before. They had the same wind-torn and shredded leaves with gray-and brown-tipped pinnae. Because we could examine these palms closely, though, we could see that some type of insect predator was also severely ravaging the leaves.

*Juania australis* is dioecious, meaning there are separate staminate (male, pollen-bearing) and pistillate (female, seed-bearing) plants. We were fortunate to find one staminate plant with old inflorescences emerging among the leaves but hanging below them in nearby lower montane forest that was sufficiently clear to photograph (Figs. 7 & 8). In upper montane forest we found a pistillate plant with torn, tattered and ravaged leaves that was in young fruit. Unfortunately we found no plants with mature fruit. We also noticed that during the developmental phases from seedling to adult plant the palms display saxophone-type establishment growth and produce a "heel," like other palms including *Chamaedorea radicalis*, *Ravenea xerophila*, *Rhopalostylis* spp. and *Sabal* spp.

We were in a special place, one in which we wanted to linger and were in no hurry to leave. We simply wanted to "soak up" the ambiance

11. The bright orange, spherical fruits of *Juania australis* are about 2 cm (0.8 inch) in diameter. Cultivated, Los Canelos, Viña del Mar, Chile.

of the moment. But the day was getting late and we had a strenuous, four-hour walk to return to the hotel. We were a happy group as we descended and then ascended a seemingly never-ending series of valleys and ridges. However, our happiness was tempered somewhat when Michelangelo twisted his ankle descending into one of the valleys, necessitating a 45-minute hiatus to recover before he was able to continue on. We were relieved finally to stagger into the hotel, take a warm shower, enjoy a lobster dinner, and share our day's adventures with Eva and Steve.

The next day we said our goodbyes to the attentive hotel staff and, after braving the wet, two-hour boat ride back to the west end of the island and the airport, we departed on our charter flight to Santiago. After saying fond farewells to the pilot and Michelangelo in Santiago, we dropped Eva off at her house and Steve, Marianne and I returned to our hotel.

**Easter Island**

The next day Marianne and I departed for Easter Island. While we both wanted to see the famous remnants of the ancient Polynesian civilization that once thrived on the island, I was keen to see the *Jubaea chilensis* that had been transported from the Chilean mainland by boat a few years ago in an attempt to "reforest" Easter Island, which is a sensitive subject in Chile. In 1984 John Dransfield and others published the name *Paschalococos disperta* for an extinct palm that once inhabited Easter Island. The name was based upon some fruit endocarps (shells) found in a cave and that indicated the extinct palm was related to *Jubaea chilensis*. It is thought that the Polynesians deforested Easter Island and in the process drove *P. disperta* to extinction. They may have cut the palms for food or shelter, and or used the trunks as rollers to move the large and heavy *moais* (giant statues) from the quarries to various sites around the island.

A small controversy is raging in Chile about *Paschalococos disperta* and *Jubaea chilensis*. One group believes that these two species are one and the same and, thus, has made an effort to reestablish *J. chilensis* on Easter Island. The other group believes that the two are distinct and, thus, there should be no efforts to reforest Easter Island with *J. chilensis*. At least one initial planting of *J. chilensis* has been made, though, and small, still trunkless plants to 2 meters (6 feet) overall height can be seen at the agriculture department arboretum and the airport. It seems unlikely that the two species are the same, though, because the climate on

Easter Island is mildly tropical and coconuts are widely planted there. *Jubaea chilensis* does not grow well in a tropical climate and rather performs best or thrives in a Mediterranean climate. It will be interesting to track the progress of the few *J. chilensis* on Easter Island and see how well they grow in the years to come. Tour guides would like to have real live palms to show the tourists because of the critical role the palm might have played in the development and demise of the Polynesian culture on Easter Island. All they could show us now were purported palm trunk lava molds on the walls and ceilings of a few caves.

### Cultivated *Juania australis*

After two days enjoying the sites on Easter Island Marianne and I returned to Santiago. Our departure for Los Angeles was late the next evening, meaning we had a full day left in Santiago. We decided to visit the private garden Los Canelos in the scenic and touristy Viña del Mar near Valparaiso on the coast west of Santiago. Eduardo Sone, curator of the garden, showed us several, old, mature, and heavily fruiting specimens of *Juania australis*. Pistillate plants are showy when carrying several infructescences with bright, red-orange fruits (Fig. 9). While emerging within the leaves, the relatively short but showy infructescences are mostly held below them in fruit and typically retain several, large, thick-papery, tan bracts that persist over the cluster of fruits (Fig.10). The spherical fruits are about 2 cm (0.8 inch) in diameter (Fig. 11). Seedling eophylls are strap-like (Fig. 12). Other than these specimens, the only other cultivated *J. australis* I had ever seen were in the Lakeside Palmetum in Oakland, California near San Francisco and in Dick Endt's fabulous garden near Auckland, New Zealand. The plants in California, which are growing steadily but slowly, have yet to form trunk but the one at Dick Endt's garden had a short trunk in 2005. Larger specimens, which I have not seen but are perhaps mature, are at Illeifa, a small island in Lago Ranco, Valdivia in southern Chile.

12. Seedling eophylls of *Juania australis* are strap like. Cultivated, Los Canelos, Viña del Mar, Chile.

After seeing *Juania australis* in the wild and the few cultivated specimens on the Chilean mainland, and in California and New Zealand, I can understand and appreciate how rare this palm is in cultivation and how slowly it grows. The rather narrow and exacting environmental parameters in which it grows, with little daily or even seasonal variance, make it one of the most difficult palms to cultivate. There are few places in the world of palm cultivation that have the same or similar climate as that of Robinson Crusoe Island, and the narrow environmental parameters are difficult to duplicate artificially.

We hurried back to Santiago to do our final packing, gather our luggage, check out of the hotel, and head to the airport for our return to Los Angeles. Because I dislike hasty departures, we were much relieved and content finally to settle into our seats for the long flight to Los Angeles and fondly remember Chile's two endemic and very different palms.

### Acknowledgments

Several people and institutions facilitated our travel and visits to see palms in Chile and all have my sincere thanks. These include Veronica Lopez of Hacienda las Palmas de Cocalán; Patricio Novoa of the Jardín Botánico Nacional at Viña del Mar; Mauricio Moreno of the Reserva Ecológica Oasis de la Campana; and Eduardo Sone of Los Canelos, Renaca, Viña del Mar. Ceci Salas of Latin Trip and Michelangelo Trezza, owner of Hotel Pangal, made our trip to Robinson Crusoe Island possible and pleasurable.

