Palms

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The International Palm Society

Founder: Dent Smith

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FRONT COVER

The sunkha palm (*Parajubaea sunkha*) at sunset, growing in open and moist Andean valleys of Bolivia. See article by M. Moraes, p. 177.

Palms (formerly PRINCIPES)

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CONTENTS

The delicate flowers of *Chamaedorea ernesti-augusti,* a species threatened in Belize by illegal leaf harvesting. See article by Bridgewater et al., page 187.

BACK COVER

Chamaedorea adscendens, an unusual palm of wet habitats in southern Belize. See article by Bridgewater et al., p. 187.

NEWS FROM THE WORLD OF PALMS

We are very pleased to learn that the historic palm collection and commemorative "Dent Smith Trail" at the Florida Institute of Technology Botanical Garden, in Melbourne, Florida, are being restored. Former Florida Tech President Jerome P. Keuper, who was also president of the Palm Society from 1970 to 1972, began the collection, which had over 150 palm taxa at its peak and was profiled in *Principes* by Nixon Smiley (19: 39–64. 1975). Scott Craig, who has been supervisor of the Botanical Garden since May, sent us this update from the campus:

"Florida Tech's Botanical Garden staff has been busy rejuvenating and reclaiming the garden in honor of the school's 50th anniversary. We are restoring many of the traditional trails that have become overgrown, while retaining the richness of our native vegetation. Control of invasive weeds has been a high priority. The rich soil and abundant water are a blessing for our palms but are also fertile ground for invaders. Invasive plant removal will improve access for our community and facilitate updating our species survey. Linda Seals, the Brevard County Extension Service commercial horticulture agent, is helping us fine tune our integrated pest management plan to the special environmental needs of the area. The Central Florida Palm & Cycad Society (CFPACS), along with many of our local master gardeners, will identify the palms. We have already received a gracious donation of seeds from John Green, CFPACS seed bank coordinator, and we were pleased to reciprocate with a donation to the seed bank. Although we are always seeking donations of mature specimens, this exchange allows us to increase our future diversity. The Botanical Garden Committee, headed by Beverly Sanders, director of development at Florida Tech, is busy organizing the Third Annual Florida Tech Botanical Fest Plant and Garden Sale for 1 March 2008. Proceeds help to fund the Botanical Garden. With teamwork, we have been able to make great progress, and I see that we are on the brink of some very positive changes."

We are saddened by the news of the death of Paul Drummond on 15 Sep 2007. Although raised in New York City, Paul was enamored with palms at an early age, and in 1948, purchased land and built a home in southern Coral Gables, Florida, just a short stroll from what was then Fairchild Tropical Garden. Paul's palm collection grew as did his enthusiasm for palms, and he was a frequent visitor to Fairchild. He joined the Palm Society in its infancy and became one of its steadfast supporters, gaining the respect and friendship of palm "nuts" all over the world. Paul was a past president of the Palm Society from 1980 to 1982 and was a fixture at local palm sales and chapter events. Even after selling his home across from Fairchild and moving to a smaller, more manageable property in South Miami, Paul continued growing palms and being active in the Society. In fact, Paul allowed the IPS to borrow his set of *Principes* for scanning. A fine raconteur with a hilarious sense of humor, Paul will be greatly missed, especially in Miami, where his love of palms flourished for over 50 years.

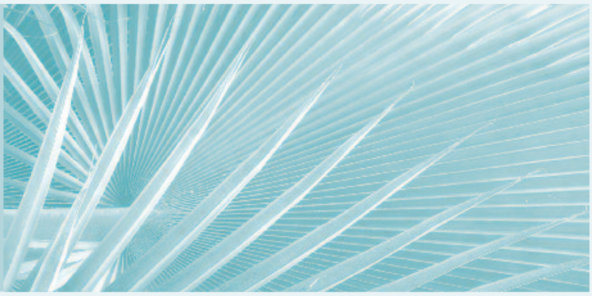
THE EDITORS

GROWING PALMS

Horticultural and practical advice for the enthusiast

Edited by Randal J. Moore

Contents



Boron Deficiency, Phenoxy Herbicides, Stem Bending and Branching in Palms – Is There a Connection?

It was with great interest that I read the short horticultural articles in the Growing Palms section of recent issues of PALMS by Don Hodel, Dave Romney, Mike Marika and Randy Moore on the subject of palm stem bending and abnormal branching. My article on "Boron (B) Deficiency Symptoms in Palms" (PALMS 15: 115–125) was submitted when this discussion began. I was wishing I had had the opportunity to discuss the possible relationships between boron deficiency and these two disorders.

Dave Romney's experiences with phenoxy herbicides (2,4-D and related compounds) on coconut palms point out the effects of excess auxins (phenoxy herbicides are potent synthetic auxins) on palm growth and appearance (PALMS 15: 57–58). When we first observed symptoms of epinasty (leaf twisting) on palms in the early 1980s in Florida, we attributed these symptoms to phenoxy herbicide injury, yet we had no evidence that such products had ever been used on or near these isolated palms. Our first clue that B deficiency might be a cause of stem bending came from our sand culture studies with *Dracaena marginata*. Boron-deficient *D. marginata* invariably began to grow sideways. Eventually the apical meristem died, and a proliferation of subapical shoots followed.

Although we had often observed branched palms, we were never able to determine the cause of this malformation. Recently, however, we observed two *Syagrus romanzoffiana* at the University of Florida's Fort Lauderdale Research and Education Center that were exhibiting multiple symptoms of B deficiency (Fig. 1). Each palm had two actively growing shoots, one of which grew laterally and downward and the other more or less upward. The branching occurred at the same time that the other B deficiency symptoms such as epinasty, little leaf, crumpled leaf, and puckered leaf were first observed. The palm shown in Fig. 1 was treated with a soil drench of Solubor (4 oz in 5 gal of water) six months before this photo was taken, and it is now producing normal new leaves. However, the side shoot continues to grow downward even though the new leaves are fairly normal in appearance.

Stem bending and other epinastic growth responses are considered tropic responses and are well-known to be regulated by auxins in plants. Thus, while the proximate cause of the stem bending we see in palms is undoubtedly excess auxin, the ultimate causes may be multiple. Boron-deficient plants, including palms, are known to contain elevated levels of auxin in their leaf tissue (Exp. Agric. 8: 339–346), and exposure to potent synthetic auxins such as phenoxy herbicides would obviously result in elevated auxin levels within the plant. Still, there may be other, as yet unidentified, biotic and abiotic factors that also promote the production of auxin within palms that may result in similar symptoms being expressed. One means of determining if stem bending is caused by B deficiency vs. phenoxy herbicides is to observe the distribution of affected plants. If a herbicide is involved, it will likely also affect other nearby plants or plant species, while B deficiency, like most micronutrient deficiencies, occurs almost randomly among plants in a given area and will typically affect only one species of plant.

1. *Syagrus romanzoffiana* exhibiting branching, little leaf, crumpled leaf, epinasty,and other symptoms of boron deficiency.

The idea that stem bending in palms is caused by B deficiency has met with some skepticism among horticulturists. If B deficiency is the problem, why do soil tests in California often show adequate amounts of B, and why have applications of soluble B fertilizers not consistently corrected the problem? First, plant uptake of B is known to be poorly correlated with soil B concentrations. Also, B becomes tightly bound to mineral soils as they dry out, and this drying process affects applied B fertilizers as well as native soil B (Plant Soil 193: 35–48). High soil pH also contributes to soil binding of B. On the other hand, in areas with higher rainfall, leaching of B out of the root zone is the primary cause of B deficiency, and this leaching also affects applied B fertilizers. Thus, B fertilization of palms is at best an imperfect science and, for the reasons just mentioned, is likely to remain that way.

As for palm branching, the multi-branched *Phoenix roebelenii* illustrated by Marika and Moore (PALMS 15: 58–62) does not show any characteristic B deficiency symptoms in the photo to implicate this cause, but their description of “leaf distortion and whorled pinnae” are characteristics of B deficiency. The necrotic leaf tips of the *Livistona chinensis* they illustrated in Fig. 5 is very typical of B deficiency in palmate-leaved palms (PALMS 15: 115–125), and the tight branching is characteristic of B deficiency in other plants such as *D. marginata*. Finally, the three-stemmed *Hyophorbe lagenicaulis* illustrated in their Fig. 6 displays traces of epinasty and little leaf (the oldest leaf on the far left shoot appears abnormally compressed). Since B deficiency is often transient and recurring, the deficiency that caused the branching, at least in these *Phoenix* and *Hyophorbe* examples, may no longer be as severe. Thus, normal foliage may eventually emerge from each of the shoots on some branched palms. Clearly, the B deficiency experienced by the *Livistona* is a chronic one.

Death of the apical meristem, followed by a proliferation of subapical shoots is a common symptom of B deficiency in other plants. However, there does not appear to be any documented link between excess auxin and branching in plants, so the relationship between B deficiency and branching may be a more direct one. Although there is evidence that B deficiency can cause branching in palms, this does not rule out alternative causes. Bud injury, caused by frost, chemicals, diseases, insects or mechanical damage, may also be responsible for some of the branching observed in palms. – *Timothy Broschat, University of Florida, Ft. Lauderdale Research & Education Center, Ft. Lauderdale, Florida, USA*

Product Review: New Pole Saw for Palms

Along with a shovel, the most important piece of garden equipment in the palm garden is probably a pole saw. However, most pole saws are poorly designed and not up to the rigors of heavy use, especially during the growing season. A new pole saw from ARS now makes it much easier to prune palm leaves and inflorescences on tall palms.

The ARS pole saw allows for the longest reach of any arborist saw available (Fig. 1). Most pole saws do not go beyond 14 or 16 feet. The longer reach eliminates climbing taller palms. The gardener can stay on the ground, and this is faster, less costly and safer than tree climbing or ladders. Although the entire rig of telescoping poles and saw head will cost about US$200, the cost is quickly recouped over the cost of alternative methods of pruning tall palms.


1. The long reach of the new ARS pole saw allows pruning of tall palms while staying on the ground.

Three lengths of telescoping poles are available: a 10′9″, a 16′ and a 20′. The 20 ft. (6.1 m) model telescopes in three sections to an extended length of 20 ft. to the tip of the saw blade. Adding a person's height gives a total reach of about 25 ft. (7.6 m) allowing for some angle of cutting. The collapsed length of this model is 9 ft. (2.7 m) to the saw tip.

The telescoping and locking mechanism on this pole pruner is also ingenious. It is far superior to the collar threaded locking rings on

2. The saw head and mount cuts on the back-stroke and has sawdust-removing gullets.

most pole pruners. Collar locking rings have a tendency to slip and also the thread can bind. The end section of the new pole saw extends to a fixed length only and is held by two retractable spring bolts. The middle section uses a clever gearing mechanism and locking clamp (Fig. 3) so that it can be extended quickly to any desired length and locked into place.

The pole is constructed of light-weight durable aluminum. The light weight is critical since the pole telescopes to 20 feet. Use of a heavier material would make impossible to handle at this great length. However, the sturdiness is not compromised because of its unique design and construction. The pole is not round in cross-section, but instead oblong (Fig. 3) similar to an iron construction beam. This elliptical shape minimizes flexing in the pole when cutting. When fully extended, it is still possible to get leverage on the blade when cutting because the pole maintains its rigidity.

3. The 3-section telescoping pole extends to 20 feet and uses a unique gear and locking clamp mechanism that allows adjustment to any length quickly and without slipping.

The saw heads (Fig. 2) are purchased separately and attach easily to the telescoping pole. The ARS Turbocut™ blades are made of a hard chrome nickel plated rust-resistant finish with very sharp teeth and gullets (gaps) between each group of teeth to remove sawdust. Two saw head lengths are available: (1) a 13″ (33 cm) blade with 22″ overall length including the mount and (2) a thicker 16″ (40.6 cm) blade with an overall length of 25″.

The saw blade draws itself into the cut on the push stroke, and allows for a full cutting stroke on the back pull. It gives a nice clean cut. The blade is hooked on the end. This is especially useful when working on palms. The hook can be used to pull an inflorescence or sheath horizontal before cutting, and to full a frond down that is trapped in the crown or held by just a few fibers. An adaptor is also available for mounting a pruner head to the telescoping pole.

The ARS Super Turbo™ Cut Pole Saw is available through A.M. Leonard Horticultural Supply (www.amleo.com or 800-543-8955). The 20 foot telescopic pole (catalog #EXP55) discussed here currently is priced at US$152.99. The 13 inch saw head and mount (catalog #34EXP) is sold separately and is currently priced at US$40.49.

– *Randal J. Moore, Poway, California USA*

Palm Seed Poaching

There is no evidence that humans have ever acted to conserve and sustain the resources they depend on, but in the past primitive technology and small human populations meant our impact was not so dramatic. Now we have larger populations and better technology, we can harvest plants and their products more quickly, but we also have better understanding of the consequences of our actions. The key is for us to not only understand what a sustainable level of harvest is, but also to actually implement this 'on the ground', where plants are being harvested. – Botanic Gardens for Conservation International

What do *Dypsis decaryi, Acanthophoenix rubra, Coccothrinax borhidiana* and *Chamaedorea tuerckheimii* have in common? Each of these palms is both threatened and coveted by collectors.

Many of the world's most highly desirable palms are already battling the effects of habitat loss, invasive species, pollution, climate change and/or unsustainable collection of plants, leaves and seeds. Some of these species have only small populations to begin with and/or low levels of reproduction. And yet it seems the more rare the palm, the more collectors want it. Some collectors will risk the continued existence of a species in the wild for the reward of adding a coveted palm to their own collection.

Since palms are our passion, our goal should be to protect them, not poach them, if for no other reason than the continued enjoyment of our favorite plant family. Instead, it seems that the rarer a species is, the more we want it. And the more we want it, the more likely we are to take the opportunity to grab some seeds when we get the chance regardless of the consequence of our action.

But before we take that next handful of seeds, we need to give a thought to the effects of our unregulated seed collection. It can adversely affect the regeneration of palm species, especially threatened species. If a palm is rare, or exists in isolated populations, stripping a plant of all or the majority of its seeds may have serious consequences on the population including the loss of genetic diversity within that species. When a group of palm collectors leaves an area barren of seeds, they may take with them the ability of the area to establish a healthy new generation. Palms that produce little viable seed (or have low germination rates) are particularly vulnerable. A good example of how poaching can affect palms is the case of *Chamaedorea tuerckheimii*, the potato chip palm, whose survival in the wild is now threatened because of over-collection (Hodel, D.R. 1992. *Chamaedorea Palms, The Species and Their Cultivation*).

