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Administrative Secretary: Larry Noblick, Montgomery Botanical Center, 11901 Old Cutler Road, Miami, Florida 33156 USA, e-mail lnob@montgomerybotanical.org, tel. 1-305-667-3800 ex 104.

Treasurer: Tom Jackson, P.O. Box 1102, Ross, California 94957 USA, e-mail jacksot@sutterhealth.org, tel. 1-415-923-3299.

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Editors: John Dransfield, Herbarium, Royal Botanic Gardens, Kew, Richmond, Surrey, TW9 3AE United Kingdom, e-mail j.dransfield@kew.org, tel. 44-20-8332-5225.
Scott Zona, Dept. of Biological Sciences (OE 167), Florida International University, 11200 SW 8 Street, Miami, Florida 33199 USA, e-mail zonas@fiu.edu, tel. 1-305-348-1247.

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PALM NEWS

Palmageddon for England's palms? The UK's Animal and Plant Health Agency is investigating the discovery of the dreaded Red Palm Weevil infesting European fan palms (*Chamaerops humilis*) sold in an Essex garden center. The palms were imported from southern Europe, and lax border controls are blamed for allowing the pest into the country. The weevil, if it becomes established, is poised to ravage palms cultivated in the warmer areas of southern England, such as central London, Devon and Cornwall.

A new study published by A. Moore et al. (Environmental Entomology http://dx.doi.org/10.1093/ee/nvw152) validates a **new tactic in the battle against coconut rhinoceros beetles**. The researchers were able to find hidden breeding and aggregation sites by following radio-tagged "Judas" beetles.

A.N. Suresh Kumar

Scott Zona

As part of the Queen's Commonwealth Canopy initiative, **conservationist planted 400 young palms** in Morne Seychellois National Park on Mahé, the largest island of Seychelles. Two endemic palm species – *Phoenicophorium borsigianum* (left), locally known as *lantannyen fey*, and *Nephrosperma van-houtteanum*, known as *lantannyen milpat* – were planted on the site. In addition to adding to the forest canopy on the island, it is hoped that the palms will support native wildlife, including birds and insects that use the palms for food and shelter.

We are deeply saddened to learn of the **passing of Dr. Natalie Uhl**. Natalie was a long-time editor of this publication and a co-author of both editions of *Genera Palmarum*. She made important advances in the study of palm anatomy while a researcher at the L.H. Bailey Hortorium, Cornell University. She is commemorated in the name *Aphandra natalia*. A more extensive obituary will appear later this year in this journal.

Exploring Robinson Crusoe or In Search of *Juania australis*

Gregg Hamann
1000 Pioneer Way
El Cajon, California 92020
USA
gregg@hamannco.com

1. The extraordinary plant life of the Juan Fernández Islands evolved in isolation from the mainland.

There is hardly a place else on earth as far off the beaten track as Robinson Crusoe Island, just a speck of land 500 miles (804 km) west of Santiago, Chile, in the Southern Pacific Ocean (Fig. 1). Robinson Crusoe is really just one of the three main islands that make up the Juan Fernández Archipelago, an island group named after the Spanish captain who first discovered these islands nearly 500 years ago.

In the early 1500s, it took many months for a ship to make its way from Lima, Peru, to Valparaiso, Chile, because the voyage was both upwind and up current, but in 1574, Juan Fernandez tried sailing west – five hundred miles west from Lima, beyond the Humboldt Current – then south toward Valparaiso. He made the entire trip in just a few weeks, and discovered the Juan Fernandez Islands along the way. For his efforts he was accused of witchcraft for having done something that everyone knew was impossible.

For centuries, the two main islands in the archipelago were known as Más a Tierra (closer to land) and Más Afuerra (farther out) based upon their proximity to the South American mainland, but then in 1966, in an attempt to encourage tourism, the Chilean government renamed the two main islands Alexander Selkirk Island and Robinson Crusoe Island – both after the somewhat sociopathic Englishman, who was marooned on Más a Tierra for four years and four months in 1704.

In a strange twist, Alexander Selkirk never set foot upon his namesake Alexander Selkirk Island, but his life story did inspire Daniel Defoe to write his famous novel, *Robinson Crusoe*, and so Robinson Crusoe Island joins a short list of geographic locations around the world whose names were inspired by fiction (California is another).

The process of getting to Robinson Crusoe is an unprecedented challenge. Despite repeated requests, our airline (ATA) refused to give us an actual departure time in advance, so we planned to arrive in Santiago a day early and stay in the airport hotel. We were rewarded for this foresight, when we checked into our hotel and got a message at the front desk (in Spanish) that said, "Meet us tomorrow morning at 9:00 a.m. at Door #4."

It seemed straightforward enough until the next morning when we walked across the street to the airport and realized that there were at least two doors numbered four, as well as a counter number 4 and a gate number four – and that there was no one at all from ATA at any of them. The prominently located information desk was no help. A desperate online search revealed a rudimentary website, but no one answered the listed phone number. A last ditch call to the "emergency" number in small print got us closer to our goal, but it was a full hour, a lot of walking and several more phone calls before we finally managed to find not a gate or a door but an ATA van. We were driven to the other side of the international runway and loaded on to our airplane, which even with only eight seats was not actually full. Tourism to Robinson Crusoe has a long way to go.

2. The view to San Juan Bautista.

3. The female Juan Fernández Firecrown hummingbird shown here is much more colorful than the chestnut-brown males.

The two-and-half hour flight was only the beginning: once landed on the far western, dry side of the island, all passengers are loaded onto an open boat (included in the airfare) for the one-hour boat ride to Cumberland Bay and the only town on the island, San Juan Bautista (Fig. 2).

We checked into our hotel and headed up the hill that afternoon for a hike to Plazoleta, a botanical park about a mile (1.6 km) outside of town. More than 60% of the plants in Robinson Crusoe are found nowhere else in the world, but the island is under assault by invasive species, especially blackberry, eucalyptus and pine. At Plazoleta, great pains have been taken to remove all alien plants and to allow the Robinson Crusoe endemics to run free. The result is stunning. Prominent among the plants in the glade was the endemic *Gunnera peltata* with huge leaves like umbrellas and stalks of tiny flowers a yard long (1 m). Plazoleta is also one of the best places on the island to see the rare, endemic and exceedingly sexually dimorphic Juan Fernández firecrown hummingbird (*Sephanoides fernandensis*) (Fig. 3).

But of course, the main reason for any International Palm Society member to visit Robinson Crusoe is to see the chonta palm, *Juania australis,* one of the southernmost palm trees in the world in habitat. Several chontas have been planted in Plazoleta; however, *Juania australis* is an extremely slow growing palm even in the heart of its native habitat, and so it will be many years before fully mature palms will be seen in Plazoleta.

Our first real look at the palm was instead… in town, where a number of islanders over the years have planted *Juania australis* in their front yards and to glorious effect (Fig. 4). This is a singularly beautiful palm with prominently ringed, sea-green trunks and large heads of golden-green, pinnate leaves. Placed as they were beside brightly colored houses and surrounded by flowers and greenery, they made for truly stunning landscapes.

In truth, chontas are virtually missing from the lowland habitat around San Juan Bautista, having been squeezed out by alien species and, even more significantly, harvested for lumber. Chonta wood was long prized by craftsmen for its deep black color and hardness. Harvesting is now illegal and there are a number of small plants planted in Plazoleta and elsewhere near town, a fact that bodes well for the future. A small park by the seaside

4. *Juania australis* can be found gracing gardens in town.

5 (top). *Juania australis* grows on steep slopes and ridge tops. 6 (bottom). Spectacular specimens of chonta palm are all but inaccessible.

is prominently planted with unusual endemics including several chontas. The National Park Service has been germinating seeds and growing on dozens of plants at their research station, and residents are offered free plants. Sadly, many have still chosen to plant alien species, such as *Washingtonia robusta*, because they grow faster. I did my best to dissuade them, comparing *Washingtonia robusta* to blackberries.

7. The magnificent endemic fern, *Blechnum cycadifolium*, looks like a small, stocky cycad growing in primeval cloud forest.

8. A fine specimen of *Juania australis*.

To truly see mature chontas in habitat, one must climb up to the top of the mountain at El Mirador, the place where Alexander Selkirk is reputed to have spent many hours watching for approaching ships. It is also the lowest pass between the north and south sides of the island. It is a climb of 3000 feet (1000 meters) almost straight up, on a path studded with several thousand over-sized and irregular stairs. Although there are a few chontas on the North side of the island, they are all a long way from the path and growing in impenetrable bush on near vertical slopes. Only at the Mirador do groves of *Juania australis* become visible on the ridge tops (Fig. 5) and especially down the trail on the south side of the island (Fig. 6). I spent several hours trying to crawl over or climb through dense underbrush and follow virtually invisible paths in order to get close to the palms but without success. They were all impossibly remote. I could not help but think that perhaps all of the "easy" palms had been harvested for lumber.

I was ready to give up when unexpectedly the clouds parted, the sun shone down the mountain and I realized that there were several palms growing right next to the path about 1000 ft (300 m) down the other side of the hill. I headed down for a closer look, but what a hike!

The south side of the hill gets more rain than the north because of prevailing winds, and being farther from the settlement, it has been less affected by alien species. The forest feels ancient and primal, with unique species of plants at every turn. One endemic fern, *Blechnum cycadifolium,* could stand in for a rare *Cycas* or *Encephalartos* in the wild (Fig. 7). There are also several endemic tree ferns associated with specific elevations and huge swathes of smaller ferns growing as groundcover under the ancient trees. The forest drips with life. Even the firecrown hummingbird made appearances, regularly buzzing the pathway.

About a mile from the Mirador, I was rewarded with several large and beautiful mature *Juania* right next to the path (Fig. 8). It was all worth the long hike back up and then down to San Juan Bautista and home. We found out too late that it is actually possible to walk the 5 hours or so from the airport to town, a trip that I would highly recommend to any future visitor. It would be a great way to visit every ecosystem on the island and get a real sense for the island as it once was.

