



PRINCIPES

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THE INTERNATIONAL PALM SOCIETY

A nonprofit corporation engaged in the study of palms and the dissemination of information about them. The Palm Society is international in scope with world-wide membership, and the formation of regional or local chapters affiliated with The Palm Society is encouraged. Please address all inquiries regarding membership or information about the society to The Palm Society, Inc., P.O. Box 368, Lawrence, Kansas 66044, U.S.A.

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Cover Picture

A coconut plantation in the Philippines. Credit: Red V Coconut Products Co., Inc. See pp. 47-62.

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Principes, 30(2), 1986, pp. 47-62

Coconut¹

FREDERIC ROSENGARTEN, JR.

88 Battle Road, Princeton, NJ 08540

COCONUT

LATIN	<i>Cocos nucifera</i> L.
SPANISH	Coco
FRENCH	Coco
GERMAN	Kokosnuss
SWEDISH	Kokosnöt
ARABIC	Jauz Al-Hind
DUTCH	Kokosnoot
ITALIAN	Cocco
PORTUGUESE	Coco
RUSSIAN	Kokós
JAPANESE	Kokonatto
CHINESE	Yeh Tzu

The coconut palm is an alluring symbol of the tropics. Its mention conjures up the image of a picturesque tropical isle—a curving beach lined with tall, stately palm trees leaning gracefully toward the sea. This plant is one of nature's most useful gifts to man, indispensable in the daily existence of millions of the inhabitants of the tropics, where the palm is a primary source of food, drink and shelter.

Every part of the coconut is utilized for some human need: its white nutmeat may be eaten raw, or shredded and dried, in which form it is known as desiccated coconut. The dried meat of the kernel is called copra, and when crushed is the source of coconut oil; its husk yields short, coarse, elastic fibers known as coir, which is widely used to make rope, cables, upholstery and coarse textiles; its large leaves, when interwoven, provide an excellent thatch

roofing material for houses and may be fashioned into hats, curtains and baskets; the midribs of the leaves are used for fencing, brooms, canes, pins and needles; thin strips of the fronds are woven into clothing. The hard, fine-grained coconut shell is a useful domestic utensil—half a shell makes a good cup, while carved shells can become spoons, buttons, ashtrays, saucers or teapots. An excellent charcoal is produced from the shells, employed not only as a cooking fuel but also in the production of gas masks and air filters. A sugary sap known as *toddy* is obtained by cutting the unopened inflorescences to extract a sweet juice which may be consumed fresh, or fermented and distilled to make a strong liquor. The outer part of the trunk of the coconut palm furnishes a construction lumber for houses and furniture, which has an attractive grain and dark color. The swollen base of the trunk, when hollowed, can be turned into a food storage container. At the top of the tree, the tender terminal bud (the palm heart) can be used in salads. One could live almost endlessly on the coconut's products.

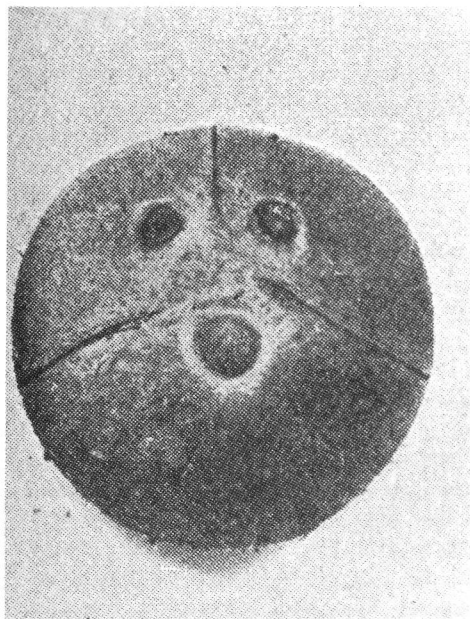
The coconut was not known to classical writers. It is first mentioned in 545 A.D. by Cosmos Indicopleustes, an Egyptian monk who visited western India and Ceylon. In his *Topographia Christiana*, Cosmos described it as the "great nut of India."

A remarkable Buddhist temple called Boroboedoe (Fig. 1) was built of volcanic lava on a hillside in central Java about 900 A.D. Among the ruins of this time-worn shrine there are numerous, splendid bas-relief carvings, several of which depict

¹ Reprinted with the permission of the publisher from THE BOOK OF EDIBLE NUTS, by Frederic Rosengarten, Jr., published by Walker and Company, New York, 1984.



1. Ancient Indonesian sculpture depicting coconuts. Among the ruins of a Buddhist temple called Borobodoer on a hillside in central Java, dating from about A.D. 900. Credits: *COCOS NUCIFERA*. F. W. T. Hunger. Amsterdam: Scheltema & Holkema's Boekhandel, 1920.



2. The origin of the word "coconut." Sixteenth-century Spanish and Portuguese explorers noticed that the three scars on the base of the shell resembled a monkey's face—two of the germinating holes representing the eyes, the third the nose. So they called the nut "coco," which was the Spanish slang word for "monkey face." Credits: Left, *De Kokospalm of Klapperboom*. L. Th. Maijer. Batavia, Java, 1917; Right, *La Noix de Coco*. Octave-J.-A. Collet. Paris, 1913.

the coconut palm. This is undoubtedly one of the oldest known illustrative portrayals of the coconut. In 1280 Marco Polo described coconut growing in Sumatra, as well as in Madras and Malabar in India, calling it *nux indica*, the Indian nut.

The generic name "Cocos" and the popular name "coconut" apparently are derived from the Spanish word "coco" meaning "monkey face." Sixteenth-century Spanish and Portuguese explorers gave this name to the coconut because the three scars or markings on the base of the shell resemble a monkey's face—two of the germinating holes representing the eyes, the third the nose (Fig. 2). By the end of the sixteenth century the word "coconut" became established in the English language.

Although coconut palms tend to lean away from each other in order to get more sunlight when growing close together, they

generally grow straight. Those near the shore lean toward the ocean because in that direction there are no other palms to shade them. Atop the unbranching trunk is a radiating crown of thirty or more arching, featherlike leaves measuring up to twenty feet in length. New leaves emerge as spearlike structures from the top-most point of the trunk and slowly unfold and open to take their place in the crown. A normal palm can produce a new leaf every month. After two and one-half to three years the leaf dies and detaches from the tree, leaving behind a distinctive ridged scar which gives the trunk its rough surface. The tough, fibrous, but pliable trunk is capable of bending and is very resistant to strong winds. The coconut is a single-stemmed tree; the tall varieties may reach a height of eighty feet or more.

A thick growth of thousands of stringlike roots spreads horizontally twenty to

thirty feet from the trunk to cover an area greater than the diameter of the crown. Although it has no tap root, the small roots and rootlets are so solidly anchored in the soil that they are seldom uprooted, even during hurricanes. Without such a strong root system, the coconut palm would not be able to lean and grow in such an inclined manner in windy and seaside locations, where it usually leans into the prevailing wind.

At maturity, roughly six to twelve years in tall varieties, the tree begins to produce green inflorescence buds in the leaf base of each new leaf. The developing inflorescence on its first appearance is two to three feet long, enveloped in a sheath called the spathe. As the bud swells it bursts the sheath, revealing the inflorescence. The flowers are pale and straw-colored. The coconut palm is monoecious, producing both male and female flowers on the same inflorescence. The smaller male flowers are produced on the end of the inflorescence, away from the trunk. The inflorescence can be either self- or cross-pollinated. The tall varieties are nearly always cross-pollinated because the female flowers mature first and are no longer receptive when the male flowers shed their pollen. Although many female flowers are pollinated and set fruit, more than fifty per cent fall during the first two months, leaving a cluster of young coconuts to develop.

After 120 days, the shell becomes filled with a clear, sweet, refreshing liquid called "coconut water," rich in sugar, minerals and vitamins. Coconut water is a refreshing drink, popular in producing areas as well as with tourists in the tropics, who sip it directly from the nut through a straw.

As the fruit ripens, this watery juice thickens. After 160 days the nut attains its full size, and the meat (endosperm) begins to form around the inside of the shell as a thin, white, jellylike layer. The shell begins to harden when the nut is about 220 days old, and full maturity is

reached at eleven to twelve months when most of the coconut liquid has solidified into nut meat, leaving an air space within the nut. Shaking the coconut to slosh the liquid is a test of its maturity. The average ripe fruit is ovoid, about eight to fifteen inches long, six to eight inches in diameter and weighs around seven to eight pounds. A smooth outside skin covers the thick, fibrous husk. The following figures indicate the approximate percentages of the components of the whole, ripe coconut: shell 12 per cent; husk 35 per cent; meat 28 per cent; and water 25 per cent.

Cocos nucifera is the Latin name or binomial for the coconut. At one time scientists recognized as many as sixty other species under the genus *Cocos*, but it is now generally accepted that the coconut palm stands by itself and is monotypic—meaning that within the genus *Cocos* only one species, *nucifera*, is recognized. Consequently, every coconut palm in the world is taxonomically the same species, which probably makes it the most abundant single food tree in existence. Since a number of other palms were once classified as very closely related to the coconut, a plethora of scientific and popular names has confused its history.

