Palms

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The International Palm Society

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FRONT COVER

The compound terminal inflorescence of *Tahina spectabilis*, a marvelous new palm from Madagascar. See article by J. Dransfield et al., p. 31. Photo by J. Dransfield.

Palms (formerly PRINCIPES)

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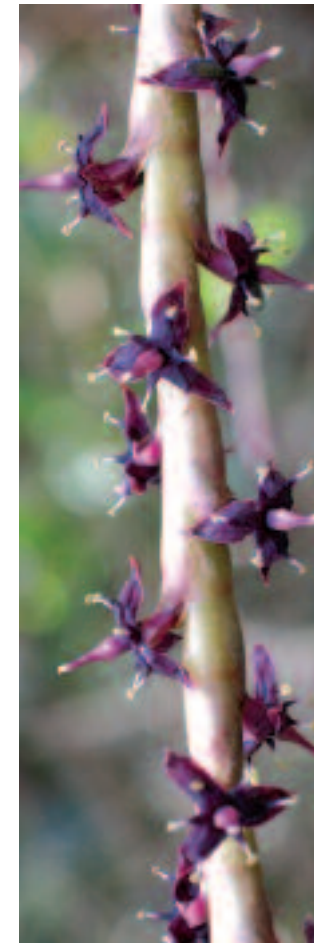

The colorful flowers of *Chuniopheonix hainanensis,* endemic to Hianan. See article by Henderson & Guo, page 41.

BACK COVER

Female plant of *Ravenea delicatula* with solitary inflorescence. See article by M. Rakotoarinivo, p. 11. Photo by M. Rakotoarinivo.

NEWS FROM THE WORLD OF PALMS

In this issue we bring news of a new genus, *Tahina*, with the single species *Tahina spectabilis*, which was discovered in north-western Madagascar. First brought to the attention of palm enthusiasts on PalmTalk, the interactive bulletin board of our society, the palm was officially described and named in the Botanical Journal of the Linnean Society in January 2008. Thereafter there was frenzied media attention with published stories sometimes becoming more and more implausible. In the article we publish in this issue, we provide accurate information on the discovery and a description of this spectacular new palm. *Tahina* was described and named just in time for inclusion in the new edition of *Genera Palmarum* that is in press, with a projected publication date of sometime this coming summer. Interestingly enough, another new genus is on the horizon and will be described very soon. Its discovery comes not from field work in a far-away country, but from laboratory work with DNA sequences. News of its naming will appear on this page in a future issue.

Palm growers in South Florida are facing a new and worrisome threat: the red palm mite, *Raoiella indica* Hirst (Acari: Tenuipalpidae), a mite from the Eastern Hemisphere that became established in the West Indies in 2004. It reached Florida in late 2007, and its spread and establishment in the American tropics seem inevitable. It is a serious pest of coconut and date palms, but it also attacks heliconias, gingers, bananas, birds-of-paradise and pandanus. It is expected to attack a wide range of ornamental palms as well. Florida's Division of Plant Industry released a pest alert in which the symptoms of red palm mite damage on coconut were described: "The red palm mite establishes colonies on the undersides of leaves, usually along the midrib.... Feeding mites, especially at high mite densities, cause localized yellowing of the leaves followed by tissue necrosis [tissue death].... In heavy infestations, the green leaves turn from a bright green to a pale green, then yellow and finally a copper-brown." The pest alert notes that symptoms caused by a heavy infestation of the red palm mite could be confused with nutritional deficiencies, so growers are advised to examine chlorotic palms carefully for signs of the mite. Colonies of the mite on the undersides of leaves are visible to the naked eye, but a magnifying glass or microscope will aid in determination. The colonies are composed of bright red females, smaller red males, eggs and the detritus of shed exoskeletons. Control of the red palm mite in landscape palms will be difficult, owing to the large size of most palms; however, natural predators and integrated pest management practices are expected to give some control.

Another threat to palms, fusarium decline, has hit *Washingtonia* and *Syagrus* palms in southern Florida. Symptoms begin as a die-off of lower leaves and gradually spread throuhout the crown. Leaves remain on the palm and do not droop or break. Infected palms die quickly, and there is no cure. Diseased palms should be removed and destroyed.

In May we gather in Costa Rica for the Society's Biennial meeting. The event will combine field visits and evening lectures as well as the Directors' business meetings. The Biennial promises to be exciting, with visits to some very special places, where we expect to see some wonderful palms.

THE EDITORS

GROWING PALMS

Horticultural and practical advice for the enthusiast

Edited by Randal J. Moore

Contents

Squirrel Damage and Control in Palms

Ground and tree squirrels can be severely damaging pests to palms. They are found in many agricultural and rural areas. Cultivated and native palms located in public parks, natural areas, nurseries and home gardens may suffer from their detrimental effects.

Identification of the species of ground or tree squirrel causing the injury to the palm is the first step in implementing a pest control program. The appropriate control method suited to the specific conditions (that is safe to humans, the environment and other wildlife) can then be undertaken to mitigate the harm.

Our investigation was prompted by the significant squirrel damage done to decades old, historic public plantings of *Brahea brandegeei* in the county of San Diego, California. In the process of this study, we noticed similar squirrel damage to *Howea fosteriana*, *Brahea edulis*, *Rhopalostylis sapida* and *Jubea chilensis*.

1. A California ground squirrel (*Spermophlius beecheyi*) is one of the most common squirrel pests found throughout the state (with the exception of the extreme desert regions and high mountains). Their gnawing and burrowing can cause severe or lethal damage to palms if not controlled.

Description. The basic appearance of the tree and ground squirrel (Fig. 1) is very similar. In California, there are several species of tree and ground squirrels. From a distance, it can be difficult to distinguish between them. Some species of tree squirrel are smaller than ground squirrels, although other tree squirrel species are similar in size. The tree squirrel has a bushy tail, while the ground squirrel does not.

Ground squirrels are brown-gray in color; tree squirrels tend to be reddish-brown. Also, at close range, some ground squirrel species can be distinguished by a noticeable triangle marking on their back. One of the best ways to differentiate between a ground and tree squirrel is also rather obvious: when pursued a ground squirrel will go into its burrow while the tree squirrel will seek safety in the upper canopy of the tree.

Activity. Ground and tree squirrels are active during the daytime (diurnal), particularly during mid-day hours on warm days. Activity is at a maximum during the breeding season. Ground squirrels breed once a year at various times depending on the species and average seven or eight per litter. The young grow rapidly to adult appearance in only six months.

Ground squirrels live in colonies in underground burrows. The burrows are about 4 inches (10 cm) in diameter and 5–30 feet (1.5–10 meters) in length extending 2–4 feet (0.5–1.25 m) below the surface (California Ground Squirrel, Pest Notes, University of California Agriculture and Natural Resources, Publication 7438, revised January 2002). The colony may include several dozen animals.

Ground squirrels hibernate during the extreme temperatures of the winter and summer (aestivation) months. While the entrance of the burrow is open, the burrow is plugged near the nest during this inactive time. By contrast, the tree squirrel does not hibernate. They are mostly confined to an arboreal life making nests in tree holes or building nests of leafs and twigs.

Tree squirrels are primarily arboreal. However, they do spend some of their time on the ground foraging for food. Unlike ground squirrels, they do not hibernate except during exceptionally cold winter weather. They are most active during the early morning and late afternoon hours.

Diet. Unlike rabbits or deer, squirrels cannot digest cellulose and must rely on foods rich in protein, carbohydrates and fat. Early spring is a hard time of year for squirrels since buried nuts are beginning to sprout and are not edible. Other food sources such as fruits and seeds have not yet become available.

2. Squirrel damage caused to the apical meristem and new petioles of a San Jose Hesper Palm (*Brahea brandegeei*) at a public park in San Diego, California. Gnawing damage in palms occurs mostly during the early Spring months when other types of food is not available.

Therefore, during the early spring months after emerging from hibernation, their diet consists primarily of green vegetation (green grasses and herbaceous plants). It is during these times that squirrels feed heavily on the buds of trees and palms and the most damage is caused.

With the onset of summer, plants began to dry and produce seed. The squirrel then changes its diet and begins eating seeds, grains, fruits and nuts. They always forage within a close range of their burrow or tree nest.

Damage. Ground squirrels damage

3. Lethal damage caused to an entire historic grove of San Jose Hesper Palms (*Brahea brandegeei*). A safe and effective control program must be implemented early when damage is first identified. Sometimes there is reluctance to take immediate and firm steps toward control due to public concern for the wildlife.

many agricultural and ornamental plants. In our case, we were specifically concerned about the damage being caused to plantings of mature palms in public spaces within the County of San Diego, California.

Squirrels are rodents, so most of the damage to palms is caused by gnawing. They eat the soft tissue of the apical meristem and devour seedling palms (Fig. 2). When left unchecked, the damage can be lethal to palms and destroy entire groves (Fig 3). The damage is not limited to the meristem and petioles; a squirrel will also strip clean the palm inflorescence and infrutescence (Fig. 4). In the case of ground squirrels, the burrows can cause palm root damage and desiccation.

There are other ancillary problems that can be caused by squirrels. Gnawing by squirrels causes damage to sprinkler heads and irrigation lines. Gnawing also damages wood buildings, utility lines and the cambium of other trees. Ground squirrel burrows can present a hazard to people and machinery and cause soil erosion. Squirrels can also carry diseases.

Legal Considerations. Most vertebrate pests, including many ground and tree squirrel species discussed here, are subject to the protection of State Fish & Game and Federal Regulations. This may restrict the allowed control methods used to limit damage to palms.

Generally, native squirrel species are considered game mammals and are therefore subject to game management rules. They can be taken only as provided by hunting regulations. When documented evidence of damage or destruction can be provided to wildlife officials, a revocable permit is usually issued with restrictions on the poison and traps that can be used. For example, non-native pests, such as the red fox squirrel (*Sciurus niger*) introduced from the Eastern United States and now common in city parks and adjacent areas in the Western U.S., are exceptions and can be taken at any time and any manner.

Squirrel populations are affected by the available food supply. When squirrels are provided food by public feeding, or the improper securing of food waste, populations will increase. Convincing

4. Squirrels feed on the inflorescence and infrutescence of palms. A Guadalupe Fan Palm (*Brahea edulis*) has been stripped of its flowers and fruit. Similar damage has been noticed in many other species of cultivated palms.

the public to avoid feeding squirrels has proven to be a difficult challenge for wildlife control officials. Posting signs with warnings is one method intended to discourage public feeding (Fig. 5).

For example, in the State of California, the feeding of squirrels is prohibited by Fish & Game laws (California Dept. of Fish & Game, Regulation 251.1). Feeding artificially increases the squirrel population beyond natural levels exacerbating pest problems. It can also increase their aggression towards humans and make them more dependent on human food.

Controlling Damage to Palms. The objective of a squirrel control program is to reduce or eliminate the specific damage being caused to palms in a cost-effective and acceptable manner. It should also be safe to the environment, humans, and other non-target species. In some cases, great care must be taken to protect populations of other endangered wildlife species from the detrimental effects of the pest control method.

A case in point are programs that attempt to control the California ground squirrel (*Spermophilus beecheyi*) which are found in the same agricultural areas as several species of the endangered kangaroo rat (*Dipodomys* spp.). Many kangaroo rat species are dwindling and traditional ground squirrel control methods may threaten them with extinction. A modified bait station for the ground squirrel was developed that avoids the incidental poisoning of kangaroo rats (Modified Bait Stations for California Ground Squirrel Control in Endangered Kangaroo Rat Habitat, Desley A. Whisson, Proceedings of the 18th Vertebrate Pest Conference, Univ. of Calif., Davis, 1988, pp. 233–235.).

Trapping Methods. A trapping program can reduce or eliminate squirrels from an area. Traps are effective for controlling smaller populations of squirrels in restricted areas. Individual trapping can become impractical for larger infestations.

A wooden box-type squirrel trap is generally used. They are available commercially, or may be constructed from a modified box-type gopher trap. The traps should be enclosed to minimize

the chance of accidental harm to children, pets or other wildlife. For ground squirrels, control can be achieved using an unbaited wire trip inside the burrow that the animal will pass through and trip the trigger.

A nut-meat bait is placed behind the trigger mechanism to trap the squirrel. Supplementing the bait with rolled corn available from a feed store has proven highly effective in attracting ground squirrels (Donald Martin, pers. comm.). Some bait should also be placed in front of the trap entrance to attract the squirrels.

Generally, the trapper will leave a baited trap in place without setting it for several days so that the squirrels can first become accustomed to it. After the squirrels are used to taking the bait, the trap can be re-baited and set.

For tree squirrels, the trap is generally placed in a tree, on a fence, or on a rooftop. They are nailed or fastened securely in place. The bait must be tied to the trigger with a string. For ground squirrels, the box trap is placed on the ground near the burrows.