Juania australis will probably never be generally cultivated in palm gardens around the world. Although beautiful and charismatic, it is glacially slow and notoriously difficult to grow. Perhaps, the greatest challenge is climate. On most days, the swing between high and low temperatures on Robinson Crusoe is around 4°F (2°C). The week we were there in high summer (February), the high was 68°F (20°C) and the low was 64°F (18°C). In winter, the temperature range is virtually the same, but about 10°F (6°C) cooler. The ridgeline, where most of the palms live, is effectively cloud forest, with mist for several hours on most days. These conditions are almost impossible to duplicate anywhere else where palms grow. The best specimens in North America are reputed to be found in San Francisco.

This means that, at least for the foreseeable future, the only place to see real stands of *Juania australis* in health and quantity is in habitat on Robinson Crusoe Island! Happy travels.

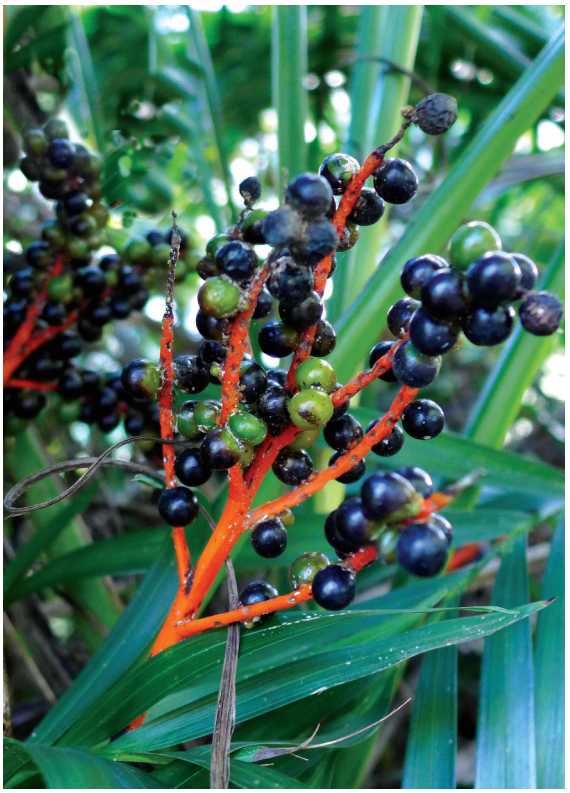
Photo Feature

Dypsis ovobontsira is a rare tree palm known with certainty only from Antanambe in Mananara Nord National Park, Madagascar. It was described and named for the first time in *Palms of Madagascar* but unfortunately without a photograph. From time to time since then various palms have been identified as this species on PalmTalk, although almost certainly incorrectly so. Here is a photograph of the real thing. The species grows in rather shrubby dense and closed canopy lowland humid forest, on a slope at an elevation of around 330 m above sea level. It can be recognized by its interfoliar inflorescence (branched to 3 orders), the leaf sheath densely covered with brown scales, the petiole and the abaxial surface of the leaf rachis covered by white scales, and the regular leaflets. This picture was taken as part of the MADCLADES project undertaken by the Royal Botanic Gardens, Kew for a phylogenetic analysis of palm diversity in Madagascar.

Mijoro Rakotoarinivo
University of Antananarivo

Seed Dispersal of *Chamaedorea cataractarum*

Scott Zona
Dept. of Biological Sciences & International Center for Tropical Botany
Florida International University
11200 SW 8 St.
Miami, Florida 33199, USA
zonas@fiu.edu



1. The fruits of *Chamaedorea cataractarum* are black when ripe and borne on bright orange rachillae.

The endocarps of *Chamaedorea cataractarum*, a rheophytic palm, have adherent fibers, which separate from the endocarp and display hooked tips after the endocarps have been submerged in water. Laboratory experiments suggest that the hooked fibers increase drag on the endocarp while in the water column and then anchor the endocarp to a substrate prior to germination and seedling establishment. *Chamaedorea cataractarum* has the characteristics of a two-phase dispersal system: first dispersal by frugivorous birds (endozoochory) followed by dispersal by water (hydrochory).

Rheophytes are plants that are adapted to growing in the beds and along the banks of fast-flowing rivers and streams and have evolved in many plant families (van Steenis 1981). *Chamaedorea cataractarum* Mart. is a well-known rheophyte of southern Mexico that, despite its native habitat, is amenable to cultivation. The species epithet of *Chamaedorea cataractarum* means "of the rapids (or cataracts)." The morphology of *Chamaedorea cataractarum* has attracted some attention, especially as it relates to its rheophytic growth habit. It has flexible leaves and narrow leaflets that bend but do not easily break (Hodel 1992). It also exhibits dichotomous branching (Fisher 1974), which results in a proliferation of stems and adventitious roots that anchor the plant and stabilize the stream banks on which it grows. Although a common palm in cultivation, little is known of its ecology, especially the dispersal of its seeds.

Like all species of the genus, *C. cataractarum* is dioecious, with female plants bearing interfoliar inflorescences, which turn orange when bearing ripe, black fruits (Fig. 1). The contrast of the shiny, black fruits against the orange infructescences is a well-known lure for fruit-eating birds (Willson et al. 1990). Frugivorous birds are believed to play a role in the dispersal of the seeds, although field data are lacking. When cleaned of their fleshy pericarp, the endocarps are smooth (Fig. 2), but after soaking in water for ca. 30–42 hours, adherent fibers separate from the endocarp. The tips of the fibers are clearly hooked (Fig 2).

The possible roles of the hooked fibers in seed dispersal are investigated here, under laboratory conditions. I hypothesized that the fibers have two functions: increasing drag in the water column and adhering the endocarps to substrate.

Materials and methods

Fresh fruits of *Chamaedorea cataractarum* were collected from plants cultivated in South Miami, Florida, USA. The fruits were rubbed with a paper towel to remove the fleshy portion of the pericarp, leaving the smooth endocarp and adhering fibers. Endocarps (n=20) were measured with calipers to determine length and diameter; fibers (n=20) from soaked endocarps were also measured. Twenty endocarps were immediately subjected to experimental treatments, while another 20 were soaked in water for 48 hours prior to experimentation. Ten endocarps were air-dried at room temperature for 96 hours.

The endocarps sink in water. In a test of their settling rate, the 20 soaked and 20 freshly cleaned endocarps were dropped, one at a time, into a glass, 250-ml graduated cylinder with water column 25 cm deep. The descent of each endocarp was timed with a stopwatch.

In a test of the adherent function of the fibers, a rigid plastic tray 38 × 27 cm was covered with fiberglass patio screening (5 threads per cm). The tray was held at an angle of ca. 45°, and a volume of water (ca. 200 ml) containing a single endocarp was rapidly sluiced onto the top edge of the screen-covered tray and allowed to flow to the bottom. The screen-covered tray was not meant to mimic a smooth, rocky or sandy stream-bottom, but rather the river banks supporting tangled, semi-aquatic vegetation, masses of roots and stranded debris.

Results

The endocarps were 7.7 ± 0.4 mm long and 6.2 ± 0.4 mm in diameter. Endocarps did not deploy their fibers until submerged for ca. 30–42 hours in water, and endocarps not submerged (i.e., air-dried) never deployed their fibers, even after 96 hours. Individual fibers are up to 10 mm long. They branch and anastomose from the raphe, wrapping around or clasping the endocarp so that the apices of the fibers are positioned at the base (stem-end) of the endocarp. Upon soaking, the fibers straighten and reflex, and the hooked ends of the fibers separate from the endocarp (Fig. 2). The hooked fibers remain deployed even if the endocarp is then allowed to dry.

The mean settling rate of freshly cleaned endocarps was 1.50 ± 0.18 seconds per 25 cm, and that of soaked endocarps was 2.04 ± 0.31. Freshly cleaned endocarps sink significantly faster than soaked endocarps (p=0.00, unpaired *t*-test). In 20 sluice trials using soaked endocarps, the fibers attached to the screen every time, and in every one of the 20 trials with freshly cleaned endocarps, they rolled to the bottom of the tray, never catching on the screen. The results are highly significant (p=0.00, Fisher exact probability test).

Discussion

The hooked endocarp fibers of *Chamaedorea cataractarum* are described and illustrated. They may have been overlooked in herbarium studies, because they are not deployed until the endocarp has been soaked in water for ca. 30–42 hours. The horticultural literature has been mute on the subject, again because

2. Endocarps of *Chamaedorea cataractarum* are smooth when cleaned of their fleshy pericarp (three lower endocarps) but display hooked fibers after soaking in water (four upper endocarps). Numbered ruler divisions are centimeters.

soaking endocarps for such an extended period of time may not be common horticultural practice. The endocarps of another commonly cultivated *Chamaedorea*, the non-rheophytic *C. seifrizii,* do not display hooked fibers, even after 48 hours of soaking (data not shown).

Chamaedorea cataractarum has the characteristics of a two-step or biphasic seed dispersal strategy. In the first step, primary or phase one dispersal (Chambers & MacMahon 1994), fruits are consumed by birds. The black, shiny fruits contrast with the bright orange rachillae in a display that is characteristic of bird-dispersed fruits (Willson et al. 1990). Birds digest the fleshy pericarps and reject the indigestible endocarp. If the endocarp falls on dry land or other unsuitable site, it will likely perish, but if the endocarp falls in a stream, it will sink or be carried along the bottom of the stream by the current. This is secondary or phase two dispersal. After ca. 30–42 hours, the hooked fibers deploy. Once deployed, the hooks increase the drag for each endocarp and slow its descent in the water column, thereby allowing the current to carry the endocarp in a continuation of phase two dispersal. The hooked fibers catch and hold the endocarp to rough features along the banks of the stream, where the seed can germinate and the plant can establish. Primary dispersal may account for seeds being moved upriver or from one river system to another; while, secondary dispersal accounts for seed movement downstream.

Pinanga rivularis, a rheophytic palm of Borneo, was shown by Dransfield (1992) to have hooked fibers, similar to those of *Chamaedorea cataractarum*. The two palms differ, however, in dispersal strategy. *Pinanga rivularis* has fruits that are dull green at maturity and lack a fleshy mesocarp and are thus presumably unattractive to fruit-eating birds (Dransfield 1992). While it is possible that the hooks function like burs, attaching the endocarps to the fur or feathers of passing animals, Dransfield (1992) noted that the fruits were held tightly to the rachillae and concluded that dispersal was monophasic, by hydrochory not preceded by endozoochory.