Two major classes of coconuts are typically recognized on the basis of stature: tall and dwarf. Most commonly planted for commercial purposes are the tall varieties, which are slow to mature and first flower six to ten years after planting. They produce medium- to large-size nuts and have a productive life of sixty to seventy years. Dwarf varieties probably originated as mutations of tall types. They grow to a height of twenty-five to thirty feet and begin to flower after three years, when only about three feet tall. Their productive life, however, is only about thirty years. Although more difficult to grow, the dwarf varieties are valued because they bear early and are resistant to lethal yellowing disease.

As a result of the world-wide distribu-

tion of the coconut in tropical areas a considerable number of named varieties—over eighty, including tall and dwarf—have been described. For the most part, each major coconut-growing region has its own dominant tall variety: for example, Ceylon Tall, Indian Tall, Jamaica Tall, Malayan Tall, and Java Tall. The San Ramon variety in the Philippines produces especially large nuts, while the Macapuno is a tall type, the nuts of which have a jellylike flesh considered a delicacy, which can be eaten with a spoon. The San Blas from Central America has an unusually high yield of coconut milk. There are also many dwarf varieties: the best known is the Malayan Dwarf. Others include the Dwarf Green and Dwarf Orange from India.

The principal coconut-growing regions of the world are located geographically within about twenty-two degrees north and south of the Equator—roughly as far north as Hawaii and as far south as Madagascar. Its native habitat lies in the humid tropics where it is frequently a pioneer plant on ocean beaches. As a plant capable of “escaping” from cultivation and growing spontaneously, it may be one of the first water-borne plants to arrive and grow on newly elevated land or reefs.

Growing naturally along the beach in a narrow band, often only a few feet wide, the coconut habitually borders an island's vegetation. The outermost trees usually lean toward the sea, seeking sun and wind. Away from this coastal fringe the coconut cannot compete successfully with inland vegetation without human assistance.

As it grows so near the ocean, the coconut may give the impression that it thrives on brackish or salt water. Apart from being able to withstand occasional brief salt water flooding, it needs a regular supply of fresh water to survive—which it derives from a lens of fresh water, which literally floats above the denser salt water, present in the soil under the beach. Originating from inland rainfall, this layer of fresh water

furnishes the coconut palm with some of its nutrients, since the sandy beach soils are infertile.

Natural dispersal of the coconut palm takes place when ripe nuts drop into the sea from leaning palms, float on ocean currents, and are deposited in new sites. Considerable distances may be traversed, for a ripe coconut can float for three to four months in salt water and still germinate. Cast onto the beach by waves, the palm is able to establish itself and then expand its range along the shore.

Scientists are generally in agreement with respect to the character of the native habitat of the coconut, but not on the particular geographic location where the palm originated. Its exact origin is lost in antiquity because of its wide natural distribution. Theories about the origin of the coconut can be divided conveniently into New World and Old World centers. A New World origin is supported by the historical fact that stands of coconut palms were found on the Pacific Coast of Panama by the first Spanish explorers and by taxonomic affinities between the coconut and various South American palms. Assuming a New World origin, it has been argued that coconuts floated across the Pacific Ocean and thence to the Asian mainland where they spread westward to India and beyond. Opponents of this theory point out that recent plant research casts doubt on the theory of New World origin, and that coconuts were not being used by the natives of Panama when the Spanish arrived in the early sixteenth century. It is not disputed that the stands of coconut palms existed in Panama in pre-Colombian times. But had the coconuts been there before they appeared in Southeast Asia, the inhabitants would undoubtedly have been using coconut products at least as much as they were exploited in the Old World.

A much more plausible theory is that the coconut originated in the Old World, probably somewhere in the western Pacific

or eastern Indian Ocean. Supporting biological evidence consists of fossilized coconuts found on North Island, New Zealand, dating from the late Tertiary period. In addition, the great number of parasites specific to the coconut which exist in Southeast Asia would seem to indicate that area was their original home. The longer a plant grows in a given area the greater the chances are that it might acquire natural enemies. Cultural and historical evidence is likewise convincing. The occurrence of the coconut in India dates back three thousand years. In the Indo-Pacific region there are countless names for the coconut and its products, deeply imbedded in the native folklore.

If the coconut originated in the Indo-Pacific region, dispersal both east and west can be postulated. Doubtless, many of the Pacific islands received the coconut through human agency, for it was a custom of Polynesian voyagers to carry nuts with them for food and drink and to plant them on new islands. Study of ocean currents indicates that coconuts could have floated from the South Sea Islands towards South America and that the Pacific Coast of Panama would have been a logical place for them to become established.

Westward dispersal is evidenced by the many uninhabited islands in the Indian Ocean which already had wild stands of coconut palms when first visited by sixteenth and seventeenth century explorers. The coconut had reached East Africa prior to Vasco da Gama's visit in 1498, for he found it in Mozambique, where it may have been introduced by Arab spice traders. It is generally agreed that the coconut was not to be found in the Atlantic Ocean basin until the Portuguese brought it there after 1500, when they introduced the palm to West Africa and Brazil. In the early sixteenth century, the Spanish carried it to the Caribbean. Through human efforts, the coconut was rapidly disseminated throughout the Caribbean and South America wherever the habitat was suit-

able, since its products were so highly appreciated. Thus, by means of flotation and later through human assistance, the coconut extended its range until its distribution was pantropical.

Today the coconut is the most widely cultivated of all palms, grown in more than eighty countries in the tropics. It can be found in most of the islands and coasts of the tropical realm and with some minor extensions into the subtropics, as in the southern tip of Florida. Although some coconuts were growing in Florida in the middle of the nineteenth century, plantings of the palm were given an unexpected boost on January 9, 1878, when the sailing vessel *Providencia*, fully-laden with coconuts from the South Pacific, was shipwrecked on a beach near Lake Worth. By 1900 more than 300,000 coconuts were growing in Florida, propagated mostly from coconuts imported from Trinidad, but supplemented by coconuts salvaged from the wreckage of the *Providencia*.

World production figures provide a picture of where coconuts are most important as a commercial crop. The table below shows that the Indo-Pacific region accounts for about eighty per cent of the world's coconuts. During the past few years, Indonesia and the Philippines have been the leading world coconut producers. Mozambique is the largest producer in Africa, while Mexico is foremost in Latin America.

COCONUT PRODUCTION 1983 (metric tons)

Indonesia	11,100,000
Philippines	9,200,000
India	3,900,000
Sri Lanka	2,300,000
Malaysia	1,200,000
All Others	7,190,000
World	34,890,000

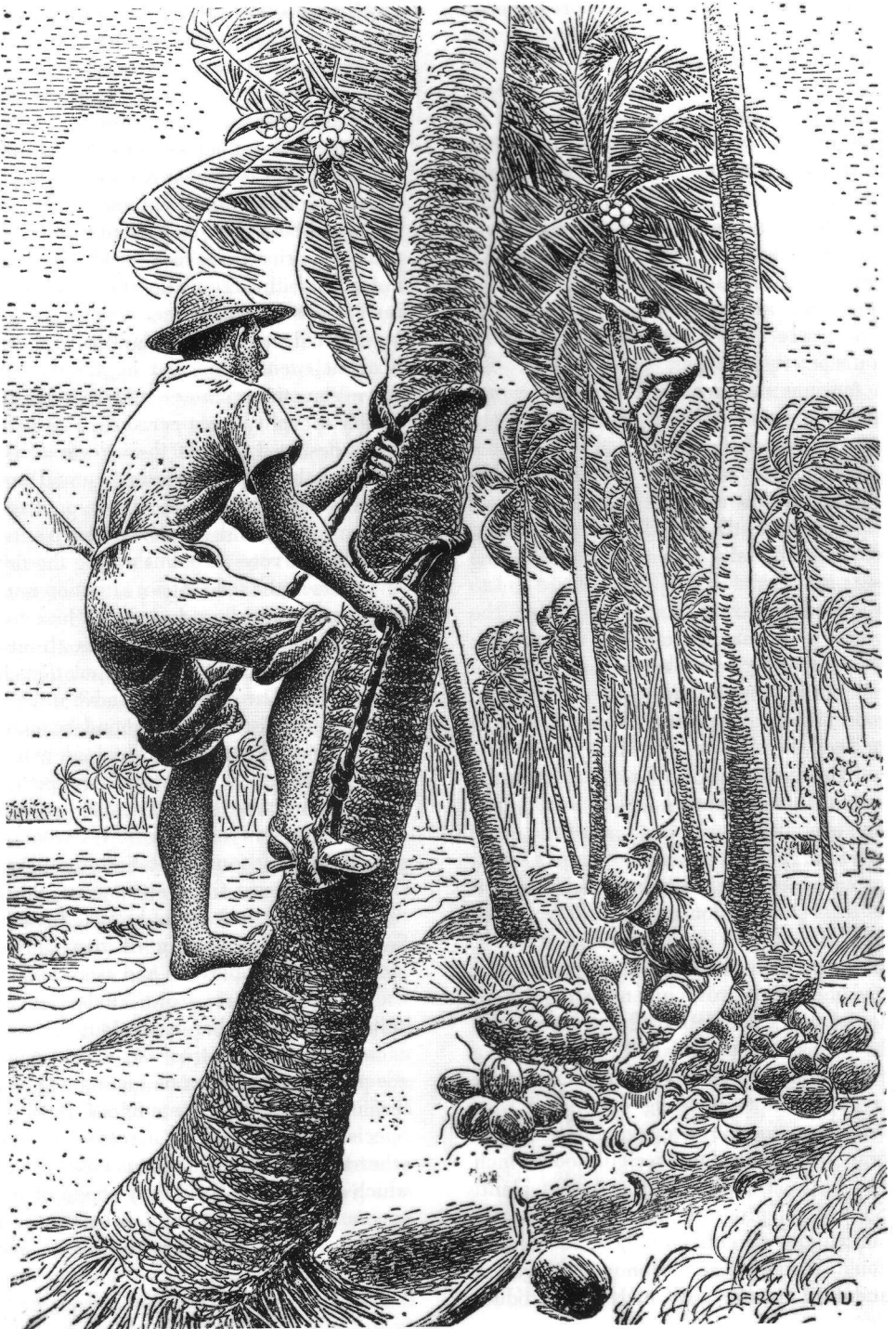
SOURCE: *FAO Production Yearbook*
1983.