# Detection of Thiabendazole Fungicide in Coconut Palms Using a Bioassay

MONICA L. ELLIOTT
AND
TIMOTHY K. BROSCHAT
*University of Florida – IFAS,*
*Fort Lauderdale Research and Education Center, 3205 College Avenue, Fort Lauderdale, FL 33314 USA*
*E-mail addresses: melliott@ufl.edu and tkbr@ufl.edu*

**A biological assay using the fungus *Penicillium* was developed for detecting thiabendazole fungicide in palm canopies. Thiabendazole was provided to *Cocos nucifera* via passive uptake infusion. Using the bioassay, the fungicide could be consistently detected in the petiole and rachis tissue for up to 90 days after it was applied. While the fungicide could be detected in leaflet tissue, it was not consistently detected at any sampling date. Detection of the fungicide decreased over time, but it did translocate into new leaves that emerged after the application.**

Increasingly, the health and survival of palms in southern U.S. landscapes is being challenged by diseases, both by new pathogens (Elliott et al. 2010) and by geographic or host expansion of established palm pathogens (Harrison et al., 2008, Harrison et al. 2009, Elliott et al. 2011, Singh et al. 2011). Unfortunately, palms that are properly managed to reduce environmental stresses appear to be just as vulnerable to diseases, especially the lethal diseases, as improperly managed palms, which limits the use of cultural methods as a means to manage these diseases and suggests a need for chemical control methods. However, only two lethal diseases of mature, large palms have been successfully managed with systemic pesticides – *Phytophthora* bud rot and lethal yellowing. Interestingly, trunk injection of the pesticides is the most effective application method for managing these two diseases. *Phytophthora* bud rot control in *Cocos nucifera* has been observed in Africa and Asia using trunk injections of the phosphonate compounds fosetyl-Al or phosphorous acid as preventive treatments (Thevenin et al. 1995, Pohe et al. 2003). Two or three trunk injection applications per year appear to be necessary for adequate disease control in Africa (Pohe et al. 2003). Distribution of the phosphonate compounds in palms has not been determined, but it is known that, in general, phosphonate compounds are translocated via xylem and phloem tissue, a unique characteristic for fungicides (Guest & Grant 1991).

In the continental U.S., the only lethal palm disease for which a successful management plan using a pesticide has been developed is lethal yellowing (LY) caused by a phytoplasma (McCoy 1974, McCoy 1976). The pesticide used is the antibiotic oxytetracycline. Various methods of applying the antibiotic to mature coconut palms were tested in the 1970s, and it was determined that only a liquid trunk injection (one injection site per palm) was effective in moving this material into the phloem tissue of the palm canopy (McCoy 1974, McCoy 1976). Soil drenches, foliar sprays and trunk implantation of solid tablets were ineffective. It was also determined that repeat applications (2 to 6.5 ml per palm, depending on size) were necessary every 4 months for disease management because foliar concentrations of the antibiotic slowly declined.

Use of both phosphonates and oxytetracycline in palms is significantly different from their use in dicot trees (Timmer et al. 1982, Darvas et al. 1984, Kostka et al. 1985, Guest et al. 1994). Multiple applications within a year are required for palms (monocots), whereas only one application per year is required for dicot trees. Only one trunk injection site per application is required for palms, but multiple injection sites per application are required for dicot trees. These differences can be explained based on the morphology of the trees. Most palms have a vascular bundle pattern referred to as the "*Rhapis* principle," wherein a bundle may start near the outside of the stem, then curve to the middle of the stem and then curve back to the outside of the stem (Dransfield et al. 2008). At the same time, vascular bundles produce short branches that connect to other vascular bundles (Dransfield et al. 2008). With thousands of vascular bundles in a palm stem, material injected into one side of the palm should be easily distributed to the entire palm.

Large palms (those with more than 1.5 to 2 m of clear trunk) in the landscape present special problems for management of diseases where the pathogen is located in the leaf canopy. Foliar application of pesticides is impractical due to palm height and canopy spread, their location within landscapes (often inaccessible without a bucket truck or lift), and environmental and human health risks caused by spray drift. Therefore, trunk injections would be more convenient and safer. However, in contrast to our knowledge about phosphonates and oxytetracyline efficacy or uptake and movement in palms, there has been minimal research conducted on these same topics for xylem-mobile fungicides that may have applicability for management of fungal palm diseases in the landscape, such as *Fusarium* wilts (*Fusarium oxysporum* ff. spp.) and petiole/rachis blights (numerous pathogens).

The limited studies on uptake and movement of xylem-mobile fungicides in palms have been conducted with benzimidazole fungicides, a xylem-mobile fungicide chemical group (Erwin 1973). One study applied benomyl (Benlate is a former trader name) to a mature *Phoenix canariensis* (~7.5 m tall) via a soil (root) drench (Surico 1977). After 45 days, benomyl was detected in the youngest leaves and the highest level detected in any leaf was 0.178 µg/g. A study in California examined the uptake and distribution of carbendazim phosphate (Lignasan is a former trade name) in mature *Phoenix canariensis* (~4.5 m of trunk) (Feather 1982). The fungicide was injected into the trunks. After 48–56 hours, the fungicide was detected in the trunk and the apical meristem, but not in the leaf tissue. This was in contrast to application of this same material in *Ulmus americana* (American elm), where the fungicide was detected in twigs and leaves. However, the elm samples were obtained at least 20 days after injections (McCain 1980, Stennes & French 1987).

The objectives of the study described herein were two-fold: a) to develop a protocol to examine uptake, distribution and persistence of xylem-mobile fungicides in tall palms; and b) to determine the uptake, distribution and persistence of thiabendazole. This fungicide is currently labeled in the U.S. for management of Dutch elm disease via trunk injections. It belongs to the benzimidazole fungicide group, so the results obtained could be compared to those observed previously with benomyl and carbendazim phosphate.

## Materials and Methods

*Cocos nucifera* with at least 2 m of clear trunk located at the University of Florida's Fort Lauderdale Research and Education Center were used for this experiment. These palms are growing in a uniform Margate fine sand soil and had not been subjected to pesticide treatments prior to this experiment. All palms had at least 16 leaves. Leaves used for sampling were numbered by starting with the newest growth at the time the fungicides were applied. The emerging spear leaf was designated leaf 0, the next oldest leaf as leaf 1 and so on down through the canopy to the oldest leaf. Leaves that emerged after the start of the experiment were labeled with negative numbers (-1, -2, etc.) as the leaves emerged.

Preliminary studies with the thiabendazole fungicide demonstrated a trunk infusion technique was a better method for fungicide uptake by palms when compared to trunk injection under low pressure (172 kPa). Infusion allows for passive uptake of the fungicides into the palm. Therefore, pine tree infusers provided by Rainbow Treecare Scientific Advancements (http://www.treecarescience.com/arborceuticals/equipment/pine-infuser-system) were used. Two holes on opposite sides of the trunk at breast height were drilled 8.5 cm deep using a ~0.2 cm drill bit. The infuser nozzle was tapped into the trunk with a rubber mallet to a 2.5 cm depth, and the capped tube attached to the nozzle was tied upright to the trunk with flagging tape. Each infuser held approximately 40 ml (Figure 1).

The fungicide formulation used was Arbotect 20-S (0.22 kg thiabendazole per liter; Syngenta Crop Protection, Inc., Greensboro, NC). There were four palms per fungicide treatment, and two palms for the untreated (water) control treatment. Each palm received 120 ml of liquid (either undiluted fungicide or water), 60 ml per infuser. For Arbotect-20S, this is equivalent to 26 g of the active ingredient thiabendazole. Since there were no fungicide rates developed for palms, the rate selected was the low therapeutic rate for an elm with 25 cm trunk diameter at breast height (DBH). The mean DBH for the four treated palms was 18 cm. Since each infuser held only 40 ml, the liquid was replenished in the infusers as the liquid was taken up by the palm. Infusers were removed after 24 hours. No signs of leakage were evident.