Live catch traps (such as HavAHart™ brand traps) can also be used. However, these traps present a problem of how to dispose of the live squirrel. Because squirrels can carry disease and may be an agricultural pest, it is usually illegal to release them elsewhere.

5. Posting public warnings not to feed wildlife provides some natural control over squirrel populations. Food provided by public feeding and unsecured waste receptacles is one cause of large squirrel infestations in public parks.

If a ground or tree squirrel problem is present, a trapping program can be successful if it is constantly monitored and operated. Of course, it is best to initiate a program as soon as the pest problem is identified.

Repellents. Some repellents are available for protecting plants from squirrels. They appear to have limited effectiveness. The repellent must be applied before extensive damage has occurred. Maintaining an adequate level of repellent can be difficult. It can be washed off by rain, spray irrigation and dew, and it must be reapplied steadily and frequently to be even marginally effective.

Fumigation. Large infestations of ground squirrels over a wide area may require fumigation. The squirrels will be killed in their burrows using toxic gas. A special permit is often required from the local agricultural official. Of course, fumigation cannot be used to control tree squirrels.

Fumigation is most effective in the spring months when the soil is moist. The gas is better contained within the burrow and does not escape through cracks found in dry soil. Since burrows can be large with several entrances, each needs to be treated and sealed. During hibernation periods (mid-winter and mid-summer), fumigation is not as effective since the ground squirrel will plug the burrow near its nest.

6. Multiple feeding box-type bait station that uses moisture-resistant paraffin bait blocks. The anticoagulant bait used here is slow acting and must be continuously consumed over a period of 5 days or more. This station has the capacity to hold a large quantity of bait so that it lasts longer without re-supply and can handle larger infestations.

Fumigation cartridges are available that are ignited and emit a toxic gas. Many of these are available in retail garden supply stores and can be used without a permit. Place the fuse into the cartridge, light the fuse and push it far into the burrow with a pole, then seal the opening with soil and tamp it lightly. Cartridges should not be used around buildings, dry grass or other flammable materials.

Toxic Baits. Toxic baits are commonly used for squirrel control. Use of some baits (primarily those for commercial use) require a permit issued through a local agricultural agency. Home gardeners generally use baits that do not require a permit.

The baits used for squirrel control (and rat control) are anticoagulants. They alter the animal's blood clotting mechanisms and eventually lead to its death. They are most effective if consumed in several consecutive feedings over a relatively short period of time. This characteristic along with an effective antidote (Vitamin K_1) make them somewhat safe to use around humans and pets.

A bait box can be used (Fig 6) to keep people and pets away from the bait. The entrance to the bait box should use a 4-inch (10 cm) hole which will allow squirrels to enter but not other larger animals. It should hold sufficient bait for several repeated feedings. And it should be secure so it does not tip over or is easily opened.

If the infestation is over a large area, use of multiple bait boxes spaced apart will be required. Use of fresh bait over a 2–4 week period is usually required. Control is indicated when feeding at the bait station stops and squirrels are not present. Dead squirrels should be buried or discarded and use of gloves is important.

Protecting palms through a control program dedicated to ground and tree squirrels can be challenging, costly and time consuming. Once control is achieved, the success will be temporary since the area will usually be reinvaded. Periodic monitoring to keep squirrel populations under control before they are firmly reestablished is the best preventative measure to avoiding extensive palm damage. – *Mike Marika, Park Arborist, City of San Diego, California and Randal J. Moore, Poway, California USA.*

A Remarkable *Ravenea* from the Montane Forest of Andilamena, Madagascar

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1. *Ravenea delicatula* in montane forest of Andilamena.

In this paper, an astonishing, beautiful new species of *Ravenea* is described for the first time.

Searching for palms in Madagascar is always exciting because every locality has its little secret. Despite the 70 species discovered by Dransfield and Beentje (1995) during the preparation of *The Palms of Madagascar*, locations not previously explored sometimes provide new species and unexpected information about species' distributions, and thus, the floristic composition of the site. Since 1995, four new species of *Dypsis* and one *Beccariophoenix* have been described for Madagascar but we are aware that there are probably several more yet to be described and named.

For the continuation of its program Threatened Plants Appeal, the Royal Botanic Gardens Kew decided in 2005 to begin again intensive research on the palms of Madagascar by funding me to study for a PhD at the University of Antananarivo. Among the aims of this research is to complete as far as possible the knowledge of palm distribution in Madagascar by targeting poorly known sites or areas not yet visited.

The first expedition as part of this research was carried out in April 2006 in the Andilamena region, in the centre of the island – an unknown locality for palms because all the previous research in the region had been concentrated in the National Park of Zahamena, about 50km further south. This fieldwork in Andilamena gave interesting information on the species taxonomy as well as on the distribution of palms in the montane forest. The most exciting find was a new species of *Ravenea,* very different from those previously described.

Ravenea, the second largest genus of palms in Madagascar, includes 16 species of which only two are found outside the island, in the Comoros archipelago (Dransfield & Beentje 1995). The genus has always been thought to have a rather uniform appearance in its stems and leaves: almost of the species are arborescent, stems are usually solitary and unbranched and the leaves always have regularly pinnate leaflets (Beentje 1994) – that is until this fieldwork at Behorefo, near Andilamena, where I found a remarkable clustering palm with slender branched stems and with irregularly pinnate leaves. Only the inflorescence structure shows that the palm is a *Ravenea* (Fig. 1).

The discovery of this palm was a moment of pure jubilation because we had just collected a climbing palm that superficially looked exactly like *Dypsis scandens*, known from a single specimen near Ifanadiana, several

2 (left). Young shoot with clustering stems of *R. delicatula*. 3 (right). Branching stem in juvenile *R. delicatula*.

4. Male plant of *R. delicatula* with multiple inflorescences.

hundred kilometers farther south. This lianescent palm is in such abundance in Andilamena, that it was a real pleasure to look at it. Anyway, it was the first time for us participants in this fieldwork to find climbing palms in their natural habitat so everyone inspected with admiration the way the palm was growing and finding its way around the canopy. While I was contemplating the beauty of this *Dypsis*, I found another undergrowth palm that looked unfamiliar to me. At first I thought it was one of these undergrowth species of *Dypsis* because of the clustering and slender stems, which are occasionally branched, and also the fascicled irregularly arranged leaflets (Figs. 2 & 3). After some time of reflection, I was finally not sure because the inflorescences were sometimes solitary, sometimes multiple and there were always two large peduncular bracts in the inflorescence, while in *Dypsis,* inflorescences are always solitary and there is only one peduncular bract. Furthermore, the inflorescences were unisexual so it is certain that the palm is not a *Dypsis* at all. Moreover, the inflorescences are very different from those of *Dypsis,* and the flowers (Fig. 4 & Back Cover) reminded me of those of orchids rather than those of palms – only the long spur is lacking! At this time the burning question for me was, what palm could it be? Once I had seen it, I forgot completely the climbing *Dypsis* and tried to work out what on earth the palm was. I asked everyone if they had any idea what the palm was, but they did not, so I collected some specimens. I had with me my copy of *Palms of Madagascar* (Dransfield & Beentje 1995), and after spending some time reading without conviction the description of the genus *Dypsis*, I was finally persuaded that the mystery palm was no species of *Dypsis*. There was even a moment that I thought I had found a new genus, but I renounced this idea quickly because I finally remembered that inflorescences of *Ravenea* can be solitary or multiple according to the sex of the plant (Fig. 4 & Back Cover). When I looked carefully at the base of the crown, it became more evident that the palm was a *Ravenea* because the structure of the crown seemed to me to resemble a miniature version of those of *Ravenea robustior, R. sambiranensis* or another species with a bulbous crown. Normally, these diagnostic characters should come automatically when you are in front of a *Ravenea* species, but the unusual vegetative characters troubled me. On the way

back to our camp, I asked every member of the field team lots of questions, such as, if they had previously found a similar palm in other regions of Madagascar and if anyone had ever seen pictures of a similar palm, but the answer was always negative. Finally, I realized that I was sure that we had found a new form of *Ravenea*; it cannot be *Ravenea nana*, the smallest species of the genus, because this last has regular leaflets and is more robust compared to the palm of Behorefo.

Back in Antananarivo, I sent one picture to John Dransfield, and he confirmed my suspicion that it is a new species of *Ravenea*. This is the first description of a new species of *Ravenea* since the publication of the book *The Palms of Madagascar* (Dransfield & Beentje 1995). I propose the name *Ravenea delicatula* to express the beauty and the delicacy of this undergrowth palm of Andilamena montane forest.

Ravenea delicatula Rakotoarinivo, **sp.nov.**, caulis gracilibus, aliquando caespitosis et ramificantibus, foliolis fasciculatis, inflorescentiis solum 2 bracteas pedunculariibis grandibus distinctissima. Typus: Madagascar, Toamasina, Andilamena, Ambatobe, Behorefo, April 2006, *Rakotoarinivo RMJ 184* (Holotypus TAN, isotypi K, P).

Solitary or clustering, dioecious, pleonanthic palm. *Stem* 4–5 m tall, occasionally branching, procumbent, 1.2–1.7 cm diam. (near crown 0.7–0.8 cm), internodes 0.4–6 cm, scars 0.2–0.4 cm, surface smooth, sheath remnants occasionally persistent. *Leaves* 6–9 in crown, spiral, arching; sheath 6–15 × 1.6–4.4 cm, densely covered with red-brown to grey tomentum, marginal parts disintegrating, the tomentum persistent; petiole 4.3– 8.6 cm long, proximally 0.2 × 0.1 cm, distally 0.1 × 0.1 cm, channelled, slightly convex abaxially, sparsely tomentose, the tomentum deciduous; rachis 21.6–33 cm, in mid-leaf 0.1 × 0.1 cm, medially sharply keeled, triangular, abaxially with red brown indument but soon glabrescent; leaflets 17–25 on each side of the rachis, 3 or 4 in each group, lanceolate, held in different planes, proximal 8.7–10.8 × 0.2–0.3 cm, median 11.8–14 × 0.3–0.4 cm, distal 9.6–10.6 × 0.2– 0.4 cm, top pair with 2 or 3 main veins. *Staminate inflorescence* interfoliar, multiple in 3s or 4s, the central ones maturing first, individual inflorescence branching to 1 order, peduncle very slender, 4.5–11.8 cm long, with red brown tomentum; common prophyll 1.1–1.4 × 0.8–1 cm, prophyll 3.2–9.6 × 0.4–06 cm, keeled, with dense red brown tomentum; peduncular bracts 2, ± the same size, densely pubescent with red brown tomentum, 15.4–17.2 × 1.1–1.3 cm, thickness less than 1 mm, opened at 5.8–7.6 cm from the base of peduncle; rachis 2.7–4.3 cm, ± glabrous, with ca. 6–9 rachillae, rachis bract 0.7–0.1 cm; rachillae 4.2–6.4 cm long, slightly zigzag, flowers 0.4–0.7 cm distant, pedicel ca. 0.5mm. *Staminate flowers*, sepals connate at the base for 0.4–0.6 mm, free parts 0.6–0.8 × 0.8–1 mm, acute; petals 6.2–8 × 1.8–2.6 mm, imbricate; stamens 6, uniseriate, filament 0.8–1.2 mm (3 epipetalous, adnate for 0.6–0.8 mmm), cylindrical; anthers basifixed introrse, 2.4–3 × 0.9–1.2 mm; pistillode 0.4 × 0.6 mm. *Pistillate inflorescence* interfoliar, solitary, branched to 1 order, 10.2–28.8 cm long, with red brown tomentum; prophylls 2, first 2.4–2.7 × 0.3–0.4 cm, second 5.1–21.2 × 1.2–1.8 cm, densely tomentose; peduncular bracts 2, 19.2–22.3 × 1.1–1.6 cm, thickness less than 1 mm, with dense red brown tomentum; rachis 2.9–4.7 cm, ± glabrous, with ca. 5–9 rachillae, 0.9 × 0.1 cm; rachillae 3.9–4.8 cm long, slightly zigzag, flowers 0.4–1.1 cm distant, pedicel c. 0.5mm. *Pistillate flowers*, sepals connate at the base for 0.8–1 mm, free parts 1.4–2 × 1.1–1.4 mm, acute; petals triangular, acute, 6.8–8.5 × 2.2–3.1 mm; staminodes 6, triangular, ca. 1.4 × 0.3 mm; ovary ovoid, 3.5–4 × 1.4–1.6 mm, stigmas 3. *Fruits* not seen. (Fig. 5).