The coconut is propagated only by seed. Unlike the date and some other palms, the coconut does not produce offshoots at the base of the trunk. Thus asexual or vegetative propagation is extremely difficult at the present time. Each nut normally contains a single embryo. Germination is slow: about four months are required for the leaf shoot to emerge from the husk. During germination, part of the embryo enlarges within the shell to form the coconut "apple," which persists until root emergence. Fresh nuts may be planted immediately after harvesting, or stored for a few months in a cool, dry, well-ventilated enclosure. Under plantation conditions, the seed nuts are collected from parent trees exhibiting such desirable characteristics as high nut production, vigorous growth and disease resistance. Sown in specially prepared seedbeds, the nuts are buried in deep, rich, loose soil to about two thirds of their depth. When the young plants are six to twelve months old, they are either transplanted directly to the field, or to a nursery for two to three years more before being set out in final field position.

Since cross-pollination is common in the coconut, consistent results of seed selection are not assured. Because of the great advantage of vegetative propagation, extensive research is being carried out on asexual propagation techniques. One avenue of research involves tissue culture, whereby plant tissue containing actively dividing cells is grown in a nutrient medium to develop a plantlet which can eventually be transplanted into soil. Encouraging results have been reported. Another research effort is being conducted with reference to the propagation of floral branches, induced to develop shoots which can be separated from the parent plant. Successful progress toward large-scale cultivation via either of these techniques could revolutionize coconut propagation and lead to markedly increased production.

Most coconuts are grown on small holdings in Southeast Asia. To establish new plantations land must be cleared, since the coconut cannot compete successfully with other vegetation. Sites with good soil drainage and annual well-distributed rainfall of 40 to 120 inches are preferable. A mature coconut palm produces on the average about fifty to seventy nuts per year. Superior trees may yield over 100 nuts, while the record in the Philippines is 470 nuts from one tree. A normal spacing for tall varieties in plantation groves is about twenty-nine feet by twenty-nine feet—sometimes closer—to give a density of fifty to eighty trees per acre. The spacing is designed so that the crowns of the mature palms do not overlap. Annual cash crops such as cassava, sweet potatoes, peanuts, corn or soybeans can be planted between the rows of palms during the first few years in the field. Strict attention must be given to weeding during the first five or six years. Coconut plantations are also utilized as pastures by local populations in some areas. The principal disadvantage of cattle-grazing is that the ground becomes packed around the trees to such an extent that soil aeration is seriously impeded. Furthermore, the livestock may trample and damage the young trees. If cattle are grazed on a coconut plantation, the palms should be at least six to eight years old so that their leaves are out of browsing reach. Sometimes intercropping of bananas or pineapples is employed, and occasionally coconut palms are grown under mixed cultivation with other tree crops such as cacao, cashew or citrus—in which event adequate spacing must be maintained and fertilizer applied to sustain soil fertility. Species of *Indigofera*, *Crotalaria* and other tall-growing leguminous cover crops which can endure the heavy shade of the coconut palms are useful in preventing erosion, controlling weed growth and improving soils.

Multiple use of the land under coconuts is virtually essential for small holders who



need to generate some income and provide foodstuffs for the first eight to ten years before coconut production begins in quantity. On large estates, catch (or supplementary) crops are also utilized to generate income during the early years.

Harvesting coconuts is carried out in different ways, depending upon the size of the grove and the products desired. The simplest method is to wait until the nuts fall to the ground and then gather them up. Such is the practice in plantings where the crop is not highly commercialized and the nuts are collected for direct consumption. On commercial plantations, nuts are usually gathered every two months to reduce labor costs. For copra production, which requires fully ripe nuts, free-fall harvesting assures maturity. The disadvantages of this method are that nuts are frequently lost where there is a thick cover crop under the trees and that impact damage to the nuts may occur.

Nuts for copra production may be picked when twelve months old. Picking on low trees is done with a knife or with a long bamboo pole about sixteen feet long, with a curved knife attached to its end. Ripe nuts are selectively cut from the trees and collected from the ground immediately. The dwarf varieties are, of course, the easiest to harvest.

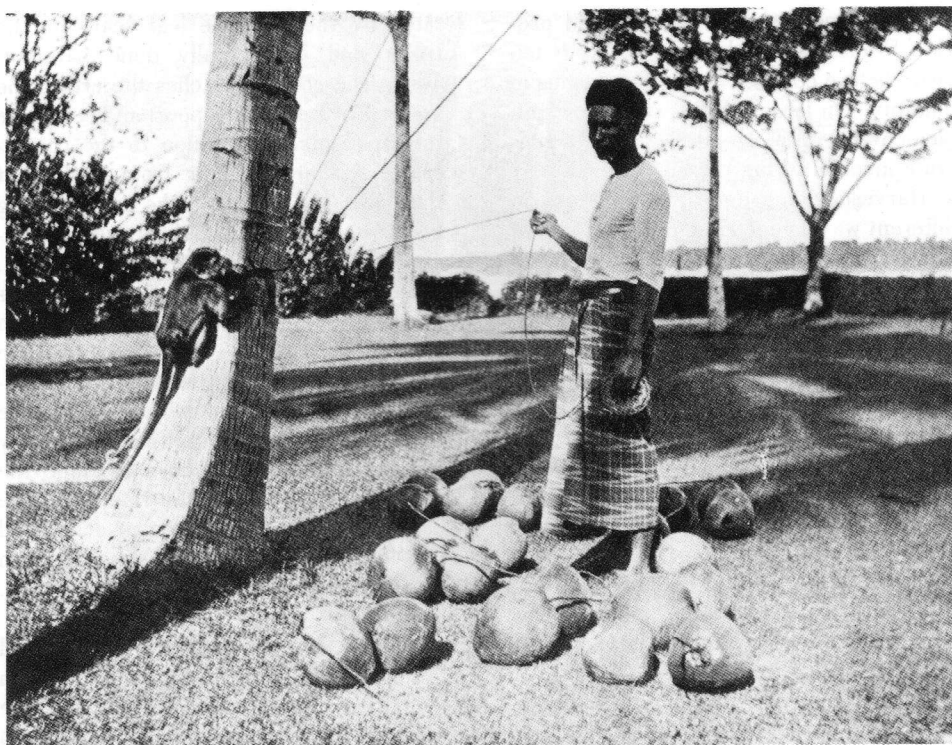
In countries such as India where coir fiber from the husk is also a key product, nuts are picked at about eleven months, when the fiber is of highest quality.

When tall varieties grow to a height beyond the reach of a cutting pole, the trees must be climbed to harvest nuts—an arduous and dangerous undertaking (Fig. 3). A number of climbing methods have been developed, but most make use of some type of rope harness which encircles the trunk and permits the climber to move it up and down. Climbing is facili-

tated by the ridgelike leaf scars on the trunk and is generally done barefoot. When the climber reaches the crown, he grasps leaf stalks for support and cuts loose the ripe nuts. In addition to the considerable danger of falling from the top of the palm, the climber risks encountering bee or hornet nests, rats and even poisonous snakes which may nest in the crown. Since this work is so exhausting, a climber can harvest only about eighteen trees in a day. Climbing is the most expensive method of harvesting coconuts. In Malaysia, Thailand and Indonesia efforts have been made to reduce harvesting costs by training pig-tailed monkeys to climb the palms and throw down the ripe nuts. The obedient apes, wearing a collar at the end of a long rope, are guided by signals from a keen-eyed handler on the ground (Fig. 4).

Copra, derived from the Hindi word “*khopra*,” is dried coconut meat from which coconut oil is expressed; it is the chief commercial product of the palm. To prepare copra, the harvested nuts are first processed to remove the thick, fibrous husk. Ordinarily this manual task is carried out in the field by impaling the nut on an upright iron spike fixed in the ground and tearing off the husk with three or four vigorous twists (Fig. 5). The work is hard, but an experienced worker can dehusk about 2,000 coconuts per day. The husked nuts are transported to the copra processing area where they are split in two by means of a chopping knife or hatchet. In industrialized operations, the released coconut water is collected and made into vinegar. The shell segments with adhering coconut meat are immediately set out to dry in the sun on racks or concrete patios or dried in heated kilns, since any delay results in deterioration. Sun-drying requires sixty to eighty hours of sunshine;

←
3. Harvesting of coconuts in Brazil. A dangerous and exhausting job. Credit: *Tipos e Aspectos do Brasil*. Illustration by Percy Lau. Rio de Janeiro: I.B.G.E., 1975.



