Celebrating 50 Years of Palms

Palms

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FRONT COVER

Basselinia porphyrea in sclerophyllous maquis vegetation on Mont Nekando, associated with *Myodocarpus crassifolius*, Araliaceae (left) and *Greslania circinata*, Poaceae (foreground). See p. 123 (Photo by J.-C. Pintaud)

Palms (formerly PRINCIPES)

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NEWS FROM THE WORLD OF PALMS

Plans are well underway for a great biennial later this summer in the Dominican Republic. We look forward to an exciting meeting of old and new friends, fabulous palms in their natural habitat and in cultivation and lectures by distinguished speakers. IPS biennials are an unparalleled opportunity to meet fellow palm enthusiasts from around the world and to learn about new and unusual palms. We hope to see you there!

Many travelers to the Biennial from the USA will pass through Miami, Florida. IPS members with time in Miami before the Biennial can take advantage of a chance to see and learn about one of the world's most famous palm collections (recently named the National Palm Collection by the American Public Gardens Association). Biennial attendees and all members of the IPS affiliated South Florida Palm Society are invited to a reception and tour of Fairchild Tropical Botanical Garden on Friday, September 29th, 2006, at 5–7 p.m. at the FTBG Jean Ellen Sheehan Visitors Center ballroom. The reception will begin at 5 pm with refreshments provided by the South Florida Palm Society and a brief welcoming address from FTBG Palm Conservation Program staff, followed by a narrated tram tour from 6 to 7 pm of Fairchild's palm collection. The event is free. RSVP by 20 September 2006 to Tricia Frank at 305-667-1651 ext. 3391 or pfrank@fairchildgarden.org.

Aves y Conservación, a bird conservation group in Ecuador, has launched a palm conservation initiative in collaboration with the Botanical Garden of Quito. The partnership is not as strange as it may seem. Large, dead palms are used as nest sites by a number of cavity-nesting birds, including the Yellow-eared Parrot (*Ognorhynchus icterotis*) and the Golden-plumed Parakeet (*Leptosittaca branickii*). Both bird species have declined in abundance in Ecuador, largely as a result of the decline in the populations of *Ceroxylon* species. The situation is now dire. There have been no recent sightings of the birds in Ecuador, although small populations are still extant in neighboring Colombia. One reason that the palms have declined is that juvenile palms are defoliated by leaf harvesters who annually cut the leaves for the celebration of Palm Sunday. Leaf harvesting is not sustainable, and over time the young palms decline and die. Aves y Conservación is recommending that celebrants use alternatives to *Ceroxylon* leaves, including roses, eucalyptus branches, or leaves from palms cultivated specifically for the religious ceremony. According to the Aves y Conservación website (www.avesyconservacion.org), the representatives of Catholic church in Ecuador have given their support to the campaign and alternative species, although the church has not taken an official position on the problem of palm destruction and its effect on the environment.

Finally, join us in extending our heartiest congratulations to Dr. Natalie Uhl, who was awarded the Botanical Society of America's Centennial Award for her "outstanding service to the plant sciences and the Society" at the recent BSA meeting in California. Natalie could not attend the meeting, but her name was added to a roster of distinguished botanists. Well done, Natalie!

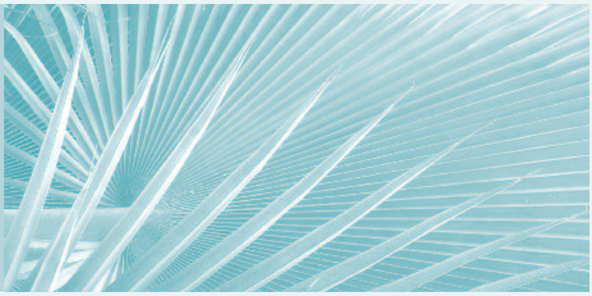
THE EDITORS

GROWING PALMS

Horticultural and practical advice for the enthusiast

Edited by Randy Moore

Contents



Stem Tapering in *Jubaea chilensis*

Jubaea chilensis is a magnificent palm that is a symbol of Chile (Fig. 1). Its most outstanding characteristic is its massive stem – one of the largest in the palm family. A mature palm can have a stem diameter of 1.5 meters at head height. Oddly, the palm stem reaches its maximum girth well before maturity. The large stem and an average height of 15 meters combine to produce a palm that weighs as much as 20,000 kg! The mass of this palm is surpassed only by the *Borassus* palm in Africa.

The largest concentration of the palms in Chile are found within El Parque Nacional la Campana, located 110 km northwest of Santiago on the Panamerican Highway. The palms occur in river valleys and hillsides near Ocoa Village in the northern sector of the park (Fig. 2). Within this population are palms of all ages. The majority of the palms are mature and have developed stem constrictions.

Stem tapering is readily observed in the native populations of *Jubaea chilensis* (Fig 1). While the tapering in *Jubaea chilensis* has been documented, there has been little or no discussion about the characteristics and causes of this narrowing. From the limited descriptions found, the impression is that the stem gradually tapers ("penciling") over time. Actually, the permanent constriction appears very suddenly and noticeably. The girth of the palm narrows by as much as 50 percent following this event.

The *Jubaea* reaches reproductive maturity in about 50 years in habitat and possibly slightly faster in cultivation. The stem tapering appears to coincide with the maturation of the palm. The hypothesis is that once the palm reaches maturity, large

1. A mature *Jubaea chilensis* in habitat dramatically exhibiting stem tapering.

2. A subpopulation of *Jubaea chilensis* in El Parque Nacional la Campana near Ocoa, Chile.

amounts of energy are redirected to flowering and fruiting. There are probably many other species of palms that exhibit similar physical reactions to attaining reproductive maturity.

It is more difficult to observe stem taping in cultivated *Jubaea*. A main reason is that most cultivated *Jubaea* have not reached maturity. It takes about 40–50 years for a *Jubaea* to reach the flowering stage. It would require another 10–20 years for the narrowing of the stem to be fully apparent.

Regular irrigation and fertilizer on cultivated palms may reduce the amount of stem tapering. At many old farm houses, with gardens older than 80 years and under good care, the *Jubaea* does not exhibit this feature. Therefore, another possible hypothesis for stem tapering is that it is related to periods of drought.

Are these hypotheses about stem tapering in *Jubaea chilensis* well founded? Further scientific examination will be required to understand this phenomenon. In the meantime, we Italians say “Se non è vero, è ben trovato (If it is not true, it makes a good story).” – *Franco Simonetti, Santiago, Chile*

Hazards of String Trimmers

Palms are structurally different from broadleaf trees and conifers. Palm stems lack a vascular cambium and do not grow in diameter by laying down an annual ring of woody conducting tissue, as broadleaf trees do. This anatomical difference is one of the classic distinctions between the traditionally recognized Monocotyledons and Dicotyledons, or Monocots and Dicots, for short. Palms, as Monocots, have discrete vascular bundles surrounded by fibrous sheaths that are scattered within an unspecialized ground tissue.

The consequence of this structural difference is that palms cannot be girdled, as can other woody plants (dicots and conifers). Girdling severs the vascular cambium that produces sap-transporting phloem tissue just beneath the bark and water-conducting xylem toward the center of the stem. Girdling is highly injurious or even fatal to most woody plants, and girdling injuries in the landscape most often result from the misuse of string trimmers (also known as weed whackers or strimmers). However, just because palms cannot be girdled like other woody plants does not mean that they cannot be injured by string trimmers.

Palms can be injured by string trimmers in two ways. First, and most obviously, the young shoots of clustering palms can be damaged or cut off by a string trimmer. Palm leaves and shoots are generally tough and fibrous, but tender, young shoots are no match for the string trimmer. New leaves may regrow and the shoot may recover, as long as the trimmer did not actually injure the growing point of the new shoot. String trimmers can also damage the adventitious roots that often emerge from palm stems at or slightly above ground level. Repeated damage can completely prevent root emergence and deprive the palm of roots for anchorage and absorption. The second way string trimmers wound palm stems is by opening routes for infection by soil-borne fungal diseases, such as *Ganoderma* and *Fusarium*. Sustained and regular use of string trimmers can erode and damage even the tough, woody trunks of mature palms and expose these palms to the risk of infection. This sort of stem erosion never heals and will always be visible on the stem, creating both physical and aesthetic damage (Fig. 1).

How can string trimmer damage be avoided? Obviously, the best way to avoid damage is never to use string trimmers against a living palm stem, no matter how tough or woody the stem may be. It is good horticulture practice to keep grass, ground covers and weeds away from the stems of palms. When these herbaceous plants must be trimmed from around a palm stem, they should be trimmed by hand, rather than with a string trimmer. If string trimming is essential, one can buy or make plastic tubular guards that slip over or around the trunk of the palm and protect it from the string. However, invariably weeds grow between the guard and the trunk and must be removed by hand. With care and training, operators can use string trimmers without harming palm stems by angling the head of the trimmer and keeping the trimmer far enough from the trunk so that the string never strikes the trunk. In my experience, few operators invest that level of effort and expertise when using string trimmers. Herbicide treatment of weeds growing against palm stems should be avoided, as some herbicides can damage palms even when applied to woody (non-green) trunks or emerging roots. – *Scott Zona, Miami, Florida, USA*

1. The bases of these *Sabal palmetto* stems bear permanent scars from repeated attacks by string trimmers.

Temperamental Licualas

Licualas are considered to be some of the most ornamental palms—and also the most difficult to grow. Highly desirable are the mottled leaf forms such as *Licuala radula* and *L. mattanensis* 'Mapu' (Fig. 1) and the circular leaf forms including *L. cordata* (Fig. 2) and *L. orbicularis*. They are similar in difficulty to many *Iguanura* species. Sometimes termed "ego plants," they challenge the grower to overcome the many obstacles associated with their horticulture.

1. A beautifully mottled *Licuala mattanensis* that has been grown under perfect circumstances. This is one of the most horticulturally challenging species of *Licuala*.

There are many familiar problems encountered in growing Licualas. Extremely slow or non-existent growth, yellowing, weak root systems and tip-browning are some of the most common disorders. Nevertheless, it is possible to grow these species under carefully managed conditions. Discussed below are some of the horticultural methods that growers are using to produce healthier Licualas.

Container culture may be the best way of successfully growing the more challenging *Licuala* species. Artificial conditions that are highly controlled are often required. Using containers in a greenhouse environment, the grower can attempt to simulate the palm's natural environment. Only under these highly-supervised conditions can horticultural adjustments be made quickly in response to changes in the health of the palm.

2. The pleated circular leaves of the dainty *Licuala cordata* make it a favorite ornamental palm; however, it is also one of the most difficult palms to grow.

While many Licualas are found growing in swampy conditions, under cultivation they do not want to be too wet. Therefore, the best container for growing many Licualas is a clay pot. When substituted for plastic pots, clay pots are more permeable which helps avoid overwatering. Because these pots also dry out faster, they also require more frequent watering.

Many species want to be kept drier than many growers would assume. For this reason, the container mixture for greenhouse culture should be very fast draining. The light mix will also warm up more quickly. Lighten the potting mix by amending with orchid bark or clay pellets. Some liken *Licuala* culture to the conditions and constant care necessary to raise orchids.

One of the most critical requirements is the need for constant warmth (Fig. 3). This includes the necessity of sustained nighttime heat. For example, many *Licuala* species do much better on the Florida Keys than on the slightly cooler Florida mainland. Of course, frost is not tolerated.

Most Licualas grow under very humid conditions in their native habitat. For example, the natural environment in Borneo, where many Licualas are found, is very humid almost to the point of misting. It is difficult to match this high level of humidity in cultivation. However, under drier cultivated conditions, the leaf tips will burn (Fig. 4). Their need for moist air makes many *Licuala* species very difficult to grow as interiorscape plants because of insufficient humidity.

3. The yellowing of this *Licuala paludosa* may be due to the need for constant warmth, micronutrient deficiency or other factors.


4. The tip burn on *Licuala orbicularis* is most likely due to insufficient humidity. Many Licualas require very high humidity.

