Palms

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The International Palm Society

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FRONT COVER

Veitchia joannis is a tall, emergent species with heavy, elegantly pendulous pinnae. See article by D. Hodel, p. 161. Photo by D. Hodel.

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BACK COVER

Hydriastele boumae on Taveuni is a tall, emergent palm with a canopy or arching, recurved leaves. See article by D. Hodel p. 161. Photo by D. Hodel.

PALM NEWS


J. Dransfield

Reproductive biology of the endangered *Johannesteijsmannia lanceolata* was the subject of a recent paper by Y.M. Chan, A.L. Lim and L.G. Saw (Journal of Tropical Forest Science 23: 213–221. 2011). Studying both cultivated and wild individuals of this spectacular palm, the authors found that small flies (Phoridae and Cecidomyiidae) and stingless bees (*Trigona* spp.) were the most abundant visitors and likely pollinators. The palm is self-compatible, which means that even isolated individuals have the ability to produce seeds in cultivation or in fragmented or isolated environments. However, seed set was very low, possibly as a result of pollinator inactivity. Pollen viability and stigma receptivity lasted just one day, so the opportunities for pollination are short-lived.


Neil O'Halloran

J.M. Fedriani and M. Delibes examined the **contradictory forces acting on the evolution of fruit dispersal in *Chamaerops humilis***. In its native habitat, the palm is dispersed by Eurasian badgers (*Meles meles*), which eat the flesh and defecate the seeds. The seeds are subject to predation by curculionid weevils. The seeds will not germinate until the flesh is stripped off the endocarp (by badger consumption), at which time the seeds are vulnerable to predation by weevils. Consequently, there are two conflicting selective forces: fruit pulp removal hastens germination, but fruit pulp retention protects the seed from predation. A balance is struck by the fact that seeds removed far from other palms by well-traveled badgers are much less likely to be predated by weevils. The study was published in Ecology (Washington DC) 92: 304–315. 2011.


Sean Long

Eman K. Al-Dous and co-workers based in Qatar have been working on the genomics of the date palm (*Phoenix dactylifera*). Selection and breeding of improved varieties and genetic analysis are complicated by the long generation time (5–8 years) and dioecy (separate male and female trees). In the course of research reported in "*De novo* genome sequencing and comparative genomics of date palm (*Phoenix dactylifera*)" (Nature Biotechnology 29: 521–528. 2011), a draft **genome sequence for a female 'Khalas' date palm was assembled**, the first genome sequence for any palm. Further sequencing of other female date palm varieties and backcrossed males identified a huge number of polymorphic sites. A small number of these polymorphisms can be used to distinguish varieties (via genetic fingerprinting). The workers identified a region of the genome linked to gender and found evidence that date palm employs an XY sex-determination system, similar to that of humans. The ability to identify and eliminate male seedlings from breeding stocks is expected to be a boon to date palm breeding programs.

Exploring for Palms in Fiji

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1. Large, mostly undivided leaves characterize *Cyphosperma tanga*.

I traveled to Fiji in October, 2008 as part of a larger, long-term project to document and photograph palms on Pacific islands. Somewhat apprehensive as I departed Los Angeles on the non-stop, late-night flight to Nadi, Fiji, I had visited these delightful islands several times in the middle 1970s and was now profoundly curious about the changes that the more than 30 intervening years had brought.

Sakiusa Masitoqui, employed at the University of the South Pacific in Suva, the capital of Fiji, and who goes by the nickname Masi, met me at the Nadi International Airport early in the morning on October 1 and, over a quick introduction and breakfast, we briefly discussed plans for the next 18 days. We planned to spend several days based on the main Fijian island, Viti Levu, and then move on to the two other large islands, Vanua Levu and Taveuni, before finishing up with a trip to the Southern Lau group of islands to see the elusive *Pritchardia thurstonii* on mushroom-shaped, limestone islets in its lagoon habitat. Masi has great knowledge of Fijian palms, places and people and had assisted others in their quest to see Fiji's palms.

I rented a 4-wheel drive pick-up truck in Nadi, and we began what I thought would be a rather leisurely, several-hour, circular drive along the north coast to Suva on the other side of Viti Levu. Under threatening skies in Ba, north of Nadi, we stopped briefly to eat lunch and purchase a machete, rope, and a few other supplies. After lunch, Masi surprised me and said that his plan was for us to traverse the mountainous center of Viti Levu via Nadarivatu and Monasavu Dam to reach Suva, rather than follow the coastal route. Traversing the center of Viti Levu would enable us to see several striking palms, some of which are found nowhere else in Fiji, including *Cyphosperma tanga* (affectionately known as "Big Leaf") and *Physokentia petiolata*. Although I was exhausted from the all night flight, Masi's plan excited me because it had been 30 years since I had last seen Big Leaf in 1978 in the company of the late Dick Phillips, long-time champion of Fijian palms, and the late Ken Foster, palm enthusiast and former president of the International Palm Society. The excitement of seeing Big Leaf just a few hours after stepping off the plane in Fiji helped to keep me awake as I drove the vehicle off the main highway and headed up a smaller, mountain road to Nadarivatu in a steady rain.

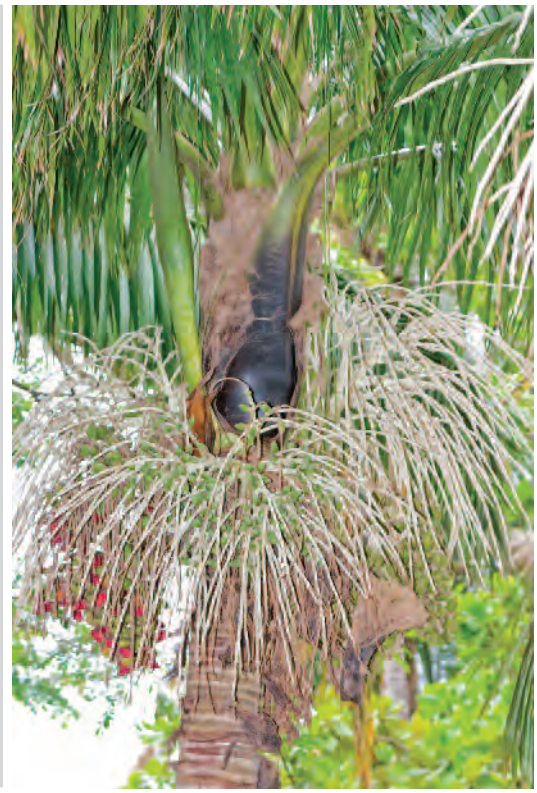
After 30 years the road up the western escarpment of Viti Levu to Nadarivatu was still familiar and, feeling confident, I thought I could nearly drive right to Big Leaf. After passing through Nadarivatu under threatening skies, we left the road and drove up a muddy track that I was sure I had walked 30 years before. I was thinking that this little trek was going to be easy. Unfortunately, the road seemed to end abruptly and unexpectedly, and the much disturbed vegetation no longer looked familiar to me. Even Masi, who had

2 (left). *Cyphosperma tanga* has an open, few branched inflorescence. 3 (right). Staminate flowers of *Cyphosperma tanga* are white.

4 (above, left). *Veitchia vitiensis* is a moderate to tall, very slender palm with gracefully spreading, pinnate leaves . 5 (above, right). *Neoveitchia storckii* is a large palm with long, spreading, pinnate leaves. 6 (below). The whitish inflorescences of *N. storckii* contrast nicely with the poorly developed but black crownshaft.

visited Big Leaf just the previous year, was unable to find the trail. We retreated to a small farm we had just passed where, after partaking in a brief *kava* ceremony and donating a gift, the Fijian farmer and his two sons agreed to guide us to Big Leaf.

With much anticipation and under a heavy drizzle, I followed Masi and the other Fijians up a rocky slope and into wet, undisturbed, mountain forest. Big Leaf had not lost its grandeur and with its large, undivided leaves looked every bit as imposing as 30 years ago (Fig. 1). Big Leaf has a slender, solitary trunk three to five meters feet tall and large, elongate, undivided or few-divided leaves three meters long with short petioles. The inflorescence, about one to two meters long, is loosely branched (Fig. 2) and at the moment was carrying small, white staminate flowers (Fig. 3). Growing nearby were the highly variable, mostly understory *Balaka longirostris* and *Veitchia vitiensis*, which we would encounter later on Viti Levu. (For a complete, fully illustrated account of *B. longirostris* and all other *Balaka* in Fiji and Samoa, see Hodel 2010).



7 (above). *Hydriastele vitiensis*, which covered valleys, slopes, and ridges, thrusts its spectacular canopy of arching, slightly recurved, pinnate leaves well above the forest trees. 8 (below). *Heterospathe phillipsii* is a slender, moderate, pinnate-leaved palm.

After saying thanks and goodbye to our Fijian guides, Masi and I returned to the road and headed east from Nadarivatu toward Monasavu Dam into what was for me uncharted territory. In the middle 1970s the road ended not too far east of Nadarivatu, and only a foot track continued across the center of Viti Levu. The construction of Monasavu Dam in the 1980s pushed a road through to the dam site and then down the eastern escarpment of Viti Levu to Suva. The unpaved road was of poor quality, muddy, with standing pools of water and deep ruts, but with careful driving we were able to negotiate its treacherous meanderings. Our goals at Monasavu Dam were *Clinostigma exorrhizum* and *Physokentia petiolata*, which Masi knew were along an access road to the dam.

When we arrived at the dam late in the afternoon, again under threatening skies, the work and guard stations were deserted, and, unfortunately, we needed a key to access the road to the dam. Under a heavy drizzle we waited in the car, chatting, reading, and snacking until dusk approached. With much disappointment we finally gave up and decided to continue on to Suva. Just as we were departing some workers arrived and unlocked the gate for us. However, because it was so late, darkness was fast approaching, and we still had several hours of rough travel remaining, we made arrangements to return to

Monasavu Dam in several weeks at the end of my Fijian sojourn.

The remaining drive down the eastern escarpment to Suva was an unforgettable experience. Somewhat disappointed from our temporary failure at the dam, and cold, wet, hungry, and with only the weak lights of our vehicle showing the way, we continued on in what seemed like a never-ending, bone-jarring, downward spiral into darkness. Finally, after what seemed like weeks but was really only four hours, the welcoming lights of Suva appeared in the distance. I dropped Masi off at his home, drove to my hotel, showered, ate and then collapsed into bed after 20 hours of no sleep but with contented visions of Big Leaf in my mind.

Masi and I spent the next three days on trips around the greater Suva area looking for palms. On October 2 in the morning we visited Colo-i-Suva Forest Park, a well known, traditional and long-popular locale for palms just a few minutes outside of Suva, where we observed and photographed *Balaka microcarpa* and *Veitchia vitiensis*. The latter is a moderate to tall, very slender palm with gracefully spreading, pinnate leaves (Fig. 4), a well developed and conspicuously mottled crownshaft, and small, bright red fruits.

After lunch we headed to Naquali in the Rewa River valley to see *Neoveitchia storckii*,

9 (above). *Metroxylon vitiense* typically grows in low, wet, sometimes swampy land. 10 (below). *Veitchia filifera* is a slender, moderately tall, mostly understory palm with distinctly ascending, pinnate leaves.

