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Contents for January

Cover Picture

Caryota cumingii growing in the Botanic Garden, Caracas, Venezuela. Photo by Andrew Henderson.

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Editorial

This first issue of 1994 represents a landmark. After 37 years the size and format of *Principes* is being changed. The size of the journal is increased to give you more space for articles and a better format for pictures. We are also considering and discussing with our new Horticultural Editor, Martin Gibbons, ways to make the contents of *Principes* more to your liking. We encourage you to let us know what you want in the international journal.

This issue includes several things related to the Venezuelan Biennial in June. The Botanic Garden in Caracas has a splendid collection of palms. The front cover shows how well *Caryota cumingii* does in the garden; while the back cover is a picture of the newly described *Oenocarpus balickii*, a Venezuelan native. Fred Stauffer and Hector Rodriguez have provided descriptions of the palms to be seen in the Cloud Forest of Henri Pittier National Park which will be visited on one of the Biennial tours. Two Venezuelan scientists, Michel Ataroff and Teresa Schwarzkopf, have described the growth patterns of *Chamaedorea bartlingiana*, now placed by Don Hodel in *C. pinnatifrons*, which he considers the most variable species in the genus. The extensive variation in habit and leaf form discovered by the authors in different growth stages may account for some of the confusion surrounding the species.

Two of our long articles are fascinating historical accounts of the influence and importance of palm products. M. Schuiling and Hugh Harries discuss the origin and early usage of the coconut in East Africa, reaching back to early Arab and European travelers and their accounts of other ages. "Fiber" is always listed as an important product of palms yet one wonders how fiber fares with today's predominance of plastics. Paul Tuley weaves a tale of brushmakers, past and present, with a discussion of how and what palms and palm structures were and are involved. Peter Perschbacher's short account of a modern cottage industry adds to the story.

Information on pollination is still lacking for many palms. Christian Listabarth has made new observations for *Desmoncus*, a genus of special interest as the only New World rattan.

The many activities of our Chapters during final days of 1993 are impressive. We wish all members a happy and productive 1994 and hope to see many of you in Venezuela in June.

NATALIE W. UHL
JOHN DRANSFIELD

DO YOU HAVE A PROBLEM?

Do you have a problem growing your palms or need to know the answer to a specific palm-related question? If so write and let us know!

At the October IPS Board of Directors Meetings, it was determined that most IPS members don't know of the existence of the IPS Horticultural Correspondents Committee. This committee was set up several years ago to answer horticultural questions relating to palm culture. Such inquiries are welcomed by the IPS. Just send your inquiry to the IPS (Lawrence, Kansas address) and one of a panel of experts [horticultural correspondents] will respond. Palm-related questions in general (not specifically limited to culture) are welcomed.

Principes, 38(1), 1994, pp. 4–11

The Coconut Palm in East Africa. 1. East African Tall

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Origin and Diversity

The general consensus has been that the coconut originated in the southwest Pacific and reached Africa later (Purseglove 1972, Child 1974, Ohler 1984). Purseglove speculated that Malaysian seafarers introduced the coconut to Madagascar in the first centuries A.D. and that from there it could have reached the coast of mainland East Africa. Merrill (1937) mentioned that the words for coconut used in Madagascar also occur in the Far East and the Pacific. However, Sauer (1967) thought that the early presence of coconuts on uninhabited islands like the Seychelles and Mauritius strongly suggested natural dispersal. It follows from this that coconuts could have floated to East Africa (Harries 1978). Subsequently, Harries (1981) showed that the common tall varieties in East Africa are late germinating, with wild type characteristics similar to the coconuts on the Indian subcontinent, while the common tall varieties in peninsular Malaysia are early germinating, domesticated types. Thus the natural dissemination favored by Sauer and the human-aided introduction suggested by Purseglove can be considered as consecutive events rather than competing theories.

It has recently been suggested that the coconut was domesticated in the region between southeast Asia and Australasia (known as Malesia), but that the ancestral coconut may have originated in western Gondwanaland at the time it split up into the present continents (Harries 1990). This raises the possibility that the wild type coconut may have existed on the fringes of the Pacific and Indian oceans since the earliest time. In that case the coconut palm could be considered indigenous over a very large area, including the coast and islands of East Africa (Harries, in press). Indeed, the two closest botanical relatives to the coconut are found respectively in southern Africa, *Jubaeopsis caffra* (Uhl and Dransfield 1987) and Madagascar, *Voanioala gerardii* (Dransfield 1989). The presence of coconuts with wild-type characteristics does not prevent the introduction of others with domestic-type characteristics nor the subsequent introgression between the two, with the former characteristics predominating. There is the possibility that when the Polynesians settled in the Pacific, related peoples sailed to Madagascar. They would have been carrying the domestic type of coconut from Southeast Asia and they may have reached the African coastline.

The first written reference to the coconut palm in East Africa is thought to be in the "Periplus of the Erythraean Sea," written about A.D. 60. The Periplus mentioned that the town of Rhapta, believed to have been located somewhere on the coast of present day Tanzania, traded in coconuts (Schoff 1912). It is thought that this town derives its name from the Greek or Arab verb " to sew" (Ravenstein 1898, Schoff 1912), because the local boats were sewn together with fibers. When the Portuguese first sailed to East Africa and India they found Arab boats sewn with coconut fiber (coir) and carrying coconuts as cargo. Although the reference to coconuts in the Periplus has been taken as evidence of the introduction of the coconut to East Africa by Hindu merchant-seafarers sometime in the 7th to 1st century B.C. (Schoff 1912, Hichens 1938, Hourani 1951), it can equally well be explained simply as the opening up of trade between the two regions where coconuts already existed. It is certain that the town Rhapta had an established place in the mercantile system of the Indian Ocean. The Periplus strongly indicates a vigorous commerce between India and East Africa. It is one author's conjecture (HCH) that coastal towns like Rhapta developed where they did because coconuts were already present. Two thousand years ago or more, the coconut palm not only served to identify seashore locations with fresh ground water, but in those places it literally acted as a natural desalination plant. The

sweet, uncontaminated drinking water from the immature nut was then, and is still now, an important use of this plant to the local community. This applies to offshore islands and to favorable parts of the African and Indian coast. It is not suggested that the early coconuts were present in large numbers or spread over extensive lengths of coastline and were certainly not found naturally anywhere in the hinterland.

While the earliest history of the coconut in east Africa remains uncertain, there is no doubt that its establishment was not a single event but a continuous affair extending over many centuries. Though the Indian influence appears to have waned somewhat after the times of the Periplus, trade relations between India and East Africa continued to exist until well after the arrival of the Portuguese. Several Arab geographers like Buzurg ibn Shahriyar, Al-Mas'udi, and Al-Biruni attest to such connections in the early Middle Ages (Ingrams 1967, Kirkman 1968, Spencer Trimingham 1975). Marco Polo wrote of ships of the Malabar coast which sailed to the islands Madeigascar and Zanghibar in the late 13th century (Wright 1892). Vasco da Gama met Hindu merchants at the larger ports of East Africa (Ravenstein 1898). Duarte Barbosa observed in the early 16th century that ships from the kingdom of Cambay, the great seaport of Gujarat, were often to be found in the harbors of Mombasa, Malindi and Mogadishu (Stanley 1866).

Early Arab History

The Arab and Persian colonization of East Africa is of even greater importance. It was a long and gradual process which began in remote antiquity and continued more or less steadily for many centuries with at certain times more massive waves of immigration due to political or religious persecution at home (Coupland 1938, Chittick 1975). There is little doubt that many of these traders and settlers brought coconuts independently. In the Khabar al-Lamu, a chronicle of Lamu, the introduction of the coconut palm on the Lamu archipelago (present day Kenya) is attributed to Arab settlers, who came by way of India in the 7th century A.D. (Hichens 1938). They brought coconut seedlings and are referred to in the chronicle as Kina Mti (kinsmen of the trees). In persistent traditions on the coast of mainland Tanzania, Zanzibar and Mafia, the arrival of the coconut is attributed to the Debuli, whose ships reputedly had sails of palm matting (Piggot 1941; Gray 1954, 1962; Chittick 1965; Baumann 1896). It is now believed that the Debuli arrived before the Shirazi and that their name derives from the town of Debul, known to the Arabs who conquered it in A.D. 711–712 as Daybul, a port situated near the mouth of the Indus. It is now identified with the excavations at Bhambor, 40 miles east of Karachi (Chittick 1965). Pemba tradition credits the introduction of the coconut palm to the Wadiba, who according to Gray (1954, 1962) hailed from the Maldive Islands, which were known to 14th century Arab geographers as the Diba Islands.

According to the Arab traveller Ibn Battuta (Gibb 1962), great quantities of cowries and coconut products were exported from these islands. Both the Maldives and the Laccadives were the scene of remarkable shipbuilding activity. The ships, including hulls, masts, ropes, stitches and even sails, were built entirely of the various products of the coconut. The Arabs and Persians from the Gulf used to import coconut products from these islands or go there to have their ships built on the spot. There is evidence that the Maldives were first settled by Singhalese Buddhists who planted coconuts and dug wells (Hourani 1951, Sauer 1967).

The Shirazi, who derive their name from the town of Shiraz on the Persian Gulf, settled in East Africa from the 9th century A.D. onwards. Wild type coconuts may have grown spontaneously around their earliest settlements, but there is no doubt that they have imported coconuts as well. Though the area around the Persian Gulf appears to be unsuitable for coconut cultivation, coconuts did and do grow there. The traveller Nasir-i-Khusraw observed them in Oman in the 11th century A.D.; Ibn-Battuta found them in the 14th century at Zafari, a port of the Hadramut, in the sultan's garden in the city of Zabid on the Red Sea and in Oman (Gibb 1962). The Arabs and Persians around the Gulf had further easy access to coconut products from India, the Laccadives and the Maldives. The Shirazi have most certainly played an important part in the distribution of the crop in East Africa. They first settled on the Benadir coast (present day Somalia and Kenya), and from the 11th century onwards they remigrated southwards and settled in many towns along the coast as far south as Sofala in present day Moçambique. Such migrations took place as late as the 17th century, witness the settlement of Khatimi-Barawi at Kun-

duchi near the present Dar es Salaam (Chittick 1975).

Two Arab geographers during the early Middle Ages have referred to the cultivation of the coconut in East Africa. Al-Mas'udi made several visits to the island of Kanbalu, the last one in 916. The island had a population of Muslims and pagan Zanj. The staple foods of the Zanj were bananas, sorghum-millet, taro and coco-yam, and they extensively cultivated the coconut palm on their islands. Kanbalu is generally considered to be the present day Pemba or Zanzibar (Ingrams 1967, Kirkman 1968, Chittick 1975). Kirkman speculates that Kanbalu could be the ruined town at Mkumbuu on Pemba and that the name Kanbalu is probably derived from a town about 40 miles northwest of Debul in northwest India. However, according to Freeman-Grenville (1962*b*), Al-Mas'udi placed the island near Sofala and he considers it therefore to be Madagascar. Ibn Sa'id reported in the 13th century that the Mand islands near Mombasa were celebrated for their coconuts. Among these islands he described Kilwa as the most important and further Zanzibar. However, the highly inaccurate description of these islands makes it unlikely that he visited the area himself. He may have referred as well to Manda, an island of the Lamu archipelago near Mombasa (Freeman-Grenville 1962*b*).

If Harries (1990) is right, the first coconuts in East Africa originate principally from the same source as those on the Indian subcontinent and adjacent islands, namely, the wild type populations that pre-date human maritime activity. Even so, the foregoing information, though partially based on local legends and conjecture, suggests that coconuts were continuously imported from the same areas later on. Emigration of people from India and the Persian Gulf to East Africa, trade relations between the Gulf and India and between both areas and East Africa, all point in that direction. As to the flourishing trade relations between India, the Persian Gulf and East Africa, these were made easy by the prevailing and predictable monsoons. Since times immemorial, traders from India, the Persian Gulf and the Hadramut arrive with the northeast monsoon, which blows from December to March, and return with the southwest monsoon, blowing from June to October. In India the coconut palm has been known for at least 3,000 years. Medieval writers such as Marco Polo refer to it as *nux indica*, the Indian (or Indies) nut (Wright 1892). Even so, Indian scholars do not regard it as indigenous (Mayuranathan 1938, Menon and Pandalai 1960).

Early European History

By the time Vasco da Gama reached East Africa in 1498, a series of independent and often competing towns and settlements ruled by Muslim Afro-Arab/Shirazi (or Swahili) dynasties were scattered along the East African coast, more sparsely south of Cape Delgado (the present border between Tanzania and Moçambique) but in increasing density to the north. The most important settlements were Mogadishu, Barawa, Siju, Pate, Lamu, Malindi, Mombasa, Pemba, Zanzibar, Kilwa, Moçambique Island and Sofala. To the Portuguese the most striking natural object around these settlements was the coconut, which was a great novelty to them. It features in many of their chronicles. In the journal of the first voyage of Vasco da Gama from 1497 to 1499 (Ravenstein 1898) the coconut palm was described from the islands of S. Jorge and Moçambique and from Malindi:

> The palms of this country yield a fruit as large as a melon of which the kernel is eaten. It has a nutty flavour.

The Portuguese also observed the sewn boats, already in use during the time of the Periplus in the first century A.D.:

> The vessels of this country are of a good size and decked. There are no nails and the planks are held together by cords. The sails are made of palm matting.

Duarte Barbosa observed the same boats on the islands of Zanzibar, Pemba and Mafia in 1517 (Stanley 1866) and Monclaro at Mombasa in 1569 (Freeman-Grenville 1962*b*). De Barros, describing Kilwa in 1505, before it was sacked by d'Almeida, wrote:

> From our ships we saw the fine houses, terraces and minarets with palm and fruit trees in the orchards, which made the city so beautiful that out men were eager to land (Dorman 1938).

An anonymous witness of the same attack on Kilwa described the pursuit of the sultan as:

> A trail of things dropped in the hasty flight of the occupants led to a palm grove, the trees of which were so dense that d'Almeida prevented his men from continuing the pursuit (Gray 1962).

The same author mentioned the use of the coconut at Kilwa as drinking nut and for making wine and vinegar (Axelson 1940, Freeman-Grenville 1962*a*). In 1522 the Portuguese invaded the Ker-

imba Islands (a small island group located near Cape Delgado) and destroyed the main town and extensive palm groves (Axelson 1940). In 1569 the Portuguese missionary Monclaro, on his way from Kilwa to Pate, stopped at Mafia (Monfia). He reported that the island had numerous palm groves and traded in tar (probably copal) and coconut fiber (Freeman-Grenville 1962*a*). In 1587 the town Faza on Pate Island was sacked by the Portuguese for giving support to invading Turks. After killing all inhabitants, they cut down ten thousand coconut palms, the main source of subsistence of the population. Afterwards they did the same in Mombasa (Strandes 1968). In 1589, after the second Turkish incursion, they took similar revenge on the town of Manda and destroyed 2,000 coconut palms (Axelson 1960). The destruction of coconut palms by the Portuguese was not merely to deprive the local people of subsistence and trade but was a deliberate act of war to prevent ships being built that could be used against them. In Rezende's description of East Africa in 1634, the kingdoms Pate, Ampaza and Siu on Pate Island, Lamu, Mombasa, Zanzibar and Pemba are mentioned to be abundant in coconuts (Strandes 1968).

Later Arab History

All these reports indicate that the coconut palm was well established in coastal settlements of East Africa at the onset of Portuguese influence, but predominantly in the present Kenya and the adjacent islands of Pemba, Zanzibar, Mafia and Moçambique. Kilwa was the only important city-state on the mainland of present Tanzania, though smaller settlements existed. In the 17th century the number of settlements of Shirazi origin along the coast of mainland Tanzania strongly increased. Freeman-Grenville (1962*b*) lists no fewer than 62 archaeological sites, many of which are still inhabited. There is no doubt that coconuts grew in these settlements from their earliest existence. To understand the distribution of the crop over the country in later years, it is important to note that the great majority of these settlements on the Tanganyika coast existed between the border of present Kenya and Ras Kimbiji, near Dar es Salaam. In the southern part of present day Tanzania there were, except for Kilwa, only two settlements, Lindi and Mikindani. Through all the centuries, the Arab and Persian settlers and their Swahili descendants exploited the agricultural resources of the land only to a certain extent. They introduced fruits like the orange and cultivated coconut palms along the rivers near their towns or irrigated by wells (Strandes 1968). These crops were mainly for local consumption; the main activity was trade in commodities like ivory, gold and sometimes slaves, but not agriculture (Coupland 1938). Therefore, with the possible exception of Zanzibar, Pemba and the Lamu archipelago, the coconut palm was restricted to limited areas around the settlements and was not grown widely along the coast as today. Hostilities between the various towns or settlements and with the African tribes of the interior must have further contributed to this fact. This situation did not change much until the most recent immigration of Oman Arabs from the 1820's onwards.

From the 1820's, Seyyid Said, Sultan of Oman from 1806 to 1856, encouraged the settlement of Omanis on Zanzibar, Pemba and the coast of the mainland. On the mainland this did not happen much before 1837, when the Mazrui family, hereditary rulers of Mombasa since 1740, were finally defeated by this sultan and most of the coastal areas of present Kenya and Tanzania came effectively under his control. These immigrants together with the local Swahili began to grow grains and coconuts on plantation scale. The Omanis took an interest in coconut production at a critical period when the earlier interest in fiber for maritime purposes was replaced by the demand for copra and oil for industrial process. Cooper (1977) described these developments on the coast of Kenya. Not only did the scale of agricultural production increase vastly from the 1820's but in parts of the coast, most strikingly in Malindi, new ways of organizing production were also developed. The typical coastal farming unit, a family supplemented perhaps by a few slaves, gave way to large-scale plantations based on closely supervised labor. Millet was much in demand in Arabia and Zanzibar, while coconuts and sesame went to Arabia and to French traders in Zanzibar. Mainland farmers found the means to meet these demands through the slave-trading infrastructure that developed in the late 18th century. According to Cooper, Mombasa started extending into the hinterland as early as 1840. In the 1860's there were thriving plantations with grain, coconuts, and fruit trees. Malindi became the granary of East Africa with a slave labor-force of 5,000–10,000. Coconuts at Malindi were planted somewhat later, in the 1880's. By 1890 there were "forests" of coconuts there. After the abolition of slavery, labor

Table 1. The number of coconut palms estimated to have grown in the various districts of German East Africa in 1890.

District	Number of Coconut Palms in the District in 1890
Tanga	450,000
Pangani	200,000
Mafia island	100,000
Bagamoyo	100,000
Saadani	20,000
DaresSalaam	50,000
Kilwa	20,000
Lindi/Mikindani	15,000
Total	955,000

became scarce and the coconut became even more favored. The same developments took place in present Tanzania, mainly in the northern Muheza and Tanga districts, on Mafia Island and later in the Pangani district. Krapf (1860) reported an abundance of coconuts around Tanga already in 1840. Baumann (1891) described in detail the extensive coconut plantations in the Tanga district, in particular the Arab-owned groves around Tanga. When Burton and Speke (1858) visited Pangani in 1857, they found few Arabs there. Coconut palms were restricted to a narrow strip around the Pangani Bay while the Pangani settlements were surrounded by a thick, thorny jungle where the people fled when pursued.

Baumann (1891) found the land north of the Pangani River covered with extensive sugarcane plantations and dense coconut groves. Many Arab settlers had remigrated from Tanga to Pangani because the harbor of the latter was inaccessible to British warships and thus favored the slave trade, by then illegal. Further, the Pangani area was more suitable for the cultivation of sugarcane. According to Werth (1915) the heyday of Pangani did not come before the rule of sultan Seyyid Barghash (1870–1888). When labor became scarce at the end of the century, the sugarcane industry declined and coconuts became even more favored. The densely planted coconut groves far inland along the Pangani River date from this period (Paasche 1906). Coconut groves were greatly extended on the island of Mafia as well, stimulated by the sultan's liwali on the island, Salim bin Said, who had a large estate himself near Terreni. This was mainly during the rule of Seyyid Barghash. Oman Arabs settled at Bagamoyo and Dar es Salaam as well, but their coconut plantations did not reach the proportions as in northern Tanzania. In the area around Bagamoyo, the activities of the Catholic Mission were important during the same period. From 1870 the Holy Ghost missionaries planted extensive coconut plantations and further strongly encouraged coconut planting by smallholders. In the southern Kisarawe, Rufiji, Kilwa, Lindi and Mtwara districts of present Tanzania, plantation-scale planting by Oman Arabs was of minimal importance. Isolated plantations of modest size, mainly planted during the rule of sultan Seyyid Barghash, existed at Mtoni, Mayungi-yungi, Kilwa Singino, Mchinga, Lindi and Mikindani only. The southern districts of present Tanzania were therefore virtually bare of coconuts.

Later European History

The initial predominance of coconut groves in Kenya and northern Tanzania compared with southern Tanzania, later greatly enlarged by the plantation agriculture of the Oman settlers, and to a certain extent the Catholic mission at Bagamoyo is best demonstrated by a coconut inventory carried out by district authorities at the beginning of German rule of present mainland Tanzania (Anonymous 1891). The number of palms estimated in the various districts of German East Africa are presented in Table 1. It is important to note that at the onset of the German colonial administration (1888–1916), only 4% of the coconut palms of mainland Tanzania grew in the southern Kilwa and Lindi districts, while 75% grew in the Tanga and Pangani districts.

During the German administration, the government, strongly stimulated coconut growing. Extensive village inquiries revealed that seednuts and seedlings were distributed by their Swahili or Arab agents (Maakida), free of charge, to smallholder farmers via the village chiefs. This happened from about 1892 until shortly after the Maji-Maji war (1905–07) along the whole coast of mainland Tanzania, except for the Bagamoyo and Mikindani districts and less so in the Tanga district. Surprisingly few references regarding these activities could be found in the otherwise abundant publications during German colonial rule. Only Stuhlmann (1909), when describing the fourfold increase in exports of copra between 1900 and 1903, mentioned that this increase was mainly due to the efforts of the government, which since about 1892 encouraged the native population at every opportunity to plant coconuts and distrib-

uted seednuts and young palms in large quantities. Between 1898 and 1903 the copra exported from German East Africa increased from about 700 tons to almost 4,000 tons (Stuhlmann 1909). Assuming that an East African Tall palm on the mainland produces about 4 kg copra per year, this means that at least 800,000 additional palms came into bearing during these years. This is a conservative estimate because the coconut is not only used for copra production but for drinking nuts, fresh nuts, and palm wine as well, though the latter use of the palm, according to Stuhlmann, was officially discouraged. It is therefore estimated that during the early years of German rule not less than 2 million seednuts or seedlings were distributed under the government scheme. A very important aspect of this distribution scheme was that the Germans got virtually all their seednuts from or via Mafia. All the senior farmers interviewed during our inquiries stated this without hesitation, even where geographical distances seem to forbid this. This is not surprising because the government had their own nurseries on Mafia, had complete control over all exports of coconuts and copra via their customs-office at Chole Island, and further spectacularly increased the number of coconut palms in Mafia during their rule by distributing seednuts there as well. There was a general consensus on Mafia that not all the seednuts used for this distribution were collected from the local palms, though there were at least 100,000 bearing palms on the island at the onset of German rule (Anonymous 1891) and therefore enough seednuts locally available. Particularly in the early years of the coconut promotion scheme, when according to Baumann there was still very little government activity on Mafia, Chole Island was only used as a distribution center for seednuts, imported into Mafia by large, motorized, Indian dhows. As origin of the seednuts, the Comores were mentioned. This seems plausible because the Deutsch-Ostafrikanische Gesellschaft (DOAG), the predecessor of official German rule in Tanganyika, obtained 1,000 acres of land on the Comores in 1886 (Prager and Frömsdorf 1986). It is possible that the Germans also imported seednuts from the Pacific, where they were planting coconuts in the Bismarck Archipelago and the Caroline Islands. At the same time, they may even have taken coconuts such as the Pemba Dwarf, from East Africa to the Pacific, as well as to territories in West Africa (Krain et al. in press).