In addition to consistent warmth and humidity, Licualas also demand good air circulation. While most need to be grown under the protected area of a canopy, they should not be surrounded by protection which will restrict air flow. Lack of adequate air movement can lead to leaf spotting from fungus. Of course, safeguards from strong wind are a must. *Licuala* leaves, especially entire leaf forms, will be torn, ripped or shredded by powerful winds. Winds will also have a drying effect that is damaging to most palms, including Licualas.

Many species of *Licuala* are more tolerant of light than is generally assumed. They do not require a deep shade environment. Filtered light is suitable for most species. In tropical climates, where there is more humidity present, some *Licuala* species can even be grown in full sun.

Using an appropriate fertilizer is essential when attempting to grow many of the delicate species of Licualas. A resin-coated balanced fertilizer with slow release duration of 180 days or more appears to be best. Nutricote® from SunGro Horticulture (www.sungro.com) is a product suitable to the requirements of Licualas. It is available in several formulations and release longevities. The resin coating provides a uniform release of nutrients. Some controlled release fertilizers are sensitive to temperature and release too much fertilizer too early. The excess fertilizer not used by the palm builds up as salts in the root zone which will inhibit growth. Some growers also believe that excess fertilization can weaken mottling, causing the yellow mottle to turn green. Slow-release fertilizer is used to fortify the container media. Grower trials have shown that fertilizers like Nutricote can be safely incorporated into the soil mixture without burning even the tenderest Licualas. The relatively high cost of using this advanced fertilizer is offset by its long duration and uniformity of release.

The weak root system exhibited by many *Licuala* species is one cause of the difficulties related to growing this genus. Some species have especially short roots. The use of liquid kelp or kelp meal will be beneficial in helping to promote a stronger root system.

Even under ideal conditions, most Licualas will grow at a slow pace. However, growth should be fairly steady and the rate should increase once the palm is past the seedling stage. Following these horticultural recommendations should improve your odds of growing the most desirable – and temperamental – *Licuala* species. – *contributed by Paul Craft, Loxahatchee, Florida; Jeff Marcus, Mt. View, Hawaii and Tri Vuong, Miami, Florida, USA*

Trials with Cocosoid Hybrids in Jacksonville, Florida

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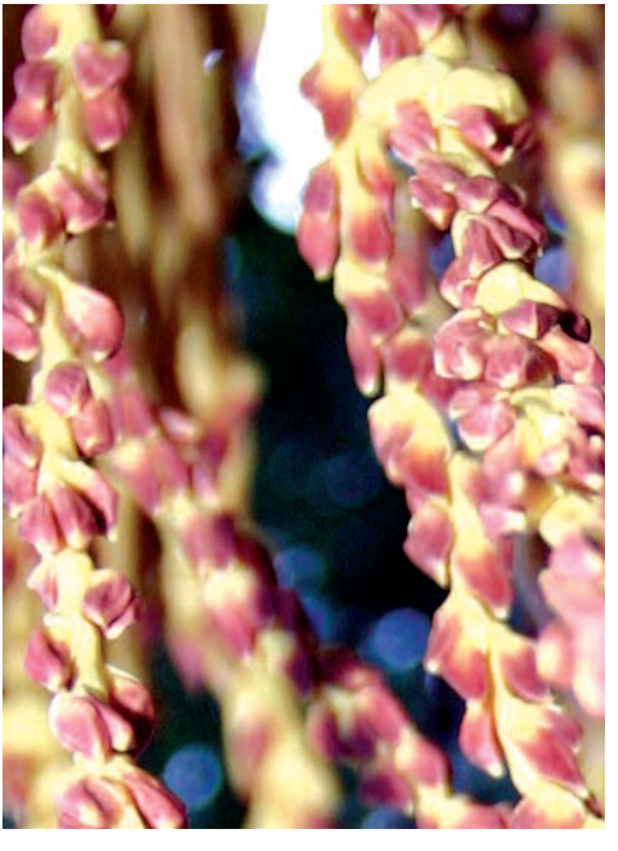

1. Flower buds of *Butia capitata* just before opening.

North Florida poses some climatic challenges to growing palms. It has a subtropical climate for most of the time, but the occasional freeze places the area decidedly in USDA growing zone 9A. At best, one can grow 50 species of palms. Hybrids may expand the number of ornamental palms available to North Florida growers, but the production of hybrid palms is a slow process.

I wasted the better part of two decades in the search for obscure species of *Syagrus, Hyphaene, Rhopalostylis, Ceroxylon, Laccospadix* and *Jubaeopsis* to extend this list of cold hardy palms. This quixotic quest carried me to such destinations as Africa, Brazil, Bolivia and many others. It was largely unsuccessful, as these plants did not survive the rigors of our climate.

It was after squandering my robust years in these journeys that I seriously considered hybridization to extend the list of suitable palms for this climate. By this time, I had a mature grove of six *Butia capitata*, and these would be the subjects for me to research various combinations of related species. Dr. Merrill Wilcox had performed extensive trials with *Butia* and *Phoenix* (Wilcox et al. 1990, Wilcox 2001). I wanted to extend his research and attempt to create different combinations of *Butia* and other species.

Butia is a cocosoid palm. *Butia* shares a number of characteristics with other genera. Table 1 compares these characteristics. These characteristics became the basis for developing new hybrids, moreover this comparison would eventually enable one to discern the

2. *Butia capitata* inflorescence bagged to destroy male flowers.

Table 1. Some comparative characteristics of selected Cocosoid taxa (from Glassman 1968, 1987; Henderson 1995).

	Parajubaea spp.	*Jubaea chilensis*	*Jubaeopsis caffra*	*Allagoptera* spp.	*Butia* spp.	*×Butiagrus nabonandii*	*Syagrus romanzoffiana*	*Sagrus coronata*	*Syagrus schizophylla*
Trunk	Single	Single	Clustered	Clustered	Single	Single	Single	Single	Single and multiple
Petiole margins	Fibrous	Smooth or fibrous	Smooth or fibrous	Smooth	Armed with fiber-spines	Dentate toward apex	Smooth or fibrous	Fibrous	Armed with fiber spines
Pinnae	Regularly arranged		Regularly arranged	Clusters in many planes	Regularly arranged	Regularly arranged; some overlap	Clusters of 2–5	Clusters of 3 or 4	Regularly arranged
Pinnae L × W (cm)		30–46 × 2.5–3.0	80–85 × 3.0–3.3		26–80 × 0.5–2.5	106 × 2.5	70–85 × 2.5		
Peduncular bract	Sulcate	Smooth or striate	Smooth or striate	Sulcate	Smooth or striate	Some striation	Deeply striate	Deeply sulcate	
Rachillae		30–60 cm; maroon	71–82 cm; greenish brown	unbranched; yellowish-green	60–80 cm; greenish or purplish	60–80 cm; greenish brown			
Number of rachillae		100		N/A	50–99	180	80–280	48–52	
Pistillate flowers		7 × 9–10 mm; maroon	8–10 × 5–7 mm; cream	Yellow/cream	3–16 × 3.5–10 mm; cream or purplish	5–7 × 4–4.5 mm	4.5–6 × 4–6 mm	9–13 × 5–7 mm; maroon	5–8 × 4–6 mm
Staminate flowers		10–14 mm; maroon	12–20 mm; cream	6 mm	4–13 mm; cream or purplish	6 mm; purplish	6 mm; yellow to cream	7–11 mm; cream	5–8 mm; yellow
Stamen number	15	15–30	8–16	7–12	6	6	6	6	6
Fruitlength × diam. (cm)	3–7 × 3.0–3.8	3.4–4.1 × 3.0–3.8	2.8–3.1 × 3.0–3.2	1.2–2 × 1–1.3	1.8–4.2 × 1.0–2.8	0.4–0.9 × 0.6–0.8	0.8–1.2 × 0.6 cm		
Embryo pores	Basal	Near middle (equatorial)	Equatorial	1–2 pores	Equatorlial sometimes basal	Apical	Apical		
Endosperm		Homogeneous		Homogeneous	Homogeneous	Slightly ruminate	Irregular, ruminate		Ruminate

3. A seedling of *Butia* × *Jubaea.*

characteristics of hybrids produced from these species. These species would serve as the candidates for my trials. I initiated a series of trials in 2001 to determine if some of these intergeneric hybrids were feasible.

To hybridize *Butia*, one must understand the floral morphology. As a cocosoid, *Butia* has flowers borne in triads of one female (pistillate) flowers subtended by two male (staminate) flowers (Henderson et al. 1995). Staminate flowers mature first and release pollen. According to Henderson (1986), staminate anthesis lasts two weeks, and pistillate anthesis lasts just one week. Within a single inflorescence, some male flowers may be producing pollen when the first female flowers come into bloom. Consequently, one must guard against unwanted self-pollination and synchronize pollination (with a candidate pollen) with the females' later receptivity.

Figure 1 depicts a close up of a *Butia* inflorescence with both pistillate and staminate flowers. To hybridize *Butia* successfully, this source of *Butia* pollen must be eliminated. This requires removing the male flowers before they can release pollen and pollinate the later opening female flowers. The male flowers are removed manually. Bagging the inflorescence or part of it isolates the female flowers and helps to prevent any residual pollen from contacting the female flowers. It may even kill residual pollen, as was suggested by Wilcox et al. (1990) and Wilcox (2001). The female flowers will become receptive several days to two weeks later (depending upon weather), and the target pollen can be introduced. Figure 2 illustrates a bagged *Butia* inflorescence.

Initial trials began in 2001. Dr. Wilcox had created a *Jubaea* × *Butia* hybrid with pollen from a *Jubaea* at Fairchild (Wilcox et al. 1990, Wilcox 2001). He opined that the Fairchild tree was probably not pure *Jubaea* and was probably itself a hybrid between *Jubaea* and *Butia*, as it had *Butia* characteristics. In North Florida, however, sources of *Jubaea* pollen were unavailable. *Jubaea* uniformly fails in North Florida, so a trip to California was necessary.

In spring 2001, Dr. Wilcox and I visited about 50 mature *Jubaea chilensis* from San Diego to Santa Barbara to study floral morphology and collect pollen. We were minimally successful, as we collected a single inflorescence and many blossoms that had fallen from larger trees. This fresh *Jubaea* pollen was introduced to several *Butia capitata* trees and over 200 viable seeds were produced. Figure 3 shows one of these *Jubaea* × *Butia* hybrids after several years.

I attempted further trials with *Syagrus romanzoffiana* with this *Jubaea* pollen but without success. *Syagrus romanzoffiana* has over 200 rachillae and emasculation is very difficult. Hybrid cross-pollinations produce seeds but no viable embryos. Other trials were conducted with accessions of *Parajubaea* and *Juabea* pollen from other sources, but no success was achieved on either *Butia* or *Sygarus* with this pollen.

In 2002, I conducted further trials with *S.* × *costae*, *Jubaea* and *Parajubaea* pollen but had no success. I further attempted several times to apply *Butia* pollen to *S. romanzoffiana* to create a “reciprocal Mule” but this produced no viable embryos. This was a year for developing technique and procedure. It was also a bad year for squirrels and so the success of pollination was inconclusive as I lost several seed batches. By this time, however, many of the 2001 *Butia* × *Jubaea* seedlings were germinating.

In 2003, I attempted trials with *Allagoptera arenaria* on the two *Butia capitata*. I also conducted further trials of applying *Butia* pollen on *S. romanzoffiana*. These multiple trials were unsuccessful. I have collected several volunteer plants at the base of these trees, but I need to defer judgment until I see some adult characteristics of the putative hybrids.

In 2004, I was the wiser for my three years of trials. I had studied the flowering cycle of my *Butia* grove and had perfected procedures of pollen collection and storage. Moreover, I had constructed scaffolds and ladders to perform pollination effectively. I conducted extensive trials with *Allagoptera arenaria, Butia* × *Jubaea, Syagrus coronata, Syagrus romanzoffiana* and *Jubaea chilensis*. These trials had mixed results. Pollinations of *S. romanzoffiana* with *Butia* and *Jubaea* were unsuccessful. However, pollinations of *Butia* × *Allagoptera,* as well as *Butia* × *S. coronata* were successful.