11 (left). The dark green, nearly black crownshaft of *Veitchia filifera* complements the whitish trunk. 12 (right). *Physokentia thurstonii* is a small to moderate, understory, stilt-root palm with a bright green, prominently and closely ringed trunk, and conspicuous, swollen, grayish crownshaft.

Metroxylon vitiense and *Calamus vitiensis*. Although we would see the last two species elsewhere in Fiji, it was our only opportunity to see *N. storckii* because of its restricted distribution, so we allocated several hours to explore wet, muddy, highly disturbed forest in search of this handsome palm. With long, spreading, pinnate leaves, *N. storckii* is a large palm (Fig. 5) and has whitish inflorescences that contrast nicely with the poorly developed but black crownshaft (Fig. 6). The bright red fruits are large and showy, adding to the palm's handsome nature. Unfortunately, there is little regeneration in this disturbed site, which is much the same in the other, highly restricted sites where *Neoveitchia storckii* occurs, and thus making it an endangered species. Later in the afternoon on the return to Suva we stopped along the road to Mt. Nakabalevu, where we again saw *Balaka microcarpa* and *Veitchia vitiensis*.

On the morning of October 3 Masi and I headed west from Suva along the southern coastal route to Nadi. At the small settlement at Naboutini we turned north or inland into the mountains along a dirt road to Nabukelevu to visit the unnamed and highly endangered, pinnate-leaved species of *Cyphosperma*, heretofore known only from and by its location, Naboutini. (For a complete and illustrated account of this new species see Hodel and Marcus, in this issue). In some ways it was like a pinnate-leaved version of Big Leaf but differed in its larger habit and lower, somewhat drier habitat. In the area we also saw scattered individuals of *Veitchia joannis* poking their canopies high above the surrounding vegetation.

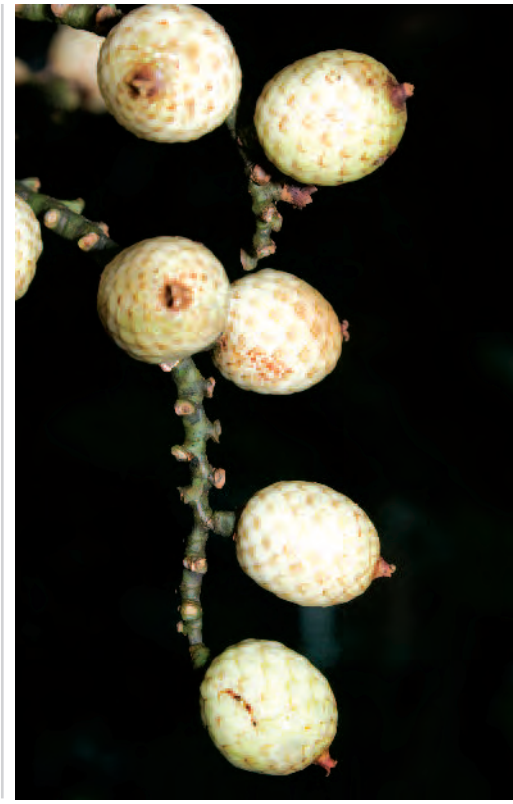
We returned to the main southern coastal road around Viti Levu and drove to Galoa, where once again we turned inland or north into the mountains, this time on the road to Waibogi. In a short while we encountered vast stands of the splendid *Hydriastele vitiensis*, which covered valleys, slopes, and ridges, thrusting its spectacular canopy of arching, slightly recurved, pinnate leaves well above the forest trees (Fig. 7). A tall palm, *H. vitiensis* has a well developed, brownish white, slightly swollen crownshaft and broom-like inflorescences. Strangely, this abundant, conspicuous, and relatively easy-to-access palm was only

13 (above left). *Calamus vitiensis* is a climbing rattan. 14 (above right). Leaf bases of *C. vitiensis* are densely spiny. 15 (below). The handsome fruits of *C. vitiensis* are small, white, and densely covered with scales.

discovered in the late 1970s and named in 1982 as *Gulubia vitiensis*. *Balaka longirostris* and *Veitchia vitiensis* grew nearby in the forest understory, completing our palm adventures for the day.

October 4 found Masi and me again along the southern coastal route to Nadi, this time turning north or inland into the mountains at Nabukavesi on a well maintained but dirt road to Namosi. *Veitchia vitiensis* was again common in this wet and intriguing forest, and we also encountered an unusual, and at that time, unnamed species of *Balaka*, commonly but erroneously referred to as *B. macrocarpa*. In my synopsis of *Balaka*, which I referred to earlier, I named this species *B. diffusa*.

Returning to the southern coastal route, we drove to Navua, where we once again turned off the main road to the north into the low hills on a poorly maintained dirt road to Nakavu Village. Here we found, in highly disturbed forest thick with invasive vines, *Heterospathe phillipsii*, named in 1997 in honor of the late Dick Phillips. A slender, moderate, pinnate-leaved palm (Fig. 8), *H. phillipsii* lacks a crownshaft and typically carries many, much



branched infructescences arising from among the leaf bases and holding the small, bright red fruits.

With several hours of daylight remaining, we returned to Suva and visited the nearby Rewa River delta area, where we photographed nice stands of *Metroxylon vitiense* (Fig. 9) and *Veitchia joannis* growing in low, wet, sometimes swampy land. Both are tall palms with pinnate leaves, and the robust *M. vitiense*, upon reaching maturity, sends forth inflorescences from the top and center of the canopy, thus signaling the end of the life of the palm. Like all *Metroxylon*, the large, handsome fruits of this species are covered with attractive, shiny scales. *Veitchia joannis*, which unlike *Metroxylon*, has a distinct and well developed crownshaft below which are the dense, much branched infructescences with large, red fruits, has a slender trunk and arching pinnate leaves.

On the morning of October 5 Masi and I flew to Vanua Levu Island and landed near Savusavu, where we met up with Jim Valentine, an Australian who has a nursery and landscape business in an idyllic setting overlooking picturesque Savusavu Bay. Jim would accompany us in our palm exploration on Vanua Levu and Taveuni and generously provided the use of his 4-wheel drive pick up truck. We drove straight to Lambasa on the north side of Vanua Levu, and after settling into our hotel, we ate lunch and planned our activities for the next several days.

The morning of October 6 dawned overcast with the threat of rain but, nonetheless, we drove south from Lambasa, navigating a labyrinth of confusing dirt roads, toward Matani Creek and the track up Mt. Sorolevu, an exciting area for palms with no fewer than five genera and seven species present, including the mostly understory *Veitchia filifera* and *Balaka* "Bulitavu," *B. seemannii* and *B. streptostachys* at lower elevations and the larger *Clinostigma exorrhizum*, *Heterospathe longipes* and *Hydriastele vitiensis* higher up.

The main objective on Mt. Sorolevu was to see *Balaka* "Bulitavu" and determine its proper taxonomic status and correct name. In a steady rain we drove as far as we could up the Mt. Sorolevu track before an immense, ugly

16 (left). *Cyphosperma trichospadix* is a small to moderate, mostly understory palm with a slender, closely and conspicuously ringed trunk and pinnate leaves. 17 (right). A tall, emergent species, *Clinostigma exorrhizum* has a stunning canopy of long, pinnate leaves with numerous, slender, elegantly pendulous pinnae.

washout abruptly terminated our ascent. Jim and Masi, who had visited the area previously, had been able to drive much farther up Mt. Sorolevu but today our fate was to walk some distance in the steady rain before entering the forest to explore for palms. The rain increased to a torrential downpour, forcing me on several occasions to stand under an umbrella for five to ten minutes at a time, camera and note pad patiently in hand, waiting for the slightest break in the rain to snap a few photos. Fortunately, our persistence under the most deplorable conditions enabled me to gather some good photos and determine that *B.* "Bulitavu" was actually *B. macrocarpa*. Although we saw a few juvenile *Heterospathe longipes*, the deteriorating conditions and continued heavy rain dampened our enthusiasm for exploring higher up on Mt. Sorolevu to see *Clinostigma exorrhizum* and *Hydriastele vitiensis*, species that we had already seen or would see in other areas, so we returned to the truck and made our descent toward Lambasa.

Farther down Mt. Sorolevu the rain let up and we stopped to observe the widespread and variable *Balaka seemannii* and *Veitchia filifera*, the latter a slender, moderately tall, mostly understory palm with a whitish to brown trunk, distinctly ascending, pinnate leaves (Fig. 10), and a dark green, nearly black crownshaft (Fig. 11). The relatively large, spreading

18 (above). *Veitchia simulans* is a moderate to tall, slender, mostly understory palm with a brownish, closely ringed trunk, a dark green, slightly mottled crownshaft, and canopy of spreading, pinnate leaves. 19 (below). In contrast to the other small, mostly understory *Veitchia* we had encountered so far, *Veitchia simulans* had unusually large fruits.

20 (left). *Hydriastele boumae* differs from *H. vitiensis* in the manner in which it retains large, undivided or few-split leaves nearly to maturity, up until it begins to emerge above the forest canopy, as here with Masi, who provides scale. 21 (right). *Heterospathe longipes* is a moderate understory palm with a slender, brownish, closely ringed trunk and canopy of spreading, pinnate leaves.

infructescences held the full size but not yet red-orange, ripe fruits.

On October 7 Jim, Masi, and I left Lambasa under bright, sunny skies and returned to Savusavu, stopping at Waisali Rainforest Reserve to see *Balaka seemannii* and *Physokentia thurstonii*, the latter a small to moderate, understory, stilt-root palm with a bright green, prominently and closely ringed trunk, conspicuous, swollen, grayish crownshaft (Fig. 12), whitish inflorescence, and curiously sculptured seeds. Stilt-root palms have always held a special fascination for me, so to see and photograph *P. thurstonii* was an exciting experience despite the dense vegetation making photography difficult. Closer to Savusavu we stopped briefly to observe a large stand of *Metroxylon vitiense* in low, wet, swampy land.

After Masi and I settled into our hotel in Savusavu, we ate lunch and visited Jim's house and nursery, admiring the many fine plants he was growing for landscaping, including numerous palms. Over dinner we discussed plans for our last day on Vanua Levu, a trip to Natewa Peninsula to see the unusual *Balaka* "Natewa" that carried large, nearly simple, undivided leaves not just in a juvenile state but nearly to maturity. I suspected this could be *B. macrocarpa* because this species was originally collected in the area.

October 8 was a bright and sunny day as we headed out southeast from Savusavu onto the Natewa Peninsula. We stopped at several places to observe and photograph *Veitchia filifera* and then found a small hill abundant with what was popularly known as *B.* "Natewa" but, which now upon examination, I could confirm it was, indeed, *B. macrocarpa* as we had seen also on Mt. Sorolevu. This Natewa population, though, was intriguing in how it carried the large, mostly undivided leaves nearly to flowering and fruiting.

Upon returning to Savusavu we learned the disturbing news that one of the two Fijian inter-island airlines that was to fly Masi and me

from Taveuni back to Suva and then on to the Southern Lau group to see *Pritchardia thurstonii* had temporarily shut down service, forcing us hurriedly to purchase new tickets on the remaining interisland airline from Taveuni to Suva. Unfortunately, this airline did not fly to the Southern Lau group, putting in jeopardy our plans to visit those islands and see *P. thurstonii*.