1. Example of system used for passive infusion of thiabendazole fungicide into the palm trunk.

A bioassay method was used to detect thiabendazole in the leaf tissue sampled. For this study, two fungi were used: *Fusarium oxysporum* f. sp. *palmarum*, a palm pathogen (PLM-249A=NRRL 53543), and a *Penicillium* sp., a non-pathogen (PLM-445). The latter is more sensitive to thiabendazole than the former. Both isolates were obtained from palm tissue in Florida. For each fungus, spore suspensions were prepared in sterile deionized water, diluted to 10,000 spores per ml and added to sterile water agar. A thin layer of this agar-spore suspension was spread on the surface of 1/5 strength potato dextrose agar amended with 300 µg/ml streptomycin sulfate to inhibit bacterial growth. The fungal-seeded medium was used immediately. After leaf tissue or paper discs were placed on the media, plates were incubated at 25°C. Zones of fungal inhibition were measured in two directions and the average recorded. This was done at 24 hrs for *Fusarium* and 40 hrs for *Penicillium*.

Standard inhibition curves were developed using sterile filter paper discs (6-mm diameter) saturated with a range of known concentrations of thiabendazole. After drying, discs were placed on fungal seeded media, incubated and inhibition zones measured. Regression analysis was performed to obtain the equation that best fit the data for the standards at each sampling time. This equation was then used to calculate the amount of thiabendazole detected in the palm tissue.

For sampling leaflet tissue, 4 basal leaflets and 4 distal leaflets (2 from each side of the rachis) were cut from the rachis, washed and blotted thoroughly dry. Leaflet tissue discs (6-mm diameter) were cut out of the leaflets (8 discs per leaflet) from both sides of the mid-rib using a paper hole punch and placed on the fungal-seeded medium.

For sampling petiole and rachis tissue, three 10-cm segments were obtained from each leaf: a) petiole section (P), located half way between the trunk and rachis, b) basal section of the rachis, located about 45 cm from beginning of the rachis (B), and c) distal section of the rachis, located about 45 cm from leaf tip (D). The epidermis of each segment was removed and a cross-section selected and cut into 5-mm by 5-mm pieces of ~2-mm thickness. There were 4 sections from each of the 3 segments placed on each of the fungal seeded media. Note that sampling the petiole and rachis was destructive sampling since the leaf was removed from the canopy. On each sample date, one of the oldest (=lower) leaves, a mid-canopy leaf (=middle), and the youngest, fully expanded leaf (=upper) was sampled from each palm.

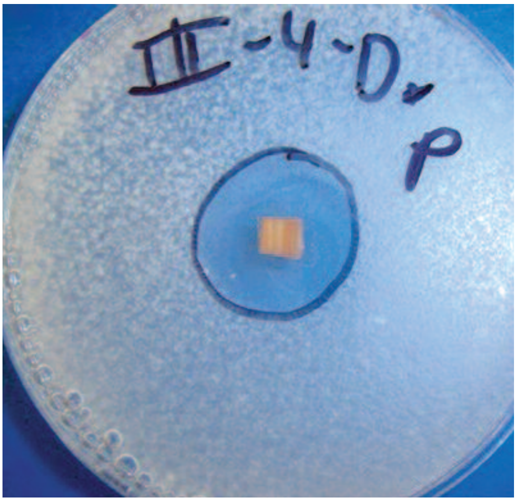
Arbotect 20-S was infused into the palms on 21 September 2009. Ten days later on October 1, only leaflets from leaves 1, 5 and 10 were sampled. Leaflets and petiole tissue of these same leaves were sampled 30 days post-application. At 60 days post-application (November 2: leaves 0, 4 and 9) and 90 days post-application (December 21: leaves -1, 3 and 8), leaflets, petiole and rachis tissues were sampled. On all sampling dates, leaf tissue samples were obtained from the two control (untreated) palms that were equivalent to leaf tissue samples from the fungicide treated palms.

**Results**

For all sampling dates, there was no inhibition of either fungus (*Fusarium* or *Penicillium*) by any leaflet, petiole or rachis tissue from the control palms, indicating there was nothing naturally present in the palm tissue that inhibited these fungi. Thus, any inhibition of these fungi by tissue obtained from treated palms described below is assumed to be due to thiabendazole fungicide. No phytotoxicity was observed on any palm leaf, despite using undiluted material.

The level of thiabendazole detected in each tissue piece on each sampling date was based on the results obtained with the fungicide saturated sterile paper discs for that particular sampling date. As preliminary studies had indicated, thiabendazole inhibition was detected at much lower levels for *Penicillium* than *Fusarium*. *Penicillium* was inhibited at 25 µg/g, but not at 5 µg/g.

Detection of thiabendazole in leaflet tissue was inconsistent among treated palms and among the leaves of each palm (Fig. 2). For example, at 10 days post-fungicide application, thiabendazole was detected in 3 of 4 palms, but not in all leaves assayed for the 3 palms. The greatest amount detected was 58 µg/g. At 30 days post-fungicide application, the fungicide was detected in all 4 palms but not in all leaves assayed from each palm. The greatest amount detected was 88 µg/g. At 60 days post-fungicide application, it was detected in only one leaf of one palm. No thiabendazole was detected in any leaflet tissue of any palm 90 days after fungicide application. Detection of thiabendazole could be determined only with *Penicillium*, since the concentrations were so low.




2. Spore germination and growth of the *Penicillium* fungus is inhibited by the fungicide present in the rachis tissue of the palm leaf, defined by the black circle. The fungicide passively exudes into the medium from the palm tissue.

The original protocol included bioassay of only leaflets and petiole tissue. Thus, at 30 days post-fungicide application, only the leaflets and petiole tissue were sampled and assayed for fungicide. Rachis tissue was not sampled. Thiabendazole was consistently detected in the petiole tissue of all 3 leaves sampled from all treated palms. This was in contrast to fungicide detection results in the leaflet tissue. Therefore, at 60 and 90 days post-fungicide application, rachis tissue from the basal and distal ends of the leaf were also assayed to determine if thiabendazole was being translocated in the leaf, beyond the petiole (leaf base).

The amount of thiabendazole detected in petiole and rachis tissue is shown in Table 1. The only time the fungicide was not detected

**Table 1. Quantity of thiabendazole detected in leaf tissue after coconut palms were infused with Arbotect 20-S on 21 September 2009.**

| | | µg/g thiabendazole[w] | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Location in | 30 days[x] | | | 60 days | | | 90 days | | |
| Tree | Canopy | P[y] | B | D | P | B | D | P | B | D |
| I | Lower[z] | 215 | NS | NS | 106 | 112 | 89 | 53 | 44 | 22 |
| | Middle | 220 | NS | NS | 108 | 56 | 50 | 88 | 86 | 90 |
| | Upper | 217 | NS | NS | 113 | 112 | 44 | 136 | 110 | 0 |
| II | Lower | 208 | NS | NS | 107 | 133 | 73 | 50 | 73 | 10 |
| | Middle | 215 | NS | NS | 61 | 108 | 97 | 64 | 46 | 0 |
| | Upper | 210 | NS | NS | 102 | 101 | 68 | 90 | 92 | 0 |
| III | Lower | 215 | NS | NS | 104 | 92 | 74 | 86 | 94 | 48 |
| | Middle | 180 | NS | NS | 90 | 89 | 94 | 66 | 65 | 36 |
| | Upper | 186 | NS | NS | 72 | 77 | 47 | 127 | 123 | 0 |
| IV | Lower | 186 | NS | NS | 59 | 51 | 48 | 8 | 0 | 0 |
| | Middle | 193 | NS | NS | 23 | 20 | 17 | 32 | 34 | 0 |
| | Upper | 180 | NS | NS | 42 | 46 | 35 | 50 | 40 | 0 |
| Mean ± SD | | | | | | | | | | |
| | Lower | 206±14 | | | 94±23 | 97±35 | 71±17 | 49±32 | 53±41 | 20±20 |
| | Middle | 202±19 | | | 71±37 | 68±39 | 65±39 | 63±23 | 58±23 | 32±43 |
| | Upper | 198±18 | | | 82±32 | 84±29 | 49±14 | 101±39 | 91±36 | 0±0 |

[w]Values are mean of four sub-samples per tissue piece sampled and are based on fresh weight of sample tissue. NS = not sampled. The regression equations used to calculate these values were $y = -0.0003x^2 + 0.2671x + 2.2771$ ($R^2 = 0.983$; $P = 0.0001$); $y = -0.0003x^2 + 0.2377x + 3.0759$ ($R^2 = 0.951$; $P = 0.005$); and $y = -0.0003x^2 + 0.2297x + 2.776$ ($R^2 = 0.963$; $P = 0.003$) for sampling at 30 days, 60 days and 90 days, respectively.