The distribution of seednuts on the mainland during German rule had by far the greatest impact in the south, in particular in the present day Kisarawe, Rufiji and Kilwa districts, because only 4% of all the coconuts in the country at that time grew there. The coconut was virtually a new crop, which was often forced upon the people. Almost all the present palms in the three districts are therefore of comparatively recent Mafia origin with a possibility that many of the original seednuts were imports from the Comores or the Pacific. It was different in the northern districts of the country, in particular the Tanga and Pangani districts. There the coconut was a long established crop; more than 75% of all coconuts in the country grew there. There is no doubt that the limited distribution of seednuts by Germans in the north had much less influence on the coconut population there.

Plantation companies and private European farmers played a modest role in the coconut growing of German East Africa, except on Mafia Island. In 1910 Europeans owned nearly 6,000 ha (or 600,000) coconut palms on the mainland (Stuhlmann 1910). However, about half of these palms were planted in unsuitable soils and later abandoned or replaced by sisal (Anonymous 1899–1912). Interest of private farmers on Mafia Island started as late as 1910 but they planted at great speed (King 1917). King considered that by 1917 most of the soils suitable for coconut on Mafia were already occupied by the crop. It is estimated that at the end of German rule there were about a million coconut palms on Mafia and between two and three million on the mainland.

From 1916 to date the coconut industry was gradually expanded, mainly by smallholder farmers. The increase was not spectacular. According to Swynnerton (1946) the copra production between 1913 and 1939 scarcely doubled while the rival cotton and sisal industries increased five-fold and coffee sixteen-fold. In the 1930's the coconut industry received a boost from German settlers, who planted or extended about 4,000 ha on the mainland and 6,000 ha on Mafia. From 1945 (copra bill) until the late 1950's the British colonial administration stimulated coconut growing by subsidies and distribution of seedlings, mainly in the Tanga and Pangani districts.

In the last decades coconut production has been in decline because of inadequate replanting, pests and a destructive disease. From 1979 the National Coconut Development Programme (NCDP), a joint project of the Tanzanian government, the German

Agency for Technical Cooperation (GTZ) and the International Development Agency (IDA), is in operation to promote the coconut industry in Tanzania.

The Lethal Disease

The lethal disease of coconut palm (LD) has caused severe losses in the coastal coconut belt of mainland Tanzania. The first reliable report of the disease was from Bagamoyo in 1902 (Stein 1905), but there is no reason to believe that it did not occur much earlier. Symptoms of LD are very similar to those of lethal yellowing-type diseases in the Caribbean area and West Africa (Schuiling et al. 1981). Mycoplasmalike organisms were associated with LD (Nienhaus et al. 1982). However, as distinct from lethal yellowing, no imported coconut variety with satisfactory resistance to LD could be found to date (Schuiling and Mpunami 1990). Another characteristic of LD, as opposed to lethal yellowing, is the great diversity in losses observed in the various affected areas. In the southern half of the Tanzanian mainland, in particular the Kisarawe, Rufiji and Kilwa districts, the disease has caused heavy losses, while in the northern half, particularly the Tanga and Pangani districts, LD has made far less impact. This may be related to the history of coconut groves in both areas. In northern Tanzania, where coconuts have grown for many centuries, a measure of equilibrium between disease and host palm may have come to exist while this did not happen in the south, where the coconut palm is a comparatively new crop, introduced from or via disease-free Mafia Island. This hypothesis lead to resistance trials with subpopulations of the local East African Tall. An extensive study on the history, epidemiology and economic impact of lethal disease in Kenya and Tanzania with reference to the history of the coconut industry has recently been completed (Schuiling 1991).

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Pollination and Pollinator Breeding in Desmoncus

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ABSTRACT

The reproductive ecology of *Desmoncus polyacanthos* and *D. mitis*, two sympatric species of the Peruvian lowland rain forest, was investigated over 15 months including two flowering periods each. Floral biology of the two species is quite similar but differs in duration of staminate anthesis and a reduced spectrum and fewer visitors in the smaller *D. mitis*. The populations of both species show a relatively short (± 60 days), synchronous flowering period. *Desmoncus* is protogynous, and female and male anthesis do not overlap. Thermogenesis occurs in both female and male stages. *Phyllotrox* sp. (Curculionidae) and *Epurea* sp. (Nitidulidae) are attracted to the pistillate flowers by the odoriferous inflorescences and stay until the next day, when staminate anthesis occurs. *Desmoncus polyacanthos* is pollinated by these two beetle species, which reproduce in male flowers. *Desmoncus mitis* is largely pollinated by *Phyllotrox* sp. only, as few *Epurea* sp. visited the inflorescences. Other visitors, especially drosophilid flies, are without quantitative importance for pollination. Hybridization between *D. polyacanthos* and *D. mitis* never occurred.

Pollination ecology is discussed with reference to *Bactris*, whose floral biology is most closely similar to that of *Desmoncus*. A highly specialized cantharophilous syndrome is recorded. Relationships between *Desmoncus polyacanthos* and the beetles *Phyllotrox* sp. and *Epurea* sp. and between *D. mitis* and *Phyllotrox* sp. are considered as a symbiosis, ensuring reproduction of both plants and animals.

Desmoncus (Arecoideae, Cocoeae, Bactridinae) is a neotropical genus distributed throughout the lowland rainforests from Mexico to Bolivia and Brazil (Uhl and Dransfield 1987). Sixty-one species have been described but there are probably no more than 7 species (Henderson, in letter). All but one species of *Desmoncus* are vines, *Desmoncus* being the only scandant palm group in America except for one species of *Chamaedorea*. Within the Bactridinae, the genera *Bactris* (Essig 1971, Mora Urpí and Solis 1980, Bullock 1981, Mora Urpí 1982, Beach 1984), *Astrocaryum* (Bullock 1981, Burquez et al. 1987) and *Acrocomia* (Scariot 1987, Scariot et al. 1991) have been investigated in regard to their floral ecology. Data on phenology and reproductive biology of *Desmoncus* are lacking, and only the survey of pollination in the Bactridinae has been done recently (Listabarth 1992). Flowering behavior and pollination ecology of two sympatric *Desmoncus* species of Peruvian Amazonia are described in detail here.

Material and Methods

Desmoncus polyacanthos and *Desmoncus mitis* were studied from October 1988 to January 1990 at "Panguana" field station (9°37′S, 74°56′W) (260 m.s.m.) in eastern Peru, Dept. Huanuco, Province Pachitea. The area under investigation is primary rain forest (annual precipitation of 2,280 mm) with some xeromorphic elements; its climate is characterized by a marked wet season (Oct.–April: 1,950 mm) and a pronounced dry season (May–Sept.: 330 mm). Herbarium vouchers are deposited in USM, AAU, NY and WU. *Desmoncus mitis* Mart. var. *leptospadix* Mart. (*Listabarth* 11-30689) and *Desmoncus polyacanthos* Mart. (*Listabarth* 11-10589) were identified by H. Rainer (Vienna) following the circumscription of A. Henderson (in prep.). Specimens of beetles are deposited at NHMW under numbers of the palms with which they were collected. The Curculionidae were tentatively identified by J. F. Voisin (Paris) and C. H. C. Lyal (London), the Nitidulidae by R. Vincent (Paris).

Procedures were carried out as follows: Eleven inflorescences (of one cluster) of *D. polyacanthos* and 39 (of 13 clusters) of *D. mitis* were studied in detail, and several additional inflorescences were followed as controls.

Temperature was measured with an electronic thermometer, on bud surface, on the flowers, or between the rachillae (but touching the flowers). In late male anthesis temperature could not be measured exactly, because touched flowers dropped. Intensity of fragrance was divided into three classes, absent (low), noticeable, and strong.

Insect visitors were tabulated. Qualitative samples were taken with an exhauster, quantitative ones with a plastic bag covering the whole inflo-

rescence to collect all the visitors. With the exception of drosophilid flies, 100% could be collected. Seventeen samples (incl. four quantitative) of *D. polyacanthos* and 19 (incl. seven quantitative) of *D. mitis* were taken.

For breeding experiments of insects counted, fallen male flowers were put into a petri dish with sterilized but moist sand. Pupation could be observed through the glass, because of the thin substrate-layer. Emerged insects could easily be collected from the tops of the petri dishes.

For bagging experiments during female anthesis three types of bags were used (1) nets (#1.0 mm) to exclude visitors but allowing potential wind pollination, (2) nets (#0.1 mm) to bar out visitors and very likely wind borne pollen as well, and (3) plastic bags to exclude all pollen sources. Only single rachillae were bagged to control the fruit set of the other rachillae (*D. polyacanthos*), but whole inflorescences of *D. mitis* were bagged, as there was enough material. A prolonged female anthesis, which probably was effected by the 100% relative humidity inside these bags, is an artefact but obviously did not influence the experiments.

Results

Habit and Phenology. In the investigation area four species of *Desmoncus* occur and could easily be distinguished even in the sterile state by their size and leaf characteristics. One species, climbing into the canopy, and another, of the understory, of which too few individuals were found, are not taken into account in this study. The two species investigated are described below. Though the reproductive period of at least three of the four species occurring in the same macro habitat is overlapping, no hybrids were found.

Desmoncus polyacanthos is a monoecious clustered, climbing palm of the understory with a maximum height of 10 m, each cluster with up to eight stems. Of eight clusters found, seven had only 1–5 stems and remained sterile, one cluster had eight stems, with five fertile stems that produced 1–2 inflorescences/flowering period. Flowering period was once a year, covering ca. fifty days from December to January. Inflorescences are interfoliar, pendulous, and branched to one order with 7–11 rachillae bearing spirally arranged triads except in the distal part which only bears single or paired staminate flowers. Fruits mature until May.

In *Desmoncus mitis*, of the same habit but much smaller, climbing up to a maximum of 4 m is commonly found. Clusters are 1–8 stemmed, but unlike *D. polyacanthos* even single-stemmed individuals produced inflorescences. Clusters with 2–4 fertile and just as many sterile stems are widespread. Up to 3 inflorescences per stem are produced, which are smaller than those of *D. polyacanthos*, bearing 3–7 rachillae. The population of *D. mitis* flowers three times a year, having a main flowering period from December to February. Some clusters produce inflorescences in July and October, respectively.

Flowering Behavior of D. polyacanthos. The first inflorescence buds appear in the last days of October. They are still upright but soon grow to nearly their full length, becoming pendulous and increasing in diameter. The day before dehiscence of the inflorescence bud (Fig. 1a) there is a color change of the peduncular bract from green to yellowish or red-brown. In late budstage temperature elevation is evident but not too prominent (1.1° C above surrounding air temperature (0.7°–1.6° C)), when measured on bud surfaces some minutes before opening. Buds open at about 6:00 p.m. (5:52–6:15 p.m.). Within one second the peduncular bract bursts adaxially (which is the morphological abaxial side) from the base to the top, with a sound like tearing silk. Then the rachillae drop out, hanging vertically (Fig. 1b). The creamy white, smooth inner surface of the bract soon inverts to become the outside (Fig. 1c) and is a bright contrast to the dark background of the forest, especially during twilight.

At this stage the minute female flowers are already at anthesis, the receptive stigmas are bright, hyaline, and adaxially covered with a liquid film, enlarging later to a drop. Male flowers remain in bud stage, but incline abaxially, when released from the pressure in bud (Fig. 1c). A strong sweetish, honeymellow fragrance is emitted. The difference of temperature between the rachilla surface and surrounding air is 1.5°–2.0° C, rising to 3.1° C during twilight (6:30–7:00 p.m.). Then, the rachilla-temperature decreases simultaneously with the air-temperature, but in a slower manner

→

1. *Desmoncus polyacanthos*: (a) inflorescence bud; (b) inflorescence at female anthesis; (c) close up of an inflorescence at female anthesis with abundant visitors; (d) inflorescence at late male anthesis, most staminate flowers abscised; (e) infructescence. Bars: 10 cm (a, b, d, e), 1 cm (c).


a
b
c
d
e

Table 1. Presence of visitors during female and male anthesis and their status in regard to pollination ecology of D. polyacanthos.

Taxon	Female Inflorescence	Male Inflorescence	Status
Coleoptera			
Phyllotrox sp.*	++	++	p
Barinae	–	(+)	v
Epurea sp.	++	++	p
Staphilinidae	(+)	(+)	pp
Hymenoptera			
Halictidae	(+)	(+)	pp
Meliponinae	–	(+)	v
Chalcididae	–	(+)	v
Diptera			
Drosophilidae	++	+	pp
Others	(+)	–	v
Heteroptera			
Miridae	(+)	–	v

– = not observed; (+) = facultative; + = constant, common; ++ = constant, very common; v = visitor; pp = potential pollinator; p = pollinator.

* *Phyllotrox* sp. was identified as a species with the *P. megalops* complex (J. F. Voisin).

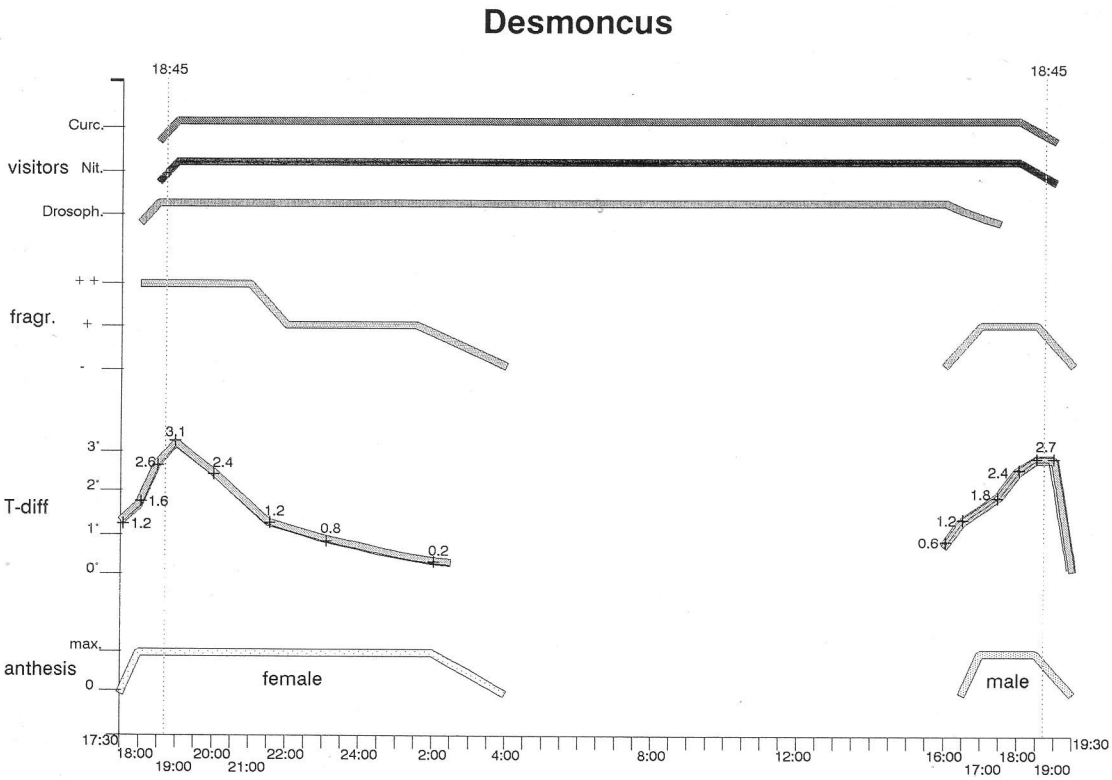
(at ca. 10:00 p.m. there is still a difference of 1° C). Emission of fragrance is positively correlated with temperature elevation, similarly the secretion of stigmatic liquid. At 10:00 p.m. stigmas are still somewhat wet but most of the stigmatic liquid has dried out or been licked. All female flowers are still at anthesis, but the inflorescence seems to have lost its attractants (with the exception of the contrasting feature of the bright bract and male buds). The end of female anthesis is characterized by the lack of fragrance and stigmatic liquid, and by a color change of the dry stigmas from hyaline to whitish, later brownish. This stage occurs shortly before daybreak or later, at least before noon while male flowers and the anthers are still closed.

Male flowers remain closed until the late afternoon of the second day; male anthesis starts at 4:00–5:00 p.m. Anthers dehisce about 15 minutes before the first flowers begin to spread their petals. Within 30 minutes the petals of all flowers of the inflorescence have spread wide enough to release the anthers. Immediately large packs of pollen are available which are sticky and therefore not adapted to wind transport. Even when the clumps dry and fall apart, the monosulcate pollen grains drop to the ground more or less vertically. Fragrance of the same quality, but less quantity as compared with the fragrance during female anthesis is emitted. Again temperature elevation of the rachillae is noticeable. There is a difference of 0.8°–1.5° C at the beginning of staminate anthesis, rising to 3° C for a short period when all flowers are completely open. As long as the flowers have a firm connection with the rachillae, thermogenesis occurs. Soon the flowers begin to abscise from the rachillae (5:30–6:00 p.m.), first one by one, then more. Within 45 minutes the triad-bearing part of the rachillae lacks any male flower (Fig. 1d); 45 minutes later all male flowers had fallen, which is the end of male anthesis (7:00–7:30 p.m.) (Fig. 2).

Insect Visitation to D. polyacanthos. *D. polyacanthos* attracts 10 species regularly (Table 1). Only five of them visit inflorescences in both the female and male stages and therefore can be potential pollinators. No other visitors have been observed. Some minutes after dehiscence of the peduncular bract the first visitors (Drosophilidae) appear. They soon crowd the inflorescence, licking the fleshy inner surface of the peduncular bract, the rachillae, and, respectively, male and female flowers. They stay during all stages of flowering, feeding and mating, but leaving then, especially before and at male anthesis. Fallen staminate flowers are substrate for their larvae; 11–14 days later the new generation emerges in large numbers. The other flies could only be found at early female anthesis before twilight, licking floral parts as well.

The halictid bee (*Megalopta* sp.), only active before and during twilight, visits inflorescences *D. polyacanthos* at both female and male stages, but does not appear constantly. Only a few individuals per inflorescence were observed, if they came at all.

About 45 minutes after the beginning of female anthesis, at twilight (6:45 p.m.), numerous beetles (*Phyllotrox* sp., *Epurea* sp.) fly towards the inflorescence. Soon rachillae are crowded and appear brown spotted by the beetles (Fig. 1c). 200–500 curculionid and 100–350 nitidulid beetles have been counted in the quantitative samples. The arrival of beetles lasts about half an hour but does not end abruptly with complete darkness. An estimated 80% of all beetle visitors are on the inflorescence then (7:15 p.m.). Beetles lick the fluid of female flowers and chew the outside of male buds, but they are mainly concerned in sexual activity, looking for mates and mating for which walking over all parts of the inflorescence is necessary. During the first hours of the night the



2. Anthesis and time-event correlation of thermogenesis (difference of temperature [T-diff] in °C), fragrance [fragr.] (+ + strong, + noticeable, − low (absent)) and presence of the most important visitors of a typical inflorescence of *Desmoncus polyacanthos*.

beetles remain active. In the early morning they hide between the male flowers (which offer shelter because of their abaxial inclination from the rachillae), staying there until male anthesis in the afternoon. When the male flowers open and copious pollen is released, beetles give up their shelter and feed on pollen, and soon are covered all over with pollen packs or single grains. The beetles leave, or are forced to leave, when flowers abscise (Fig. 2).

Two other species of beetles were found more or less regularly: some Staphilinidae, which arrived at twilight and stayed until the end of flowering the next day, and another curculionid. The latter is day-active and arrived at the inflorescence when females were not receptive any more, or later to young infructescences. This species might be a fruit parasite on this and perhaps other species, but never a pollinator.

The meliponid bees were attracted only during staminate anthesis to collect pollen. Not all male inflorescences were visited, but once the source was detected, the bees came in abundance. Other visitors were Heteroptera and Chalcididae, which could rarely be found in either female or male inflorescences and obviously do not play any role in pollination.

Breeding Experiments with Insects (D. polyacanthos). Mating activity and the fact that the most important visitors apparently oviposit into male flowers of *D. polyacanthos* led to these experiments. A survey of breeding experiments is given in Table 2.

Three species (Drosophilidae, *Phyllotrox* sp., *Epurea* sp.) develop in *D. polyacanthos*; they use buds of male flowers for egg deposition, without disturbing their function or even destroying them. Drosophilid flies deposit their eggs on male buds, *Epurea* sp. and *Phyllotrox* sp. in the buds. Their larvae develop in fallen male flowers but change into deeper layers of the soil when pupating (which is only 5–6 days after flowering). The new generations emerge 12–14 days after the flowers had dropped. While most drosophilid flies emerged in the morning (7:00–9:00 a.m.), the beetles emerged in the afternoon only (3:00–6:00 p.m.).

Table 2. Breeding experiments in Desmoncus polyacanthos

Inflorescence	No. of Insects Emerged	Emerged[a] after x-days	Species
D40-5	150	11–12	Drosophilidae
	12	11–12	*Phyllotrox* sp.
	20	13	Drosophilidae
	23	13	*Phyllotrox* sp.
	23	14	Drosophilidae
	13	14	*Phyllotrox* sp.
D40-5-total	193	11–14	Drosophilidae
(300 flowers)	58	11–14	*Phyllotrox* sp.
D40-6	10	11	Drosophilidae
	20	12	Drosophilidae
	7	12	*Phyllotrox* sp.
	1	12	*Epurea* sp.[b]
	8	13	Drosophilidae
	6	13	*Phyllotrox* sp.
D40-6-total	38	11–13	Drosophilidae
(188 flowers)	25	12–13	*Phyllotrox* sp.
	1	12	*Epurea* sp.[b]
D40-7-total	85	11–15	Drosophilidae
(390 flowers)	43	11–15	*Phyllotrox* sp.

[a] Staminate anthesis (abscising of flowers) is the 1st day.
[b] Raising of only one individual might be accidentally, as numerous Nitidulidae emerged in breeding experiments with male flowers of Bactris species (Listabarth, unpubl. data).

Fruit Set (D. polyacanthos). Two or three weeks after anthesis, non-pollinated female flowers had all aborted. Fruit set (the remaining young fruits) now could be counted and was between 50–70%. Pollinated flowers did not grow in length but increased in diameter (1 mm), changed color to green, and still had a firm connection to the rachillae. Only ca. 30% of these fruits matured (Fig. 1e) because of a curculionid parasite or being eaten or damaged by predators before maturity. Mature fruits are bright red, suggesting bird dispersal.

Bagging Experiments (D. polyacanthos). None of the rachillae, which had been bagged to exclude visitors (and in some case wind-borne pollen as well), showed fruit set. Even rachillae, from which bags had been removed in the early morning (4:30 a.m.), when pistillate flowers were still at anthesis, did not set fruit. Fifteen to eighteen days later these rachillae did not bear any fruit, while not-bagged rachillae of the same inflorescences had fruit. Thus, fruit set without pollination does not occur.

Anomalies (D. polyacanthos). Two inflorescences behaved abnormally: One opened at 6:30 a.m.; female flowers were receptive but only a few drosophilid flies and one *Phyllotrox* sp. visited that inflorescence. Pistillate flowers lost receptivity at high noon, and staminate anthesis began the same day as usual. The inflorescence in the male stage was visited by the halictid bee and a few *Phyllotrox* sp. Fifteen days later the rachillae did not bear any fruit.

Another inflorescence opened "in time" (6:10 p.m.), but showed a simultaneous female and male anthesis. When all staminate flowers had abscised (8:00 p.m.), pistillate flowers were still at anthesis. Only two drosphilid flies visited that inflorescence. All fruits aborted within the next 12 days.

Comparison with D. mitis. A comparison between the two species and a summary of reproduction events in *Desmoncus* is given in Table 3; *D. mitis* does not show substantial differences, but the following features are worth noting:

(1) Flowering behavior: male anthesis continues strikingly longer, first flowers are not abscising until dark (7:15) and male anthesis ends at ca. 8:15–8:30 p.m. Thermogenesis occurs in late inflorescence bud and during female and male anthesis, but the temperature difference never exceeds 1.7° C.