We departed Savusavu on the morning of October 9, again heading onto the Natewa Peninsula, but this time to catch the ferry to take us and Jim's truck across the narrow strait to Taveuni Island. After a one-hour ferry ride we landed on Taveuni and drove to Somosomo, purchased food for the next several days and then settled into our rather spartan accommodations.

Although Taveuni promised to be an exciting island for palms, our enthusiasm was somewhat tempered by the wet conditions we had encountered on Vanua Levu. Taveuni is even wetter than Vanua Levu, with some places receiving over nine meters of rain annually! Fortunately, we had three, mostly sunny days on Taveuni, making our stay there a productive and enjoyable time.

I was especially full of excited anticipation on October 10 as we walked up the trail from Somosomo to the Crater Lakes, long a classical and fabled locale with a rich assemblage of palms, including *Balaka seemannii*, *Calamus vitiensis*, *Clinostigma exorrhizum*, *Cyphosperma trichospadix*, *Physokentia thurstonii* and *Veitchia simulans*. On this sunny day the forest was breathtaking, vibrant and exuberant with a rich mixture of palms, shrubs, and trees, many supporting a rich and heavy load of epiphytic mosses, ferns, orchids and aroids. The first palm we encounter was the spiny, climbing rattan *C. vitiensis* (Figs. 13–15), which seemed well adapted to survival in lower, open, disturbed areas as well as in mostly undisturbed forest. Its small, scaly, whitish fruits were unusually attractive (Fig. 15). Again, the widespread and variable understory *B. seemannii* was in abundance and was especially conspicuous with open clusters of showy, red fruits. Farther on in the forest we soon encountered the stilt-rooted *Physokentia thurstonii*, which we had seen earlier on Vanua Levu, and *Cyphosperma trichospadix*, a small to moderate, mostly understory palm with a slender, closely and conspicuously ringed trunk and pinnate leaves (Fig. 16). A more diminutive palm than *C. naboutinense* and

22. The especially showy and fragrant, bright red fruits of *Heterospathe longipes* are held on short infructescences that arise from among the deeply split leaf bases.

23. Before weathering away, trunks of *Clinostigma exorrhizum* are covered with white, powdery wax.

even *C. tanga*, it nonetheless has the same deeply split, green leaf bases that do not form a crownshaft and from which the few branched inflorescences arise.

A little farther on we began to see *Clinostigma exorrhizum*, a tall, emergent species with an attractive, smooth but ringed, whitish green to brown trunk supported on a cone of thick, robust stilt roots, a well developed elongate, greenish crownshaft, and a stunning canopy of long, pinnate leaves with numerous, slender, elegantly pendulous pinnae (Fig. 17). Many short-branched inflorescences in all stages of flower and fruit were held just below the crownshaft and were particularly showy when heavily laden with small, red fruits.

As we made our late-afternoon return down the trail to Somosomo, we stopped to admire and photograph *Veitchia simulans*, a rather shy, moderate to tall, slender, mostly understory palm with a brownish, closely ringed trunk, a dark green, slightly mottled crownshaft, and canopy of spreading, pinnate leaves (Fig. 18). In contrast to the other small, mostly understory *Veitchia* we had encountered so far, this species had unusually large fruits although not as large as those of *V. joannis* (Fig. 19).

On October 11 we drove to the southeast side of Taveuni to make a trek into the Vidawa Rain Forest Walk, reputed to be one of the wettest places in Fiji, but that featured many fine palms, including *Balaka seemannii*, *Calamus vitiensis*, *Heterospathe longipes*, *Hydriastele boumae* and *Veitchia filifera*. With sunny, cooperative weather, we checked in at the park's headquarters, paid our entrance fee and hired the required Fijian guide to take us up into the forest. The first palm we encountered and the most abundant and widespread was *H. boumae*, which, like its close relative on Vanua Levu and Viti Levu, *H. vitiensis*, was an emergent species with a tall, brownish trunk, conspicuous, swollen, whitish crownshaft, canopy of arching, recurved, pinnate leaves, and broom-like inflorescences (Back Cover). Its most unusual but striking feature, and one of its distinguishing characters, was the manner in which it retained large, undivided or few-split leaves nearly to maturity, up until it began to emerge above the forest canopy (Fig. 20).

Heterospathe longipes, a moderate understory palm with a slender, brownish, closely ringed trunk and canopy of spreading, pinnate leaves, was locally common (Fig. 21). It has deeply split leaf bases that do not form a crownshaft but from which the relatively short, heavy, few branched inflorescences arise. These hold the whitish staminate and pistillate flowers and later the large, especially showy and fragrant, red fruits (Fig. 22). Unfortunately, many of the leaves showed extensive and severe skeletonizing from an unknown pest.

Our last day on Taveuni, October 12, was spent along the road to the summit of Des Voeux Peak, another traditional locale for palms. Under foggy but not rainy conditions we observed many fine specimens of *Clinostigma exorrhizum*, and here the cone of stilt roots, which supported the handsome, greenish brown, ringed trunk with a heavy, white waxy glaucous covering (Fig. 23), was unusually well developed (Fig. 24). On some individuals the cone of stilt roots reached nearly two meters up the trunk and spread for well over two meters at the base. The large, thick, robust

roots emerged bright orange, their enlarged tips capped with a mossy glove, before aging to the more common brown. Close by were a few specimens of *Veitchia simulans*, a species that we had seen several days earlier on the trail from Somosomo to Crater Lakes. As we descended Des Voeux Peak the rain began in earnest and we felt fortunate to have had three days of mostly fine weather in one of Fiji's rainiest places.

On October 13 Masi and I said our good byes and thanks to Jim for his admirable companionship and help in the field, and we boarded our plane for the flight back to Suva. Upon arrival in Suva we immediately and persistently tried to make new arrangements to travel to the Southern Lau group to see *Pritchardia thurstonii*. Unfortunately, it became increasingly clear that a trip to the Southern Lau group was impossible to arrange for the last few days of my Fijian stay and, with much disappointment, I realized my sojourn to see *P. thurstonii* would have to wait for another time.

I spent my extra days in Suva wisely, examining *Balaka* and *Cyphosperma* specimens at the herbarium at the University of the South Pacific and, with Masi, visiting public and private gardens to see cultivated specimens of exotic and Fijian palms. The Thurston Gardens in Fiji contained many fine specimens of Fijian and other Pacific Island palms, many planted by the late Dick Phillips, including mature, fruiting *Carpoxylon macrospermum*, various *Veitchi*a, and the Melanesian form (small-fruited) of *Pelagodoxa henryana*. Another fine collection of palms is in the small botanical gardens of the University of the South Pacific, and several places on the campus had fruiting Fijian palms, including *Heterospathe phillipsii*, *Neoveitchia storckii* and various *Veitchia*. Dick Watling, author of the exceedingly handsome *Palms of the Fiji Islands*, has perhaps the finest collection of Fijian palms, including several notably specimens of *Balaka*, *Heterospathe longipes*, *H. phillipsii*, *Metroxylon vitiense*, *Neoveitchia storckii* and various *Veitchia*.

One day I spent with Marika Tuiwawa, director and curator of the herbarium at the University of the South Pacific, traveling to the west on the southern coastal route towards Nadi, stopping at a few places around Pacific

24. Masi provides scale for this exceptional cone of orange stilt roots supporting the trunk of this *Clinostigma exorrhizum*. Note the root tips clad in their mossy "gloves."

25. The conspicuous, rose-colored inflorescence of *Physokentia petiolata* distinguishes it from *P. thurstonii*.

Harbour to see *Metroxylon vitiensis* and the widespread and variable *Balaka longirostris* and then visiting Robbie Stone's superb collection of exotic and Fijian palms, many received from the late Dick Phillips.

My stay in Fiji was fast approaching its final days, and on October 18 Masi and I planned once again to traverse the center of Viti Levu from Suva to Nadi to return to Monasavu Dam to see *Clinostigma exorrhizum* and *Physokentia petiolata* before my late night departure to Los Angeles on October 19. Around midnight on October 17 I was awakened by a strong, steady rain, which by morning had turned into a torrential downpour, easily one of the heaviest rains I had ever experienced. I was sure that our trip through the center of Viti Levu would have to be cancelled and I would be returning to Los Angeles without seeing all the palms I had intended to see. However, when Masi arrived at the hotel early in the morning of October 18 he assured me that we should still make an attempt across the center of Viti Levu! I was stunned and much less confident than Masi, but nonetheless, we set out in a driving rain, negotiating flooded streets as we made our way through a nearly deserted Suva, heading for the road to Monasavu Dam in the center of Viti Levu. Easily the scariest point of the trip was when we had to cross a raging tributary of the Rewa River. The brown, swiftly moving water was actually slightly lapping over the top of a narrow, one-lane bridge about 50 meters long. I hesitated before crossing but Masi assured me it was safe, so off we went, and I gave a huge sigh of relief when we reached the other side. Later we learned that the bridge had to be closed because of rising water.

Out troubles were not over, though, because on several occasions we had to traverse long, deep pools of water in the heavily rutted road and on more than one occasion water rose so high that it came inside the cab of our vehicle, flooding the floor. The rain continued as we made our way up the switchbacks of the eastern escarpment of Viti Levu. The mountain seemed to be oozing water, for at nearly every turn of a switchback a raging, roaring torrent was gushing forth from the mountain and tumbling over rocks into the rainy, misty, unseen depths below. As we neared the top of the switchbacks the rain ceased abruptly and we were greeted with leaden, overcast, drizzling skies. Once the sun even tried to fight its way through the clouds, and we stopped to

admire several handsome *Veitchia joannis* with heavy, elegantly pendulous pinnae (Front Cover) before continuing on to Monasavu Dam.

At the dam we gained admission to the access road and Masi quickly guided me right to *Physokentia petiolata*, a small, understory, stilt-rooted palm that differed from *P. thurstonii* in its striking, rose-colored inflorescences (Fig. 25). Although the dense, thick vegetation was dripping wet, we lingered, taking photographs and notes, admiring this palm and its cool, mossy, mountain habitat for some time. We had to push on, though, so we drove farther along the access road, finally stopping to view an extensive population of *Clinostigma exorrhizum*. I took more photographs but time was calling and we turned around and headed back to the main road and continued our cross-island trek, arriving in Nadi late in the afternoon.

The next morning I said my heartfelt thanks and goodbyes to Masi, who returned to Suva via bus, and I spent the day touring the grounds of the Garden of the Sleeping Giant just north of Nadi. A superb garden, it contains fine, mature specimens of exotic and Fijian palms, many that Dick Phillips provided. My time in the garden was relaxing and made for a perfect end to my nearly three-week sojourn in which I was fortunate to observe all but one of Fiji's native palm species. Seeing *Pritchardia thurstonii* in the Southern Lau group, now becoming a life-long quest, would have to wait for another trip.

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The International Palm Society and Audrey and Philip Keeler supported my travel to Fiji. Jim Valentine and especially Sakiusa Masitoqui were admirable companions in the field, helping to locate palms more easily and rapidly and making for a most enjoyable time. Marika Tuiwawa facilitated my studies in the herbarium at the University of the South Pacific (SUVA) and accompanied me on one short field trip and to see Robbie Stone's garden. Robbie Stone and Dick Watling graciously opened their fine gardens to me. The staff at the Garden of the Sleeping Giant generously shared their garden with me, even permitting me after-hours access. All have my sincere thanks.