The two-phase dispersal strategy – endozoochory followed by hydrochory – is not unique to *Chamaedorea cataractarum*. Endocarp fibers were observed and illustrated by Galeano-Garcés and Skov (1989) for the rheophyte *Geonoma cuneata* subsp. *linearis* (as *G. linearis*). The fruits are shiny black at maturity and likely animal dispersed. The endocarp fibers deploy in water; however, they are not hooked. They may increase drag in the water column, but they have no special characteristic for anchoring the endocarp to a suitable substrate. Similarly, *Dypsis crinita*, which is a rheophyte while in the seedling and juvenile stages (Dransfield & Beentje 1995), has animal-dispersed fruits and endocarp fibers without hooks (Dransfield 1992).

Hooked fibers occur on the endocarps *Euterpe oleracea*, a hydrophilic palm of river margins and floodplain forests of the Amazon Basin with a two-phase dispersal strategy (Moegenburg 2003). Its fleshy fruits are attractive to birds and other animals, which consume the fleshy portion of the pericarp. Moegenburg (2003) used field trials and mark/recapture experiments to show the endocarps with hooks were dispersed a shorter distance than endocarps with hooked fibers removed. She showed that the hooks aided in lodging the

endocarps along the stream banks where the seeds can geminate. Moegenburg (2003) also pointed out that the fibers may fulfill other roles, such as retaining moisture critical to seed germination. Although the experiments reported here were all conducted under laboratory conditions, I expect that, under natural conditions, the hooked endocarps of *Chamaedorea cataractarum* would behave in a way similar to those of *Euterpe oleracea*.

Other rheophytic palms, such as *Phoenix roebelenii*, *Hydriastele rheophytica* and *Areca rheophytica*, appear not to possess any special dispersal characteristics in their fruits or seeds. These palms have fleshy, colorful fruits that are attractive to animals, and dispersal is likely by endozoochory, although fruits that fall directly in water may also be dispersed by hydrochory. While hooked endocarp fibers are not essential to the rheophytic lifestyle, in those palms that have them, they both promote dispersal (by increasing drag and allowing the current to carry the endocarp farther) and retard dispersal (by fixing the endocarp to substrate).

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Tahina spectabilis: an Exciting New Discovery in Madagascar Ten Years On

LAUREN M. GARDINER*
Conservation Science, Royal Botanic Gardens, Kew, Richmond, Surrey, TW9 3AE, UK

DAVID RABEHEVITRA
Kew Madagascar, Lot II J 131 B Ambodivoanjo, Ivandry, Antananarivo 101, Madagascar

ROKIMAN LETSARA
Parc Botanique et Zoologique de Tsimbazaza, Antananarivo / California Academy of Sciences Madagascar

ALISON SHAPCOTT
University of the Sunshine Coast, Maroochydore DC 4558, Queensland, Australia

**Author for correspondence, l.gardiner@kew.org*

A decade after the extraordinary hapaxanthic Coryphoid palm was discovered on a remote peninsula in northwest Madagascar, a team from Kew revisited the site to see how successful conservation activities have been and were able to confirm a stunning discovery back on the mainland.

"Picnicking family stumbles on a suicidal monster palm tree," read the headline in The Times Online newspaper in January 2008. Thus, the attention of the world was focused on the remote location in Madagascar where *Tahina spectabilis* was discovered just a decade ago by Xavier Metz, the manager of the VERAMA cashew plantation on the Ampasindava Kely peninsula, whilst out walking with his family. Members of the palm community had a sneak preview in late 2006, when the first images of the unidentified spectacular fan palm up to 18 m tall, with leaves 5 m across and an enormous terminal inflorescence, were posted by Bruno Leroy on Palmtalk (the online forum of the International Palm Society). Kew's John Dransfield was intrigued by the photographs, which seemed to show either a member of the genus *Corypha* far, far away from any of its Asiatic relatives, or a taxon completely new to science. In January 2007, John's PhD student, Mijoro (Joro) Rakotoarinivo, managed to reach the site and, with Xavier Metz, collect herbarium material, a DNA sample for analysis, and more images. He sent them back to Kew, where he and John were able to confirm that the discovery represented an entirely new monotypic genus, *Tahina*, which was formally published in January 2008 with much

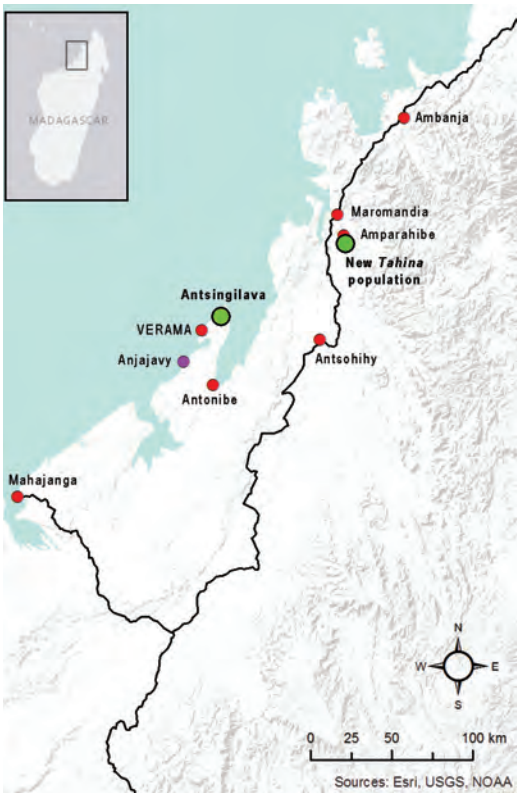
accompanying international media interest (Dransfield et al. 2008a, 2008b). John and Joro visited the site in September 2007, just missing anthesis of an individual, made further important herbarium collections and discussed with the Metz family conservation actions that would be appropriate.

With its combination of a basally cleft petiole and unarmed petiole margins, costa-palmate leaf with leaf splits reaching to different depths, a hierarchy of primary and secondary folds held at different levels relative to the costa, overlapping tubular rachillae bracts, solitary trunk, and enormous hapaxanthic terminal inflorescence, *Tahina spectabilis* was like no other palm. During the last ten years, no other populations of the species (or anything similar) have been found anywhere else.

Tahina spectabilis seed distribution around the world

The site where the *Tahina* was originally found is a fragment of vegetation in and around a limestone karst (*tsingy*) formation called Antsingilava (Fig. 1), surrounded by grassland and rice paddy fields, with a nearby village called Antanamarina. In September 2008, Alison Shapcott from the University of the Sunshine Coast, Australia visited the site hosted by Xavier Metz and undertook a full demographic survey of the species, collecting DNA samples in order to study the population genetics and diversity of the plants. The 2008 census showed that the known *Tahina* population was extremely small – just 29 trunked individuals were recorded, including two individuals slightly away from the main *tsingy* site. Microsatellite work undertaken by Alison and one of her students, Heather James, subsequently showed that the genetic diversity of the individuals at the site is extremely low (James 2010). There were signs that other populations of *Tahina* may exist: some rare genetic alleles were found in the population, and one of the outlier plants contained alleles not present in the main population. With such a small population size and tangible threats to its continued survival, Joro was able to assess the species using the IUCN Red List categories and criteria as Critically Endangered (Rakotoarinivo et al. 2012, 2014).

Controlled harvesting of a proportion of the many tens of thousands of seeds produced during flowering events in 2007 and 2008 was undertaken by local people under the guidance



1. Map of NW Madagascar showing sites where Tahina is found (Antsingilava and Amparahibe).

of Xavier and advice from John. Through a collaboration between the Kew's Millennium Seedbank, the Madagascan national seedbank (Silo National des Graines Forestières), the VERAMA Corporation and Tobias Spanner of RarePalmSeeds.com, *Tahina* seeds were distributed widely around the world to botanic gardens and private collectors. Today the species is certainly protected in *ex situ* conservation – although it should be noted that these plants all came from a very small genetic base. Funds from the seed sales went back to the community at Antanamarina to pay for a range of community-based conservation activities to protect *Tahina* in the future (including the creation and maintenance of a large firebreak around the site) and some much needed community development activities (including the renovation of the village school).

Journey to Antsingilava, ten years later

In September 2016, with the support of the Mohamed bin Zayed Species Conservation Fund, an international team set off overland from Kew's Madagascar base in the capital,

2. Adult *Tahina spectabilis* in the wild at Antsingilava, Madagascar (Photo by David Rabehevitra, KMCC).

Antananarivo, to attempt to reach Antsingilava a decade after the original discovery of the species. The team comprised Alison Shapcott (returning for the first time since her 2008 trip), Lauren Gardiner from the Conservation Science department of RBG Kew, UK, Rokiman Letsara from Parc Botanique et Zoologique de Tsimbazaza (PBZT) and the California Academy of Sciences Madagascar, and David Rabehevitra and Roger Rajaonarison from Kew Madagascar (KMCC). With one of Kew Madagascar's newly acquired Landrover Defenders, the expert driving of Roger, and a period of dry weather preventing the zebu tracks and rivers becoming impassable, the team reached VERAMA's base camp on the peninsula of Ampasindava Kely after two solid days of traveling, one day of which was entirely off-road. En route, the group traveled across rocky tidal zones, beaches and mangroves, dry (and some not so

3. Crowns of *Tahina spectabilis* in the setting sun at Antsingilava, Madagascar (Photo by Lauren Gardiner, RBG Kew).

dry) riverbeds, and swathes of recently burned land, with the ground sometimes still radiating heat from the fires that had swept through and the blackened vegetation still smoldering.