The act of collection itself often damages palms. This is especially true when collectors cut down a palm to harvest seeds that are too high to reach. Palms are also damaged as collectors bend tall stems or break off stems, making the plant more vulnerable to attacks by pests and disease. Depending on the extent of the damage, we may contribute to even longer-term negative effects as the pollinators, seed dispersers, plants and animals that rely on a healthy ecosystem are affected by population decline and species loss.

To add insult to injury, much of the collected seed never actually germinates. A seed that is taken away from forest may never result in a viable plant thereby losing its potential if it had been left alone. Believing they may never have another opportunity to collect a species, collectors may harvest seeds before they are mature. They may store them poor conditions or sow them in less than ideal conditions for germination.

Advice for keeping palms wild includes:

Do not pay for threatened or rare palms "by the pound" from people that collect from the wild. When we pay for seeds to be collected, especially from members of poor communities, our demand will be met out of a desire to put food on the table and not to harvest palm seeds sustainably. Rather than collecting from the wild, buy, trade or ask for seeds from *cultivated* sources such as nurseries, other palm enthusiasts and botanic gardens, or purchase from community groups actively involved in conservation.

Take a tip from conservationists in the big-game hunting community who now take a shot with a camera instead of gun when their quarry is in their sights.

If you must collect from the wild, first and foremost obtain the proper permits from the country from which you will be collecting.

Never take all the available seed. Collect only a small percentage of the total available seed, and collect from several different plants, rather than stripping one plant completely.

Collect with care, and use the proper tools to avoid damaging the plants. Use secateurs (pruners) to make good cuts when collecting seeds and a pole cutter to gather seeds safely from tall specimens.

Look where you are going. Take care not to trample small palms and seedlings.

If the seed is from a rare species, leave some of the seed with a botanic institution in the country of origin.

And of course encourage others to engage in ethical collection practices.

If you should chance to see a seed-laden *Chamaedorea pumila* on the upcoming IPS Biennial in Costa Rica, please think twice before pocketing the seeds! It will not be possible to collect seeds from protected areas during the IPS Biennial. Our role should be conserving not jeopardizing the health of the very plants we love the most. – *Heather duPlooy, Curator, Belize Botanic Gardens (www.BelizeBotanic.org), San Ignacio, Belize*

Call for Articles

Collectively, the members of the International Palm Society embody a great wealth of knowledge on the horticultural issues of palms. While many topics have been addressed in detail in past issues of Principes/PALMS, new horticultural issues, products and methods are continually arising.

For example, many areas in the world are experiencing severe droughts that threaten the fresh water supplies essential to palm hobbyists and commercial growers. Is the use of recycled water a viable alternative? What are the water quality issues involved on salt-sensitive palms? How will commercial growers confront water rationing and minimize water use while remaining economically viable?

Articles can be of any length and may be a follow-up response to a prior Growing Palms article. If you have an article to submit, a suggested topic or a referral for a potential article please e-mail it to Horticultural Editor Randal J. Moore at Randal.Moore@cox.net

Uses of *Vara Casha* – a Neotropical Liana Palm, *Desmoncus polyacanthos* – in Iquitos, Peru

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1. Tangle of *vara casha*, near Iquitos, Peru ready for extraction.

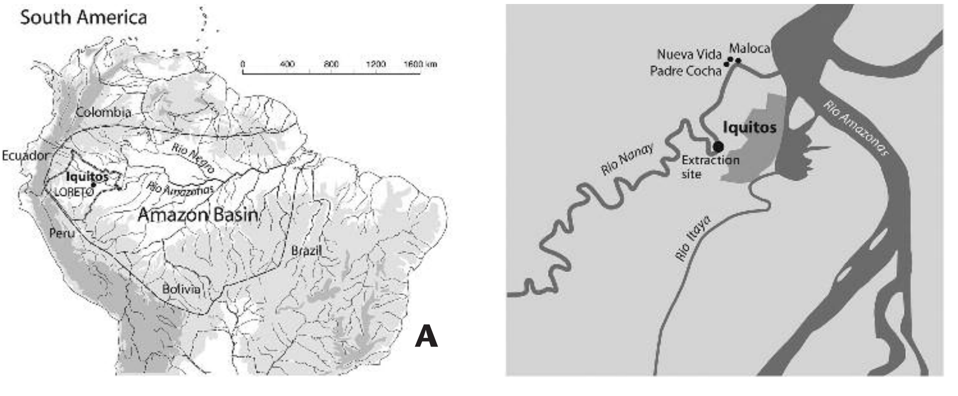
Desmoncus polyacanthos or _vara casha_ (Fig. 1) is commonly used for weaving baskets and seats in Iquitos in Amazonian Peru. Furniture with vara casha weaving is found all over the town, in restaurants and public buildings and in private homes. The abundance of artisans that harvest vara casha from wild stands and weave products from them is a testimony to the local importance of this climbing palm, but paradoxically only few vara casha products are available at the town markets and in commercial centers.

Desmoncus, the only American palm genus with the liana life form, occurs from Mexico to Brazil and Bolivia and is quite common in many parts of that area (Henderson et al. 1995). The genus is recognized by its long, slender stems with equidistant and distichous leaves along the upper part and the spiny, closed leaf sheaths that form a several layered tube around the climbing stem. The sheath terminates in an ocrea that forms a tubular extension above the insertion of the petiole. The blades are pinnate and extended into a cirrus in which the leaflets are reduced to rigid hooks that point towards the base of the blade. The cirrus hooks attach the palm to the surrounding vegetation and permit it to reach 20–30 m up into the canopy. *Desmoncus polyacanthos* is most easily distinguished from the widespread species *D. orthacanthos* by its spines. The spines on the petiole and rachis are strongly recurved and short (to 0.5 cm) in *D. polyacanthos*, whereas they are more or less straight and long (to 5.5 cm) in *Desmoncus orthacanthos* (Henderson 1995). Although 90 "species" have been described in *Desmoncus*, many of the names deserve synonymy status only and the genus may have as few as seven morphologically recognizable species (Henderson 1995). Tremendous morphological variation within the taxa, depending on age and habitat, has confused their circumscription (Wessels Boer 1965) and consequently, the present taxonomic resolution of the genus remains uncertain (Henderson et al. 1995).

Desmoncus may be seen as the American equivalent of the Old World liana palms, the rattans (subfamily Calamoideae in part; Henderson et al. 1995), and the two groups share features of both ecology and uses. *Desmoncus,* however, has never had any noteworthy economic importance outside regional markets (Balslev & Barfod 1987, Henderson & Chávez 1993). *Desmoncus* stems have many of the same physical properties that rattans have, with great tensile strength as the most remarkable one, but the stems are not particularly resistant when bent (Isnard et al. 2005).

The first reports of *Desmoncus* uses were from upper Rio Negro, in the northern part of the Amazon basin, where A.R. Wallace (1853) described how indigenous tribes used plaited cylinders made from its "rind" or "bark" for processing *farinha*, a flour made from the root tubers of the manioc plant – *Manihot esculenta*. Other uses, reported from most corners of its area, include a wide range of local products such as traps, hats, baskets and furniture (Schultes 1940, Pinheiro & Balick 1987, Gentry 1988, Henderson & Chávez 1993, Belsky & Siebert 1997). Although *Desmoncus* species are commonly used, these economic aspects of its biology are only scantily documented (Henderson & Chávez 1993).

Iquitos, the capital of the province of Loreto in the middle of the Peruvian Amazon rain forest (Fig. 1), has about 350,000 inhabitants and is only accessible by aeroplane or boat. For the last thirty years, Iquitos has had an economic boom due to its strategic position for providing supplies to the extensive oil explorations in the Peruvian Amazon. Despite, or maybe because of its economic growth the social stratification of its population is immense. The poor are always on the lookout for any kind of work that can contribute to their modest household incomes. The many cottage industries in Iquitos are a sign of how the poorer inhabitants use locally available natural products to make a living. It was a short note in *Principes* by Henderson and Chávez (1993), mentioning the *vara casha*



2. Map of our study area (B) in and around Iquitos in Amazonian Peru and its location on the continent (A).

cottage industry in Iquitos, that made us curious about this Non Timber Forest Product (NTFP). From that note it was obvious that many questions were still unanswered and much remained to be learnt. Consequently we decided to conduct a more detailed study based on interviews with extractors, weavers, re-sellers and consumers. In this way we hoped to document the craftsmanship and the uses of *vara casha* in more detail, and to gain some insight into its economic importance in the Iquitos area. Although we were told of many uses of *vara casha* for such items as bed-heads, wardrobes, room separators, indoor windows, bakery grates, small carpets and counters, we here report only on the use of stems and skeins for baskets and furniture production.

Fieldwork

We conducted two series of interviews in Iquitos in July of 2005. The first series included 25 artisans who practiced *vara casha* extraction or weaving, or sold furniture to consumers. The second series of interviews involved 102 consumers or potential consumers. These interviews were done by knocking on the doors of 52 houses along two streets in a poor neighborhood, 25 houses along one street in a middle class neighborhood, and finally 25 houses along one street in a wealthy neighborhood of Iquitos. The interviews were structured and we used pre-printed questionnaires. The artisans were asked about methods and amounts of harvest, types of products made from *vara casha*, manufacturing techniques, tools used, prices and income from selling the products. The consumers were asked about their knowledge of *vara casha* and their preferences for using that product compared to alternative products. In addition to making the interviews we accompanied one extractor on a collecting trip to make direct observations and ask additional questions that were not covered by the prepared questionnaires. We also made direct observations of the weaving of the various products and of the use of the products in the consumers' homes. All price equivalents between the local currency Soles and US dollars given below correspond to the exchange rate in July 2005, when the field work was carried out.

Extraction of *vara casha* stems from the wild

People who extracted *vara casha* were easy to find in Iquitos. After the first informant was located, the word spread and almost every informant could lead us to a new one. *Vara casha* stems were extracted either for use in the extractor's own cottage industry or they were sold as stems or skeins to people who used them for weaving. All extractors we encountered lived in Iquitos and no weaver could tell about suppliers of stems from out of town in spite of previous reports that stems were collected by country people and brought to town (Henderson & Chávez 1993).

Extraction of stems of *vara casha* was done in the flood plain rain forest around Iquitos within a distance of one half to several hours of paddling in a canoe from the town. *Vara casha* clones were abundant on the riverbanks in both open and closed forest. The visited extraction site was on the bank of Río Nanay, a tributary of the Amazon River with its mouth on the eastern outskirts of Iquitos (Fig. 2). At this site, in the vicinity of Iquitos, clones of *Desmoncus* grew within a few steps from each other, and on the same trip other suitable places for extraction were identified. One large-scale supplier told us that he extracted *Desmoncus* near Río Itaya, another tributary running into the Amazon River within the city limits of Iquitos. The extractors all said that it was easy to find the plants in the forest, even though some suggested that they had to travel farther now than ten years ago to get to the sites. Most extractors had certain favorite sites where the palm was particularly abundant and suitable for extraction, i.e. where it had long slender stems with a diameter up to 10 mm after removal of leaf sheathes.

The practice of extraction appeared sustainable. All mature (usable) stems of a clone were cut down, and the juvenile stems were left behind for later extraction. A few of the extractors we interviewed cut all stems in the clone and then picked the suitable ones, leaving others behind, but this way of semi-destructive extraction method did not appear to be a common practice. The stems were cut with machetes and leaf sheaths were immediately removed with the bare hands (Fig. 3). Clones were not cultivated or tended in any way, and stems were extracted exclusively from the wild. Tending would indeed be fruitless, require a lot of work, and it would take many years before extraction would be possible. The land tenure system in the area does not promote such practices because the land is not owned by the extractor and he cannot protect the clones, which would therefore be accessible to anyone passing by. Two extractors did however spread seeds to increase the abundance of clones. This requires

3–5. *Vara casha* (*Desmoncus polyacanthos*) extraction near Iquitos, Peru. 3. Extraction of *Desmoncus* stems at a river bank reached after 30 minutes of paddling from Iquitos. 4. Bundle of fresh stems coiled up one by one, ready for preparation. 5. Bundle of skeins, each weighing 500 grams, ready for selling.

little effort because the seeds are often a by-product of the extraction. A single harvest incident usually yielded 10–25 kg of fresh stems (Fig. 4). After cutting, stems had to be processed within a few days although one of the most important extractors said that the stems could be processed as much as one week after harvesting. The previous reports were that the stems should be processed within two days (Henderson & Chávez 1993). If left for too long without processing the stems would dry up and become rigid and useless.

Three of the 10 extractors interviewed harvested stems every week, some of them 2 or 3 times a week. Four of them extracted every month, and the three remaining extracted on intervals of more than one month. The fact that the palm can be extracted close to Iquitos is crucial both to the necessity for fast preparation of the skeins and to the ease of getting stems. Anyone with access to a canoe and a machete, which both appear to be common goods in Iquitos, can extract *vara casha* stems from the wild. Although informants from Iquitos now and then had to paddle for hours to reach their extraction sites, people we interviewed in Padre Cocha, Maloca and Nueva Vida, three villages located about one hour of paddling from Iquitos, did not harvest *vara casha* stems regularly or deliver products of it to the town, even if one of the informants was closely related to a weaver in Iquitos and had clones growing at her doorstep. At first this seemed peculiar, but informants from these villages were all occupied with other activities, such as production of clay pots and trinkets and performing indigenous dance shows to visiting tourists and possibly they found these activities more attractive than handling the hostile *Desmoncus* stems with the great many spines and hooks. In the village Nuevo Porvenir on Río Corrientes, 500 km by river W of Iquitos, uses of vara casha were known but not practiced, and nobody knew of anyone using *Desmoncus* stems.