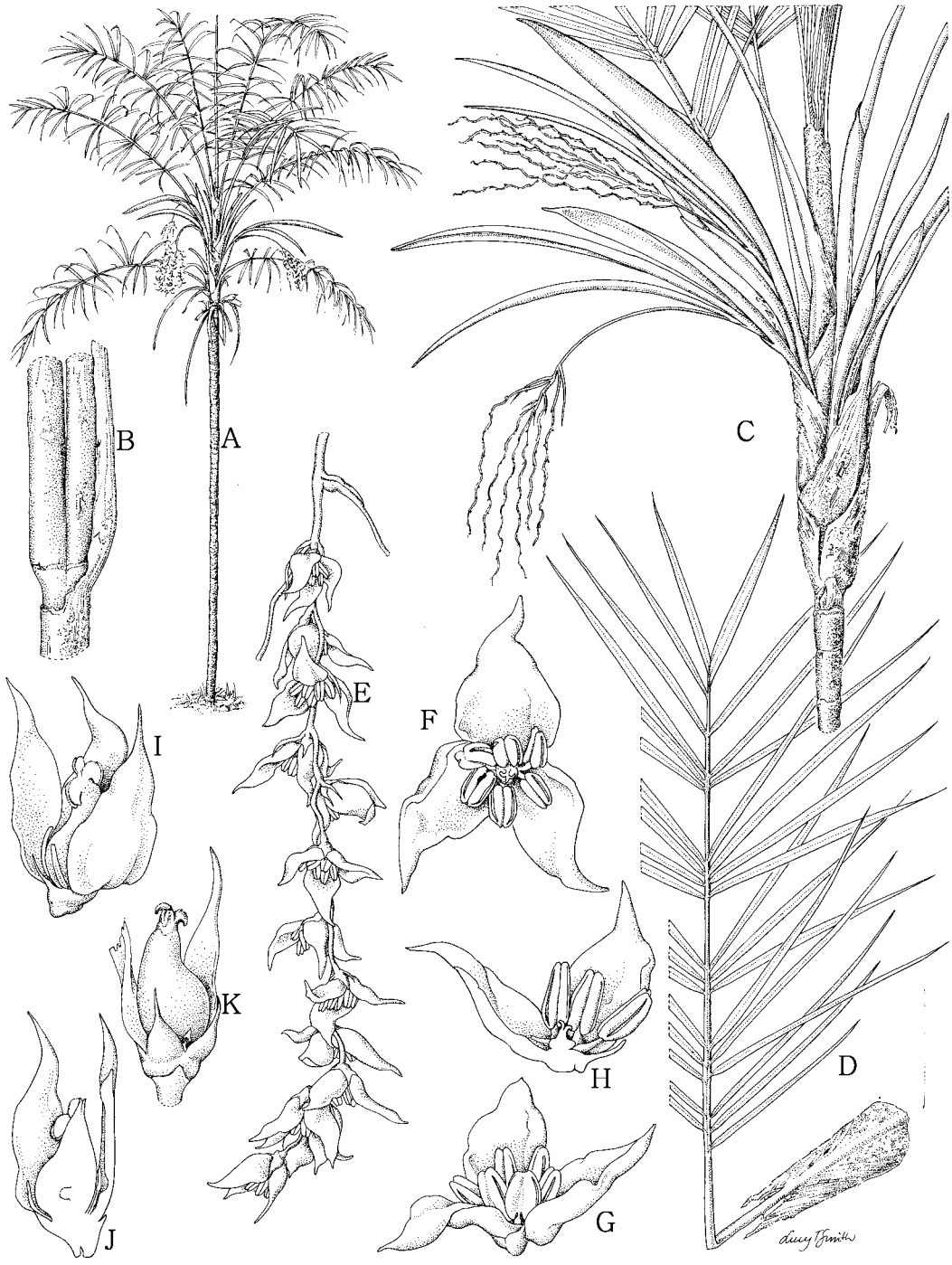
SPECIMEN EXAMINED. Madagascar, Toamasina, Andilamena, Ambatobe, Behorefo, April 2006, *Rakotoarinivo RMJ 184* (Holotype TAN, isotypes K, P).

DISTRIBUTION. Central Madagascar, known from a single site: Madagascar, Toamasina, Andilamena, Ambatobe, Behorefo. 16°59′ S × 48°50′ E.

HABITAT. *Ravenea delicatula* is an understory palm of montane forest occurring between 800–1000 m at Behorefo (Fig. 6). This forest has a low rather open canopy of 6 or 7 m tall. Trees are small, few in number and some are deciduous; the undergrowth is scrubby and full of bamboos and pandans. The humus is fine, and in certain places mosses may form a continuous lawn on the ground.

LOCAL NAME. Anivo (Sihanaka)

NOTES. From the data of BIOCLIM (www.bioclim.org), the precipitation of the region is estimated annually to be between 1300–1400 mm and the mean annual temperature is about 20°C. Annual range is



5. ***Ravenea delicatula***: **A** Habit, solitary stem × 1/10 **B**. Branching on the stem × 1/2, **C**. Crown with multiple staminate inflorescences x 1/6, **D**. Leaf × 1/3, **E**. Detail of a staminate rachilla inflorescence × 2, **F**. Male flower, view from above × 4, **G.** Male flower, side view × 4, **H.** Male flower, longitudinal section × 4, **I.** Female flower, side view × 4, **J.** Female flower, longitudinal section × 4, **K.** Young fruit, × 4. Scale bar: A = 15 cm; B, C = 2 cm; D = 3 cm; E= 2 cm; F–K = 4mm. All from *Rakotoarinivo RMJ 184*, Drawn by Lucy T. Smith.

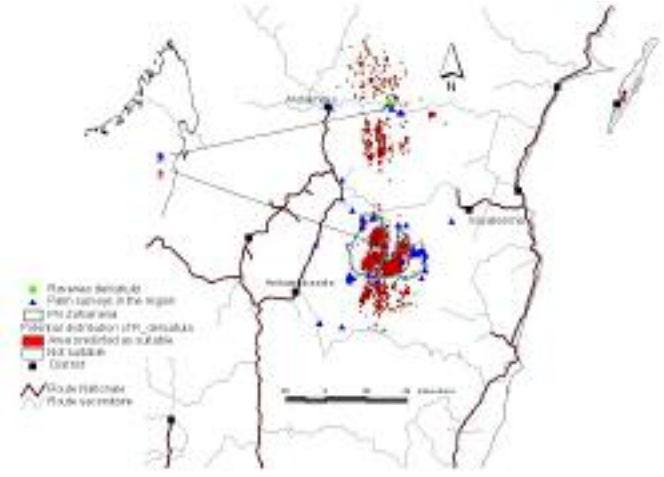
very high because the minimum temperature can fall to 11°C whereas the maximum temperature is estimated at 28°C. Dry season lasts about five months between May and September. Bioclimatic type, after Cornet (1974), is temperate humid with accentuated

6. Montane forest of Behorefo, the habitat of *R. delicatula*.

winter. The dry season coincides with the winter and is characterized by drizzle and fog in the morning (Morat 1969). The geology in this region is composed of Precambrian crystalline base made up of granite, gneiss and schists (Besairie 1970).

The modelling of the habitat of this species and the analysis of the region on Maxent 2.1 (Maximum Entropy Species Distribution Modelling, Version 2.1) shows that the species has similar ecological preferences to *Dypsis pumila, Ravenea latisecta and R. louvelii*. All of these species are only found along the summit of the eastern escarpment. It seems that the distributions of these palms is closely correlated with the values of the precipitation of the driest month (34–62 mm, July), the precipitation of the coldest quarter of the year (168–260 mm between June and August) and the maximum temperature that should not exceed 29°C.

Ravenea delicatula is, at the moment, only known in the Andilamena area but the combination of all these factors and some ecological variables (annual precipitation, minimal temperature, altitude, geology, slope,



7. Potential distribution of *R. delicatula*.

and aspect) allowed Maxent 2.1 to model its habitat and predict the potential distribution of the species. The result shows that this palm is restricted in the region of Andilamena and Ambatondrazaka (Fig. 7). This species is not yet recorded in Zahamena but it is highly possible that it occurs in the center and the south of the Parc, since palm inventories were mostly concentrated in the eastern and western limits of the protected area, around Ambatondrazaka and Vavatenina.

Notes: The palm can form a bush with its numerous young shoots surrounding the 4–6 adult stems. Branching was found especially in juvenile individuals or immature stems. It seems that the first stem dies after branching, and the second branch continues then to live. Stems with inflorescences frequently show scars indicating previous branching

Conservation: *Ravenea delicatula* is abundant in this forest; more than 30 mature individuals together with about 40 juveniles were counted in Behorefo. At present, the forest fragment where the palm grows is not protected. Even though the place is not easy to access, the forest is being destroyed because the local population is clearing it to establish hill rice. Moreover, numerous finds of rubies have been made near Behorefo. This palm is threatened by the many holes dug by miners inside the forest in order to look for minerals.

Acknowledgments

This article is written in the context of my PhD preparation at the University of Antananarivo. Fieldwork and the research on the Palms of Madagascar are sponsored by the Friends of the Royal Botanic Gardens, Kew through its program Threatened Plants Appeal in Madagascar. I am very grateful to Dr. John Dransfield, my PhD Supervisor at Kew, for the continual encouragement, his help during the preparation of the text and also for having done his best to improve my English. Lucy Smith made the plate at Kew. Roger Rajaonarison and Hanta Vololona Razafindraibe accompanied and helped me to collect palms in Andilamena.

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PALM LITERATURE

PALMS, SENTINELS FOR AMAZON CONSERVATION. Michael Goulding and Nigel Smith. Amazon Conservation Association and Missouri Botanical Garden Press, St. Louis, Missouri. 2007. ISBN 978-9972-2974-0-3. Price $35.00. Softcover. Pp. 356.

For those of you who always loved the wetland palms of the Amazon Basin, this is a book you will want. For those of you who, like I, never gave a second thought to the wetland palms of the Amazon Basin, this is the book we need. Goulding and Smith's new book brings to life fascinating palms seldom seen outside their soggy Amazonian home or, for that matter, in the pages of most palm books. With brilliant photography and an impressive 45-page bibliography, the authors bring their considerable experience in Amazon ecology and biogeography to bear on the palm ecosystems of river margins, swamps, flooded forests and mangroves.

The book begins with a chapter that introduces the region and history of palm studies and another that reviews the nine different kinds of wetlands in the Amazon Basin in which palms occur. The fifteen chapters that follow focus on the palms, with each genus given its own chapter (with the exception of *Socratea* and *Iriartea*, which are treated together). Each chapter includes a distribution map and breath-taking photographs of palms in their natural habitat. Predictably, much space is devoted to the most economically important species of *Mauritia* and *Euterpe*, but chapters on genera, such as *Manicaria*, *Mauritiella*, *Leopoldinia* and *Desmoncus*, review the current knowledge of these lesser-known palms. The palm chapters are followed by a chapter that reviews the amazing animals that live in, on and among the palms and by a chapter on human influence on palms and their habitats. The book ends with a chapter on the need for palm conservation, although the authors noted in the introduction that "At present no Amazonian wetland palm species is faced with extinction and it is hard to imagine this would be a problem in the next few decades." Given that, one wonders why the conservation flag is waved so prominently in the book's title.

This book is significant in that it is the first book to focus on the wetland palms of the Amazon and their roles in riverine ecosystems. It is a synthesis of ecology, geography and ethnobotany, as well as primer on the palms that have complex ecophysiologies that allow them to survive periodic inundation. These are remarkable palms that are terrestrial in some months and aquatic in others, and no other book treats them so beautifully. The pictures lure us in, but the hook is the very real discussion on how water quality, sediment load and flood periodicity, among other factors, influence the distribution palms in these very specialized habitats.

My criticisms of the book are minor. I would have appreciated a map of major river systems that are discussed in the text. I was also puzzled by statements such as, "In the Rio Negro Basin, *Leopoldinia piassaba* is most abundant in the left-bank blackwater tributaries." Why the left bank and not the right? I am not fluent in river science, so the book occasionally left me in its wake. The authors frequently confused endosperm, endocarp, mesocarp and pericarp in their discussions of palm fruits, but these errors can easily be remedied in a second edition.

The book does not shy away from the technical aspects of wetland ecology, but it is awash with beautiful and striking photographs. The photographs clearly separate this book from all others on Amazon palms. It was as much a pleasure to peruse as it was enlightening to read.

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Gulf Stream Coconuts. The Harries-Baker Test for Discrimination between Flotsam/Jetsam and Natural Dissemination

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Harries and Baker's (2005) paper in PALMS was based on the discovery of coconuts (*Cocos nucifera*) with their husks intact in drift on Balevulin Beach on Tiree (Inner Hebrides, UK). They argued that such entire coconuts might arrive with the Gulf Stream from the Caribbean. They suggested a viability test to prove this and suggested trying to let them germinate at a warm moist place at a minimum temperature of 25ºC. I am not so sure this 'Harries-Baker' test is conclusive. Flotsam and jetsam coconuts might also germinate, and the time needed to reach Europe with the Gulf Stream might be too long for the coconuts to remain viable.