[x]Days after treatment on 21 September 2009.

[y]P = petiole (leaf base); B = basal portion of rachis; D = distal portion of rachis.

[z]Lower = older leaf (leaves 8, 9 and 10); Middle = mid-canopy leaf (leaves 3, 4, and 5); Upper = younger leaf (leaves 1, 0 and -1).

was in the distal portion of the rachis sampled at 90 days post-fungicide application. The greatest amount of thiabendazole detected in the palm canopy was at 30 days after fungicide infusion (October 21). Thereafter, the levels dropped. Of particular note is the detection of thiabendazole in leaf -1 ("upper" leaf on December 21). While the fungicide was not detected in the distal portion of this leaf, it was detected in the petiole and basal portion of this leaf and at levels equivalent to or greater than the older leaves. While *Fusarium* was inhibited in the 30-day post-application assay, thereafter, the amount of thiabendazole was too low for detection with *Fusarium* and could be detected only with the *Penicillium* assay.

**Discussion**

This experiment demonstrated that it is possible for a xylem-mobile fungicide to move passively into the palm canopy (via trunk infusion) and persist for at least 90 days, although at low levels. These low levels justified using the *Penicillium* isolate in the bioassay. Although the thiabendazole levels present in the leaves (leaflets, petiole or rachis) were usually not great enough to inhibit spore germination and growth of one of our target pathogens, *Fusarium oxysporum* f. sp. *palmarum*, it is important to remember this is an in vitro bioassay. Further testing will be necessary to determine the levels of thiabendazole necessary to either prevent disease development or significantly reduce the speed of disease development in living palms.

An important aspect of this study is the fact the fungicide thiabendazole was moving into leaf tissue that was in development at the time of the fungicide application, as it was detected in a leaf that emerged after the fungicide had been applied (leaf -1). The level of thiabendazole in this newly emerged leaf was equivalent to levels in leaves present at the time of the application. Longer term studies would be useful to determine just how many developing leaves are affected by a single application of the fungicide, and whether multiple applications per year are required to maintain inhibitory levels.

A primary hindrance to the application of fungicides such as thiabendazole via the trunk is the amount of material that must be used. The rate selected for this study required the infusion of 120 ml per palm. If applied as specified for dicot trees, the formulated material should have been diluted with water, which was not feasible. In contrast, the amount of the most commonly used formulated oxytetracyline material (Tree-Saver®) being injected into coconut palms for management of lethal yellowing is never more than 6.5 ml per palm. Thus, a single antibiotic dose can be easily injected into a palm. Likewise, with phosphonate injections into coconut palms for bud rot, the amount of formulated material does not exceed 25 ml per palm (Thevenin et al. 1995).

Thiabendazole levels appear to decline over time, which would be similar to oxytetracycline. This indicates there would be a need to treat palms more than once a year with xylem-mobile fungicides. It also appears that it might take time for thiabendazole to move into the canopy. There was more consistent detection of thiabendazole in the leaflet tissue at 30 days (all 4 treated palms) than at 10 days post-application (only 3 of 4 palms). This might explain why another benzimidazole fungicide, carbendazin phosphate, was not detected in palm leaf tissue in a California study in the 1970s (Feather 1982). In that study, researchers trunk injected carbendazim phosphate into a *Phoenix canariensis* (Canary Island date palm) with about ~4.5 m of trunk. After 48–56 hours, palms were felled, and trunk, bud and leaf tissue were bioassayed for the fungicide, which was detected in the trunk and bud tissue but not in the leaf tissue. In our study, a very limited amount of thiabendazole was detected in leaflet tissue and it was detected in leaflets of only a few leaves during the first two sampling dates. This is in stark contrast to the consistent detection of thiabendazole in the petiole and rachis tissue of the same leaf. This may be a methodology issue as there is probably more exposure of vascular tissue in the internal petiole and rachis tissue than in the leaflet disc tissue.

In summary, passive uptake of thiabendazole, a xylem-mobile fungicide, into the palm canopy after trunk infusion was demonstrated based on a bioassay with a *Penicillium* isolate sensitive to this fungicide. The fungicide could be consistently detected in petiole and rachis tissue, but not leaflet tissue, for at least 90 days after fungicide application.

**Acknowledgments**

Funding for this project was provided by a grant from the International Palm Society. We thank Elizabeth Des Jardin and Susan Thor for their support in this research project.

LITERATURE CITED

DARVAS, J.M., J.C. TOERIEN AND D.L. MILNE. 1984. Control of avocado root rot by trunk injection with phosethyl-Al. Plant Disease 68: 691–693.

Dransfield, J., N.W. Uhl, C.B. Asmussen, W.J. Baker, M.M. Harley and C.E. Lewis. 2008. Genera Palmarum: The Evolution and Classification of Palms. Kew Publishing, Royal Botanic Gardens, Kew, Surrey, U.K.

Elliott, M.L., E. Honeycutt, J. West and P. Franklin. 2011. First report of *Fusarium* wilt caused by *Fusarium oxysporum* f. sp. *canariensis* on Canary Island date palm in Texas and South Carolina. Plant Disease 95: 358.

Elliott, M.L., E.A. Des Jardin, K. O'Donnell, D.M. Geiser, N.A. Harrison and T.K. Broschat. 2010. *Fusarium oxysporum* f. sp. *palmarum*, a novel forma specialis, causing a lethal disease of *Syagrus romanzoffiana* and *Washingtonia robusta* in Florida. Plant Disease 94:31–38.

Erwin, D. C. 1973. Systemic fungicides: disease control, translocation, and mode of action. Annual Review of Phytopathology 11: 389–422.

Feather, T.V. 1982. Occurrence, Etiology and Control of Wilt and Dieback of *Phoenix canariensis* in California. Ph.D. Thesis, University of California, Riverside. 119 pp.

Guest, D. and B. Grant. 1991. The complex action of phosphonates as antifungal agents. Biological Reviews 66:139–187.

Guest, D.I., R.D. Anderson, H. J. Foard, D. Phillips, S. Worboys and R.M. Middleton. 1994. Long-term control of Phytophthora diseases of cocoa using trunk-injected phosphonate. Plant Pathology 43: 479–492.

Harrison, N.A., E.E. Helmick and M.L. Elliott. 2008. Lethal yellowing-type diseases of palms associated with phytoplasmas newly identified in Florida, USA. Annals of Applied Biology 153: 85–94.

Harrison, N.A., E.E. Helmick and M.L. Elliott. 2009. First report of a phytoplasma-associated lethal decline of *Sabal palmetto* in Florida, USA. Plant Pathology 58: 792.

Kostka, S.J., T.A. Tattar and J.L. Sherald. 1985. Suppression of bacterial leaf scorch symptoms in American elm through oxytetracyline microinjection. Journal of Arboriculture 11: 54–58.