(2) Insect visitors: The spectrum of visitors is similar to that of *D. polyacanthos*, but lacks Meliponinae, Chalcididae, and Miridae; overall the same species as in *D. polyacanthos* were found. The number of visitors is lower according to the size of the inflorescences, especially in relation in nitidulid beetles. In quantitative samples *Phyllotrox* sp. dominates (115–250 individuals, once even 402), whereas *Epurea* sp. is of less importance (max. 16/sample).

(3) Breeding experiments resulted in new generations of Drosophilidae and *Phyllotrox* sp. but not of *Epurea* sp. Bagged inflorescences never showed fruit set. Anomalies as in *D. polyacanthos* never were observed.

Floral Dynamics and Geitonogamy in D. mitis. *D. mitis* is especially suitable for investigation of these aspects. Individuals were numerous enough to investigate a population within a plot to find the flowering mechanisms of individual clusters.

A plot with five clusters inside (Fig. 3) was marked for a separate investigation of flowering phenology. This plot contained a total of 14 fertile axes with 22 inflorescences which flowered from mid-December 1989 until mid-January 1990. The days when female anthesis occurred within one

Table 3. Comparison of reproduction events between D. polyacanthos *and* D. mitis.

		Reproductive Events		T-diff/fragr	
Day	Time	*D. polyacanthos*	*D. mitis*	*D. polyacanthos*	*D. mitis*
1st day	ca. 6:00 p.m.	female anthesis starts		2.0/++	1.2/++
	6:30–7:15 p.m.	visitors arriving in profusion		3.1/++	1.7/++
	during night	feeding-mating-oviposition of Drosophilidae/*Phyllotrox* sp./(*Epurea* sp.)			
2nd day	morning	end of female anthesis—visitors hidden, inactive		0.0/−	0.0/−
	ca. 4:30 p.m.	male anthesis starts—visitors become active, feeding on pollen		1.5/+	0.9/+
	5:30–6:00 p.m.	first male flowers drop	all flowers on rachillae	3.0/+	1.2/+
	6:30–7:00 p.m.	visitors leave			
		only a few flowers left	all flowers on rachillae	0.0/−	1.2/+
	ca. 7:30 p.m.	end of male anthesis	first flowers drop—without visitors		1.2/+
	ca. 8:30 p.m.		end of male anthesis		

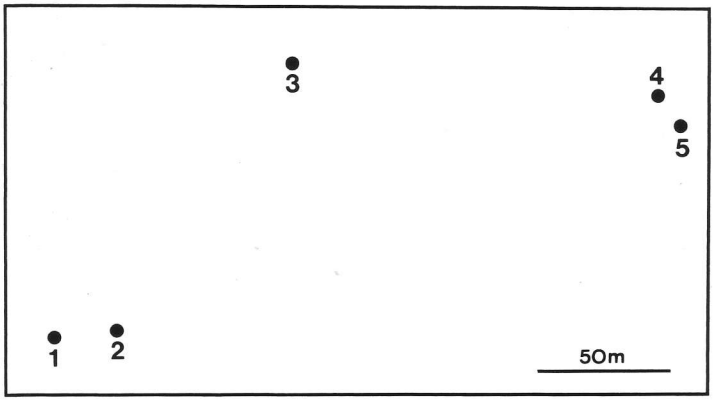
For abbreviations see Figure 2.

week show a typical pattern of flowering in *D. mitis*. Inflorescences with a neighboring pollen source inside the plot appear in bold print. Seventy-five percent of the inflorescences during female anthesis had a pollen source even within that limited area, without regard to the surrounding clusters outside the plot.

Possibilities of geitonogamy, which is autogamy or self-fertilization in a broad sense, are of multiple origin: First, geitonogamy within the same inflorescence is avoided completely by the strict dichogamy (anthesis of staminate and pistillate flowers at different times) of the inflorescence and no exception was found. Second, geitonogamy between two inflorescences of one stem, which are at anthesis during two subsequent days was observed only rarely (Fig. 4). The third case, geitonogamy between inflorescences of different stems of one cluster, is frequently found. Autocompatibility was not tested.

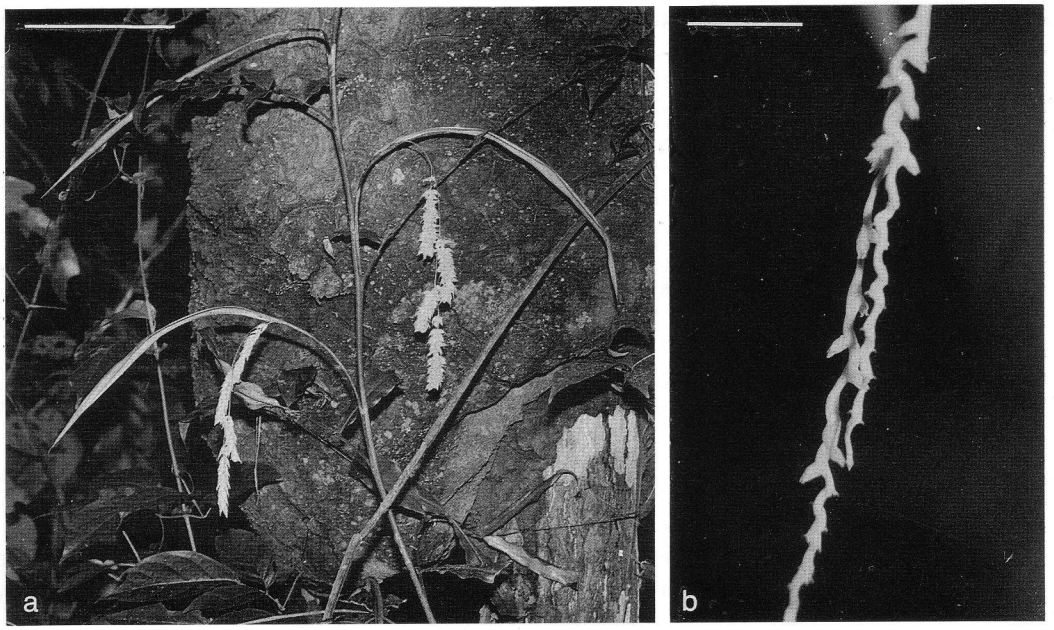
Discussion

Desmoncus *within the Bactridinae.* Derelomini (Curculionidae) and Nitidulidae are frequent palm pollinators (Henderson 1986, Barfod et al. 1987, Anderson et al. 1988, and many others). Within the Bactridinae they were found in the protogynous inflorescences of *Astrocaryum* (Bullock 1981, Burquez et al. 1987, Listabarth 1992), *Acrocomia* (Scariot 1987, Scariot et al. 1991) and *Bactris* (Essig 1971, Mora Urpí and Solis 1980, Bullock 1981, Mora Urpí 1982, Beach 1984, Listabarth 1992). Special attention should



date	No.
24/12/89	5
25/12/89	**5**
26/12/89	**1**
27/12/89	**1**
27/12/89	**4**
27/12/89	**3**
30/12/89	2
31/12/89	**1**

3. Distribution of the clusters of *Desmoncus mitis* and list of female anthesis during one week; for further explanations see text.



4. *Desmoncus mitis*: (a) Stem with inflorescence bud (uppermost) and inflorescences in male (middle) and female (below) stage. (b) detail of a rachilla after male anthesis with minute female flowers. Bars: 10 cm (a), 1 cm (b).

be given to *Bactris*, which apparently shows the flowering cycle most similar to that of *Desmoncus*. Essig (1971), Mora Urpí and Solis (1980) and Mora Urpí (1982) state that pollination of *Bactris* is by Derelomini and Nitidulidae; but Bullock (1981) and Beach (1984) found *Cyclocephala* and *Mimeoma* (Scarabaeidae: Dynastinae) to be probably more important than the abundant small beetles. However, *Phyllotrox* (Curculionidae: Derelomini) and *Epurea* (Nitidulidae) are the pollinators of *Desmoncus polyacanthos* and *D. mitis* in Peru.

Another limiting factor is duration of pistillate anthesis in the protogynous *Bactris*. Stigmas are considered to remain receptive during male anthesis (e.g., Beach 1984). The inflorescences of *Desmoncus*, mentioned as "apparently protandrous" (Uhl and Dransfield 1987) were found to be strongly protogynous. Drying and withering of the stigmas seemed to be a valuable feature for determination of the end of female anthesis and occurred regularly before staminate anthesis in *Desmoncus*.

Uhl and Moore (1977) suggested a clear correlation of floral anatomy with pollination in *Bactris*. The anthers were found to be well protected by fibrous sheaths and raphides in the proximal parts of the petals while the outer parts were without protection and the tissue adapted to attract and feed beetles. Tannins, which are distasteful to herbivores were lacking completely. In contrast pistillate flowers were protected firmly by vasculature and tannins. Complexity of the system has been underestimated, because reproduction of the pollinating beetles in the male flowers (see Table 2) of any member with the Bactridinae was not established until now. Breeding of the pollinators undoubtedly is a striking and important feature in the pollination ecology of the two closely related genera.

Visitors. As pointed out above (Table 1), only five species are possible as pollen vectors in *D. polyacanthos* and *D. mitis*. Of these only the drosophilid flies, *Phyllotrox* sp. and *Epurea* sp., that occur in both, can have quantitative importance for pollination.

Drosophilid flies, frequently found on palm inflorescences and sometimes reported to be pollinators (Henderson 1986, Olesen and Balslev 1990) do not play an important role in *Desmoncus*. Most individuals left before or during early male anthesis, when female inflorescences are not yet opened. They seem more active during female anthesis, licking fluids, mating and ovipositing, not waiting for more reward (which is offered during

male anthesis). They even seem to be disturbed by the abundant beetles of *Epurea* sp. and *Phyllotrox* sp., which become more and more active during male anthesis and may therefore leave. Their further activity is unknown. Beach (1984) raised Drosophilidae from the fallen staminate flowers of *Bactris*. The same situation occurs in *Desmoncus*. He further reported drosophilid flies which defend eggs against foraging meliponid bees. This was not observed in *Desmoncus* and eggs were not in danger, as shown by the great number of emerging insects in the breeding experiments (Table 2). Drosophilid flies can cause pollination in *Desmoncus*. They are not the most effective pollinators, but may still represent a potential pollinator in the absence of the beetles.

Phyllotrox sp. and *Epurea* sp. in *D. polyacanthos* and *Phyllotrox* sp. in *D. mitis*, are the legitimate pollinators. They arrive on inflorescences at female anthesis and remain there until the next day, feeding on pollen during male anthesis. At twilight they depart for another plant which is at female anthesis. Beetles could rarely be observed arriving on inflorescences at male anthesis. In the two *Desmoncus* species beetles leave for different purposes at the same time: while *D. polyacanthos* shows a more sophisticated system and abscising of the male flowers forces visitors to depart for another inflorescence, *D. mitis* underlines the much bigger attractiveness (fragrance!) of inflorescences at the female stage (Table 3). At twilight *Phyllotrox* sp. change from the inflorescence still at male anthesis to one at female anthesis, where they will find their mates as well as food and shelter. *Phyllotrox* sp. and *Epurea* sp. do not show essential differences in behavior. Once on an inflorescence at female anthesis they mate and oviposit into the male buds, feed on flower tissue or lick fluids of female flowers; thus, pollen, which is adherent to them can be transferred. In late female anthesis they begin to look for shelter, waiting for pollen which will be released during male anthesis the next day.

The main pollinators of *Desmoncus*, *Phyllotrox* sp. (and *Epurea* sp.) may not be seen as a "pollinator team," changing at the same time from one inflorescence to another. More often there is an exchange of the beetles involved. Those which did not succeed in mating or still continue to reach maturity will join; still others might not find any inflorescence or will die after ovipositing.

Staphilinids and the halictid bees were found facultatively on inflorescences at female and male anthesis. While staphilinids do not play a role in pollination (too few, small individuals), the halictid bee, if present during female anthesis, is a potential pollinator. The halictid bee when searching for pollen sources is attracted by the conspicuous inflorescences during twilight. It is also visually oriented as typical for bees, and inflorescences bagged with a plastic bag (no fragrance) were also visited. When visiting an inflorescence at female anthesis the bees, covered ventrally with pollen (ventral collectors), looked for pollen on the whole inflorescence or at least on single rachillae and left without success. What happens is therefore not a pollen theft (sensu Inouye 1980) only, but affecting pollination by accident. However, even if we consider pollination by the halictid bee as at best a rare event, the bee's possible role is as a long distance pollinator.

Pollination and Breeding System. Pollination of *Desmoncus* by insects should be considered as the rule. The syndrome: The protogynous fragrant inflorescence attracts pollinators (temperature-elevation supports emission of fragrance). Visitors are there for mating and feeding and shelter (during the non-flowering period). Male anthesis provides pollen. This syndrome has been reported in all its features several times as for Nymphaeaceae (Prance and Arias 1975, Prance and Anderson 1976), *Magnolia* (Thien 1974), Annonaceae (Gottsberger 1977, 1990), Araceae (Gottsberger 1990), Cyclanthaceae (Beach 1982; Gottsberger 1990, 1991) and Palmae (e.g., Beach 1984) and in many other studies. *Desmoncus* also ensures reproduction of its pollinators. Beetles do not influence the function of the male flowers and their larvae utilize flowers out of function. Thus, the relationship between *Desmoncus* and these beetles can be considered as a symbiosis and demonstrates a relationship with at least one co-adaptation of beetles to the plant, representing more than "a one-sided adaptation of flowers to be the behavior, necessities, and sense capacities of beetles," which Gottsberger (1990) states for the taxa cited above. Adaptations of beetles need not necessarily be of morphological nature only; for instance, activity patterns of the beetles or their ability to find inflorescences of *Desmoncus* must have been evolved in an adaptive way to make the system so effective. Or, if we follow Beach (1984) that *Bactris* is pollinated by Dynastidae and Curculionidae, how would a one-sided adaptation of *Bactris* toward a 20 mm and a 2 mm beetle appear? However, we still lack answers for

hosts of questions concerning the biology of beetle pollinators of cantharophilous plants and should stress that in future work.

Pollen was found to fall down the inflorescence, but not to rise, as does pollen of anemophilous species. Thus, the distances between the individuals make it quite unlikely that wind pollination plays any role in the reproductive biology of *Desmoncus*. Inflorescences bagged to deter visitors but which allowed penetration of wind-borne pollen never showed fruit set. Nevertheless, pollination caused by gravity (which then most likely is geitonogamy) should be possible.

There are no experimental data but, for obvious reasons, a hypothesis of self-compatibility and geitonogamy versus the existence of self-incompatibility mechanisms is reasonable in *Desmoncus*. As pointed out above the prerequisites for geitonogamy within the inflorescences of the same cluster are present. Pollinators would not look for an inflorescence far away when being next to one of the same cluster. As such inflorescences which had a genetically identical pollen source showed an average fruit set of 50–70%, self-compatibility may be regarded to occur.

On the other hand, an inflorescence, which showed female and male anthesis simultaneously (see anomalies), did not bear any fruit. At least in a few pistillate flowers pollination by gravity should have occurred. One must exclude the possibility of self-compatibility in this case.

We may not expect a clearcut distinction between the two breeding systems considered, since even species where self-incompatibility has been established may set fruit to a certain extent (Bawa 1979). There are data for rates of self-compatibility in *Bactris gasipaes* (Clement and Arkcoll 1984) but they are without quantitative significance, as controls showed the same output of mature fruit as the self-compatibility rate stated. However, the data are appropriate to suggest the occurrence of self-compatibility in *B. gasipaes*. We see that without a profound series of specific experiments there is no solution to this problem.

Vegetative reproduction (clustering) is for two reasons an important part of the reproductive cycle of *Desmoncus*. First, the individual extends its life span and second, the number of inflorescences provided per individual is dramatically increased, thus influencing the flowering dynamics of the population. Vegetative reproduction in *Desmoncus* therefore seems to favor sexual reproduction, while an effective pollination system and pollinator breeding provides outcrossing by beetles (Drosophilidae and halictid bees) and production of seeds.

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Vegetative Growth in Chamaedorea bartlingiana*

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ABSTRACT

Chamaedorea bartlingiana is a dioecious solitary palm, growing up to 4 m in height, that occurs as an understory species of some Andean cloud forests in Colombia and Venezuela. In this paper, we describe the main changes in vegetative morphology of *C. bartlingiana* from germination to the adult stage, and we estimate how long the plant lasts in each stage: juveniles 7 years, prereproductives 6 years, and more than 50 years as adults. Total life span is 60 to 66 years.

C. bartlingiana shows important morphological changes in leaf shape and size (from only a small bifid blade to a 53 cm paripinnate lamina), and in stem thickness and orientation (thin, horizontal and underground, to 2 cm in diameter, vertical and aerial), when plants change from juvenile to adult stages. There are no vegetative morphological differences between males and females.

Biomass allocation changes between stages: leaves and roots are more important in juveniles, stems and roots are more important in adults. There is no evidence that sexes have different storage organs or higher storage in some particular tissue.

Chamaedorea bartlingiana H. Wendl. is a dioecious solitary palm which grows up to 4 m in height (Fig. 1). It is found as an understory species in some Andean cloud forests in Colombia and Venezuela. In Mérida, Venezuela, this species is dominant in undisturbed understories between 2,000 and 2,500 m.

Individual palms have a flexible, thin stem with a diameter no greater than 2 cm, which continues to grow even when the weight of branches falling from the canopy bends the plants to the ground. The low rate of leaf production, long leaf life span, and different reproductive patterns in both sexes suggest a high adaptation of this species to understory environments (Ataroff and Schwarzkopf 1992).

In this article, the main changes in vegetative morphology of *C. bartlingiana* are described from germination to adult stage, with the absolute age of the plant estimated in each stage.

* Now *C. pinnatifrons*. See "Chamaedorea Palms" (Hodel 1992).

Study Area

This study was conducted in a cloud forest in the locality of Monte Zerpa, 3 km north of Mérida at 2,150 m. The nearest meteorological station, Santa Rosa (1,950 m), reports a mean annual temperature of 16.9° C and a bimodal water regime with two periods of low precipitation: the lower period between January and February and another in July; and two periods of high precipitation: the lower from March to June, and the higher from September to November. The mean total annual precipitation is 2,072 mm with a mean driest month of 68 mm. The high degree of cloud cover is seen by the mean sunshine of 5.3 hours of sunshine/day with a minimum of 3 hours of sunshine/day in April and a maximum of 7 hours of sunshine/day in January.

The complex vertical structure in this forest presents different strata with undefined limits. It is also rich in epiphytes (bryophytes, pteridophytes, Bromeliaceae, Orchidaceae, Araceae). There are between 30 and 80 tree species/ha (Sarmiento et al. 1971) with the canopy at approximately 25 m. The understory has more than 30 species of angiosperms, mainly Solanaceae, Rubiaceae, Piperaceae, Begoniaceae, and Poaceae. However, a single palm species, *Chamaedorea bartlingiana*, dominates the undisturbed forest understory, reaching its highest density (1 adult/m^2) in the study area in well-drained soils and under a dense closed canopy (Schwarzkopf 1985).

Methodology

The growth data is derived from two sources: (1) 272 individuals were marked and followed as part of a sampling design for population dynamics and reproductive patterns studies (Ataroff and Schwarzkopf 1992). Morphological changes and leaf production of all marked individuals were monitored for 3½ years of study (November 1985–April 1989). The marked individuals were dis-

1. Adult of *Chamaedorea bartlingiana* (female).

tributed as follows: 100 juveniles (J), 50 prereproductive (P), 22 young adults (A_I), 50 intermediate adults (A_{II}) and 50 old adults (A_{III}, A_{IV} and A_V). (2) In order to establish a relationship between age, leaf production, and stem morphology, all new emergent seedlings in 61 plots of 1 m^2 were marked and followed from October 1986 until April 1989. Stem morphology was determined by dissection of several plants of different ages during the first years of the plants' lives. Data were taken monthly for the first two years and every two months for the remainder of the study.

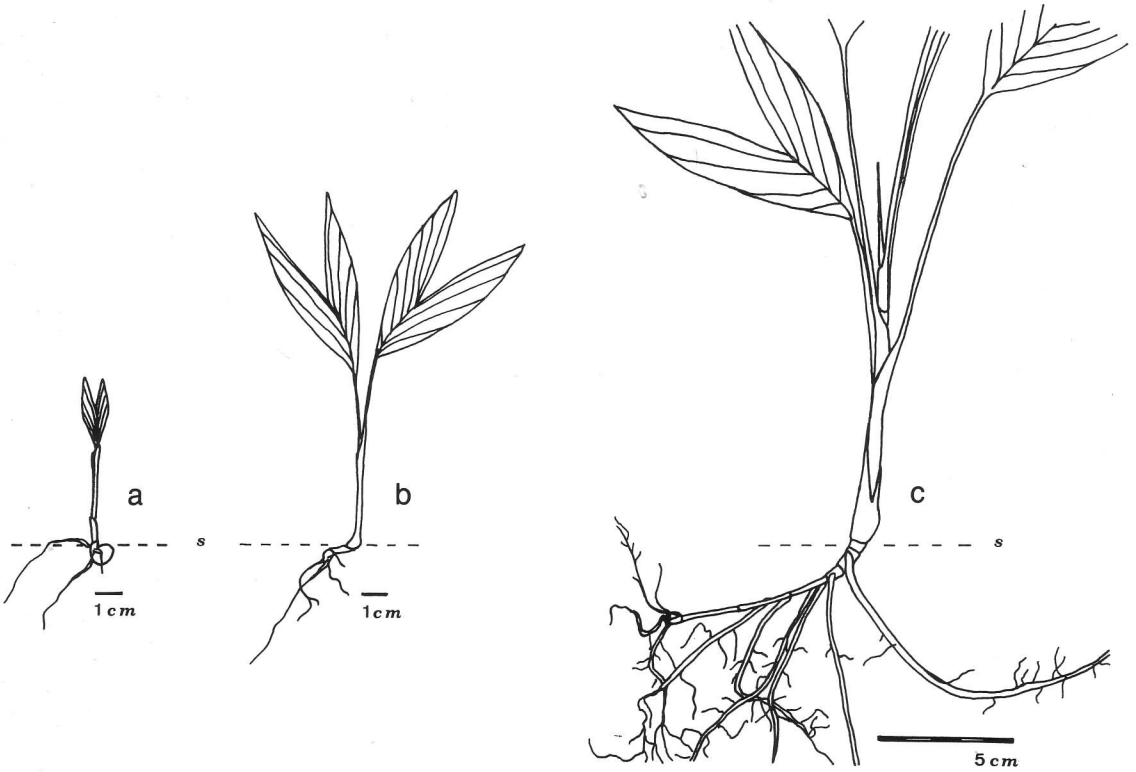
In order to establish morphological information, 40 individuals, representative of different stages, were taken to the laboratory for study of the stem base morphology, node count, and inflorescence scar sequences.

Age was estimated as follows: $D_i = N_i/L_i$ and $A_i = A_{i-1} + D_i$, where i = development stage (from seedling to old adult), D_i = stage duration (years), N_i = leaves (nodes) produced during the stage "i", L_i = mean leaf production (leaves/year) during the stage "i", and A_i = age at the end of stage "i" (years).

Another set of individuals representative of different stages was taken to the laboratory and separated into seed (in the case of seedlings), roots, stem, stem apex (which includes sheath of live leaves), live leaves, inflorescence, peduncle of inflorescence, and necromass (dead leaves and reproductive parts attached to the plant). This material was oven-dried until constant weight was reached and weighed for the biomass study.

Results

Growth Stages. Shape and size of stem base and leaves change during the individual's life span.



2. Vegetative growth from germination to prereproductive stage. a) germination, seedling younger than 15 days old, b) 2 years old juvenile, c) beginning of prereproductive stage (4 of its 5 leaves are juvenile type). S: soil surface.

Based on these changes, three main stages are defined in a plant's life: juvenile, prereproductive, and adult. Figures 2, 3 and 4 show the most significant morphological changes.

I. Juvenile Stage: The juvenile stage starts with germination (Fig. 2a), which is adjacent-ligular (Uhl and Dransfield 1987). From the moment the second leaf appears, the stem base curves and becomes horizontal (Fig. 2b). During this stage, internode development occurs underground, directly under the surface, and the stem remains horizontal (Fig. 2).