Resurveying Antsingilava

The first glimpse of *Tahina* in the wild was an unforgettable experience (Fig. 2). The route from the VERAMA plantation base to Antsingilava leads through the village of Antanamarina and along a six-meter wide strip of bare earth cutting through the grassland. A group of half a dozen young women with scythes and hoes were clearing the plants from this strip, which turned out to be the firebreak the local community had created around the *Tahina* site and were maintaining each year to protect the plants in the *tsingy*. Pulling up and pitching camp approximately 100 m from the dark green island of vegetation and light gray rock, as the sun was setting across the grassland sea, we marveled at the enormous light green leaves of individual *Tahina* crowns that shone out from the other vegetation as the last of the sun's rays turned the limestone rock orange-red (Fig. 3).

Over the next few days, the team was relieved to find the Antsingilava *Tahina* population in good condition, with lots of seedlings and young plants (Figs. 4–6), and plenty of evidence that the local people have been protecting the species in its natural habitat *in situ*. From local records, we learned that five adult plants at Antsingilava at least initiated flowering and died since the 2008 survey, and the remains of fallen, decomposing trunks and hollows showed where several of these adults previously stood. Five of the juvenile plants recorded in the 2008 census have grown large enough that they now have trunks and fit into the adult category, effectively replacing the five dead adults. There seems to be a gradual progression of individuals from juvenile to adult, complemented by the presence of many seedlings and young plants in and around the *tsingy* outcrop. These palms originated as seedling cohorts resulting from the various flowering and fruiting events that have taken place over the last decade.

Based on information previously provided by Xavier in 2010, we located another but much smaller *Tahina* site approximately 1.5 kilometers away from Antsingilava, at a place called Ambatosaromby (literally "place of the rocks that look like zebu"). Here, 170 seedlings were counted, and local people spoke of at least one adult tree that had flowered and died some years ago. The main Antsingilava population, the Ambatosaromby seedling population, and the two outlying individuals nearer to Antanamarina were demographically surveyed. DNA samples were taken for population genetic study and will be analyzed in conjunction with the 2008 data. As of the

4. Rokiman Letsara with seedlings of *Tahina spectabilis* at Antsingilava, Madagascar (Photo by David Rabehevitra, KMCC).

2016 census, the total known population of *Tahina spectabilis* on the peninsula is 740 individual plants.

Conservation activities and challenges in Antanamarina

An important part of the expedition was to find out what conservation actions had been implemented by Xavier and the local people to protect *Tahina*, whether or not these actions seemed to be working, and if there were any areas where they might need additional support to conserve the species. With VERAMA's support, the community at Antanamarina has formed a Community Based Organisation (COBA) with a subcommittee

5. David Rabehevitra with young juvenile plants of *Tahina spectabilis* at Antsingilava, Madagascar (Photo by Lauren Gardiner, RBG Kew).

called the Comité de Gestion de *Tahina* (CGT) that organizes the activities to protect the species. VERAMA manages the funds from the seed sales, allocates them to the COBA on an annual basis (a relationship that seems to have worked well) and has created an ongoing program of protection over the last decade. Each year the COBA rebuilds fences across the entrances to the tsingy canyons to prevent zebu trampling the seedlings and damaging the larger plants (Fig. 7). They also maintain the firebreak around the main population at Antsingilava to stop grassland fires threatening the plants (Fig. 8). Attempts were previously

6. Alison Shapcott measuring young adult *Tahina spectabilis* plants at Antsingilava, Madagascar (Photo by Lauren Gardiner, RBG Kew).

made to transplant some of the seedlings from the *tsingy* to other sites – gardens and semi-natural habitats nearer the cashew plantation – but the transplanted individuals all died soon after being moved. Plants grown from seed and planted near the plantation buildings and other villages nearby had a better survival rate. A proportion of the funds generated from the seed sales was allocated to two larger infrastructure projects: the construction of a new well for the village of Antanamarina and the refurbishment and expansion of the village

7. Fences built by local people to keep grazing zebu out of the *tsingy*, to stop them trampling *Tahina* seedlings at Antsingilava, Madagascar (Photo by Lauren Gardiner, RBG Kew).

school, with a new classroom created and new toilets provided for children. The COBA has also organized a system of agricultural development microloans for local people to purchase equipment such as plows, whereby the funds are paid back after first harvest.

Based on the findings of the expedition team, the COBA agreed to put more (and reinforced) fences around some of the seedlings near the edge of the *tsingy*, where there were signs of trampling damage, and to put a firebreak and fence around the seedling population at

Ambatosaromby. Representatives from the COBA and VERAMA were trained in carrying out a simplified demographic survey of *Tahina*, in the hope that annual records can be kept of the population. An interesting point to note is that at Antsingilava, the presence of ancestors' tombs inside the *tsingy* makes it *fady* (taboo) for people to collect or damage plants – the expedition team was accompanied at all times and received permission for all of their activities at the site. This *fady* ultimately offers the plants of the *tsingy* an important level of protection, as local people are generally uncomfortable even entering the *tsingy*.

Although the outlook for *Tahina* appears to be good at Antsingilava, the species is still Critically Endangered. With a hapaxanthic palm it is difficult to classify an individual as a "mature adult." By definition, those plants that are reproducing will shortly die, and we do not known how old a *Tahina* individual needs to be before it is able to reproduce. The team used the presence of a trunk as a proxy for classifying an individual as a "mature adult," yet even with such a liberal definition, the mature adult population is still very small, certainly fewer than the standard maximum of fifty mature individuals used by the IUCN Red List to define a Critically Endangered species. Even with the firebreak, a major fire could breach the firebreak and severely damage the population. The local people reported the illicit collection of seeds and possibly seedlings and young plants from the *tsingy* by foreigners, actions which – as well as being illegal – could easily reduce the survival of such a small population.

Even more worryingly, most of the last five known flowering events do not seem to have produced viable seeds, and there are reports and photographs of inflorescences rotting and collapsing before seeds were set. The triggers for *Tahina* to initiate flowering are unknown but thought likely to be linked to environmental patterns. Flowering events are known to be infrequent, and there was no sign of any inflorescences developing in September 2016. A single successful flowering event can produce tens of thousands of seeds, but with such a small population and the death of each individual imminent once it has initiated flowering, whether or not the event is successful, we are highly concerned that plants are dying without reproducing. Insect larvae have been found in the collapsed inflorescences when cut open, and we observed evidence of holes bored by insects in the collapsed trunks and remains of inflorescences – although we cannot say conclusively that these happened post-mortem/collapse, or that they caused the abortion of seed production.

8. Young woman from the local village, Antanamarina, maintaining part of the firebreak around Antsingilava, Madagascar (Photo by Lauren Gardiner, RBG Kew).

A brief but beautiful respite at Anjajavy

After leaving Antsingilava and Antanamarina, the expedition took a detour to travel to the other side of the peninsula, to the luxury fly-in resort of Anjajavy, at the invitation of the proprietor, Cedric de Foucault, a passionate nature-lover and entrepreneur. Cedric has not only created with his team a stunning holiday paradise at this remote and biologically rich site, but he has protected seven hectares of pristine habitat including mangroves, dry deciduous forest, *tsingy*, and pristine white sand beaches, via a private projected area managed by Anjajavy. Cedric is now working with local people and the government to expand this area to encompass a much larger protected area managed for the benefit of both the plants and animals but also the local people, providing employment opportunities and resources for their needs. Cedric has taken a keen interest in the discovery and

9. Local villagers at the new *Tahina* site, near Amparahibe, Madagascar (Photo by David Rabehevitra, KMCC).

conservation of *Tahina*, has led trips for his guests to visit Antsingilava and has experimented with purchasing and growing some plants from seed. There are suitable sites within the bounds of the Anjajavy site. We hope that he can create a semi-natural *Tahina*

population, a kind of "field gene bank," with seeds collected from future flowerings at the main site, again securing the species' survival within what may well have been the species original ecological distribution in the past.

A spectacular new discovery inland

The expedition had met, and exceeded, all of its objectives, so the final part of the trip was to investigate reports of a *Tahina*-like palm some 80 km northeast from the site on Ampasindava Kely and much further inland. Previous reports of an unusual fan palm that might be Tahina have always transpired to be *Borassus* or *Bismarckia*, but images taken on a mobile phone by Theophile Rajaonilaza in November 2014 and sent to KMCC had been positively identified as *Tahina* by John, Joro, and Xavier, so the team went to try to find this new population. Ten kilometers off-road from the Route National 6, connecting Antananarivo with the northern town of Ambanja, in a fragment of humid forest in a valley, two hours' hike from the village of Amparahibe, the team found an entirely new population of *Tahina spectabilis* (Figs. 9 & 10). With one medium-sized (ca. 12 m high) adult and twenty-four smaller individuals from seedlings to one young adult with a short trunk, the population is far smaller than that as Antsingilava, but its presence at such a distance from the original site is highly significant. This region is subject to extreme pressures from humans, and the environment is highly degraded. Yet, as the expedition team found, there are still fragments of rich and important vegetation, often tucked into valleys and near water, so the vegetation has not been devastated by slash-and-burn agriculture and human-caused grassland fires (Fig. 11).

As on the Ampasindava Kely peninsula, there are two isolated individuals several kilometers away from the main population. Both are on exposed hillsides, vulnerable to burning. One site had recently been cleared and burned, and the stunted *Tahina* had leaves removed with a machete and signs of digging at its base. Local people reported that the heart (apical meristem) of the species is good to eat and that the broad, strong leaves are sometimes cut and used as mats for ceremonial purposes. At the main population, in humid forest near a watercourse in the valley, the plants are not nearly as exposed, but there were signs of people having cut leaves. Furthermore, a young adult that had been present a year before (and that was in the original photographs sent from a mobile telephone)

10. Rokiman Letsara with juvenile plants of *Tahina spectabilis*, near Amparahibe, Madagascar (Photo by David Rabehevitra, KMCC).

11. Remnants of vegetation and soils exposed to erosion after slash-and-burn activity near Amparahibe, Madagascar (Photo by David Rabehevitra, KMCC).

had been cut down at some point, probably for its edible heart. It was noted that at the Amparahibe site there are tombs of ancestors, as at Antsingilava, which affords the forest – and by extension species like *Tahina* – a special protection from deliberate destruction. The population was surveyed and DNA samples made, and a leaf from one of the larger juveniles was collected to make a permanent herbarium record for the site (Fig. 12).