McCain, A.H. 1980. The influence of site on the distribution of benzimidole fungicides in elm. Journal of Arboriculture 61: 153–155.

McCoy, R.E. 1974. Techniques for treatment of palm trees with antibiotics. Proceedings of the Florida State Horticultural Society 87: 537–540.

McCoy, R.E. 1976. Uptake, translocation, and persistence of oxytetracycline in coconut palm. Phytopathology 66: 1039–1042.

Pohe, J., B.K. Dongo and N. N'Goran. 2003. Effectiveness of aluminum-fosetyl in the control of early nutfall of coconut tree due to *Phytophthora katsurae* (Pythiaceae). Agronomie Africaine 3: 123–133.

Singh, R., A. Castro, D.M. Ferrin, R. S. Harris III and B. Olson. 2011. First report of Fusarium wilt of Canary Island date palm caused by *Fusarium oxysporum* f. sp. *canariensis* in Louisiana. Plant Disease 95: 1192.

Stennes, M.A. and D.W. French. 1987. Distribution and retention of thiabendazole hypophosphite and carbendazim phosphate injected into mature American elms. Phytopathology 77: 707–712.

Surico, G. 1977. Sul possibile uso del benomyl nella lotta contro il "bayoud" (indotto da *Fusarium oxysporum* f. sp. *albedenis*) della palma da dattero. II. Assorbimento e distribuzione del benomyl in piante adulte e resultati di lotta in serra. Phytopathologia Mediterranea 16: 69–74.

Thevenin, J.M., H.F.J. Motulo, S. Kharie and J.L. Renard. 1995. Lutte chimique contre la pourriture du coeur à *Phytophthora* du cocotier en Indonésie. Plantations, Recherche, Développement 2: 41–50.

Timmer, L.W., R.F. Lee and L.G. Albrigo. 1982. Distribution and persistence of trunk-injected oxytetracycline in blight-affected and healthy citrus. Journal of the American Society for Horticultural Science 107: 428–432.

# *Dypsis robusta* Found in the Wild

JOHN DRANSFIELD
*Herbarium, Royal Botanic Gardens, Kew, Richmond, Surry, TW9 3AE, UK*
*j.dransfield@kew.org*

JEFF MARCUS
*Floribunda Palms, P.O. Box 635, Mountain View, Hawai'i, HI96771, USA*
*info@floribundapalms.com*

AND

DAN TURK
*PC(USA) - SAF/FJKM, B.P. 623, Antananarivo 101, Madagascar*
*daniellturk@hotmail.com*

***Dypsis robusta*, a large palm named in 2005 from a specimen grown in Hawai'i but from seed that came from an unknown location in Madagascar, has been found in the wild, just east of Ranomafana National Park.**

In June 1994, people from Masomanga, a village 2 km east of the town of Ranomafana near Ranomafana National Park in eastern Madagascar, found a palm seedling with leaves less than a meter long growing at a site being prepared for a growth trial of native Malagasy trees. As it was the only palm growing at the site, the seedling was protected. As the palm grew, it became apparent that it was probably a species of *Dypsis* but different from *Dypsis mananjarensis*, the only other similar large *Dypsis* known from the area. Dan Turk's efforts to identify the palm using *The Palms of Madagascar* (Dransfield and Beentje 1995) did not yield a match. The flora of the area nearby is quite well known; the Ranomafana National Park has been the center of intensive studies of lemurs and the flora and vegetation, yet no one who has seen the palm knows its local name or knows of other palms like it.

Fast forward to October 12$^{th}$ 2008, when a group of palm enthusiasts lead by John Dransfield came to the site and contemplated the palm that was beginning to flower for the first time. As he looked at it, Jeff Marcus, one of the group, suggested the palm might be *Dypsis robusta* and John Dransfield concurred. They were in a position to know, being two of the three authors who named *Dypsis robusta* Hodel, J. Marcus & J. Dransf. (Hodel et al. 2005) from a palm growing on Jeff Marcus's property on the island of Hawai'i. That tree had grown from seeds that came from an unknown location in Madagascar. The following month Dan Turk collected a proper herbarium specimen from the palm and when it eventually reached Kew, John Dransfield confirmed the identification by comparing the specimen with the type of *Dypsis robusta*.

As the only individual of its species known growing in the wild (Fig. 1), the specimen of *Dypsis robusta* at Masomanga has a legitimate claim to the title "Rarest Tree in the World in the Wild." Fortunately, *Dypsis robusta* is not

1. *Dypsis robusta* and Germain Andrianaivoson at the Ranomafana Arboretum, October 2011.

in immediate danger of extinction because seedlings from Jeff Marcus's tree in Hawai'i have been widely distributed, and seeds from the Masomanga tree also have yielded about 50 seedlings that will be planted at protected locations around Madagascar. We feel sure that at some time in the future it will be found elsewhere in eastern Madagascar in the wild.

In March 2007, the site of the 1994 tree trial was officially opened as the Ranomafana Arboretum, a place for tourists and local people to appreciate Madagascar's amazing native trees. Located on a beautiful 4 ha site overlooking the Namorona river, the Arboretum has over 180 species of native trees including many, like *Dypsis robusta*, that arrived at the site on their own, without human intervention. The Arboretum serves as an *ex situ* protection site for rare Malagasy palms such as *Dypsis scandens*, *Dypsis basilonga* and *Tahina spectabilis*. Since 2009, the Ranomafana Arboretum also has the largest collection of fruit trees at one location in

2. The enormous inflorescence of *Dypsis robusta* at the Ranomafana Arboretum. Germain Andrianaivoson provides scale.

Madagascar (over 170 different varieties), including low-chill varieties of peaches and apples and ultra-tropicals such as mangosteen, pulasan, and breadfruit. The fruit trees are contributing to efforts to improve food security and increase income for farmers in southeastern Madagascar. The Ranomafana Arboretum is owned by the Commune of Ranomafana and managed by a local committee with technical assistance from the Development Department of the FJKM church.

*Dypsis robusta* is a very ornamental palm with one of the largest inflorescences in the genus. In October 2011, *Dypsis robusta* at the Ranomafana Arboretum had a tremendous inflorescence, 2.8 m wide and over 3 m long (Fig. 2).

*Dypsis robusta* is among a group of five Malagasy palms that were first described from specimens cultivated outside Madagascar without knowledge of the species' locations in the wild. Along with *Dypsis robusta*, *D. albofarinosa*, *D. carlsmithii* and *D. leptocheilos* have now been found in the wild (although D. *albofarinosa* has yet to be documented with a herbarium specimen), leaving only the natural habitat of *D. plumosa* yet to be discovered.

### Literature Cited

Dransfield, J. and H. Beentje. 1995. The Palms of Madagascar. Royal Botanic Gardens, Kew and the International Palm Society.

Hodel, D.R., J. Marcus and J. Dransfield. 2005. *Dypsis robusta*, a large new palm from cultivation. Palms 49: 128–130.