Nelson (2000) wrote an excellent book on tropical seeds and fruits stranded on beaches in north-western Europe. He enumerated some 36 different species of genuine Gulf Stream drift seeds and fruits identified from European coasts. The first were found on the coast of Cornwall already more than 400 years ago. Cornwall is still a favorite and rich place for collectors of tropical drift. Darke (2003) collected here over 200 larger tropical drift seeds in four years! Nelson (2000) also mentioned some 20 other exotic species that are not real long-distance floaters but probably transported by man to our coasts. For some

seeds and fruits it remains difficult to discriminate between transport by man and by the Gulf stream (Cadée 1997, Nelson 2000, Brochard & Cadée 2005); among these is the coconut (Fig. 1) (Nelson 2000, Cadée 1988a).

Guppy (1917) estimated the time needed for tropical drift seeds to cross the Atlantic Ocean to be on average 14 months based on drift bottles released in the north-eastern part of the West Indies and reaching the European coast. Such bottles were filled partly with sand to decrease the effect of wind and make them follow the surface water layer. Empty plastic bottles offer a much larger surface to the wind and these may travel much faster over the Atlantic Ocean – the fastest took 4 months (Cadée 1988b). From experiments with drifters that can be followed via satellites we know the path travelled is not a straight line but one with many spirals (e.g., Otto & van Aken, 1996, fig. 11), so the distance traveled by drifting objects is much longer than as the crow flies. This fact was already obvious from shipwrecks that were followed from the US coast all over the Atlantic (e.g., the *W.L. White* wrecked 13 March 1888 near Cape Hatteras and stranded 23 January1889 on the Outer Hebrides, see Krümmel, 1911 fig. 169).

Viability of coconuts after floating in sea

Although it is repeatedly stated that coconuts do not remain viable after a couple of months floating in the sea (Nelson 2000, Brochard & Cadée 2005), actual experiments are scarce. Thor Heyerdahl's experiments aboard the *Kon-Tiki* in 1947 are probably the most famous. Its cruise over the Pacific from Peru to Raroia took from 28 April to 7 August 1947. The coconuts kept under the raft in contact with seawater did not remain viable. Seawater had slowly penetrated the area of the coconut eyes, causing microorganisms to start the rotting process. However, of those kept on deck (as food), a number started germinating, and after 10 weeks at sea, the *Kon-Tiki* had six coconut palms of one foot length on board (Heyerdahl, 1948, 1968). During their *Kon-Tiki* cruise, Heyerdahl was unaware of the experiments of Edmondson (1941), which he, however, mentioned in 1968.

Edmondson (1941) did more quantitative experiments on viability of coconuts after floating in the ocean. Unfortunately his experiment did not last more than 4 months. Contrary to the data of Heyerdahl, he observed that 10 out of 15 coconuts were capable of developing after having floated up to 110 days

1. A 21 cm long coconut with husk found on the beach of the Island of Texel in the 1980's by Dr R. Witbaard (collection G.C. Cadée)

in the sea. Some started germinating during the experiment. Remarkable was the long time it took the coconuts, planted in the Botanical Garden after the experiment, to sprout (from 3 months to over one year). The roots appeared before the stem, one specimen having floated 28 days required 582 days for the stem to emerge.

Some comments on Harries and Baker (2005)

Harries and Baker (2005) stated that it could take a coconut 6 months to cross the Atlantic. However, the time needed will be at least twice as long. Even the wreck of the *White*, which must have profited more from westerly winds than a coconut, took 11 months to cross the Atlantic from near Cape Hatteras to the Outer Hebrides. Coconuts must come from the Caribbean farther away.

Whether coconuts can remain viable after drifting in seawater for one year or more remains questionable. The experiments on the *Kon-Tiki* indicated that coconuts could not survive three months in seawater. Edmondson (1941) noticed that 2/3 of his coconuts remained viable after floating up to 110 days. No newer and longer experiments are known to me. Harries and Baker (2005) may be right that the Caribbean coconut has wild type characteristics, one of which is slow germination.

Harries and Baker (2005) stated that very few coconuts are nowadays shipped across the Atlantic *with their husks intact*. Nevertheless,

such intact coconuts do arrive on the Dutch coast, albeit less often than those without husks. One of the regular beachcombers on the island of Texel, the Netherlands, my colleague Maarten Brugge (pers. comm.), regularly collects coconuts on Texel's beach, most without husk but some intact; even in 2005 he collected one with husk.

The Dutch coast receives far fewer genuine tropical drift seeds and fruits than the UK coasts. Brochard and Cadée (2005) could document only 35 for the period 1955–2003 (exclusive of the coconuts, which they thought mainly to be man-transported). Darke (2003) collected more tropical drift seeds per year on the Cornish coast! Darke mentioned only one coconut but did not state whether this had its husk intact. Some years ago, germinating coconuts could be bought in flower markets in the Netherlands, so there must have been transport of intact coconuts. However, coconuts may drift almost forever. Perry and Dennis (2003) described a coconut (without husk) that had floated for >30 years! So coconuts certainly will be able to cross the Atlantic as Gulf Stream drift.

Cadée (1988b) mentioned a coconut that was found during the exceptional warm summer of 1947 by L.F. Weijdt to have germinated on Engelsmansplaat, an uninhabited, very high tidal flat in the Dutch Wadden Sea. This coconut passed the Harries-Baker test. There are rumors (which I have not yet checked) that more have been found in the warmer summers of recent years. Is this proof of Harries and Baker's "natural dissemination"? I still think this could have been a man-transported coconut, even though they may also pass the Harries-Baker test.

Acknowledgments

I am very grateful to my son Niels (RSPB, Edinburgh) for sending me "Mystery of island coconut bounty" from BBC News Scotland of 18 September 2006, based on the Tiree coconuts. Remarkable that BBC news believed that Dr. W.J. Baker considered the possibility of commercial growing coconuts in the UK, which must have been a practical joke to get BBC interested. I also thank Dr. W.J. Baker (Kew) for discussions via e-mail and for sending me a copy of his paper (with Harries) in PALMS. I thank Maarten Brugge (Texel) for his data on coconuts from the beach of Texel.

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PALM LITERATURE

FIELD GUIDE TO THE RATTANS OF AFRICA. Terry Sunderland. Kew Publishing, Royal Botanic Gardens, Kew, Richmond, Surrey TW9 3AB, UK. 2007. ISBN 978 1 84246 180 8. Price $40.00. Paper. Pp. 66.

This is another volume in the series of palm field guides published by Kew Gardens.

The guide begins with an introductory section on rattans and their ecology, distribution and uses in Africa. Notes are also given on collecting herbarium specimens of rattans. A key to the genera is given, and there are also keys to the species of each genus.

Twenty-two species of rattan are found in west and central Africa, and all are treated in this guide. For each species the guide gives the Latin name and common names, a description, notes on uses, conservation status, habitat, distribution and distribution map, a line drawing – very nicely done by Lucy Smith – and several, beautiful color images.

I found hardly anything to criticize – in fact this guide could serve as a model for other aspiring authors. One small thing I noticed and found slightly confusing was that the page of images opposite the treatment of *Eremospatha barendii* are not of that species, nor those opposite *Oncocalamus wrightianus* of that species.

Like the other guides in this Kew series, the *Field Guide to the Rattans of Africa* is based on sound taxonomic research. The author spent many years in West Africa working on rattans and has a deep knowledge of his subject. This knowledge is reflected in the guide – it is an excellent, high-quality piece of work, and the author is to be congratulated.

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GROWING PALM TREES IN HAWAI'I AND OTHER TROPICAL CLIMATES. David Leaser. Mutual Publishing, Honolulu, Hawaii. 2007. ISBN 987-1-56647-825-0. Price $12.95. Softcover. Pp. 128.

This how-to volume is David Leaser's follow-up to his attractive homage to palms, *Palm Trees: A Story in Photographs*. While the first book was a visual tour de force, it had virtually no information on palm horticulture. Persons attracted to the palm family by the photos in the first book had to look elsewhere for information on growing the palms. Leaser's second book is the perfect companion to the first. While it lacks photographic impact of the first, it has illustrated chapters on choosing the right palm for specific environments, planting palms, pests and diseases, germinating seeds, and pruning and grooming. A brief glossary is also included. While this book is aimed mostly at Hawaii, palm growers in other tropical or subtropical areas will find something of value in this manual.

Most of the book's pages are devoted to portraits of commonly cultivated palms from Hawaii and other warm areas. This "sampler" of palms covers an impressive 81 species. Each portrait takes up most of the page and is captioned with a short paragraph giving the scientific and common names, place of origin, distinctive features and noteworthy horticultural traits. Almost all of the portraits illustrate mature palms, so readers can get an accurate idea of each palm's size, shape and garden-worthiness.

A very useful feature of this book is the section on Hawaiian botanical gardens with important palm collections. Leaser provides names and addresses (and websites) of a dozen botanical gardens, arranged by island. He also gives a brief account of each garden, highlighting the size, history or important palms for each garden. The garden section is followed by a section on palm organizations, including the International Palm Society. Contact information for local palm societies around the world is also included.

his book is deceptively slim, but it carries much the same weight as some of the larger books already on the market. It covers a very broad range of topics, not always in great depth, but with enough solid information to get the first-time palm grower off on the right foot. This book would be an excellent accompaniment to the purchase of a first palm or a welcome gift to a newcomer to palms (or a new neighbor, whose landscape needs palms!). With this book, Leaser has produced an attractive, affordable guide to growing some of the world's most beautiful plants.

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Doum Palm Habit and Leaf Collecting Practices in Niger

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1. Arborescent habit of the Doum palm, *Hyphaene thebaica.*

Intensive harvesting of juvenile leaves strongly affects the development of the Doum palm, *Hyphaene thebaica*. The arborescent habit changes into a subterranean-creeping habit, and palm stands are reduced to dense carpets of leaves emerging from the ground. A description of the growth pattern of this palm species makes it possible to understand better this singular phenomenon.

The importance of Doum palms in the local and regional economy in Africa, as well as the impact of human use on the groves of these palms, or their improvement as agro-forestry and agro-pastoral systems, is emphasized for several species of the genus *Hyphaene*. These include *H. compressa* in Kenya (Amwatta 2004, Barrow 1991, Hoebeke 1989), *H. petersiana* in North-Central Namibia (Konstant et al. 1995, Sullivan et al. 1995), *H. coriacea* in South Africa (McKeana 2003) and *H. thebaica* in Djibouti (Audru et al. 1987). Some data on the nutritional composition of the fruit of *Hyphaene* spp. are also available (Atchley 1984, Bonde et al. 1990).

Hyphaene thebaica is a very common palm species in Niger where its remarkable crown shape marks the landscapes of the Sudan-Sahelian regions between the 400–700 mm isohyets. It can grow to heights of over 15 m and forms a dichotomously branching tree with 2, 3 and even 4 orders of aerial branches (Fig. 1). In the most arid regions of the country, *Hyphaene thebaica* forms dense groves in depressions and in the oases. Most of its parts are used by local people. The leaves are intensively used as detailed below. The trunk makes good construction material, the poles being especially well adapted with their forked branches to support the cross-beams. The ripe fruit with its fleshy mesocarp is appreciated everywhere in Niger. The gelatinous albumen contained in the green fruit is a prized food that is marketed through essentially national circuits. In the region of Agadez, it is dried and the local production is known by the name of "*togodaray*". The dead parts of the palm tree are frequently used for firewood. In addition, the leaves also serve as green fodder for cattle in the dry season.

The economic importance of *Hyphaene thebaica* and the need for sustainable management of its groves are dealt with in several unpublished reports and degree dissertations (Adamou 1993, Anonymous 1989, Brah 1995, Dadé 2000, Ganda 2005, Harouna 2005, Ousmane 2003, Ousseini no date, Saley 1994). During the last few years, the protection of the Doum palm and the development of a commercial network have been the objectives of development projects at Government level.

Leaf harvesting is very intensive throughout the country, but collecting practices differ from one region to another, as shown by comparing those of the Aïr region, north of Agadez, with those of the Dalol Bosso region, south of Birni Ngaoure in the Niger River valley. Through the description of the growth pattern of *Hyphaene thebaica*, we propose here to explain how the intensive collection of the juvenile leaves has a spectacular effect on the palm habit.