The local people spoke of foreigners who had been in the area asking them to collect young plants, including palms, and they suggested that we might like them to uproot and sell us plants there and then. As with so many places around the world, it was a stark reminder the vendors and nurseries one sees operating by the side of the road are generally selling unsustainably – and illegally – collected plants straight from the wild.

Initial discussions with the local community at Amparahibe about the importance of *Tahina spectabilis* and the need to protect the species went well. Discussions took place about the experiences of the people at Antanamarina and the activities and opportunities that are dependent on the species being protected *in situ* by the local people. We discussed the specific threats to the species from illicit collection of plants (and seeds, when the first one flowers), cutting of the leaves and consumption of the heart – a completely catastrophic fate for the plants. A follow-up trip in October by another team from Kew reinforced and continued these initial discussions. They investigated the needs of the community and how conservation and development might be brought together at this new site. It is hoped that funding will soon be secured to help with the early stages of this work. A local COBA is being created, and the community is now signed up to work on (and benefit from) Kew's existing conservation and development projects on seed banking across Madagascar and Kew's Darwin Initiative project on the sustainable production of yams.

Future directions for *Tahina* conservation

The team returned to Antananarivo elated that not only had a second site for *Tahina* been confirmed but also that the original population was clearly being well looked after and was expanding rather than contracting, as had been feared. A species conservation management plan has been drafted for *Tahina spectabilis* and is currently being discussed with the main stakeholders. It is hoped that an action plan will be developed and

12. Lauren Gardiner preparing a herbarium specimen from a juvenile leaf of *Tahina spectabilis*, near Amparahibe, Madagascar (Photo by David Rabehevitra, KMCC).

implemented by the appropriate people for this charismatic, extraordinary palm. A full study of population genetics for the two sites and demographics of the two population censuses (2008 and 2016) is in preparation and will be published in due course. The species distribution models previously undertaken by Joro can now be improved based on the combined characteristics of the two sites. We hope it will be possible to target fieldwork to search for *Tahina* in other fragments of vegetation. At both sites, the local people will continue to be included in the conservation planning and activities, and both communities will receive some educational resources to help teach the local people more about the precious species of which they are guardians. Both communities have agreed to monitor the species for signs of illegal collecting or use, for the presence of pests and the initiation of developing inflorescences so that more seeds can be collected and dispersed and more funds generated to benefit the communities.

This article is dedicated to the memory of the late Xavier Metz, who with his family discovered *Tahina spectabilis* in the wild, brought this spectacular species to the world's attention, laid the groundwork for its conservation and continued to have a deep interest in the palm until he passed away in January 2017.

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The *Coccothrinax* "azul" from Sancti Spiritus, Cuba

Celio E. Moya Lopez
Sociedad Cubana de Botánica
90 South Blvd. Apt. 2C,
Boynton Beach, Florida
33435 USA
Celio.Moya@gmail.com

Raul M. Verdecia Perez
Jardín Botánico Cupaynicú,
Municipio Guisa, Carretera a
Bayamo, Granma, Cuba
verdecopernicia@gmail.com

Julio P. García-Lahera
Jardín Botánico Sancti
Spiritus, Apdo. 52,
Sancti Spiritus, Cuba

AND

Lester R. Martínez-Pentón
Sociedad Cubana de Botánica
Carretera de Zaza s.n.,
entre Rotonda y Línea,
Sancti Spiritus, Cuba

1. The natural habitat of *Coccothrinax spirituana*. Photo by R. Verdecia.

A new species of *Coccothrinax* from Cuba is described and compared with similar species of the genus.

Coccothrinax is restricted to the Caribbean basin, with the greatest diversity in Cuba. Cuba has 46 taxa, comprising 38 species, seven infraspecific taxa and one hybrid recently described. Only one Cuban species is not endemic to the island.

In 1975, two different *Coccothrinax* were collected from San Felipe in Sancti Spiritus Province and planted at the National Botanic Garden (NBG) in Havana. One had green leaves and the other blue leaves (Rodriguez & Diaz 1982). They were planted in the NBG's serpentine area, known as "Cuabal," with the blue morph having the accession number 1981-00325. The blue morph is known as *Coccothrinax* "azul" and has maintained its ash-gray color, similar to ones growing in its native habitat. The *Coccothrinax* sp. "blue leaves" referred to by Moya and Mayotte in 1966 is this same species. The green-leafed species is *Coccothrinax clarensis* subsp. *clarensis* León.

In 1995, Moya and H. Rodriguez from Cienfuegos Botanical Garden and Dr. Peter Mayotte, a palm enthusiast from South Florida, visited the serpentine areas of San Felipe looking for *Coccothrinax* "azul" (Figs. 1 & 2). They collected herbarium vouchers of the *Coccothrinax* species with blue leaves, which are deposited in Sancti Spiritus Botanic Garden Herbarium (HJBSS). One month later Moya, with the Sancti Spiritus Botanical Garden team, collected five different accession numbers of this palm and deposited them at HJBSS. This blue-leaved species showed substantial differences in leaves and leaf sheath from other *Coccothrinax* species. In subsequent visits, the population was found being badly damaged by quarrying activity, with bulldozers working intensely.

Now 20 years later, we compare this palm with other *Coccothrinax* species, looking for differences and similarities. We compare it with the original description of *Coccothrinax macroglossa* by Leon in 1939, and the subsequent description done by Muñiz and Borhidi in 1981. Our diagnosis can be seen below. Verdecia recently collected samples of the mystery palm in 2015, and we use his samples to describe a new species.

A recent visit to the area found a well-conserved population with large numbers of individuals (Fig. 3). Another population grows in the neighboring province of Ciego de Avila.

Coccothrinax spirituana R. Verdecia & Moya, **sp. nov.**

This palm differs from other species of the genus by having leaves ash-gray on both surfaces of the blade (Figs. 1 & 2). It is related to *Coccothrinax macroglossa* but can be

2. *Coccothrinax spirituana* in its natural habitat where ash-gray leaves are conspicuous. Photo by J. García-Lahera.

3. Google Earth satellite view. The ash-gray leaves of *Coccothrinax spirituana* are visible on the right side of the image. Photo from Google Earth.

distinguished by its lower stature (3–5 rather than 8–12 m), leaf sheath longer (50–55 as opposed to 30–50 cm), with the free portion shorter (9.5–10 rather than 10–25 cm), its loosely woven strands, well developed free strand tips that are thicker and stiffer, and fewer leaf segments (34–32 rather than 40–50), smaller adaxial hastula (1.5–2 rather than 2.5–3 cm long), 2 or 3 rather than 3 or 4 primary branches in the inflorescence, the primary branches longer (32–39 cm as opposed to 10–12 cm) that are thicker (4.5–6 mm rather than 4 mm diameter), and the dark reddish–purple instead of blackish mature fruit. Type: CUBA. Provincia Sancti Spiritus, Municipio Jatibonico, San Felipe, Arroyo Blanco, 22º04'09''N 79º01'07''W, 200 m, 2 Jul. 2015, *R. Verdecia* with J.P. García–Lahera *RV15/06* (Holotype HMC!, isotype HAC!).

Small, solitary, unarmed palm to 3–5 m tall (Fig. 4). Stems erect, 12–15 cm diameter, usually covered with a fibrous network of leaf sheaths, becoming bare in older palms. Leaves 15–20 per stem, palmate, orbicular, rigid, and undulate; leaf sheaths 50–55 cm long, lower portion 15–18 cm wide, densely woven, covered with a dense velvety tomentum, apical portion 16–21 cm wide, loosely woven, containing fiber strands that occur in two layers and run in a crisscross direction, the outer layer strands 2–3.5 mm thick, and the inside strands 1 mm thick, free leaf sheath truncate, 9.5–10 cm long, with free strands tips 2.5–3.5 cm long, 1.5–2 mm thick and attenuate (Fig. 5); petiole from leaf sheath base to hastula 58–78 cm long, 5–7 cm wide at sheath base, 2.4–2.5 cm wide at free sheath portion and 1.8–2 cm wide at hastula base, basally slightly flattened adaxially, convex abaxially, biconvex apically, covered densely with a deciduous white tomentum at the base; adaxial hastula 1.5–2 cm long, rigid, rounded, abaxial hastula 1–1.7 cm long, acute; leaf blade with 34–42 segments, adaxially channeled, dark bluish–silver, covered densely with a deciduous layer of whitish wax, abaxially silvery, covered with dense clusters of white scale–like hairs, between them numerous brown dots, central segments 50–70 cm long, palman 10–23 cm long, free portion more than two thirds its length, 4.5–6 cm wide at its widest point at the shoulders where it abruptly narrows and then tapers gradually for 20–30 cm to the apex, apex bifid for about 2–4 cm, with slightly thickened edges; midrib light brown, impressed adaxially, prominent abaxially, secondary veins slightly wider than the tertiary veins, both impressed and visible adaxially, abaxial veins little visible being masked by the thick waxy hairs, margin thickened, dark glossy brown, when joined in the palman forming thick yellowish ribs when fresh, transverse veinlets absent. Inflorescences, shorter than the leaves, pendant, arching, 50–105 cm long, branched to 1 order, 2 or 3 primary branches 50–60 cm long, very close; peduncle and rachis of the main axis overlapped by the woody bracts; prophyll deeply buried among the sheaths, inserted 1–1.6 cm above the base of peduncle, striate, rigid, 14.5–20.0 cm long, 1.5–2.5 cm wide, two keeled covered with hairs, tubular base, overlapping peduncular bract, ventral opening distally up to 3.8 cm, dorsal opening 4–8.5 cm, apex acute, margins covered with light brown hairs, outside with a layer of strands joined together, very light cream-colored, thicker up to 0.05 mm; inside with two layers of interwoven strands, brownish; peduncle covered with tomentum, short, 7.9 cm long, width basally 0.4 cm, distally 0.8 cm; peduncular bract 1, 22–32 cm long, 1.6–2 cm wide, bicarinate, base tubular, rachis bracts overlapping, ventral opening up to 9 cm, dorsal opening 1.6 cm, apex acute, slightly bifid, with margins covered with light brown hairs; rachis up to 13.1 cm long, width basally 0.6 mm and distally 0.8 mm, covered with arachnoid indument; rachis bracts spirally arranged, base tubular, apex entire, acute, rigid; first rachis bract up to 40 cm long, 2.5 cm wide, lateral opening up to 7.9 cm, secondary rachis bract up to 27 cm long, 2–2.5 cm wide,

4. A tall and old *Coccothrinax spirituana* in its habitat. Photo by R. Verdecia.

all of them longitudinally striate, basally glabrous, covered outside from the opening to the apex with cottony white indument; primary branches slender, 32–39 cm long, 4.5–6 mm diameter, basal bract 5–9 mm long; all bracts persistent; rachillae around 30 per primary branch, basally 7–12 cm long, 1.5–2 mm thick; rachilla bracts 2.5–4 mm long, triangular, acute apically. Flowers solitary, with pedicel 1.5–2.5 mm long, bracteoles triangular, 0.6–0.8 mm long; perianth 6, 0.9–1.0 mm long, connate at the base 0.4–0.5 mm, cupuliform, filiform towards the apex; stamens 6, exserted, filaments connate for 0.1–0.2 mm,

5 (top). *Coccothrinax spirituana*, detail of leaf sheath with a long free strands tips. 6 (bottom). Infrutescence of *Coccothrinax spirituana* with ripe fruits. Photos by R. Verdecia.