# The Critically Endangered *Ceroxylon sasaimae* Rediscovered in the Wild

RODRIGO BERNAL
*Instituto de Ciencias Naturales, Universidad Nacional de Colombia, Apartado 7945, Bogotá, Colombia*
*rgbernalg@unal.edu.co*
AND
HÉCTOR FAVIO MANRIQUE
*Jardín Botánico del Quindío, Calarcá, Quindío, Colombia*
*vivero@jardinbotanicoquindio.org*

**The critically endangered wax palm *Ceroxylon sasaimae* was previously known only from adult palms surviving in agricultural areas on the Eastern Cordillera of Colombia. A wild population has been discovered in a forest fragment on the Central Cordillera, 144 km northwest of its known locality, and across the deep Magdalena river valley.**

The genus *Ceroxylon* is a characteristic element of the Andean mountains and includes the world's tallest palm, *Ceroxylon quindiuense*, growing up to 60 m tall, and the palm thriving at the highest elevation, *Ceroxylon parvifrons*, which occurs at altitudes up to 3500 m in Ecuador (Borchsenius & Moraes 2006).

*Ceroxylon* comprises twelve species (Sanín & Galeano 2011), and is most diverse in Colombia, where seven species occur (Galeano & Bernal 2010). Four of the species occurring in Colombia are considered threatened (Galeano & Bernal 2005, Bernal & Galeano 2006), mostly as a result of habitat loss. Three of these species are categorized as endangered — *Ceroxylon alpinum*, disjunct in Colombia and Venezuela, *C. quindiuense*, disjunct in Colombia and Northern Peru (Galeano et al. 2008) and *C. ventricosum*, ranging from southern Colombia to Ecuador. The fourth species, *Ceroxylon sasaimae* is endemic to Colombia and is considered to be critically endangered.

*Ceroxylon sasaimae* was described in the late 20th Century from palms growing among coffee plantations on the western slopes of the Eastern Cordillera near Bogotá (Galeano 1995), and no more than 100 adult individuals were known in the first years of this Century [the figure mistakenly given as 200 by Galeano and Bernal (2010)], mostly in the municipalities of Sasaima and San Francisco (Galeano & Bernal 2005). Many young plants are now grown on farms near the type locality and elsewhere, as interest in this critically endangered endemic has grown in the country.

The former distribution of this species is unknown. Its original habitat, premontane forest, is one of the most severely altered ecosystems in Colombia, as it is the ideal climate for cultivating coffee, one of the

1. *Ceroxylon sasaimae* (foreground, left) in recently cleared forest near San Luis, Antioquia, Colombia, with *Euterpe precatoria* and *Wettinia kalbreyeri*.

country's major crop plants. Most extant palms near the type locality are probably survivors of former forest rather than cultivated plants. No plants had been recorded in forest habitats.

During recent field work in the Central Cordillera of Colombia, in the Department of Antioquia, we discovered the first recorded wild populations of *Ceroxylon sasaimae* (Figs.

2. Crown of *Ceroxylon sasaimae* near San Luis, Antioquia, Colombia.

1 & 2), ca. 144 km northwest of its currently known distribution, and across the warm Magdalena River valley. The palm grows in premontane forest on the eastern slope of the Cordillera near the town of San Luis, an area that remained off limits to botanists during the last 25 years due to warfare but is now at peace and accessible. We spotted eight

3. Forest and clearing with *Ceroxylon sasaimae* near San Luis, Antioquia, Colombia.

individuals in a forest remnant and in adjacent areas that have been cleared for pasture and growing coffee, at an elevation of 1350–1460 m (Fig. 3). The forest in that remnant reaches up to 1952 m and harbors other palm species common in premontane forests at the northern end of the Central Cordillera, such as *Euterpe precatoria*, *Pholidostachys synanthera*, *Welfia regia* and *Wettinia kalbreyeri* (Fig. 1).

Forest remnants near this locality with the suitable elevation for *C. sasaimae* cover an area of ca. 2800 ha in two separate blocks (Fig. 4). However, we do not know the extent of the area where the palm actually grows within these remnants. The species does not grow in forests at the same elevation farther north or farther west on the same slopes of the Cordillera. It might occur in a big forest remnant ca. 30 km south of San Luis, but that area has not been explored for palms, as it was also inaccessible during the last two decades.

We were not able to estimate the number of adult individuals of *C. sasaimae* at the new locality but judging from palms left in pastures and crowns spotted in the forest canopy, the palm is not abundant. It is certainly far less common than the three other large palms seen in the area, *Euterpe precatoria*, *Welfia regia* and *Wettinia kalbreyeri*.

We have made no attempt to re-categorize the species under IUCN Red List parameters (IUCN 2001), awaiting a detailed exploration of the area and a better understanding of the population's structure. However, the finding of this new population probably will not alter the conservation status of the species as Critically Endangered (CR), considering the small size of the forest remnant where it grows, the low density of the palm and the continuing deforestation in the area, which will probably increase now that peace returned to this zone and people who had fled from the area are returning and expanding the agricultural frontier. There were clear signs of recent deforestation at the place.

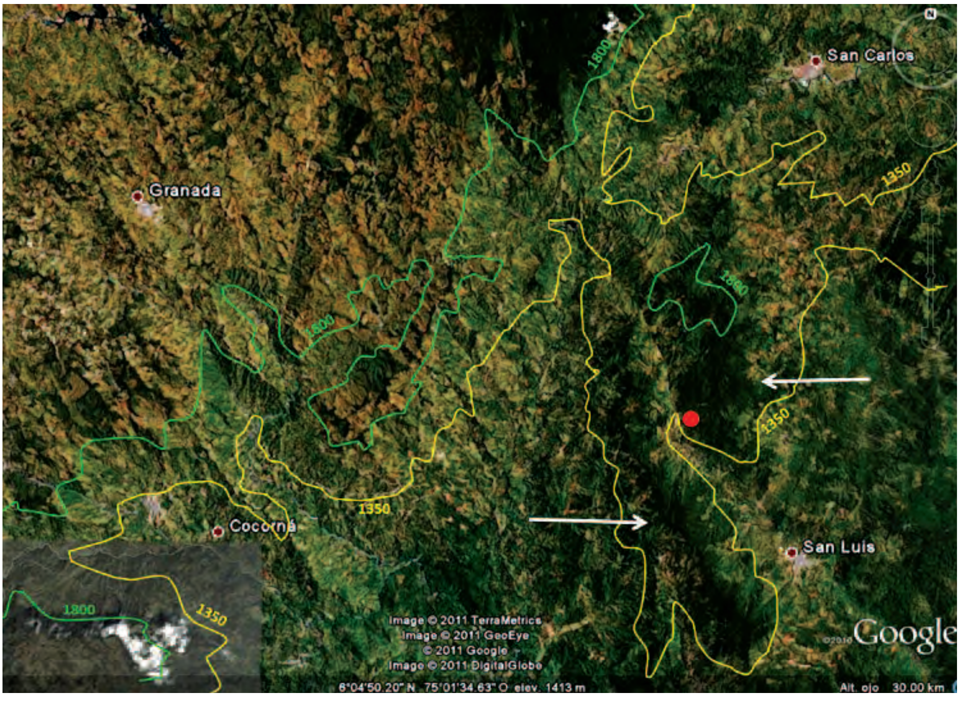
SPECIMEN EXAMINED. COLOMBIA. **Antioquia**. Municipio de San Luis, Vereda Manizales, Finca San Judas, 7 km NW of San Luis, on the left margin of Río Dormilón, 6° 04'50.9''N, 75°01'34.9''W, 1459 m alt., 28 August 2011, *Bernal & Manrique 4766* (COL).

## Acknowledgments

Field work was supported by Instituto de Investigación de Recursos Biológicos Alexander von Humboldt and Jardín Botánico del Quindío. We thank Juan Lázaro Toro for help during field work and for enlightening discussion, and Gloria Galeano and María José Sanín for critically reading the manuscript.