Economic importance of the Doum palm

The leaves mainly provide a commercial network on a large scale. First, the segments are separated and detached from their insertion in the short rachis. Then the central veins are taken out; tied in bundles of 400 to 500, they serve as brooms. The parts of the leaf blade without the central vein are then regrouped by bundles of approximately 300 pieces of an average length of 35 to 50 cm according to

2. Doum palm after leaf collection in the Aïr mountains.

3. Field of Doum palms for the production of leaves in the Dalol Bosso region.

whether the material originates from the adult or juvenile leaves. Sold at an average price of 25 francs cfa (4–5 US cents), the bundles are purchased by craftswomen to make mats, commonly used in these semi-arid regions, which serve essentially to sit on and to make the walls and roofs of dwellings. The segments of leaves are used for basketry for different uses, trays, boxes and containers. Ropes of different diameters are woven according to the strength needed – the thickest are used for drawing water from very deep wells (up to 70 meters), the medium for animals and to tie together the different parts of dwellings and granaries or to tie up bundles of millet spikes, while the finest are used for the most common purposes; sewn together they are used as padding for packsaddles.

4 (left). Juvenile palm before branching. 5 (right). Juvenile palm with two axes from dichotomous branching.

6. Juvenile palm with 8 axes from dichotomous branching.

7. Branch developing with greater vigor; it will produce the aerial dichotomous structure of the palm.

The sale of the leaves and derived products, such as mats, basketry and ropes, is highly developed in the regional markets all year long. Networks of producers and dealers in Doum palm leaves and baskets are organized from the Niger River valley towards the semi-arid zones of the North or towards the neighboring countries (Benin, Ivory Coast, Nigeria). In other regions that produce these leaves, similar networks, national and international, have been organized since pre-colonial times, such as, for example, the circuits operating in the Aïr mountains from a very heavy production in the oases towards the regions that have no palm trees, and since the years 1872–73 towards Europe. Nowadays the Handicrafts Service in Agadez markets the craft production of 3 000 women organized into cooperatives for a total revenue of 60 million francs cfa (ca. 115,000 US dollars) per year.

Two ways of harvesting leaves

In the oases of the Aïr region: The palms are most commonly subject to harvesting when they are short-trunked or still stemless with the leaf base entirely emerged from the soil. Just before opening, the new leaf is cut at two-thirds of its height by the harvesters, who collect the free segments. When the leaf amputated in this way opens out, the basal part of the blade forms a fan (Fig. 2). This method of harvesting the leaves does not seem

significantly to affect the growth of the palm tree.

In the Dalol Bosso region: Women harvest especially the juvenile palmate leaves, the bases of which still remain buried in the soil. The shoots have not yet formed a trunk above ground. With a knife, they cut off the stalks of the leaves right at ground level, a few centimeters below the leaf blade. When the women conduct these harvests regularly and intensively, the landscape takes on a very singular appearance. The ground is covered in dense and more or less circular patches of juvenile palmate leaves (Fig. 3). There are no trunked palms, or only some rare tall individuals can be seen far away on the horizon; the field resembles a nursery of Doum palms.

This second way of harvesting Doum palm leaves is much more traumatic for the palm than that described from the Aïr region. However, to understand better the phenomenon, we must first consider the way in which *Hyphaene thebaica* grows.

Morphological features and habit in *Hyphaene thebaica*

Germination, leaves, inflorescence: Only 17 of the 60 seeds put in a plot of sandy soils on 2 April 2004 at the end of the dry season had germinated by 29 July during the rainy season. The eophyll and the first leaves are entire and lanceolate. The juvenile leaves are palmate; the leaf sheath with a part of the petiole is still underground. Costapalmate leaves will be formed when the trunk starts emerging from the soil. The inflorescences are produced from lateral buds and remain in the crown between the leaf bases. Flowering takes place in February–March. The fruits ripen in October–December.

Dichotomous branching: The main stages in the growth of this palm tree are described here from observations *in situ* after excavation of the underground apparatus of individuals at different stages of development. The dichotomous branching expresses early in the soil and in succession forms 2, 4, 8 branches and so on (Figs 4–6). Not all the branches divide at the same time and intermediates are most often observed. Then one or several branches grow more vigorously than the others (Fig. 7). These prominent stems will develop into the aerial dichotomous structure, while the others persist at the base of the cluster.

Basal axillary branching: The basal axillary branching is expressed later among older plants or when the trunks have been cut. Old stocks can regenerate in this way.

Specificity of Hyphaene thebaica *habit*: Hallé and Oldeman (1970) have defined the dichotomous growth mode of trees as Schoute's model. However, they contest the dichotomous nature of branching in *Hyphaene thebaica*, i.e. the fact that the apical meristem divides into two equal parts, each producing a new axis. For these authors, the apical meristem after dying is replaced by two lateral

8. Doum palm habit under regular harvesting of juvenile leaves.

buds, each of them producing a new branch. Uhl and Dransfield (1987, see diagrammatic drawings p. 4) describe four different habits in dichotomously branching palms: (i) dichotomous branching and basal axillary branching in *Hyphaene coriacea*, (ii) upright, dichotomously branching stem in *Hyphaene compressa*, (iii) prostrate, dichotomously branching stem in *Nypa fruticans*, and (iv) erect, dichotomously branching stem – in which one half of the dichotomy ends in a terminal inflorescence and the other half continues as a vegetative axis which may branch again in a similar dichotomous fashion – and basal axillary branching in *Nannorhops ritchiana*.

The habit of *Hyphaene thebaica* differs from the four forms defined above in the following ways: (i) a very precocious underground dichotomous branching; (ii) the differential growth in dichotomy ends leading to the prominence of one or a few axes which then produce the aerial dichotomous structure; and (iii) the late basal axillary branching which may play a role in the regeneration of palm groves.

A dwarfing process as a function of leaf collecting practices

How can we understand the different palm habits observed in the Dalol Bosso region, where women intensively harvest the juvenile palmate leaves? The excavation of the subterranean apparatus clearly shows that all the shoots issued from dichotomous branching develop equally and soon divide into two new short shoots of equal size (Fig. 8). Prominent axes with higher vigor are not observed any more. The aerial structure of the palm cannot be built as a result. The palm pursues its development underground, spreading out in a centrifugal way and forming patches of leaves which emerge from ground at the periphery. This process goes on while women maintain their collecting pressure. The Doum palm is then condemned to creep underground and to produce only juvenile palmate leaves, the most prized for making mats and baskets.

A similar dwarfing process has been noted among *Nannorrhops ritchiana*, the Mazari palm in Pakistan (Gibbons & Spanner 1995).

Acknowledgments

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PALM LITERATURE

FIELD GUIDE TO THE PALMS OF MADAGASCAR. John Dransfield, Henk Beentje, Adam Britt, Tianjanahary Ranarivelo, and Jérémie Razafitsalama. Kew Publishing, Royal Botanic Gardens, Kew, Richmond, Surrey TW9 3AB, UK. 2006. ISBN 978 1 84246 157 0. Price $45.75. Paper. Pp. 172.

FIELD GUIDE TO THE PALMS OF NEW GUINEA. William Baker and John Dransfield. Kew Publishing, Royal Botanic Gardens, Kew, Richmond, Surrey TW9 3AB, UK. 2006. ISBN 1 84246 138 9. Price $36.60. Paper. Pp. 108.

The Palms of Madagascar, by John Dransfield and Henk Beentje, was published in 1995. Despite its color illustrations and maps, the work was a technical monograph on the palms of the island, and a weighty one at that. Now the authors, together with three other colleagues, have produced a distilled version: *Field Guide to the Palms of Madagascar*.

The *Guide* begins with a very nice illustrated glossary, followed by an illustrated key to the genera, followed by species descriptions for each genus. The generic treatments start rather abruptly, with the key and without any introductory information. So, for example, to know how many species of *Dypsis* there are in Madagascar, one would either have to refer to the original *Palms of Madagascar*, or to count all 140 of them in the index of scientific names. The species descriptions, with one or two pages per species, are very attractively laid out. For each species, the page contains the Latin name, Malagasy name, key characters of the species, uses, conservation status, habitat and a short, non-technical description. Almost all species are illustrated by beautiful color images. Finally there is a section on similar species.

From my brief test of the keys, they appeared to work very well. It is, of course, difficult to construct a key to a large genus such as *Dypsis*, but the authors appear to have succeeded. However, I think it too much to expect the user of a field guide to count the stamens, let alone to see if they are opposite the sepals or petals!

I was struck by several things as I looked through this book – the extraordinary diversity in leaf and inflorescence form in *Dypsis*, as if the genus had tried out every conceivable variation known in other palms (there are even aquatic *Dypsis* and climbing *Dypsis*!). However, one's wonder at such diversity is tempered by the fact that so many of these species are endangered in their native habitats.

I have few criticisms of this fine book. The maps are rather dark and the dots rather big – I think the maps in *The Palms of Madagascar* worked better. The small sketches given for each species, showing characters of stems, leaves and inflorescences, are in some cases misleading (showing, for example, aerial stems for species that may be acaulescent) and are probably superfluous, given the descriptions. For *Dypsis*, 77 species are treated with full-page spreads, but the remaining 63 species are only referred to in the "similar species" sections.

I have long been a fan of field guides, and this volume is a model – scientifically accurate but presented in an accessible and attractive format. I feel sure that IPS members will appreciate this guide. There is also a Malagasy language version.

This New Guinea guide has exactly the same format as the *Field Guide to the Palms of Madagascar,* but this is a guide to the 31 genera of palms found in New Guinea. For this reason I feel the Guide is somewhat misleadingly entitled (especially compared to *Field Guide to the Palms of Madagascar*) and should have been entitled *A Field Guide to the Genera of New Guinea Palms*.

The book has a more extensive introduction than in *Field Guide to the Palms of Madagascar*. There are notes on New Guinea and its palm flora, plants that look like palms, how to collect palm specimens, and where to see palms in New Guinea. There is also an illustrated glossary. The keys are rather different than the dichotomous keys of *Field Guide to the Palms of Madagascar*, although this format will work only when there are few taxa to key out, as is the case here.

The descriptions of each genus are laid out in a very similar way as the Madagascar guide: Latin name, key characters, notes on distribution, habitat, number of species, habit and description. The distribution of the genus in New Guinea is given by a shaded map. For the larger genera, several color images, again very beautiful, of various species are given. There is also an Indonesian language version.

There have been at least three previous works on the New Guinea palms, and I still do not think we are quite there yet!

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Tahina – A New Palm Genus from Madagascar

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1. Soejatmi Dransfield provides scale for the flowering individual of *Tahina spectabilis*.

Tahina, the most massive fan palm in Madagascar, has recently been described and named as a new genus with the single species, _T. spectabilis_ (Fig. 1). The story of its discovery follows.

The first intimation that there was a new and quite extraordinary palm in northwest Madagascar reached members of the International Palm Society in December 2006, when pictures of a strange fan palm were posted on the IPS Bulletin Board, PalmTalk.

The discovery

The discovery of a new palm genus in north-western Madagascar has come as a complete surprise. The area where this palm was found is a very remote part of north-western Madagascar, northeast of the port of Mahajanga. The area is very difficult to access by land. It would take at least three days from Mahajanga by four-wheel drive during the dry season. During the wet season would probably be next to impossible. The human population in the area is very sparse for Madagascar, with a thin scattering of villages.

In the area are three fly-in beach resorts and a prawn hatchery. The prawn hatchery and rearing ponds produce Madagascar Tiger Prawns that are shipped out on a regular basis to supply the supermarkets of Europe. The tiger prawn company, UNIMA, has recently established a cashew nut plantation in the area as a method of re-forestation with the potential to play a significant role in carbon-trading, as well as providing a high quality cash crop. The manager of the plantation is Xavier Metz, a Frenchman born in Madagascar, who lives on the plantation in a house perched on the cliff overlooking the Mozambique Channel, together with his wife, Nathalie, and daughters, Marie-Nirina, Anne-Tahina and Léa-Mirana. In this remote part of Madagascar, opportunities for weekend family outings consist of boat trips and picnics on land. In 2005 on one such family outing, the Metz family came across a low limestone hill to the northeast of the plantation where they saw interesting vegetation and old cliff graves. At the foot of the limestone hill they saw several huge palm trees. In the absence of flowers or fruit they assumed this to be a palm called locally *dimaka* (*Borassus madagascariensis*, a palm restricted to the west of the island where it is never very common) .

In September 2006 they revisited the hill and were astonished to see one of the palms in spectacular flower, with the flowers being borne in a huge pyramidal bunch above the leaves of the palm. The Metz family had never seen anything like it, so they photographed it. Later that year, Xavier Metz met an old friend of his, Bruno Leroy, in the Madagascar capital, Antananarivo. Bruno is a palm enthusiast. Xavier shared his photographs with Bruno and neither of them could say what it was. Bruno posted the pictures on the interactive bulletin board, PalmTalk, of the International Palm Society (www.palms.org) on 6 December 2006.