7. Vegetation at San Felipe "cuabal" with *Coccothrinax spirituana*. Photo by R. Verdecia.

1.3–1.5 mm long, 0.4 mm wide at base, triangular, acute and free distally; anthers oblong, 0.8–2 mm long, 0.4 mm wide, dorsifixed subapically, base sagittate at maturity; ovary globose, 0.7–0.8 mm in diameter; style up to 1 mm long, cylindrical at the base, gradually widening in the upper half; stigma infundibuliform, 0.5 mm long, 0.5 mm wide. Infrutescences interfoliar, pendant. Fruit depressed–globose to globose, 9–10.5 × 12–13 mm when fresh, 6.8–8.8.× 6.5–8.1 mm dry; pedicels 2.5–4 mm long; epicarp smooth, shiny, light purple to dark reddish–purple at maturity (Fig. 6). Seed depressed–globose to globose, cerebriform, 6.2–8.2.× 5.2–7.5 mm, grooves 4–6, wide and deep; endosperm homogenous, intruded partially through the center from apex to near the base. Eophyll lanceolate, very narrow, rigid, with 3 prominent veins adaxially, greenish, 15–29 cm long, 2.5–3 cm wide.

Specimens examined: CUBA. Province Sancti Spiritus, Municipality Jatibonico, San Felipe, Arroyo Blanco, 3 Aug. 1995, *C. Moya with H. Rodríguez & P. Mayotte s.n.* (HJBSS!); 3 Aug. 1995, *C. Moya with H. Rodríguez & P. Mayotte s.n.* (HJBSS!); 1 Sep. 1995, *C. Moya with L. Cañizares & L. Martínez-Pentón s.n.* (HJBSS!); 1 Sep. 1995, *C. Moya with L. Cañizares & L. Martínez-Pentón s.n.* (HJBSS!); 1 Sep. 1995, *C. Moya with L. Cañizares & L. Martínez-Pentón s.n.* (HJBSS!); 1 Sep. 1995, *C. Moya with L. Cañizares & L. Martínez-Pentón s.n.* (HJBSS!); 1 Sep. 1995, *C. Moya* with *L. Cañizares & L. Martínez-Pentón s.n.* (HJBSS!); 2 Jul. 2015, *R. Verdecia with J.P. García-Lahera RV15/06* (HMC!), 2 Jul. 2015, *R. Verdecia with J.P. García-Lahera RV15/07* (HMC!), 2 Jul. 2015, *R. Verdecia with J.P. García-Lahera RV15/08* (HMC!).

ETYMOLOGY: Named for the province of Sancti Spiritus. The ghostly white color of the leaves can be seen on the satellite image (Fig. 3).

DISTRIBUTION: Central Cuba, sector Camagüeyicum, district Claraënse in the sector Eastern Central Cuba (Borhidi 1996). Province Sancti Spiritus, municipality Jatibonico and province Ciego de Avila, municipality Florencia.

HABITAT: The "*cuabal* of San Felipe" (Fig. 7) is a dry evergreen thorny shrub-land on serpentine soil, located on the eastern side of the district Claraënse in the Eastern Central

8. *Coccothrinax spirituana* (foreground) and *C. clarensis* ssp. *clarensis* (background). Photo by R. Verdecia.

sector of Cuba (Borhidi 1996), consisting of slightly undulating hills, 185–235 m elevation. The main vegetation types on the San Felipe outcrop are secondary thorny xeromorphic serpentine shrub land, pine forest plantation, secondary serpentine grassland, and gallery forest. (Bécquer et al. 2003). Dominant shrubs and trees include the following species: *Brya ebenus*, *Bursera inaguensis, Diospyros crassinervis*, *Ternstroemia peduncularis*, *Pera bumeliefolia*, *Byrsonima lucida*, *Jacaranda cowellii, Gochnatia cowellii*, *Phyllanthus orbicularis*, *Reedia fruticosa*, *Maytenus buxyfolia* and *Chamaecrista lineata*. *Coccothrinax clarensis* ssp. *clarensis* also shares the habitat with *C. spirituana* (Fig. 8). The climate is seasonal, with a rainy period from May to October and a dry season in the winter.

CONSERVATION STATUS: Vulnerable [VU D2]. Known only from San Felipe, the eastern area of district Clarense, growing on serpentine. The area of occupancy is estimated to be less than 25 km^2. The species is threatened with habitat loss, because it grows in a forested area that is being mined, subsequently destroying natural vegetation that is being replaced with exotic species such as *Eucalyptus* spp., *Casuarina equisetifolia* and *Acacia mangium*. This causes the entry of invasive species such as *marabú* (*Dichrostachys cinerea*). The serpentine rock is mined for use as a road base throughout the area.

NOTES: The species belongs to subsection *Coccothrinax* of section *Coccothrinax*, according to the classification of Muñiz and Borhidi (1982), and Miraguama complex of the Pauciramosa Group, according to the informal classification of Nauman and Sanders (1991).

FLOWERING: June and October.

USES: The leaves are cut to make brooms, although those of *C. clarensis* produce better quality fibers that are preferred by local people. It is cultivated in Florida as an ornamental.

GERMINATION AND CUTIVATION: Seed collected by Verdecia in 2010 from the "*cuabal*" of the Cuban National Botanical Garden germinated in 15 days and produced seedlings in two months. These were planted after three years in volcanic soil and now are up to 3 m tall. Sancti Spiritus Botanical Garden has seedlings from seed collected by Garcia-Lahera in November 2015.

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Uses of *Parajubaea torallyi*, a Vulnerable Palm of Bolivia

Mónica Moraes R.
Instituto de Ecología, Universidad Mayor de San Andrés, Casilla 10077 – Correo Central, La Paz, Bolivia.
monicamoraes45@gmail.com

Julissa Roncal
Department of Biology, Memorial University of Newfoundland, 232 Elizabeth Avenue, St. John's, NL A1B 3X9, Canada.
jroncal@mun.ca

AND

Rosember Hurtado
Herbario Nacional de Bolivia, c/27 Cota Cota s/n, La Paz, Bolivia.
rosemberh@gmail.com

The *janch'icoco* palm, *Parajubaea torallyi*, is endemic to Bolivia and in 2004 was recognized as a national emblem, symbolizing the plant richness of Bolivia. In 1997, the first protected area in the department of Chuquisaca (central Bolivia) was created as a Natural Area of Integrated Management (NAIM) called "El Palmar," specifically to protect this remarkable palm, the reserve becoming part of the national system of protected areas.

Parajubaea torallyi (Mart.) Burret, known in Bolivia as *janch'icoco* (which in Quechua means chewable or dry coconut), *Manzana* (apple) or *Pasopaya* palm, is one of three species of an endemic Andean genus (Moraes & Henderson 1990), with two species endemic to Bolivia (Moraes 1996). Although it has been considered "Endangered" in the past by the IUCN Species Survival Commission (Johnson 1988, Moraes 1998), it is now thought to be "Vulnerable" in the Redbook of Andean plant species of Bolivia (Navarro et al. 2012), and for this reason it is a high conservation priority. Among the factors that threaten it are its slow growth, unsustainable use, accidental burning of its habitat, seasonal frosts that reduce fruit production, forest fragmentation that progressively affects the quality of its natural ecosystem and intensive land use conversion for local crops.

Parajubaea torallyi is unusual in the family, growing as it does in areas of low precipitation at high elevation, 2000–3400 meters above sea level, on steep rocky slopes (Fig. 1) (Cárdenas 1970, Moraes 1996, 2004, Ribera & Liberman 2006). Its geographic range covers 150 km along both the Rio Grande and Pilcomayo river valleys in southern Bolivia. Four populations have been reported with an unknown number of individuals, growing dispersed or in groups (Moraes 2004). Populations located in the northeast of the Chuquisaca department have large fruits, while populations in central Chuquisaca and eastern Potosi have smaller fruits (Moraes 1996). It was thought that the population in El Palmar was the most

1. *Parajubaea torallyi* stand at the Natural Area of Integrated Management El Palmar, Bolivia, where hundreds of individuals of this endangered palm can be seen in its natural habitat. Photo: Julissa Roncal.

extensive in Bolivia, but an extended visit to other sites in December 2016 by MM verified that it also develops widely and with large fruits in Sauce Mayo in Villar and Ruditayo in Icla (central Chuquisaca). An analysis of the structure of the largest *janch'icoco* population at the NAIM El Palmar suggests that overall the species shows signs of regeneration, but at a smaller spatial scale in specific zones, juvenile recruitment may be limited due to density-dependent population control and reduced habitat suitable for seed germination and seedling establishment (Thompson et al. 2009).