By June, 2005, I had conducted multiple trials with *A. arenaria, S.* × *costae* and *S. schizophylla*. Several seed sets are in the making. I am attempting a reciprocal cross of *A. arenaria* with *Butia* pollen. The emasculation process is a bit more difficult as the male flowers are concentrated in a dense spike, yet it is possible to produce fairly clean spikes for introducing *Butia* pollen. It requires further washing with high pressure water to remove any residual *Allagoptera* pollen. This technique has been fairly successful, as I have several seed batches.

Over the course of the last four years, I have produced approximately ten healthy *Butia* × *Jubaea* hybrids; moreover, I have produced apparently viable seeds of *Butia* × *S. coronata* and *Butia* × *Allagoptera* hybrids. Successes have been few, but persistent trials have refined my knowledge and technique and paid some modest dividends. It is early to declare definitive success on the hybrids, as it may be some time before the plants exhibit the mixed characteristics of species. I am looking forward to comparing the characteristics of these various hybrids to see what is produced. I am planning future trials with *Acrocomia, Jubaea*, and *Jubaeopsis* pollen.

Acknowledgments

I thank Jim Wright, Jerry Hooper and Mark Heath, who supplied pollen, good ideas and advice. Most of all, I acknowledge Dr. Merrill Wilcox, who first lit the candle that has illuminated my imagination during this journey.

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Cultivated Açai Palm (*Euterpe oleracea*) and Associated Weevils: *Foveolus maculatus* and *Dynamis borassi* (Coleoptera: Dryophthoridae)

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1. Damage by the larvae with a pupal cell, on a rachilla of an inflorescence of *Euterpe oleracea*.

Observations on two species of weevils that live on the açai palm in cultivated areas of Brazil are provided.

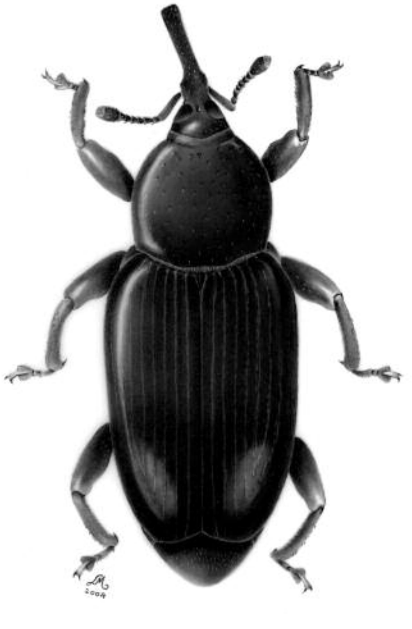
The açai palm (*Euterpe oleracea* Martius), is a palm native to eastern Amazonia (Henderson et al. 1995) and forms dense populations in the estuary of the Amazon River in Brazil. The açai palm is now cultivated in private and experimental orchards. It is exploited for palm heart and for fruit pulp used for the preparation of açai wine, sorbet and other products (Oliveira et al. 2000b). Para State is the principal producer of fruits with 54.507 metric tons in 1979 (Moussa & Kahn 1997) and 91.851 metric tons in 1995 (Alves 2002).

We report observations on two species of weevils that live on the açai palm (Fig. 1) in cultivated areas. The observations have been made in the experimental plantation of Embrapa Eastern Amazon (Embrapa Amazonia Oriental) at Belém, State of Pará, Brazil (1°25′ S; 48° 32′ W).

Foveolus maculatus O'Brien (Fig. 2)

Biology: the adults are attracted to the inflorescence before the peduncular bract is open and aggregate at its median part. The female bores the bract with her mouthparts and inserts the eggs. The larvae live in the bract and eat the flowers and the rachilla. At the end of their development the larvae make a pupal cell with fibers of the rachilla in the bract (Fig. 1). When there is a large number of larvae in the bract, the bract will not open normally and cannot produce fruits. The time of the larval and pupal stages are not known.

2. *Foveolus maculatus* O'Brien (male). Length of the insect = 11 mm (original drawing by Maurice Tran).



Two species of parasitoides of this weevil have been observed: *Cyclaulacidea matilei* Villemant & Simbolotti, and *Lixophaga* sp. near *aristalis* Townsend (Diptera Tachinidae).

Euterpe oleracea was the first host plant reported for *Foveolus maculatus*. Three other species of *Foveolus* are known on palms: *F. aterpes* on *Oenocarpus mapora* H. Karst, in Eastern Amazonia (Couturier et al. 2000), *F. anomalus* on inflorescences of *Attalea maripa* (Aubl.) Mart. in Manaus, Central Amazonia (Cravo 1997) and *F. atratus* on *Attalea microcarpa* Mart. in Central Amazonia (Küchmeister et al. 1998).

Dynamis borassi (Fabricius 1801)

This weevil is known on various Amazonian palms including *Astrocaryum carnosum* Kahn & Millan and *A. chonta* Martius in natural areas where the larvae live in the stem (Couturier et al. 1998), and in *O. mapora* where the larvae live in the inflorescence, before the opening of the peduncular bract, and in the stem. This species causes much damage in plantations (Oliveira et al. 2000a). In *E. oleracea*, we found it only in the stem of adult plants. There are 1–4 larvae in an infested stem. At the beginning of the attack the presence of the larvae cannot be detected. Later, a characteristic smell of fermentation permits the localization of the damage. After some months the palm weakens and dies. *E. oleracea* is not previously reported as a host plant for *D. borassi.*

Foveolus maculatus and *D. borassi* are potential pests in all the areas where *E. oleracea* is cultivated for production of fruits and hearts of palm.

Acknowledgments

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CLASSIFIED

The Impact of Forest Disturbance on the Palms of New Caledonia

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1. Seedlings of *Kentiopsis pyriformis* germinate on red colluvium rich in iron oxide. This material originates from the erosion of ultrabasic rocks (peridotite) on nearby slopes. *Kentiopsis pyriformis* is one of the first plant species to establish itself on these unstable, newly deposited soils.

As natural vegetation is being transformed by human activities, survival of many species depends on their ability to persist and reproduce in anthropogenic vegetation. Deforestation is the major effect of human intervention in the tropics, causing endangerment of many species strictly associated with primary forest. Other forest species on the contrary, including various palms, can take advantage of these changes and become more abundant than they are in undisturbed habitat, eventually becoming dominant or invasive in some secondary vegetation types (Mitja & Farraz 2001).

New Caledonian palms provide an interesting illustration of this phenomenon. The island's palm flora includes 37 species in our present taxonomic understanding (Hodel & Pintaud 1998), although this number will rise to 39–40 with forthcoming taxonomic treatments. All species are endemic to New Caledonia and grow primarily in forests. Moreover, the vast majority of species have very small distribution ranges, which make them especially vulnerable to habitat destruction.

Alteration of natural habitats has indeed been extensive in New Caledonia. Primary forests have been greatly reduced and highly fragmented all over the island, due to mining activities, logging and land conversion for agriculture. Despite this, only six species are considered endangered or critically endangered, according to IUCN Categories (Pintaud et al. 1999 and Table 1). Among these species, four are threatened by habitat destruction.

So how do palm species respond to habitat changes? At least 16 species have ecological adaptations which make them able to survive in disturbed vegetation, and sometimes to thrive more successfully in such environments than in primary forest.

Response of palms to primary forest disturbance

Even under natural conditions, the tropical rainforest of New Caledonia is a very dynamic and changing ecosystem. Landslides are frequent along the rapidly eroding steep slopes of the mountains that cover most of the island, and cyclones can cause widespread damage to the forests. Some species are specialized in surviving such damage, especially through a biological phenomenon called mast seeding (i.e., considerable variation from year to year in seed output in perennial plants). In some cases, most of the plants flower at the same time and subsequently die, after dispersing huge quantities of seeds. This is typically the case of the endemic bamboo genus *Greslania*, which is common in forests on ultrabasic rocks and in secondary vegetation. In the case of the monocarpic pioneer tree *Cerberiopsis candelabrum* (Apocynaceae), cyclones promote massive flowering. Millions of winged seeds

2 (left). The rare *Kentiopsis piersoniorum* requires local events of forest disturbance to establish new stands but will not tolerate a strong alteration of its habitat. 3 (right). A dense stand of *Cyphokentia macrostachya* forms a monospecific canopy in a former gap produced by logging activities four decades earlier in the Rivière Bleue Provincial Park.

are thereafter wind-dispersed and germinate quickly in open areas, where they begin to regenerate the forest. Southern beeches (*Nothofagus* spp.) also undergo mast seeding and constitute patches of mono-dominant forests, which are presumably established similarly, although there is no direct evidence of it due to slow growth of these species (Read et al. 1995).

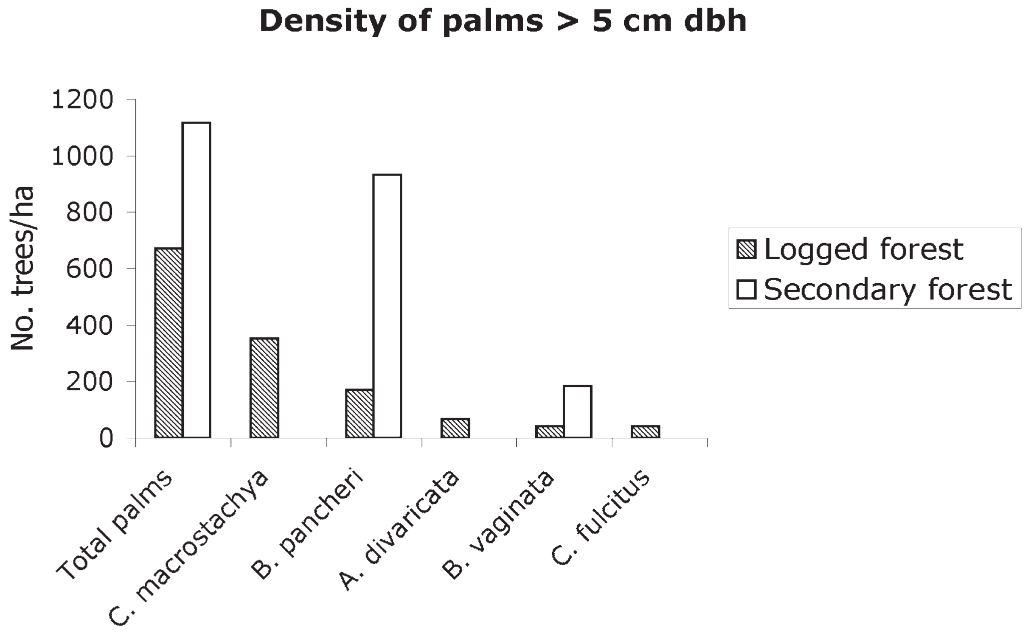
Some palms that tend to form pure stands, such as *Kentiopsis* species (Pintaud & Hodel 1998), also have distinctive fruiting patterns. Each year these palms produce over a short period (one month) large quantities of small, bright red fruits, which are actively dispersed by birds. Seeds germinate within a few days after dispersal, especially on barren soil (Fig. 1), and probably contribute to restoring mono-dominant stands in more or less open, or disturbed areas. As for *Nothofagus*, this must, however, take so much time that it is difficult to demonstrate. Despite their ability to grow in naturally disturbed sites, *Kentiopsis* species are rare and endangered. In fact, they do not tolerate any human alteration of their environment and are threatened by habitat loss. It seems that they need vast areas of natural forest, only infrequently and very locally disturbed, in order to maintain their population dynamics (Fig. 2).

4. In undisturbed forest, *Cyphokentia macrostachya* occurs as isolated, scattered individuals (Rivière Bleue, 250 m elevation).

Table 1. Conservation status and occurrence of New Caledonian palm species in primary and secondary vegetation types. IUCN conservation status: LRlc = low risk, least concern; LRcd = low risk, conservation dependant; Vu = vulnerable, E = endangered, CR = critically endangered.