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Cyphosperma naboutinense, a New Species from Fiji

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1. *Cyphosperma naboutinense* is a solitary, slender, understory palm in the rain forest near Naboutini, Viti Levu, Fiji.

A new species of *Cyphosperma*, *C. naboutinense*, is described and illustrated.

This new species of *Cyphosperma*, long recognized by palm enthusiasts and others as likely to be distinct, is restricted to a small area along the southern coast of Viti Levu, Fiji's largest island. Marcus has grown it in his nursery in Hawaii for several years where it has flowered and fruited regularly. Because he has widely distributed seedlings since 2009, it

2. In areas disturbed by logging near Naboutini, Viti Levu, Fiji, *Cyphosperma naboutinense* is often exposed to higher light or full sun and has a more compact canopy.

is named and described here as a new species. This paper, part of a larger, long-term project on Pacific Island palms that Hodel is leading, is based on the examination of wild-growing plants in Fiji, cultivated plants in Hawaii, and herbarium specimens in Fiji and California.

Cyphosperma naboutinense Hodel & J. Marcus, **sp. nov.** *C. tanga* affinis sed foliis pinnatis differt; *C. trichospadici* affinis sed fructibus minoribus (13 × 8 mm vs. 21 × 18 mm) differt. Typus: Fiji. Viti Levu. Serua Prov.: ca. 6 km north of Naboutini along main logging road, *Fuller et al. 302*, 17 November 1995 (Holotypus CAS!, Isotypus SUVA!). Figs. 1–7.

Solitary, slender, unarmed, pleonanthic, monoecious, understory tree palm to 12 m tall (Figs. 1 & 2). Stems 10–12 cm diam., green

aging to brown or gray, with slightly raised, irregular leaf scars, these 1 cm wide, internodes 6 cm (Fig. 3). Leaves 15–18, pinnate, ascending to mostly spreading, to 2.8 m long, canopy typically with several persistent, dead, brown leaves hanging below the green ones (Fig. 5); leaf bases to 30 cm long, deeply split opposite petiole and not forming a crownshaft (Fig. 4), green distally, dark brown proximally, persistent on the distal 75–100 cm of stem below the leaves; petiole to 75 cm long, green, convex abaxially, concave adaxially; rachis to 2 m long; pinnae 25–30 on each side of rachis, mid- and proximal mid-blade pinnae largest, these 75 × 4.5 cm, lanceolate, sigmoid, long-acuminate, opposite to subopposite, midrib prominent adaxially, lacking scales, 1 primary nerve and 1 or 2 secondary nerves on either side of midrib, proximal pinnae subopposite, to 40 × 2.5 cm, most distal pinnae to 35 × 4 cm, all nerves slightly more conspicuous abaxially with midrib having 10–15, slender, reddish brown, medifixed ramenta 5–10 mm long in proximal 20 cm. Inflorescences several, interfoliar in flower, interfoliar or infrafoliar in fruit, exceeding petiole but much shorter than leaves, to 1.6 m long, laxly branched to 3 orders (Fig. 6); peduncle to 75 cm long, 11 cm wide at attachment, 6 cm wide at prophyll scar, narrowing to 2 × 1.2 cm at 1st peduncular bract; prophyll not seen but attached 3 cm distal of base and incompletely encircling peduncle at attachment, 1st peduncular bract attached 3 cm distal of prophyll attachment, to 75 cm long, tattered, long-acuminate, 2nd peduncular bract attached 28 cm distal of prophyll, to 3 cm long, tattered, 3rd peduncular bract not seen but attached 37 cm distal of prophyll; rachis to 85 cm long with up to 9 branches and 6 unbranched rachillae, branches attached at right angles to rachis, proximal 1st-order branches with up to 5 2nd-order branches and 5 rachillae each, peduncle of 1st-order branches to 35 cm long, rachis of 1st-order branches to 30 cm long, peduncle of 2nd-order branches to 18 cm long, rachis of 2nd-order branches to 7 cm long, 3rd-order braches simple rachillae, bracts subtending large, proximal branches to 35 cm long, long-acuminate, bracts subtending smaller branches and rachillae to 5 cm long, short-acute to long-acuminate; up to 70 rachillae, these to 45 cm long, 1.5 mm diam. at base, 1 mm diam. at apex; peduncle, rachis, and rachillae with reddish brown tomentum. Flowers in triads of later-opening, central pistillate flower flanked on each of two sides by earlier-opening staminate flowers, triads 5–15 mm distant proximally becoming more densely placed to nearly contiguous distally where replaced with solitary or paired staminate flowers, triads in clefts 3 mm long, 1.5 mm wide, 0.5 mm deep, subtended proximally by knife-like bracteole 1 mm high, 2 bracteoles subtending pistillate flower 1.75 mm high, 2.25 mm wide, imbricate, nerved abaxially, 1 bracteole subtending each staminate flower 1 mm high. Staminate flowers whitish, 5–6 × 6–8 mm; calyx 1–1.25 × 2 mm, cupular, sepals 1.25 × 2 mm, cup-like, broadly rounded to truncate distally, imbricate nearly to apex; petals 2.75–3 × 1–1.25 mm, boat-like, valvate, prominently nerved abaxially, less so adaxially; stamens 6, 5–6 mm high, exserted beyond petals, attached on a short base 1 mm high, filaments 4–4.5 mm long, slender, spreading, connate basally and there adnate to proximal 0.75–1 mm of pistillode, anthers 1–2 mm long, medifixed dorsally; pistillode 2.75–3.5 mm high, columnar, ± stout, prominently grooved longitudinally when dry and apex enlarged.

3. Stems of *Cyphosperma naboutinense* are green aging to brown or gray, with slightly raised, irregular leaf scars (Naboutini, Viti Levu, Fiji).

4. Like all species in the genus, *Cyphosperma naboutinense* has deeply split leaf bases not forming a crownshaft (Naboutini, Viti Levu, Fiji).

Pistillate flowers in bud 3 × 2 mm; calyx 2.5 mm high, cupular, sepals 2.25–2.5 × 2.25–2.5 mm, cup-like, prominently nerved abaxially, less so adaxially, imbricate nearly to apex; petals 2.5 × 2–2.25 mm, boat-like to cupular, mucronate, prominently nerved abaxially, less so adaxially, imbricate nearly to apex; pistil 2.5 ×1.5 mm, proximal 1.75 mm globose, pebbled, style 0.75 mm long, smooth; staminodes 0.4 × 0.2 mm, tooth-like. Fruit 13 × 8 mm, dark orange when fresh ripe, conspicuously bumpy when dry (densely covered with small but prominent, rounded protuberances); perianth 3–4 mm high, sepals 2.5–3 mm high, petals 3–4 mm high. Eophyll bifid (Fig. 7).

5 (top). In its natural condition as an understory palm the canopy of *Cyphosperma naboutinense* is composed of gracefully arching and spreading leaves. Note the several, persistent dead, brown leaves hanging below the green leaves (Naboutini, Viti Levu, Fiji). 6 (bottom). Inflorescences of *Cyphosperma naboutinense* are interfoliar in flower but may become infrafoliar in fruit, are longer than petiole but much shorter than leaves, and branched to three orders (Naboutini, Viti Levu, Fiji).

Distribution and Ecology: *Cyphosperma naboutinense* is known only from Naboutini in Serua Province along the southern coast of Viti Levu, Fiji. At the type locality slightly inland from the coast, it is restricted to several, small populations confined to four adjacent drainages in lowland rain forest at about 300 m elevation.

7. The eophyll and seedlings of *Cyphosperma naboutinense* are bifid (Naboutini, Viti Levu, Fiji.

Additional Specimens Examined: Fiji. Viti Levu. Serua: Naboutini, *Fiji Dept. Agric. 13992* (*Koroiveibau & Qoro*) (SUVA); ca. 6 km north of Naboutini along main logging road, *Fuller et al. 181* (CAS, SUVA).

Notes: *Cyphosperma* includes five species of solitary, moderate to large, pinnate-leaved, rain forest palms indigenous to Fiji (three species), Vanuatu (one species), and New Caledonia (one species) in the southwest Pacific. Members of the genus lack a crownshaft and have an incomplete prophyll (initial bract enclosing the inflorescence does not entirely encircle the peduncle at the point of attachment), long-pedunculate, mostly interfoliar inflorescences and conspicuously sculptured seeds. A member of the subtribe Basseliniinae, *Cyphosperma* is likely to be most closely related to *Basselinia*, *Burretiokentia*, *Cyphophoenix* and *Physokentia*.

Cyphosperma tanga (from Viti Levu) and *C. trichospadix* (from Vanua Levu and Taveuni), the other two Fijian species, differ in their mostly undivided leaf and much larger fruit, respectively. Also, *C. tanga* has scales on the adaxial midrib of the pinnae, a feature lacking in *C. naboutinense*. The species from New Caledonia, *C. balansae*, differs in its much larger habit and size of various organs, the thicker, heavier texture of the leaves, the peduncle exceeding the petiole and the stem with prominently indented leaf scars. The relatively poorly known species from Vanuatu, *C. voutmelense*, which in gross morphology may be the most similar species to *C. naboutinense*, differs in its much smaller habit and size of various organs, the low, rounded bracts subtending the inflorescence branches and the ramenta on the midrib of the abaxial surface of the pinnae apparently restricted to the very proximal area near the attachment to the rachis.

Cyphosperma naboutinense was first collected in 1964, and Moore (1979), in his treatment of palms for the *Flora Vitiensis Nova*, included this 1964 collection with *C. tanga* although he made note of the differences in leaf division and habitat between the two taxa. However, it was not until the early 1990s that the late Dick Phillips, long a grower and champion of Fiji's amazingly rich and diverse treasure trove of palms, suspected that this taxon from Naboutini was distinct and brought it to the attention of others. Fuller (1997), in his excellent and comprehensive treatment of Fijian palms, and Watling (2005), in his superb and handsomely illustrated account of Fijian palms, referred to this taxon as *Cyphosperma* sp. "Naboutini," also the name under which Marcus has distributed seedlings.

Conservation Status: *Cyphosperma naboutinense* currently has no risk assessment designation (IUCN 2010). However, Fuller (1997) and Watling (2005) contended that it should be considered Critically Endangered according to IUCN criteria because of its small population size of only about 50 mature plants in or near a highly disturbed site that was logged and then replanted with mahogany. Logging has occurred near the site for many years. According to Watling (2005), the first generation of mahogany was logged in 2003, which severely damaged or killed many palms. Watling also reported that local people were aware of the palms and their precarious existence, and they were trying to prevent further logging damage. However, when DH visited the site in October, 2008, active logging operations were underway, and many palms had been recently damaged or destroyed.

The narrow, restricted range of *Cyphosperma naboutinense* increases susceptibility to a single, disruptive event, like a cyclone, and to potential damage from invasive weeds, animals, pests and disease. Low seedling recruitment and small population size suppress regeneration. Because it is readily and easily accessible on Fiji's main island, fruits and/or small plants have been occasionally gathered, and *C. naboutinense* is now cultivated in Fiji, Hawaii and perhaps elsewhere.