Information on the natural history of *janch'icoco* is limited. The stem can reach to 26 m tall and 70 cm diameter at breast height (Moraes 1996). The pinnate leaves can be 7 m long (Roncal pers. obs, Fig. 2). The interfoliar inflorescences are up to 1 m long and can produce approximately 100 fruits (Cárdenas 1970, Moraes 1996). Each fruit can contain one to three seeds, which germinate in approximately 431 days (Carretero 1999). According to some historical records, an individual can live more than 500 years and reach reproductive maturity at 50–80 years old (Moraes 1996). Pollinators include bees (*Apis melifera, Trigona* sp.), bumblebees (*Bombus* spp.), wasps (*Agelaia multiplicata*, *Eumenes* sp.) and flies (*Volucella* sp., *Eristalis* sp., *Syrphus* sp.) (Guerra et al. 1997). Anecdotal information from local inhabitants report that the Andean spectacled bear (*Tremarctus ornatus*) is one of the main seed dispersal agents of *janch'icoco* (Anibarro 1994). The palm is considered a multi-purpose species because it is used as an ornamental, its fruit are edible for humans and wildlife and it provides material for construction, utensils, handicrafts, rope and animal feed (Cárdenas 1970, Thompson 2007,

2. Individuals of *Parajubaea torallyi* showing habit. Photo: Julissa Roncal.

Moraes 2014). However, *janch'icoco* is mostly known for the preparation of a cold refreshment (Fig. 3) or hot drink made by mixing the ground seeds with boiling milk and cinnamon; in this way seeds have reached the markets in the cities of Sucre and Cochabamba (Moraes 2004). These uses have been included in the cultural rescue plans of the NAIM El Palmar, where several indigenous communities are settled in their ancestral territories.

The objective of this paper is to highlight the different ways that local inhabitants of the NAIM El Palmar use *janch'icoco* palm. Anibarro (1994) published a short list of categories of uses based on former interactive workshops and interviews organized with local communities in this protected area. This is the second interview-based study that comprises all use categories. Information obtained from this study will add to our knowledge of the impact of uses on the sustainability and economic potential of this non-timber forest product.

The El Palmar protected area

The study was conducted at the NAIM El Palmar in the Zudañez Province of the Chuquisaca Department, a protected area located 165 km NE of Sucre city (Guerra et al. 1997, MDSP & SERNAP 2001). This area was established with the goals of biodiversity protection and sustainable development for indigenous communities (Sanchez & Brugioni 2003). Located in the central mountain chain of the Andes, it is an area of deep valleys, steep slopes, ridges and high plateaus. Within the area, palms grow in Andean humid to

3. Refreshing drink made with crushed *janch'icoco* seeds and previously boiled with cinnamon and sugar. Photo: Viviana Vargas.

semideciduous forest (Ribera & Liberman 2006).

The climate in the area is temperate, pluviseasonal and xeric (Ribera et al. 1995, Navarro 2002). Average temperatures are 8°C minimum and 15°C maximum. Annual precipitation reaches 1000 mm due to the presence of orographic rains and high frequency of nocturnal fog (Ribera & Liberman 2006). The greatest climatic risks are drought between the months of July and November, hailstorms between December and March and frost between June and August (Sanchez & Brugioni 2003). We restricted field observations to El Palmar (18°37'23"–18°43'14"S, 64°52'38"–64°56'36"W), because the population of *P. torallyi* is the largest in the area, occupying about 24 km^2, and because it is more accessible and utilized by local inhabitants (Anibarro 1994, Ribera & Liberman 2006).

There are five rural communities associated with the palm forests: El Palmar, Mulani, Rodeo El Palmar, La Joya and Seripona (Anibarro 1994, Ribera & Liberman 2006). The first two have a direct relationship with the forests of El Palmar, with an estimate of 60–90 families using resources in the area intensively (Ribera pers. comm.). While the main activities of these communities are subsistence agriculture and livestock husbandry (Anibarro 1994, Sanchez & Brugioni 2003), the sale of *P. torallyi* seeds represents the only source of income for poor families (Anibarro 1994).

We present information from three sources: First, from Anibarro (1994), who gathered data from a community assembly of three sites comprising El Palmar, Molani and Rodeo El Palmar; second, from Thompson (2007), who worked with 25 inhabitants of El Palmar; and third, from peasants and park guards in a recent visit to El Palmar. Information was also gathered by MM during fieldtrips conducted in 1994 and in a recent visit by JR in October of 2016. To evaluate uses, two interviews using the list of questions in Table 1 were conducted between March and December in 2005 on people 18–70 years old; of these, only five were women, because most were reluctant to participate (Thompson 2007). Questions were designed to address the following topics: palm uses, palm product destination, parts of the palm used for each type of use and features of the palm trees harvested (i.e. size of the palm or its leaves, presence or absence of a trunk, whether the harvested leaves were young or old).

Uses of the *Janch'icoco* Palm

Up to 20 residents of the community El Palmar harvest six parts of *P. torallyi*, which have 40 uses within seven use categories (Table 2, Figs. 4–6), namely: food, forage, domestic (including utensils and tools), commercial, firewood, construction and ornamental. The apical meristem (palm heart) was reported for food consumption, but this practice stopped after the establishment of the NAIM. Both the apical meristem and leaf petioles showed only one use category, food and firewood, respectively. Seeds were included in three use categories, mainly food related, while young leaves had the highest number of uses, four. The use of petiole fibers has stopped after the establishment of the NAIM because its extraction damaged the palms. Seeds and young leaves are harvested for commercial purposes, and young leaves and fruits are used for forage.

The commercialization of seeds and basketry is on a small scale. Seeds removed from the endocarp are sold or exchanged for other products with neighbors, seed collectors and nearby residents in the towns of Presto or La Joya. Occasional trips to Aiquile, Sucre, Cochabamba and Santa Cruz are conducted to sell seeds. Families can usually accumulate between 7–12 kg of peeled seeds every month. A good campaign of fruit harvest commercialization could reach 1 quintal (= 220.5 pounds or 100 kg) of seeds per month, which

they transport after two months to guarantee the sale of two quintals at a price of less than US$1 per pound (=$2.20 per kg) (Anibarro 1994). Each seed can weigh between 3.72 to 6.61 g. Commercial scale basketry (Fig. 7) is not practiced by all residents, since this activity was only implemented in the last decade through workshops offered by the Jesuit Loyola Cultural Association.

According to the features of the palms exploited, four growth classes are harvested: seeds, late juveniles, subadults and adults (Thompson 2007). When fruits are still immature, they are fed to domestic animals (pigs and chickens). Ripe fruits are used by local peasants, who usually first remove the fibrous mesocarp from the fruit (Fig. 8) and then break the hard endocarp by hitting the fruit with a stone on a rocky base. Over time, the stone base develops holes which directly accommodate the different sizes of harvested fruit. The fruit residues and the shell are used to feed cattle. Moreover, livestock can facilitate seed recovery by eating the fruit epicarp and fibrous mesocarp, without digesting the endocarp containing the seed. The endocarps are collected from the ground by local inhabitants and air dried for several days in the forest or in their settlements. Air-drying in the sun is also helpful because seeds become detached from the endocarp permitting their complete extraction. Laboratory analysis showed that the seed is nutritious for human consumption (Anibarro 1994). Seed collection is therefore a non-destructive harvest practice. However, seed harvest may have some consequences on the ecology of the forest. Also, the sprawling and browsing of the livestock present in the study area could negatively affect seedling survival and growth and needs more investigation.

Most of the harvest practices do not affect palm individuals. For example, since a tall

Table 1. Questionnaire for semi-structured interviews on uses of *Parajubaea torallyi* in the Natural Area of Integrated Management El Palmar, Bolivia (modified from Thompson 2007).

General questions:

1. What is your name? What is your age?

Palm resource uses

1. Do you use the palm? Which parts? What for?

2. Do you collect *janch'icoco* seeds? In which months? Where? What do you use *janch'icoco* for? Do you sell it? Where?

3. Do you collect palm leaves? What for? How are the leaves that you collect for (mention the use)? What is the size of the palm from which you extract the leaves? Why do you prefer that size?

4. Do you use or once used the heart of the palm? Where do (did) you extract the heart from? What are (were) the palm sizes?

5. Do you use or once used the petiole fibers (*yunka*)? Which palm size do you use or used? How do (did) you extract the *yunka* from the palm? What use do (did) you give to it?

6. Do you use palm trunks? What for? How do you choose the palms that you will use?

4. Number of reported uses across seven different categories of *Parajubaea torallyi*.

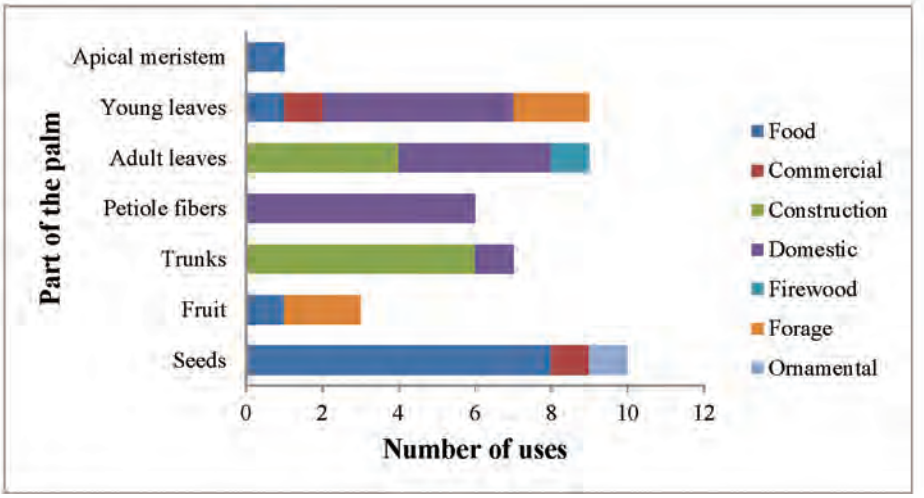


Table 2. Uses of *Parajubaea torallyi* reported by the local community of the Natural Area of Integrated Management El Palmar, Bolivia. Local names in parentheses (based on Anibarro 1994, Thompson 2007, and our observations). †no longer in practice.