Palm species	Conservation status	Primary forest	Secondary forest	Maquis
Actinokentia divaricata	LRlc	+	+	
Actinokentia huerlimannii	Vu	+	+	+
Alloschmidia glabrata	LRlc	+		
Basselinia deplanchei	LRlc	+	+	+
Basselinia favieri	LRcd	+		
Basselinia gracilis	LRlc	+	+	
Basselinia humboldtiana	LRcd	+	+	
Basselinia iterata	Vu	+		
Basselinia pancheri	LRlc	+	+	+
Basselinia porphyrea	LRcd	+	+	+
Basselinia sordida	LRlc	+		
Basselinia tomentosa	Vu	+		
Basselinia velutina	LRlc	+		
Basselinia vestita	CR	+	+	
Brongniartikentia lanuginosa	LRlc	+		
Brongniartikentia vaginata	LRlc	+	+	+
Burretiokentia dumasii	LRcd	+		
Burretiokentia grandiflora	LRcd	+		
Burretiokentia hapala	Vu	+		
Burretiokentia koghiensis	Vu	+		
Burretiokentia vieillardii	LRlc	+		
Campecarpus fulcitus	LRlc	+		
Chambeyronia lepidota	LRlc	+		
Chambeyronia macrocarpa	LRlc	+		
Clinosperma bracteale	LRlc	+	+	
Cyphokentia macrostachya	LRlc	+		
Cyphophoenix elegans	Vu	+	+	+
Cyphophoenix nucele	CR	+		
Cyphosperma balansae	LRlc	+		
Kentiopsis magnifica	Vu	+		
Kentiopsis oliviformis	E	+		
Kentiopsis piersoniorum	LRcd	+		
Kentiopsis pyriformis	CR	+		
Lavoixia macrocarpa	CR	+		
Moratia cerifera	LRlc	+		
Pritchardiopsis jeanneneyi	CR	+		
Veillonia alba	LRlc	+		
Total	Vu: 7; E: 1; CR: 5	37	11	6

Rainforest species, which develop in the understory or lower canopy at low to moderate densities, appear more prepared to survive larger-scale disturbance than the tall gregarious *Kentiopsis* species. Many of these species have a long establishment phase consisting of increasing leaf size without producing an aerial trunk (Tomlinson 1990). This phase can go on under low light conditions, while trunk development requires a significant increase in light intensity (Kahn & de Granville 1992). Typically, populations of these palms comprise

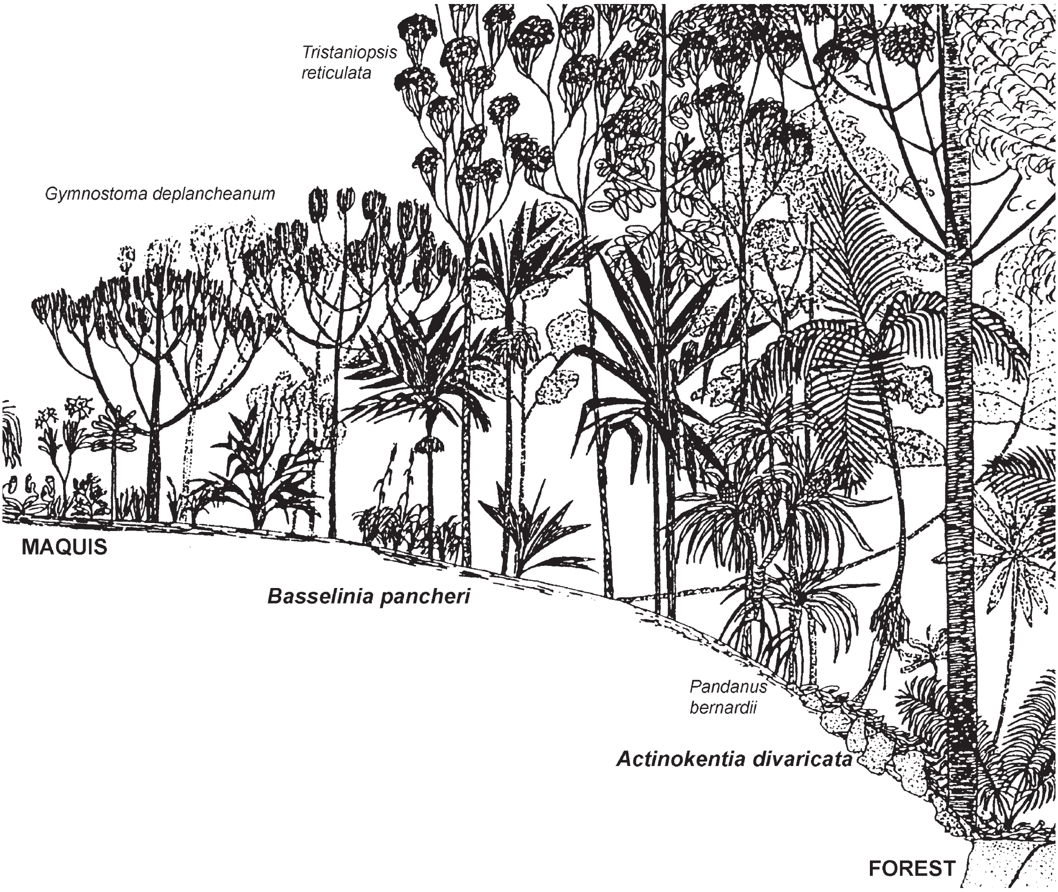


5. Composition of palms communities in adjacent selectively logged forest and secondary forest at Rivière Bleue. Total palm density is higher in secondary forest, but species diversity is much lower than in selectively logged forest.

a large proportion of juveniles in establishment phase, many of them waiting for appropriate growth conditions, a few in the stage of rapid growth, and adult trees showing only slow growth. An anthropogenic disturbance such as selective tree logging, producing many gaps in the canopy, will therefore promote a rapid growth of the trunk in a great number of juvenile plants, allowing them quickly to reach the adult size, before closure of the canopy. This will result in unusually high densities of adult palms, persisting decades after the restoration of the canopy.

In fact selective logging has affected most of the New Caledonian rainforest at low to medium elevation. Some large tree species providing excellent woods have been extensively logged, especially *kaoris* (*Agathis* spp., Araucariaceae) and *houp* (*Montrouziera cauliflora*, Guttiferae), modifying substantially the forest structure. In the rare but spectacular remnants of lowland pristine forests, *Agathis* trees (*A. lanceolata* on ultrabasic rocks and *A. moorei* on schists) are so abundant that they tend to form a 40–45 meters-tall canopy above the 25 m tall angiosperm species. On ultrabasic rocks, narrowly columnar araucarias (*A. subulata*) reaching 60 m tall emerge from the canopy. Logging of these conifers basically suppresses the upper forest layer. *Montrouziera cauliflora* is a gigantic emergent and scattered tree producing a magnificent and extremely durable red wood. Logs abandoned in the forest of Mont Koghi above Nouméa after WWII are still in perfect shape. Removing these enormous trees produces large gaps in the forest and leads to local disappearance of the species, prompted by its very slow and difficult regeneration.

Such human interventions produce an important light increase in the forest understory, of which subcanopy palms with a long establishment phase benefit considerably, increasing rapidly their density. A few decades after selective logging, the forest will look pristine to an observer unaware of these processes, while the forest has in fact been considerably modified in its structure and to some extent, floristic composition. With more than 2000 individuals of *Cyphokentia macrostachya* of all sizes per ha. (Pintaud 1999), some forests in southern New Caledonia will look spectacular to the palm enthusiast (Fig. 3). This, however, is clearly an anthropogenic effect, *C. macrostachya* being much more scattered in primary forest (Fig. 4). Other species commonly forming dense populations as a consequence of selective logging include *Burretiokentia vieillardii* and *B. hapala*, *Cyphosperma balansae* and *Chambeyronia macrocarpa*.



6. Structure of a forest edge on ultrabasic rocks regenerating after fire, at Rivière Bleue. *Basselinia pancheri* develops abundantly in the *Gymnostoma deplancheanum* scrub on the forest edge and in the adjacent myrtaceous (with *Tristaniopsis reticulata*) low secondary forest. *Actinokentia divaricata* appears farther inside the forest, among well-grown secondary forest species such as *Cerberiopsis candelabrum* (*C. c.*) and *Pandanus bernardii*. No primary forest palm is found within these early successional stages of the forest (Drawing by J.-C. Pintaud).

Palms in secondary forest

In the previous paragraph, I dealt with alterations of the primary forest which do not disrupt the biological and ecological cycles of the ecosystem. Secondary forests, on the contrary regenerate after complete destruction of the original forest, and have a much simpler structure and poorer floristic composition. These forests will eventually return to primary forest, but after a very long time. In New Caledonia, eleven palm species occur in secondary forest (Table 1), and some of them in much higher densities than in primary or moderately disturbed forest. The most frequent and widespread cause of primary forest destruction and therefore secondary succession in New Caledonia is fire. Early mining activities and traditional agricultural practices produced extensive fires, but natural fires have also been important for a long time (Hope & Pask 1998). Surveys in the Rivière Bleue Provincial Park, in southern New Caledonia, showed marked differences in adjacent palm communities in selectively logged forest and secondary forest regenerating after burning. In selectively logged forest, there were five species, the most abundant being *Cyphokentia macrostachya* and *Basselinia pancheri* on colluvium, *Campecarpus fulcitus* and *Actinokentia divaricata* on eroded rocky soil, while the rarest species was *Brongniartikentia vaginata*, with no more than 10 adult trees per ha. On the contrary, in secondary forest, there were only two species, *Basselinia pancheri* and *Brongniartikentia vaginata*, both at much higher densities than in the selectively logged forest (Fig. 5). In both forest types, palms are the most abundant trees at the family level, representing 9–10 % of all stems > 2 cm dbh, followed by Guttiferae (8%) and Cunoniaceae (7%) in secondary forest, and Lauraceae (8 %) in primary forest (Pintaud 1999).

Secondary forests harboring dense palm populations are mostly restricted to ultrabasic rocks. Typically, the regeneration of the forest on ultrabasic rocks begin with a scrub developing on bare oxidic soil or iron-rock hardpan were *Gymnostoma* species (Casuarinaceae), especially *G. deplancheanum* and *G. glaucescens*, develop and eventually form a mono-dominant low forest. These trees produce an abundant litter and have a root symbiosis with a micro-organism (*Frankia*), allowing them to assimilate atmospheric nitrogen and fertilize the soil, as do legume plants with other symbionts (*Rhizobium*). These improved ecological conditions allow in turn the development of a more diverse forest flora, including the first palms, especially *Basselinia pancheri*. As the forest continues to grow, other palms appear, such as *Actinokentia divaricata*, *Brongniartikentia vaginata* and *Clinosperma bracteale* (Fig. 6.). Palms restricted to the primary forest, such as *Cyphokentia macrostachya*, *Campecarpus fulcitus*, *Burretiokentia vieillardii* and *Chambeyronia macrocarpa* will only begin to appear in a much later stage of the succession.

7. Architecture of mono-dominant forests and associated palm communities at Rivière Bleue. *Nothofagus* forests (A) have a very simple architecture with basically a smooth canopy made of southern beeches of same size and presumably age, and a subcanopy layer composed mostly of *Basselinia pancheri*. *Arillastrum* (Myrtaceae) forests (B), have a much more irregular and open canopy, allowing the development of a diversified and heterogeneous subcanopy layer, where *Basselinia pancheri* and *Brongniartikentia vaginata* are abundant (Drawing by J.-C. Pintaud).