Culture: Marcus planted seeds of *Cyphosperma naboutinense* and *C. trichospadix* in 1993 at his nursery near Kurtistown on the island of Hawaii, an area of mild temperatures (19–29ºC, 65–85ºF) and abundant rain (250 cm, 100 inches annually). Resulting seedlings were sufficiently large to plant out in 1995, and plants of both species began to flower in 2008. They are perhaps the only fruiting plants of these two species in cultivation.

From flowers to mature fruits takes about one year for *Cyphosperma naboutinense*. Seeds germinate readily, and seedlings are easy to grow. With *C. trichospadix* and *C. balansae*, in contrast, from flowers to mature fruits takes longer, germination is more sporadic and seedlings somewhat trickier to grow. Marcus has less experience with *C. tangae,* but seeds of this species germinate much more slowly and sporadically than the others.

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A New Species of *Ptychosperma* from Halmahera, North Moluccas

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1. The typical ultramafic heath forest in Halmahera Island, North Moluccas with the crown of palm *Hydriastele* sp. towering up above the forest canopy.

This most attractive species of *Ptychosperma* has recently been discovered in Halmahera, North Moluccas. The combination of morphological characters and its area of distribution make this new species most distinctive. It is also very decorative and would make a fine ornamental.

2. *Ptychosperma halmaherense*, showing slender and solitary habit and growing on steep terrain.

As part of an environment impact assessment undertaken in the Maba-Ferro Nickel Project, in Halmahera Timur, North Moluccas, I had the privilege to join the team as botanist to carry out the initial survey of biodiversity in the area. The initial survey took one week with the aim of gathering data of plant species occurring in the area and other related information, including distribution and conservation status. The result of the survey will enhance the preliminary data and information from previous studies and

3. Crown of *Ptychosperma halmaherense*, showing beautiful strongly-arching leaves, the crownshaft and the inflorescences.

contribute to the development of the environmental management of the project, especially in support of the post-mining rehabilitation program. The main target was the heath forest developed on ultramafic soils, which will be most affected by the mining.

The ultramafic heath forest on Halmahera is very interesting, characterized by uniform forest canopy, slightly grayish in color and composed of dwarf vegetation. In some areas there is a mosaic of forest disturbance, with clumps of dead trees caused by periodic dieback and/or forest burning (Fig. 1). This type of forest is mostly dominated by *Gymnostoma* aff. *papuana* (Casuarinaceae), *Ploiarium sessile* (Bonnetiaceae), *Leptospermum* sp. (Myrtaceae), *Hydriastele* sp. (Arecaceae), *Pandanus* sp. (Pandanaceae), *Myrsine rawecensis* (Myrsinaceae), *Calophyllum* spp. (Clusiaceae), *Gnetum gnemon* (Gnetaceae), *Podocarpus polystachyus* (Podocarpaceae), a few species of *Syzygium* (Myrtaceae) and some species of the coffee family Rubiaceae. The tree *Nageia wallichiana* (Podocarpaceae) is also found but is very rare in this forest type. *Nepenthes danseri* (Nepenthaceae) and *Carex* sp. (Cyperaceae) were abundant as ground cover on rocky outcrops and areas regenerating after burning. This composition reminded me of the ultramafic heath forest on Gag Island in the Raja Ampat Islands, in northwestern New Guinea, in which a species of *Hydriastele* is so dominant with its crowns reaching up out of the forest canopy. This spectacular scenery is not known on other islands in Raja Ampat or even in the main island of New Guinea. The discovery of a species of *Ptychosperma* in ultramafic heath forest on Halmahera is most unexpected, far from any other species in the genus (Figs. 2–7).

The genus *Ptychosperma* Labill. consists of 29 species (Dransfield et al. 2008, Zona et al. 2011) and is most abundant in New Guinea. Eleven species are distributed outside the main island of New Guinea, such as the westernmost species *P. propinquum* in Aru Island and Kei Island in Moluccas, the southernmost species *P. elegans* in Queensland, Australia, and the easternmost species *P. salomonense* in the Solomon Islands (Essig 1978). The taxonomy of the genus still remains challenging, especially at the species level (species circumscriptions, their relationships and re-assessment of infrageneric classification). For instance, from 29 accepted names of the species in the genus, only 25 names were accepted in the last revision of the genus *Ptychosperma* by Essig (1978), and another four names as dubious or confused taxa because they were described from single specimens

and/or from material cultivated in Bogor Botanic Garden, West Java, Indonesia, where the plants no longer survive.

Essig (1978) proposed four subgenera and two sections within the genus; they are subgenenera *Ptychosperma*, *Actinophloeus*, *Ponapea* and *Korora*, but the latter two are now included in the resurrected genus *Ponapea* based on the recent molecular phylogeny studies (Dransfield et al. 2008; Baker et al. 2009, 2010; Zona et al. 2011). Essig (1978) also proposed sections *Actinophloeus* and *Caespitosa* under subgenus *Actinophloeus* based on characters of the pistillode of the staminate flowers, rumination of the endosperm, seed shapes in cross section and the stem solitary or clustering.

Taxonomic treatment

Ptychosperma halmaherense *Heatubun* **sp. nov.,** habitu solitario et endospermio ruminato ad subgenerum *Ptychosperma* pertinens; species geographice sejuncta a Halmahera in solis serpentinis crescens; inflorescentia in 3 ordines ramificans floribus staminatis et pistillatis minimis, atropupureis, staminibus 16; fructus luteus perianthio persistenti atropurpureo distincto, endocarpio laeve non porcato; a ceteris speciebus subgenerum *Ptychospermatis* endocarpio perfecte laeve non porcato bene distincta. Typus: Indonesia, North Moluccas Province, Halmahera Timur Regency, Maba Town, PT. Buena Persada (Solway International) Nickel Mining Concession Area, Gunung Batu, 25 Feb 2011, *Heatubun 1125* (Holotypus MAN!; isotypi K!).

Solitary, pleonanthic, moderate tree palm. Stem up to 12 m tall, 5–7 cm diam.; internodes 5–7 cm long, light brown to whitish, with nodal scars conspicuous, dark brown. Leaves 9 in crown, pinnate, strongly arching, 190–200 cm long (including petiole); sheath tubular, 40–50 cm long and about 15 cm wide, smooth, greenish-brown, slightly powdery, covered by white wax; crownshaft well defined, up to 75 cm long; petiole 22–23 cm long, about 2 cm wide and 1.1 cm thick at the base, channeled adaxially, rounded abaxially; rachis arching, somewhat flat adaxially, slightly rounded abaxially; blade with regularly arranged leaflets, 25–26 on each side of the rachis, longest nearest the petiole and gradually becoming shorter towards the apex, middle leaflets erect, somewhat stiff, borne on adaxial surface of rachis, forming a V-shaped blade; leaflets single-fold with inconspicuous main vein, basal leaflets somewhat lanceolate, 55–75 cm long, 2.5 cm wide, tip acuminate with projecting dangling remains of the rein, up to 27 cm long, middle leaflets somewhat elongate, lanceolate, 44–48 cm long, 3.5–4 cm wide, tip truncate, terminal leaflets somewhat elongate, 12.5–15 cm long, 0.3–1.2 cm wide, paired or just one, tip truncate, leathery, slightly discolorous when dried, light brown adaxially, paler abaxially, conspicuous large brown ramenta on abaxial veins. Inflorescence infrafoliar, up to 65 cm long at anthesis, protandrous, branching to 3 orders, with 18–20 branches (including terminal rachilla); peduncle 10–15 cm long, dark purple to light orange with numerous minute purple-brown trichomes; prophyll about 20 × 4 cm, lanceolate, 2-keeled, leathery, cream to light brown, entirely enclosing the inflorescence, then splitting longitudinally when inflorescence expanding and still enclosed with peduncular bract, and falling before staminate flowers anthesis; complete peduncular bract about 30 × 3 cm, elongate, 2-keeled, leathery, cream to light brown, with abundant tiny purple-dot-like indumentum scattered on surface; upper peduncular bract and other bracts reduced to inconspicuous stubs, horizontal, scar-like grooves or sometimes triangular, very low; rachis purple to light orange; the first order (basal-most) branch 40–45 cm long, about 10–13 branches (including terminal rachilla), 1–7 cm between branches; rachillae numerous, 7–12 cm long, glabrous, elongate, each bearing 8–15 flowers clusters. Staminate flowers very small, elongate, bullet shaped, 5.5 × 2 mm, somewhat asymmetric; sepals 3, imbricate, keeled, rounded, about 2.2 × 2 mm, purple; petals 3, valvate, strongly keeled, 4.5 × 2 mm, elliptic, tip slightly rounded, thick and fleshy, somewhat striate, purple with cream tinge at the tip; pistillode equal in height to the stamens, sometimes inconspicuous, about 2.5 × 0.1 mm, furcate, cream; stamens 16, variable in length, 2.5–4 mm long, filaments 1.75–2 mm long, dark brown, inflexed; anthers somewhat sagittate 2.5–3 mm long, cream-colored, longer than the filaments. Pistillate flowers slightly larger than the staminate, bullet shaped, 6.5 × 6 mm; sepals 3, strongly imbricate, keeled, rounded, 3.5 × 3.5 mm, somewhat asymmetrical, thicker at the base, purple with white line along the margin; petals 3, strongly imbricate, elliptic, 5 × 4 mm, purple with a thin line along the margin; gynoecium ellipsoidal, 4.5 mm high, 2.5 mm wide, purple, stigma trifid, hairy, white at anthesis; staminodes inconspicuous; ovule basal. Fruits

4 (left). Staminate flowers before anthesis of *Ptychosperma halmaherense*, showing the bullet shape typical for Ptychospermatoid palms. 5 (right). Pistillate flowers of *Ptychosperma halmaherense* at anthesis.

13–15 × 10 × 10 mm, ellipsoidal, somewhat beaked, up to 2 mm long, stigmatic remains apical, persistent, black, perianth persistent; epicarp smooth, shiny, very thin, purple and becoming bright yellow or light orange when mature; mesocarp fibrous, about 0.5 mm thick, fleshy, mucilaginous and tanniniferous; endocarp very thin, adhering closely to seed; seed somewhat ellipsoidal, 10 × 8.5 × 7 mm, without any grooves or angles, rounded in cross-section, hilum elliptical, elongate, stretching from base to apex, up to 3 mm wide, raphe branches anastomosing; endosperm deeply ruminate; embryo basal, 2.5 × 1 mm, white.

Distribution: Known only from the type of locality in East Halmahera, North Moluccas, Indonesia.

Habitat: This palm grows on very steep terrain (more than 45°) on rocky outcrops in ultramafic heath forest at an elevation of 530–550 m above sea level. This new species is adapted to the extreme conditions of the ultramafic rock and thin soils, sometimes without any apparent soil. The ultramafic rocks have produced extremely weathered Oxisol soils that are reddish yellow caused by the high concentration of iron, magnesium and other heavy metals, including nickel.

Local Name and Uses: There is no record of local names or uses for this new palm among the local people who live near the area (Maba town and Wailukum village).