4. Labor saving. In some regions of Indonesia, Malaysia, and Thailand, tame monkeys such as *Pithecus nemestrinus* are trained to climb the coconut palms and loosen the ripe nuts. Credit: *A Practical Guide to Coco-nut Planting*. R. W. Munro and L. C. Brown. London: John Bale, Sons & Danielsson, Ltd., 1920.

the copra is covered at night and during periods of sudden rains. The meat is removed from the shells after two or three days to accelerate the drying process. In kilns, drying can be accomplished in four to five days. About ninety per cent of copra production comes from small holders, so sun-drying or the use of kilns of limited size is most common.

Drying reduces the moisture content of coconut meat from fifty to fifty-five per cent down to five to six per cent. Properly cured copra can be stored for extended periods with minimal deterioration or loss from insects or fungi. Before being marketed, copra is graded into about six classes in order of quality, then bagged for export.

Copra comes mainly from the same five countries which lead in coconut produc-

tion. The leading copra producer is the Philippines.

COPRA PRODUCTION 1983 (metric tons)

Philippines	1,930,000
Indonesia	1,070,000
India	350,000
Malaysia	204,000
Sri Lanka	145,000
All Others	<u>849,000</u>
World	4,548,000

SOURCE: *FAO Production Yearbook* 1983.

Copra yields vary considerably depending upon environmental conditions, age of



5. Husking the coconut, 1884. A century later, the same method is used to remove husks: the coconut is impaled on a sharp spike set in the ground. Credit: *The Prince of Palms*. W. P. Treloar. London, 1884.

the palms, methods of cultivation and the varieties grown. In tall varieties, about 5,000 nuts will yield one metric ton of copra; among dwarf varieties, from 6,000 to 8,000 nuts are required.

The value of copra is based on its oil content, and with a content of about sixty-five per cent it is one of the richest for vegetable oil extraction. Coconut oil is obtained by direct processing of wet kernels or through crushing of good quality copra. The oil is even more important in the country of origin than in importing nations; about sixty per cent usually goes into domestic use, while the remaining forty per cent is exported. After extraction from copra, coconut oil is refined into a clear liquid which has neither the taste nor the odor of the coconut. It is a fluid in warm tropical climates but at temper-

atures below 76 degrees Fahrenheit changes to a solid fat with the consistency of butter.

Coconut oil gained international economic stature in the middle of the nineteenth century as an ingredient for soap in Europe. It is one of the finest oils for that purpose; rich in glycerins, it lathers freely in hard or salt water. Following its use in soap-making, coconut oil became a major ingredient in margarine and remained the most important vegetable oil in the world trade, until surpassed by soybean oil about twenty years ago. Coconut oil now constitutes about eleven per cent of the total fats and oils entering world markets; it is one of the most digestible of the vegetable oils, universally popular as an ingredient in cooking and in the preparation of countless tropical dishes. New

uses are constantly being discovered for it. The popular cream substitutes for coffee and tea are a good example.

A versatile commodity, coconut oil has many food and non-food uses. In food, in addition to margarine, it is employed in shortening, confectionery, baked products, ice cream, frozen desserts and whip toppings. Hindus in India prepare a highly important, vegetarian butter from coconut oil called *ghee*.

Coconut oil's non-food uses include the manufacture of toilet soaps, shaving creams, shampoos, toothpastes and cosmetics such as lipsticks, hair dressings and lotions. The charcoal industry employs it in the production of glycerine, fatty acids, synthetic rubber, plastics and paints; while in pharmaceuticals it is utilized as a solvent for vitamins and hormones, and as an ointment base because of its ready penetration into the skin and water-absorption properties.

According to the United States Department of Agriculture, an estimated 3,017,000 metric tons of coconut oil were produced in the world in 1980, with a market value of between \$568 and \$836 per metric ton.

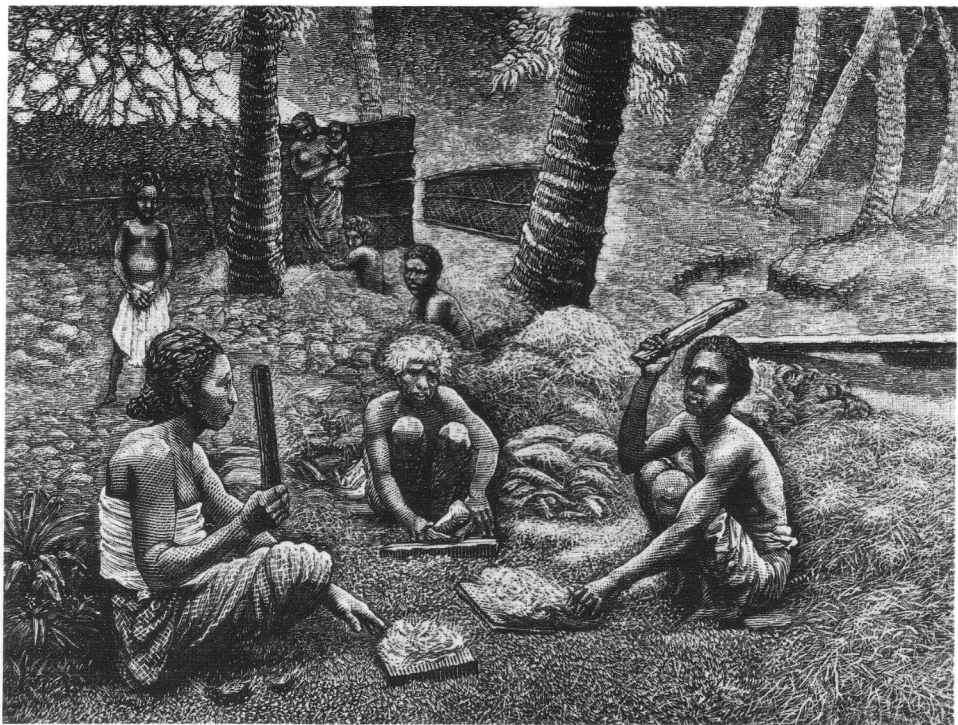
After expression of the oil from copra, the remaining residue is a by-product known as coconut cake, copra cake or "poonac," which when used in limited quantities is a valuable cattle and poultry feed, rich in proteins and fats.

Desiccated coconut is fresh coconut meat which is shredded and dried; it has a moisture content of less than three per cent and an oil content of about sixty-eight per cent. Currently this product is processed to a large extent in the Philippines (for the United States market) and in Sri Lanka (for Europe). Following shelling, the reddish brown skin is pared off the outside surface of the white meat; the meat is then washed, pasteurized, blanched, shredded, dried and graded into extra fine, fine, medium and coarse qualities. A significant, hygienic pasteurizing

process has been developed in the Philippines for desiccated coconut. This product is exported in kraft sacks lined with polyethylene film; it is packaged in fancy cuts—strips, chips, slices and threads—and in recent years has become a familiar and popular ingredient in the confectionery and baking industries. It may be further processed by sweetening and toasting. At retail, the product is commonly called "shredded coconut," and is sold in plastic bags or cans. Coconut chips, a popular snack food, are sliced strips of desiccated coconut which have been roasted, salted and vacuum-packed in cans. This snack item is popular among tourists in Hawaii and the Caribbean islands.

The adaptability of the coconut is shown in other food products: coconut gelatin, a dessert made of coconut water, sugar, acetic acid and a bacterial pineapple culture; colored coconut, used mainly for topping in confectionery and baking, and prepared by mixing desiccated coconut with a certified food coloring and anhydrous corn sugar; coconut milk, made by squeezing fresh, grated coconut meat through a sieve, often serves as a substitute for cow's milk in Asia where it is fed to infants; coconut cream, a concentrate of coconut milk; coconut spread, a mixture of coconut cream with eggs and sugar; coconut juice, a diluted noncarbonated soft drink, and carbonated coconut soda, both prepared from coconut milk. The juice, milk and cream are consumed at the retail level as the ingredients of the pineapple-coconut-alcoholic beverage known as *piña colada*. Coconut sport or macapuno is an unusual product from a coconut variety in which the ripe fruit contains no water but is filled instead with a thick curd. This delicacy is eaten fresh, or cut into strips and cooked in syrup.

These coconut products, imported for the most part from the Philippines, Thailand, Singapore and Puerto Rico, are processed foods which can be found in jars



6. Beating coconut fibers to produce coir in Ceylon, 1884. Credit: as Fig. 5.

or cans in food markets in the United States.

Another edible delicacy, well liked in the Far East, is the coconut "apple" which develops in the shell as the nut germinates. A refreshing drink known as coconut lemonade, popular in India, is prepared by boiling coconut water, sugar and lemon juice. Coconut flour, produced from partially defatted edible coconut gratings, is utilized in India and the Philippines in nutrition feeding programs in schools.