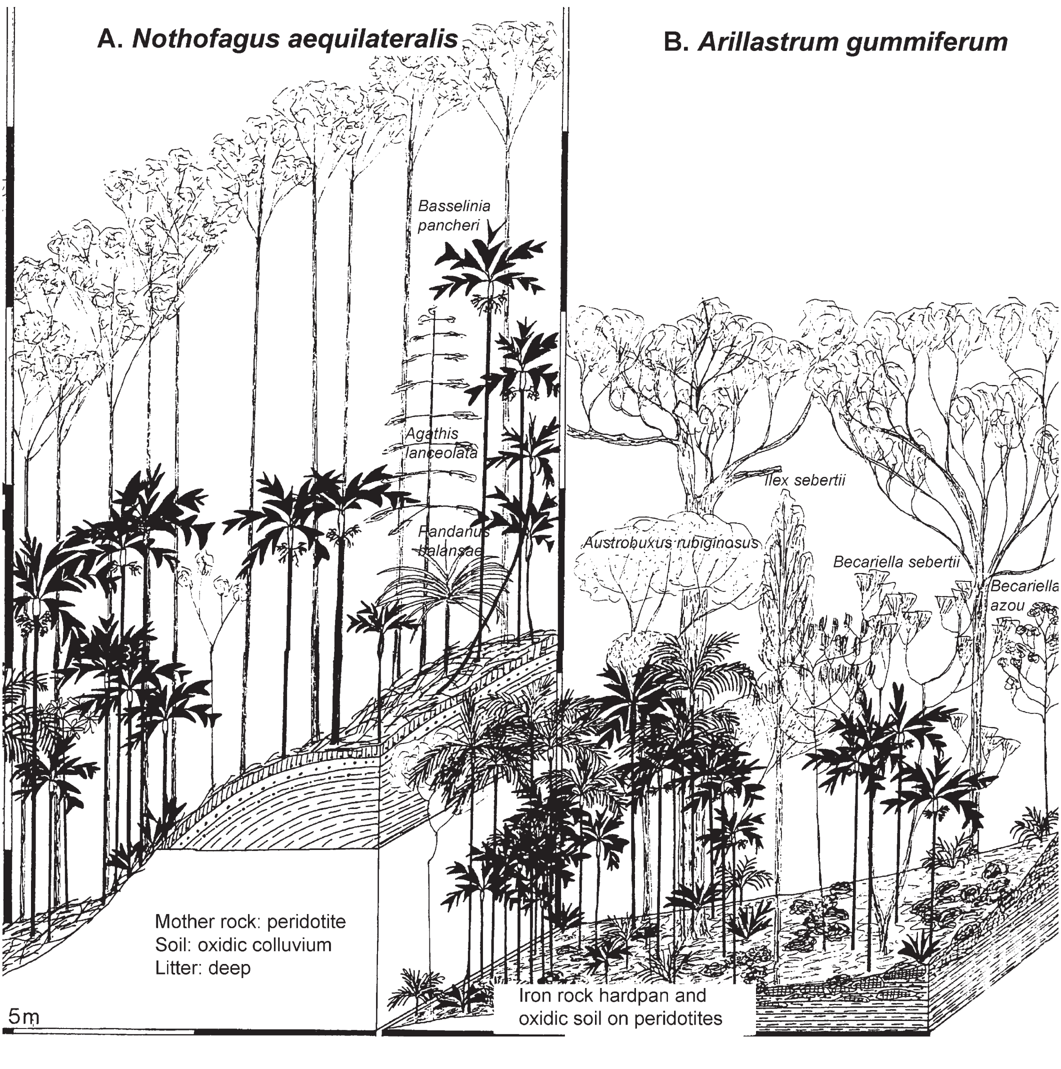


Table 2. Structure of palm communities in secondary forests. Species abundance high (+++), moderate (++), low (+), absent (-). All species present are characteristic of secondary vegetation (see Table 1).

Lowland Secondary Forests				
Secondary forest type:	Monodominant	Mixed	Monodominant	Monodominant
Main floristic trait:	*Nothofagus aequilateralis*	*Guttiferae-Cunoniaceae*	*Nothofagus aequilateralis*	*Gymnostoma glaucescens*
Location:	Rivière Bleue Park	Rivière Bleue Park	Pic Grand Kaori	Nodela
Elevation:	150 m	150 m	200 m	600 m
Palm species:				
Actinokentia divaricata	+	-	+	++
Basselinia pancheri	+++	+++	+++	++
Basselinia gracilis	-	-	+++	++
B. pancheri × gracilis	-	-	++	+
Brongniartikentia vaginata	+	++	-	-
Clinosperma bracteale	-	-	-	+
Total number of species	3	2	3 + 1 hybrid	4 + 1 hybrid
Number of species in adjacent primary forest	5–7	5–7	4	7

There are several other interesting features of secondary forests on ultrabasic rocks. Secondary forest types are surprisingly varied on this substrate. They can be divided into two main types: mixed and mono-dominant. Mixed secondary forests have a canopy composed of many different species, while mono-dominant ones have an upper layer composed of a single species. The causes determining the forest types are not very clear.

Table 2 (continued)

MONTANE SECONDARY FOREST

Secondary forest type:	Monodominant	Monodominant	Monodominant	Mixed
Main floristic trait:	*Nothofagus codonandra*	*Nothofagus balansae*	*Nothofagus baumanniae*	*Araucaria mont.* *Araliaceae*
Location:	Mont des Sources	Menazi	Mont Mou	Me Ori
Elevation:	950 m	1000 m	1050 m	900 m
Palm species:				
Actinokentia divaricata	+	+	-	-
Basselinia pancheri	-	+	-	+
Basselinia gracilis	-	-	-	+++
Basselinia vestita	-	-	-	+
B. gracilis × vestita	-	-	-	++
Brongniartikentia vaginata	+	-	-	-
Basselinia deplanchei	+++	++	+	-
Basselinia humboldtiana	++	+++	-	++
Basselinia porphyrea	++	-	-	-
Clinosperma bracteale	-	-	-	++
Total number of species	5	4	1	5 + 1 hybrid
Number of species in adjacent primary forest	7	4	0	5

For example, regeneration after a fire on a forest edge can lead to either mixed secondary forests (with a predominance of Araliaceae, Guttiferae, Cunoniaceae or Myrtaceae) or mono-dominant *Gymnostoma* forests.

Moreover, very commonly we can observe a mosaic of mixed-canopy primary forest and patches of mono-dominant forests composed either of *Nothofagus* spp., *Arillastrum gummiferum* (Myrtaceae), *Balanops pancheri*

8. A hybrid between *Basselinia vestita* and *B. gracilis* on the top of Me Ori. The plant is reminiscent of *B. gracilis* but has the greyish tomentum on the underneath of leaflets characteristic of *B. vestita*. As hybrids already outnumber pure individuals of *B. vestita*, this species endemic to the summit of Me Ori is likely to disappear within the genepool of the more abundant and widespread *B. gracilis* and *B. pancheri*.

(Balanopaceae), *Cerberiopsis candelabrum* (Apocynaceae), *Cocconerion minus* (Euphorbiaceae) *Agathis ovata* (Araucariaceae) and some other species. Ecologists assume that all these mono-dominant forest patches are of secondary origin, establishing through some kind of disturbance. In the case of rapidly growing species, such as *Cerberiopsis* or *Cocconerion*, this can be demonstrated, but in many other instances, the causes promoting the establishment of stands are unknown. This is especially true for *Nothofagus* stands, which can be very large and are common and widespread on ultrabasic rocks. Interestingly, all mono-dominant forest types contain palm communities very similar to those of typical mixed secondary forest, thus indicating their probable secondary origin (Table 2 and Fig. 7).

Another curious characteristic of secondary forests on ultrabasic rocks is that their palm species richness increases with elevation, while it is the opposite in primary forest (Pintaud et al. 2001). Consequently, secondary forests are much poorer in palm species than adjacent primary forest at low elevation (Table 2a and Fig. 5) but they are often equally rich or richer at higher elevation (Table 2b). This is due to the fact that primary forest above 900–1000 elevation is lower, more open and structurally more similar to secondary forests, but with a more diverse flora of dicotyledonous trees and conifers.

Palm communities in secondary forests are not only modified with respect to primary forests in species composition and density of individuals, but are also deeply affected at the level of plant biology and population genetics. Light increase in the understory of secondary forest promotes growth and flowering of palms, and higher densities of individuals in some species facilitate cross pollination, as all species except *Pritchardiopsis* are strongly protandrous and thus allogamous. In the complex of closely related and often sympatric species of *Basselinia* section *Basselinia*, such processes will promote interspecific hybridization. As a matter of fact, hybridization in this group has been repeatedly observed in various secondary forests, but never in primary forest. We have seen that density of *Basselinia pancheri* can be more than five times higher in secondary than in primary forest (Fig. 5). In several secondary forests where *B. pancheri* grows with *B. gracilis*, interspecific hybrids have been observed. *Basselinia pancheri* is solitary and has bilobed fruits, while *B. gracilis* is caespitose with rounded fruits. Among these typical plants, are also found individuals which are caespitose but with bilobed fruit. Similarly, a putative hybrid between *Basselinia pancher*i and *Basselinia deplanchei* occurring on Mont Nekando, has the fruits of the first parent and the habit of the second. It was initially described as a separate genus (*Nephrocarpus schlechteri*) and latter reduced in synonymy of *Basselinia pancheri*. On Me Ori, a dome-shaped mountain of central-western New Caledonia reaching 1000 m elevation, there are three sympatric species of *Basselinia* section *Basselinia: B. gracilis*, *B. pancheri* and *B. vestita*, the last endemic to Me Ori. In the secondary forest, apparently pure individuals of *B. vestita* are very scarce, while hybrids of this species with *B. gracilis* and *B. pancheri* are very common. Some plants even show a mixture of characters from the three species. Such phenomena can have various implications. For one part, it locally increases the genetic and morphological diversity, producing a wide range of intermediate forms between the parent species and also completely new characters as a result of genetic recombination. This may promote the evolutionary dynamics of the species complex. However, it is at the same time a threat to the integrity of each individual species, and may lead to extinction through genetic dilution in the case of the very locally endemic *Basselinia vestita*. Extensive burning on Me Ori and surrounding areas has limited the extension of *Basselinia vestita* to the very top of the mountain and at

9. The Col d'Amos range in far north New Caledonia has been almost entirely deforested since pre-European times. Captain Cook found this desolate landscape reminiscent to the Scottish (Caledonian) countryside and therefore named the island New Caledonia. Crowns of *Moratia cerifera* emerge from a gully where a fragment of forest persists. In the foreground is a *maquis* vegetation on schistose rocks with *Dracophyllum verticillatum* (Ericaceae).

the same time promoted the expansion of *Basselinia gracilis* and *B. pancheri*. Hybrids with *B. vestita* have been observed up to the summit of Me Ori (Fig. 8), which means that this species no longer exists as a pure population. In a previous study (Pintaud et al. 1999), I did not give much attention to this problem and assessed the conservation status of *B. vestita* as vulnerable. Here I consider it to be critically endangered due to the hybridization process (Table 1).

On schistose rocks, the situation is very different. Only two palm species occur in secondary forest. One of them, *Basselinia gracilis*, is the species having the largest geographical distribution and broadest ecological range in New Caledonia; therefore it is not surprising to find it in secondary forest. The other species, *Cyphophoenix elegans,* has on the contrary a limited distribution. It is associated with *Kentiopsis magnifica* and *Moratia cerifera* (Fig. 9) in remnants of the primary forest in far northern New Caledonia, and develops in adjacent secondary forest and *Melaleuca* maquis regenerating after fire. Absence of palms in most secondary forests on schistose rocks is probably due to competition with fast growing pioneer Cunoniaceae and Myrtaceae species. Secondary vegetation has a much slower growth on ultrabasic rocks (and also on the very windy schistose ridges of northern New Caledonia where *Cyphophoenix elegans* thrives), allowing establishment of the slow growing palm species.

10. Brilliantly coloured crownshafts of *Basselina deplanchei* are a common sight in secondary forest and *maquis* on ultrabasic rocks. Haute Neuménie, 900 m elevation.

Palms in *maquis* vegetation

The *maquis* is an open, low vegetation composed of sedges, ferns and sclerophyllous shrubs. It is essentially developed on, and characteristic of ultrabasic rocks, although it can be found occasionally on schistose rocks (Fig. 9). It is mostly of secondary origin, replacing the forest after fires, but it also occurs naturally under severe conditions (on sharp rocky or windswept ridges or on iron rock hardpan for example). Nowadays, the maquis covers 80 % of all ultrabasic outcrops, while only 15 % of the area is occupied by rainforest and 5% by swamps. The soils on which develop the maquis of the ultrabasic outcrops are very poor, with high content in toxic heavy metals and very low content of organic matter.