Skeining of the stems

The uses of *Desmoncus* stems reported here were exclusively based on split stems called skeins. Skeins could be either coarse skeins that consisted of half stems with the pith remaining and used for baskets, or fine skeins with the pith removed and used for seats and other finer weaving. The properties and manufacturing of the coarse and fine skeins were distinctively different. The coarse skeins were made immediately before making the basket in order to retain flexibility. Leaving the pith in these coarse skeins made them curl longitudinally but this was seen as an asset because it supposedly gave strength to the baskets. The waste when skeining for basketry was very limited, because stems with major defects had been rejected at the time of harvest. Skeining for finer weaving was done by splitting stems longitudinally in halves using a knife to initiate the splitting (Figs. 6, 10). Each half stem was then split in two and a part of the pith was subsequently removed using a knife. This is slightly different from the previous report that the pith was removed after the stems were split in half (Henderson & Chávez 1993); removing the pith from a stem split in half would require more work and a rounded instrument, and we did not observe such instruments. Each quarter-stem was once again split into halves and the rest of the pith was removed, and the frayed edges were trimmed thus providing eight skeins per stem. By removing the vast part of the pith, breaking and longitudinal bending of the fine skeins was avoided. This was necessary to produce durable skeins for fine weaving. The fine skeins with the pith removed were bundled in coils of roughly 500 g each, ready for use or sale (Fig. 5). These skeins could have a length of up to eight meters each, with an estimated average length of 5.6 m which agrees well with the previous report that stems were cut into six meters long sections (Henderson & Chávez 1993) although we did not see that the artisans aimed at any particular length of the skeins. These skeins could dry up without damage or lowering the quality. If skeins eventually became too dry for weaving, they could be soaked in a bowl of water prior to use. The price per kg skeins was 30 Soles (=US$ 9.3). Estimates of waste per cent of skeining for weaving were very scattered, but up to 90–95 pct. were mentioned which agrees with the previous report that 10 kg of raw stems are needed to produce 1 kg of "prepared strips" (= skeins in our terminology)(Henderson & Chávez 1993).

Weaving and basket making

The actual weaving and basket making were all done in cottage industries, in private homes, back yards, garages, etc. The previous report by Henderson and Chávez (1993) used the terms "factories" and "workshops" for the *vara casha* production places, but in our experience none of the production places was especially erected for this purpose, so we here use the term "cottage industries" to imply that the production was done in the houses of people and not in any special buildings or rooms. As for the extractors it was quite easy to locate these cottage industries in Iquitos, and again one producer interviewed could easily lead us to the next. The most common *vara casha* products in Iquitos were seats and backs for dining-room chairs, but seats and backs for whole living-room suites with armchairs, rocking chairs and sofas were also common (Fig. 9). Among the consumers in Iquitos, *vara casha* was the over all preferred natural product for weaving furniture (Table 1) due to its comfort, elegance and durability.

By the time of weaving, stems were further selected by color, with white shades being the preferred quality. The weaving was done on a wooden frame with holes through which skeins were pulled in a certain pattern involving six layers of which four were perpendicular to the frame and two were diagonal. We found only this one weaving pattern, which was used by all 16 weavers visited (Fig. 14). This pattern is identical to the one shown in the previous report (Fig. 3 in Henderson & Chávez 1993), and this appears to be the same pattern as the one used in the manufacturing of rattan chairs. The wooden frame with holes bored all through permitted the weaver to use the full length skein without cutting (Fig. 8). The end of the skein was fastened by tying a knot on the back of the frame. Another method for weaving the seats was to bore holes half way through the frame, and then cutting the skeins in suitable length so both ends of the skein could be attached in the appropriate hole with glue (Fig. 7). This method seemed to be more difficult and time consuming, but resulted in a more elegant chair. This tedious gluing method we observed only once.

Rough skeins made by halving stems were used for all sizes of baskets, from bread baskets to large baskets with handles, lid and bases. The price of breadbaskets were 4 Soles (=US$1.2) and the large baskets cost 10 Soles (=US$3.1). Time consumed producing a 55 cm high basket was about two hours and it consumed 15–20 stems each of five meters length (Fig. 11). Baskets made from *vara casha* were not common, even though they were considered to be very durable, but the trouble of procuring the stems seemed to counterbalance the advantages. Although *vara casha* was used for basketry, other materials such as *huambé* (*Philodendron* sp., Araceae) and *tamshi* (*Heteropsis* sp., Araceae) were preferred for such products because they were cheaper and easier to obtain.

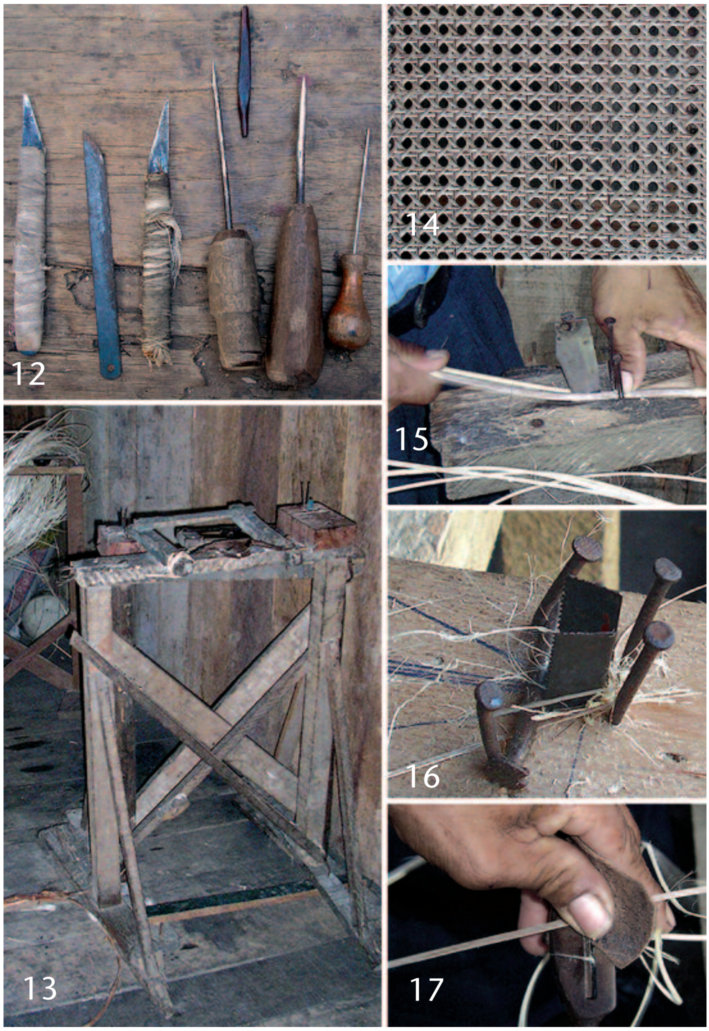
The weavers we interviewed were 22–80 years old, suggesting that weaving is a work suitable for a wide age range. Actually, the youngest person that we heard of who had taken part in the *vara casha* trade was five years old. This agrees well with the general cottage industry concept, which is a concept in which all members of a family participate in the production, whenever there is spare time from other duties. It also agreed with the cottage industry principle, that the trade was mainly learned from family and friends. The time it took to weave a seat was said to be from one hour to a whole day. The price of the woven piece depended on its final size. Typically the price of a chair seat was 20 Soles (= US$6.2). The amount of skeins needed for a chair seat was calculated to be ca. 85 grams and to this

6–11. Manufacturing and some products of *vara casha* (*Desmoncus polyacanthos*) in Iquitos, Peru. 6. Splitting of fresh stem. 7. Chair seat with each cross skein cut to measure and fastened by glue. 8. A weaver, 75 years old. 9. Armchair with seat woven of *vara casha*; part of a 25–30 years old living room suite. 10. Splitting of stem into halves. 11. A weaver using half stem skeins with pith to produce a basket; a labor of about two hours.

should be added an estimated waste during weaving which is 30 percent. In all about 110 grams of skeins, which have a cost of 3.3 Soles (approx. US$ 1) is needed to weave a chair seat. The wooden frame was usually supplied by the customer. Two weavers sold products from a market stand, and one from a shop. The remaining weavers all sold their products from their home. Only one weaver sold his products to a shop, but he also sold from his home. Some weavers mixed *vara casha* with synthetic materials in their weaving. One weaver showed an interest in improving the assortment of furniture. He could show a large collection of books and press cuttings with pictures of woven furniture in many designs.

Tools

As far as the tools used in *vara casha* weaving are concerned (Fig. 12–17), it appears that only a few simple tools are needed, and most of them can easily be made by the weaver and they are therefore cheap and easy to obtain. A machete was used for extracting. The basket makers tools consisted of a hand knife used for cleaving the stems and a large wooden bodkin used to make gaps in the weave when adding rods. A hand knife was needed for skeining and the same instrument was used both for cleaving, removing the pith and for trimming the edges. The knives were ordinary hand knives or a piece of ground hacksaw blade in which one extreme was covered with a piece of cloth to serve as a handle. Weavers also used a small wedge, made from a piece of hardwood, to keep the skeins from slipping back when weaving. A steel awl was used to widen the holes in the frame, when skeins took up more and more space in the holes as the work proceeded. One extractor, supplying several weavers with skeins, had improved his tools and reduced his working effort



12–17. Tools used in the manufacture of *Desmoncus polyacanthos* (*vara casha*) products in Iquitos, Peru. 12. Knives made from hacksaw blades, awls and a wooden wedge. 13. Stand with tools for planning backside and edges of skeins; some unbundled skeins are seen behind the stand. 14. The prevalent vara casha weaving pattern for chair seats. 15. Stand for splitting half stems into quarter stems. The stand is made of a few pieces of wood, a broken hand knife blade and two nails as guides. 16. Two knives made of hack saw blades positioned in a certain angle, with two nails as guides; used for trimming edges of skeins (detail of 13). 17. Reversed spoke shave used for removing pith of the skeins (detail of 13).

considerably. He had made two stands that he could use after the preliminary halving of stems. One stand was used for skeining half stems into quarter stems (Fig. 15), and the other was used for making smooth the backside and edges of the skeins (Figs. 13, 16, 17). The basic production materials for the stands were wood, ground hacksaw blades, nails and for the plane stand also a spoke shave with straight bottom.

The chain of *vara casha* artisans

The *vara casha* products are sold either by the weavers themselves or by carpenters who manufacture furniture on order. Not surprisingly the number of re-sellers was limited, which agrees with the usual principle of cottage industries, i.e. that the manufacturers sell their products directly to the consumers. Consequently the chain from harvest of *vara casha* in the wild to end user involves at the most four and often only two steps (extractor – weaver – re-seller – end user; or extractor/weaver – end user). None of our informants, regardless of the position in the chain of *vara casha* artisans, knew of any other intermediaries and had never heard of such ones. The step involving re-sellers is uncommon. The only two re-sellers of *vara casha* products that we heard about in our interviews were two carpenters. The furniture dealer shops did not sell *vara casha* products. Typically new chairs were ordered at a carpenter who would either weave the seats and chair backs himself or use a sub-contractor to do the weaving. The social status of the artisans working with *vara casha* was clearly reflected in their position along the chain of *vara casha* artisans. The extractors appeared to be the poorest, and they lived mostly in palm cottages on poles close to the river. Weavers typically lived in brick houses or better quality palm houses, directly on the ground and further away from the river. The re-seller shops and carpenter workshops were brick houses located at the commercial centers.

The *vara casha* consumers

Almost every one of the 102 people we interviewed in our door-to-door consumer survey knew of *vara casha* products (Table 1) and half of them found that *vara casha* was a superior weaving material. Only one of them preferred *tamshi* (*Heteropsis* sp., Araceae), and two of them found plastic superior. It was more common to have *vara casha* products among the wealthy and middle class consumers than among the poor ones. The average number of furniture owned varied from 0.1 pieces per household in poor neighborhoods to 1.52 per household in wealthy neighborhoods (Table 1). The majority of both the middle class and wealthy consumers clearly preferred this type of furniture over other types (Table 1). Among the poor only a few owned *vara casha* products, but one third of them preferred this type of furniture (Table 1). One of the reasons for preferring *vara casha* furniture was the coolness when used, a reason which makes good sense in the humid and hot environment of Iquitos. Another reason for the popularity was the durability of *vara casha* furniture which may outlast almost any other products, including plastic. Several of the consumers interviewed could tell about 25–30 years old *vara casha* dining room chairs and living room suites, which despite of having patina were not worn to the extent that their usefulness had been reduced (Fig. 9). Fifteen percent of the consumers interviewed, half of them belonging to the wealthy category, stated that the reason they did not have *vara casha* now, was because they could not find the products at the local markets, and did not know where to purchase them (Table 1). This all points to a considerable local demand for *vara casha* products, even though the previous report which inspired our study suggested the opposite (Henderson & Chávez 1993). It is a paradox that the consumers in one part of Iquitos, who want *vara casha* products and have the economic power to buy the products, cannot find the artisans in the other end of the town who manufacture these products.

Conclusion

It appears that *vara casha* is an important NTFP in Iquitos, and it could be an even more important commodity if some improvements were made in publicity, production and sale. It was peculiar, however, that Iquitos, as a center of jungle ecotourism, could not provide any *vara casha* products for tourists. A NTFP jungle product like this would undoubtedly fit the taste of many a tourist. In addition almost two thirds of the wealthy social group of local Iquitos inhabitants preferred *vara casha* furniture over furniture made from other products, but nearly one half of these potential costumers did not know where to buy the products. In this perspective, manufacturing of *vara casha* products could be one of many possible ways to increase poor peoples' income considerably. Like the abundant shops in the center of Iquitos that sell wooden souvenirs, a shop selling *vara casha* basketry and weavings, might thrive serving both locals and tourists. A shop, located at the commercial centers, could be the link connecting artisans and local consumers in town and with some

Table 1. Consumer preferences and ownership of *vara casha* (*Desmoncus polyacanthos*) furniture distributed among social classes in Iquitos, Peru.

Social class	Lower	Middle	Upper	Total
Number of informants	52	25	25	102
Percentage knowing *vara casha*	96	100	100	98
Percentage preferring *vara casha* furniture	35	72	64	51
Percentage not knowing where to buy *vara casha* furniture	13	4	28	15
Percentage owning *vara casha* furniture	4	20	44	18
Average number of *vara casha* furniture owned per household	0.1	0.96	1.52	0.66

product development the range of goods could be widened with even more tourist friendly (i.e., light and small) products. The shop could be a working shop with the artisans serving costumers – locals and tourists – with a quality product.

Extraction of NTFP's, sometimes referred to as Non-Wood Forest Product, (Sastry 2002), has often been suggested as an important alternative to logging (Salick *et al*. 1995, Logback *et al*. 2002, Balmford *et al*. 2002, Sheil & Wunder 2002). With almost 40% the Peruvians living below the $2 poverty line (Watkins 2005) very simple development projects could enhance the manufacturing of *vara casha* products. Production of just one single chair seat a day could raise a persons income from zero to above the $2 poverty line. The raw materials can apparently be extracted in a sustainable manner from the wild, and the needed tools are cheap and can be made by the manufacturer himself.