Conservation Status: Critically Endangered – (CR B1ab(i)(ii)(iii)(iv)(v)c + 2a; C). This palm meets CR B1ab(i)(ii)(iii)(iv)(v)c + 2a; C criteria for threat category "Critically Endangered" (IUCN 2001), because its extent of occurrence is estimated to be less than 100 km^2 area and is known to exist at only a single location, the type locality. The population of the palm is likely to decline if current activities in the area affect the extent of occurrence, area of occupancy, area, extent and/or quality of habitat, the number of locations and subpopulations and numbers of mature individuals. Besides that, the area of occupancy is estimated to be less than 10 km^2 and is

6 (left). Pistillate flowers *Ptychosperma halmaherense* after anthesis of. 7 (right). Ripe fruits of *Ptychosperma halmaherense*, showing color contrast between fruit, perianth and stigmatic remains.

known to exist at only a single location. Moreover, the population size is estimated to number fewer than 250 mature individuals.

Specimens Examined: INDONESIA. North Moluccas Province, Halmahera Timur Regency, Maba Town, PT. Buena Persada (Solway International) Nickel Mining Concession Area, Gunung Batu, path way back from camp D to the main camp, 00°42'50.6"N, 128°06'02.6"E, 25 February 2011, *Heatubun* 1125 (Holotype MAN!; isotype K!).

Notes: This new species differs from all species in the genus *Ptychosperma* based on the seed morphology, by having a seed without any grooves or angles, fully rounded in cross-section, elliptical hilum elongate from base to the tip and the raphe branches anastomosing. Furthermore, the combination of purple flowers and yellow or light orange fruits is unknown elsewhere in the genus.

Ptychosperma halmaherense belongs to subgenus *Ptychosperma* (*sensu* Essig 1978) based on pistillode of staminate flowers equaling or exceeding stamens in length, fruits small (less than 22 mm long), endosperm ruminate, stem always solitary and inflorescence with upper peduncular bract and rameal bracts reduced to inconspicuous stubs and scarlike grooves; other species in the subgenus are *P. salomonense* Burret, *P. elegans* (R. Br.) Blume, *P. gracile* Labill., *P. rosselense* Essig, *P. tagulense* Essig, *P. ramosissimum* Essig, *P. caryotoides* Ridl. and *P. mooreanum* Essig.

Ptychosperma propinquum (Becc.) Becc. is the nearest species in the area of distribution of the genus. Based on the distribution map provided by Essig (Essig 1978: 448), *P. propinquum* is distributed from the islands of Tanimbar, Kei and Aru in the southeastern Moluccas north to the islands of Misool, Salawati and Batanta in Raja Ampat, Northern New Guinea. I have visited and collected specimens of *P. propinquum* from Salawati Island, Batanta Island, north coast Bird's Head Peninsula and Arguni Bay but have never seen it in Misool Island. However, the distinction between *P. halmaherense* and *P. propinquum* is very clear. *Ptychosperma propinquum* belongs to Essig's subgenus *Actinophloeus* section *Caespitosa,* which is characterized by clustering stems, leaflets irregularly arranged, inflorescence green, upper peduncular bract and rameal bracts prominent and endosperm homogenous. These characters are in marked contrast to *P. halmaherense.*

Ptychosperma halmaherense is the first ultramafic species ever reported in the genus and the westernmost species of the genus.

Since conservation is a major issue, the presence of threatened and endangered species in a mining concession must be taken into serious consideration. The existence of an endemic palm *P. halmaherense* with its conservation status critically endangered on Halmahera is a sensitive issue. Halmahera is one of the most important nickel mining areas in Indonesia, and the mining contributes much to the local economy and also generates a massive impact for regional and national economies. However, conservation and preservation of the endemic flora must be a high priority. The conservation and preservation of this new endemic palm species could be implemented by *in situ* and *ex situ* programs. For *in situ*, I would suggest that the habitat of *P. halmaherense* is demarcated as an enclave within the mining concession and protected. This forest enclave would be a good representation of ultramafic heath forest and would be a "small natural monument" with *P. halmaherense* as a flagship species. In the future, this enclave also would support the post-mining rehabilitation program by providing seeds and seedlings for reclamation activities. The habitat of *P. halmaherense* covers a small area with steep slopes on hillsides but still has good representation of the ultramafic heath vegetation.

For *ex situ* conservation, the approach is much easier to implement. Seeds from this new palm should be propagated first in the nearest town or other places within Halmahera Island, then widening to botanical gardens and then to palm collectors or hobbyists. It is important to involve local communities to increase their awareness about their unique biodiversity and conservation in general. They will get some small economic benefit by selling this beautiful palm to the palm collectors or even to the mining company for reclamation. By doing this, the local communities will be motivated to maintain it. Collaboration between the mining company and local community will be essential for any such schemes. It is hoped that the Corporate Social Responsibility (CSR) scheme – a form of corporate self-regulation integrated into a business model that encourage a positive impact through its activities on the environment, consumers, employees, communities, stakeholders and all other members of the public sphere – will act as the bridge that will bring all of us to our goals, namely, that the nickel ores will be mined, the welfare of people will increase and this endemic palm will still stand.

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Management of the Spiny Palm *Astrocaryum malybo* in Colombia for the Production of Mats

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The palm *Astrocaryum malybo*, endemic to Colombia, is the base of an important handicraft industry in some towns of the Caribbean lowlands. We provide information about fiber harvesting and processing and discuss the sustainability of its current management.

In Neotropical ecosystems, rural communities obtain fibers from an enormous variety of wild plants, including a large number of palms (Macía 2006, Linares et al. 2008). In Colombia, for example, about 20% of all fiber-producing species are palms (Linares et al. 2008). In other South American countries, widespread palm fiber extraction has also been documented (Borgtoft Pedersen 1994, Holm Jensen & Balslev 1995, Borgtoft Pedersen 1996, Vormisto 2002, Coomes 2004, Macía 2006, Hubschmann et al. 2007, Kronborg et al. 2008, Isaza 2011).

Fibers are obtained from different parts of palms, such as stems, leaf sheaths, petioles and, more frequently, the unexpanded leaves (Linares et al. 2008, Isaza 2011). They are used for making baskets, bags, hats, hammocks, mats, brooms and furniture. These items are mainly produced for local use, but some of them have gained great commercial value, and in some areas their trade has a strong impact on local communities (Borgtoft Pedersen 1994, Holm Jensen & Balslev 1995, Borgtoft Pedersen 1996, Castaño et al. 2007, Linares et al. 2008, Isaza 2011, Valderrama 2011). For this reason,

1. *Astrocaryum malybo* growing in fallows in Chimichagua, Colombia.

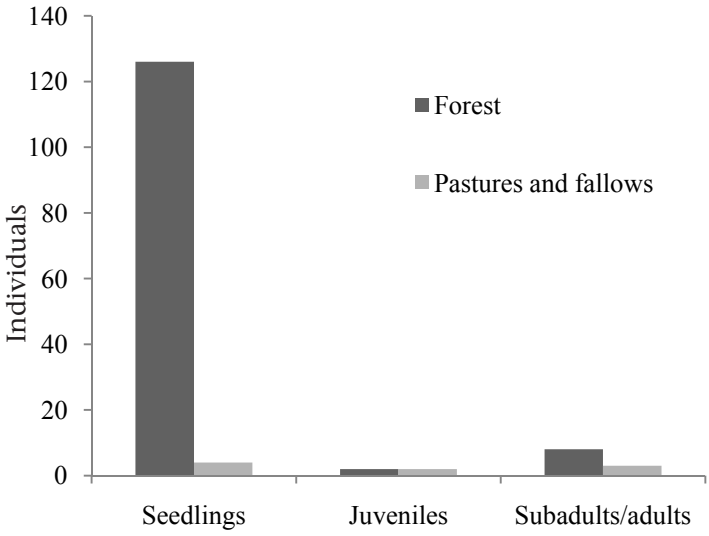
some wild populations of some species have been overexploited and depleted (Castaño et al. 2007, Linares et al. 2008). In other cases, harvest has a low impact, as a result of a low demand, as is the case with *Mauritia flexuosa* L. f., *Mauritiella macroclada* (Burret) Burret, and *Welfia regia* H. Wendl. ex André (Bernal et al. 2011). A more complex scenario occurs when the transformation of ecosystems, especially deforestation for agricultural expansion, causes the reduction of populations, thus increasing the pressure on the surviving palms, modifying traditional harvest practices and causing a greater impact.

A well-known source of palm fibers is the genus *Astrocaryum*. At least 12 species have been reported as fiber-producing plants (Isaza 2011); among these, the most frequently used are *A. chambira* Burret (*chambira*), *A. standleyanum* L.H. Bailey (*mocora* or *güérregue*), and *A. malybo* H. Karst. (*palma estera*) harvested in the Caribbean lowlands of Colombia (Borgtoft Pedersen 1994, Holm Jensen & Balslev 1995, Velásquez 2001, Vormisto 2002, Barrera et al. 2007, Kahn 2008, Linares et al. 2008, Isaza 2011, Valderrama 2011). Fibers from *Astrocaryum* are obtained from the leaflets of the spear leaves. These fibers are processed in two ways: the epidermis of the leaflets is peeled off and twisted to produce strong strings, as in *A. chambira* and *A. standleyanum,* or the leaflet midvein is removed and the whole leaflet blades are used as fiber, as in *A. malybo*. In the last species, which is endemic to Colombia, the leaflets are used to weave mats, an important handicraft industry in some towns of the Caribbean lowlands.

This paper presents information about harvest and processing of *A. malybo* fibers, and discusses the sustainability of its management and the current state of its populations. Data originate from a two year study at the Caribbean lowlands of Colombia, in the towns of Chimichagua and Tamalameque (Cesar), and El Banco (Magdalena), between 8°51′–9°16′N, 72°49′–73°58′W, the area where use of this palm is most important. We studied the state and use of the palm through field observations and interviews with local people; we also considered socioeconomic aspects associated with the use of the fiber and tried to define some bases for its management.

Methods

Study species: *Astrocaryum malybo* is a solitary and usually acaulescent palm, although stems occasionally grow up to 2 m; its leaves reach 5–6 m in length and they are armed with strong spines (Fig. 1). It is a monoecious palm, with female and male flowers in the same inflorescence. Fruits are elliptic or rounded, up to 4 cm long and 2–3 cm in diameter



2. Average number of individuals/ 0.1 ha of seedlings, juveniles and sub-adults/adults (harvested palms) of *Astrocaryum malybo* in secondary forest, and pastures and fallows at Chimichagua, Colombia.

(Henderson et al. 1995, Galeano & Bernal 2010). It is endemic to northwestern Colombia, although it might just reach eastern Panama (Galeano & Bernal 2010); it inhabits wet or dry tropical forests, mainly in the valleys of the Magdalena, San Jorge and Sinú rivers in the Caribbean lowlands, and at the northern end of the Pacific Coast (Galeano & Bernal 2005, Kahn 2008, Linares et al. 2008, Galeano & Bernal 2010). Currently this species is mostly found in small forest fragments, along river margins, or isolated in pastures, due to the deforestation and fragmentation of its natural habitat, especially for agriculture and cattle farming. Natural regeneration is abundant within the forest but limited in pastures, due to the action of cattle. For these reasons, *A. malybo* has been listed as endangered (Galeano & Bernal 2005, Galeano & Bernal 2010).