Nine out of ten plant species developing in this very peculiar habitat are endemic to New Caledonia (in total 1019 endemic species out of 1142 reported from maquis by Jaffré et al. 1994). Among them, only six species are palms, and three belong to the genus *Basselinia* (Table 1). The maquis is the preferential habitat of two palm species, *Basselinia porphyrea* and *Basselinia deplanchei*. Both species occur only marginally in primary forest. They have very hard and thick leaves and are especially attractive, although very slow growing (Front Cover). *Basselinia deplanchei* is a very polymorphic species, with either pinnate or bifid leaves, and generally colorful crownshafts (Fig. 10). These species represent an adaptation to very harsh conditions, uncommon among New Caledonian palms. *Basselinia porphyrea* has a very limited distribution, while *B. deplanchei* is widespread and has probably expanded through the extensive maquis on ultrabasic rocks of anthropogenic origin. On schistose rocks, *Cyphophoenix elegans* occasionally occurs in maquis in the form of dwarf individuals with very thick leaves, similar in habit to *Basselinia porphyrea*.

Therefore, disturbed vegetation on ultrabasic rocks, with its structural and floristic diversity, contributes significantly to conserve the endemic New Caledonian flora, and especially the palms, as nearly one-third of them not only survive but sometimes develop exuberantly in such habitats.

Acknowledgments

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PALM LITERATURE

PALMS OF THE FIJI ISLANDS. Dick Watling. Illustrated by George Bennett. Environmental Consultants (Fiji) Ltd, 2005. ISBN: 982-9047-02-4. Price US$39.95, soft cover. Pp 192. Available to order online at: www.environmentfiji.com.

Anyone interested in Fiji's amazing palms or planning to visit Fiji should buy this book. Dick Watling has managed to write one of the best general books on palms I have seen anywhere. In addition, this book will also prove satisfying to people who grow palms (horticulturalists, landscapers and gardeners), people who study palms (botanists, ecologist and natural historians) and to conservationists. The beautiful illustrations provided by George Bennett may alone be another reason to have this on your bookshelf.

The book presents a detailed account of 32 species of palms including 26 native and 6 naturalized species accounts. At the last count, 24 of the 26 native species found in Fiji are found nowhere else in the world, which means an impressive 92% are endemic. Additionally around half have very limited natural ranges. The species accounts include general descriptions, distribution (including maps), habit and ecology information, details of cultural uses (if known), conservation status and of course the beautiful color illustrations. The illustrations focus on habit (usually showing a mature tree in its native habitat) and mature fruit – both of which are excellent ways to identify Fiji's palms while in the field. There are also sections on propagation and culture (how to grow these palms and where to find them in existing collections). A general overview of the vegetation of Fiji and a detailed account of the conservation status of Fiji's palms including a summary of the current situation on the ground in the country are provided. There are also a number useful tables and charts included throughout the book plus maps on both covers and an altitudinal range guide inside the back cover.

The first section of the book is the introduction, which sets the scene, so to speak, by covering the purpose of and how to use the book, as well as a basic guide to identifying palms. The second section covers "Fiji: The Country, Vegetation and the Palm Flora" giving the reader 25 pages on the general vegetation of Fiji, details on the diversity and how Fiji's palms might be distributed – including a very interesting table on potential birds and bats that may be agents for palm dispersal around Fiji. This section also has a detailed up-to-date account on the conservation status of the palms within Fiji, including a call to action to help protect and study these unique trees.

The third section is by far the largest, covering the species accounts first with the native species and then the naturalized. Species accounts are listed in alphabetical order; there is no identification key. Most species accounts are 4 or 5 pages long with the text, including a description and additional details plus a distribution map and then at least two illustrations, which should help with identification. The fourth and final major section covers "Propagation and Culture of Fiji's Native Palms," and this may be one of the more interesting parts for those of us interested in growing palms. This chapter was written by the late Dick Phillips, who was a true champion of palms within and without Fiji. This account gives us a wealth of information on how to grow most Fijian palms as well as some ideas of where to find these palms in cultivation within Fiji and around the world. All of Fiji's palms are of course handsome to the palm enthusiast, yet only a small percentage are known to be widely cultivated. Perhaps this section will encourage new legal efforts to cultivate Fiji's palms. The book includes a good reference section, glossary and a useful index.

This book is specifically aimed at the non-specialist. However, I encourage all readers of PALMS to buy a copy. Mr. Watling's background is as an ecologist, environmental consultant and bird expert – which means he has given the book a strong slant for people who want to see palms in the wild or who want to protect or grow palms. The book is also not too heavy and can easily fit in any day pack or carry-on bag for the long flight to Fiji from North America, Europe or Asia.

Dylan Fuller

A Red Latan Population on the South Coast of Réunion

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Latan palms are emblematic of the Mascarene Archipelago, since each island has its own species. The red latan, *Latania lontaroides*, is endemic to Réunion Island. Specimens are scattered here and there along the west coast and more frequently on the south coast of the island. A small population is also present in the Cirque de Mafate, near Bras des Merles creek. Some place names, such as Ravine des Lataniers, at La Possession, are testimony to a not too distant past, when red latans were much more abundant than nowadays.

For over two centuries red latan was a source of cheap timber and roofing for farm buildings and small cabins. When the first settlers landed in Réunion in the mid-seventeenth century, red latan was also the only fruit species present, bearing "*pommes latanier*," the immature endosperm of which was appreciated as a delicacy.

Over-harvesting of red latan led to the scarcity of the species. However, as long as the palm tree was considered useful and necessary, some protective measures were taken. If the *pomme latanier* is still eaten occasionally, the other parts of the red latan are now considered useless and the bitter taste of the cabbage never aroused gourmet enthusiasm.

Another reason for the scarcity of red latan on coastal farm lands is due to mechanical removal of stones from fields. This program, led by Conseil Général and Ministry of Agriculture over the last thirty years, has cleared sugarcane fields of basalt boulders and, at the same time, of pockets of latan palms that survived among the rocks. This is how the last red latans in Terre-Rouge, a farming area of Saint-Pierre, were "eradicated" in December, 2003. Twenty years earlier an important population of *Latania lontaroides* suffered the same misfortune in Manapany.

However, the red latan is still present in the landscape of the south coast of Réunion, especially from Ravine des Cafres to Vincendo, with more abundant populations in Grands-Bois and along sea cliffs, near Grande Anse, in the district of Petite-Ile.

A couple of years ago, Philippe De Vos brought to our attention the presence of "a forest of red latans emerging along virgin coastline" at Cap




1 (upper left). The red latan "forest" at Cap de l'Abri; in the foreground is *Scaevola taccada* (left) and *Noronhia emarginata* (right). Photo by Marc Gérard. 2 (upper right). The red latan "forest" at Cap de l'Abri in the undergrowth. Photo by Marc Gérard. 3 (lower left). Red latan seedling with two eophylls. 4 (lower right). "Pommes latanier" eaten by rats.

de l'Abri, near Grande Anse beach (Figs. 1 & 2). Located along the cliff rim, on a section which slopes down gently toward the ocean, this impressive *Latania lontaroides* population is found on a substratum of oceanite-type lava from the Piton de la Fournaise volcano, approximately 350,000 years old. This population numbers about 200 specimens, distributed in three groups, most of them adults, including 73 female individuals bearing heavy infrutescences. The stems are 6–8 meters tall, with an average diameter of 20 cm, though the stem base is often swollen (diameter up to 45 cm). Twin specimens with merging swollen bases are not uncommon; it is thought that they either result from two seeds that germinated together on the same spot or from one single big seed containing two distinct embryos. It is difficult to give a reliable estimation of the age of these latans since they grow in harsh environmental conditions – rocky soils, strong winds and sea spray, which probably slows down growth. It seems reasonable to estimate they are 60–80 years old. The ground strewn with many rocks and boulders is covered with a litter of dry leaves that prevents a good germination rate at the foot of the female palms, but at the same time keeps away some invasive species such as *Lantana camara* or *Schinus terebenthifolius*, which are present on the surrounding land.

In October, 2003, on our previous visit, we noticed many seedlings at the stage of one or two eophylls (Fig. 3). If local conditions are not particularly favorable to good regeneration, the rocky substrate, with wide cracks, retains enough humus and fine soil to allow germinating seeds to send down their roots. In May 2004, we found one single seedling and no *pommes latanier* on the ground! It appears that some seeds and seedlings had been collected on the site, though access through Grande Anse, by climbing the cliffs, is dangerous; the only other access requires crossing private lands, subjected to owners' authorization.

The red latan population of Cap de l'Abri belongs to a littoral ecosystem including native as well as exotic species, some of which are potentially invasive. Table 1 lists the species present. Half of these species are exotic and two must be considered as very invasive plants: *Lantana camara* and *Schinus terebinthifolius*, though a third one, *Agave vera-cruz,* is also

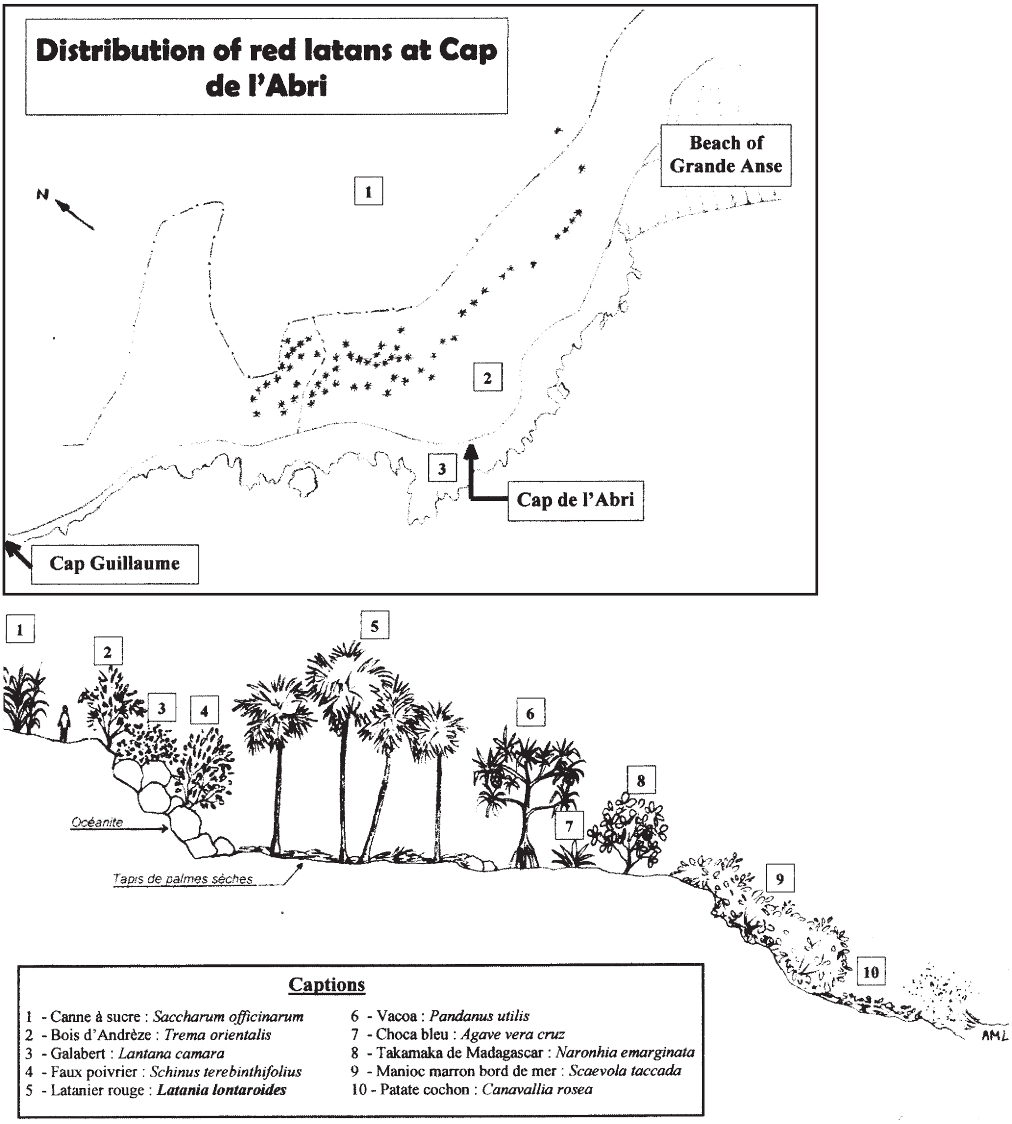
Table 1. Plants associated with the Cap de l'Abri littoral ecosystem.