This makes research on *vara casha* particularly interesting, because it is an easily obtainable, and sustainable NTFP with abundant natural stands. These stands are available to many local artisans who can use it for manufacturing a product with a seemingly unsaturated regional market. It is therefore an alternative way of earning an income to the household without felling any timber.

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Literature Cited

Balmford, A., A. Bruner, P. Cooper, R. Costanza, S. Farber, R.E. Green, M. Jenkins, P. Jefferiss, V. Jessamy, J. Madden, K. Munro, N. Myers, S. Naeem, J. Paavola, M.Rayment, S. Rosendo, J. Roughgarden, K. Trumper, and R.K. Turner. 2002. Economic reasons for conserving wild nature. Science 297: 950–953.

Balslev, H. and A. Barfod. 1987. Ecuadorean palms – an overview. Opera Botanica 92: 17–35.

Belsky, J.M. and S.F. Siebert. 1997. Nontimber forest products in community development and conservation: The palm *Desmoncus schippii* in Gales Point, Belize, pp. 141–154, *in* R.B. Primack (ed.). Timber, Tourists and Temples: Conservation and Development in the Maya Forest of Belize, Guatemala and Mexico. Island Press. Covelo, CA.

Gentry, A. H. 1988. New species and a new combination for plants from trans-Andean South America. Annals of the Missouri Botanical Garden 75: 1429–1439.

Henderson, A. 1995. The Palms of the Amazon. Oxford University Press, New York.

Henderson, A. and F. Chávez. 1993. *Desmoncus* as a useful palm in the western Amazon basin. Principes 37: 184–186.

Henderson, A., G. Galeano, and R. Bernal. 1995. Field Guide to the Palms of the Americas. Princeton University Press, Princeton, New Jersey.

Isnard, S., T. Speck, and N.P. Rowe. 2005. Biomechanics and development of the climbing habit in two species of the South American palm genus *Desmoncus* (Arecaceae). American Journal of Botany 92: 1444–1456.

Logback, J., L.L. Fernandez, P. Erickson, M. Cote, and H. Lloyd. 2002. Economic alternatives protect the Amazon rainforest in Ecuador. Pp. 123–136 *in* J.R. Stepp, F.S. Wyndham, and R. Zarger (eds.). Ethnobiology and Biocultural Diversity. Proceedings of the Seventh International Congress of Ethnobiology. The International Society of Ethnobiology, Athens, Georgia.

Pinheiro, C.U.B. and M.J. Balick. 1987. Brazilian Palms. Contributions from The New York Botanical Garden 17: 1–198.

Salick, J., A. Mejia, and T. Anderson. 1995. Non-timber forest products integrated with natural forest management, Río San Juan, Nicaragua. Ecological Applications 5: 878–895.

Sastry, B. 2002. Rattan in the twenty-first century – an outlook. FAO Non-Wood Forest Product Bulletin 14 [online] URL: http://www.fao.org/documents/show_cdr.asp?url_file=/docrep/003/y2783e/y2783e19.htm.

Schultes, R.E. 1940. Plantae Mexicanae V. *Desmoncus Chinantlensis* and its utilization in native basketry. Botanical Museum Leaflets 8: 134–140.

SHEIL, D. AND S. WUNDER. 2002. The value of tropical forest to local communities: Complications, caveats, and cautions. Conservation Ecology 6(2): 9 [online] URL: http://www.consecol.org/vol6/iss2/art9.

WALLACE, A.R. 1853. Palm Trees of the Amazon. John van Voorst, London [Facsimile Coronado Press, Kansas, 1991].WESSELS BOER, J.G. 1965. Palmae. Pp. 1–172 *in* A.L. STOFFERS AND J.C. LINDEMAN (eds.). Flora of Suriname, Leiden 5(1).

WATKINS, K. 2005. Human Development Report 2005. United Nations Development Programme, New York.

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Phytogeographical Patterns of Bolivian Palms

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In this paper the phytogeographical patterns of palms in Bolivia are analyzed with respect to the boundaries of phytogeographical provinces and the present vegetation. Palm communities are characteristic of specific geographical regions. Species related with the Amazon region are 51% of the total palm diversity of the country, followed by the other regions: Andean (31%), Cerrado (14%), and Gran Chaco (2%). Higher species richness is present on humid, well-drained soils over a wide altitudinal range when compared to wet or flooded substrates.

Bolivia has rich biodiversity, with more than 2500 known species of vertebrates and an estimated 18,000 species of vascular plants, both groups placing Bolivia among the most important countries in Latin America for the conservation of biodiversity. This diversity is the result of a juxtaposition of tropical and subtropical climates with mean annual temperatures ranging from 8 to 27°C and mean rainfall of less than 100 to 1800(–6,000) mm (decreasing westwards and southwards) along an altitudinal gradient of 140–6700 m above sea level (although slightly over half of the country lies at 230–900 m). Bolivia includes diverse ecoregions (Moraes & Beck 1992) and is divided into two main zones: highlands to the west (500–6700 m) and lowlands to the east (below 500 m); most of these ecoregions will be mentioned according to the presence of native palms. A preliminary approach to biogeography of Bolivia recognizes four main phytogeographic provinces: the Amazonian, Cerrado, Gran Chaco, and the Andean region, this last subdivided into the Altiplano, the mid-east, south-east and west cordilleras (based on Moraes & Beck 1992, see figure 1). The Amazon is characterized by a tropical climate (temperatures of 22–27°C and rainfall of 1000–2000 mm per year) with less than five dry months, and the landscape is covered by different types of forests, savannahs, and wetlands. The Cerrado is more related to a prairie landscape and island forests on a hilly relief; the climate is also tropical. The Gran Chaco is mostly dominated by spiny and xerophytic forests and has a very extreme climate: dry and hot during winter (reaching 40°C at noon and dropping to -10°C at night).

1. Phytogeographical provinces of Bolivia based on Moraes & Beck (1992).

Finally, the Andean region shows a distinct chain of mountains and valleys in its eastern slopes and also a high plateau between both "cordilleras." Climatically, there is a north portion with wetter conditions while the south is dry and the vegetation shows a seasonal dynamic during the winter; for example, in the high plateau (or Altiplano) has temperatures 7–11°C (and during winter below 0°C) and rainfall of 300–500 mm, while the montane slopes has ranges of 16–19°C and 1000–1500 mm. The vegetation on the eastern slopes varies from moist forests in the north to dry forests and also a mixture of tropical and temperate forests in the tucumano-boliviano formation towards the north of Argentina. No native palms are found in the western side of the Andes, nor the high plateau where prairies, deserts and salt lakes are found.

Palms are an important source of fruit, fiber and wood for human communities and are often considered to be a keystone functional group due to their importance to wildlife populations. The distribution patterns of palms are important for the interpretation of their natural history and evolution as well as understanding variation at local and regional scales (Uhl & Dransfield 1987). In addition, they are a useful surrogate for understanding overall patterns of plant diversity because their geographic ranges have been well documented (Henderson 1995, Henderson et al. 1995). Henderson et al. (1995) indicated that for South America as a whole 16% of the species are Andean, and 34% are Amazonian, whereas the Cerrado and Gran Chaco species combined make up 8% of the South American species.

The purpose of this paper is to summarize current knowledge about phytogeographic patterns of native Bolivian palms at the species and community level.

Bolivian palm flora

Eighty palm species, in 28 genera, belonging to four subfamilies are known from Bolivia (Moraes 2004). The most important collection of Bolivian palms is located at the National Herbarium in La Paz (LPB), which has been a general reference for comparative identification. In addition, a database has been compiled from approximately 3500 herbarium collections at LPB and other herbaria, particularly The New York Botanical Garden (NY). Some species are known only from a few limited collections. Some observations are based on less documented sets of specimens

Box 1. Palm genera and species of Bolivia grouped according to phytogeographic provinces; number of species in parentheses.

Amazonian taxa
Astrocaryum (4), *Attalea* (3), *Bactris* (10), *Chamaedorea* (2), *Chelyocarpus chuco, Desmoncus* (3), *Euterpe precatoria, Geonoma* (8), *Iriartella stenocarpa, Mauritia flexuosa, Mauritiella armata, Oenocarpus* (3), *Phytelephas macrocarpa, Socratea exorrhiza, Wendlandiella gracilis*

Andean taxa
Aiphanes horrida, Bactris (2), *Ceroxylon* (3), *Chamaedorea* (2), *Dictyocaryum lamarckianum, Geonoma* (6), *Hyospathe elegans, Iriartea deltoidea, Oenocarpus mapora, Parajubaea* (2), *Prestoea acuminata, Socratea salazarii, Syagrus* (2), *Wettinia augusta*

Cerrado taxa
Acrocomia aculeata, Allagoptera leucocalyx, Astrocaryum (2), *Attalea* (2), *Bactris glaucescens, Syagrus* (4)

Gran Chaco taxa
Acrocomia aculeata, Copernicia alba, Trithrinax schizophylla

that inadequately document variation recently described for species with two or more subspecies known to occur in the Amazon region. Some genera, such as *Astrocaryum* and *Geonoma*, are represented by incomplete material making identification uncertain (e.g. flowers for *Astrocaryum* are often lacking).

Phytogeographic patterns

Native palms of Bolivia have been analysed with respect to their occurrence in one or more of the four phytogeographic provinces of Bolivia (Box 1 & Fig. 1). Some species have distributions that span more than one phytogeographic province showing intermediate affinities. These include Cerrado-Amazonian species in the north-east of Bolivia, Andean-Amazonian species along the Andean foothills, Gran Chaco-Andean species in several valleys of the eastern Cordillera, and Andean-Cerrado from foothills in the west towards the eastern plain of the country (Boxes 2 & 3). Several Amazonian species reach their southern limit in Bolivia, while some Andean taxa reach their southernmost limit near the border with Argentina. Both the Cerrado and Gran Chaco provinces have their westernmost limits in the north-central region of the Bolivian lowlands and Andean foothills.

The Amazonian taxa

Species whose diversification is centered in the Amazonian, actually fall into two distinct groups: species that occur throughout the neotropics and species restricted to Amazonia. Although data are scarce, fifteen genera and 41 species are in these categories (Box 2). Three species are widespread throughout the Neotropics: *Astrocaryum murumuru*, *Attalea phalerata* (Fig. 2), and *Desmoncus polyacanthos*. Those species that cross into an Amazonian-Andean transition zone are *Chamaedorea angustisecta*, *Geonoma deversa* and *Socratea exorrhiza* (Box 2). Four species that occur in the Amazonian province as their natural occurrence or possibly due to human intervention are presently found in boundaries of Cerrado-Amazonian landscapes, e.g. *Astrocaryum jauari* and *Oenocarpus distichus*.

2. The *motacú* palm (*Attalea phalerata*) a widespread species in the lowlands and Andean foothills.

Box 2. Palms centered in the Amazon with restricted and widespread distribution.

Amazonian centered species origin with a distribution beyond Amazonia (widespread)
Astrocaryum murumuru, Attalea phalerata, A. butyracea, Bactris major, B. maraja, Desmoncus polyacanthos, D. mitis, Mauritia flexuosa

Amazonian centered species origin widely distributed within Amazonia (restricted)
Astrocaryum aculeatum, A. gynacanthum, A. jauari, Attalea maripa, Bactris acanthocarpa, B. brongniartii, B. chaveziae, B. concinna, B. elegans, B. hirta, B. riparia, B. simplicifrons, Chamaedorea pauciflora, Chelyocarpus chuco, Geonoma laxiflora, G. leptospadix, G. maxima, Oenocarpus balickii, Wendlandiella gracilis

Palms in both Andean and Amazonian landscapes
Aiphanes horrida, Astrocaryum murumuru, Bactris gasipaes, Chamaedorea angustisecta, Geonoma deversa, G. interrupta, G. macrostachys, G. stricta, Hyospathe elegans, Iriartea deltoidea, Iriartella stenocarpa, Oenocarpus bataua, O. mapora, Phytelephas macrocarpa, Socratea exorrhiza, Wettinia augusta

Palms in both Amazonian and Cerrado landscapes
Astrocaryum jauari, Desmoncus orthacanthos, Mauritiella armata, Oenocarpus distichus

Box 3. Palms centered in the Andes with restricted and widespread distribution.

Andean centered taxa with a restricted distribution
Bactris. faucium, Ceroxylon parvifrons, C. parvum, C. vogelianum, Chamaedorea linearis, Geonoma brongniartii, G. densa, G. jussieuana, G. macrostachys, G. orbignyana, G. undata, G. weberbaueri, Parajubaea sunkha, P. torallyi, Syagrus yungasensis

Andean centered taxa with a widespread distribution
Aiphanes horrida, Chamaedorea angustisecta, Dictyocaryum lamarckianum, Oenocarpus bataua, Syagrus sancona

Palms in both Andean and Amazonian landscapes (see Box 2)

Palms in both Andean and Cerrado landscapes
Syagrus sancona, S. yungasensis

Palms in both Andean and Gran Chaco landscapes
Acrocomia aculeata, Trithrinax schizophylla

Geonoma brevispatha has a disjunct distribution in the Cerrado and in the Andean foothills. Some riparian species expand their distribution along rivers, such as *Bactris glaucescens* (Fig. 3), *B. major, B. riparia* and *Syagrus sancona*.

The Andean taxa

Henderson (1995) listed 21 genera and 87 species in the Andes, and this is updated to 24 genera and 110 species (Borchsenius & Moraes 2006). In Bolivia, 25 species belong to the Andean province (Box 1). Some species such as *Ceroxylon vogelianum*, *Dictyocaryum lamarckianum*, and *Geonoma jussieuana* are clearly centered in the Andes (Box 3), whereas *Syagrus sancona* and *S. cardenasii* appear to be transitional between the Andean and the Cerrado. *Aiphanes horrida, Hyospathe elegans* and *Iriartea deltoidea* are part of transitional Andean-Amazonian ecosystems. The moist

3 (left). *Bactris glaucescens* that grows in clumps in riverine forests along Amazonian rivers. 4 (right). Three stands of *Parajubaea torallyi* are centered in dry sandstone valleys up to 3400 m elevation.