Within 24 hours there was already a rapidly developing discussion on what the spectacular palm might be. Several people suggested it was *Borassus*, or even *Bismarckia* (both native fan palms in Madagascar) while others pointed out that the flowers were completely wrong and resembled the Asian genus *Corypha*, the Talipot palm. On 7 December, Matt Patricelli of San Diego, a frequent contributor to the message board, alerted John Dransfield, to the mystery palm. John looked at the images, amazed. The palm looked incredibly like Asiatic *Corypha* from a distance. Could the palm have been introduced? However, the palm was unlikely to be planted as it occurs so far from anywhere and it was growing apparently on inhospitable karst limestone. Unfortunately details on the pictures were at too low a resolution to allow proper diagnosis. John posted his comments and also contacted Bruno directly. In January 2007, Bruno emailed a Google Earth reference point for the locality and amazingly palm crowns are actually visible in Google Earth, so enormous is the palm. It is also fortunate that there is relatively good resolution in Google Earth for this bit of Madagascar.

John made arrangements with Bruno for his PhD student Mijoro Rakotoarinivo, to go in January 2007 to see the palm and to make scientific collections. Mijoro was successful and took further photographs, emailed to Kew, in which the palm looked significantly different from Asiatic *Corypha*.

The mystery palm has a massive trunk to 18 m tall with huge fan leaves up to 5 m in diameter, making it the biggest fan palm in Madagascar. John made a preliminary conclusion that the palm was almost certainly not only a new species but probably also belonged to a new genus. He then had to wait impatiently until the material of the palm reached Kew. At the same time, John and his co-authors, were putting the final touches to the manuscript of the second edition of *Genera Palmarum*, with the plan to hand in the manuscript to the publisher at the end of March 2007.

Meanwhile, Mijoro arrived in Kew to continue his work for his PhD, and then at the end of March, the material of the mystery palm finally reached Kew. John and Mijoro opened the parcels of material, once they had passed through the Herbarium quarantine process of freezing, and it was immediately obvious that the palm was not *Corypha* nor was it even related to *Corypha*, but instead had features clearly showing it to be a new genus, and suggesting a relationship with the tribe Chuniophoeniceae that includes three other genera – *Chuniophoenix* in China and Vietnam, *Kerriodoxa* in southern Thailand and *Nannorrhops* in Arabia, Afghanistan and Pakistan.

Faced with this, John had to down tools and immediately draw up a description of the new genus, even though this would have to be based on incomplete material (mummified flowers and ripe fruit) and then incorporate the description in the manuscript of Genera Palmarum. This involved a great deal of renumbering and changing of cross references. Kew artist Lucy Smith prepared analytical drawings to go with the description. Finally the manuscript of *Genera Palmarum* was ready for the publisher, about one month late.

At the same time leaf material was sent off to colleagues Jack Fisher and Jay Horn in Fairchild Tropical Botanic Garden in Miami for anatomical study and further leaf samples were handed over to the Jodrell Laboratory in Kew for analysis of DNA by Ross Bayton. Ross's molecular analysis confirmed the position of the genus in tribe Chuniophoeniceae of subfamily Coryphoideae. This palm group has a highly paradoxical distribution pattern, very difficult to understand, but morphology and DNA are unequivocal – the new genus has to belong to this group.

How could such a spectacular and enormous palm have been missed in previous surveys, despite the great deal of attention given to the palms of Madagascar? The answer must be that the palm grows in an extremely remote part of Madagascar, an area which is otherwise very species poor in palms, and if the palm had been seen and not in flower it would probably have been overlooked as *Borassus* or *Bismarckia*.

In June 2007, another individual of the palm showed signs of coming into flower – a giant asparagus-like shoot appeared above the leaves. Xavier Metz followed the development of the palm over the next few months, once the flower-bearing branches had emerged, collecting small samples into alcohol and photographing progress. As the huge compound inflorescence began to develop, it looked increasingly likely to be in flower in September, just when John Dransfield planned to visit Madagascar, to supervise Mijoro's research. John and Mijoro thus planned to spend a few days at end of the trip to see the new palm.

2. Anne-Tahina Metz, for whom the palm is named, standing at the foot of a tall individual of *Tahina spectabilis*.

In the meantime a full description of the palm was submitted to the Botanical Journal of the Linnean Society, naming the palm *Tahina spectabilis*. *Tahina* in Malagasy means blessed or to be protected, and is part of the given name of the Metz's second daughter, Anne-Tahina Metz (Fig. 2). The name has local meaning rather than being an unpronounceable Greek or Latin-based name of no obvious meaning to local people. The paper was finally published on 17 January 2008 (Dransfield et al. 2008).

In mid September, John and his wife, Soejatmi, and Mijoro visited the cashew plantation and

3 (top). View over the dry rice field to the *tsingy* and the flowering individual of *Tahina spectabilis*. The close proximity of the inflorescence to the limestone hill made sampling of the flowers unusually easy for such a big palm. 4 (bottom) The crown of *Tahina spectabilis* showing the deep triangular cleft at the base of the petiole.

5. The leaf of *Tahina spectabilis* viewed from beneath showing the major and minor folds.

stayed with the Metz family. The flowering individual of the palm was about six days away from flower opening so they just missed the event. Nevertheless they were able to collect more material and made copious notes on the population (Figs. 3 & 4). They had extensive discussions with the Metz family and met people from the nearby village. The major topic of discussion was how to conserve the palm population for the future and how to harvest and distribute seed fairly worldwide without damaging the wild population but at the same time providing potential income to the village to act as an incentive to the conservation of the palm.

Six days after they left the palm came into full flower, producing vast quantities of nectar that dripped off the flowering branches. Bees and wasps circled the inflorescence in huge numbers, and the Greater Vasa Parrot did some

damage, ripping off flowering branches to get at the nectar. Xavier and Nathalie continued to make observations and collect further samples of the flowers. Their close observations have added greatly to our understanding of the morphology of the palm. We now know that each bract on the flowering branches of the inflorescence (rachillae) has the potential to produce three flowers, although towards the tips of the rachillae only two or even one flower is produced. Flower opening seems to come in three waves, each one with massive production of nectar. It also seems that fertilisation is sporadic and the resulting fruit may originate from any of the three waves of flowering. Fruit seems to take about three to three and a half months to reach maturity.

When the palm was in flower in September the flat land surrounding the limestone hill was bone dry and the soil surface cracked. By the end of December most of this land was under water, including the base of the palms at the foot of the limestone hill. Much of this seasonally flooded flat land was cleared long ago for rice cultivation and any semi-natural vegetation survives only at the foot of the limestone hill.

The Palm

Tahina spectabilis is a solitary massive hapaxanthic hermaphroditic fan palm. The stem reaches about18 m tall and is about 50 cm in diameter at breast height, with internodes 8–10 cm long, the nodal scars conspicuous. There are about 12–18 huge leaves in the crown; they are induplicate, costapalmate, and marcescent in immature individuals, tending to fall under their own weight in trunked individuals. The leaf sheath is about 80–100 × 52–58 cm and has a conspicuous triangular cleft below the petiole, with the margins tending to erode into broad tattered lobes. The petiole is massive, about 5 m long in juvenile palms, but shorter in adults and is covered with white wax; it is 10–12 cm wide near the base and is deeply grooved on the upper surface and rounded beneath, and has smooth margins, completely lacking in spines. At the tip of the petiole is a well developed triangular hastula on the upper surface and a low ridge-like hastula on the undersurface. The costapalmate leaf blade is approximately 3.5–5 m in diameter in well grown adult palms, but in exposed individuals and juveniles it is much less; the blade is divided to ca. 1/2 its radius into multi-fold segments, these in turn more shallowly divided into a total of 110–122 single-fold segments, themselves shallowly divided along the abaxial folds, the blade between each fold being up to 10 cm wide; the main abaxial (lower) ribs of the blade are very conspicuous, very crowded at the base of the blade, with some much more robust than others, the less robust ribs tending to be inserted in a more adaxial (upper) position compared with the robust ribs – this curious arrangement of folds seems to be unique to this genus and would be a very useful character for distinguishing the palm when sterile (Fig. 5). There are abundant transverse veinlets between the main ribs. The whole leaf texture is surprisingly thin when compared with that of *Bismarckia* or *Borassus*. The inflorescence is held above the leaves and

6. Close up of a rachilla of *Tahina spectabilis* with flower buds.

is a huge compound structure to 6 m tall, composed of numerous (to ca. 45) lateral inflorescences, each branched to 3 orders, all branches ending in rachillae. The tubular inflorescence bracts are conspicuous throughout, and are generally covered in thick white indumentums. The rigid rachillae are 10–15 cm long and ca. 0.5 cm in diameter and are covered with conspicuous chestnut brown bracts that subtend the flower clusters (Fig. 6). the flower clusters consist of up to three flowers with their attendant bracteoles. The flowers are hermaphroditic, approximately 8 × 2.5 mm in bud and are exerted from the rachilla bracts. Flower opening (anthesis) seems to proceed in up to three waves, as the flowers of the flower cluster reach maturity sequentially. The thin membranous calyx is tubular with three rounded lobes and splits irregularly. The corolla has a basal solid stalk and three green lobes that become strongly reflexed when the flower opens, with the base of the lobes appearing to be nectar producing. The stamens are 6 in number and have free rod-like filaments and bright yellow anthers attached at their middles and versatile on the filaments. The gynoecium consists of three completely fused carpels, each with an anatropous basally attached ovule, and a common style ending in three minutely divide stigmas that appear not to reflex at anthesis. The fruit is green at maturity and is broadly ellipsoid to obovoid, 25–30 × 20–22 mm, borne on the stalk-like corolla base, 5–7 × 2 mm. Each fruit contains a single seed and has apical stigmatic remains; the epicarp is smooth and glabrous, the mesocarp is moderately thick, spongy, with few longitudinal fibers and the endocarp thin, 13–17 × 17–22 mm, crustaceous, with a pronounced longitudinal groove and a short apical beak, and irregularly anastomosing grooves. The seed is globose, 1.8–2.2 × 1.4–1.8 cm, laterally attached with an elongate hilum, and with deep grooves corresponding to the rapheal bundles; the endosperm is strongly ruminate, without a central hollow and the embryo is sub-basal. Germination is remote-ligular with a palmate eophyll.

The population

During a complete census of the palm in September 2007, Xavier Metz counted 92 individuals, of very mixed ages, from small rosette palms to huge non-flowering adults. As well as these established plants, there are several hundred one or two-leaved seedlings resulting from the 2006 flowering event. As far as can be seen, these seedlings are restricted to the base of dead trunk and to areas perhaps a few meters away. All the palms are restricted to the northern end of the narrow north-south

7. Three massive individuals of *Tahina spectabilis* at the foot of the limestone hill.

8. Using ecological parameters the possible potential distribution of *Tahina spectabilis* can be calculated using the GIS program MAXENT. The red marked areas are areas where the palm should be sought.

orientated limestone hill (Fig. 7), except for a single individual – a well established juvenile palm with a very short trunk, which occurs about 0.5 km away from the limestone hill at the edge of the nearby village and at the edge of the seasonally flooded flat lands.

The Habitat

When news first came through about the palm, we assumed that it grew on limestone. This is, however, not the case. All individuals grow in deep soil at the very foot of the limestone. This habitat is dry during the dry season but may be flooded up to 50 cm deep with freshwater during the rainy season. The palms thus grow with their feet in water during this wet period. That they should be confined to the very foot of the limestone hill is perhaps a reflection of the fact that this part of the seasonal swamp is not under rice cultivation and is also hardly affected by seasonal fires – the limestone protects the palm in the narrow areas between the outcrops. As mentioned above, there is one individual growing about a half kilometer away from the limestone hill at the edge of a nearby village, at the edge of the seasonally flooded area, adding evidence that the palm is perhaps only secondarily associated with limestone.

We speculate that the palm was perhaps a dominant plant of seasonally flooded wetlands in this area and now survives only where it has some protection from fire. One can imagine how spectacular a swamp filled with gigantic palm may have been before the arrival of man.

Are there likely to be any other populations of the palm? Given that this population has only just been discovered, it seems not impossible that there may be other populations. Mijoro carried out a prediction based on the ecological parameters of the site as we know them and concluded that there is a limited predicted distribution as shown in Fig. 8. Unfortunately, most of the predicted areas have rather poor resolution in Google Earth so the prospect of scanning through image after image to look for the distinctive gray-green crowns and finding anything seems unlikely. Furthermore blue green Bismarckias are abundant throughout the predicted range and could easily be confused with *Tahina* in satellite imagery. We suggest that the palm is almost certainly a great rarity.