### Literature Cited

Bernal, R. & G. Galeano. 2006. Endangerment of Colombian Palms (Arecaceae): change




4. Google Earth image of the forest fragments where *Ceroxylon sasaimae* grows near San Luis, Antioquia, Colombia. The yellow and green lines mark the contour lines of 1350 and 1800 m, respectively, the altitudinal range where the species is expected to occur. Arrows show the relevant forest fragments within this range. The red dot marks the place where the palm was photographed and collected.

over 18 years. Botanical Journal of the Linnean Society 151: 151–163.

BORCHSENIUS F. & M. MORAES. 2006. Diversidad y usos de palmeras andinas (Arecaceae). Pp. 412–433, *in* MORAES, M., B. ØLLGAARD, F. BOCHSENIUS & H. BALSLEV (eds.). Botánica Económica de Los Andes Centrales. Universidad Mayor de San Andrés, La Paz.

GALEANO, G. 1995. Novedades en el género *Ceroxylon* (Palmae). Caldasia 17: 395–408.

GALEANO, G. & R. BERNAL. 2005. Palmas (familia Arecaceae o Palmae). Pp. 59–223 *in* E. CALDERÓN, G. GALEANO & N. GARCÍA (eds.). Libro Rojo de Plantas de Colombia, Volumen 2. Ministerio de Ambiente, Vivienda y Desarrollo Territorial/ Instituto Alexander von Humboldt/Instituto de Ciencias Naturales, Bogotá.

GALEANO, G. & R. BERNAL. 2010. Palmas de Colombia. Guía de Campo. Editorial Universidad Nacional de Colombia, Bogotá. 688 pp.

GALEANO, G., M.J. SANÍN, K. MEJÍA, J.-C. PINTAUD & B. MILLÁN. 2008. Novelties in the genus *Ceroxylon* (Arecaceae) from Peru, with description of a new species. Revista peruana de biología 15(supl. 1): 65–72.

IUCN. 2001. IUCN Red List categories and criteria: Version 3.1. IUCN, The World Conservation Union, Gland, Switzerland.

SANÍN, M. J. & G. GALEANO. 2011. A revision of the Andean wax palms, *Ceroxylon* (Arecaceae). Phytotaxa 34: 1–64.

# New Shoots from Inflorescences in *Calamus castaneus* in Peninsular Malaysia

NADINE RUPPERT,
ASYRAF MANSOR
AND
SHAHRUL ANUAR MOHD SAH

*School of Biological Sciences,*
*Universiti Sains Malaysia,*
*11800 Penang, Malaysia,*
*ruppert.nadine@googlemail.com*

1. Acaulescent non-climbing rattan *Calamus castaneus*.

**_Calamus castaneus_ (subfamily Calamoideae) is one of the most common rattan species in Peninsular Malaysia yet little is known about its reproductive behavior. Although _C. castaneus_ is known to produce new shoots from its stem, here, we present evidence of the formation of a new shoot from the inflorescence apex.**

*Calamus castaneus* (Calamoideae) is one of several non-climbing rattan species in Peninsular Malaysia. With its acaulescent habit, its chestnut-colored fruits, bright yellow-based spines and broad lush green leaves that are gray on the undersurface, it is easily recognizable and helps shape the undergrowth vegetation of primary lowland forests in the region (Fig. 1).

*Calamus castaneus* usually produces inflorescences up to about 45 cm long that are borne low on the abaxial surface of the leaf sheath immediately above the subtending axil, the origin obscured by other leaf sheaths. Female inflorescences have about 15 rather stiff crowded rachillae covered with dense bracts. Male inflorescences are more highly branched, more lax and sinuous (Dransfield 1979). The

2. Normal male inflorescence of *Calamus castaneus* with closed flowers towards its distal end.

3. Vegetative shoot arising from the apex of a male inflorescence of *Calamus castaneus*.

apex seems to continue growing for a while producing new rachillae towards the end of the inflorescence (Fig. 2). Normally, growth stops and after single flowers undergo anthesis, subsequently the flowers fade and the whole inflorescence becomes dry and drops off.

Here we record a male individual of *C. castaneus* that produces a new vegetative shoot from the apex of the inflorescence. It was found growing in a primary forest site in Segari Melintang Forest Reserve on the west coast of Peninsular Malaysia (4°18–19′N, 100°34–35′E). The whole reserve has a size of 4566 ha and contains mainly primary forest and alluvial fresh water swamp vegetation. It hosts a relatively high number of individuals of *C. castaneus* with an average of approximately 60 per hectare along its western edge (a total of 5 ha is being sampled at the moment). The described male individual was found at a dry lowland site growing next to a small seasonal stream (at 04°19.581′N, 100°34.988′E). Three other male individuals were found in very close proximity (less than 0.5 m from stem to stem) with all of them flowering but none of them bearing similar shoots.

This male flower-bearing individual was found producing a vegetative shoot arising from the apex of its inflorescence (Figs. 3–5). The shoot seemed already mature and well developed

4. Vegetative shoot arising from the apex of a male inflorescence of *Calamus castaneus*.

during the observation period (9 Nov 2011 to 27 Jan 2012), although no roots were present. All the male flowers of this particular inflorescence had faded and no longer produced fresh pollen. Other inflor-escences on the same plant were producing fresh pollen and buds were present.

Other individuals of *C. castaneus* growing in the 1-ha study plot were closely examined in a survey walk after the shoot was discovered but none of them showed a similar phenomenon so far. Two out of 62 samples individuals, however, were bearing axillary shoots growing at the base of the stem of the mother plant (Fig. 6).

A local villager living near the forest and having vast experience in entering the study area reported to us that he already found examples of new shoots developing from inflorescences in C. *castaneus* in former times. Sometimes one plant would produce up to four shoots at a time. Although we have no reason to doubt him, further investigation is required to verify his statement.

With the current results at hand, the specific ecological role of this shoot proliferation is unclear. As more individuals of *C. castaneus* in a 1-ha study plot were examined and none of them showed similar behavior to date, we do not know whether this shoot proliferation represents an alternative to sexual reproduction in the species or if it is a one-off mutant individual. Furthermore, we do not know whether these vegetative shoots have the ability to root and establish new plants once in contact with the ground.

Asexual reproduction is quite common in many seed plant species in general and this reproductive method might be of advantage if the environment has been stable for many generations and genetic variability may play a minor role for species survival.

Many rattan species are clustered, but in these the production of axillary shoots only adds to the size of the individual cluster, not to the establishment of independent plants. In rattans, unusual asexual reproduction has been reported in some species in Borneo, with the development of new axes at the tips of the inflorescences; these eventually root and, with the rotting of the old inflorescence, develop into independent individuals. Examples are *Daemonorops ingens*, *Calamus pygmaeus* and a


5 (left). Vegetative shoot arising from the apex of a male inflorescence of *Calamus castaneus*. 6 (right). Vegetative shoots of *Calamus castaneus* arising from its stem.

form of *Calamus nematospadix* (Dransfield 1992). Asexual reproduction can also occur in a few palm species in the Peninsular Malaysia, e.g. *Salacca flabellata* (Furtado 1949). A more detailed and longer-termed survey of this phenomenon needs to be undertaken to clarify its role in the ecology and reproductive biology *C. castaneus*.

## Acknowledgments

The authors thank John Dransfield for his comments on the manuscript. This study was financed by RU USM-Postgraduate Research Grant (1001/-PBIOLOGI/843098) and Universiti Sains Malaysia Research University Grant (1001/PBIOLOGI/811131).