5 (left). A representative of the Cerrado genus *Allagoptera*, *A. leucocalyx* shows a spicate infructescence and a very short aerial stem up to 10 cm high. 6 (right). *Trithrinax schizophylla* with it characteristic stiff and palmate leaves is found in dry and spiny forests.

interandean valleys of Bolivia include a relatively high palm diversity, whereas the dry to moist valleys (in the center and south of the country) contain fewer species in total and more endemic species (Moraes 1999a).

In addition, five species are endemic to Bolivia (Box 4), most of them of Andean origin and restricted to interandean valleys of the Cordillera Oriental. Both species of the genus *Parajubaea* – *P. sunkha* and *P. torallyi* – are centered in the so called "interandean" valleys and both are endemic to Bolivia (Front Cover & Fig. 4).

The Cerrado taxa

The Cerrado includes the regions of central and NE Brazil and adjacent areas of Bolivia and Paraguay, which are characterized by a strong seasonal climate. It has five palm genera (Henderson 1995). Eleven Bolivian species have a largely Cerrado distribution corresponding to the Brazil Shield which is typified by highly weathered soils with limited fertility (Box 1). These species reach their westernmost limit in Bolivia and are extensively adapted to open vegetation types. Palm species transitional to Amazonia and belong to savannas and other open vegetation types are *Allagoptera leucocalyx* (Fig. 5), *Astrocaryum huaimi* and *Bactris glaucescens*, while *Syagrus cardenasii* is also found in the Andes.

The Gran Chaco taxa

The Gran Chaco or Chaco-Pampean province is a semi-arid scrub land with scattered grasslands that are usually associated with sand dunes; in Bolivia three species have distributions that are largely restricted to this phytogeographic province (Box 1). The transitional Chaco-Andean palm taxa include *Acrocomia aculeata*, and the transitions between Chaco and the Amazon include *Copernicia alba*. *Trithrinax schizophylla* (Fig. 6) is found between Cerrado and Gran Chaco boundaries.

In conclusion, there are 15 genera in the Amazonian province, 14 in the Andes, whereas the Cerrado has five, and the Gran Chaco three. The palm species of the Amazon make up 51% of the Bolivian species, the Andean 31%, the Cerrado 14%, and the Chaco 2%. The remaining few taxa are mixed in more

7. *Bactris riparia*, whose stands are closely related with rivers and flooded zones in the lowlands.

than one phytogeographic province. In addition, when the palms that grow in the lowlands of Bolivia are analyzed according to their phytogeographic affinities, the trends are different: 63% of Bolivian palm species belong to genera whose distribution is centered in the Amazon, 16% are Andean, whereas 24% were mixed from the Cerrado and/or Gran Chaco (Moraes 1999b).

Along the Andean foothills an important exchange of palm species occurs with the Amazon phytogeographical province (Box 2). Palms of the Cerrado are found in Bolivia only on Precambrian substrates in the eastern region of the country and there are included main diversity of the genus *Syagrus* in the country: *Syagrus petraea, S. comosa* and *S. oleracea*, while *S. cardenasii, S. sancona* and *S. yungasensis* show extensive ranges towards the Andes. *Syagrus sancona* is adapted both to flooded and riparian forests and to seasonally inundated forest islands with a wide distribution on the alluvial plain. Both genera of the Butiinae, *Syagrus* and *Allagoptera* (Moraes 1996a & b), are diversified in central Brazil, with few species reaching the interandean valleys and the Amazon plain, respectively.

Palms in different vegetation types and altitudinal gradients

Native palm species of Bolivia are found in savannas (alluvial, seasonally flooded and on well-drained soils), marshes (riparian or alluvial) and forests (evergreen to deciduous in the lowlands montane or riparian habitats)

Box 4. Endemic palm species of Bolivia, their origin and present distribution in vegetation types.

Bactris faucium	Andes: Interandean humid montane forests (central to NW Bolivia)
Parajubaea sunkha	Andes: Dry interandean valleys on rich soils (south valleys in central Bolivia)
Parajubaea torallyi	Andes: Dry interandean valleys on sandstone (central Bolivia)
Syagrus cardenasii	Cerrado: Alluvial plain in eastern lowlands also on low interandean foothills) (central – SE Bolivia)
Syagrus yungasensis	Andes: Dry interandean valleys towards NW of the country

8. Amazonian vegetable ivory, *Phytelephas macrocarpa,* showing male inflorescences on a very short trunk.

(Moraes 1996c). Also they are distributed along an altitudinal gradient at 140–3400 m. No palm species grow in the west where a xeric and reduced vegetation cover dominates the highland landscape.

Some species show remarkable environmental adaptability, such as *Bactris gasipaes, Iriartea deltoidea, Oenocarpus bataua* and *O. mapora*, which grow in wet montane forests up to 1000 m elevation and also are found in the lowlands at 200 m. Near 900 m in the Yungas forests of these Andean moist slopes, *Euterpe precatoria* sometimes is found growing together with *Dictyocaryum lamarckianum*; while in the Amazon lowlands the former usually is most commonly associated with *Socratea exorrhiza* and occasionally with some species of *Bactris*. Canopy and subcanopy palms in montane forests are *Syagrus sancona, Euterpe precatoria, Aiphanes horrida, Dictyocaryum lamarckianum, Ceroxylon vogelianum, Prestoea acuminata, Socratea exorrhiza, S. salazarii, Geonoma weberbaueri* and *Wettinia augusta*. In the understory palms are represented by *Chamaedorea linearis, Geonoma orbignyana* and *Bactris faucium*. On the piedmont of the Andean mountains and in interandean valleys, several species of palms have been used as a main reference for vegetation description, such as *Socratea exorhriza, Astrocaryum murumuru* and *Bactris major*.

Flooded alluvial plains in the lowlands host different palms in island forests (among trees: *Attalea phalerata, Syagrus sancona* and *Astrocaryum murumuru*; also a common climber: *Desmoncus polyacanthos*), savannas with dense stands of *Copernicia alba, Acrocomia aculeata* and *Attalea phalerata*, and marshes with *Mauritia flexuosa, Mauritiella armata* and different species of *Bactris*. A group of species are found in the forest understorey like *Geonoma deversa, G. brongniartii, G. macrostachys, Bactris maraja, Chamaedorea angustisecta, Ch. pinnatifrons* and *Hyospathe elegans*. Finally, in the upland savannas and rock outcrops of the Precambrian Shield, dwarf palms such as *Allagoptera leucocalyx, Syagrus petraea, Attalea eichleri* and *Astrocaryum campestre* are common.

Most species are found between 140 and 500 m mainly along the Andean piedmont and on Tertiary undulating plains in northern Bolivia meeting Amazonian landscapes. Fewer than half of the Bolivian palm species occur between 500 and 1800 m in the mountain forests and piedmont on the eastern slopes of the Andes, where *Iriartea deltoidea* is the most abundant species (see Table 1 for other sites). In contrast, only one species – *Syagrus cardenasii* – is present in the southern part of the country in the Andes between 900 and 2200 m (Tab. 1), while only *Trithrinax* *schizophylla* is found in an extensive area of dry shrubs in the south along a gradient of 400–1100 m. These trends of palm richness (summarized in Tab. 1 according to palm richness) fit into the four climatic zones in which moist conditions host a higher number of species than drier valleys: 1) NW–NE with moist to perhumid conditions throughout the year and with high palm diversity, 2) W–SW with dry conditions with no native palms, 3) SE with extreme seasonality and with few palms, and 4) Center–E with seasonally moist conditions throughout the year with medium palm diversity.

Palm species richness is relatively high in upland evergreen forests and savannahs. Only few species grow on rich riparian soils, such as *Attalea butyracea, Bactris riparia* (Fig. 7) and *Chelyocarpus chuco*, whereas *Mauritia flexuosa* and *Mauritiella armata* are adapted to permanent marshes with organic soils. *Allagoptera leucocalyx* and *Geonoma deversa* are most common in well-drained, sandy soils. Species adapted to seasonally flooded soils are *Copernicia alba* and *Trithrinax schizophylla*. Colluvial soils host palms such as *Parajubaea, Ceroxylon* and *Prestoea* in different physiographic zones of Bolivia.

Mixed palm communities occur in different types of landscapes, and the communities are characteristic to a variety of ecological conditions. *Attalea phalerata, Oenocarpus bataua, Iriartea deltoidea* and *Astrocaryum murumuru* grow together in the lowlands at 200–1000 m altitude. In fragmented forests on alluvial plains, *Copernicia alba, Acrocomia aculeata* and *Attalea phalerata* occur in northern Bolivia. *Syagrus sancona, Attalea phalerata, Desmoncus polyacanthos* and *Astrocaryum murumuru* are found in savannas with forest islands. Flooded and riparian forests are characterized by *Bactris riparia, B. major, Syagrus sancona and Attalea phalerata. Euterpe precatoria, Bactris major, B. maraja* and *Socratea exorrhiza* are part of seasonally flooded forests in the lowlands and near the Andean foothills; these forests are mostly dominated by few palm species.

Certain species form a continuous and dense population such as on landscapes in northern Amazonian Bolivia (*Astrocaryum murumuru, Geonoma deversa* and *Mauritia flexuosa*), the Cerrado landscape (*Attalea speciosa*) and the Gran Chaco (*Copernicia alba*). *Oenocarpus bataua* and *Phytelephas macrocarpa* (Fig. 8) also share this pattern and are presently distributed

Table 1. Palm species diversity registered in different sites of Bolivia.

Sites	Altitude (m)	# Palm species	References
W Pando, NW Bolivia	280	26 (33%)	Alverson et al. 2000*
E Pando, NE Bolivia	140	30 (38%)	Alverson et al. 2003**
S Iturralde (N La Paz), W Bolivia	500–1800	51 (64%)	Moraes et al. 1995b
Alto Madidi (N La Paz), W Bolivia	200–700	21 (26%)	Parker & Bailey 1991***
E Tamayo (E La Paz), W Bolivia	350–700	11 (14%)	Moraes unpubl. data
C Cochabamba, C Bolivia	500–2200	20 (25%)	Kessler 2000
Chapare, Cochabamba, C Bolivia	360–700	9 (11%)	Moraes 1998a
W S. Cruz, C Bolivia	350–2000	25 (32%)	Nee unpubl. data
NE Velasco (E S. Cruz), E Bolivia	200–900	27 (34%)	Killeen & Schulenberg 1998
SE Velasco (SE S. Cruz), E Bolivia	170–400	4 (5%)	Parker et al. 1993
S–C Chuquisaca, C Bolivia	900–2200	1 (1.3%)	Schulenberg & Awbrey 1997
C Tarija, C–S Bolivia	350–800	3 (4%)	Moraes 1998b

* One new record for the country.
** Three new records.
*** Two new records.

in disjunct spots (along the Andean piedmont and also in Amazonian forests of northern Bolivia). Finally, *Parajubaea torallyii* and *P. sunkha* in inter-Andean valleys have dense populations.

Conclusions

Palm species distribution and diversity in Bolivia are related to a continental scale phytogeographic patterns, as well as local and regional features such as climate, elevation, soil properties, and vegetation types. Twenty-eight genera and 80 palm species are known to occur in Bolivia, but the distribution and abundance of many taxa are still poorly known and some are poorly documented. The inventory by Henderson et al. (1995) produced a total of 67 genera and 550 species of South American palms. Bolivia thus contributes 42% at the generic level, but has only 14.5% of all these species.

Most of the genera occurring in the Andes are more species-rich in the lowlands and only three genera (*Ceroxylon, Wettinia* and *Aiphanes*) are more diversified in the Andes (Moraes et al. 1995a). A preliminary analysis of palm diversity and its distribution patterns demonstrate general features showing trends that largely correspond to Amazonian, Andean, Cerrado, and Gran Chaco phytographic provinces. There is a high palm richness at the boundary between Amazonian and Andean landscapes (at less than 1,000 m) that decreases to the south. Cerrado and Amazonian taxa are mixed together in the east of the country with moderate levels of species diversity.

Two phytogeographic regions contribute the majority of the actual diversity and geography of native palms of Bolivia, namely the Amazonian and Andean provinces. The Cerrado and Gran Chaco provinces contribute to the palm flora of Bolivia to a lesser degree. Restricted and widespread geographic patterns for certain palms have potential implications for understanding the conservation at both local and regional scales.

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Literature Cited

Alverson, W. S., D. K. Moskovits and J. M. Shopland (eds.). 2000. Bolivia: Pando, Río Tahuamanu. Rapid Biological Inventories 1: 179.

Alverson, W. S., D. K. Moskovits & I. C. Halm (eds.). 2003. Bolivia: Pando, Federico Roman. Rapid Biological Inventories 6: 1–141.

Henderson, A. 1995. The Palms of the Amazon. Oxford University Press, New York.

Henderson, A., G. Galeano and R. Bernal. 1995. Field Guide to the Palms of the Americas. Princeton University Press, Princeton, New Jersey.

Kessler, M. 2000. Upslope-directed mass effect in palms along an Andean elevational gradient: a cause for high diversity at mi d-elevations? Biotropica 32: 756–759.

Killeen, T. J. and T. S. Schulenberg. 1998. A biological assessment of Parque Nacional Noel Kempff Mercado, Bolivia. RAP Working Papers 10: 1–372.

Moraes R., M. 1996a. Novelties of the genera *Parajubaea* and *Syagrus* (Palmae) from interandean valleys of Bolivia. Novon 6: 85–92.

Moraes R., M. 1996b. The genus *Allagoptera* (Palmae). Fl. Neotrop. Mon. 73: 1–35.

Moraes R., M. 1996c. Diversity and distribution of Bolivian palms. Principes 40: 75–85.

Moraes R., M. (ed.) 1998a. Estudio de biodiversidad en el Parque Nacional Carrasco – Bloque Chimoré I (Cochabamba). Instituto de Ecología-FUNDECO, La Paz. 1–43.

Moraes R., M. (ed.) 1998b. Estudio de biodiversidad de la Reserva Nacional de Flora y Fauna Tariquía (Tarija). Instituto de Ecología, La Paz. 1–41.

Moraes R., M. 1999a. Ecología de palmeras en valles interandinos de Bolivia. Revista Boliviana de Ecología y Conservación Ambiental 5: 3–12.

Moraes R., M. 1999b. Fitogeografía de palmeras en las tierras bajas de Bolivia. Acta Botanica Venezuelicae 22: 127–140.