The leaves are small and have a bifid blade (Figs. 2a,2b,4a). The last two or three leaves of this stage frequently have two or three little folioles. This stage ends when the node 10 ± 2 is formed.

It is difficult to distinguish a seedling stage from a general juvenile stage because stem and leaf morphology do not change. However, we can consider the life-span of the first two leaves as the first stage, since the seed remains attached to the plant in this period and leaves have a longer life-span: 20.9 months for the first leaf and 22.0 months for the second leaf compared to 17.5 months for the third leaf (Ataroff and Schwarzkopf 1992).

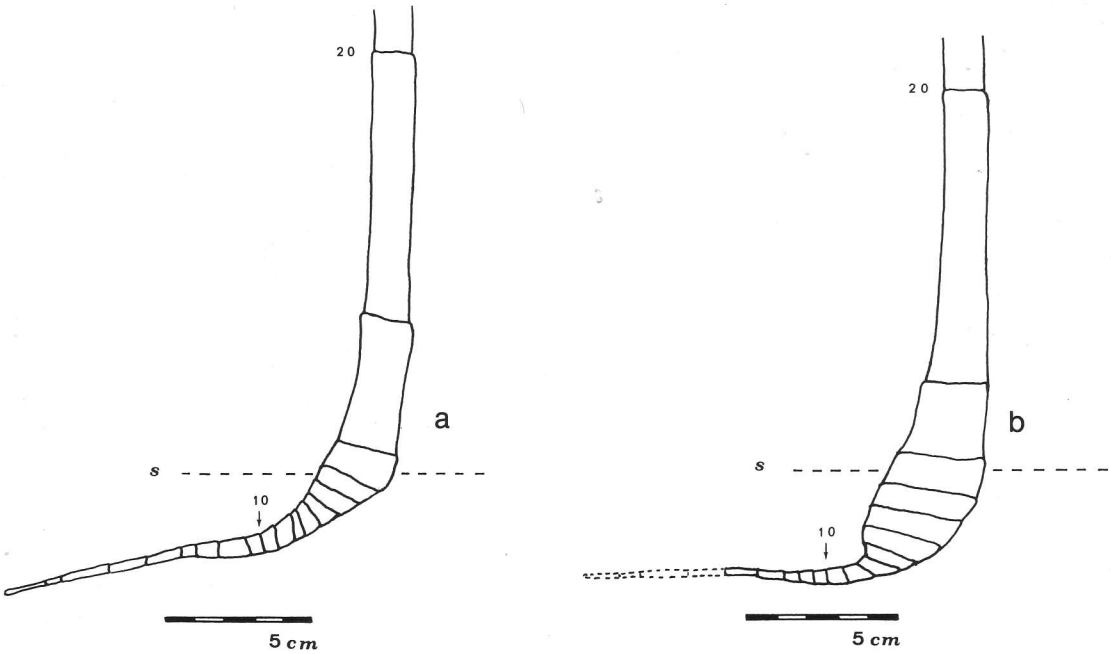
II. Prereproductive Stage: The prereproductive stage begins at the end of horizontal stem growth. New internodes elongate causing the stem to curve upward, or vertically. All internodes are curved, forming the future stem base of the adult plant (Figs. 2c,3a). This stem base swells during the prereproductive stage until it reaches its definitive diameter.

Simultaneously, leaves change to paripinnate with 3 to 10 leaflets (Fig. 4b) with each leaf growing larger than its precedent.

This stage ends with the formation of two long, above ground and vertical internodes (nodes 18 to 20). Their diameter is the maximum diameter reached during stem growth (Figs. 3a,3b).

III. Adult Stage: Adult stage begins when an axillary bud, corresponding to node 17 to 20, differentiates into a reproductive bud. From this moment on, all axillary buds become reproductive, leaving a marked scar over each node.

During this stage, the stem grows above ground and vertically. As the weight of branches falling



3. Adult stem base and underground parts, without roots. a) beginning of adult stage (individual with 23 nodes, apex bud at 70 cm), b) adult (individual with 31 nodes, apex bud at 120 cm, 1st reproductive bud in node 22). Nodes 10 and 20 are indicated; S: soil surface.

from the canopy bends the stem to the ground, new internodes curve to attain a vertical position. This decumbent form is accidental. The stem base diameter remains the same as reached in the preceding stage. The oldest part of the stem, corresponding to the first underground nodes, decomposes and disappears (Fig. 3b).

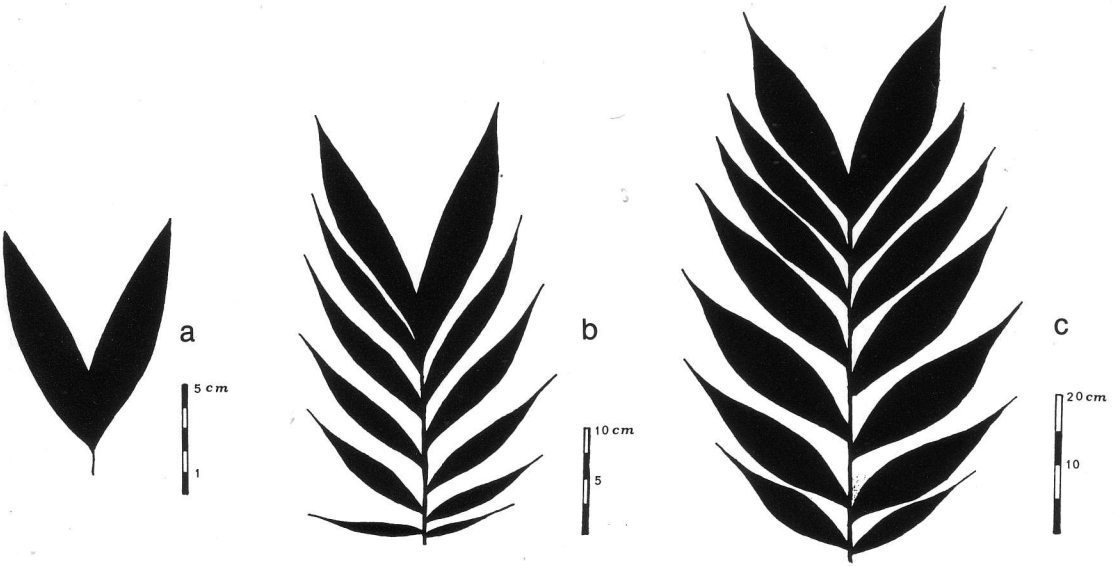
Leaves remain paripinnate, but they are bigger than in prereproductive, 68.3 cm including lamina and petiole, with 7 to 14 wider leaflets (Fig. 4c).

Stage Duration. The number of nodes produced during life span and all nodes that have produced inflorescence are easy to count since nodes form strong rings around the stem and inflorescences leave conspicuous scars. Only one leaf and one inflorescence are produced per node in adults of this species. The only way to grow is by leaf or node production. The knowledge of total nodes and rate of leaf production per stage (Ataroff and Schwarzkopf 1992) allows a correlation between stages and absolute age of plants (Table 1). Juvenile and prereproductive stages are long-lived, 7 ± 1 years and 6 ± 1 years respectively; it takes nearly 13 years for plants to become reproductive. This species is reproductive for the duration of the adult stage, which lasts more than 50 years $^4/_5$ of the plant's life. A population dynamics study would be necessary to evaluate the contributions of each stage to the population growth.

Leaf Growth. Between germination and the adult stage, each new leaf is bigger than the preceding one (Fig. 5). During the juvenile stage, there is slow growth at a rate of 1.5 cm per new leaf lamina. During the prereproductive stage, the lamina mean growth rate increases to 3.5 cm. In adults, leaf lamina size remains around the mean, 53 cm. The leaf lamina size ranges from 7.5 cm, in the first juvenile leaf, to 53 cm in adults (Table 2).

The petiole length increases from the first leaf in the juvenile stage (3.1 cm) to the mean juvenile length (6.5 cm) and continues to grow in the prereproductive stage (25.8 cm) (Table 2). The maximum length is reached in the prereproductive stage and then declines in the adult stage (15.8 cm). Although the petiole growth pattern is distinct, the growth of the entire leaf is similar to that seen in lamina growth in Figure 5.

Leaf life span values of *C. bartlingiana* (Table 3) corresponds to long-lived leaves, common to understory plants (Bentley 1979, Kikuzawa 1989), but they are surprisingly low compared to other understory palms: *Rhapidophyllum hystrix* 5.9 years (Clancy and Sullivan 1990), *Podococcus*



4. Leaf types (lamina): a) juvenile leaf, b) prereproductive leaf and c) adult leaf.

barteri 5 years (Bullock 1980), 3 years *Geonoma congesta* (Chazdon 1992), and other values reported by Corner (1966) and Tomlinson (1990): *Elacis guineensis* 3.5 years, *Cocos nucifera* 5 years, *Nypa fruticans* 5.5 years, *Rhopalostylis sapida* 7 years and *Lodoicea maldivica* 18 years.

Biomass Allocation. The biomass distribution to each big structural part of the plant changes during its life span. During the juvenile stage, leaves are 35% to 45% of the total biomass, while the rest is divided more or less equally between stem and roots (Fig. 6, Table 4). During the prereproductive stage, the stem apex (the future stem base) swells, concentrating resources and becoming the largest part of plant (Fig. 6, Table 4).

At the beginning of the adult stage, leaves reach their maximum size. They remain unchanged for the rest of the plant's life (Fig. 5). Stem and roots continue growing, so their biomass increase with age in relation to the rest of the plant (Fig. 6, Table 4). Leaves, reproductive parts, and necromass have approximately equivalent relative biomass proportions.

The root system is strongly attached to soil and

Table 1. Growth characteristics and age of stages. Adult stage has been subdivided into 5 categories each comprising the production of 20 new nodes (since this is an arbitrary division error of ±2 or ±1 comes from former stages).

Stage		Final Leaf (or Node)	Mean Leaf Production (Leaves/Year)	Stage Duration (Years)	Final Age (Years)
Juvenile		10 ± 2	1.5	7 ± 1	7 ± 1
Prereproductive		20 ± 2	1.7	6 ± 1	13 ± 1
Adult I	♀	40 ± 2	2.1	10 ± 1	23 ± 1
	♂		2.4	8 ± 1	22 ± 1
Adult II	♀	60 ± 2	2.0	10 ± 1	33 ± 1
	♂		2.2	9 ± 1	31 ± 1
Adult III	♀	80 ± 2	1.9	11 ± 1	44 ± 1
	♂		2.1	10 ± 1	41 ± 1
Adult IV	♀	100 ± 2	1.8	11 ± 1	55 ± 1
	♂		2.2	9 ± 1	50 ± 1
Adult V	♀	120 ± 2	1.8	11 ± 1	66 ± 1
	♂		1.8	11 ± 1	61 ± 1

Table 2. Mean leaf length in cm ($\bar{X} \pm s$).

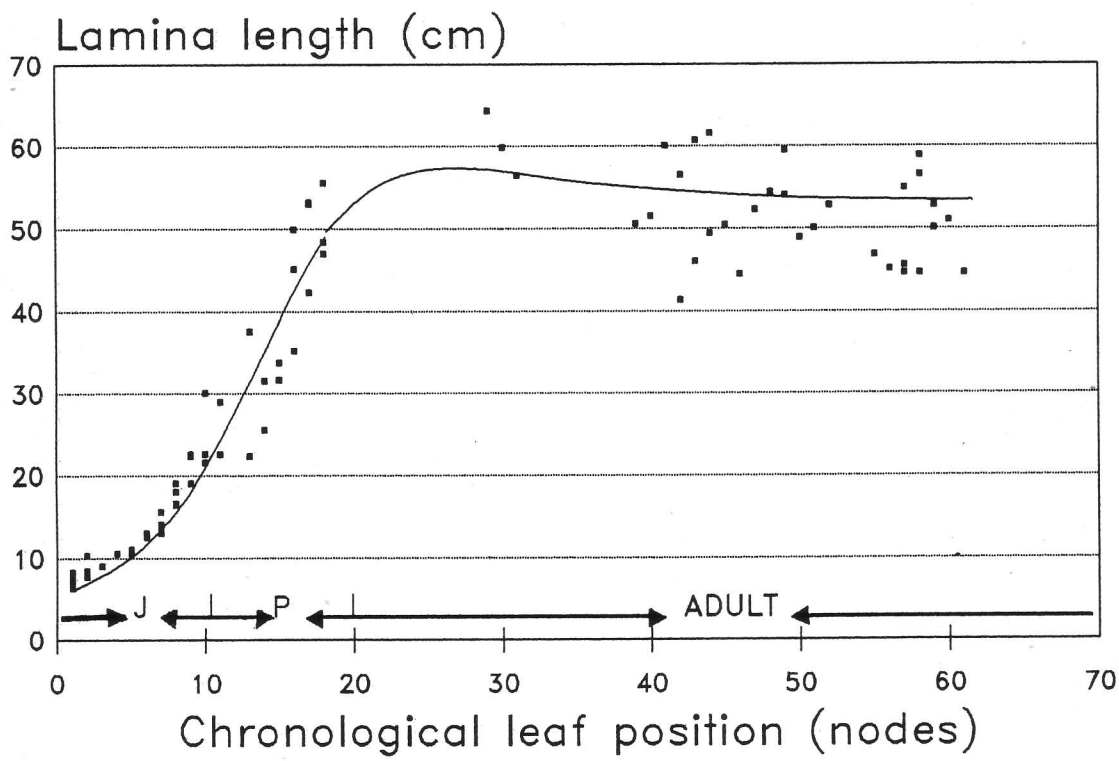
	Juvenile Stage	Prereproductive Stage	Adult Stage
Lamina length	11.35 ± 0.8	33.19 ± 2.4	52.70 ± 1.2
Petiole length	6.49 ± 0.8	25.84 ± 2.1	15.80 ± 0.8
Total leaf length	17.57 ± 1.6	56.29 ± 4.5	68.31 ± 1.6

mixed with the roots of other species, particularly in adults. Because of this, biomass is underestimated even with careful root collection. Total biomass of two nearly 30 year old individuals, approximately 2 m high, differ greatly with values of 410.6 g and 240.0 g (Table 4). This difference is not necessarily due to sex, since the means of total male individuals and female individuals show different biomass distribution, for example, in reproductive parts, stem apex, and necromass (Table 4).

Vegetative Characters vs Sexes. There are no differences between male and female vegetative morphologies. Therefore, juveniles and prereproductives cannot be typed according to gender. In the study area, male-female ratio in adults was equivalent (51% F/49% M). The same has been reported for other dioecious palms (Clancy and Sullivan 1990).

Leaf production rate is consistently slower in females, with a significant difference in leaf production time, 0.5 to 1.5 months (ANOVA $P < 0.024$) (Ataroff and Schwarzkopf 1992) and total leaf production, 1.97 leaves/year compared to 2.20 leaves/year for the male individuals (ANOVA $P < 0.0001$).

Except for youngest adults, the mean crown size is slightly larger in females, but differences are not statistically significant. Crown size and leaf production rates allow estimation of leaf life-span since, under normal conditions, a new leaf unfolds as the oldest dies (Table 3). Average leaf life-span



5. Leaf size variation (lamina length, cm) from 1st to 61st leaf.

Table 3. Vegetative growth parameters in young individuals, and in adults of both sexes.

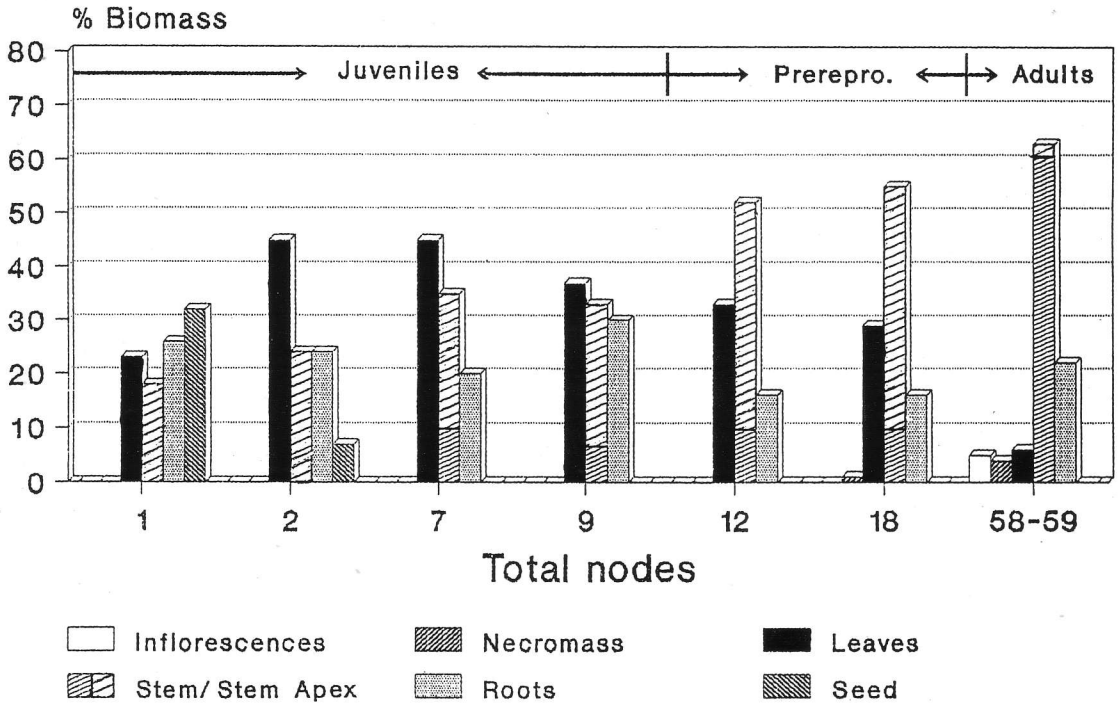
Stage		Mean Crown Size (Leaves/Crown)	Mean Leaf Production (Leaves/Year)	Mean Leaf Life-span (Years)
Juvenile		2.5 ± 0.09	1.5 ± 0.03	1.8 ± 0.03
Prereproductive		3.5 ± 0.16	1.7 ± 0.04	2.3 ± 0.05
Adult I	♀	5.0 ± 0.00	2.1 ± 0.12	2.6 ± 0.11
	♂	5.3 ± 0.42	2.4 ± 0.13	2.3 ± 0.12
Adult II	♀	4.3 ± 0.20	2.0 ± 0.07	2.3 ± 0.06
	♂	4.4 ± 0.24	2.2 ± 0.08	2.1 ± 0.05
Adult III	♀	4.7 ± 0.22	1.9 ± 0.04	2.6 ± 0.05
	♂	4.4 ± 0.15	2.1 ± 0.05	2.2 ± 0.04
Adult IV	♀	4.1 ± 0.14	1.8 ± 0.08	2.4 ± 0.11
	♂	4.0 ± 0.58	2.2 ± 0.29	1.9 ± 0.15

is significant at 2.5 years for females and 2.2 years for males (ANOVA $P < 0.0001$).

Discussion

C. bartlingiana exhibits important morphological changes in leaf shape, leaf size, stem thickness, and stem orientation as the plants develop. There are no vegetative morphological differences between sexes. Therefore, it is not possible to distinguish sex in non-reproductive individuals. The main vegetative differences between sexes are leaf life-span and leaf production rates.

Leaf production rates vary at different stages and between sexes (Ataroff and Schwarzkopf 1992), lower in juveniles and prereproductives compared to adults, and lower in females. Similar variances have been reported for other palms (De Steven et al. 1987, Oyama 1990) and other dioecious species (Lloyd and Webb 1977).



6. Biomass allocation: distribution of total biomass (%) between different parts of a plant, in individuals with 1, 2, 7, 9, 12, 18, 58 and 59 nodes.

Table 4. Biomass in dry weight (g) distributed into different structural plant parts, in plants of different age and sex.

Total nodes:	1 *	2 *	7	9	11 **	18 *	58 ♀	59 ♂	Adults x♀	Adults x♂
Age (years)	0.5	1	5	6	8	11	31	28		
Stem apex	0.03	0.2	0.5	1.1	5.4	16.1	10.7	9.5	8.2	15.9
Single lamina	0.04	0.19	0.18	0.32	0.84	2.22	5.85	4.5	4.0	4.2
Peduncle	—	—	—	—	—	—	5.4	5.8	3.9	4.1
Inflorescence	—	—	—	—	—	—	11.0	11.2	6.2	8.4
Total reproductive	—	—	—	—	—	—	16.4	17.0	10.1	12.5
Necromass	—	—	—	—	—	0.3	15.2	13.3	4.8	6.6
Leaves	0.04	0.37	0.9	1.6	3.6	10.5	23.4	13.5	18.6	22.4
Total stem	0.03	0.2	0.7	1.4	6.4	19.7	251.9	159.5	—	—
Roots	0.05	0.2	0.4	1.3	2.1	5.7	103.7	36.7	—	—
Seed	0.05	0.06	—	—	—	—	—	—	—	—
Total plant	0.17	0.8	2.0	4.3	12.1	36.2	410.6	240.0		

*: the mean of 3 plants.
**: the mean of 2 plants.
x♀: the mean of 4 plants, with 31, 44, 52 and 58 nodes (16, 23, 27 and 28 years respectively).
x♂: the mean of 2 plants, with 49 and 59 nodes (23 and 28 years respectively).
Total reproductive: sum of reproductive parts (peduncle and inflorescence).
Total stem: sum of stem apex and the rest of the stem.
Total plant: sum of total reproductive, necromass, leaves, total stem, roots and seed.

The lower leaf production rates in females have been interpreted as a consequence of a higher reproductive cost (Hoffman and Alliende 1984, Lloyd and Webb 1977, Silvertown 1987, Clark and Clark 1988). In addition to the fact that females produce fewer leaves/year and leaves are more long-lived, the main feature of *C. bartlingiana* is a female reproductive pattern with rest periods which allows them to meet the energetic cost of fruit production (Ataroff and Schwarzkopf 1992).

It would be interesting to prove that females have a higher energy expenditure than males during the life-cycle. Since females have a higher inflorescence abortion rate, we hypothesize that the total cost of reproduction for females is not significantly higher than that for males. If this is the case, it would differ from reports of other dioecious species (Hoffman and Alliende 1984, Lloyd and Webb 1977, Silvertown 1987, Clark and Clark 1988, Maze and Whalley 1990, Oyama and Dirzo 1991).

Since there are no vegetative differences in morphology or biomass allocation between sexes, there is no proof of different storing organs or higher storage in particular tissues. However, weight data is not always conclusive and nutrient content analysis is convenient (Bullock 1984, Ashman 1992). A particular case has been reported for *Chamaedorea tepejilote* showing no differences in nutritional and secondary compounds of leaf tissues between sexes (Oyama and Dirzo 1991). In the same context, *Chamaedorea tepejilote*, a well studied understory dioecious palm, also shows no significant differences between sexes in response to disturbances such as leaf tissue loss and net height gains in a four year study (Oyama 1990). Defoliated male and female plants had significantly more new leaves than control plants (Oyama and Mendoza 1990).

Acknowledgments

We would like to express our gratitude to Pedro Jiménez, M. Josune Canales, and L. Daniel Otero for field assistance; Herbario de la Facultad de Ciencias Forestales, Universidad de Los Andes, for species identification; and, Mario Fariñas, Gerardo Piñeiro, Fermin Rada, and Melissa Goldman for their generous assistance.