Toddy is the sugary sap obtained by tapping the tender, unopened inflorescence of the coconut palm. This sweet liquid can be drunk fresh or boiled down (like maple sap) to make a palm sugar called *jaggery*. Distillation of fermented toddy yields a liquor called *arrack*. Fermentation of toddy (matured by aging in closed casks) also produces coconut vin-

egar. In India this vinegar is sometimes flavored with spices such as black pepper, nutmeg and cinnamon.

Coir, an important industrial product in India and Sri Lanka, is the stiff, elastic fiber extracted from the husk of the coconut. Its name comes from the Tamil word "kayiru," meaning rope. The short, wiry elastic fibers of the husk are durable and resistant to water. Winning the fiber requires time and much hand labor (Fig. 6). The husks must be retted in water before the fiber can be extracted. The longest and finest white fiber, obtained from the husks of unripe coconuts, may be spun into yarn for making ropes, cables, twine for lobster pots, rugs and acoustic insulation; a coarser, brown coir produces brush bristles, while the shortest fibers are utilized for stuffing mattresses and upholstery. The husks of approximately 1,000

coconuts are required to produce 180 pounds of coir. Coir dust, a by-product of coir processing, serves as an excellent rooting material and nursery mulch.

Virtually every part of the coconut palm has some reputed medicinal application. The liquid of the unripe coconut has been prescribed traditionally in India as a medicine to treat fevers, cholera and urinary disorders, as well as an anthelmintic to destroy and expel intestinal worms. Coconut meat is recommended in India as a cure for constipation and to relieve the build-up of gas in the stomach. Coconut oil has been found to soothe and help heal cuts, scratches and burns of the skin, including sunburn. Coconut milk is prescribed in Hindu medicine to help cases of sore throat and to calm stomach ulcers. In the Far East it is believed that ash from burned coconut shells can quell stomach pains; coconut roots may be used as tooth picks.

Because of its multifarious and diversified uses, the coconut palm has been given the names "tree of life" and "tree of heaven" in the Orient. Myth and ritual are involved with the palm in its Indo-Pacific homeland. In New Guinea, a native belief holds that the coconut originated by sprouting from the head of the first man to die. Thousands of miles away in Northern India, the coconut is considered a sacred fruit, linked to prosperity. It is likewise a symbol of fertility: shrines often keep a supply of coconuts to be given by priests to women who wish to conceive.

Coconuts themselves have served as primitive money. On the Nicobar Islands

in the Indian Ocean, whole coconuts comprised the local currency, and the value of goods was reckoned in coconuts until the early twentieth century. Discs carved from coconut shells formed part of the shell-money strings which served as currency on some islands in the Carolines and in the Bismarck Archipelago in the South Pacific.

The importance of coconuts in human nutrition in the Indo-Pacific region is reflected in the estimated per capita consumption of 140 nuts per year in Sri Lanka; this figure is probably even higher in some Pacific Islands.

Nutritionally, coconut products contain protein, fat and carbohydrates—all three of the major food constituents. Analysis of the products reveals the percentages as shown in Table 1 below.

Probably all plants suffer from insect pests and disease. The coconut palm is no exception. More than 100 species of insects afflict it. The large rhinoceros beetle is the most serious, because it penetrates the terminal bud, causing damage to unopened leaves and occasionally death to young palms. This beetle can be controlled by destruction of its breeding sites in decaying vegetable material. Palm weevils are another major pest. They lay eggs in the crown of the tree and the burrowing larvae damage the trunk. Chemical control is usually effective, but in severe infestations the tree must be felled and burned.

A dozen or more serious diseases affect the coconut palm. Of recent prominence in the New World is lethal yellowing dis-

Table 1.

Product	Water	Protein	Fat	Carbohydrates	Fiber	Minerals
Coconut water	95.4	0.1	0.1	4.0	—	0.4
Coconut meat	36.3	4.5	41.6	13.0	3.6	1.0
Copra	6.8	7.6	63.7	16.1	3.8	2.0
Coconut cake	11.0	19.8	6.0	45.3	12.2	5.7

Source: K. P. V. Menon and K. M. Pandalai. *The Coconut Palm*. Ernakulam, India, 1957.

ease which first appeared in the Caribbean in 1870, spread among the islands, and has been devastating coconuts and nearly thirty other species of palms in mainland Florida since it first turned up in Key West in 1955. First symptoms of the disease are dropping of immature nuts and yellowing leaves. Death usually follows in a matter of months. Most of the estimated 500,000 coconut palms in South Florida are the Jamaica Tall variety which is highly susceptible to the disease. The vector has recently been identified as a leaf hopper which transmits the mycoplasma-like organism that causes the disease. Fortunately, dwarf varieties of coconut are resistant to lethal yellowing: Malayan Dwarf and the newly developed Maypan hybrid are being planted to replace the more susceptible tall coconut varieties. At least three-fourths of the tall coconut trees of Jamaica have died due to lethal yellowing. In Florida, widespread injections of oxytetracycline (also known as tetracycline in garden shops) have been carried out to control the disease temporarily. These treatments must be repeated at four month intervals. Lethal yellowing, recently reported in the Rio Grande Valley in Texas, looms as a very real threat to Mexico's coconut palms and could spread throughout Latin America. Plant diseases are seldom confined to a limited area despite governmental control programs, and in the years to come there may have to be a wholesale shift to dwarf varieties in the New World.

Planting dwarf varieties leads to earlier production in three or four years, but the nuts are smaller and the trees have a shorter productive life than the tall varieties. Should lethal yellowing reach the Old World, there might be little choice but to shift to dwarf varieties or dwarf hybrids. The brightest hope for coconut growers may be the development of simple and inexpensive vegetative propagation techniques which could be applied to reproduce selected, high-yielding, disease-

resistant varieties on a large scale. This could bring about a sharp increase in production and strengthen the competitive position of the coconut in world vegetable oil markets.

Within producing countries, wide and varied utilization and long-standing cultural traditions assure that coconuts will always be important. Industrialization of coconut products over the past decades has brought about changes. Whereas raw copra used to be the major export, extraction of coconut oil and its export is increasing steadily at the present time. A similar pattern is seen in the shift from exporting coconuts in the shell to exporting desiccated coconut. Both of these changes have benefited the countries of origin by creating additional employment in those tropical, developing areas of the third world.

It is estimated that approximately one billion coconut palms are currently planted throughout the world on some twenty-two million acres. About thirty-three billion coconuts are used annually—roughly eight nuts for every human being. The life cycle of the coconut corresponds curiously to the human: it reaches full bearing at about twelve to fourteen, more or less the time of puberty; produces well until about sixty, when it begins to decline and ultimately dies at about eighty.

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Meeting of Palm Specialists

A satellite meeting of palm specialists will be held during the IV Congreso Latinoamericano de Botanica, 29 June to 5 July, 1986 in Medellín, Colombia. The object of this meeting is to draw together botanists working on all aspects of palm biology in the New World and to exchange information about current and future research projects. No research papers will be presented during this meeting. Persons wishing to give papers are invited to do so during the Technical Sessions of the Congreso.

For information about the satellite meetings, contact: Rodrigo G Bernal, Instituto de Ciencias Naturales, Universidad Nacional de Colombia, Apartado 7495, Bogotá, Colombia.

Error in Palmeter

Third prize in the Raffle to be held at the 1986 Biennial Meeting is a complete set of *Principes*, bound. The value should have been \$700, not \$187 as printed in the Palmeter, *Principes* 30(1): 192.

Principes, 30(2), 1986, pp. 63-70

The Chacobo Indians and their Palms¹

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ABSTRACT

An ethnobotanical study of the Chacobo Indians in northeastern Bolivia revealed 12 species of palms recognized by this Amazonian tribe. In a 1 hectare forest inventory 7 of these species were found; ecological importance values were calculated and the ethnological importance of each was assessed.

The Chacobos belong to the southeastern Panoan language group of Amazonian Indians (Métraux 1948). There are at present some 400 Chacobos, but the Tribe formerly numbered in the thousands. Late in the last century they lived in small groups in the northeastern Bolivian Department of Beni, scattered between Lago Rogoaguado and the Río Mamoré, 13°-14°S, 65°-66°W.

Since then the Chacobos have been forced northward by more aggressive Tacanan tribes. Their range and numbers were further diminished this century by "civilized" Bolivians looking for rubber and sport in the form of hunting the Indians like wild animals. The Summer Institute of Linguistics (SIL) claims to have made the first friendly contact with the Tribe in 1955 (Prost 1970). At that time the Chacobos numbered only about 135, and lived in four groups, each with 30-35 individuals. Their villages were located in isolated regions along the Ríos Benicito, Ivon, Geneshuaya, and Yata. They were seminomadic, living by hunting and fishing with bow and arrow, and collecting wild fruits and nuts from the forest. They were also agriculturalists who cultivated principally

sweet manioc, corn, and bananas. Both men and women pierced their nasal septum to accommodate an adornment of feathers and earlobes where they wore incisor teeth of the wild pig. The men dressed in barkcloth made from the inner bark of *Ficus* spp. and wore a crown of feathers on their heads. Feathers and various other adornments were worn around their arms, wrists, and ankles. A collar of beeswax into which they pressed blue-colored seeds completed the outfit. The women wore only a small loincloth held in place by a liana belt. Necklaces of different colored seeds were common for both men and women. They cut their hair in the form of bangs in the front, but let it grow long in the back. The men wrapped their long hair into a ponytail, while the women let theirs hang free. They commonly painted their bodies with various red, black, and blue plant dyes. They celebrated the harvests of manioc and corn with festivals which were the occasions for consuming great quantities of *chicha* (fermented beverage made from manioc or corn flour), much dancing and singing. Among all the Chacobos, only a couple spoke any Spanish, and they lived quite effectively outside of the Bolivian cash economy. More information on traditional Chacobo culture can be found in Torrico (1977) and Prost (1970).