Moraes R., M. 2004. Flora de palmeras de Bolivia. Herbario Nacional de Bolivia, Instituto de Ecología, Universidad Mayor de San Andrés. Plural Editores, La Paz.

Moraes R., M. and S. Beck. 1992. Diversidad florística de Bolivia. Pp. 73–111. In: Marconi, M. (ed.). Conservación de la Diversidad Biológica en Bolivia. CDCBolivia/USAID Bolivia. La Paz.

Moraes R., M., G. Galeano, R. Bernal, H. Balslev and A. Henderson. 1995a. Tropical Andean palms. Pp. 473–487. In: Churchill, S. P., H. Balslev, E. Forero & J. L. Luteyn (eds.). Biodiversity and Conservation of Neotropical Montane Forests. The New York Botanical Garden, New York.

Moraes R., M., J. Sarmiento and E. Oviedo. 1995b. Richness and uses in a diverse palm site in Bolivia. Biodiversity and Conservation 4: 719–727.

Nee, M. H. (in prep) Palms – Flora de la Región del Parque Nacional Amboró, Bolivia. The New York Botanical Garden.

Parker, T. and B. Bailey. 1991. A biological assessment of the Alto Madidi Region and adjacent areas of northwest Bolivia. RAP Working Papers 1: 1–108.

Parker, T. A., A. H. Gentry, R. B. Foster, L. H. Emmons and J. V. Remsen Jr. 1993. The lowland dry forests of Santa Cruz, Bolivia: a global conservation priority. RAP Working Papers 4: 1–104.

Schulenberg, T. S. and K. Awbrey. 1997. A rapid assessment of the humid forests of south central Chuquisaca, Bolivia. RAP Working Papers 8: 1–84.

Uhl N. W. and J. Dransfield. 1987. Genera Palmarum: a classification of palms based on the work of H. E. Moore Jr. L. H. Bailey Hortorium, and the International Palm Society. Lawrence, Kansas: Allen Press.

Belize's *Chamaedorea* Conundrum

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1. A fishtail palm (*Chamaedorea ernesti-augusti*) after repeated leaf harvests.

Heather DuPlooy and Brett Adams (2005) reported on the launch of a UK-funded Darwin Initiative project assisting the Belizean government to conserve and manage its populations of *Chamaedorea*. These were being threatened by illegal harvesting of their leaves for the floricutural industry (Fig. 1). The *Chamaedorea* conundrum faced by the Belize Forest Department – how to conserve yet financially benefit from *Chamaedorea* – is still far from being resolved. This article describes some of the findings of the project, significant recent developments in Belize's nascent *Chamaedorea* industry and outlines the challenges ahead.

Chamaedorea is the largest palm genus in the Neotropics, occurring as an understory component in rain forest from Mexico to Bolivia. Comprising 80–100 species (Hodel 1992, Henderson et al. 1995), the genus – locally known as *xaté* – is of regional and international significance due to its trade as a houseplant and as a source of foliage for flower arrangements (Hodel 1992, Oyama 1992, Endress 2004). Around 75% of all *Chamaedorea* species are considered to be threatened by IUCN (Walter & Gillett 1998), the biggest threat to wild populations being the loss of their natural habitat.

A second significant threat is the harvesting of leaves and seeds, which began in Central America in the 1950s with the industry expanding dramatically since that time (CEC 2002). Cut leaves from *Chamaedorea* are one of northern Central America's most important non-timber forest products, the *xaté* industry providing an estimated 6,000–10,000 seasonal and full-time jobs in Guatemala (FIPA and USAID 2002, Rainforest Alliance 2004).

Xaté exports from the Maya Biosphere Reserve, Guatemala, were calculated as worth more than US$4 million in 2000 (Alianza Para Un Mundo Justo 2003). Typically, the industry is based around collectors cutting leaves in the wild who subsequently sell their harvest to contractors. The leaves are then sorted and shipped primarily to the USA and Europe. The *xaté* industry as currently practiced is extremely wasteful, with an estimated 60–70% of the collected leaves later discarded as they do not meet the exacting requirements of the export industry (Radachowsky 2004, Grant 2004, pers. comm.). Although such leaves are of no commercial value, they are of considerable physiological value to the palms themselves.

Belize has not traditionally exploited *xaté* leaf, despite having a relatively high abundance of *C. ernesti-augusti*, currently one of the most valuable species (Fig. 2). However, with international demand for *xaté* outstripping supply, in the late 1990s, certain sectors of the industry turned their attentions toward Belize and its unexploited *xaté* resource. This shift was compounded by the depletion of populations of *Chamaedorea* palms in other regions due to long-term over-harvesting (Reining et al. 1992, Escalera Mas 1993, Radchowsky et al. 2004). Belize was therefore perceived as a rich resource to be freely tapped, and *xaté* collectors (*xateros*) from Guatemala began illegally crossing into Belize inflaming

2. A healthy fishtail palm (*Chamaedorea ernesti-augusti*)

Table 1. *Chamaedorea* species in Belize's Forest Reserves: conservation status and presence

Species	IUCN Red List category (Walter & Gillett 1998)	presence in Belize's Forest Reserves	Comments
C. *adscendens* (Dammer) Burret	vulnerable	Absent	Rare in Belize; only seen by authors at one locality in western Toledo, southern Belize.
C. *arenbergiana* H. Wendl.	not listed	Absent	Rare in Belize; only seen by authors at one locality in western Toledo, southern Belize.
C. *elegans* Mart. **	not listed	CFR	Limited distribution in Belize in the Cayo District; leaves commercially traded, although not yet in Belize.
C. *ernesti-augusti* H. Wendl. **	not listed	CFR, CRFR, MFR, SFR, MMFR	Abundant in central and southern Belize; only species whose leaves are currently harvested in Belize.
C. *geonomiformis* H. Wendl.	indeterminate	CRFR, MMFR	Present south of the Maya Mountains.
C. *schippii* Burret	vulnerable	CFR, MFR	Confined to limestone hilltops in scattered populations.
C. *neurochlamys* Burret	not listed	CFR, CRFR, DRFR, MFR, SFR, SFR	Geographically widespread, although rarely abundant.
C. *oblongata* Mart. **	not listed	CFR, CNP	Widespread; abundant in the CFR; leaves commercially traded, although not yet in Belize.
C. *pinnatifrons* (Jacq.) Oerst.	not listed	Absent	Although cited for Belize, this species was not observed by the authors. Previous records of this species encountered in Belize have since been found to be C. *neurochlamys*.
C. *seifrizii* Burret	vulnerable	FCFR	Found growing wild only in the north of Belize, although cultivated elsewhere
C. *tepejilote* Liebm. *	not listed	CFR, CRFR, DRFR, MFR, MMFR, SFR	Geographically widespread.
C. *woodsoniana* L.H. Bailey	not listed	Absent	Not recorded by the authors; single specimen record for the country (*Balick 1801*; MO)

Commercial *xaté* species: ** = most important; * = less important;

Belize's Forest Reserves: CFR, Chiquibul Forest Reserve; CRFR, Colombia River Forest Reserve; DRFR, Deep River Forest Reserve; FCFR, Freshwater Creek Forest Reserve, MFR, Manatee Forest Reserve; MMFR, Maya Mountain Forest Reserve; SFR, Sibun Forest Reserve.

3. Confiscated fishtail leaves illegally harvested by *xateros*.

the long-standing border dispute between these two countries (Fig. 3). These activities were first observed in the Chiquibul Forest Reserve (CFR) and the Chiquibul National Park (CNP) in 2000 (Bridgewater et al. 2006).

Chamaedorea in Belize: The basics

Twelve species of *Chamaedorea* have been recorded for Belize, eleven of which are cited in the most recent checklist for the country (Balick et al. 2000)(Table 1). The one extra species included here is *C. neurochlamys*. Although considered a synonym of *C. pinnatifrons* by Henderson et al. (1995), recent molecular work supports the claim of Hodel (1992) that these two taxa are distinct and should be kept separate (Thomas et al. 2006). Molecular work on *Chamaedorea* from the Chiquibul Forest Reserve and field work elsewhere in Belize (Thomas pers. comm., Brewer, pers. comm., Hodel pers. comm) confirm that *C. neurochlamys,* rather than *C. pinnatifrons,* is present. The one species recorded in the country checklist but not encountered was *C. woodsoniana*. This single record is based on a specimen from Cayo District (*Balick 1801*, MO). Of the ten confirmed species in Belize, four have leaves of commercial value: C. *ernesti-augusti*, *C. oblongata*, *C. elegans* (Fig. 4) and (rarely) *C. tepejilote*.

In the course of our study, 461 20 × 20 m plots were surveyed across Belize in an attempt to understand the distribution and abundance of the genus. The majority of the samples were located within Belize's Forest Reserves, with the primary focal point of the study being the CFR and the CNP, where 209 surveys were completed. The distribution data are summarized in Table 1.

Seven species were encountered. Three species (*C. elegans*, *C. adscendens* [Back Cover] and *C. arenbergiana*) were rare and observed only outside the formal plots. *Chamaedorea seifrizii* was restricted to the drier and more seasonal north of the country (Orange Walk and Corozal Districts), whilst *C. adscendens* and *C. arenbergiana* were observed only in the Toledo District in the wetter south. The south of Belize (400–450 cm ppt/year) receives over three times the average annual rainfall of the north (160–150 cm ppt/year). *Chamaedorea geonomiformis* was restricted to areas south of the Maya Mountains, being especially prevalent in some areas of the Colombia River Forest Reserve, whilst *C. elegans* was found only in isolated populations in Cayo District (western Belize). *Chamaedorea schippii* was recorded only on limestone hilltops. *Chamaedorea ernesti-augusti, C. oblongata, C. neurochlamys and C. tepejilote* were widespread, varying locally in abundance across their broad range, although *C. ernesti-augusti* became scarcer in the north of the country. In the Chiquibul Forest Reserve, for example, *C. oblongata* was by far the most abundant, with an average of 538 individuals per hectare. *Chamaedorea ernesti-augusti* (228 individuals per hectare), *C. neurochlamys* (133 individuals per hectare) and *C. tepejilote* (95 individuals per hectare) were less abundant. However, within the region, abundance values varied greatly over relatively short distances. Although *Chamaedorea* is particularly prevalent on calcareous soils or limestone rock in lowland (0–500 m) or submontane (500–1000 m) broadleaf forest, it can occur on more acid substrates.

Xaté – leaf of gold: the economic value of Belize's _xaté_ and the extent of illegal harvesting

There has been considerable hype related to the value of Belize's *xaté*, with inflated figures of its worth frequently cited. Although *xaté* leaf doubtless has a financial value, this has been much exaggerated by the Belizean media in the past. The figure of a single leaf being worth U$1 to a *xatero* is one often cited. Although this may be close to the eventual market value in the US or Europe, it is far from the truth at the base of the market chain. Sadly, such misinformation has hindered the development of a rational debate on whether, and if so how, Belize can best develop its own *xaté* industry. In an attempt to clarify the value of Belize's *xaté* resource, a literature review was conducted on the economics of *xaté*, together with information on local supply chains from semi-structured interviews with industry informants (Pickles 2004). This information was then combined with abundance survey data of commercial *xate* species in the Chiquibul Forest Reserve in an attempt to provide an assessment of the value of the resource within the Greater Maya Mountain Area (Bridgewater et al. 2006), Belize's largest forest area centered around the CFR in Cayo District.

At the time of the study, the range of prices historically paid to *xateros* varied from US$0.30 to US$1.7 for 100 leaves. Average values were US$0.77 for *C. ernesti-augusti* (called "fishtail" in commercial markets), but only US$0.45 for *C. elegans* and US$0.41 for *C. oblongata* (Pickles 2004). However, prices fluctuate constantly, and depend upon the species, leaf size, seasonal demand, country of origin and export destination. Current prices for fishtail are already significantly higher than those we encountered in 2004 with values reportedly reaching about U$3.00 for 100 leaves in early 2006. This price increase reflects its continued status as the species currently most in demand.

As an example of the standing economic value of fishtail, the average number of high quality unblemished leaves suitable for export per hectare in the CFR was estimated at 118 for *C. ernesti-augusti* and 225 for *C. oblongata*. The combined value to a *xatero* of these leaves is under US$3/hectare (based on average historical prices), although this rises to about US$4.5/hectare if the most recent highest prices for fishtail are used. Across the whole Chiquibul Forest Reserve (59,822 ha.), the current value of the standing *xaté* crop to *xateros* is approximately US$122,000 if historical average prices are used. This value increases to US$277,053 if the highest recent values for fishtail are included. Assuming all high quality harvested leaves survived transportation, this equates to a standing export value of the fishtail resource of approximately US$1.8 million, based on an export value of US$4 per 15 leaves (Bridgewater et al. 2006).

It is clear from our studies that the CFR and CNP, and more recently, the Colombia River Forest Reserve, have suffered widespread illegal harvesting in recent years. However, only *C. ernesti-augusti* has been the target of *xateros*, with 75% of all individuals affected. On average, fishtail individuals throughout these reserves have half the number of leaves (3) expected of a mature healthy individual (6). A staggering estimated 37.8 million leaves of fishtail, worth just under US$0.3 million to the harvesters alone (average historical values), have been removed from the CFR since illegal harvesting began in the late 1990s (Bridgewater et al. 2006). What is not yet clear is whether the severe harvesting pressure is reducing reproduction and population health. At the time the surveys were conducted (2004–2005) only the Chiquibul region and the Colombia River Forest Reserve appeared to have been the focus of *xatero* attentions. However, Belize Forest Department and local NGO reports from 2006 indicate that fishtail harvesting has now been observed in the Manatee Forest Reserve, the Bladen Nature Reserve, the Maya Mountain Forest Reserve and the Sarstoon and Temash National Park. Illegal harvesting is spreading and many Belizean communities, in addition to Guatemalans, are now involved.

Affects of harvesting on *Chamaedorea* health

Knowing how fast a forest product can replenish itself is vital if it is to be managed in a sustainable manner. In an attempt to determine the rate at which Belizean *Chamaedorea* palms produce new leaves, two Darwin research programs were initiated at the Las Cuevas Research Station in the CFR. Preliminary data from 70 20 × 20 m plots indicate that *C. ernesti-augusti* produces only one to two leaves per year (Wicks 2004, Porter Morgan 2005). These data confirm the findings of other studies suggesting that wild *Chamaedorea* leaf production rates are low (Endress et al. 2004, Endress et al. 2006).