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Principes, 38(1), 1994, pp. 33–35

An Oklahoma Cottage Industry Utilizing the Dwarf Palm Sabal minor

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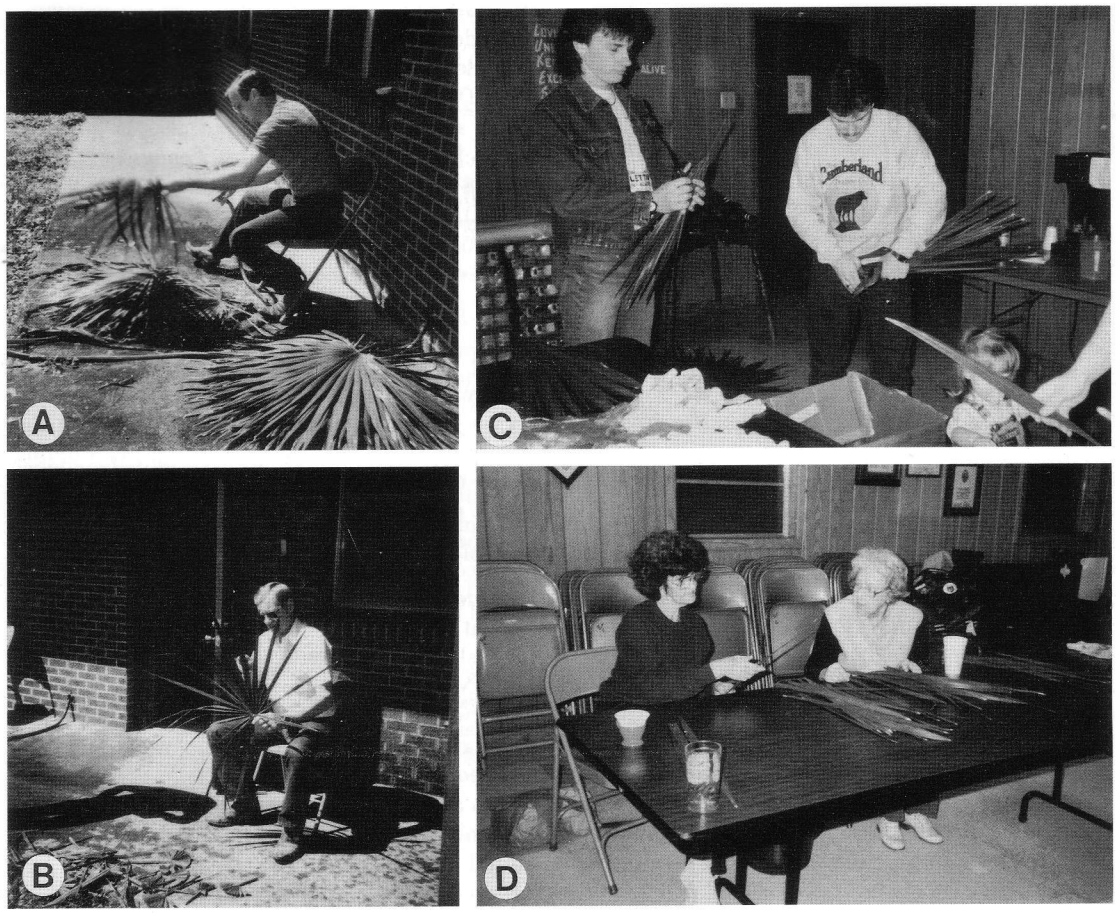
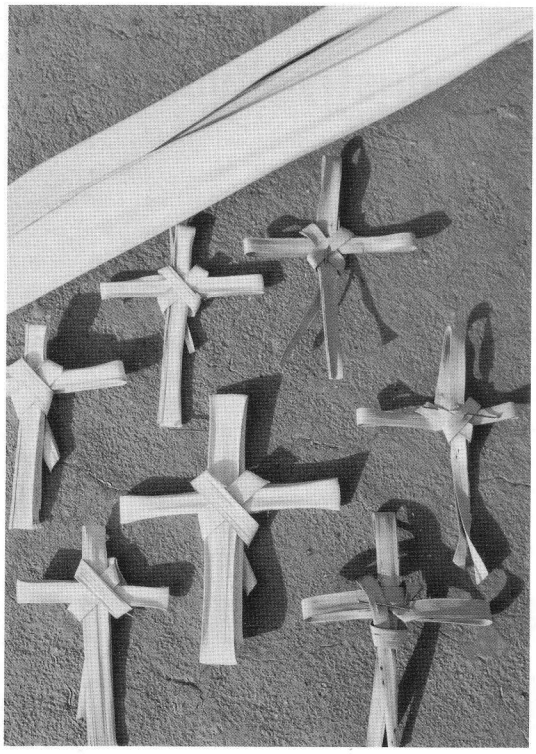
The dwarf palm or palmetto (*Sabal minor*) occurs in wet alluvial ground in southeastern U.S.A., and extends northward into the states of Oklahoma, Arkansas, and North Carolina (Vines 1960). Vines indicated that this trunkless palmetto, which grows to 2.5 m tall, is occasionally used as fodder for cattle. I wish to report another use by Christians during the Easter season of this sole member of the palm family in Oklahoma.

Beginning some ten years after the founding of St. Luke's Episcopal Church in Broken Bow, Oklahoma, a cottage industry, utilizing the local palmetto population and run by the church community, has been in continuous existence for approximately 25 years. The nature of the cottage industry is apparent in its organization. The leader, Susan Harper, begins the process in January. At this time the men of St. Luke's make the first of



1. Processing steps of Dwarf Palms (*Sabal minor*). A. Leaves are washed. B. Washed leaves are trimmed. C. Trimmed leaves are separated into segments ("fronds"). D. Fronds are separated into best quality for frond products and good quality to be made into crosses.



2. Each of the 10,000 crosses shipped in 1991 for Easter season observances by St. Luke's Episcopal Church was woven from a dwarf palm segment.

3. *Sabal minor* growing on the mowed highway shoulder in extreme southeast Oklahoma.

approximately five trips to harvest the palmetto leaves. Three products are fashioned and sold from the leaves: crosses, fronds, and fans. The crosses are segments formed into crosses which are worn on Palm Sunday, the fronds are segments that are carried in the Palm Sunday procession, and the fans are the entire leaf which may be used for decoration on Palm Sunday. From each palmetto, 2–3 fans approximately 1 m in height, are selected, and from each fan, 10–12 segments are obtained. The leaves are washed, trimmed, and most separated into segments (Fig. 1). These strips are evaluated by appearance (Fig. 1) and the good become "fronds" and the not-so-good are made into crosses (Fig. 2) in six to seven homes. The congregation is employed on a volunteer basis and involves 15 people, virtually the entire congregation. The youth were employed on a salary basis last year because of the large demand. The palm products are mailed, refrigerated, two weeks prior to Palm Sunday. A wine and cheese party starts the season and a dinner, called "the last roundup" (attended by the bishop), ends the effort. This is the sole money maker for the church. In 1991 $2,500 was the income from customers, primarily in the southwestern region, but also as far away as Michigan, Wisconsin, and Tennessee. Of the total, $2,000 was from the sale of crosses, sold at $10/50 crosses. Fans are sold at $8.50/10, and fronds at $7.50/100. No advertising is used at present; expansion is being considered. The major problem is an allergy to the mold on the leaves.

The "palm patch" is now in Arkansas, approximately 50 miles from Broken Bow. The palmettos are purposely not killed during harvesting of the 400–500 leaves. The patch is leased to a hunting group that considers the palmettos a nuisance. Dwarf palms in Oklahoma are restricted to the extreme southeast corner of the state, adjacent to the Red River. Apparently, the population has been decreasing because of clearing and development. On a recent field trip led by Jim Norman of Muskogee, Oklahoma, sponsored by the Oklahoma Native Plant Society, only one palmetto was found where a patch had existed. The plant was found growing adjacent to the highway, tolerating the frequent mowing (Fig. 3).

It is appropriate that one of the few indigenous craft industries to use native palms in this country should have developed in Oklahoma. The resourcefulness and strength of this state is well known from the Dust Bowl era. Indeed, this cot-

tage industry developed out of the economic necessity to exploit a local source of palm products. It is perhaps also appropriate that a rather maligned species of palms is being used to glorify arguably the most important figure in human history.

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SURVEY OF ALL IPS MEMBERS SOON

In October, 1993, the IPS Board of Directors commissioned that a survey of all active members be conducted by the IPS Membership Promotion Committee Chairman, Phil Bergman. The board wishes to determine what services IPS members want and what they do not want. Also, how do members think the services already offered by the organization can be improved.

Look for this survey in your mail and please take just a moment to complete and return it to the IPS. After all, the IPS board cannot act on your wishes if they remain unknown.

MAKE YOUR PLANS TO ATTEND THE INTERNATIONAL PALM SOCIETY BIENNIAL MEETING IN CARACAS, VENEZUELA IN JUNE, 1994

Hopefully many of you are making plans to attend the 1994 International Palm Society Biennial Meeting in and around Caracas, Venezuela, during the week of June 12–16, 1994. The Biennial meeting is being co-hosted by the Venezuelan Botanical Foundation (Botanic Gardens) and AVEPALMAS, the Venezuelan Palm Society. There will be garden tours and special events during the weekend that the meeting opens as well as during the meeting week. Relatively inexpensive airfares have been negotiated from most departure cities and attractive hotel rates are available. Food is very inexpensive in Venezuela and the IPS Registration Fee includes many meals and all required in-country transportation.

Also plan to attend the special pre-Biennial 4-wheel driving tour of Avila National Park palm habitats on Sunday, June 12, and Post-Biennial palm expeditions within Venezuela beginning on June 17th (for from 3 to 10 days each, depending upon your selection of itinerary modules). Post-Biennial excursion modules include expeditions to the palms of high-altitude cloud forests, lowland river delta jungle habitats, upper llanos and others.

You should have already received full schedule and registration information on the 1994 Biennial by mail. If you have not received your copy or if you want additional information on the city, its palms, or any other aspects of the Biennial, please contact Jim Cain, 12418 Stafford Springs Drive, Houston, Texas, telephone (713)558-6153 or fax (713)964-6555.

Principes, 38(1), 1994, pp. 36-46

African Bass/Piassava—A Historical Perspective

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Everyday objects and commonplace domestic utensils seldom stimulate enthusiastic enquiry and are rarely the subject of series study. The humble brush or broom is a typical example. However, the provision of natural brush fibers to meet a wide range of household and industrial applications has supported a major international trade in such materials, particularly since the middle of the nineteenth century. Notwithstanding the advent of plastic substitutes, there is still a considerable demand for the traditional natural brush-fibers and, in today's more environmentally conscious ambience, there is a growing movement towards the use of "friendly" products and ones that can be seen to support the economies of developing countries. The palms are a major source of brush-fiber, but here we will concentrate on the rise and decline of the West African trade, based on certain species of the genus *Raphia*, broadly embraced by the term "African Bass."

Brushes and Brushmaking

While this is not the forum to embark upon a detailed account of the complexities of the brush industry, nevertheless, some appreciation of the structure of the trade, past and present, is desirable to understand the role of this specific component of it. Radical changes in the craft occurred in Europe during the mid-nineteenth century (Kerby 1953). Prior to this time, there had been a sharp division between the Craft Guilds of the Brushmakers and the itinerant Broommakers, the latter typically gypsies and in the case of Britain, often Irish. The Brushmakers' Guilds claim to be one of the oldest trade unions and were well versed in the techniques of the "closed shop," price fixing and the usual gamut of restrictive practices. They were an early example of anti-feminist prejudice, excluding cheap female labor and heavily penalizing members who did not comply. Their working materials were primarily derived from animal hair and bristle, often stiffened with split whalebone. The itinerant Broommakers were free spirits, obtaining their materials without cost from the countryside and producing the traditional "Witch's Broom" or "Besom." Such brooms are formed by hand with a simple bundle of twiggy material tied about a central stake, and even today many gardeners still prefer them to the conventional brush for many tasks.

The Introduction of Piassava to Britain

The circumstances in 1843 under which a new and highly versatile vegetable brush-fiber became available to the trade are quite extraordinary, coinciding fortuitously with the expanding demands of the new industries and the rapidly growing population and cities. Prior to this period, there had been little interest in searching out new sources of supply. Despite the long period of European contact with the tropical world and familiarity with some useful fibers from those parts, particularly for marine cordage, sailcloth and the like, brush-fiber appears to have been of little account. A typical example is the Report to the Court of Directors of the Sierra Leone Company of 1798, where Afzelius, an eminent botanist of the period, had been employed to identify native products of potential commercial value. Fibers of any ilk were not even considered. As the nineteenth century progressed, however, it became increasingly apparent that current techniques and traditional materials could not meet demand.

The events are recorded with due sense of occasion by Kiddier in his "The Brushmaker and his Craft" of 1912. This work is most informative on the period but has been out of print for many years and copies are not readily obtainable. The author claims full authenticity for his account, having heard the story from his father, who, as a young apprentice Brushmaker, was present when the material was first offered to his Master, appropriately named Bass! At the time there was a thriving trade in sugar between Brazil and the Port of Liverpool. In the ships' holds, the cases

of sugar were protected on loading, by packing between them a locally abundant fibrous material. On arrival, as the cases were unloaded, this material was dumped on the wharves and often left there, much to the displeasure of the Liverpool Port Authority who, as the problem grew, insisted on prompt removal of the eyesore. I have not been able to trace the name of the "genius," as Kiddier hails him, with perhaps a degree of overenthusiasm, who first spotted the brushmaking potential of these undressed and probably unsavory smelling fibers. One can assume that he made a killing by charging for the removal from the docks and gaining a fair price for the product. Kiddier gives the date as 1843–44 in Loughborough, when Mr. Bass, not without a degree of suspicion, gained his first sight of the fiber and, after some cutting experiments on the neighboring butcher's block, invested in his first consignment. The travelling salesman involved assured him that the fiber was rapidly being taken up by the fraternity in "The North," presumably in the Liverpool area. So it would appear that the generally accepted dating of the early 1840's for the introduction of "Piassava" to Britain is about right.

It is now necessary to consider the origins and usages of the term "piassava" or "piassaba" by which this material came generally to be known. The name derives from "piaçaba" in Tupi, an Amerindian tongue, modified by the alternate "v" and "b" in Portugese, The name applies presumably to the fiber, and not the palm, *Attalea funifera* Mart., from which it is derived. When first introduced to the trade, it was described as "Bahia Bass," but it is significant that the term "piassava" was in common parlance almost immediately after, indicating that contact between Liverpool and the source in Brazil was rapidly established. Hooker (1849) uses the name, noting the value of this replacement for whalebone. He also comments on the admirable quality of the new brooms and the increase in cleanliness of the streets in the developing towns resulting from their use. Such was the demand for the new material that by mid-century a second Brazilian palm fiber, from *Leopoldinia piassaba* Wallace, was on offer on the Liverpool Exchange as "Para Piassava" or "Monkey Bass." This fiber was less hard-wearing than the original but softer and more flexible. Here the term "piassava" is applied as a trade name, being offered as a substitute for the original, the native name being totally linguistically dissimilar, "Chiquichique." Similarly, as we will pursue later, the term has been applied also where there have been other subsequent attempts to place competing palm fibers on the market, primarily from Africa and Madagascar. Other palm and natural brush-fibers, mainly of Asiatic and Central American origin with specific properties of their own, have tended to retain their native or trade names.

The use of the term "Bass" in the trade is of some antiquity and certainly predates the events of 1840's, although its use by the salesman added to the suspicions of our Mr. Bass. The fact that the word appears in reverse in "piassaba" is an odd coincidence, but its almost certainly a corruption of "Bast," the material obtained by stripping the outlayer of phloem fibers from dicotyledenous plant stems. Such strips were widely used in tying the twig bundles in besom making. The Victorian Brushmaker can be forgiven his being unfamiliar with the finer points of plant anatomy in equating the monocotyledonous vascular fibers obtained from the petiole and leaf base of the palm with a well known product.

So, what was so exceptional about the new fiber to engender such enthusiasm and so swiftly transform the craft? The basic construction of a brush involves the insertion of a tuft of fibers, with a pitch or other glue, into the drilled recesses of a stock of variable size and shape. These were either hand- or treadle-drilled, and there is an early reference in the records of the London Society of Journeyman Brushmakers, 1833, forbidding its members to sell drilled stocks to the itinerant "hawkers." The new fiber was of a length never before available that could be cut as required and easily worked by the old hand methods. The great gain, however, was the property of the fiber that permitted it to be folded, perhaps after hot water or steam treatment, and then staple punched into the stock, at first by hand but soon after by the new machines that were developed for the purpose. The fiber was hard-wearing, with the right balance between stiffness and elasticity to give a firm stroke to the brush combined with a self-cleaning reverse-spring action to the punched tufts. The fiber tended to shed water and surface dirt and was capable of taking up colored dyes and waterproof dressings—all-in-all, the near perfect brush-fiber for the outdoor, traditional, yard or stable broom. Even today, top grade, clean, selected Bahia Bass commands a superior place in the affections of the industry and usually a higher price than competing fibers, both plastic and natural, that have since emerged and despite the improved techniques of the manufacturer to blend and adapt the range of materials available to him.

It is, therefore, no surprise that for a period of some forty years, Bahia Bass, and to a much lesser extent (some 4–5% only) Monkey Bass, held a dominant position in the trade. In the 1880's, imports to Britain were running at the order of some 6,000 tons/pa priced at £15–£20/ton. A major industry in "fiber dressing" emerged, particularly around Manchester and Liverpool, the main port of entry, supplying clean, graded fiber to the brushmakers. The British brushmakers had a flying start, having first gained access to these fibers, and even today the traditional yard broom is known as an "English Broom" in parts of Continental Europe. Importation of the fiber, however, also rapidly expanded in mainland Europe, and towards the end of this period the strains were starting to show in the market, as demand began significantly to exceed supply. Overcutting and eradication of the palms was greatly reducing not only supply but also affecting the quality of the fiber. Transport costs within Brazil were increasing as the cutters were forced to move further and further inland. The price rose dramatically, much of the fiber was of inferior quality, and the brush industry was in serious trouble. To quote some prophetic words from Kiddier:

> Piassava had become an indispensable thing. The bass broom could not be done without. Though our grandfathers could put up with the besom we could not. So it is, when the new article affords more comfort than the old, a new need will grow. The new thing may be a luxury to begin with, but directed by the dealer, luxuries become necessities in the end. If the world but knew the secret we would live by one-half of what we now consume.

At this time of crisis, there was a clear market opportunity for any source of fiber that could emulate, if only approximately, at a reasonable price, the South American material. It is against this background, that we come to discuss the rise of the West African trade, the confusions that have arisen over the palms concerned, and the nature of the various fibers involved.

The Rise of the West African Trade

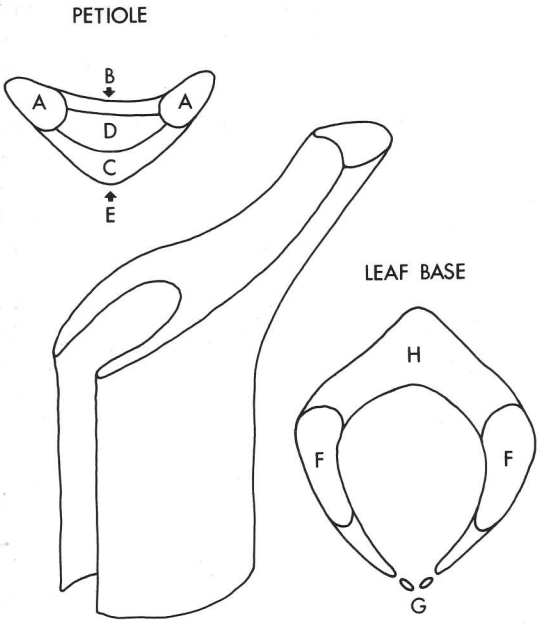
The first commercial shipment of African Bass has been attributed to the initiative of one J. H. Hugges, of Grand Bassa, Liberia in 1889–90. He is reputed to have been the first to recognize the potential of these fibers, well known and widely used in the local economies, as a serious competitor for the now failing supplies of South American piassava. Quite who this gentleman was remains to be elucidated, but there are precise references to him by name via the U.S.A. Consular and Trade Reports and the Consul in Monrovia in both the Kew Bulletin and L'Agric. Prat. Pays Chaude of 1910. However, as we shall see, his claim to fame is perhaps suspect. Interest in these fibers spread rapidly along the Coast at that time and, by 1901, regular shipments were being made, albeit on a modest scale, from virtually all the colonial territories concerned. The archives of the Royal Botanic Gardens, Kew, possess a copy of the poster issued in 1890 by Governor Moloney, at Lagos, calling the trading community of the town to the Customs House to view this new and valuable export commodity and the Kew Bulletin of January 1891 records an exchange of correspondence with the Governor on the topic. As early as February 1890, the Manchester buyers were actively seeking the fiber and were able to send a sample to Lagos, promising a good demand if a similar quality could be imitated and maintained. In October of that year, the first samples from Lagos arrived at the British Colonial Office, then in Downing Street, which were forwarded to Kew for appraisal. Kew in turn consulted one of the major commodity brokers in the trade, Messrs. Ide and Christie, who reported that they were familiar with this fiber and, somewhat surprisingly, that small importations had been made "some years ago." These however, had not been well received by the trade and they were far from enthusiastic regarding the prospects for the new samples, particularly when compared with Bahia Bass. However, almost immediately after this assessment, in a letter to Kew, only a fortnight later, they offer a modified and far more encouraging view. This arose from their attendance at an auction of recently arrived West African fiber which had attracted surprisingly high prices. This may well have been a reflection of the times and panic buying, given the state of the South American trade, as there are records of the first Liberian shipments into Liverpool in 1890 reaching the quite remarkable price of $336, say some £80/ton. It was now apparent that the new fiber, or as it emerged, range of fibers, while perhaps not fully matching the characteristics of the South American material, was nevertheless a reasonable compromise substitute.

From these modest beginnings, the trade in these fibers developed somewhat erratically, with numerous fluctuations in price and demand. The trend to the export statistics, however, shows overall expansion, reaching a peak during the 1950's

and early 1960's and a general decline subsequently. Liberia in the early part of this century dominated the market, largely in response to the high prices being obtained for the product and, by 1904, bass had superseded coffee as the leading export commodity from the country. In 1908, some 7,000 tons were exported, but quality was beginning to suffer and strong competition from other producers along the Coast and also from the South American trade, which was responding to this threat to their market, was forcing down the prices at auction. By 1910, Liberian bass was fetching only some £20/ton. Exports, however, continued, usually around some 3,000–4,000 tons per year, the major part latterly, going to the Netherlands. Nigeria, by 1910, was producing some 300 tons per year which rose to some 3,000 tons per year during the early 1960's and reaching a record 5,000 tons in 1966 at the onset of the Biafran War, Since then, exports have been substantially reduced (Otedoh 1975). Several other sources of supply along the Coast made modest shipments, the then Gold Coast for example, but there any prolonged effort gave way to the more attractive returns from the cacao crop. Prior to the 1914–18 War, the German colonies gained a good reputation for the quality of their fiber. Even The Gambia attempted to develop a foothold in the trade, but by 1918 only some 28 tons were exported and the marketing and processing facilities were in serious trouble (Dawe, 1921). Over the years, however, the dominant participant in the trade has been Sierra Leone, exports progressing from some 7 tons in 1901 to around 5,000 tons per year in the early 1960's, with a record 6,500 tons in 1964 (Martin 1928, Imperial Institute 1935). Numerous trade names became part of the market jargon, Grand Basssa, Junk River, River Cess, Sherbro, Sulima, Calabar, Opobo, Gabon and so on. These, however, tended to be related to the port or adjacent area of shipment rather than to specific differences in the product but, as the trade developed, certain of them gained a reputation for consistent qualities desired by the manufacturers. The export market was directed in the main part to Europe with some direct shipment to the U.S.A. Import statistics in Europe, however, give little indication as to the final destination of the fiber, as the port of arrival is merely indicative of which shipping line called more regularly at which West African port. Prior to relatively recent improvements in port facilities, access to the coast was notoriously difficult and typically involved lighterage by local dugout canoes through the surf, which for much of the rainy season was a hair-raising experience for anyone participating in the transit of goods and persons. Most boats concerned in trading with the Coast were especially built with very shallow drafts to permit as close an approach as possible in the estuaries. In consequence, as many travellers of the times recall, they tended to "roll like pigs" in quite modest swells, to the general discomfort of all on board, usually when crossing the Bay of Biscay. The Sulima bar in Sierra Leone adjacent to the Liberian border, for example, was particularly tricky to cross at certain times of the year, and as a German company made the most regular calls, with a short break for the period of the 1914–18 war, the bulk of the production from those parts finished up in Hamburg, whence it was further distributed throughout the European market. In common with most tropical agricultural commodities, the trade in bass went through very difficult times during the world economic recession of the 1930's. The period of the Second World War saw major interruptions to the flow of goods to and from the Coast. Quite apart from anything else, there were substantial losses of shipping around the Freetown convoy assembly point from German U-Boats operating under cover of the Vichy-held territories. In the British and Free French Territories, there were intensive drives towards self-sufficiency and supporting the war effort, and much of the fiber was diverted to rope making, sacking and bags for agricultural produce, as the supplies of jute had been cut off. An interesting comment appears in a post-war report produced by the Government Printer, Lagos (1945), "A Colony's Effort." It appears that this fiber went to war with the West African Regiments and in the North African, Italian, and Burma Campaigns: the ramrod used to sponge out the barrels of the 25-pounders was known to the gunners as "A Piassava," a term not found in dictionaries!