Species	Local names	Status	Characters
Agave vera-cruz	*Choca bleu*	Exotic from Mexico	Acaulescent succulent plant, 1.5–2 m tall
Canavalia rosea	*Patate cochon*	Native	Lianescent creeping weed
Delosperma napiforme	*Lavangère*	Endemic to Reunion	Small succulent herb with tuberous roots
Flacourtia indica	*Prune malgache*	Exotic from Madagascar, or native?	Shrub or bush with alternate glossy leaves
Ipomoea pes-caprae	*Patate à Durand*	Native	Lianescent creeping weed
Lantana camara	*Galabert*	Exotic from Central America	Invasive thorny bush
Latania lontaroides	*Latanier rouge*	Endemic to Réunion	Single stemmed palm with costa-palmate leaves
Noronhia emarginata	*Takamaka de Madagascar*	Exotic from Madagascar, or native?	Small tree or bush
Pandanus utilis	*Vacoa*	Endemic to Mascarenes	Small tree with stilt roots
Scaevola taccada	*Manioc marron bord de mer*	Native	Spreading shrub with bright green leaves
Schinus terebinthifolius	*Faux poivrier*	Exotic from South Anerica	Very invasive bush or small tree bearing small pink berries
Stenotaphrum dimidiatum	*Traînasse*	Native	Grass with a creeping rhizome
Trema orientalis	*Bois d'andrèze*	Exotic from Africa, Asia or native?	shrub

potentially invasive. Two other species are usually abundant in the south coastal ecosystem, especially in nearby Grande Anse – *Casuarina equisetifolia* and *Flacourtia indica*. The first one is not present at Cap de l'Abri; the second one is barely present. We have located only two small specimens on the lower edge of a sugarcane field.

Several other species are common on the rocky coast line in southern Réunion. *Canavalia rosea* and *Ipomoea pes-caprae*, though more often present on sand beaches, are creeping along the rock surface at the lower level of the site. *Delosperma napiforme* grows in the cliff rocks exposed to sea spray. *Scaevola taccada* is abundant and grows in dense thickets up to 1.5 m in height. The small tree *Noronhia emarginata*, and to a less extent, *Pandanus utilis*, form a sort of wind screen at the intermediate level, behind the *Scaevola taccada*, which protects the *Latania lontaroides* palm grove located beyond (Fig. 5).

Except for *Delosperma napiforme* and *Latania lontaroides*, none of these species is unique to the south coastal ecosystem of Réunion. Instead it is the juxtaposition of native species, includeing *Noronhia emarginata,* whose status is doubful, and the presence of *Latania lontaroides* that makes the coast of the "*Sud Sauvage*" (wild south) unique, and the site of Cap de l'Abri is the highlight of this coast, with its dense population of red latans.



5. Map of Cap de l'Abri (top), showing location of sugarcane fields (1), *Latania lontaroides* population (2) and sea cliff (3), and diagram of the littoral vegetiation (below), showing the zonation from the sea (at the right side of the diagram) to the inland (left side).

Nevertheless, the Cap de l'Abri vegetation, restricted to a small area, is threatened by several factors: a strongly anthropogenic environment, with sugarcane farming right up to the cliff rim and more and more houses built on adjacent land; the presence of invasive, alien species on the edges of the site and the high risk of intrusion in the red latan population; the over-harvesting of seeds in by nursery owners and palm seed traders, as well as the regrettable harvesting of seedlings whose chances of survival after transplanting are minimal; the predatory action of rats that climb up the palms and eat the *pommes latanier* while the endosperm is still soft (Fig. 4).

We consider the Cap de l'Abri littoral vegetation is of major botanical interest. It is worth taking conservation measures urgently, especially since an explicit mandate for environmental protection exists. Among these measures we suggest: expropriation of the land by Conservatoire du Littoral; eradication of *Latana camara* and *Schinus terebinthifolius* by manual uprooting; sowing red latan seeds "in situ" on ground previously cleared and re-introduction of young palms grown from seeds harvested on the site; belting of female palms trunks to prevent rats of reaching the infrutescences; control of the area by guards to prevent seed and seedling poaching.

These protective measures should reinforce the dynamics of red latan regeneration and lead to expansion of the population at the expense of invasive species. This is a necessary rescue of the coastal ecosystem, even if one may wonder why there is such a density of *Latania lontaroides* on the edge of a deeply anthropized background. A "*gramoun*" (Creole word for old man or grand father) living nearby reported that in "*temps longtemps*" (or "*tan lontan*" meaning in the old days) less than a century ago, people still used to grow red latans for roofing. What should we understand? Possibly the action of sowing a few seeds in a hole with the hope that several decades later, one could look at two or three sturdy palms and collect their leaves for one's own purpose.

The red latan palm grove at Cap de l'Abri, whether in its natural state or reinforced by human interaction, is unique. This justifies all the steps that should be taken for the conservation of this habitat, with the partnership of all local institutions, including the Conservatoire du Littoral and Palmeraie-Union, the local chapter of the International Palm Society.

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Conservation Status and Economic Potential of *Parajubaea sunkha*, an Endemic Palm of Bolivia

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Parajubaea sunkha **Moraes, one of three species of an endemic Andean genus, is known exclusively from 1700 to 2500 m above sea level within the province of Vallegrande, department of Santa Cruz in Bolivia (Fig. 1 & Back Cover). Early data suggested that *P. sunkha*, a locally important economic species, could be the most threatened of all Bolivian plants (Ibisch 2004a). However, more detailed studies for an adequate assessment were lacking. Now, in the present paper, for the first time, the species' conservation status and threats are assessed quantitatively.**

Perhaps due to its rarity and the lack of taxonomic studies, *Parajubaea sunkha* was not distinguished from *P. torallyi* (Mart.) Burret until recently (Moraes 1996). The first and only contribution on the ecology and use of the species was provided by Vargas (1994). According to this author, the species' habitat is characterized by a mean annual precipitation of about 550 mm with a marked dry season of at least five months, usually between June and October. In the dry season frosts can occur at night. The adaptation of *P. sunkha* to the

1. Typical stand of *Parajubaea sunkha*, east of the town of Vallegrande, Bolivia (photograph J. Enssle).

climate of the high Andean valleys makes the palm suitable for warm-temperate and subtropical localities worldwide.

The seedling prefers shade, while the mature tree is favored by direct sunlight and suppresses accompanying vegetation by closing the canopy. In the heavily shaded *Parajubaea* understory, a humid temperate microclimate and humic topsoil formed by rotting palm leaves provide ideal conditions for germination of the palm seeds. After pollination, fruits reach maturity in about 20 months. The seeds are distributed by rodents who feed on mesocarp of fruits fallen to the ground. Under natural conditions, the seeds require 17 months for germination (Vargas 1994), but with the help of *in vitro* cultivation the germination time of *P. sunkha* and *P. torallyi* can be reduced to only several weeks (Ibisch 2004b). When undisturbed, the palm can display abundant regeneration in its natural habitat. Grazing, land-clearing, burning and harvesting of the palm's fibers, however, all negatively impact regeneration of this rare species.

Parajubaea sunkha is known to occur naturally on only 14 sites within a 300 km^2 range in the province of Vallegrande, department of Santa Cruz (Vargas 1994). The authors estimate that the overall population size comprises about 25,000 mature individuals. In the study region farmers typically possess ~4 ha of cultivated

2 (left). Harvest of fiber by climging. 3 (right). Harvest of fiber using a log as a ramp. (photographs J. Enssle)

land. Maize and wheat are the main staple crops, while potato is the only cash crop and is restricted to irrigated areas. Livestock, mainly cattle, sheep and pigs, serve as capital and are sold only in emergencies when money is needed for materials or for medical care. The limitations for earning money in the rural areas is reflected in the high migration rate of young people from the rural areas to urban centers, leaving many farm households with only grandparents and children. It is in this context that we have to understand the use of the *palma zunkha* (local name), which plays an important role in daily life of local farmers: they use its leaves as forage for cattle and for making baskets and fans (Vargas 1994).

The soft fiber that grows at the petiole base can be harvested annually and is processed and manufactured into mattresses, saddle pillows and ropes. Although the harvesting method is non-destructive for the individual, it results in a total loss of all flowering and fruiting inflorescences, leaving the tree without offspring. Vargas already observed that palm stands exploited over several years have a population structure heavily biased towards mature individuals with scarce rejuvenation.

Parajubaea sunkha suffers both from habitat destruction and overexploitation. Although apparently endangered, it has not yet been included in a CITES appendix, nor was it on the 2004 Red List of the IUCN Species Survival Commission because of insufficient data about the remaining population. Nonetheless, the Bolivian non-governmental organization "Fundación Amigos de la Naturaleza" (Friends of Nature Foundation) developed a conservation project applying *in-situ* and *ex-situ* measures. Strategically, it was intended to achieve conservation by providing increased incomes for local farmers through international commercialization of *Parajubaea* as an ornamental plant.

The objective of this paper is to integrate biological and socio-economic data in order to get a better picture of the actual conservation status and the socioeconomic factors that may have an impact on the palm population and its use. Additionally, we assess if an economic use of *P. sunkha* as ornamental plant or as a non-timber forest product is viable when tendencies of land-use change are taken into account.

Methods

Selection of the study site. Most of the 14 sites where *P. sunkha* naturally occurs are either very remote and difficult to access or the number of individuals is so low that the palms are not used for fiber extraction (Fig. 1). Therefore, the present study focuses on the two main stands east of the town of Vallegrande (UTM/ Prov.SAM56: 0399490E, 07951853N) where we estimate that 70% of the entire population of *P. sunkha* occurs and where, due to its local abundance, the pressure of fiber extraction is highest.

Rapid rural appraisal (RRA). We conducted a RRA of the socioeconomic factors that influence the population dynamics of *P. sunkha* through semi-structured interviews with 21 farmers. We estimate that 90% of all farmers who harvest palm fiber commercially were surveyed. Interview questions covered aspects of land use, socioeconomic situation of the families, past and current market prices for palm fiber products and management practices applied to the *palma zunkha*. In the town of Vallegrande, two merchants who trade palm fiber were interviewed about dynamics of the regional market and about the potential for palm fiber commercialization.

Palm population inventory. As internationally standardized methodologies for the inventory of palm trees do not exist, we decided to establish transects of 500 × 20 m (1 ha), each belonging to a different farm property and considered representative of the palm stands east of Vallegrande. For each tree, we recorded height at leaf base, number of inflorescences, date of last harvest and signs of anthropogenic

4. Weighing the fiber (photograph J. Enssle).

5. Merchant, presenting her innovative mattress. The mattress will be finished with a cotton cover. (photograph J. Enssle).

injuries such as broken or burned trunks. Regeneration was assessed in 25 m^2 plots at the two extremes and middle of each transect.

Fiber productivity assessment. Fiber productivity was assessed by polynomial regression, with fiber produced per tree approximately one year after last harvest as the dependent variable, and tree height multiplied by diameter at breast height (DBH) as the independent variable. In November, 2003, the fiber of 119 trees was harvested and weighed using a spring balance (Figs. 2–4).

Results

Findings of the rapid rural appraisal related to Parajubaea sunkha. Most farmers interviewed in the study region do not have access to irrigation water and, thus, their agricultural mode is subsistence farming. Their only monetary income is generated by working off-farm or by harvesting *Parajubaea* fiber. Access to the regional and national market has improved since 1984, when a road was constructed linking the study area with the town of Vallegrande. The standard daily wage for agricultural work in the study region is $US 2.50.