In concession licenses, the Belize Forest Department (BFD) now stipulates that no more than one leaf can be removed per individual per year, which is clearly a pragmatic attempt to improve on the current uncontrolled harvesting by *xateros*. The long-term affects of low-level harvesting on population health are still unknown. Preliminary data indicate that over-harvesting leaves increases mortality and decreases reproductive capacity in both *C. ernesti-augusti* and *C. oblongata* (Porter Morgan 2005). These findings are supported by data obtained from a six-year study on C. radicaulis conducted in Mexico (Endress et al. 2006). Short-term studies elsewhere also suggest that the harvesting of palm leaves can eventually result in the production of shorter leaves (O'Brien & Kinnaird 1996), which, in the case of *Chamaedorea*, can mean that they are no longer suitable for sale.

Belizean wild-harvesting: legalizing the industry

Where does the Belizean industry go from here? The BFD issued the first guidelines and concessions for *xaté* harvesting in 2005, based on the available data described above. There had been considerable political pressure to redirect the economic benefits of illegal wild-harvesting to a legal industry benefiting Belizeans. Therefore, the BFD felt it was important to establish a legal structure for the industry and set regulations for compliance of concessions, in spite of the many recognized uncertainties and problems. Whether or not such concessions will ultimately be sustainable is still impossible to know for sure, as the data on the long-term affects of leaf harvesting on both the *xaté* plant, and the surrounding forest – even if it were at the low level of one leaf per plant per year – are not yet available. However, any kind of control on the industry is an improvement on the former situation, which was one of uncontrolled leaf "mining."

One major problem, however, is the monitoring of such concessions. Monitoring is currently impossible with the human and financial resources at BFD's disposal. This problem is further exacerbated if legal concessions are to operate in areas where illegal harvesting currently occurs. Also, although it is clear that it is economically viable for Guatemala *xateros* to harvest leaves in Belize, it will not be as economically attractive for Belizeans whose official minimum wage (U$1/hour in the agricultural industry) is approximately double that of Guatemalans.

In 2005, Belizean *xaté* concessions were applied for in the Chiquibul Forest Reserve and the Vaca Forest Reserve and subsequently granted by the BFD. Neither was actively taken up. In part, this was due to the illegal over-harvesting already suffered by these forest areas,the depleted nature of the *xaté* resource and uncertainties related to the dependency of Belize upon the Guatemalan business infrastructure. Also, with no way of controlling illegal *xatero* activity, the concessionaires, who would have to abide by a strict management plan, would be in direct competition with illegal *xateros* who have no such restrictions. The situation is therefore not conducive to the establishment of a successful business. However, despite this, in late 2006, another concession was applied for, and granted by the BFD, for the Chiquibul Forest Reserve, and this has since become active. Between November 2006 and February 2007, approximately 50,000 leaves of fishtail have been legally harvested from this area by Belizeans, with Chico-Mex Belize being the exporting company. However, illegal leaf cutting continues in the same area by Guatemalan *xateros*. Although the first shipments of fishtail leaf have been exported to the US direct from Belize, it remains to be seen whether a Belizean *xaté* business based on this area can be profitable in the long-term if it adheres to strict ecologically and sustainable harvesting guidelines.

In addition to the above concession, another has been granted for national lands (including Forest Reserves) in the Toledo and Stann Creek Districts. This southern concession, granted in early 2006, was the first to be issued in Belize, and was an acceptance by the Belizean authorities that the industry was in Belize to

4. *Chamaedorea elegans.*

stay. This concession provides an alternative legal market to illegally operating *xateros* in the south of the country. In essence, the initiative will initially attempt to intercept illegally harvested leaves en route to Guatemala, pay a competitive price for them, and persuade harvesters that they should register as legal collectors.

Over the longer term it is hoped that management plans and commercial inventories will be established by the communities themselves, with enrichment planting encouraged. This concession is a very welcome development in Belize, although just as for the Chiquibul concession, it is still too soon to know whether it will act as the genesis of a long-term legitimate and sustainable Belizean industry.

Until early 2007, all Belizean *xaté*, originating from illegal harvesting and from the first legal concessions, was exported to Guatemala. Relying on the Guatemalan industry infrastructure is clearly not ideal and makes any Belizean business reliant on the vagaries of border bureaucracy. Various attempts have been made since 2000 to establish a sorting house and refrigeration store in Belize and to export direct from Belize City. These were unsuccessful until early 2007, when Chico-Mex Belize established the first packing and sorting house in Santa Elena, and began to ship by sea direct to the US. This is a further important development, and the future of the Belizean industry will most likely depend on both the current concessionaires pooling their leaf resources so that regular, reliable, large, high-quality deliveries can be made to the exporters. An export container of fishtail typically contains approximately 129,000 leaves.

Belizean plantations: A way forward?

In recent years businesses in both Mexico and Guatemala have been establishing plantations of *xaté* for leaf and seed production, which provide improved economies of scale and are potentially more profitable than wild harvesting. There are, however, critics of the large-scale plantaton approach who argue that they may ultimately benefit political/industrial elites at the expense of wild-harvesting *xaté* communities (Wilsey & Endress 2007). The species most favored for planting is *C. elegans*, although fishtail plantations have been increasing in popularity due to its current high market price. However, fishtail plantations have been established only in recent years, and it is not yet known how profitable these ventures will ultimately become. Several farming cooperatives in Belize are experimenting with growing *xaté* under a natural secondary forest canopy or under organic cacao for which they have an existing market. Plantation establishment takes approximately three years. At the time of planting in 2005, these farmers hoped that, by the time their plantations were ready to produce, a market in Belize would have established itself, and this now appears to be the case. In Toledo in the south of Belize, approximately 50,000 *xaté* seedlings are now growing in three trial cultivation plots under forest canopy in the Golden Stream Corridor Preserve (0.8 ha.), Indian Creek community lands (0.4 ha.) and under mature cacao (0.4 ha.) near San Jose. In Cayo District in central-western Belize, 20 farmers from the communities of San Antonio and Cristo Rey have planted out a further 40,000 seedlings of *C. elegans* and *C. ernesti-augusti* on 10 acres. Much of the training work related to these horticultural initiatives has been facilitated by the Belize Botanic Garden (BBG), the Ya'axché Conservation Trust (YCT) and the Asociación Coordinadora Indígena y Campesina de Agroforestería Comunitaria Centroamericana. The BBG and YCT have produced a cultivation manual for the production of organic *xaté*, which can be accessed on-line at: www.belizebotanic.org/xate_manual.pdf

These trial Belizean plantations are relatively small and in their current form will generate only small amounts of income of a few U$100s per hectare per year, dependent of course, on the price attained for the leaf, growth rates, the intensity of harvesting and the density of the plantations. However, should the trials prove successful, it is hoped that these will be expanded. Of course, there are environmental issues related to the establishment of plantations. The procurement of seeds is one area of particular concern to the BFD. The authors have observed an increase in illegal seed collecting in Belize over the last few years, with fishtail being the primary focus of collectors. Collectors rarely leave any seeds on the plant.

Some Belizean farmers are hoping that in the future they may be able to attract premium prices through labeling their *xaté* as organic and sustainable. Ecolabeling of this kind presents an opportunity to provide consumers with an informed choice as to the origin of the products they buy, with such labels often playing to consumer's ethical preferences. Ecolabeling in the *xaté* industry is in its infancy, and unlike the timber industry, recent research has shown that there is currently a low general market interest in ecolabeled *xaté*, with consumer knowledge of its origins being poor (CREM 2002). The community-based forest concessions, including one at Carmelita, have recently applied for Forest Stewardship Certification for their *xaté*, to be accredited by Smartwood. Such initiatives are a significant step forward. However, they should also be treated with a degree of caution because long-term ecological studies and monitoring are needed in these areas to ensure that harvesting practices warrant the sustainable label they have been awarded.

Conservation of *Chamaedorea* in Belize

Our studies suggest that within Belize, the three *Chamaedorea* species most under threat are *C. adscendens*, *C. arenbergiana*, *C. seifrizii* and, too a lesser extent, *C. schippii*. All have restricted ranges and relatively small population numbers. Their natural habitats are threatened by agricultural expansion. Secondary threats to these species may also come from specialist seed collecting. Although seed collecting for the international palm industry does occur in Belize, it is regulated, with only one authorized specialist seed supplier operating in Cayo District. Any conservation efforts should first concentrate on accurately documenting and monitoring existing populations of the species listed here. Also, a priority is to identify populations of *C. woodsoniana*. The authors have not been able to locate this species, despite visiting the locality listed by the single specimen on which the record is based. The other species are widespread with high population numbers. They are therefore under no great threat, except *C. ernesti-augusti*, which is the current focus species of commercial harvesting. Although it has a broad distribution, and populations are large, leaf harvesting is widespread and intensive. This species should be carefully monitored: local populations could gradually be extirpated, one by one, if intensive levels of harvesting continue and spread to other areas.

Conclusions

Although a new legalized industry has been established, it is likely that the long-standing illegal operations will continue in the near future. What is urgently needed is to restrict the illegal industry as far as possible and positive initiatives are in place to do this. Ideally, an increased Belizean presence in its forest would be accompanied by a corresponding change in purchasing policy of both the primary *xaté* sorting houses in Guatemala and international buyers. At present there appears to be little questioning of the source of traded leaves.

There is a need to improve the awareness of international buyers and the public of the non-sustainable basis of the business in general and the illegality of certain aspects of the trade. Once such concern has been raised, the foundations are laid for the introduction of *xaté* certification and associated labeling schemes that could be used as market tools to help the industry improve the way it operates.

Attempts to calculate payment by quality are being introduced into the community managed forests of Uaxactún and Carmelita (Guatemala) using sorting houses where *xateros* are paid only for good leaves, and this practice has been adopted by the concessionaire working in Toledo District. Developed by the World Conservation Society, the Rainforest Alliance and the Association of Forest Communities in the Petèn, early results from this initiative show that wastage is significantly reduced, with the proportion of high quality leaves delivered by *xateros* increasing from 50% to over 90%.

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Literature Cited

Alianza Para Un Mundo Justo. 2003. Growing together: socioeconomic development of southern Petén and Belize communities through the sustainable management, controlled harvesting and commercialization of xate. First Quarter Project Report. Alianza para un Mundo Justo. Santa Elena, Guatemala.

Balick, M.J., M. Nee and D.E. Atha. 2000. Checklist of the Vascular Plants of Belize. Memoirs of The New York Botanical Garden 85. 246 pp.

Bridgewater, S.G.M., P. Pickles, N.C. Garwood, M.G. Penn, R.M. Bateman, H. Porter Morgan, N. Wicks and N. Bol. 2006. *Chamaedorea* (*xaté*) in the Greater Maya Mountains and the Chiquibul Forest Reserve, Belize: An economic assessment of a non-timber forest product. Economic Botany 60: 265–283.

Commission For Environmental Cooperation (CEC). 2002. In search of a sustainable palm market in North America. Commission for Environmental Cooperation (CEC). Montreal. http://www.cec.org/files/pdf/ECONOMY/PALM-09-02-e.pdf [accessed 7 July 2005]

Consultancy And Research For Environmental Management (CREM). 2002. European market survey and analysis for sustainable xate, harvested in Guatemala. Amsterdam, Netherlands.

Duplooy, H. and B. Adams. 2005. A little palm, a lot of palaver. Palms 49: 48–51.

Endress, B.A., D.L. Gorchov and M.B. Peterson. 2004. Harvest of the palm *Chamaedorea radicalis*, its effects on leaf production, and implications for sustainable management. Conservation Biology 18: 822–830.

Endress, B.A., D.L. Gorchov and M.B. Peterson. 2006. Sustainibility of a non-timber forest product: effects of alternative leaf harvesting practices over 6 years on yeild and demography of the palm *Chamaedorea radicalis*. Forest Ecology and Management 234: 181–191.

Escalera Mas, C.E. 1993. Caracterización de los factores ecológicos relevantes en las comunidades donde el shate (*Chamaedorea* spp.) es componente, en San Miguel la Palotada, Petén. Facultad de Agronomía. Guatemala, Universidad de San Carlos de Guatemala.

Forum Interparlementaire Des Amériques (FIPA) and United States Agency For International Development (USAID). 2002. Xate (*Chamaedorea* spp.): Situación del sistema de recolección y exportación y recomendaciones para un plan de trabajo: insumo para una politica de recursos forestales no maderables en areas protegidas. Guatemala.

Henderson, A., G. Galeano and R. Bernal. 1995. Field Guide to the Palms of the Americas. Princeton University Press, Princeton, New Jersey.

Hodel, D.R. 1992. *Chamaedorea* Palms: The Species and their Cultivation. International Palm Society, Lawrence, Kansas.

O'Brien, T.G. and M.F. Kinnaird. 1996. Impact of harvest on leaf development of the Asian palm *Livinstona rotundifolia*. Conservation Biology 10: 53–58.

Oyama, K. 1992. Conservation and exploitation of tropical resources – the case of

Chamaedorea palms. Evolutionary Trends in Plants 6: 17–20.

PICKLES, P. 2004. Eco-labeling *xaté*: the potential of certification to aid the development of a sustainable Belizean palm industry. Master's Thesis. Dept. of Geosciences, Edinburgh University.

PORTER MORGAN, H. 2005. Towards the sustainable use of *xaté* palms in Belize (*Chamaedorea* spp.): the effects of defoliation on leaf growth and reproduction. Report to the UK Darwin Initiative.

RADCHOWSKY, J., V.H. RAMOS, R. GARCIA, J. LÓPEZ AND A. FAJARDO. 2004. Effects of managed extraction on populations of the understory palm, *xate* (*Chamaedorea* sp.) in northern Guatemala: Monitoring ecological integrity of the Maya Biosphere Reserve, Péten, Guatemala. Report. Wildlife Conservation Society.

RAINFOREST ALLIANCE. 2004. Reliable sources: environmentally sound and socially just harvesting of non-timber forest products: certified chico initiative at the Rainforest Alliance. Profiles in Sustainable Forestry Rainforest Alliance, New York. http://www. rainforest-alliance.org /programs/profiles/ forestry-chico-initiative.html [accessed 07 July 2005].

REINING, C., R. HEINZMAN, M. CABRERA MADRID, S. LÓPEZ AND A. SOLÓRZANO. 1992. Non-timber forest products of the Maya Biosphere Reserve, Petén, Guatemala. Washington D.C., Conservation International.