Field studies: We carried out field observations and interviews to characterize the whole process of *A. malybo*, from harvest to marketing. In order to assess the state of the resource for handicraft use, we established ten 50 × 20 m transects in a patch of secondary forest, and 47 transects in five areas of pastures and fallows. We counted seedlings in plots of 2 × 2 m placed at the beginning, middle and end of each transect. Palms were classified according to their size as: seedlings (first leaf bifid), juveniles (pinnate leaves, leaf length ≤ 2 m), sub-adults (leaf length > 2 m, and suitable for harvesting) and adults (reproductive individuals). In addition, thirty harvested adult palms were followed during one year, in order to determine the spear leaf production rate.

Results

Figure 2 shows the average number of individuals per size classes in 0.1 ha in secondary forest and in pastures and fallows. There were on average eight harvested palms (subadults and adults) in 0.1 ha in secondary forest (range 4–12, n=10) and three in pastures and fallows (range 0–10, n=47) (Fig. 2). In secondary forest, 92.% of the palms were seedlings, 1.4% juveniles, and 5.9% sub-adults and adults, whereas in pastures and fallows 53% were seedlings, 19% juveniles and 28% were subadults and adults.

Based on information obtained from local people and artisans in Chimichagua and Tamalameque, about 158 ha of palm-harboring pastures and fallows and only about 10 ha of secondary forest (several scattered fragments) were harvested in 2009–2010. Although this figure probably underestimates the real abundance of the palm in the area, artisans claim that there is a shortage of the resource. Community inhabitants claim that deforestation and devastation of native vegetation where *Astrocaryum* grows have been a steady activity during the past 15 years.

Harvest: According to artisans, palms can be harvested for the first time when they are 6–8

Table 1. Natural dyes used in *Astrocaryum malybo* mats in Chimichagua, Colombia.

Dye	Color
Jagua (*Genipa americana* L., Rubiaceae)	Blue or green (depending on hour of day)
Bija (*Fridericia chica* (Bonpl.) L.G. Lohmann, Bignoniaceae)	Brown-red
Dividivi (*Caesalpinia coriaria* (Jacq.) Willd., Fabaceae)	Black
Achiote (*Bixa orellana* L., Bixaceae)	Orange-red
Totumo (*Crescentia cujete* L., Bignoniaceae)	Green
Sangregao (*Croton* sp., Euphorbiaceae)	Red
Calostrodiendro (*Cochlospermum vitifolium* (Willd.) Spreng., Bixaceae)	Pale yellow
Uva playera (*Coccoloba uvifera* (L.) L., Polygonaceae)	Purple
Majuagüito (*Senna reticulata* (Willd.) H.S. Irwin & Barneby, Fabaceae)	Pale-green
Mango (*Mangifera indica* L., Anacardiaceae)	Gray
Tuy (*Vismia baccifera* (L.) Planch. & Triana, Hypericaceae)	Terracotta
Peralejo (Byrsonima crassifolia (L.) Kunth, Malpighiaceae)	Pink
Mud	Pale brown
Bija + *sangregao*	Red
Bija + mud	Brown
Dividivi + *achiote*	Orange
Dividivi + ash	Mustard
Majuagüito + lemon (*Citrus limon* (L.) Burm. f., Rutaceae)	Pale yellow
Mud + *bija*	Black

years old and have leaves reaching ca. 2–3 m long. This age estimation, however, may underestimate the duration of the establishing phase, and needs additional long term studies. Harvested palms growing in secondary forest had on average 12 leaves (X=11.57, sd=2.06), 4.7 m long (X=4.68, sd=0.75), and produced three spear leaves/year (X=3.09, sd=0.31). Spear leaves are selected based on their size (≥2 m) and degree of maturity (when they start to expand at the tip and the pinnae are yellow). When the pinnae turn green, the spear leaves are too old to be collected and are useless as a fiber source. Harvesters usually beat the spear leaves to check if the leaflets are loose, indicating that they are ready for harvest. A long wooden hook is used to pull the spear leaves, since *A. malybo* has abundant sharp spines up to 20 cm long. When mature leaves are tightly packed and do not allow easy access to the spear leaf, they are bent or sometimes are cut, causing an extra damage to the palm.

Once the spear leaf is held in one hand, the middle leaflets (measuring up to 1.2 m long) are striped off with the other hand (Fig. 3A). About 100 pairs of leaflets are obtained from a spear leaf, depending on its size. The artisans try to reduce damage by leaving the leaf in its original position and not removing the basal and apical leaflets. In practice, some spear leaves break in the process and eventually die, but most of them survive and continue their natural cycle. It is common to find palms with healthy and fully expanded leaves showing evidence of this kind of selective harvest (Fig. 3B). Occasionally harvesters cut the spear leaf in order to manipulate it in a more comfortable place, to avoid the hazard of being hurt by the spines.

Some artisans believe that it is not appropriate to harvest during the days around full moon, perhaps because a higher water content could make the fiber more vulnerable to pests. However, in practice harvesters and artisans usually collect the spear leaves from the palm at any time, regardless of the moon phase.

To reach the areas where the palm populations are located, artisans need to walk during 15–60

3. Harvesting and processing spear leaves of *Astrocaryum malybo* in Colombia. A. Artisan harvesting spear leaves. B. Palm showing a leaf that was harvested and survives with only some leaflets. C. Artisan processing leaflets. D. Leaflets drying under the sun.

min. They start their journey early in the morning and finish by noon if they find enough material. An experienced artisan harvests up to 20–25 spear leaves per hour, thus obtaining 1.5–2 bundles of leaflets, which are equivalent to an average of 5 kg of dry fiber. Processing fibers is a family activity and includes: removing the spiny margins and the

midribs, splitting each blade longitudinally in two halves, and hanging them to dry under the sun for 3 or 4 hours (Fig. 3C). Spiny margins are thrown away, and midribs are used to make brooms. Leaflets roll up while drying, becoming a rigid material called fiber by artisans. Finally, fibers are left under the sun during some hours every day for at least 2 or 3 days (Fig. 3D).

Craft process: Making mats from *A. malybo* fiber is an ancient tradition, which probably originated from Indians that inhabited the Caribbean region (Andrade 2004), most likely the Chimilas. Although knowledge about fiber use is still preserved among rural inhabitants, only in the south of the departments of Cesar and Magdalena, it has become an economically important activity (Linares et al. 2008). Two types of mats are recognized: traditional and modern mats. Traditional mats, called *petates*, are woven with simple designs, using few colors, and mixing fibers obtained from spear leaves of another palm (*Elaeis oleifera* (Kunth) Cortés, known as *nolí* or *corozo*); among artisans and tourists, traditional mats are little appreciated, resulting in a restricted production and market.

Modern mats, on the contrary, are in great demand, have higher prices, and according to artisans, are more profitable. To a large extent, the great variety of designs in modern mats (Fig. 4) relies on the dyeing process using natural or artificial colors (Table 1). Natural colors are obtained from plants cultivated at home gardens or from wild plants growing in nearby fields or forests. Artisans have been using natural colors since the 1980 s, when they were qualified in this activity as an alternative to improve mat trade.

The first step to make a mat is to build a loom. The loom consists in a wooden frame, frequently made with wood of *lengua de vaca* (*Mabea occidentalis* Benth., Euphorbiaceae), to which two short and sturdy sticks (*balsas*) are tied. The latter support the warp, which is made with polypropylene strings or sometimes with *fique* (*Furcraea cabuya* Trel., Agavaceae) strings. The loom is made depending on the mat size, which is usually up to 1.2–1.5 m tall. After the mat is finished, the loom is dismantled, ant its pieces are put aside for next time.

Before being used, fibers are moistened to prevent breakage. Two aspects determine mat quality: type of weaving, and final touches. High quality mats are considered to be those in which the warp is not easily visible, have no knots or loose ends, the colors are uniform, and the designs are symmetric and sharp. The mat must also be firm, which is proved by rolling it up and standing it on end so that it stays upright. Although mats are made in many sizes, the most common ones are those between 1–2 m^2, that is, small and medium sized mats. Occasionally large mats up 18 m^2 are also made, as well as table mats, coasters and other small handicrafts (Fig. 4A, B).

Productive chain and exploitation of the palm as a source of income: Traditionally, mats were used like utilitarian objects, and their trade was restricted to local markets. They had simple designs and low prices. However, in the last decade, under the auspice of Artesanías de Colombia (the state's firm promoting handicraft production and marketing), Corpocesar (the regional environmental authority) and some NGOs, mats have been promoted as handicrafts with great economic value. Today there is a large demand of *Astrocaryum* mats for the markets of Bogotá, Medellín and other cities. A significant evolution in their design has taken place as a consequence, including geometric figures and plenty of color (Figs. 4A, B).

Artisans usually collect their own raw material. Some harvesters collect the fiber for artisans within their own family or sell it to others. The palms are usually harvested in private lands, with or without permission of the owners, because most of the harvesters are landless peasants or they merely own small plots just large enough for subsistence crops. Although mat-weaving takes place throughout most of the year and incomes are significant, mat production is only a part-time occupation alternated with other economic activities.

In the department of Cesar there are two centers of mat production. The most important one is Chimichagua, where there are seven organizations comprising almost 200 artisans, especially women. The other center is Tamalameque, where there is one organization comprising about 10 artisans. In the department of Magdalena, the activity with *Astrocaryum* is limited to the municipality of El Banco, especially in the village of Hatillo de La Sabana.

At Hatillo de La Sabana, most families harvest the fibers from wild populations close to the village in order to sell them to traders or to artisans in other towns, but they do not produce mats by themselves anymore.

Apparently, they formerly wove traditional mats, but the business became unprofitable and disappeared. In August 2009, processed fibers were sold for US$0.5 per kg, and brooms made from the midribs, were sold for US$0.5–0.7. Incomes from fiber harvesting and processing were limited and sporadic; therefore, families worked on other activities like fishing or agriculture.

In Chimichagua and Tamalameque most artisans make the whole process from harvesting to weaving. Only elderly or unhealthy artisans, who cannot extract fibers, buy spear leaves from other artisans. Prices in this region are similar to those at Hatillo de La Sabana. Mat weaving is a female activity involving all women in a family, including grandmothers. Although weaving is taught by oral tradition among members of a family, formal training of youths has been promoted recently.

A spear leaf yields ca. 60–310 g of dry fiber (X=184, sd=68), depending on its size. A 1 m^2 mat requires ca. 1.4 kg of fiber, which is obtained from 5–11 spear leaves, and a woman spends about 12 hours to weave it. In August 2009 such a mat was sold in Chimichagua for US$ 13–36. In the highest-selling season, a woman wove mats for up to18 days per month and earned US$ 175–437. Minimum wage in Colombia was US$ 257/month in 2009. Incomes are much lower for artisans producing exclusively traditional mats, which are sold for US$ 5–6 per m^2.

Mat marketing fluctuates throughout the year. Three major selling seasons are recognized: first, March to May, centered around Easter holidays and other festivals such as the Festival de la Leyenda Vallenata, a traditional musical event celebrated in Valledupar (Cesar), the state's capital; second, June to July, due to local and regional festivities; and finally, the most important selling season is during Expoartesanías, an international crafts fair, and the country's largest one, which takes place in December in Bogotá. Participation of artisans in these and other fairs is facilitated by their formal organization in associations. These associations also allow them to reach agreements with specialized stores in Colombia or in other countries, like the United States.