Today much of this has changed. A number of aspects of their culture, including their ceremonies, traditional mode of dress, and supernatural beliefs have already been lost (Fig. 1). Other aspects, including their botanical knowledge, are for the most part intact although they too

¹ Presented as publication no. 13 of the New York Botanical Garden's Institute of Economic Botany.

are being lost due to the acculturation the Tribe is now experiencing. The SIL was responsible for reducing the Chacobos' nomadism by encouraging them to take up the collection of wild *Hevea* rubber for sale in the town of Riberalta. Also, in the early 1960s they orchestrated several transfers of villages and scattered families to centralized locations. Presently, the SIL has left the region and the Swiss Evangelical Mission has contact with the Tribe. With the cash they earn from the sale of rubber and brazilnuts, the Chacobos buy clothes, firearms, radios, and various foods (when their agricultural production falls below expectations). Most of the Tribe live today on 43,000 hectares of forested land along the Río Ivon. They own this piece of land, thanks to the SIL, and on it they make their capital village, Alto Ivon. It was here that I concentrated my study.

Much has been written on the significance of the forest to Amazonian Indians, but the degree of importance has never really been quantified. A primary goal of my study was to attempt such a quantification. In this paper I report on the results obtained for the palms.

Methods

During my seven months at Alto Ivon, I employed two basic approaches to study the palms (and other plants) used by the Chacobos. The first I call the "artifact/interview" technique. It is simply the traditional approach to ethnobotany as generally practiced by anthropologists, and involves asking from what plants a particular item is made. For example, what species are employed to make dugout canoes or to thatch house roofs? Once the name is known, a trip is made to the forest to find that specific plant. This approach also involves the outright interviewing of informants, without any particular artifact present, as to the use of plants as foods, fuels, medicine, or in construction and crafts, ceremonies, or commerce.

The second approach I call the "inventory/interview" technique. This involves the active collection of plants and the subsequent interviewing of informants as to names and uses. In the present study, in addition to making general collections around Alto Ivon, I did an ethnoecological inventory of 1 hectare of forest about 4 km from the village. This area of forest was far enough from the village that plants were not collected there by the Indians. Yet it was typical of areas of the forest closer to the village which were being actively entered and utilized. In this hectare I marked and collected every tree with a DBH (diameter at breast height) of 10 cm or more. Then I went back and did fifty 2 m square subplots to sample for saplings, shrubs, and lianas, and then fifty 1 m square subplots to sample for epiphytes and herbs. For all of these collections I obtained names and use information from Chacobo informants.

Palm Occurrence

In the hectare inventoried I found 94 species and 649 individuals of trees. Of this total, 7 species and 127 individuals were palms (Table 1). In other words, 7.4% of the total species and 19.6% of the individuals in the hectare were palms. The palms accounted for 18,714 sq. cm, or 8.7% of the total of 214,846 sq. cm basal area. By summing these three percentages (relative diversity, relative density, and relative dominance) one obtains the Family Importance Value (FIV), as defined by Mori et al. (1983). For the hectare sampled, the Palmae have a FIV of 35.7. In this study only two families have FIVs higher: Moraceae (53.6) and Myristicaceae (41.3). Thus, ecologically the palms appear to be quite significant arboreal components of the forest surrounding Alto Ivon.

Ecological data for each of the seven species are presented in Table 2. I have followed the standard definitions and cal-

Table 1. Occurrence of *Palmae* in 1 hectare forest inventory.

	All Families Total	Palmae	
		No.	% Total
Species	94	7	7.4
Trees	649	127	19.6
Basal Area, cm sq.	214,846	18,714	8.7
Family Importance Value:			35.7

culations of relative frequency, density, dominance, and importance value as Curtis and Cottam (1962). It is important not to confuse these species values with the FIVs discussed above. In order to calculate relative frequency, five consecutive 10 m sq. plots were combined to make a single sampling unit (e.g., plots 1-5 = sampling unit 1, plots 6-10 = sampling unit 2, etc.). Thus, my 100 plots yielded 20 sampling units. The presence of each species was then recorded each time it appeared in a sampling unit. It is necessary to aggregate the 10 m sq. plots into larger units because if the plots themselves are used then frequency and density are nearly the same. By counting the total number of occurrences of all species (374) and dividing that into the number of occurrences for a particular species, one obtains the relative frequency for that species.

The other two values, relative density and dominance, are easier to understand.

Relative density is simply the number of trees of a species divided by the total number of trees recorded (649). Relative dominance is the basal area of a species divided by the total basal area for all trees recorded (214,846 cm sq.). By summing the relative frequency, density and dominance, one obtains the importance value for each species.

As can be seen from Table 2, only two species are really common, *Euterpe precatoria* Mart. (I.V. = 16.01) and *Socratea exorrhiza* (Mart.) H. A. Wendl. (I.V. = 14.46). It is virtually impossible to stand anywhere in the forest surrounding Alto Ivon and not see both of these species. Both are easy to spot: *E. precatoria* with its crown of leaves with gracefully drooping pinnae and *S. exorrhiza* with its spiny stilt roots. Less common, but certainly not rare, is *Astrocaryum aculeatum* Meyer (I.V. = 6.57), a heavily armed, erect species in subgenus *Pleio-gynanthus*.

Table 2. Frequency, density, dominance, and importance values for *Palmae* in 1 hectare forest inventory.

Species	No. Sampling Units of Occurrence	No. Trees	Basal Area (sq. cm)	Rel. Freq. (%)	Rel. Den. (%)	Rel. Dom. (%)	Impor. Value
<i>Euterpe precatoria</i>	18	53	6,509	4.81	8.17	3.03	16.01
<i>Socratea exorrhiza</i>	17	46	6,061	4.55	7.09	2.82	14.46
<i>Astrocaryum aculeatum</i>	10	15	3,416	2.67	2.31	1.59	6.57
<i>Jessenia bataua</i>	4	6	1,552	1.07	0.92	0.72	2.71
<i>Oenocarpus mapora</i>	4	5	530	1.07	0.77	0.25	2.09
<i>Maximiliana maripa</i>	1	1	346	0.27	0.15	0.16	0.58
<i>Scheelea princeps</i>	1	1	299	0.27	0.15	0.14	0.56

Table 3. Palms recognized and used by the Chacobos at Alto Ivon. Voucher specimen numbers are on Boom's series and are deposited at NY.

Chacobo Name	Spanish Name	Voucher	Scientific Name	Use	Parts Used
xëbichoqui	motacusillo	4573	<i>Maximiliana maripa</i>	thatch food toy	leaves fruits bracts
quëboitsama	bacaba	4152	<i>Oenocarpus mapora</i>	medicine food thatch	sap fruits leaves
panabi	assaí	4151	<i>Euterpe precatoria</i>	drink, food medicine thatch	fruits leaves leaves
itsama	mayo	4538	<i>Jessenia bataua</i>	brooms drink, food doors	leaves fruits petioles
xëbini	motacú	4145	<i>Scheelea princeps</i>	food thatch medicine	fruits leaves leaves
onipa	pachuba	4155	<i>Socratea exorrhiza</i>	baskets medicine walls, beds grater	fruits/bark trunks roots
panima	chonta	4159	<i>Astrocaryum aculeatum</i>	food, bait bows baskets	fruits "wood" leaves
pani	chonta loro	4154	<i>Astrocaryum huicungo</i>	food	fruits
huanima	chima	4984	<i>Bactris gasipaes</i>	food, drink bows	fruits "wood"
canahuanima	—	4129	<i>Bactris humilis</i>	medicine	fruits
shinishëoxo	—	4509	<i>Bactris monticola</i>	food	fruits
tanane	—	4436	<i>Geonoma juruana</i>	arrows thatch	stems leaves

The next two species are about equally important ecologically: *Jessenia bataua* (Mart.) Burret (I.V. = 2.71) and *Oenocarpus mapora* Karst. (I.V. = 2.09). The last two of the seven species in the inventory are quite rare in the forest, each only occurring once in the hectare: *Maximiliana maripa* (Correa de Serra) Drude (I.V. = 0.58) and *Scheelea princeps* (Mart.) Karst. (I.V. = 0.56).