Fiber Type and Quality

Following this brief outline of the export trade in African Bass up to the mid-1960's, it is now necessary to consider the product in some detail. As with many natural commodities, the definition of "good quality" and the inspection routines to assess it are often largely subjective. While mechanical and chemical testing equipment has become increasingly sophisticated, the innate



1. Diagrammatic representation of petiole and leaf base.

judgement of the experienced buyer/manufacturer still dominates the decision as to acceptance and market value. Initially, the West African product was judged by comparison with Bahia Bass, but as the trade developed and the demand for a wider range of brush types expanded, the various forms of African Bass found niches in the market in their own right. Bass brooms for example, were employed in certain steel founding techniques, to remove surface bubbles from the molten metal. The fiber was known to have a particularly low ash content and had for years been used by West African artisans to produce a very fine textured charcoal. This was much favored for the manufacture of a suitable grade of gunpowder for the locally made flintlock-like "Daneguns."

To appreciate the problems associated with the production of a uniform commercial consignment of acceptable fiber, it is first necessary to understand the construction of the *Raphia* leaf. The leaf in this genus is large, huge in most species, typically exceeding 15 m in length. For our purposes it can be considered as comprising three principal components: the upper leaf stalk (rachis) bearing rows of leaflets on each side; the bare lower leaf stalk (petiole); and the tubular leaf base (Fig. 1). The soft raffia fiber of commerce is obtained by stripping the surface of the leaflets in some species, but it is the two lower parts of the leaf that are concerned in brush-fiber production. The petiole, of the order of some 3–5 m long and some 5–6 cm broad for much of its length, tapers to the junction with the rachis and expands markedly towards the trunk, where it merges into the leaf base. It is broadly triangular in cross-section and gently channelled above. These petioles, when cut, often with a length of the lower rachis left attached, assume the role that bamboo plays in Asiatic societies and are often so-termed where English is used in West African markets. These "bamboos" are employed in a wide range of structural building and craftwork. The tubular leaf bases embrace the trunk and lie in a concentric format, each overlapping one or more of its kind above. As the trunk extends, the lower leaves die back and then fall away, leaving the leaf base and a short length of the old petiole in place. With expansion of the lower trunk, the leaf bases are pressurized in ascending order and a distal, vertical, linear cleavage opens up along the length of the structure. As the cleavage widens, the outer tissues break apart, giving rise to a mass of fibers and interstitial tissue, the nature of which varies considerably with different *Raphia* species and, indeed, is often a useful field character for identifying some of them.

There has always been a degree of confusion in the literature regarding the origins and critical differences between the range of fibers available. This applies particularly to the three main types in the trade, to which all the others can be related, namely: Prime Sherbro, Sulima, and Calabar (Opobo). These fibers are obtained from *Raphia hookeri* Mann & Wendland and *R. palma-pinus* (Gaertn.) Hutch, and although similar materials can be obtained from other members of the genus, these have not been significant in the West African trade. In earlier literature on this topic, *R. hookeri* is often misnamed as *R. vinifera*. As this plant is the well known Wine Palm, widely distributed throughout West Africa, this is an excusable error, but *R. vinifera* is a distinctly different palm which does not yield good fiber but is renowned for the length, strength and longevity of its "bamboos." It has a more restricted distribution in the higher rainfall areas between Ghana and Gabon and, ironically, is a poor wine producer. Similarly, *R. palma-pinus* is also often wrongly referred to as *R. gracilis* or *R. gaertneri* in early reports. This palm is largely confined to coastal swamps of the high rainfall areas from westerly Ghana to the Gambia Valley. It is now considered to have two

distinct forms or subspecies (Otedoh, 1982) which require further study. Whether one or other is the better source of fiber also remains to be established. There is a good research project here for a local botanist, particularly as one form is recorded as forming a "Pseudostem," the precise nature of which has never been described in detail, but it is presumably similar in construction to that found in the bananas and plantains (*Musa* spp.). Whatever, there are fundamental differences in habitat between the two species which bear closely on the type and yield of fiber available.

R. hookeri	*R. palma-pinus*
Tall in the trunk, 5 m plus	Short in the trunk, to some 5 m. Pseudostem sometimes formed
Leaf base long, 3–4 m	Leaf base short, some 1 m only
Petiole 3–4 m long	Petiole to 2 m long
External fibers about trunk long, dark, some broad and contorted	External fibers about trunk shortish, straight, often pale
Trunk single or restricted branching from base	Freely suckering
Ubiquitous, occurs in upland farms and compounds as well as freshwater swamps. Often planted	Swamp palm with fair degree of salt tolerance in coastal areas
Much prized for wine	Minor wine producer

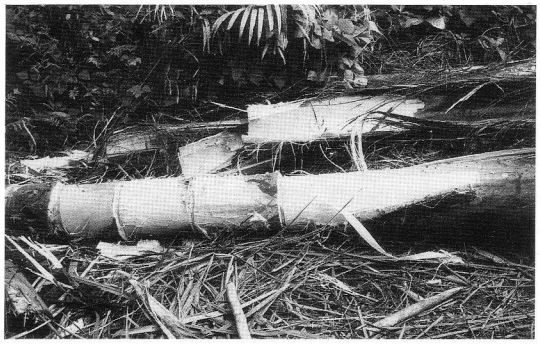
As with many palms, if left to develop naturally, the crown of leaves at the head of the trunk in *Raphia* remains fairly constant in size and number, once the seedling and early development stage is past. This cycle of leaf initiation at the apex, with a concomitant dying away of the older leaves below, continues through the elongation and life of each individual trunk until the inception of flowering. At this stage, further extension growth ceases and, following the completion of fruiting, the trunk dies. In a largely non-suckering species such as *R. hookeri*, where the wine is highly prized and can only be obtained in reasonable quantity at the onset of flowering (Tuley 1965), there will be a degree of reluctance by the cultivator to diminish vigor by the cutting of active leaves for fiber. Mature or moribund leaf stalks, however, can be taken with little effect on eventual wine yields. This would explain why Prime Sherbro, derived as it is from this palm, has always been in shorter supply than Sulima, which is largely obtained from *R. palma-pinus*. Here, the suckering habit will be further stimulated by regular cutting, and the number of leaves available for harvesting greatly increased. Providing a balanced cutting cycle is practiced to prevent the taking of immature leaves, a much higher level of production can be achieved.

It is not generally recognized that there is a fundamental difference between the fibers of the Calabar/Opobo group and the Sherbro/Sulima group. Although both Sherbro and Calabar are derived from the same palm, *R. hookeri*, the former is derived from cut lengths of the petiole while the other is extracted from the tubular leaf bases. This in turn affects the processing procedures. Why these practices have become so divorced towards the extremities of the West Coast is far from clear. However, *R. palma-pinus* is the more dominant species in the coastal areas of the more westerly states. Here, the shorter leaf base precludes the extraction of fiber of reasonable length from this part of the palm and necessitates employing the petiole for this purpose. As this palm dominated the trade in these areas, it might be assumed that similar methodology was applied to the lesser participant, because of the common practice of cutting the petioles of both species more or less at random, with a resultant admixture of the fibers. Indeed, it was the generally held view that the superiority of Sherbro over Sulima was merely a reflection of better processing and grading. By the late 1920's, it was recognized that superior brush-fiber could be obtained from selected parts of the petiole and leaf base. The extent of the variation in fiber conformation within these structures was perhaps not fully appreciated, as a wealth of useful fibers can be extracted from them, ranging from stiff, brittle and woody, then grading through a sequence of increasing flexibility and decreasing strength, finally yielding a soft, sponge-like material. This permits numerous useful applications in local industries and crafts, ropes, matting, wickerwork and the like (Otedoh 1975, Stevens 1945). Indeed, given the value placed upon these materials in native manufacture and their prominence in the traditional markets, it is somewhat surprising that their export potential was not noted before, during the forty year solo reign of South American piassava.

On first inspection, it would appear to be the

2. Felled mature trunk of *R. hookeri.*

case that harvesting cut lengths of petiole from a relatively low growing palm would be an easier option than prizing the tightly-held leaf bases from the trunk. In the event, paddling in the thick mud of a leech-ridden swamp, the typical habitat of *R. palma-pinus*, has little to commend it. It is small wonder that the harvester tends to overcut and take an undesirable proportion of immature leaves, once he has dragged himself into position at the base of the selected palm. With *R. hookeri*, while this does occur as a swamp plant, generally it does not flourish under saline conditions and can usually be approached under more amenable circumstances. If being harvested for the petiole, however, mature palms of some height will offer problems of reach. To part the leaf bases from the trunk requires considerable leverage. This is usually a team effort involving several persons. Stout poles, flattened at the end, are inserted into the sucture of the lowest leaf base and, while additional weight is applied to the remnant stump of petiole,



3. *R. hookeri*—trunk with leaf bases removed.

the whole is levered away from the central axis. The process is then repeated sequentially upwards. It is possible, providing care is taken, to remove older leaf bases from the lower part of the trunk of a standing live palm, but the more common practice is to let each trunk complete its growth cycle, tap if for wine and then fell it (Fig. 2). The leaf bases can then be more conveniently removed from the horizontal posture (Fig. 3).

Marketing, Processing and Grading

Historically, most agricultural exports including bass were traded along the Coast in close-knit marketing-chains, linking the trading companies or marketing boards at the ports with the traditional local markets. Typically, trade goods would move up the chain as export commodities moved down. The middlemen who operated the links in the chain could be either officially appointed agents of the companies or government or local businessmen, or quite often extremely astute businesswomen, operating on their own account. The lady traders of the West African markets could be formidable negotiators. In Sierra Leone and to some extent Liberia, Lebanese dealers were closely identified with the trade. Credit schemes to permit immediate cash payments to the producer at village level were operated in some areas and financed and supervised by the local banks. These activities were often linked into extension programs aimed at improving the quality of the product. Prices at local level were often adjusted drastically downwards to cover the middleman against subsequent grading losses at the buying centers. The prices offered were often punitive and there was therefore little incentive for the producer to clean or grade his fiber to any other than a minimum standard. It also led to bad harvesting practices and

the excessive cutting of immature leaves. Producer cooperatives, promoting good practice and paying fair prices, proved a successful incentive in some areas. Several of the territories involved had active produce inspection departments. Here, the bass could only be shipped under their seal and, while these services remained diligent and incorruptible, they largely eliminated the export of inferior or adulterated produce.

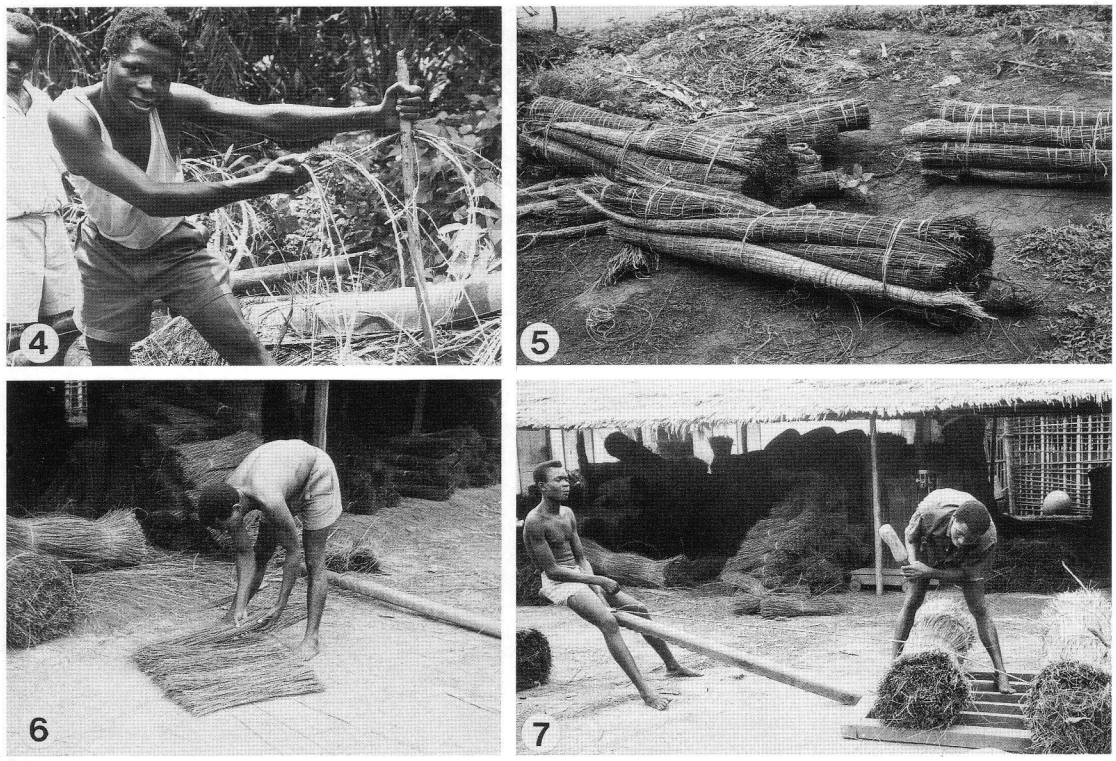
To recapitulate upon the needs of the brush manufacturer, the aim is to obtain a water-resistent, hard-wearing fiber, of adequate strength and length, also possessing the necessary flex/elasticity to permit ease of machine working and to give the desired "springy" action when pushed or drawn across a surface. Figure 1 depicts a general view and cross-section of the leaf base of *R. hookeri* and a median cross-section of the petiole in both species. In the petiole, the best brush-fiber, cylindrical with a softer core, some 1–1.5 mm diameter, is obtained from the "wings" (A) as shown. The fiber derived from *R. hookeri* possesses a smoother surface than that from *R. palma-pinus*, which tends to have a more roughened outer layer (Slack 1947, Kidd 1957). That, from the upper, adaxial surface (B) is also of reasonable status, as are the more flattened fibers from the lower, abaxial surface (C) adjacent to (A). The fibers near the central flattened ridge at (E), however, are thicker, more flattened, woody and distinctly brittle. The central core (D) gives rise to a supple, markedly soft fiber, the so-termed "straw," a common adulterant in commercial samples. A similar "straw" is found if the petiole is cut too long, as, towards the rachis, even the best fiber tapers into a similar material. It is, however, necessary to emphasize that the criteria apply to a mature leaf, as, in a more juvenile condition, there is a general lowering in fiber quality from all parts.

In the leaf base, the objective is to obtain a brush-fiber of very different character. Typical Calabar Bass is solid and flatter in section and distinctly stiffer than Sherbro/Sulima but still with adequate flexibility to be folded for machine punching without snapping. Fiber falling within the ideal size range, some 0.5–4.0 mm broad, is extracted from the zone some third to halfway around the radius, as shown at (F). Towards the line suture (G), the fibers rapidly broaden and become more brittle, at the extremity reaching as much as 4.0 cm across. In the opposite direction, within the thickened body of the structure (H), the fibers progressively become more pliable and softer in texture and more circular in section with a soft core or even a hollow core. The strongest are excellent for platting strong ropes and the remainder are used in a wide range of domestic applications.

To extract the fiber, it can be seen that the differences in the two structures necessitate different methodologies. In the one case, the tubular leaf base, particularly towards the suture line, is already moribund and the background tissue has already started to soften and break down. The outer thicker and more brittle fibers can be stripped off, or in some areas it is the practice to fire the trunk and remove them in this way. Then, starting from the outer wings, the fibers can be sequentially stripped by hand, working round the circumference until the zone of softer fiber at the rear is reached. When the fibers do not part easily, usually in younger leaf bases from the upper part of the trunk, beating the tissue with a stout stick is an effective way of obtaining a reasonable yield. If the leaf bases are particularly recalcitrant, the felled trunk is left to lie exposed to the elements until they are suitably softened.

With the petiole fibers, these are embedded in the cut length of stalk, within a solid matrix of background tissue and the hard outer (epidermal) layer. To remove the fiber here, without undue damage, precludes physical stripping techniques, and the traditional practice is to soften the stalks by immersion in water for a considerable period. In the past there has been a degree of confusion over the detail of this "retting" procedure and there was concern that immersion for a prolonged period would weaken the fiber. In the event, the main difficulty turned out to be the reverse in that the harvester, who was often hard pressed for money and seeking a early return on his investment, was not allowing sufficient time for the background tissue to soften adequately. This was particularly common during the "hungry season" when the farming community was at maximum stress. Some two to three months is generally considered to be the optimal retting period, with the stalks, which split readily along the longitudinal axis, divided into three or four splits, before being tied into bundles for immersion. After this period, the fibers can be stripped out with relative ease.

In the trade, certain color preferences have developed, which in certain cases are related to the retting process. Calabar tends to be naturally dark-colored, sometimes distinctly black. Sherbro and Sulima are both somewhat pale at harvest but



4. Selecting and cleaning the fiber. 5. Bass prepared for transport to Buying Center. 6. Final grading by length, uniformity and cleanliness. 7. "Bundling" the bass prior to shipment.

develop shades of brown on retting. The nature of the water involved affects this coloration: material retted in fresh running water tends to be pale brown but that placed in stagnant swamp pools, a common practice in the Sherbro area, develops an attractive reddish-brown tinge. A good sample of Prime Sherbro with this coloration commands excellent prices. It is of interest to note that the soil/water relationships of these swamps have been the subject of detailed study, with an eye to their employment for rice production. They are particularly intractable in this respect because of the intense acid-sulphate conditions that prevail, and it must be assumed that it is these chemical conditions that impart the desired color to the fibers.

When first extracted, both types of fiber still retain a coating of adherent, decomposing background tissue. The common practice with Calabar is to strip this by drawing the fiber by hand through a cleft cut into a green stick or a length of the palm petiole (Fig. 4). With Sherbro/Sulima, the retted splints are usually flogged over, and drawn through, a comb of pointed sticks. The same or very similar techniques are used in all the producing areas along the Coast. The care that is taken with these processes and the consequent cleanliness of the fiber, has a major impact on quality and potential market value.

Length of fiber also bears significantly on fiber quality, there being a distinct market preference for a longer conformation, giving a greater degree of flexibility in pre-processing and dressing by the trade. Shorter lengths are acceptable within reasonable limits, say no less than 25–30 cm, but, whatever the size, it is essential that the fiber be bundled in units of uniform length, with neatly trimmed extremities. Where Sherbro/Sulima have been harvested correctly from mature leaves and the petioles cut to optimum length, then there is typically minimal variation in the length of the high quality fibers extracted, some plus or minus 1.5 m. The normal practice is to gather these into bundles of 56 lb (25 kg) weight. In Calabar, there is much greater variation in the length of the fibers stripped out of the leaf base. The task of separating these and sorting them into bundles of uniform length is, of necessity, tedious and time consuming. Traditionally, the harvester or a middleman

trader gathers the mixed fiber into an elongated, tapering bundle, some 2 m or more long, and in this form it is transported to the local market or trading post (Fig. 5). Here the bundles are weighed and priced, then cut open to join a vertically stacked agglomeration of fiber. The sorting process involves an experienced employee of the buyer standing above the massed fiber and sequentially plucking out individual strands in descending order of length. Following this initial classification, the selected classes are laid out horizontally and checked for size and the ends are uniformly trimmed (Fig. 6). All being well, they are tightly bound into cylindrical bundles, some 70–100 cm in diameter and weighed for shipment (Fig. 7). Quite why, in the trade, the shorter length bundles were associated with Opobo and the longer with Calabar is something of a mystery. Both ports are situated in southeastern Nigeria, the former being founded by the legendary King Jaja following the cannon battle at Bonney between the warring Trade Houses of Anna and Manila Pebble on the 13th September, 1869 (Hargreaves 1975). As the prime motive for establishing the new settlement was to seal the Imo River and cut off the hinterland and down-river trade in palm oil and kernels to Bonney on the coast, it follows that Calabar, sited on the estuary of the much larger Cross River, had greater ease of access to the ever larger vessels that were involved in trade with the Coast. It may be that more difficult lighterage problems at Opobo favored the smaller and more compact bundle.

The water content of the fiber has always created problems. The humid conditions of the high rainfall areas of the Coast make air drying difficult for most of the year. Also, as the fiber was sold by weight, there were obvious temptations to maximize returns by the more unscrupulous trader. At the very beginnings of the trade, we find Holland, then Curator of the Botanic Garden, Calabar, complaining of malpractice in his annual report of 1895 to Kew. The most common device was to bind a wet bundle with an outer layer of dry fiber. Apart from the fraud, this practice resulted in total loss of quality from discoloration by fungal/bacterial fermentation and weakening of the fiber. It also created a not inconsiderable fire hazard in warehouses and ships' holds and there are stories, perhaps apocryphal, of serious fires at sea from bass cargos, the effect of the wet fiber being similar to that occurring in damp hay and straw stacks.

To summarize, an ideal consignment of bass for export should comprise neatly trimmed bundles with selected fiber of the correct type, of uniform length and within acceptable thickness criteria. It should be suitably cleaned, thoroughly dried and free of "straw" and other undesirable fibrous material. In reality this is extremely difficult to achieve. Even with the best practice and rigorous grading procedures, the nature of the vascular fibers within the tissues invariably means that a commercial sample will embrace a range of dimensions and some adulteration. Within the Sulima/Sherbro Group, all but the very top of the range will be a mix of fiber from the two species involved. Providing however this variation falls within reasonable limits, it is usually acceptable to the trade.

Epilogue

This account has attempted to give a brief overview of this particular palm product, from the origins of the trade until the rise of plastic broom in the 1950–60's. Even in the heyday of the trade, there were major problems and many producers dropped out of the market in times of economic depression or by failing to maintain quality standards. In more recent times, many of the West Coast producing countries have had to face critical social, economic and political problems and the breakdown of essential services. Active warfare has occurred, and still continues, in some of the main producing areas. Increased labor costs and the attractions of more remunerative activity, diamonds, oil and the like, have wiped out many of the traditional agricultural exports. It says much for the entrepreneurial skills and traditional trading instincts of the population that African Bass still enters the market, albeit on a much reduced scale. The bass broom, either pure or in admixture with other fibers, both natural and man-made, is still to be purchased in industrialized countries and, as intimated at the beginning of this paper, with the growing pressures for a "greener" world, there may yet again be a significant place for this extremely environmentally friendly fiber.

Acknowledgments

Sincere thanks are due to Mr. T. S. Jones, OBE, and to Mr. P. Coward and his fellow Directors of the Hill Brush Company, Mere, Wiltshire, for valuable background information. The Pitman Publishing Company have kindly given permission to quote from W. Kiddier, "The Brushmaker and his Craft."

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BOOKSTORE *(Continued from page 12)*

* New arrivals

The palm books listed above may be ordered at the prices indicated plus $2.50 extra per book to cover packaging and postage. (California residents please add 7.25% sales tax.) Foreign checks must be in U.S. dollars and payable on a USA bank. In some countries it is possible to send U.S. International Money Orders through the Post Office. No credit cards. Please include your International Palm Society membership number. ALL SALES FINAL. Send check payable to: The International Palm Society, Pauleen Sullivan, 3616 Mound Avenue, Ventura, CA 93003, U.S.A.

ERRATA ON BIENNIAL FORM:

The Registration Fee and Optional Sunday Day-Trip Fee were mis-stated in one location on the Biennial Registration Form recently mailed to all IPS members. The correct prices are given inside the box on the lower part of the form and are **US$260** per person for the Registration Fee and **US$40** for the optional Mt. Avila tour. Please register as soon as possible so that an accurate head count can be obtained for planning purposes.