Impact of harvesting and conservation: According to our field observations, fiber exploitation can be sustainable, due to the widespread practice of harvesting only the central leaflets, without cutting the spear leaves or otherwise affecting the palm (Fig. 3B). The origin of this harvesting technique is not clear, but it seems to be an old practice, which otherwise has no precedent in South American palm management (Bernal et al. 2011). In recent years, environmental authorities have encouraged the use of this interesting management practice. Another management practice used by harvesters is to leave two or three unharvested spear leaves between two harvested ones. Apparently, this practice is carried out regularly, as evidenced by the harvested leaves that can be easily identified in the palms. Although some artisans claim that there is a shortage of spear leaves, the fact is that in frequently harvested places it is possible to find palms with all their leaves in good condition, and palms with one, two, or rarely three leaves with signs of harvest. Extraction intensity appears to be reasonable and does not pose an additional threat to *A. malybo* in this region.

The main threat to the populations of *A. malybo* is not harvest, but habitat depletion, since more than 90% of the original forest where the palm used to grow has disappeared (CORPAMAG 2011). Artisans are really concerned about the devastation of the forest where the palm grows. Some land owners even cut down palms to prevent the entrance of harvesters to their farms. On the other hand, some owners are probably aware of the importance of the palm and preserve it on their land to provide raw material for family members.

In terms of habitat, our observations showed that although palms that grow in pastures and fallows are currently an important source of fiber for craft activity, they do not have chances to regenerate, because their seeds often do not germinate and their seedlings and juveniles do not survive. This is the reason of the great disparity in population structure between forest and pasture (Fig. 2). While in secondary forest there are palms of all ages, especially seedlings, in pastures there are just a few seedlings, sub-adults and adults. The latter are palms that have survived deforestation; they are hardy and often tolerate grazing and fire. In view of this situation, palm conservation depends on populations that are growing in secondary forest, which, however, are also being affected by cattle and deforestation. The effective conservation of *A. malybo* requires the establishment of protected areas and the implementation of measures to prevent cattle from entering forest remnants.

4. Mat woven from *Astrocaryum malybo* in Colombia. A–B. Mats.

Artisan associations are interested in growing the palm in their own lands. Initially, 13 ha of land were given by the municipality of Chimichagua to four artisan associations to cultivate the palm (Barrera et al. 2007), but currently only 2 ha are in use. Cultivation attempts in this area have been a valuable experience for the artisans. For example, noticing the high mortality rate of seedlings in pastures, they have explored what they regard as a better scheme – combining the palm with various crops in different strata, like staple crops and plants used to dye the fiber. With this practice they can keep the area clean of weeds, create hedges to avoid the entrance of neighboring cattle and get some cash income until the palm is ready to be harvested.

Conclusions and recommendations

Although harvesting *Astrocaryum malybo* fibers for handicraft production could potentially reduce growth and eventually decrease population, this impact is low in comparison with the devastation and pressure that the species undergoes as a result of deforestation and land clearing for cattle farming. Actually, the sustainable use of *A. malybo* might be considered as a conservation strategy, not just for this particular species, but for the entire ecosystem. Considering the economic value of the spear leaves, conserving the palm is a relevant issue for land owners. Palms species that are deemed useless are often destroyed by land owners (Bernal et al. 2011). Moreover, the craft activity is an ancient tradition with great cultural and social value and its preservation will help to conserve the regional identity.

Strategies to conserve the palm must be focused on banning palm destruction, and on the enrichment of the lands where the palm grows. Improvement of the artisanal work is also important. If this occupation provides greater income to local communities, conservation policies will find more support. Although estimates of supply and demand of raw material are still rough, the resource will probably become scarce in the near future if the current trends do not change. For this reason, projects encouraging artisanal work must focus on increasing the commercial value of the final product, looking for more attractive designs and more diverse products and improving access to markets. This is a better alternative than increasing the volume of low-quality products, which would cause a higher demand of the resource, with a negative impact on the palm.

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Validation of Laccospadicinae (Arecaceae: Areceae)

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Laccospadicinae (Arecaceae: Areceae) is published to replace the illegitimate name Linospadicinae.

In our paper on the suprageneric classification of palms (Arecaceae) (Dransfield et al. 2005) and in the second edition of *Genera Palmarum* (Dransfield et al. 2008) we accepted Linospadiceae Hook. f. in Bentham and Hooker's *Genera Plantarum* 3: 872, 876. (1883), corrected to Linospadicinae, explicitly published at subtribal level, as the name for the subtribe that includes four genera of Areceae – *Linospadix* H. Wendl., *Calyptrocalyx* Blume, *Howea* Becc. and *Laccospadix* Drude & H. Wendl. This subtribe had also been accepted in the first edition of *Genera Palmarum* (Uhl & Dransfield 1987). However, we overlooked the fact that *Linospadix* Becc. (non *Linospadix* H. Wendl.) on which the subtribal name is typified is not legitimate because it was published later than Wendland's name and lectotypified on *Linospadix arfakianus*, now included in *Calyptrocalyx*. As a result the subtribal name Linospadicinae based upon it is also not legitimate. Thus, a new name for this subtribe is required and Laccospadicinae is proposed here.

Laccospadicinae J. Dransf., N.W. Uhl, C. Asmussen, W.J. Baker, M.M. Harley & C. Lewis, nom. nov. Typus: *Laccospadix* Drude & H. Wendl.

Linospadicinae Hook. f. in Benth. & Hook. f., Gen. pl. 3: 872, 876 (1883) ('Linospadiceae') (nom. illeg.). Type: *Linospadix* Becc. ex Hook. f. in Benth. & Hook. f., Gen. pl. 3: 903 (1883) (non H.Wendl. 1875).

We thank James Reveal for pointing out to us the illegitimacy of Linospadicinae Benth. & Hook. f.

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Bees Collect Resin from *Mauritia flexuosa* in Roraima, Brazil

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1. Ripe *buriti* fruits.

Stingless bees and Africanized honey bees were observed collecting resin from immature flowers, fruits and the vegetative parts of female inflorescences of *Mauritia flexuosa*. The bees probably use the resin as nest-building material. *Mauritia* is the first known palm to attract resin-collecting bees.

Mauritia flexuosa is a dioecious, solitary-stemmed palm that grows in flooded savannas and gallery forests of the Caribbean and South America. In Brazil, the fruits are called *buriti* and are consumed in various forms and used in cosmetic products. Male and female inflorescences of *M. flexuosa* are superficially similar, although male inflorescences are larger and contain more flowers than female inflorescences. Staminate flowers are smaller than pistillate flowers and have six stamens and a minute pistillode. They produce pollen and emit a strong, sweet odor. Pistillate flowers are larger, with six staminodes and a scaly gynoecium with a superior ovary. Female flowers do not produce pollen or nectar and emit a sweet odor, although it is weaker than that of male flowers.

Buriti fruits are round to ellipsoid, scaly, and measuring 4–6 cm in length and 3–5 cm in width (Fig. 1). The color of ripe fruits ranges from light orange to dark red. The mesocarp or pulp of ripe fruits is yellowish-orange. Fruits are usually one-seeded, and less frequently two- to three-seeded. One infructescence can produce up to eight hundred fruits, and each female individual produces an average of three to five infructescences per season, although I have observed females yielding up to 11 infructescences in one season.

The outer surface of female flower buds, the pedicels, rachillae and the developing fruits are coated with a viscid secretion that appears to be resin. I did not observe resin on male inflorescences. The resin of *M. flexuosa* is tasteless to the human palette, clear and jelly-like when fresh, eventually turning amber and hardening. When dry, the resin is slightly brittle and not malleable. Green, immature fruits are often sticky from the resin, and drops of the hardened resin can be observed on the surface of ripe fruits and dried flowers and fruits (Fig. 2). The resin does not dissolve in water, consistent with Langenheim's (2003) definition of resin. Further analyses are necessary to determine its chemical composition.

During my diurnal visitor watches in savanna and forest sites conducted between 2009–2011, I consistently noticed stingless bees (*Trigona sp.*; Apidae, Meliponini) collecting resin from immature fruits and flower buds (Figs. 3 & 4). I also observed Africanized honeybees (*Apis mellifera scutellata*) collecting resin, although in lower abundance and less frequently than *Trigona* sp. Bees most frequently foraged on unripe fruit, and the rachises and primary branches of female inflorescences. They also foraged on immature floral buds that were still green and closed, as well as floral and fruit scars where floral buds and immature fruits had abscised. Less frequently, they foraged on the floral pedicel or the calyx of the flower. Bee individuals were collected from female inflorescences and *buriti* resin was present in their corbiculae and hairs. My field observations suggest that both stingless and honey bees visit female infructescences and inflorescences only to collect resin, and do not collect nectar or pollen.

Bees collect plant resins to build their nests, taking advantage of the waterproof, anti-microbial and anti-fungal properties of the resin (Armbruster & Webster 1979, Roubik & Hanson 2004). European honeybees collect plant resins to protect the entire colony from pathogens (Simone et al. 2009). Meliponine bees may mix the resin of *M. flexuosa* with resin from the flowers of *Clusia sp.* (Armbruster 1984), which co-occurs with *M. flexuosa* in enclave savannas and gallery forests of this region.

2. Resin drops on dry, aborted, immature fruits.

The adaptive significance of this resin, from the plant's perspective, remains unclear. Resin not only protects the plant from microbes and fungus (Levin 1976), but it also deters herbivores, especially ovipositing lepidopterans (Langenheim et al. 1982). In addition, this palm may produce resin to attract bees, which in the process of collecting resin may also physically protect the plant from herbivores. However, resin does not appear to serve as a pollinator attractant in this species, given that resin is produced outside of the flowers and that bees do not collect pollen nor do they make contact with the stigma. Resin also plays a physiological role in plants by acting as a UV protectant (Leonhardt & Bluthgen 2009) and anti-transpirant (Meinzer et al. 1990). Further chemical analyses and field studies are needed to determine the chemical structure of this resin and elucidate its ecological and evolutionary functions.

Resin production in palms is not common and has been recorded only in *Daemonorops draco* (Willd.) Blume (Calamoideae) and other *Daemonorops* species of Asia. The resin from these palms, known as "dragon's blood" accumulates on the surface of maturing fruits and is commercially important (Pearson & Prendergast 2001). Another palm that secretes

3. Stingless bee collecting resin from immature fruit. Note resin drops on top fruit (top left corner).

4. Stingless bee collecting resin from female floral scar. Note that open flowers are being ignored by bees.

a resin-like substance on the surface of its rachillae and fruits is *Pritchardia viscosa* Rock, of Hawaii (Hodel 2007). The chemical nature of this substance and whether it is resin have not been determined. In his original description of *Chamaedorea resinifera* (now *C. elatior* Mart.), Wendland (1853) mentioned resinous female inflorescences, but further studies confirming the nature of this resin-like substance are lacking. Although only a few studies document resin and resin-like substances in palms, this study is the first to report interactions between a resin-producing palm and resin-collecting bees.

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