## Literature Cited

Dransfield, J. 1979. A Manual of the Rattans of the Malay Peninsula. Malayan Forest Records 29. Forest Department, Ministry of Primary Industries, Malaysia.

Dransfield, J. 1992. The Rattans of Sarawak. Royal Botanic Gardens Kew and Sarawak Forest Department.

Furtado, C.X. 1949. Palmae Malesicae X. The Malayan species of *Salacca*. Gardens' Bulletin, Singapore 12: 378–403.

# Nong Nooch and the IPS Biennial 2012

LELAND LAI
*Topanga, CA 90290 USA*

1. Bromeliads and *Cyrtostachys renda* are part of the spectacular gardens at Nong Nooch.

**The 2012 Biennial will take place in Nong Nooch Tropical Garden in September, 2012. The palm collection at Nong Nooch promises to be dazzling (Fig. 1).**

The 600-acre Nong Nooch Tropical Garden that lies some 163 km southeast of Bangkok, is perhaps one of the world's largest privately owned gardens. The land was originally purchased to create a mango and other fruit orchard for Mr. Pisit and Mrs. Nongnooch

2. Nong Nooch's grounds include temples and other landscape features.

Tansacha. The Garden formally opened to the public in 1980, and the orchard was transformed into themed sub-gardens. Nong Nooch has evolved through the years, and under the guidance of Kampon Tansacha, the Garden, dedicated to preservation, research and conservation, has now taken on another primary goal of education for generations to come.

For those IPS members lucky enough to have attended the 1998 Biennial in Thailand, Nong Nooch comprised six gardens displaying the artistry of landscaping, palm collections, floral

3. Biennial participants will want to spend time in the Palm Shadehouse.

4. Stonehenge at Nong Nooch. Photo by Paul Craft.

and theme-based gardens (Figs. 2 & 3). Since then, an aerial walkway over one kilometer long has been established over part of the collection for canopy viewing, and several more venues have been developed including one of the world's most extensive collections of cycads, a lake where one can feed giant catfish and a reproduction of Stonehenge in the English garden (Fig. 4). Transformation has included non-plant related venues (expanded cultural shows, rides and exhibits) that have been added to broaden the interest base for younger children, who often accompany grandparents during day visits while parents work. Education, conference and hotel facilities make the garden a haven for everything botanical.

The 2012 Biennial will be the 28th IPS Biennial since the first one in 1958 (Miami). The 2012 **IPS Biennial starts (Day I) on Tuesday, 11th September 2012**, and will be a seven-day, seven night Thai extravaganza **ending Tuesday, 18th September**. The pre-Biennial tour will go to southern Thailand and will end in Bangkok at the start of the Biennial. The post-Biennial tour to Vietnam is being organized by the New York Botanical Garden's Dr. Andrew Henderson (ahenderson@nybg.org), starting on Tuesday, 18th September (see announcement in the Supplement to Palms 55(4) Dec. 2011).

Information on registration will be posted in the March Supplement to Palms, on the IPS website (www.palms.org) and on PalmTalk shortly (www.palmtalk.org/forum). Space is limited, so register early to take advantage of early registration discount and to reserve your place.

**Day I:** Tuesday 11th September: Arrival at Bangkok (Suvannaphum Airport), hotel check-in and the welcoming dinner will be held in Bangkok. Those of you deciding to arrive earlier can do so over the weekend, leaving you ample time to recover and explore the wonders of Bangkok, its temples, *klongs* (canals), shops and open markets.

**Day II:** Wednesday, 12th September: Visit to a private palm garden within Bangkok followed by viewing *Pinanga sylvestris*, *Licuala*

5. The hotel in Nong Nooch in which Biennial attendees will stay. Photo by Paul Craft.

*poonsakii* and other palm species in their natural habitat to the north in the **Khao Yai National Park**, the oldest and second largest national preserve in Thailand. We will be there during the rainy season (May to October) when on most days there is a high chance of precipitation and high humidity with average temperatures of 27°C (80°F) during the day, dropping to 13°C (55°F) at night; bring appropriate clothes and rain gear. There are abundant waterfalls, as the park is located within three mountain ranges that are home to 3,000 species of plants, 320 species of birds such as red jungle fowl and green peafowl and 67 species of mammals including Asiatic black bear, Asian elephant, gaur, tiger, gibbon, Indian sambar deer, pig-tailed macaque, Indian muntjac, dhole and wild pig. The park encompasses forests and grasslands, ranging from 400 to 1000 m above sea level. Dinner and overnight will be at the Juldis Hotel, Khao Yai.

**Day III:** Thursday, September 13th: In the morning a visit to view wild populations of *Corypha lecomtei*. Lunch will be taken on our arrival at **Nong Nooch Garden 2** in

6. *Copernicia fallaensis*, one of the many rare species in the Nong Nooch collection.

Prachinburi, where we will see plantings in this new garden extension before going on to Nong Nooch Tropical Garden in Pattaya, where the 1998 event was held. IPS Biennial guests will stay in NNTG's own hotel (Fig. 5).

**Day IV:** Friday, 14th September: Tour the wonders of **Nong Nooch Tropical Garden**, starting from the Orchid House, Palm Garden at the Thai House, French Garden, Variety Garden and ending at the Cactus Garden

7. *Carpoxylon macrospermum*, another rare species. Photo by Paul Craft.

8. *Saribus rotundifolia*. Photo by Paul Craft.

before lunch. The afternoon brings us to the Palms of the World (Figs. 6, 7 & 8). Of the estimated 2,400 species of palms existing in the world, NNTG has approximately 1,100 species. The idea that NNTG will become a living repository of palms has credibility, for factors of climate, care and maintenance and its management's enthusiasm for collecting palms have joined to assure this continuing objective. With the further advancement of palm studies worldwide and rapid destruction of forests where palms formerly dwelled, both visitors and scientists have yet another option at NNTG of a primary source of palm species for which they would otherwise not be able to see or to collect specimens.

9. An x-ray of a mature fruit of *Lodoicea maldivica* reveals the four chambers partially filled with endosperm.

Growth of palms has been spectacular, sometimes surprisingly so. For example *Lodoicea maldivica*, often cited as not flowering and fruiting until at least 30 years old, has, in Nong Nooch, started to flower at 18 years old, with seed being produced in year 23. A fruit, still somewhat immature, was x-rayed at a local hospital to examine seed and embryo development (Fig. 9).

The day will conclude at Cart Cross Arboretum for our first series of guest speakers followed by dinner at Nong Nooch.

**Day V:** Saturday 15th September: Free day where attendees will be given a multitude of sports, beach, and tour activities on the coast, or in nearby villages, or just a day to relax and revisit parts of the garden. Members of the IPS Board of Directors will hold the annual meeting.

**Day VI:** Sunday 16th September: Our tour of NNTG continues with the Cycad Collection and Hortus Botanicus plant collection, with afternoon visit to the themed gardens. We end the day with our second series of guest speakers followed by dinner.

**Day VII:** Monday17th September: Morning events with Thai cultural show and the Elephant performances at NNTG. Lunch and afternoon is on your own, but our Farewell Dinner will start at 6:30pm at the Nanta Lawn.

**Day VIII:** Tuesday 18th September: Attendees depart Nong Nooch for Suvannaphum airport (BKK) and the start of the Post Biennial Tour to Vietnam.

Stay tuned to the Supplement, PalmTalk and the IPS website for updated announcements concerning this not-to-be missed event. See you in September!