What we know of its natural history

None of the villagers has any recollection of the palm ever flowering before 2006 when the first individual flowered. It is very difficult to imagine that the villagers who live so near to the limestone would miss such a spectacular event as the palm producing the giant compound inflorescence. Furthermore there are no signs of dead trees with decaying inflorescences apart from the tree that flowered in 2006. This all seems to suggest that flowering has been a very rare event. Thus we have absolutely no idea how long it takes for a seedling to grow to adulthood and flowering and we cannot estimate how old the magnificent trees that tower over the nearby juveniles are.

As mentioned above it seems to take about three months from the first appearance of the inflorescence to full expansion of the rachillae and flower opening and a further three to three and a half months for fruit to reach maturity. With up to three flowers per rachilla bract produced sequentially there are three waves of flower opening. Throughout flower opening there is production of copious nectar, apparently from the petal bases. This attracts large numbers of bees, wasps and flies, and also parrots.

The Future

The key to the survival of *Tahina spectabilis* in its natural habitat lies with the villagers who

live nearby. Under current Malagasy Government legislation the people of the two villages nearby have control over the exploitation of the natural resources under COBA. This legislation empowers the villagers to make decisions affecting the survival of local biodiversity. To us, the best way of ensuring that the villagers protect the palm is if they understand that there is benefit to be had from maintaining the palm population in good health. Unfortunately, the locality is so far off the beaten track that it is very unlikely that a significant number of tourists will visit to view the palm, so the potential for income from tourism seems negligible. On the other hand, palm enthusiasts world wide are highly likely to want to grow the palm. Even if it may take decades to reach flowering size, and even if most amateur growers are unlikely to have the space to grow the palm in the ground, there is no doubting the appeal of the palm, especially as seedlings and young juveniles. In order to satisfy this potential demand, we have proposed a controlled harvest of seed from the individual that flowered in 2007. A substantial number of seeds will be allowed to fend for themselves without human intervention. A further proportion will be sown on site, and further seeds grown in a nursery at the cashew plantation, with progeny being plated on site where suitable. A proportion of seed will be distributed to botanic gardens and arboreta within Madagascar and, finally, seed will be harvested specifically for distribution overseas, gratis to suitable botanic gardens, and the rest sold with a significant proportion of the profit being returned to the village committee to be used for village development (such as improvements to the water supply). It is hoped in this way the village will appreciated the benefit of the palm and that this will provide an incentive to protect it.

Already to this end the villagers have set up a parrot patrol to scare away the birds from the palm and prevent damage to the flowers and developing fruit. The palms have now been fenced by the villagers to prevent zebu cattle from damaging the young plants of the palm. A village committee has been set up to take control of the conservation of the palm and conspicuous signs placed outside the fenced area prohibiting access.

Acknowledgments

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PALM LITERATURE

SEED TO ELEGANCE. KENTIA PALMS OF NORFOLK ISLAND, SOUTH PACIFIC. Kevin Williams. Studio Monarch, Norfolk Island 2899, South Pacific. 2007. ISBN 978-0-9775121-1-9. US$24.95.

In this attractive little book (available via www.kentiapalmbook.com), Kevin Williams tells the story of the part played by Norfolk Island and its residents in the kentia palm's rise from obscurity to ubiquity. The kentia palm, *Howea forsteriana* from Lord Howe Island, is nowadays an extremely important horticultural commodity on account of its ease of cultivation and tolerance of temperate conditions. A substantial proportion of the kentia market is supplied by Lord Howe Island via a nursery run by the island's governing board, but in this book Williams advises us that a startling 60% or more of world demand is in fact met by plantations on Norfolk Island. The scale of seed and seedling export, and of downstream palm production described by Williams demonstrates that the kentia is very big business indeed.

The book provides an outline of Norfolk Island's sometimes brutal history and its close links with the infamous HMS Bounty mutineers. Williams then goes on to explain how the kentia became so popular in Victorian horticulture and a favorite of British royalty. In outlining the origins of the Norfolk Island kentia plantations, the author explains how kentia seeds from Lord Howe were traded for Norfolk Island pine seeds (*Araucaria heterophylla*). The pines are now well established on Lord Howe, no doubt providing valuable timber over the years and are popular with the local seabirds, especially terns, for nesting, but ironically are becoming invasive and require some controlling – they are certainly not the cash crop that kentia has become on Norfolk Island! The book concludes with a detailed description of kentia production methods and distribution, and guidance on the use and cultivation of the palm.

Kevin Williams has provided a very informative summary of the Norfolk Island kentia story, richly illustrated with excellent photos, including wonderful archive material, and elegantly formatted for an easy read. It will be of interest to all IPS members, especially those gardening in cooler areas. There is little to criticize. I spotted a few botanical blips, such as the capitalization of the species epithet, which should of course be lower case. And do my eyes deceive me, or is the clustering palm in the elegant Washington salon on p. 27 (and on the website) not *Dypsis lutescens*? But these are trivial points. The only real disappointment for me is the fact that the much more elegant curly palm (*Howea belmoreana*) has not become as popular in commercial horticulture as its more amenable sister species. One day perhaps…?

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The Palms of Hainan

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1. *Chuniophoenix humilis* at Diao Luo Shan.

Hainan Island in southern China has a diverse and interesting palm flora. In this article, we describe a recent visit to the island to see the island's palms.

Hainan, lying in the South China Sea, is one of China's smallest provinces, with an area of 34,000 km^2. It extends about 260 km from west to east and 210 km from north to south. It is the most southerly of China's provinces, almost exactly the same latitude as Hawaii. It has a tropical climate with annual rainfall of about 2000–2400 mm on the east coast and about 1000–1200 mm on the west coast. Like many other tropical areas, deforestation has been severe, and now less than 20% of the island is still covered by forest, most of which is in protected areas. The highest mountain on the island, Wuzhi Shan or Five-Finger Mountain, is 1867 m elevation. Hainan has high biological diversity, and there are an estimated 4600 vascular plant species – including 26 species of palm (see Sidebar).

In March 2006 we visited the island province of Hainan in China, to carry out field work for the book *Field Guide to the Palms of Southern Asia* (Henderson, in prep.). This field work was supported by a grant from the International Palm Society. We arrived in the capital, Haikou, by air and left the next day for our first locality,

2. *Chuniophoenix hainanensis* at Diao Luo Shan. 3 (inset). Flowers of *Chuniophoenix hainanensis.*

List of the palms of Hainan

Arenga caudata
Arenga westerhoutii
Calamus egregius
Calamus hainanensis
Calamus multispicatus
Calamus pulchellus
Calamus rhabdocladus
Calamus simplicifolius
Calamus tetradactyloides
Calamus tetradactylus
Calamus walkeri
Caryota maxima
Caryota mitis
Chuniophoenix hainanensis
Chuniophoenix humilis
Daemonorops jenkinsiana
Licuala fordiana
Licuala hainanensis
Livistona chinensis
Livistona jenkinsiana
Nypa fruticans
Phoenix loureiroi
Pinanga baviensis
Plectocomia microstachys
Rhapis excelsa
Rhapis gracilis

4. *Licuala hainanensis* at Diao Luo Shan.

Diaoluoshan, a forested mountain area in the southeast of the island. This turned out to be an excellent locality for palms. One genus that we were particularly interested in seeing was *Chuniophoenix*, and here we found both Hainanese species. *Chuniophoenix humilis* is a small palm, similar to *Rhapis* in general appearance (Fig. 1), and is rare on the island. It is sometimes included in *C. nana* from northern Vietnam, but we consider it distinct, based on its broad, hooded leaflets. *Chuniophoenix hainanensis* is more common and much larger, and we saw plants up to 4 m tall growing in the forest (Fig. 2). While we were there, this species was in full flower, with beautiful purple flowers (Fig. 3). Both these species of *Chuniophoenix* are endemic to Hainan. Also here were two species of *Licuala*. One of these, *L. fordiana*, formed large, stemless clumps in the forest. It occurs in Hainan and also in the mainland province of Guangdong. The second species has been called *L. spinosa*. However, subsequent study of our collections showed this to be a distinct species, which we have described as a new species, *Licuala hainanensis* (Fig. 4). It is unusual in being dioecious, with separate male and female plants. A *Pinanga* was common here and elsewhere on Hainan. We identified it as *Pinanga baviensis*, a widespread species in southern China and northern Vietnam. There were a few rattans here, including *Calamus walkeri, C. rhabdocladus,* and *Daemonorops jenkinsiana*. We found two forms of *D. jenkinsiana* on Hainan, possibly representing two different taxa. We were also delighted to find *Plectocomia microstachys*, a very poorly known species which turned out to be quite common in the forest here (Fig. 5).

After a couple of days at Diaoluoshan we proceeded to Five Finger Mountain. Here we saw many of the same palms we had seen at Diaoluoshan, but there were also a few new ones, including *Caryota maxima* and a couple of species of *Calamus*. We finally concluded that these were *C. egregius* and *C. simplicifolius*, both endemic to Hainan. These two species

5. *Plectocomia microstachys* at Diao Luo Shan.

are large rattans which climb by cirri – long, whip-like extensions of the leaf rachis.

Our next locality was Jianfengling National Forest Park, a famous nature reserve in southwestern Hainan (Fig. 6). This mountainous area is covered in beautiful rain forest, full of palms! We saw many of the species we had seen at other sites, but also found *Calamus tetradactyloides*, a beautiful small rattan, endemic to the island of Hainan (Fig. 7). Common here were large plants of *Arenga westerhoutii*. There were also two species of *Livistona* here. One, very abundant along the river banks, we took to be *L. jenkinsiana*. The second, of which we found only one plant, appeared to be *L. chinensis*, with its characteristic pendulous leaflets.

Near Jianfengling we visited the Tropical Forest Experimental Station. In the grounds of the station we were shown another endemic Hainan rattan, *Calamus multispicatus*. We had thought it might be the same as *C. henryanus*, but when we saw it in the field we realized it was quite distinct, especially by its short female flowering branches (Fig. 8). It was cultivated with *Calamus tetradactylus*.

Our third, and final locality was Bawangling, another nature reserve in western Hainan, and last remaining home of the endemic Hainan

6. Jianfengling National Forest Park.

7 (left). Leaf sheath of *Calamus tetradactyloides* at Jianfengling. 8 (right). *Calamus multispicatus* near Jianfengling.

gibbon, now on the verge of extinction. Here we had a wonderful day in the forest, and were shown a population of *Rhapis excelsa*. This was growing with a species of *Calamus*, *C. hainanensis*. This species is sometimes included in *C. gracilis*, but appears to differ in its larger fruits.

On our drive back to Haikou we saw many plants of *Phoenix loureiroi* growing in disturbed places and between rice fields. We finally left Hainan by ferry, crossing the Hainan Straits to the mainland Leizhou Peninsula.

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Indigenous Management Practices of *Chit* (*Thrinax radiata*) in Quintana Roo, Mexico

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***Thrinax radiata* Lodd. ex Schult. & Schult. f. (*Chit* in Maya) is an important non-timber forest product in the Yucatan Peninsula. Since 1994, *Chit* is listed as a threatened species in Mexico (NOM-ECOL 59-2001). The major threat for *Chit* populations is habitat destruction due to human activities, mainly tourism, agriculture and cattle raising, but also direct use by local people. Actually, commercial harvest of this species requires a permit based on a management plan that establishes the potential effects of harvesting on natural populations. Nevertheless, illegal cutting and commercialization of this palm is frequent in the Yucatan Peninsula (Calvo-Irabien & Ceballos-Gonzalez 2004).**

User's perception of non-timber forest products extraction provides valuable insights for the development of conservation and management strategies (Ticktin 2004). In this paper we describe the local use of *Chit* as well as the practices associated with harvesting and commercialization. We discuss the potential for sustainable harvest of *Thrinax radiata* in the Yucatan Peninsula.

Species and study site

Thrinax radiata is the only species of this genus in Mexico. Its distribution is restricted to the semi-evergreen forests and coastal vegetation of the Yucatan Peninsula (Quero 1992). *Thrinax radiata* is also found in the Bahamas, Cuba, Jamaica, Haiti and Florida. It is a solitary palm with a slender, straight stem reaching to 17 m in height. The leaves are fan-shaped, from five to 25 in number, and up to 1 m in width. Olmsted and Alvarez-Buylla (1995) reported that reproductive palms, above 3 m, produce between 300 and 3000 white fruits. Palm growth is slow, an 8 m trunk of *Thrinax radiata* may be 100–145 yrs. old (Olmsted & Alvarez-Buylla 1995).

The study area is located within the ancient Mayan province known as Ecab in NW Quintana Roo. The region has been populated since pre-Hispanic times. Local ethnic groups are Maya and Mestizo, coming from Yucatan and Quintana Roo, and a small group of Totonac descendants from Veracruz (La Torre-Cuadros & Islebe 2003). Their main livelihood activities are agriculture and extraction of

forest products. Cattle raising, fishing and apiculture are complementary activities.