IPS SEED BANK OPERATING PROCEDURES

The Seed Bank will resume its operations on a pay-as-you-go basis (credit limited to $30), offering only seeds available from Lyon Arboretum in Hawaii or from Southern California. A new seed list will soon be forthcoming.

If you have an outstanding balance with the IPS Seed Bank and have not requested a refund, then you will soon be receiving a note from Lynn Muir concerning disposition of these funds.

Questions on the Seed Bank should be addressed to Seed Bank Director, Lynn Muir and may be sent either directly to Lynn Muir, 33802 Valencia Place, Dana Point, CA 92629 or to the main IPS address in Lawrence, Kansas.

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Palms in the Cloud Forest of the Henri Pittier National Park, Venezuela

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The coastal range is located in the northern part of Venezuela and is roughly 870 kilometers long and between 10 and 80 kilometers wide. It begins in the west in the depression of the Yaracuy River (at approximately 69°45′ west longitude and 10° north latitude), is interrupted in the Unare depression (at about 65° west longitude), then extends to the Paria Peninsula in the east (at approximately 61°15′ west longitude and 10°15′ north latitude). The range separates the maritime coastal zone from the plains and comprises two branches: the coastal branch and the interior branch, separated by the Tuy Valleys and the basin of the Lake of Valencia.

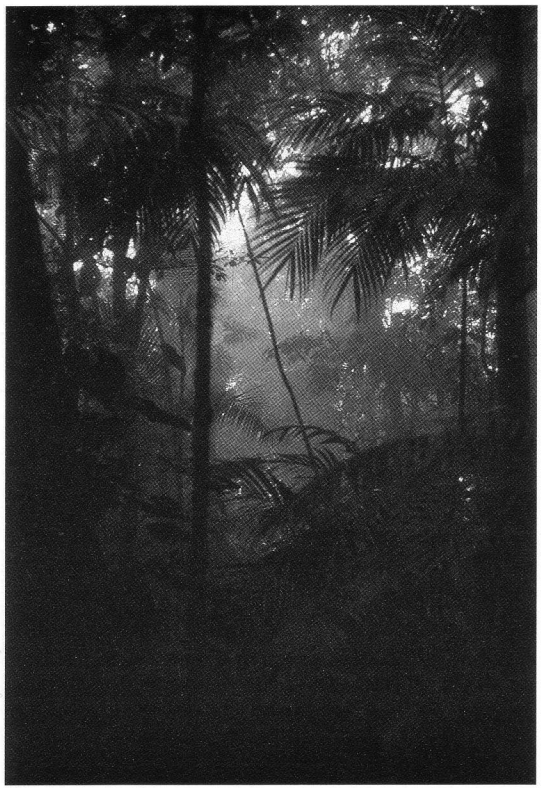
The Henri Pittier National Park is set in the central zone of the coastal branch, between Aragua and Carabobo States. Declared a National Park in 1937, it was the first of Venezuela's parks to obtain such a distinction. Altitudes vary from sea level up to 2,436 meters (7,992 feet) in Cenizo Peak, displaying a diversity of vegetation habitats, among which the cloud forest is one of the most conspicuous. It is understood that this type of forest must develop on a mountainous system since only the slope of a mountain or sierra enables the formation of clouds or orographic mist that is regular and frequent for most of the year at constant altitudes, playing a dominant ecological role in the ecosystem. Though broadly speaking, floristic composition is varied within cloud forests, the common environmental characteristic is the presence of clouds throughout the year, forming at altitudes ranging from 800 to 2,400 meters (2,625 to 7,875 feet) on both the southern and northern slopes, the latter being the side where clouds form at the highest altitude.

In the surroundings of the Rancho Grande Biological Station, located in the Henri Pittier National Park cloud forest, we observe a daily alternation in the prevailing wind regime that is undoubtedly one of the main factors in the formation, distribution, and duration of the clouds and mists in the mountainous zone. Prevailing local winds in the morning coming from the basin of the Lake of Valencia and the trade winds from the northeast that predominate in the afternoons both cause cloud formation on the mountains by forcing the air upward past its condensation altitude and temperature. This effect is called orographic cooling. The afternoon trade wind effect is somewhat less frequent in the dry season (December to March). Based on rainfall and temperature records, which are more or less continuous for the zone with altitudes ranging between 1,150 and 1,670 meters (3,773 to 5,479 feet), one observes an average annual rainfall of 1,170 mm (46.1 inches). February is the driest month with an average of 24 mm (0.9 inches) of rain, while August is the wettest with an average of 284 mm (11.2 inches). The annual mean temperature is 20°C (68° F). January is the coolest month with a monthly average of 18.4° C (65° F), and August, with an average of 21° C (70° F) is the warmest. Daily temperature oscillations vary between 1.5° and 8.2° C (2.7° and 14.8° F).

Following are brief descriptions of the palms which to date have been identified in the Henri Pittier National Park cloud forest; their main vegetative characteristics, by which they may be easily identified, are pointed out. Scientific descriptive terms have been used where necessary to keep the descriptions concise. A glossary of such terms is included at the end of the article.

Bactris setulosa Karsten

Monoecious palm, armed, clustered, rarely solitary, 8 to 10 m; adventitious roots occasionally present; leaves 4 to 5, pinnate, leaflets regularly



1. *Hyospathe pittieri* growing in the Henri Pittier National Park cloud forest.

2. Well-developed roots of *Dictyocaryum fuscum.*

distributed on the rachis, linear-lanceolate with acuminate apex, intensely green; inflorescence yellow; fruit globe-shaped, 1.5 to 2 cm in diameter, scarlet-red; prefers well-shaded locations.

Catoblastus praemorsus (Willd.) Wendl.

Monoecious palm (Fig. 3), unarmed, solitary or clustered, 10 to 15 m; roots well developed, 1 to 1.5 meters long with sharp superficial protuberances; leaves 4 to 5, pinnate, leaflets regularly distributed on the rachis, lacerated on the edges; the last pair joined in the form of a semi-open fan; bracts 3 to 6; fruit (Fig. 4) globe-shaped, 2 to 2.5 cm in diameter, brown to yellow; prefers well-shaped locations.

Ceroxylon klopstockia Mart.

Dioecious palm, unarmed, solitary, 15 to 20 m; wax secretions along the entire stem; leaves, 10 to 15, pinnate, leaflets regularly distributed on the rachis, linear-lanceolate, long acuminate apex, green on the upper surface, grayish white on the reverse side; fruit globe-shaped, 2.5 to 3 cm in diameter, purple-red; generally prefers well-shaded conditions, but occasionally found in sunny locations.

Chamaedorea pinnatifrons (Jacq.) Oerst.

Dioecious palm, unarmed, solitary, 1.5 to 2 meters; adventitious roots, 10 to 15 cm long, smooth, orange red; leaf-scar rings well developed; leaves 3 to 5, pinnate, leaflets regularly distributed on the rachis, rhomboid, alternate or opposite each other; fruit elliptic, 1.5 cm long, 1 cm wide; orange then black when ripe; prefers well-shaded locations.

Dictyocaryum fuscum (Karst.) Wendl.

Monoecious palm, unarmed, solitary, 15 to 20 meters; roots well-developed (Fig. 2), 1 to 1.5 m long with sharp superficial protuberances; leaves 5 to 7, pinnate, leaflets regularly distributed on the rachis, lacerated at the apex; bracts curved,

3. *Catoblastus praemorsus* is one of the most frequent palms in the cloud forests of the coastal range of Venezuela.

4. *Catoblastus praemorsus* with fruit.

joined together forming a horn; fruits globe-shaped, 2 to 2.5 cm in diameter, light brown; surface of seed reticulate; generally prefers well-shaded conditions, but occasionally found in sunny locations.

Euterpe microcarpa Burret and
E. stenophylla Trail

Monoecious palms, unarmed, clustered, 15 to 20 meters; leaf-scar rings inconspicuous on adult plants; leaves 5 to 7, pinnate, sheath light purple, leaflets regularly distributed on the rachis, linear-lanceolate, long acuminate, lax; fruit globe-shaped, 0.5 to 1 cm in diameter, brown to black; prefers well-shaded locations.

Geonoma pinnatifrons Willd.

Monoecious palm, unarmed, clustered or rarely solitary, 3 to 4 meters; leaves 5 to 7, pinnate, leaflets irregularly distributed on the rachis, broad at the base and narrow towards the apex; fruit ovoid, 1 cm long and 0.8 cm in diameter, black; prefers well-shaded locations.

Geonoma simplicifrons Willd.

Monoecious palm, unarmed, solitary, 1.5 to 2 meters; leaves pinnate, 4 to 5, leaflets irregularly distributed on the rachis, broad at the base and narrow towards the apex; fruit globe-shaped, 1 cm in diameter, green; prefers well-shaded locations.

Geonoma solitaria (Engler) Jahn

We have never observed this palm, but Jahn (1908) and Badillor et al. (1984) report it as existing in the Henri Pittier National Park, describing it as a monoecious palm, unarmed, solitary, 4 to 6 meters; leaves, 5 to 7, entire, bifid, with reddish central vein; fruit ovoid, 1 cm long and 0.5 cm in diameter, green; prefers well-shaded locations.

Geonoma tenuis Burret

Monoecious palm, unarmed, solitary, 0.5 to 1 m; leaves 7 to 10, entire, bifid, intensely green; bracts completely deciduous; fruits globe-shaped,

0.5 to 1.1 cm in diameter, black; prefers well-shaded locations.

Geonoma undata Klotzch

Monoecious palm, unarmed, solitary, 4 to 8 m; leaves 4 to 7, pinnate, sheath with fibrous edges; leaflets irregularly distributed on the rachis, broad at the base and narrow towards the apex; fruit ovoid, 1 cm long and 0.8 cm in diameter; chestnut brown to black; prefers well-shaded locations.

Hyospathe pittieri Burret

Monoecious palm (Fig.1), unarmed, clustered, 8 to 10 meters; leaves 10 to 12, pinnate, sheath light green, leaflets regularly distributed on the rachis, linear-lanceolate with an acuminate apex, the last pair joined to almost half of the length; inflorescence red; fruit globe-shaped, 0.5 to 1 cm in diameter, dark purple; prefers well-shaded locations.

Table 1. Distribution of palm species in the cloud forests of the Henri Pittier National Park, Venezuela.

Palm species	T.C.F.	C.F.	S.C.F.
Bactris setulosa	+	−	0
Catoblastus praemorsus	−	+	−
Ceroxylon klopstockia	0	0	−
Chamaedorea pinnatifrons	+	−	−
Dictyocaryum fuscum	−	+	−
Euterpe microcarpa	−	−	0
Euterpe stenophylla	−	−	0
Geonoma pinnatifrons	+	−	−
Geonoma simplicifrons	+	−	0
Geonoma solitaria	0	0	−
Geonoma tenuis	0	+	−
Geonoma undata	0	0	+
Hyospathe pittieri	−	+	−

T.C.F. = Transition cloud forest (900–1,400 meters or 2,950–4,595 feet elevation). C.F. = Cloud forest (1,400–1,600 meters or 4,595–5,250 feet elevation). S.C.F. = Superior cloud forest (greater than 1,600 meters or 5,250 feet in elevation). + = frequent; − = occasional; 0 = absent.

Glossary of Descriptive Terms Used

acuminate—tapering to a point
adventitious—arising or occurring spontaneously in other than the normal location
armed—spines of some type present
bifid—divided in two, usually equal, parts
bract—modified leaf associated with the inflorescence
deciduous—shed periodically, falling
dioecious—when male (staminate) and female (pistillate) flowers are borne on different plants
elliptic—oblong, with regularly rounded ends
inflorescence—the branch that bears the flowers, including all its bracts and branches
lanceolate—narrow, tapering at both ends, the basal end often broader
lax—loose or non-rigid
linear—several times longer than wide, usually narrow
monoecious—both sexes present on a single plant, i.e., describing a plant bearing both staminate and pistillate flowers
petiole—the stalk of a leaf
rachis—the axis of a leaf beyond the petiole
reticulate—having veins, fibers or lines in a netlike pattern
rhomboid—shaped like a parallelogram with oblique angles
sheath—the basal part of a leaf, usually tubular or enrolled

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The Rancho Grande Biological Station in the Henri Pittier National Park is a scheduled side trip at the **IPS Biennial** to be held in June in Caracas. Several of the post-biennial tour options also include more in-depth visits to this cloud forest environment. Perhaps you can be the one to find the elusive *Geonoma solitaria.*

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CHAPTER NEWS AND EVENTS

(All items by Jim Cain unless otherwise noted).

Southern California Chapter News

In addition to the regular September 18th meeting, a special slide show and lecture was held at Ventura College on September 11, 1993. Dick Endt, IPS member from New Zealand, showed slides of his travels through South America hunting for rare palms. Included were pictures of species of *Ceroxylon*, *Geonoma*, *Prestoea*, *Parajubaea* and others. He also talked about the great red-crownshafted palm he discovered on the Inca Trail in Ecuador.

The Southern Chapter met on November 6, 1993, in Orange County. The starting point was the palm collection at Crystal Court, South Coast Plaza, 3333 Bear Street, Costa Mesa. There are about 82 different species in the ground at Crystal Court. This was followed by the group's first tour of the garden of Elva and Nadine West at 5201 E. Crescent Drive in Anaheim. This garden of 1.2 acres features a row of 16-year-old Royal palms (*Roystonea* sp.), *Ravenea rivularis*, *Chrysalidocarpus*, *Caryota*, *Ptychosperma*, *Archontophoenix*, *Neodypsis* and *Chambeyronia macrocarpa*. Most notable were the Foxtail palm (*Wodyetia bifurcata*), potted plants of *Hyophorbe verschaffeltia*, *H. lagenicaulis* and *Veitchia* species. Elva is also very interested in tropical fruits, with many varieties of mango, papaya, banana and other tropical and non-tropical fruits. The meeting was followed by the usual palm raffle and auction.

The Chapter's Annual Banquet was held on February 5, 1994, at the Hyatt Newporter in Newport Beach, starting at 11:00 a.m. The Hyatt Newporter has a very extensive collection of palms.

News from Central Florida

The Central Florida Palm Society held an old-fashioned Barn Raising in the Dent Smith Palmetum at Sugar Mill Gardens in Port Orange, Florida, on November 13–14, 1993. An expandable tridesic dome was constructed for protecting tender palms in winter conditions. It will be covered with agricultural frost blanket in the winter and heated with charcoal, oversized candles or supercharged compost bins.

New IPS Affiliate Society in Florida

At their October 1993 meeting in New Orleans, the IPS Board of Directors unanimously ratified the IPS Executive Committee action approving The Broward County Palm and Cycad Society as an affiliate of the International Palm Society. The group met all requirements for affiliation and had submitted the required documents to the Executive Committee. All IPS members should join me in welcoming this new Affiliated Chapter of the IPS to our ranks.

Along with each other IPS affiliated chapter, the Broward County Chapter will receive a collection of available back issues of *Principes* (set of assorted issues) along with a gratis chapter membership in the IPS for membership year starting 1994. Their first news report follows.

News from the Broward County Chapter

The Broward County Palm and Cycad Society met on September 23rd at the Cooperative Extension Service Office, College Avenue, in Davie, Florida. The speaker was Chuck Hubbuch, Curator of Palms & Cycads at Fairchild Tropical Gardens, who was accompanied by Don Hodel, author of "Chamaedorea Palms, The Species and Their Cultivation," recently published by the IPS. Chuck began his talk with a report on the cloud forest in the mountains of Panama. Slides were presented of various species of *Aiphanes*, *Chamaedorea*, *Calyptrogyne*, *Cryosophila*, *Coccothrinax*, *Geonoma*, *Iriatella*, *Reinhardtia*, *Pholidiostachys*, and *Welfia*. Also shown were *Zamia pseudoparasitica* and *Z. skinneri*. Chuck also spoke about Summit Gardens, a botanical garden in Balboa, Panama, which was started years ago in part by David Fairchild. The gardens are in need of maintenance assistance. Anyone wishing to help, please contact Chuck Hubbuch at Fairchild Tropical Gardens. Following the lecture, a palm raffle was held with *Coccothrinax miraguama*, *Areca cathecu* and *Syagrus* (*Rhytococos*) *amara* being awarded. Sandy Haller won the door prize of a *Calyptronoma dulcis*.

The November 18th meeting featured "The Licury and the Lears" or "The Palm and the Parrot" by Dr. Alan Meerow, Associate Professor and Palm & Tropical Ornamental Specialist at the University of Florida's Fort Lauderdale Research and Education Center. The lecture described Dr. Meerow's involvement with a group in Brazil trying to save the endangered Lear's Macaw by plant-

ing the Licury Palm (*Syagrus coronata*). The seeds of this palm are a favorite food of the macaw. Indeed, during breeding season, the birds will only nest near Licury Palms. If there is not an adequate supply of these seeds, the endangered macaw will often not nest at all. Ranchers sometimes strip off fronds and seeds of the palm as cattle fodder. Because of the lack of seeds and exotic bird trappers, the macaw's numbers are in serious decline. The palm is also not repopulating because of the stripping. Several cattlemen have become interested in the project, and young palms will be planted on three ranches. The ranchers understand the problem and will not be stripping the trees of their seeds. Hopefully this will promote breeding of the rare Lear's Macaw.

At the January 27th meeting, Nancy Edmonson of Fairchild Tropical Gardens spoke on garden plans, including plans for a new rare plant house which will feature an exhibit simulating a cloud forest environment. Her talk also touched on certain restoration projects including the Bailey Palm Glade.

All chapter meetings are open to any interested persons and each features a speaker, food, a palm or cycad raffle, and a palm or cycad auction. Meetings are generally held on the 4th Thursday of every other month.

The group will hold a Palm Sale on May 7–8, 1994. All IPS members are invited to attend.

News from the West Palm Beach (Florida) Chapter

The West Palm Beach Chapter held their Holiday Party on Wednesday, December 1 at Mounts Botanical Garden. In addition to holiday festivities, door prizes were awarded, and a palm auction was held. It was also announced that the fall Sale generated total gross income of US$29,878.89—this even with rain for about half of Saturday.

At the January 5th meeting, Paul Craft gave a presentation on his recent trip to Queensland; he showed slides of some beautiful gardens, including the Townsville Palmetum.

The February 2nd meeting featured Terrence Walters, researcher from Fairchild Tropical Gardens, who spoke on his expedition to China, the cycads found there, and their conservation. An auction followed.

Work days were held at the Norton Sculpture Gardens on January 15th and February 5th. Over 300 species are now in the garden, requiring tender loving care.

The group also participated in a "clean up" effort in the Summit Gardens in Panama, scheduled for March 9–13, 1994.

The Spring Sale will be held at Morikami Park on April 9–10, 1994.

News from the South Florida Chapter

The Fall Palm Sale of the South Florida Chapter of the IPS was held at the Fairchild Tropical Gardens on November 6–7, 1993, and featured 55 vendors from all over south Florida, each offering their finest palms for sale. The event featured "Palms of the Pacific Islands." Awards were given for "Best Pacific Island Palm" to Jeff and Larry Searle (*Pelagodoxa henryana*), for "Best Florida Native Palm" to Cynthia Aikin (*Thrinax radiata*), for "Best Containerized Palm" to Rick Leitner (*Phoenicophorium borsigianum*) and for "Best Palm of the Show" also to Jeff and Larry Searle (*Calyptrogyne sarapiguensis*). "Second Place, Best of Show" went to George Zammas (*Marojejya darianii*) and "Third Place, Best of Show" was awarded to Mark Friedrich (*Cyrtostachys renda*). The "Best Educational Exhibit" was awarded to the South Florida Chapter of the IPS.

The Fairchild Tropical Garden Ramble was held on December 4–5, 1993, from 9:00 to 4:30 daily. The South Florida Chapter set up an educational exhibit to promote palms and membership in the IPS.

The South Florida Chapter also met on December 15th for a Holiday Season Party and Annual Christmas Palm Extravaganza.

News from the Pacific Northwest Chapter

CKVU TV in Vancouver featured the palms and bananas in the gardens of Rudi Pinkowski and Larry Wick, with Rudi given a short interview. Previously, Rudi's garden won First Prize in 1988 as the Best Residential Garden in North Vancouver and in September 1990, Vancouver magazine selected it as "the most innovative private garden" in the city.

A workshop on "shelters and heaters" to help members prepare for the coming winter was held by the Pacific Northwest Palm and Exotic Plant Society (PNWP&EPS) at Phil Davies's home near

Cloverdale in suburban Vancouver on October 23rd. This subject was again covered at the PNWP&EPS meeting on October 30th at the home and garden of Kathy and David Latimer, 28845 229th Ave SE by Sawyer Lake, Kent, Washington.

The November 29th meeting at Van Dusen Gardens in Vancouver featured a general meeting and elections, with Jim Reynolds presenting a slide show on the Singapore Botanical Gardens.

On December 18th, the PNWP&EPS met at the home of Edie Baer, 12235 SW Landwood, Portland, Oregon. Mel Frank, President, gave a slide show on "Palms in California."

Meetings planned for 1994 include general meetings at Van Dusen Gardens, Vancouver, on February 28th, May 31st, August 22nd and November 28th. In addition, PNWP&EPS participated in the Northwest Flower and Garden Show on February 9–13 at the Convention Center in Seattle and is planning for the Pacific National Exhibition in Vancouver from August 20th to September 28th.

The Pacific Northwest Chapter has announced a dues increase for 1994. This also impacts IPS members from other areas who wish to receive *The Hardy Palm International* magazine. Rates effective January 1, 1994, are Cdn$20.00 for Canadian addresses, US$15 for US addresses and US$20 for foreign addresses. Please update the information provided in the recent *IPS Roster*. Back issues of *The Hardy Palm International* magazine are also available from PNWP&EPS for Cdn$5 or US$4 each.

French Chapter Takes Trip to Portugal

The French palm association, *Fous de Palmiers*, sponsored a trip to see the palms of Lisbon, Portugal, from October 1–4, 1993. This was the first field trip which the association held outside of the borders of France. Members of the European Palm Society were also invited to attend. French members traveled from Paris, meeting members from other nations in Lisbon. Visits were made to: the Jardim do Ultramar, the Tower of Belem, the Faculty of Sciences Botanic Garden and Estufa Fria in Lisbon; the garden of Moneiro Mor on the city outskirts; and, Quinta de Montserrate in Sintra. The group was escorted by International Palm Society member and Lisbon native, Mr. Felipe Nobre Guedes, who was subsequently made an Honorary Member of Fous de Palmiers for his hospitality and efforts.

Lisbon probably offers the most extensive collection of adult palms growing outdoors anywhere in Europe. With its history as a leading maritime nation with colonies all over the world, plants from around the world were frequently introduced to Lisbon, where the recorded temperature has never dropped below freezing. Over 35 species of palms were seen growing outdoors in the various gardens, including *Phoenix canariensis*, *P. sylvestris*, *P. reclinata*, *Jubaea chilensis*, *Syagrus romanzoffiana*, *Howea forsteriana*, *H. belmoreana*, *Trithrinax acanthacoma*, *Rhopalostylis sapida*, *R. baueri*, several species of *Sabal*, *Brahea* and *Butia*, and (of course) *Chamaerops humilis*, *Washingtonia filifera* and *W. robusta*. Numerous cycads and other exotic plants were also seen and enjoyed.

A complete travelog by Steve Swinscoe of this enormously successful trip to Lisbon with details on experiences in each garden will appear in the next edition of *Chamaerops*, the journal of the European Palm Society [for subscription information, see page 7 of your latest *IPS Roster*]

Steve Swinscoe/Jim Cain

European Palm Society Plans 1994 Trip to South of France

Martin Gibbons of the U.K. advises that the European Palm Society is planning a trip to the South of France in the summer of 1994. The visit will probably center on Nice and last about 4 days. Members will see the fabulous Boulevard des Anglais running along the Mediterranean Sea with hundreds of mature *Phoenix* and *Washingtonia*. Nearby gardens have species of *Jubaea*, *Sabal*, *Livistona*, *Trithrinax*, *Rhapis*, *Brahea*, *Syagrus* *Butia*, *Howea*, *Phoenix*, *Trachycarpus*, *Chamaerops* and other palm genera. Some private gardens to be visited should also have *Trachycarpus martianus*, *Wallichia*, *Syagrus* × *Butia*, *Rhopalostylis*, *Archontophoenix*, *Caryota* and rarer species of *Butia* and *Brahea*. Cycad enthusiasts will enjoy dozens of species of *Cycas*, *Encephalartos*, *Dioon*, and other genera. A possible side trip is the "Bambouseraie de Prafrance" for the bamboo lovers. Quite a few other entertain-

ments will be offered in addition to the garden tours.