Part of the palm	Part used and/or consumed	Features of the palm used	Use description	Use category
Apical meristem	Palm heart	Subadult and adult crowns	Salads†	Food
Young leaves (yellowish)	New pinnae before leaf opens	2–4 m tall palms without trunk, pinnae 1 m long	Ropes (*q'iswa*)	Domestic
			Twisted strings (*simp'a*)	Domestic
			Basketry	Domestic
			Basketry (bread baskets, hats, jewelry cases)	Commercial
			Food for domestic animals	Forage
			Andean bear	Forage
	Pinnae rachis	Pinnae 1 m long	Brooms (*pichanita*)	Domestic
	Fully opened leaves and their rachis	2–4 m tall palms	Basketry (woven kitchen utensils, baskets, fans)	Domestic
			Fermented leaf sap for alcoholic beverages	Food
Adult leaves	Dry foliar base	Dried leaves harvested from the ground	Firewood	Domestic
			Seats	Domestic
			Spoon to make the *chicha* drink	Domestic
	Leaf rachis	Palms with 3-6 m tall trunks, leaves 5 m long	Ceilings	Construction
			Walls (*Palma k'aspi*)	Construction
			Woven containers to store grains (*pirhua*, *truji*), mats, beds	Domestic
	Open leaves	Palms of different sizes, usually with leaves 2–3 m long	Ceiling with sparse leaves to provide shade (*ramara*)	Construction
			Fences (*q'empo*)	Construction

Table 2. Uses of *Parajubaea torallyi* continued.				
Part of the palm	**Part used and/or consumed**	**Features of the palm used**	**Use description**	**Use category**
Adult leaves	Petioles	Palms 5–15 m tall with developed leaves	Petioles collected without rachis and pinnae are burned for cooking	Firewood
	Petiole fibers (*yunka*)	Palms 2–4 m tall with or without trunk	Mattresses†	Domestic
			Fretwork	Domestic
			Ropes and twisted strings	Domestic
			Small fiber cushion (*carona*) for pack animals	Domestic
			Thin ropes for tying loads and utensils (*maroma*)	Domestic
			Ropes to adjust saddles	Domestic
Trunks	Fallen trunks	Mature palms, 50–60 cm diameter	Wood	Construction
			Boards	Construction
			Doors	Construction
			Drawers	Construction
			Construction units made up by small sections of trunks mixed with mud	Construction
			Frames	Construction
			Cots	Domestic
Fruit	Epicarp and mesocarp	Mature palms, fruiting	Andean bear, wild pig feed	Forage
			Domestic animal feed (cows, mules, donkeys, hens, sheep)	Forage
			Thick soup (*lagua*)	Food

Table 2. Uses of *Parajubaea torallyi* continued.

Part of the palm	Part used and/or consumed	Features of the palm used	Use description	Use category
Seeds	Endocarps	Mature palms, fruiting	Local and domestic plantations (gardens)	Ornamental
	Peeled seeds (without endocarp)	Mature palms, fruiting	Refreshments	Food
			Breakfast	Food
			Cocktail	Food
			Chili pepper	Food
			Mix with wheat flour	Food
			Hot sauce (*llajua*) mixed with tomatoes and chilies	Food
			Oil	Food
			Direct consumption	Food
			Sold to people at El Palmar, nearby towns, or in Sucre and Cochabamba cities	Commercial
Total	**13**		**45**	**7**

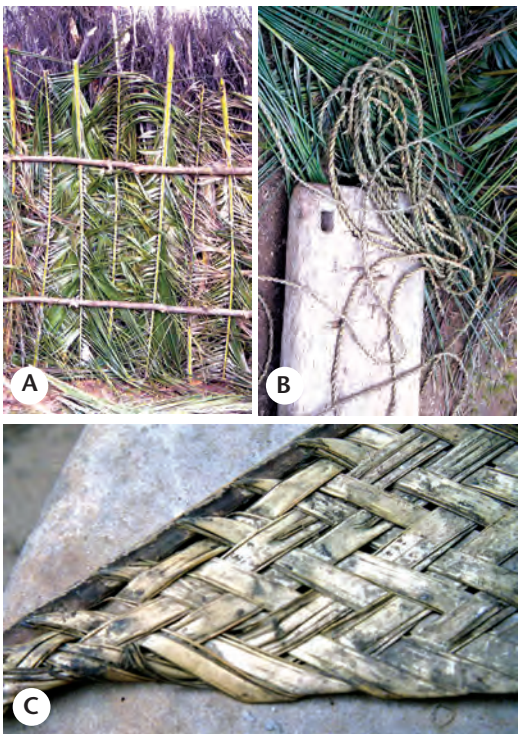
5. Uses of *Parajubaea torallyi*. **A.** Woven container to store grain (*truji*); **B.** Ropes and baskets elaborated from fibers of young leaves; **C.** A kitchen wall made of the rachis of adult leaves, and boards made of palm trunks. Photos: Natali Thompson.

palm has a difficult-to-reach crown and infructescences, local people typically exploit palm resources intensively when an individual has fallen to the ground because of old age or lightning strike. A fallen palm allows the harvest of fruit, leaves, parts of the inflorescence or infructescence and the trunk.

To harvest the apical meristem or palm heart and petiole fibers (called *yunka*), villagers once used late juveniles or sub-adults. To harvest petioles and petiole fibers, some respondents mentioned the need to knock down the palm or cut its apical meristem, an action that is currently prohibited because of the location of the population within a protected area, while others said they could perform the extraction without killing the individual. Unexpanded pinnae from new leaves are harvested from late juveniles. Fibers of unexpanded pinnae are more durable than those of open leaves (Thompson 2007). Open leaves are also extracted from juvenile palms, but people leave the leaf bases and petioles, and some intact leaves to assure continued growth. From subadults and adults of lower height (4–7 m), local people harvest the rachis of open leaves for construction. The trunks of the taller adults are also used for construction. The petiole, dry rachis and leaf bases of mature fallen leaves are used for various purposes, for example, as fire kindling, as seats (in the case of larger leaf bases and petioles), or as spoons (smaller leaf bases). Although harvest of fallen leaf bases does not directly affect the palm individual, this practice could influence the growth of other plant species in the forest understory as it reduces the accumulation of leaves on the soil and allows the regrowth of vegetation.

In general, harvest and usage of *P. torallyi* are very similar to those of *P. sunkha*, another endemic species of Bolivia. Vargas (1994) described major uses of *P. sunkha* (as *P. torallyi*), its distribution and seed propagation. Both palm species are considered multipurpose, although *P. sunkha* is mostly harvested for its leaf fibers, from which mattresses and handmade dolls are made (Moraes 2014).

The high density of *P. torallyi* at El Palmar makes the sustainable management of this resource feasible. Thompson (2007) reported an adult density of up to 121 individuals/ha, which is a similar number to that reported by Peters et al. (1989) for *Oenocarpus bataua* (104 indiv./ha) and *Mauritia flexuosa* (138 indiv./ha), two other economically important palms. This high adult density combined with the observed species regeneration, the high infructescence production, the diversity of palm parts used and the different growth classes suitable for extraction make this species a commodity that could increase the income of this Andean community, if carefully managed. We recommend that capacity building of local inhabitants should be conducted in order to improve the quality of the palm products (listed on Table 2), which could then attain a higher market value. Resource management and conservation practices should take into account the different palm population structure and microhabitats observed at El Palmar (Anibarro 1994, Thompson 2007), as well as the ecological requirements of each growth class of the *janch'icoco* palm (Thompson et al. 2009). Future research should quantify the number of inhabitants harvesting resources, their harvest intensity, and extend this research to the other four communities close to the NAIM, which also use these palm resources. Since *janch'icoco* is adapted to large temperature fluctuations and water stress, future research should also



6. Other products made of *Parajubaea torallyi*. **A**. Fence made of palm leaves; **B**. Rope and construction units made of small sections of trunks mixed with mud (*tapialera*); **C**. A woven hand fan made of young leaves. Photos: Natali Thompson.

address if and how the availability of this resource will vary in the face of global climate change.

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7. A beautiful small basket with lid woven by inhabitants of El Palmar with a potential to generate income if linked to the ecotourism industry. Current price is US$2. Photo: Mónica Moraes.

8. Fruits of the *janch'icoco* palm showing the sequence of removal of the epicarp and mesocarp. From left to right: two complete fruits, two fruits with epicarp and mesocarp removed leaving the endocarp with a fibrous cover, and a cross section of a single endocarp with seeds removed, the two locules indicating that this endocarp had two seeds (the species has 1–3 seeds per fruit). Photo: Mónica Moraes.

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Ray Hernandez
IPS President

PALM LITERATURE

PALMEIRAS NATIVAS DO BRASIL – Ricardo Lopez, Maria do Socorro Padilha de Oliveira, Marcelo Mattos Cavallari, Rosa Lía Barbieri, Léo Duc Haa Carson Schwartzhaupt da Conceição. Editores Técnicos. Embrapa, Brasilia, DF. 2015. Price: unknown. 432 pages. (in Portuguese)

This is a volume of papers on the botany, ecology, utilization and conservation of a selection of indigenous Brazilian palms. These include the most economically important of all Brazilian palms, viz., *Euterpe oleracea*, *Attalea* spp. (under the heading of *babaçu*), *Oenocarpus* spp. (other than *O. bataua*), *Mauritia flexuosa*, *Butia* spp., *Elaeis oleifera*, *Attalea maripa*, *Acrocomia* spp., *Oenocarpus bataua*, *Bactris gasipaes*, *Astrocaryum aculeatum* and *Astrocaryum vulgare*. Each species is discussed in detail, with a wealth of new information. The whole volume is illustrated with fine photographs, and the printing is generally excellent throughout.

John Dransfield
Royal Botanic Gardens, Kew

Editors' Note: As this issue goes to press, the book is available at a 30% discount from the Livraria Embrapa <www.embrapa.br/livraria>. The discounted price is R$49.00 (ca. US$15.87).

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