Farmers and the two main palm fiber merchants in town reported that prices for palm fiber dropped from $US 2.50 to $US 0.80 per unit of 12 kg between 1993 and 2003, possibly due to increasing availability of synthetic substitutes. As a consequence, fiber harvesting is becoming less and less profitable. Only the more innovative and technically sophisticated palm fiber mattresses with springs and a cotton cover still sell well (Fig. 5).

Palm population inventory. While saplings were rather abundant in all four sample stands, the size class of 0.5 m tall palm trees was scarce in two stands and completely missing in the remaining two stands (Fig. 6). None of the palms in the inventory were higher than 8 m. Almost all palms between 0.5–2 m were harvested annually and thus experience the strongest exploitation pressure. In all four sample stands signs of anthropogenic injuries were common. On average 60% of palms had stairs cut into their trunks to climb them easier, about 5% had burned trunks but still lived, about 2% were found dead (either burned, cut or broken by wind) and almost 45% of all palm trees were harvested within the last year, and thus did not generate offspring.

Fiber productivity. Individual palm trees produced between 0.1 and 1.8 kg of fiber annually (mean 1 kg, n=119). Tree height multiplied by DBH explained 66% of variation in fiber production ($R^2 = 0.66$, $P < 0,001$, $n = 119$) (Fig. 7).

Discussion

Population structure. The abundance of different age classes deviated from that expected for undisturbed forest stands (in which age class abundance should decrease exponentially). The enormous loss of individuals in the early stages (saplings and rosettes) may partially be explained by natural die-off. The under-representation of 0.5 m high palms, however, implies that for some time in the past little or no regeneration took place in the sampled palm stands. The questions are what factors caused this unbalanced population structure, and could they still be impacting the conservation status of *P. sunkha*?

The absence of palms around 0.5 m of height (ca. 20 years old; personal communication by Vargas and various farmers) at two sites can be traced back to the construction of a road that connects the stands with the town. Before the road was built, farmers transported fiber on their backs or with donkeys to the local market. This limited them in terms of the quantity they could transport and facilitated the continuing fructification of adult palms to ensure future regeneration. Since the road was built in 1984, it became possible to transport much larger quantities of palm fiber. Farmers confirm that in this time almost all palms were under exploitation. As a result, the regeneration of the species almost came to a halt. The palm stands with no 0.5 m tall palms were directly adjacent to the road and more heavily exploited (Fig.6 S1+S2). The other stands studied were about an hour's walk from the road. Exploitation in these palm stands was not as intensive and some regeneration could occur as shown by the presence of more young palms 0.5–1 m tall (Fig 6 S3+S4).

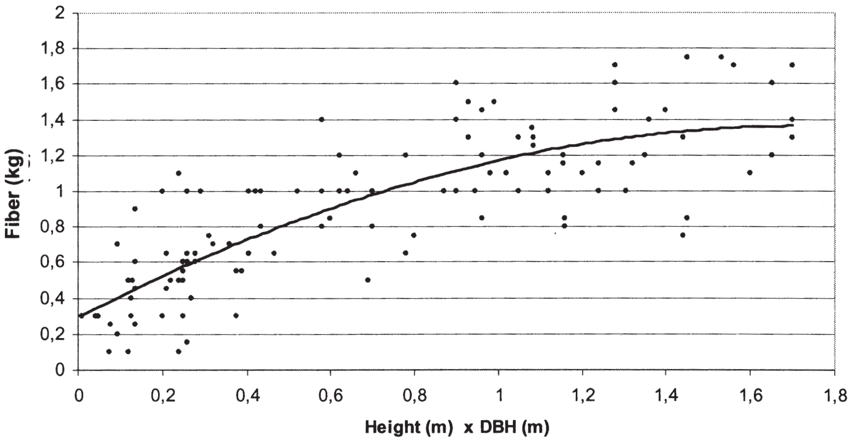
The abundant regeneration of young palms in the last 5 years (approximate age of rosettes) is evidence of the changing dynamics of the palm fiber market. The wider usage of synthetic substitutes, such as nylon, caused a decline of the market price for palm fiber. Farmers once earned between $US 2.0–2.5 per unit of fiber (12 kg), but recently earned only $US 0.8–1.2 per unit. However, to be profitable, farmers need a minimum price of $US 1.5 per unit. As a result, harvest intensity declined and far more trees were able to develop their fruits. Decrease in use has led to increased opportunity for regeneration of the species.

Despite this positive effect, mortality remains high. Most young plants naturally do not survive long-term. However, mortality seems to be increased anthropogenically. Since the palms grow on agricultural lands, saplings and rosettes are frequently victims to browsing livestock (Fig. 8). During the dry season, the young palms are often the only green forage available. Man-made fires and extensive land clearing for agriculture further impede recruitment.

Another interesting question is why the palms' maximum height in the four heavily exploited sample stands does not exceed 8 m (Fig. 6), whereas the palm naturally grows up to 15 m. The explanation is unambiguous: Farmers stated that they felled trees higher than 8 m because the natural production of fiber from this height onwards undergoes a disproportionate reduction. Moreover, harvesting such trees is not economically viable taking into account the additional personal risks of climbing such high palms. The inventory showed that farmers prefer trees 0.5–3 m tall. They are easy to climb, highly productive and provide the best quality fiber. Where arable land is scarce, the palm is a direct competitor to agriculture and is removed as soon as it ceases to be profitable.

Fiber productivity. The amount of fiber that a palm tree produces may depend on three main factors: diameter, tree height (an indicator of light availability or other environmental factors) and habitat (soils, climate, etc.). Given the palm's habitat was relatively homogeneous, the best predictor for fiber production

6. Population structure of four palm stands.



7. Fiber production one year after last harvest correlated with height and diameter (DBH = diameter at breast height) (R^2=0.66, P < 0.001; n = 119, $y=0.2892 + 1.2409x - 0.3584x^2$).

was a combination of tree height and DBH. Our results can be used to predict harvest volumes and indirectly the economic value of a specific palm stand for its owner. However, farmers may select palm trees for harvest based not only on fiber production but more so by height, sometimes harvesting only trees <3 m tall for reasons stated in the previous paragraph.

The palm and its economic potential

Fiber commercialization. When market prices for palm fiber were favorable (~$US 2.5 per 12 kg), a farmer had to harvest about 5 trees (average 1 kg each) to earn $US 1. If prices continue at current levels (~$US 0.8 per unit), he has to harvest about 16 trees to earn $US 1. An experienced person needs about 15 minutes to harvest one tree. In order to earn $US 1, at recent prices, a farmer would need to work for 4 hours. These calculations do not include the additional time needed for transport and negotiations with the merchants in town. Compared to the minimum standard wage of $US 2.5 per day for agricultural work, at current low prices palm fiber extraction is only slightly profitable.

The economics of the merchant in the town of Vallegrande, however, appear different. The merchant adds value to the raw fiber by combining it with cotton and metal springs and processing it into high quality mattresses (Fig. 5). This manufacturing process takes two days. One of these mattresses can be sold for about $US 110 on the national market. The profit per mattress for the merchant is around $US 40. Taking the current price levels for raw palm fiber (~$US 0.8 per unit), a farmer – who needs one day to harvest the fiber necessary for one mattress – earns only $US 1.6. Nevertheless, the merchant has a series of additional indirect costs such as store rental, employee wages and advertising.

In conclusion, if prices for raw palm fiber stay at the current low levels, it is obvious that farmers will change their agricultural practices, and as arable land in the region is scarce this may well have deleterious consequences for *P. sunkha*. Even if the managed commercialization of palm fiber as a 'Non Timber Forest Product' improved prospects for the conservation of this palm, lack of access to new markets, declining market prices, lack of infrastructure and limited resource supply are obstacles to achieving sustainable harvest goals.

The palm as an ornamental plant and a genetic resource. Another opportunity to conserve the species is its commercialization as an ornamental plant. As aforementioned, *P. sunkha* is one of the more frost-tolerant palms and as such might be suitable for regions with a warm temperate climate. In 2004, web-based offers for packages of 100 seeds ranged from $US 40–90. The important question, however, pertains to the method by which such seeds can reach the market. While the import of rare palm species may be legal, the uncontrolled export of such species from Bolivia is illegal. Farmers of the region, currently, do not earn any real income or derive any benefit from this unregulated business while they should and actually could when fair and governmentally approved projects came into existence.

8. Young palms are frequently browsed by cattle, which also feed on leaves cut during harvest.

Currently, any unapproved export of genetic resources is violating Bolivian law. *Parajubaea* clearly has to be considered as a genetic resource, and therefore article 15 of the Convention on Biological Diversity (CBD) and Decision 391 of the treaty of Cartagena (in Bolivia: Decreto Supremo 24676, Art. 3) on access to genetic resources must be applied. According to these regulations, "the authority to determine access to genetic resources rests with the national governments and is subject to national legislation" (CBD Art. 15.1). Unfortunately the implementation of the Bolivian legislation is currently hindered by severe socio-political problems. Until now, the 'access and benefit sharing' regulations have not stimulated novel bioprospecting activities or innovative uses of genetic resources and Bolivian society failed to generate any benefits (Galarza 2004, Ibisch 2005). It may be difficult to get official Bolivian approval for trade of a genetic resource, but irrespective of such regulations, if species like *Parajubaea sunkha* are propagated and horticulturally developed in large quantities abroad, the consequences may be disastrous. Without enjoying some form of spin-off benefit, local people will probably lose interest in conserving *Parajubaea sunkha* in its natural habitat.

Use it or lose it? The future of *Parajubaea sunkha*

It is a dilemma. Although pressure of palm fiber harvest has decreased in the last few years and regeneration is increasing, the conservation of this rare palm species is by no means secure. To the contrary, the conservation status may worsen due to extension and intensification of livestock production and agriculture because palm fiber is no longer a viable income alternative. The story of *P. sunkha* may validate the motto "use it or lose it." The underlying assumption behind the idea that NTFP (Non-timber Forest Products) exploitation can promote biodiversity conservation is that people will ensure the reproductive capacity of products that are valuable sources of income (Fisher and Dechaineux 1998). As with most natural resources, there is a potential contradiction between the utility of the species and its long-term prospects for survival: high demand may lead to over-exploitation, whereas low demand may lead to land clearing for other agricultural purposes with subsequent reduction of the remnant population.

Conservation of *P. sunkha* through sustainable commercialization of its fibers faces uncertainties and might not be viable. A detailed market analysis is still needed to evaluate this question. Commercialization of the palm as an ornamental plant may have more economic potential, but mechanisms need to be created to assure the conservation of the natural resource in its habitat. Among others, a necessary precondition is the application and enforcement of the existing Bolivian legislation. The establishment of a protected area at the municipal, departmental or national levels should be heavily promoted. Meanwhile, it is important to monitor the palm's conservation status and its population dynamics. The inclusion in the 2006 Red List of the IUCN Species Survival Commission that was proposed and accepted as result of this study hopefully will bring more international attention to this endangered palm species.

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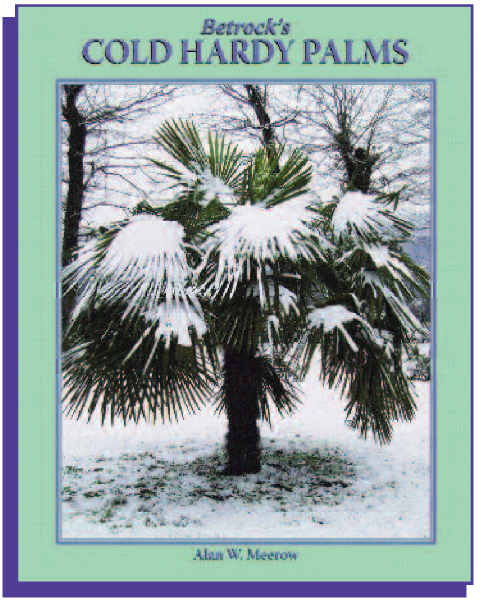

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