Five additional species are found around Alto Ivon, but did not enter into the inventory, so I have no quantitative data for them. Two are semicultivated palms (*Astrocaryum huicungo* Damm. ex Burret and *Bactris gasipaes* Kunth) which were never found in undisturbed forest, but rather occurred in abandoned fields near the village. The three other palms

are small, understory species (*Geonoma juruana* Damm., *Bactris monticola* Barb. Rodr., and *B. humilis* (Wallace) Burret). *Bactris humilis* is quite common in the region, while the other species are much less so.

Palm Utilization

Information on all 12 palms recognized by the Chacobos is presented in Table 3, which shows the vernacular names in Chacobo and Spanish (when known), my collection voucher numbers, scientific names, uses, and parts of the palm used. Specimens are deposited at the Herbarium of The New York Botanical Garden (NY).

Xëbichoqui (*Maximiliana maripa*) is not a common palm, but its fruits are



1. A modern-day Chacobo family posing in front of a mango tree in Alto Ivon, the principal tribal village.
2. Around a Chacobo house palm uses abound. Seen in the foreground is the bract of *xêbichoqui* (*Maximiliana maripa*) which serves as a toy for children. The outer roof and wall thatch on the house is of leaves of *panabi* (*Euterpe precatoria*), which is underlain by a layer of *mani* leaves, *Phenakospermum guyanense* (L. C. Rich.) Endl. ex Miq. (Strelitziaceae).

highly prized so Indians will often travel considerable distances to collect them when ripe. A side bonus of such trips is the

collection of the large, woody bracts which are a favorite toy for the children (Fig. 2). The leaves are said to be used for

thatch, but this cannot be regarded as an important use since the trees of this species are so widely spaced in the forest.

Quëboitsama (*Oenocarpus mapora*) is slightly more frequently encountered than *xëbichoqui*, and it too produces fruits with an edible pulp and has leaves which are employed as roof thatch. A sap extracted from the trunk is drunk as medicine to cure high fever.

Panabi (*Euterpe precatória*) is unquestionably the palm most used for roof thatch by the Chacobos (Fig. 2). Generally, the Indians will thatch their roofs with a combination of the leaves from *panabi* and *mani*, *Phenakospermum guyanense* (L. C. Rich.) Endl. ex Miq. (Strelitziaceae). A less important use for the leaves is to employ them as make-shift brooms. The leaves are used medicinally to alleviate chest pains: the pinnae are shredded and boiled in water to produce a decoction which is drunk when cooled. The fruits are eaten after being soaked in water to soften them or are made into a drink to which sugar is often added to sweeten it. Surprisingly, the Indians do not eat the heart of this species.

Itsama (*Jessenia bataua*) has fruits that the Chacobos eat after being soaked in water or prepare as a drink as with *panabi*. The rather stout petioles of *itsama* are occasionally lashed together to form a door for those houses with walls (some Chacobo houses are open on all four sides).

Xëbini (*Scheelea princeps*) produces a fruit which is highly prized. The Chacobos bite one end of the fruit to enable them to peel back the hard exocarp to get at the thin, but edible, pulp which is eaten raw. The leaves are occasionally used as a roof thatch or are employed as medicine to cure diarrhea, one of the most common medical problems in the Tribe; a leaf decoction is prepared and drunk as for *panabi*. The most important use for the leaves of *xëbini*, however, is in the weaving of loose, light-duty baskets known in Chacobo as *poropachi*.

Onipa (*Socratea exorrhiza*) is used occasionally to cure fever; a fruit and/or bark decoction is drunk. A much more important use for the species, however, is in construction. The trunks are split to form boards which are employed as walls, bed slats, or floor platforms for those houses with elevated floors. An interesting use, which is no longer practiced, is the grating of manioc tubers on pieces of the spiny stilt roots to obtain flour. Today, this grating is accomplished on pieces of tin having ragged-edged perforations.

Panima (*Astrocaryum aculeatum*) is a very important species to the Chacobos. The fruits are so highly esteemed that special trips will be made into the forest to collect an infructescence that is just about ripe; if they wait until it falls, most of the fruits will be lost to forest mammals. An interesting, and indirect way of using the fruits is to extract the white-colored grubs (which sometimes live inside) for use as a fishing bait. The hard, black "wood" from the trunk of *panima* is carved into hunting bows called *canati* in Chacobo. Five varieties of arrowheads are carved from the same wood: *quëréquë*, *paca*, *tëpi*, *tahua quëspini*, and *bicobi*. Each point is designed to hunt a particular type of game or to fish. Today, most hunting is done with firearms, but fishing is still done with bow and arrow, usually using the point *bicobi*. The *bicobi* point has a bent, filed nail affixed into the tip to serve as a gaff. The carved points of most arrows fitted into a shaft made from the hollow stem of a grass, *Gynerium sagittatum* (Aubl.) Beauv., which is cultivated specifically for this purpose. The leaves of *panima* are the most important materials for basketry. The pinnae are split longitudinally and then tightly woven into different sizes and styles of baskets. An open-topped, low-sided basket, such as would be used for storing rice, is called *shichuma*. A basket with a top for storing valuables is called *chichabë-casa*. A fan woven from *panima* leaves is known as *huana huëquëti*. Given this

multitude of uses, I would nominate *Astrocaryum aculeatum* as the most important palm to the Chacobo culture.

Pani (*Astrocaryum huicungo*), an acaulescent species in subgenus *Mono-gynanthus*, is, in comparison to its larger relative, not so important. Yet, it furnishes one of the most prized of all fruits gathered by the Chacobos. They rate it along with the mango in terms of popularity. *Pani* is under semicultivation in abandoned agricultural fields and along trails in secondary forest. Also grown in such areas is *huanima* (*Bactris gasipaes*), the Peach Palm. It furnishes a hard, black "wood" which is occasionally carved into hunting bows and arrow points. Of course, the primary utility of *huanima* is the food and drink derived from its fruits.

The remaining species are of comparatively little importance to the Tribe. *Canahuania* (*Bactris humilis*) has medicinal value as a remedy for stomach ache; a decoction of the fruits is drunk. *Shin-ishëoxo* (*Bactris monticola*) produces fruits which are occasionally eaten. *Tananë* (*Geonoma juruana*) has leaves which are sometimes used for thatch on small huts. The stems are reportedly used as arrow shafts when the cultivated *Gynerium sagittatum* is not available.

Discussion

As can be seen, a palm's ecological importance is not necessarily proportional to its utilitarian importance. It is precisely this discrepancy which lends support to the view that it is necessary to set aside large tracts of forest as reserves if indigenous Amazonian cultures are to survive. If two of the Chacobos' most useful palm species (*xëbichoqui* and *xëbini*) occur at such a low average density as 1 individual per hectare, then quite a few hectares are needed to accommodate enough trees to meet the cultural needs of the Tribe.

Another point that must be remembered is that, while the Chacobos of today

make extensive use of their palms, their ancestors of 30 or more years ago (before they entered into the Bolivian cash economy and began a period of rapid acculturation) must have had an even greater dependance on the forest in general and palms in particular. It is probable that when the Chacobos were still seminomadic they came across a greater variety of palm species. This is certainly the case with the palm known in Bolivia as *Palma Real* (*Mauritia* sp.) a species of the eastern grasslands. The Chacobos know of this species from the time when they lived further south, more on the fringes of the savannas. Today, since they live deep in the forest, they have no more contact with *Palma Real*. Braun (1968) discusses the extensive use made of *Mauritia* palms by various Indians in Venezuela; no doubt they were similarly important to the Chacobos.

More ethnobotanical studies are urgently needed in order to record indigenous palm uses while there are still tribes available to study. The problem of cultural extinction, and consequent information loss, is especially acute in Amazonia. This brief survey of the palms used by the Chacobos serves to illustrate and emphasize once again the importance of the Palmae to the peoples of this fascinating region.

Acknowledgments

This study was supported by a generous grant from the Edward John Noble Foundation. The assistance of M. Balick, A. Henderson, and J. Strudwick in the identification of specimens is gratefully acknowledged. Finally, the cooperation of the government of Bolivia, the Swiss Evangelical Mission in Riberalta, and the Chacobo Indians in and around Alto Ivon made this study possible.