THOMAS, M.M., N.C. GARWOOD, W.J. BAKER, S. HENDERSON, S.J. RUSSELL, D.R. HODEL AND R.M. BATEMAN. 2006. Molecular phylogeny of the palm genus *Chamaedorea*, based on the low-copy nuclear genes PPPRK and RPB2. Molecular Phylogenetics and Evolution 38: 398–415.

WALTER, K.S. AND H.J. GILLETT. 1998. 1997 IUCN Red List of Threatened Plants, IUCN – The World Conservation Union, Gland, Switzerland and Cambridge, UK.

WICKS, N. 2004. Preliminary fishtail xaté (*Chamaedorea ernesti-augusti*) growth survey data in the Chiquibul National Forest, Belize. Report for the Darwin Initiative.

WILSEY, D.S. & B.A. ENDRESS. 2007. Evaluating the role of certification in the sustainable harvesting of *Chamaedorea* leaves. Sustainable Palm Initiative Working Paper 1. www.wildshareintl.org/chamaedorea.pdf

CLASSIFIED

PALM LITERATURE

IMPORTED AND AMERICAN VARIETIES OF DATES IN THE UNITED STATES. Donald R. Hodel and Dennis V. Johnson. University of California Agriculture and Natural Resources Publication 3498. University of California, Oakland. 2007. ISBN 978-1-879906-78-5. Price $25.00. Softcover. Pp. 112.

Although date palms (*Phoenix dactylifera*) are an ancient crop in their area of origin in the Middle East and adjoining areas in North Africa and South Asia, their utilization as a food crop in the New World is relatively recent. Knowledge of the climatic requirements for successful date production, appropriate cultural practices and varieties suitable for production under New World conditions was lacking. In the very late 19th century and the very early 20th century, the United States Department of Agriculture (USDA) began research aimed at supplying the knowledge necessary for a successful date industry to be established in the US. The USDA established a research station in the low desert area of Southern California in 1904. The US Date Garden (as it was originally called) was moved to Indio, California, in 1907, and until its closure in 1982, the majority of research on dates carried out in the US was performed by Date Station personnel.

The key figure among all date researchers at the Date Station, and indeed among *all* US date researchers, was Roy Wesley Nixon. In a career that began in the 1920s, when dates were a new crop in the United States, and lasted for nearly half a century, Nixon carried out important investigations in all areas of date culture. His research efforts included metaxenia (the effect of pollen from specific males on fruit characteristics), pollination, bunch covering, fertilization, irrigation, fruit thinning and varietal development. The development and economic success of the US date industry was due in no small part to the knowledge that Nixon developed and disseminated to growers.

Nixon was a prolific author of technical publications and industry-oriented popular articles. Among his writings were two book-length works and the manuscript of a third. *Imported Varieties of Dates in the United States* was published by the USDA in 1950. This work described the many varieties of dates that had been imported to the US. Most of these varieties were no longer extant at the time of writing, as the US industry concentrated on the 'Deglet Noor' and a few other varieties. A companion manuscript, *American Varieties of Dates*, was prepared about 1955 but never published. The reasons for its lack of publication are not known; however, various copies of the draft were in circulation among date researchers and growers.

Nixon's other book, *Growing Dates in the United States*, was first published in 1939 and was updated and revised five additional times through 1978. This book remains the general work most useful to date growers in the US and in other countries. It summarizes Nixon's work as well as that of other researchers in all areas of date production.

These books have long been out of print and difficult to find for most persons. Therefore, the publication by the University of California Division of Agriculture and Natural Resources of *Imported and American Varieties of Dates in the United States* is good news, as it will put the valuable information contained in Nixon's works into wider and more accessible circulation. The authors, Donald R. Hodel and Dennis V. Johnson, are knowledgeable workers with dates and other types of palms. Their update contains some valuable new information in addition to the information taken from the earlier works by Nixon.

The book begins with a new section that offers a brief history of the date industry in the US and a snap shot of the industry as it exists today. This is a valuable summary of sometimes difficult to obtain information from various sources. The next section briefly describes the botany of the date palm and the botanical characteristics used to describe, characterize and distinguish date palm varieties.

The next two chapters are revisions and updates of Nixon's book on imported date varieties and his unpublished manuscript on American-derived varieties. In contrast to Nixon's alphabetical organization, the authors divide date varieties into "commercial" and "non-commercial" types. Most of the descriptive work is taken directly from Nixon's work, but the authors have updated it as necessary. In addition, they have added descriptions of a few domestic varieties developed since the mid-1950s. An appendix briefly lists many obscure non-commercial types of imported dates.

Chapter 5 is essentially an updated version of *Growing Dates in the United States*. The authors have retained the original information and advice given in the 1978 edition where appropriate and have updated and expanded specific sections, particularly those dealing with irrigation, fertilization and propagation.

The book concludes with various useful appendices, including a brief biography of Roy Nixon and a list of his works. The book as a whole is nicely produced and attractive. In place of the archival USDA photographs, new color plates (many by noted fruit detective David Karp) vividly illustrate the varieties and cultural practices described. *Imported and American Varieties of Dates in the United States* serves as a good, up-to-date, single-volume source of information on all aspects of date growing in the US. Anyone with an interest in date palms will find this book useful. Even those having an earlier copy of *Growing Dates in the United States* will want to acquire a copy for the updated information and color plates. It is highly recommended.

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Biodiversity of Costa Rica: IPS Biennial 2008

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When Columbus arrived near Limón, Costa Rica, on 18 September 1502, he must have truly thought this was a very rich discovery even though the indigenous natives numbered perhaps under 30,000 at the time. For much of its history, this country of 50,895 sq. kilometers fell under Spanish rule, while the population has grown to about three million inhabitants. Costa Rica is located in Central America between Nicaragua and Panama between 8 and 11° north of the equator. The country runs east to west and is divided by a backbone of mountains and volcanoes, some quite active today and is part of the Pacific "Rim of Fire." At its narrowest point, the two oceans are separated by a mere 119 km (about 75 miles), and the nation boasts more than a dozen distinct climatic zones.

San Jose, the capital, will be the base (Meliá Cariari Hotel) for the 2008 IPS Biennial (3–10 May 2008) and is located in the rich Central Valley. All trips to habitats and gardens will be day-trips with the longest outing being to Arenal, some three hours from San Jose. The Caribbean coastal plain is much wider than the Pacific coast and generates much of the climatic and fertile conditions of the Central Valley. We have selected a wide spectrum of sites that will take us from coastal elevations into the cloud forests of Braulio Carrillo National Park. There is no summer or winter. The rainy season runs from May to November, and temperatures are elevation dependent with a mean of 72°F (22.2°C) in the Central Valley. Average rainfall is 100 inches (254 cm)), but again some cloud forests can generate 25 feet (7.6 m) of precipitation along the Caribbean facing slopes. Palms seen growing in their natural habitats will include the following genera: *Chamaedorea, Geonoma, Iriartea* (Fig. 1), *Socratea, Calyptrogyne, Asterogyne, Astrocaryum, Euterpe, Acrocomia, Bactris, Synecanthus, Hyospathe, Welfia* and *Raphia*.

Costa Rica maintains very strong ecological, conservation and educational policies regarding its natural resources. This country constitutes less than 1% of the global land mass yet is home to 5% of all species biodiversity. Nearly 23% of its total land mass is devoted to national parks or reserves or is under private management to check the growth of commercial development. One consequence is that no seed collection can take place in our tour sites. Even though some sites are forested habitat, eco-tourist developmental policies have made these sites visitor-friendly to all ages. Given the lush and wet nature of Costa Rica, many of the sites will have paths from which we shall be able to view the palms and other flora and fauna.

Biennial Itinerary:

Saturday, 3 May: Arrival, Registration, Welcoming Reception.

Sunday, 4 May:

Marco & Gerardo Herrero's Farms: Two adjacent farm/nurseries (20 hectares each) were founded with stock from the Wilson Garden in Las Cruces. The Herrero collection contains over a thousand species, both indigenous to Costa Rica and exotic, from the global

PALMS 51(4): 200–202

collections of Marco and Gerardo Herrero and Robert Wilson.

INBioparque: This sensory experience combines nature trails with multimedia technology. The 20-acre (8.1 ha) park's development is based upon introduction to the wide spectrum of biodiversity allowing attendees to experience living samples of Costa Rica's native ecosystems: tropical humid forest, tropical dry forest and Central Valley native forest. The introduction covers ecology, conservation and commercial use of the biodiversity and the search for and development of new products, such as medicines, cosmetics, and nutritional and agricultural products. The guest speaker before dinner will be Dr. Gerardo Avalos, Ph.D., on the functional ecology of palms in Costa Rica.

Monday 5 May: Due to conservation and low-impact policies the Biennial attendees will be split into two groups. The venues for the two groups will be reversed during the Monday through Thursday activities. In all cases, IPS members will return to the hotel each night for joint dinners, lectures and festivities.

Group 1: Arenal Hanging Bridges.

Group 2: Rain Forest Aerial Tram and Quebrada González Station in Braulio Carrillo National Park.

[On Wednesday, Group 1 will visit the Rain Forest Aerial Tram and Quebrada González and Group 2 will tour the Arenal Hanging Bridges.]

Arenal Hanging Bridges: The Arenal Hanging Bridges are located in La Fortuna within a 250-hectare (618-acre) reserve of primary forest adjacent to the active Arenal Volcano. This conservancy has 15 bridges from 5 to 100 meters long, a third of them of suspension design along a 3 km rain forest circuit of paved trails. Groups will be limited in size with a naturalist guide pointing out palms and other flora and fauna from ground level, mid-canopy and from above-canopy views of the tropical rain forest (Fig. 2). The highest bridges exceed 45 m (>150 ft) above the forest floor.

Rain Forest Aerial Tram & Quebrada González: The Rain Forest Aerial Tram takes attendees through the rainforest canopy with its hanging garden of plants and animals high in the tops of tropical trees. The canopy is home to two thirds of the rainforest's species and the Aerial Tram site, on the northern border of Braulio Carrillo National Park, possesses one of the richest canopy communities in the world. The tram allows close observation of the varied life forms of the otherwise inaccessible canopy while causing minimal impact to the surroundings.

1. The distinctive leaf of *Iriartea deltoidea*.

Braulio Carrillo National Park has two ranger stations, the Zurqui sector and the Carrillo (**Quebrada González**). Primary cloud forest and rainforest cover the reserve with its abundant flora and fauna in multiple habitat zones and innumerable rivers. This site is only one of three open for the public and loops 1.5 km (0.9 mile) in the cloud forest.

Tuesday, May 6:

Group 1: Poás Volcano & La Paz Waterfall.

Group 2: Carara National Park.

[On Thursday, Group 1 will visit the Carara National Park and Group 2 will visit the Poás Volcano & La Paz Waterfall.]

Poás Volcano features two high elevation craters: one active and one that has formed into a lake. The massive active crater often has sulfuric smoke rising out of the boiling muddy lake on its bottom. A 20-minute hike separates the two craters passing through high altitude volcanic vegetation that does not support palm species but hosts a wide spectrum of birds and plants native to high ash environments.

The La Paz Waterfall Gardens is located at an altitude ranging of 4300–5000 ft (1311–1524 m), which provides an ideal climate for both cloud and rain forest. Its three kilometers of serpentine paved trails and viewing platforms, allow attendees to experience and photograph the forest and the four majestic waterfalls from a number of view points. This site starts off with several separate conservatories housing hummingbirds, snakes, frogs and butterflies covering 18, 000 square feet (1672 sq. m) and includes a collection of ten species of the most colorful butterflies of Costa Rica.

Carara National Park is relatively small in size (4,700 hectares), but its importance arises from its coastal location within a transition zone between the tropical dry forest to the north and the more humid Pacific rainforest to the south. Carara has flora and fauna from both eco-systems. The the virgin forest that covers most of the park is the ideal environment for such rare wildlife as the Scarlet Macaw (*Ara macao*), the Collared Aracari (*Pteroglossus torquatus*) and three species of monkeys.

Wednesday and Thursday, 7 and 8 May:

For Wednesday and Thursday, the schedule is the reverse of the Monday and Tuesday's schedule respectively. Many of the sites are visitor-limited, and this alternating schedule allows for a higher guide-to-group ratio.

Friday, 9 May:

This will be a free day or for optional events to be booked during the week with the CRT at the hospitality desk (at additional cost). Optional events may include a city tour, canopy traversing or white-water rafting.

Attendees should return to the Melia Hotel for the farewell festivities beginning at 6:00 pm.

Saturday, 10 May:

The Biennial will conclude. Attendees will be taken to the airport to return home and/or the start of the Costa Rican extension tours and the Peruvian Amazon Post-tour.

Biennial attendees will have a number of choices for extending their stay in Costa Rica to experience the country. Three such extension tours will start on 10 May (the departure date for Biennial attendees). These include the Tortuguero National Park along the Caribbean coast, Las Cruces Biological Station (Wilson Gardens) near the Panamanian border and Corcovado National Park on the Osa Peninsula. These extension tours are coordinated by CRT Destination Marketing & Management Services, lead agency for the 2008 IPS Biennal. See Palms 51(3) Supplement, September 2007, or the IPS website (www.palms.org) for further information. Further details can be secured from Rebeca Murillo of CRT at rmurillo@crtteam.com.

2. A view from one of the suspension bridges at the Arenal Hanging Bridges.

For those who wish to venture into the Amazon, a post-tour to Peru's Tambopata Reserve will also start on 10 May with a flight to Lima, Peru. The palms to be seen are: *Socratea exorrhiza*, *Iriartea deltoidea*, *Euterpe precatoria*, *Astrocaryum murumuru*, *Attalea phalerata*, *Attalea moorei*, *Mauritia flexuosa*, *Bactris concinna*, *Bactris gasipaes*, *Bactris maraja*, *Bactris martiana*, *Desmoncus polyacanthos*, *Chamaedorea angustisecta*, *Geonoma brongniartii*, *Geonoma deversa*, *Geonoma macrostachys* var. *acaulis*, *Oenocarpus bataua*, *Oenocarpus mapora*, *Phytelephas macrocarpa* and more. This tour is being arranged by Inkaterra Reserva Amazonica, the lead agency for the post-tour. See Palms 51(3) Supplement, September 2007, or the IPS website (www.palms.org) for further information.

Index to Volume 51