Fieldwork was conducted in three *ejidos,* Chiquila-San Angel, Kantunilkin and Solferino, that surround the Natural Protected Area of Yum Balam (21°13'N and 87°26'W; Fig. 1). (*Ejidos* are grants given to peasant communities that hold land collectively in usufruct for farming and natural resource use. *Ejidatarios* are members of the *ejido* with land rights according to needs.) The climate in the region is warm, sub humid with summer and winter rains. The vegetation of the area is a dry semi-evergreen tropical forest, with a canopy stature of 15–20 m. *Manilkara zapota, Simarouba glauca, Swartzia cubensis, Bursera simaruba, Sabal yapa* and *Thrinax radiata* are the most abundant tree and palm species in these forests (La Torre-Cuadros & Islebe 2003).

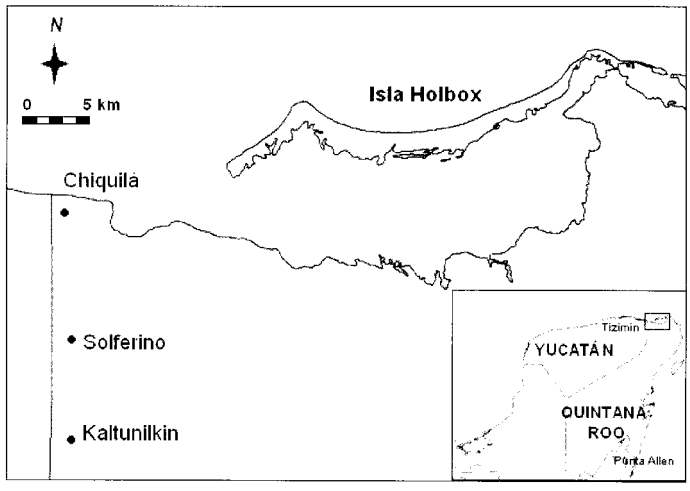
Methods

To explore the importance of *Chit* uses in relation to other forest species, we conducted a free listing exercise (Bernard 1994) in which men and women were asked to name the useful forest plants and describe particular uses. In Kantunilkin, 250 people participated, 125 in San Angel and 125 in Solferino, representing ca. 25% of *ejidatarios*, who are the main resource users. Based on this information and combined with *Chit* uses reported in the literature, detailed semi-structured interviews related to local use, harvesting practices, commercialization and ecological knowledge of *Thrinax radiata* were conducted with 50 ejidatarios in Solferino. Additionally, day trips into the forest were organized to accompany key informants when harvesting *Chit* and participant observation was used to obtain information on harvesting methods and ecological knowledge.

Traditional usage

Results from the free listing exercise showed that the use of *Thrinax radiata* differed between communities. Solferino was the community where *Chit* was more frequently mentioned as a useful forest species (Table 1). In addition, assuming that the species listed first are the most important to the person providing information (Bernard 1994), Solferino was also the community with the highest percentage of *Chit* listed among the first three forest species (Table 1). This result might be due to the fact that Solferino is the *ejido* with the most intense and well organized forest extraction and with a higher reliance of household economy on forest products, while in San Angel and Kantunilkin the most important economic activities are horticulture and commerce, respectively. The economic importance of this palm species at the household level needs further study. Differences in *Chit* densities and distance to harvesting places could also explain the observed results. Solferino is the communal forest with the highest densities (44 individuals >7 m height per hectare) and accessibility (Calvo-Irabien & Ceballos-González 2004).

Results from the 50 semi-structured interviews showed that every participant knew *Thrinax radiata*, 82% reported to actually have used it in the past year. The trunk was the most frequently used plant part and was considered of major economic importance to households. *Chit* poles are appreciated for their strength, endurance, slenderness and straightness. For housing, 2 m long poles are set up together to construct walls (30% of responses), roofs (30%)



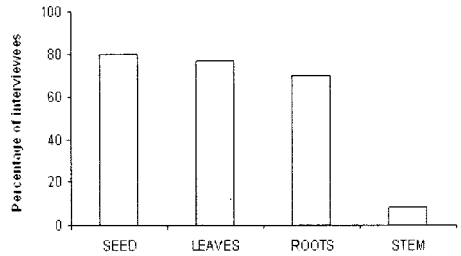
1. Map showing study area and locations mentioned in the text.

or fences (13%). A typical Mayan house is built with 250 to 300 *Chit* poles and has a lifetime between 15 and 40 years (Calvo-Irabien & Ceballos-Gonzalez 2004).

Chit trunks are also used for building lobster traps, as was mentioned by 27% of the interviewees. Lobster traps, together with broom-making, represent the main products for commercialization. One additional use, cited by one man, was for manufacturing shoe brushes, which so far had not been reported in the literature.

Leaves were the plant part with the highest diversity of uses, half of the participants mentioned to have used *Chit* leaves in the previous year. Palm leaves are mainly used for thatching, broom making, for handicrafts, and for wrapping food to be cooked in underground ovens. Additionally, a number of leaf uses are clearly associated with rubber extraction. Chit leaves are used to build campsites, as rubber containers and as a cataplasm for machete injuries during sap harvest. Sword leaves (unopened) are chosen for particular purposes such as weaving fishing nets, hats, baskets and other handicrafts. Fruits were reported as edible (1% of the interviewees).

Our findings coincide with those previously reported for *Chit* (Roys 1931, Olmsted & Alvarez-Buylla 1995). Nevertheless, none of the uses reported by Pulido-Salas and Serralta-Peraza (1993) for medicinal purposes were mentioned. We found two medicinal uses, which had not been reported before. *Chit* leaves are used as a cataplasm to stop bleeding; leaves are cut and peeled to make a plaster that is placed over the wound. Fibers from the leaf sheath are also used for this purpose. The second medicinal use was mentioned by a participant, who explained how to prepare an infusion of *Chit* roots, to treat kidney stones and nervous disorders.



2. Percentage of interviewees that mentioned biological interactions with different plant parts in *Thrinax radiata* (N = 50).

Ecological knowledge

Seventy five percent of all interviewees had knowledge of biological interactions between *Chit* and other species, mainly animals. Men whose jobs were related to the extraction of forest products showed most detailed ecological knowledge. The seed was the plant part with the highest frequency of mentioned biological interactions (Fig. 2). The following species were reported to eat *Chit* seeds: bats, spider monkeys (*Atelles geoffroyi*), chachalacas (*Ortalis vetula*), toucans (*Ramphastos sulfuratus*), great curassow (*Crax rubra*), deer (*Odocoileus virginianus*), armadillos (*Dasypus novemcinctus*), and collared peccaries (*Tayassu tajacu*). Animal interactions with *Chit* leaves were also frequently reported; bats use leaves as a refuge and spider monkeys eat young leaves, "in search for water during the dry season." In the case of roots, a frequent interaction was mentioned but with one animal species only. Tuza (*Orthogeomys* spp.) eats *Chit* roots apparently causing palm death. Additionally, four men stated that trunk borers caused holes in *Chit* stems.

Harvesting techniques and commercialization

Techniques related to harvesting and commercialization are described only for *Chit* trunk, because this was the plant part most

Table 1. *Thrinax radiata* uses according to a free listing exercise in three Mayan communities of NW Quintana Roo.

	Listing frequency (%)	Listing order*	N
Kantunilkin	12.0	30.8	250
San Angel	11.2	15.4	125
Solferino	34.4	48.9	125

* = percentage of interviewees that mentioned *Thrinax radiata* within the first three useful forest species.

frequently used and with the highest economic and ecological importance.

Cutting *Chit* trunks is a common practice in Solferino. More than half of all participating ejidatarios (54%) reported to have cut this palm in the year previous to the interview.

Two kinds of *Chit* are distinguished for harvesting. The young ones, palms that reach 2–3 m in height, non-resistant to seawater and that are used only to harvest leaves for thatch, handicrafts, and brooms. The other type is adult trunks reaching between 6 m and 12 m tall. In this case, trunks are considered strong enough for building houses or lobster traps and therefore, palms are completely felled. Among these harvestable trunks men preferred the taller ones, between 8 m to 10 m, arguing that "they will soon fall down anyway." Dense stands of *Thrinax radiata* (*Chitales*) are well known places among land holders, and are frequently visited for harvesting purposes.

In order to increase the durability of *Chit* products men mentioned the need to harvest during the right phase of the moon, "few days before or after the half moon." This practice has been previously reported for *Sabal uresana* in Sonora (Joyal 1996).

As for commercialization, only 18 men (36%) declared to harvest *Chit* for outside selling. The most important selling locations are fishing communities; 65% of all participants cited Isla Holbox and 28% Chiquila, both communities located no more than 50 km away. Another 7% quoted Punta Allen, a fishing town at approximately 400 km in southeast Quintana Roo (Fig. 1).

There are no sales records, but when asked, harvesters stated that before the ban in 1994, annual sales varied between 5,000 and 30,000 trunks. Recently, Isla Holbox has developed into an important tourist area where *Chit* trunks and leaves are highly demanded to build restaurants and eco-tourism huts. When prompted about selling prices for *Chit* trunks interviewees said between 50 cents and 10 Mexican pesos, per 2 m trunk.

The market demand for *Chit* trunks, used for building lobster traps in Holbox and Chiquila, was between 42,000 and 151,000 trunks. Each lobster trap is built with approximately 36 trunks of 1.5–2 m length, lasting 5–10 years underwater (Calvo-Irabien & Ceballos-Gonzalez 2004).

Leaves are usually sold for thatching and less frequently for broom making, 76% of the harvested leaves are sold in Holbox, 18% in Chiquila, and only 6% in Tizimin, a town *ca*. 200 km from the study area (Fig. 1). It is understandable that for both trunk and leaves a larger proportion of total sales occurred in nearby localities.

The harvesting limitations imposed by the ban have considerably changed the communal mechanisms that controlled access to this non-timber forest product. Nowadays it is illegal to harvest *Chit*, for commercial purposes, without a permit. These changes have generated intra-community conflicts, as well as conflicts between community members and environmental authorities. Moreover, *Chit* harvesters and other community members do not perceive *Chit* as a threatened species. In the 1994 law, no information is provided on the specific reasons to declare the ban for this and other listed species and very few governmental efforts are made in order to inform of the rationale of listing species as threatened, nor of the new rules governing the use of *Thrinax radiata*. Additionally, the costs associated with the new harvesting and selling conditions (technical studies for the management plan, permits, reforestation and organized commercialization) are prohibitive for *Chit* harvesters. Besides, fishermen, the main *Chit* trunk buyers, are not willing to pay higher prices derived from new management costs.

In relation to markets, there is some potential for market diversification of *Thrinax radiata*. In our study, none of the interviewees used or sold *Chit* as an ornamental plant. Nevertheless, this palm is highly appreciated for its aesthetic properties (Evans1981), particularly in urban areas of the Yucatan Peninsula. *Chit* cultivation in nurseries is low-cost and relatively simple. Seed germination and survival of young palms are high, ca. 90% (Perez et al. 2005). Another potential use for this palm species is the manufacturing of handicrafts for tourists. In the two previously mentioned alternatives, adult palms, the most vulnerable life cycle stage (Olmsted & Alvarez-Buylla 1995), are not felled. Therefore, harvest of seeds for ornamental purposes, and of leaves for handicrafts, would have a smaller impact on population dynamics than trunk cutting.

Conclusions and recommendations

Traditional use patterns of *Thrinax radiata* are changing. Commercial items such as tin or cement roofs, synthetic fibers, non-wood building materials, as well as plastic brooms

and containers, are replacing *Chit* products. At the same time, mechanisms that controlled access to a common property resource have changed drastically due to the ban imposed in 1994. In the studied communities, harvesting *Chit* for commercial purposes has disappeared, or is performed illegally, generating conflicts. Although studies on population dynamics for *Thrinax radiata* have shown the potential for sustainable harvest (Olmsted & Alvarez-Buylla 1995, Calvo-Irabien & Ceballos-Gonzalez 2004), under the current situation, the management-related costs imposed by the ban are prohibitive for peasant communities. As proposed by Balmford and Whitten (2003), it is necessary to find mechanisms that more widely disperse the conservation costs of threatened species and habitats, which are actually borne largely by local communities.

On the other hand, changes in land use patterns, increasing demand by fishermen and the tourist industry, and uncontrolled illegal cutting could jeopardize the maintenance of *Thrinax radiata* populations in the Yucatan Peninsula.

A long-term adaptive management strategy for the sustainable use of *Chit* needs to be formulated through close cooperation with managers, local harvesters, consumers, and scientists. Such a strategy needs to take into account socio-economic and ecological factors and use monitoring information to revise the management of this palm species.

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