Plans are now in formative stages but will be finalized soon. If you are interested in attending, please contact Martin Gibbons, European Palm Society, % The Palm Centre, 563 Upper Richmond Road West, London SW14 7ED, phone 44-81-876-3223 or fax 44-81-876-6888.

Martin Gibbons/Jim Cain

Gulf Coast Chapter News

The Gulf Coast Chapter of the IPS held its summer meeting on July 11, 1993, at the West End Men's Clubhouse in Panama City, Florida. Barbecue chicken with all the fixin's awaited members and guests for a wonderful summertime luncheon. After a short business meeting, attention was turned to Panama City palm activity. Bob Hoxie reported that Panama City is now a "Tree City USA." It was further reported that the unusual and much admired 4-headed *Syagrus* (*Butia*) *capitata* in the area will not have to be moved, as previously feared. Dave Hamon advised that he wished to donate two *Phoenix canariensis* to the City of Pensacola, with suggested planting at the proposed park site where the old San Carlos Hotel once stood. Maxwell Stewart of Mobile gave a report on his attempts to induce a multi-headed *Sabal palmetto* by physically splitting the crown. Results to date have not been successful, but ongoing experiments continue. Plans were also discussed for planting *Sabal texana* [= *S. mexicana*] on Isle Dauphine, AL. Transportation by boat was organized but no date set. Members then discussed problems and successes they had experienced with their palms. A post-meeting excursion was made to Bob Hoxie's home to see his collection, which included *Phoenix sylvestris* × *canariensis* cross, *Livistona saribus*, *Washingtonia* sp., and many varied *Chamaedorea* species.

The Gulf Coast Chapter has donated palm plants and installation to various groups and communities along the Gulf coast. In the Mobile area, palms have been placed with Spring Hill College (an 8-foot *Phoenix roebelenii* and several small *Chrysalidocarpus lutescens* for indoor use); University of South Alabama (3- to 5-gallon sizes of *Sabal palmetto*, *Trachycarpus fortunei*, *Phoenix canariensis*, *Livistona chinensis*, *Butia capitata*, plus 3 field-grown specimen-sized *Rhapidophyllum hystrix*); and the City of Dauphin Island, Alabama (1–5 gallon seedlings of *Sabal texana*, *S. palmetto*, *S.* "Riverside," *Butia capitata* and *Livistona chinensis*, as well as two 45-gallon plants each of *L. chinensis* and *P. canariensis*). In addition, a *Phoenix canariensis* with 6 feet of clear trunk was donated to Dauphine Island.

The Chapter's Fall meeting was rescheduled to October 10th to coincide with the IPS Board of Directors Meetings in New Orleans. IPS directors and their guests were invited to extend their stay and make a one-day trip over to Mobile from New Orleans to be the guests of the Gulf Coast Chapter at Maxwell Stewart's estate, Laurel Place. This went off extremely well, with over 20 of the IPS directors' group and a number from the Louisiana Chapter joining the Gulf Coast Chapter members. Maxwell and Gloria Stewart were the perfect hosts, with Maxwell providing an excellent tour of the many palms at "Laurel Place" and Gloria organizing an absolutely wonderful meal with bacon-wrapped roasted quail as the main dish.

Following the garden tours and lunch, all attended the Gulf Coast Chapter meeting. The chapter Vice-Presidents from Panama City (Frank Storli), Pensacola (Tom Mignerey) and Mobile (Tim Gwaltney) each gave a report on activities in their respective areas. IPS President Jim Cain and Vice-President Phil Bergman gave a brief report on the IPS Board Meetings, with emphasis on the board's direction "to increase and improve the Society's services to IPS members and local chapters." It was stressed that the first step toward achieving this goal was determining what members really wanted from the IPS. A survey of all members will soon be forthcoming to help refine the IPS goals. IPS Seed Bank Committee Chairman Lynn Muir also gave a report on the revised operating procedures for the IPS Seed Bank, approved the previous day in New Orleans.

A palm auction was held following the business meeting. This turned into a very festive event, with "guest auctioneers" Phil Bergman and Jim Wright from the Southern California Chapter working in a team with Tim Mignerey of the Gulf Coast Chapter. The auction yielded over $300 for the Gulf Coast Chapter.

News from Louisiana

The Louisiana Chapter arranged various events for the IPS Board of Directors meetings held in New Orleans in early October. The events were attended by 14 IPS directors and an additional

21 out-of-town people, including directors' spouses, IPS Committee Members, etc. To open board events, the Louisiana Chapter hosted an open house, garden tour, and afternoon meal at the home of Danny Braud in New Orleans. Expenses for the meal were shared 50/50 between the Louisiana and Texas IPS chapters, but all of the considerable work was performed by Louisiana Chapter members. Visitors were amazed at the diversity of palms, bananas, gingers and other exotic plants growing outdoors at Danny's place. The garden was extremely lush with numerous tropical plants in bloom at the time. Several palms generally considered too tender for the area were being grown outside. Danny admitted that a number were lost in the December 1989 freeze and had been replaced. The last few winters have been very mild and the garden looked fantastic. Many of the IPS board members commended the non-structured afternoon as a chance for board members to meet and visit with their local hosts and get better acquainted with each other outside of the formal meeting environment. The weather couldn't have been more cooperative.

The tour of the Barataria Unit of the Jean Lafitte Park the following morning showed the IPS board members and guests the completely different look of wild Louisiana swamplands. This featured a 0.75-mile boardwalk over typical Louisiana swamp. Large areas of the cypress swamp were home to an extensive population of *Sabal minor*, many with 3 to 5 feet of clean trunk. This affinity towards an above-ground trunk is apparently caused by the growing conditions, as trunked *Sabal minor* plants are extremely rare outside of the wetlands. Louisiana Chapter member Rod Gates served as an extremely knowledgeable guide to the many plants encountered in the swamps. Rod seemed to know the scientific name of EVERY plant visible from the trail. The group's only disappointment was the lack of alligator sightings—the only one seen was in a private lake where a refreshment break was taken at tour end.

Following formal IPS Committee meetings on Friday afternoon, the board members and their guests invited the officers of the Louisiana Chapter and the President of the Texas Chapter and his wife to a Cajun night on the town at Mulate's Restaurant in New Orleans. The food offered an authentic introduction to Cajun cuisine for those not having previously experienced it. The hit of the evening was the Cajun dancing! Particularly for director Norm Bezona from Hawaii and Jesse Bergman, son of IPS Vice President Phil Bergman (San Diego, CA). Norm wore his overalls and looked very authentic.

IPS Board of Directors meetings took place all of Saturday, with everyone free Saturday night to do as they wished. At the IPS board meeting, several key decisions were reached which are intended to improve the responsiveness of the IPS to its members (see related notices elsewhere in this issue).

The Fall Meeting of the Louisiana Chapter was held jointly with the Gulf Coast Chapter in Mobile, Alabama, in conjunction with the visit to Mobile of the IPS board members and their guests (see write-up under Gulf Coast Chapter).

I received numerous comments from IPS board members and their guests who attended the New Orleans meetings. These were, without exception, positive and complimentary to the city, the meeting venues, and the Louisiana and Gulf Coast Chapter members involved. I would like to take this opportunity to publicly express my appreciation to the Louisiana Chapter officers, particularly to Danny Braud for opening his home and garden and to Wilbur and Marguerite LeGardeur for the great support they provided in planning the various New Orleans events. Thanks also go to Maxwell and Gloria Stewart for the wonderful hospitality shown to all on the trip to Mobile.

Jim Cain, IPS President

Hawaii Island Palm Society Chapter Activities

The Hawaii Island Palm Society (HIPS) Chapter met on December 9th at the UH Ag Complex for a slide show on "Pinangas of Thailand" by Dr. Peter Mayotte and Greg Braun, who had just returned from a trip to Thailand where they identified new species of *Pinanga*. A short business meeting was also held and refreshments were served.

Texas Chapter News

On September 4th, the Texas Chapter met in southwest Houston at the home of Grant Stephenson for a special auction of palms. Long-

standing member Peter Heinz of Brownsville donated a large truck and trailer load of numerous species of palms to the Texas chapter, and Grant assisted in getting the plants arranged for the auction at his home. Plants purchased by members and guests included several species of *Ptychosperma*, *Caryota mitis*, *C. urens*, *C. commingi*, *Copernicia alba*, *Livistona rigida*, *L. benthami*, *Latania lontaroides*, *Chrysalidocarpus cabadae*, *Pseudophoenix sargentii*, *Licuala spinosa*, *Pritchardia thurstoni*, *P. pacifica*, *Hyophorbe lagenicaulis*, *Neodypsis decaryi*, *Phoenix rupicola*, various *Chamaedorea* and numerous other palms in 1–5 gallon containers. Larger plants bought included 3 large *Brahea brandegeii* with about 5–6 feet of clear trunk each, an 8-foot *Acrocomia mexicana*, a large (>6 feet tall) cluster of Mediterranean fan palms (*Chamaerops humilis*) and a nice specimen plant of *Arenga caudata*. Plants not purchased by members were to be donated to public botanical collections in the Houston/Galveston area. Many thanks to Peter for the generous donation. Grant also had some very nice *Jubaea* plants available for sale. Dinner was served following the sale.

The October 2nd meeting and Fall Members' Sale was held at the home of Horace and Cynthia Ford Hobbs in south Houston, near Hobby airport. The sale included a number of each of the following seedlings: *Trithrinax campestris*, *T. acanthacoma*, *Syagrus* (*Butia*) *bonneti*, numerous *Livistona* and *Chamaedorea* species, *Wodyetia bifurcata*, *Copernicia alba* and others. A nice group of *Rhapis excelsa* cultivars (both green and variegated types) was provided on consignment by Lynn McKamey of Rhapis Gardens in Gregory, Texas. Horace was thinning out his greenhouse for the winter and thus also offered a number of nice specimen plants for sale to complement those already in the Texas Chapter inventory. The traditional Hobbs Mexican tamale dinner with assorted *pan dulce* was served following the sale. By the way, Horace, the Texas Chapter President, has been nominated as an IPS director for the period 1994–1996.

The November 13th meeting was held at Bill and Kelley Burhans's home in southwest Houston. Bill Burhans gave a slide presentation of palms viewed at Lyons Arboretum on Oahu, visited during his recent trip to Hawaii. The Burhans's garden was new, but very attractively landscaped with many interesting young palms. The weather wasn't cooperative, with severe thunderstorms and tornado warnings posted throughout the meeting day. No tornados were seen, but there were plenty of severe thunderstorms and heavy rain present. The 20 brave souls who came out in the weather enjoyed the meeting and the dinner which followed. Mike Burnett also distributed a nicely prepared Texas Chapter Newsletter Mailing List at this meeting. This will provide all chapter members with names and contact information on other palm enthusiasts. The mailing list will be distributed to all active (paid) members with the next chapter newsletter. The mailing list is available *gratis* to anyone else who requests it.

Palm-related visitors to the Houston area this fall included Rod Moulden and his wife from Australia, and Lucian and Judi Kapp from Illinois. Rod is currently President of the Gold Coast Tweed Palm & Cycad Society in southern Queensland. Lucian is an avid palm enthusiast from a colder climate and sports a registration tag of "PALM" on his automobile. Anyone coming to Texas and wanting to see area palms is asked to contact Horace Hobbs or Jim Cain.

The 1994 Texas Chapter Annual Palm Sale will be held on April 9, 1994, at the Mercer Arboretum just north of Houston. Many uncommon varieties of palms and other exotic plants will be available for purchase.

South African Palm Society (SAPS) News

Several items of general interest to IPS members were revealed at the SAPS 1993 Congress and Annual Meeting held May 21–23, 1993. In mid 1993, the South African Palm Society (SAPS) reported 335 members in 15 countries, with 20 percent of the memberships from outside South Africa.

Honorary Life Memberships in SAPS for both Cyril Manthe and Errol Harrison were proposed and unanimously approved at the AGM, in recognition for their services to the society over many years.

South Queensland Group (SQG) News (PACSOA)

The September meeting of the South Queensland Group (SQG) featured a slide presentation by Stan Walkley on his trip to the Cycad '93 conference in South Africa. The SQG also plans to prepare informative plant labels for commercial

nursery purposes. Existing labels are often misleading and may contain incorrect information.

The SQG met at Bread House, opposite Brisbane Grammar in Brisbane on November 15th. It was noted that the SQG has consistently enjoyed an attendance of about 40–50 people at each of its meetings in 1993. Rolf Kyburz gave an interesting slide presentation on his 1992 visit to Nong Nooch Village just south of Bangkok in Thailand. IPS member Kampon Tansacha has developed a garden resort with a very large and diverse planting of palms within its 1,000+ acres.

The SQG held an outing in October at Hank's Nursery on Rifle Range Road in Pimpama. Of particular interest were the 2.5 meter (>8 foot) *Verschaffeltia splendida* and several specimens of *Phoenicophorium borsigianum*. Both species are cold-sensitive but have grown well in the protected conditions of their garden. Hank had, however, lost 3 *Deckenia nobilis*, despite special efforts in acclimatizing them to the Brisbane area. An added meeting attraction was watching a baby owl just learning to fly.

The SQG held a BBQ 1993 Christmas Party on Sunday, November 28th, at the home of Cheryl Basic at 362 Winstanley Street in Carindale. Congratulations are also in order to Cheryl who was recently nominated as a director of the International Palm Society.

The January 17th meeting marked the election of new officers for the SQG for 1994.

An Anniversary Dinner was held March 5, 1994, with an attendance of more than 200; it was held on March 4–6, 1994, at the Mt. Cootha Botanical Gardens in Brisbane in association with the PACSOA Annual Palm and Cycad Sale. Dr. John Dransfield from Kew Gardens (England) and co-author of *Genera Palmarum*, spoke on "Palms of Madagascar" at the dinner, open to all members. Tony Irvine also spoke on "Aspects of Queensland Rainforests." This was the tenth anniversary of the Palm & Cycad Sale and featured other special events. It also marked the 20th anniversary of the formation of the Australian Palm Society.

Gold Coast Tweed (PACSOA) News

The Gold Coast Tweed Palm & Cycad Society (GCTPACS), a branch of PACSOA, met on October 11th at the Miami High School. Members participated in a "bring and tell" session with *Opsiandra maya*, *Phoenicophorium borsigianum*, *Jubaea chilensis* and *Parajubaea cocoides* presented.

On September 14th, the group held a field trip beginning with a morning tea at the garden of King and Maureen Newman of Condong. The many palm trees included a large *Phoenix roebelenii* and a newly established *Chamaedorea* garden. *Macrozamia* were planted throughout the garden along with a *Zamia furfuracea*. Many fruit trees and tall tree ferns were featured along with numerous native Australian plants. The team then visited Lindy and Phil Thomas's farm in Upper Dungay, stopping for a walk into the natural bush to examine *Lepidozamia peroffskayana* (both mature plants and young 2-leaf seedlings). The Thomas property featured a handmade rope bridge across a creek and a walk through bush which has been undisturbed for the last 80 years. Pickabeen palms are starting to establish themselves along the creek, and a nearby orchard has many unusual fruit and nut trees. The farm holds a government certificate for chemical-free fruit and vegetables which are sold locally. The day concluded with afternoon tea and homemade cookies.

On November 14th, a GCTPACS field trip was held to two nurseries on the Sunshine Coast specializing in palms and cycads, both owned by PACSOA members. The visit started at Palm Fascinations in Nambour, which has been going for about 5 years, with a number of nice palms in the ground. This was followed by lunch at the Wappa Falls Dam Park picnic facilities, again populated with significant specimens of local palms. After lunch, the group toured the nursery of Leo Gamble, former President of the Sunshine Coast Palm & Cycad Society, which offered a wide range of established palms and cycads, many up to 10 years old. Both nurseries had a good selection of plants for sale and most members took a few home.

The GCTPACS Christmas Party was held on December 12th at the 12-acre property of Jennifer and Warwick Laurie in the Mudgeeraba Valley (8 Gilward Drive, Mudgeeraba). This combined a Christmas "breakup" with a Swap and Sale meet, as well as offering scrumptious BBQ for all.

News from South Australia (PACSOA)

The Palm & Cycad Society of South Australia (PACSOSA) met in September at the home of Heinz-Dieter Froehlingsdorf. A group order for palms was prepared at the meeting from vendors

who had made their lists available to PACSOSA. Plants ordered include *Acoelorraphe wrightii*, *Brahea decumbens*, *Burretiokentia viellardi*, *Calamus caryotoides*, *Chamaedorea ernesti-augustii*, *C. geonomiformis*, *C. glaucifolia*, *C. seiffritzii*, *Chambeyronia macrocarpa*, *Linospadix monostachya*, *L. minor*, *Neodypsis baronii*, *N.* sp. "Red Neck," *Ravenea anavary*, *R. glauca*, *R. madagascariensis*, *Rhapis multifida*, *Wodyetia bifurcata* and others. While lists were being finalized, an excellent supper was prepared by Heinz's wife Chris and daughter Jessamy. Plant lists and dinner were followed by presentation of two videos: "Rare Palms of Malaysia" presented by Laurie Watson and "Cycad Reproduction" by Knut J. Norstog. In a short business session, Ivan Iljcesen was elected treasurer of PACSOSA for 1994.

PACSOSA also met on December 5th at the Adelaide Zoo on Frome Road to check out the palm and cycad plantings at the zoo. There have been some extensive plantings there in recent years. The zoo visit was followed by a breakup show at Heinz's home. Members brought their specimens of *Ravenea rivularis* given out at a previous meeting a few years earlier, with a prize awarded to the largest and most attractive plant.

Sydney Branch (PACSOA) News

The Sydney Branch of PACSOA met on September 21st at the Maiden Theatre of the Sydney Royal Botanic Gardens. Former International Palm Society Board member Dick Phillips from Suva, Fiji, was guest speaker. Dick gave an amusing and informative talk on the joys and problems associated with gardening in Fiji.

At the November 16th meeting, Paul Anderson gave a slide presentation on a recent trip to New Caledonia. Rob Smith also showed slides of Lord Howe Island. Both meetings were followed by the usual palm auction, featuring some rare and well-grown plants.

The Sydney Branch Christmas Party was held on December 4th at the home of Paul and Elizabeth Anderson at 2 Poole Close, Empire Bay. Garden tours and a catered dinner were provided. A "car boot sale/swap session" of various plants was also held.

North Queensland Palm Society News (PACSOA)

The North Queensland Palm Society (NQPS) met on October 4th at Tumbetin Lodge, The Palmetum, in Townsville. The speaker was Jo Valentine, Wet Tropics Public Contact and National Parks and Wildlife Service Ranger for the Department of Environment and Heritage. The presentation was entitled "From the Sea to the Edge," a photographic journey through Queensland's Wet Tropics from the seashore to its western edge. This lecture was originally planned for August 2nd, but was postponed until October.

The NQPS held their Annual General Meeting on December 6th at Tumbetin Lodge. In addition to election of officers for 1994, the meeting featured an interesting slide presentation by John Dowe on "Pollination and Reproduction of *Wodyetia bifurcata*, the Foxtail Palm," based on recent studies of mature *Wodyetias* in The Palmetum.

There is an interesting news item by John Dowe in the October issue of *Mooreana*. On May 26, 1993, Mayor Makato Ogawa of Tokuyama, Japan, unveiled plaques in the Townsville Palmetum to commemorate the beginnings of two projects in the Palmetum being sponsored, as a gift of friendship, by Townsville's Japanese sister city. The first project will be the "Licuala Palm Walk" which features *L. ramsayi* and will be developed in the lower portion of the Swampforest area extending down to Jensens Creek. A timber cantilever bridge will span the creek, with walkways extending outwards from nearby paths. The bridge will offer attractive views down on the palm crowns.

The second project is a "Traditional Australian Tropical Garden" to be established in the area west of Tumbetin Lodge. According to John Dowe, "This garden will feature a formal arrangement of plants traditionally used in domestic gardens in tropical Australia. It shall include palms, gingers, large trees and other plants with lush and often colorful foliage. The sponsorship from Tokuyama amounts to A30,000 to be spent over three years."

Sunshine Coast News (PACSOA)

The Sunshine Coast Palm & Cycad Society (SCPACS) met on Monday, October 4th, 1993, at the Nambour Band Hall on Daniel Street. An educational slide show was given by Robbie Kelly on his recent trip to Fiji, Costa Rica, and Hawaii. Raffle prize was a beautiful *Howea forsteriana* (Kentia palm) in a 12-inch tub.

Members of the Sunshine Coast group hosted a field trip of the Gold Coast Tweed Palm & Cycad Society in November (see details under write-up for Gold Coast Tweed).

The group met on December 6th, 1993, with a slide presentation entitled "Cycads of Africa" by guest speakers, Stan Walkley and Peter Heibloem. Some of the best private cycad gardens and botanical gardens in the world were featured.

The Sunshine Coast Christmas Party was held on December 12th at Ron Koll's Rare Palm & Cycad Nursery, Browns Creek Road, Yandina. Ron's was a beautiful location, surrounded by 2 creeks, rainforests, palms and cycads, with swimming possible.

Palm and Cycad Society of Mackay (Australia)

The Palm and Cycad Society of Mackay (PACSOM) of PACSOA met on September 26th at the home of Les and Gwen Shailer, 7 Muggleton Street, Sarina.

On October 24th, the group met at the Coral Coast Nursery, owned by the Shea family on Cape Hilsborough Road. Twenty-one members and guests were first greeted by a shaded glen filled with magnificent old trees. A great variety of palms, creepers, vines, trees and shrubs have been planted and are now established and starting to look their best. Merve Shea has been in parks and gardens all his life and supervised the landscaping on Royal Hayman Island. This expertise and experience shows clearly in the wonderful layout at the Coral Coast.

Raffle results of recent meetings were *Arenga australasica* and *Thrinax parviflora* to Brenda Harold, *Caryota griffithi* to Clyde Rowles, *Calamus caryotoides* and *Veitchia merrillii* to Russ King, *Halmoorea trispatha* to Lois McGregor, *Chamaedorea tepejilote* to Juanita Duncan, *Neodypsis baronii* to Dwayne Shea, *Neodypsis tsaratanensis* to Helen Graham, and two lots of *Borassus* seeds to President Percy Simonsen.

The "Christmas Break Up" was held on November 28th at the Farleigh Plot. A BBQ and plenty of socializing followed a short meeting.

A meeting to finalize plans for 1994 was held February 3rd in Farleigh.

Palm and Cycad Society of Western Australia

The Society's September meeting at the Leederville Town Hall featured a lecture on soil and fertilizer by Chris Oliver of Bentley TAFE College. The Society met again on October 18th at the Leederville Town Hall. Gary Barker gave a talk on earthworms. Ken Adcock gave an excellent talk on *Lytocaryum weddellianum*, the Wedding Palm, from Brazil. The November 15th meeting featured a palm and cycad "quiz" with Neil Jones arranging the questions and cycad plants as prizes.

The group also had a display at the Horticultural Spectacular held on November 5–7, 1993. Palms and cycads were shown and offered for sale as were the Society's Palm book and other books on palms and cycads.

Gascoyne Park Palm Garden work days were held on September 25–26 and November 21, 1993. Work recently accomplished includes pipe laying, fertilizer spreading, palm planting, weeding, snail eradication and mulching. In addition, a fence has been erected by the group to enclose 50 square meters for cycad cultivation. This has been a joint effort by many members of the society.

The Palm & Cycad Society of Western Australia Christmas Party was held on December 12th at the home of Peter and Lori Skinner in Orange Grove. Members had adequate opportunity to visit the gardens and extensive shade house.

Back Cover

The colorful fruiting branches of *Oenocarpus balickii*, a recently described Venezuelan palm. Photo by Andrew Henderson.