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Geonoma chlamydostachys, a New Species from Colombia

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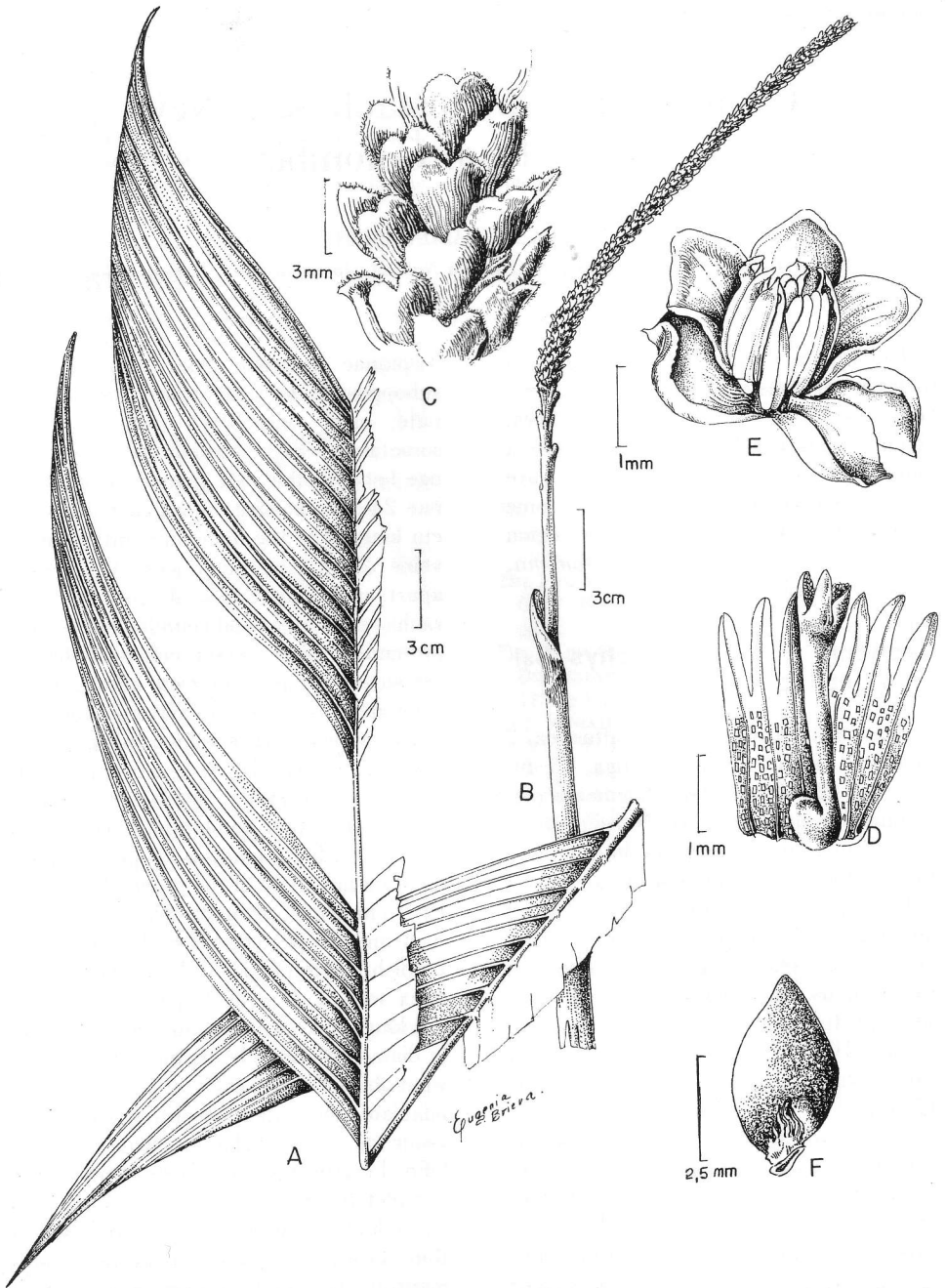
The region of the middle Magdalena River, in northwestern Colombia, has a very rich, interesting and little known flora, which is being rapidly devastated before a considerable number of its elements are scientifically known. The study of some recent palm collections from that region has disclosed a new species of *Geonoma*, which is described below.

***Geonoma chlamydostachys* Galeano, sp. nov. (Fig. 1)**

Caudex solitarius, 1-2.5 m altus, ca. 2 cm diam. Lamina ambitu oblonga, 45-60 cm longa, 25-30 cm lata. Segmenta plerumque 3 in quoque latere. Nervi primarii 26-32 utrinsecus, cum rachi angulum 45-50° formantes. Inflorescentia spicata, pedunculo 35-43 cm longo, spica 15-32 cm longa, 7-8 mm diam.; foveae in seriebus 8 dispositae, labio inferiore valde protracto; tubus staminodialis in dentes 6 lineares profunde divisus. Fructus ovatus, acutus, 10-12 mm longus, ca. 6 mm diam. Typus: Colombia, Rio Claro, *Hernández et al.* 685 (Holotypus HUA).

Solitary palm. Stem 1-2.5 m high, ca. 2 cm in diam., conspicuously ringed. Leaves reddish when young; sheath 10-15 cm long, thin, covered with ferruginous easily removable indumentum; petiole 10-15 cm long, the abaxial surface strongly convex and covered with a scattered indumentum like that of the sheath; rachis 45-60 cm long, produced at the apex into a slender thread; blade oblong in outline, 25-30 cm wide, usually with

3 pinnae on each side, these similar, subopposite, 4-6 cm apart, long-acuminate, each with 8-14 primary veins; sometimes with 1-4 uninerved, linear pinnae between the wide pinnae; middle pinnae 24-30 cm long, apical pinnae ca. 20 cm long along the upper margin; primary veins 26-32 on each side, 0.7-1 cm apart, emerging at about 45-50° from the rachis, prominent and rounded above, less prominent, acute and scarcely pilose below; secondary veins immersed above, more prominent than the primary ones and with scaly caducous hairs below. Inflorescence spicate; prophyll 15 × 1-1.5 cm, linear, thin, covered with a dense brown-ferruginous persistent tomentum; peduncular bract 20-26 cm long, its shape and indumentum like those of the prophyll, inserted ca. 1 cm above; peduncle 35-43 cm long, 3-4 mm wide, compressed, with scaly reddish-brown persistent hairs, toward the apex with 3-4 small bracts, less than 1 cm long; spike 15-32 cm long, 7-8 mm in diam.; pits densely arranged in 8 somewhat oblique series, each pit 2-3 mm wide, bilabiate, the upper lip entire, short, the lower one ovate, slightly striate, briefly bifid, long protracted, about 3 mm long, completely covering the pit or sometimes exceeding it, the surface covered with a thin, brown-ferruginous, persistent indumentum. Staminate flowers near anthesis 4-5 × 2-2.5 mm; sepals oblong-lanceolate, obtuse, keeled toward the apex, ciliate at the margin, 3.5-4 × ca. 2 mm; petals lanceolate to obovate-lanceolate, slightly nerved, acute and thickened at



1. *Geonoma chlamydostachys* Galeano. A, Leaf; B, Spike showing part of the peduncle and the peduncular bract; C, Detail of the spike; D, Pistillate flower showing the staminodial tube unfolded, and the pistil; E, Staminate flower before anthesis; F, Ripe fruit. A-C from Hernández & Hoyos 89; D-F from Hernández et al. 685.

the apex, 4–5 mm $\times$ 1.5 mm; stamens 6, the filaments 4 mm long, connate for ca. 2.5 mm; thecae linear, free, ca. 2 mm long, apparently sharply reflexed from the filaments; pistillode pyramidal, ca. 1 mm long, briefly trifid at the apex. Pistillate flowers near anthesis 3.5–4 mm long, elongate; sepals oblong-lanceolate; petals linear-lanceolate, acute and thickened at apex, 3.5–4 mm $\times$ 1 mm; staminodial tube 1–1.5 mm long, digitately 6-lobed, each lobe 1–1.5 $\times$ ca. 0.2 mm; gynoeceum ca. 1 mm long; style 3 mm long, deeply trifid. Fruits ovoid, acute at apex, 10–12 $\times$ ca. 6 mm, the surface slightly granulate; seed ovoid, acute at apex, dark brown, shining.

Distribution and Habitat: known only from southeast Departamento de Antioquia, in the zone of influence of middle Magdalena River, at 300–1,000 m altitude, in disturbed moist forest.

Specimens Examined: Colombia: Departamento de Antioquia: Municipio de San Luis, Río Claro, 400–1,000 m alt., 13 Jan 1983, *Hernández et al.* 685 (holotype HUA); same locality, 480 m alt., 12 Oct 1981, *Hernández & Hoyos* 89 (COL, HUA); same locality, 600 m alt., 24 Jun 1982, *Hernández & Hoyos* 415 (COL, HUA); same locality, 325–450 m alt., 1984, *Cogollo* 1280 (JAUM); same locality, 330–500 m alt., 1 May 1984, *Cogollo & Borja* 1633 (JAUM); same locality, 21 Feb 1982, *Rentería et al.* 3038 (JAUM).

Geonoma chlamydostachys belongs to section *Taenianthera* (Burret) W. Boer, according to the last interpretation of the genus *Geonoma* (Wessels-Boer 1968). The species of this section, formerly regarded as constituting a genus of their own (Burret 1930), were considered by Wessels-Boer to be a natural group characterized by the combination of several characters, particularly the acaulescent or short-stemmed habit, the spicate, long-peduncled inflorescence, the densely arranged

flowerpits, and the digitately lobed staminodial tube of the pistillate flowers.

Eight species were previously known in section *Taenianthera* (Wessels-Boer 1968, De Granville 1975); five of them, *Geonoma acaulis* Mart., *G. camana* Trail, *G. macrostachys* Mart., *G. poiteauana* Kunth, and *G. tamandua* Trail are distributed in the Amazon basin, the last two species being known also from the Guiana shield. The remaining three species have a more limited distribution; *G. oldemanii* J. J.-de Granville is known only from French Guyana, and *G. paradoxa* Burret and *G. chococola* W. Boer are known from the Pacific coastal area in western Colombia. *G. chlamydostachys*, discovered in northwestern Colombia is, thus, the northernmost species in the section.

Only two species of section *Taenianthera*, *G. macrostachys* and *G. chococola*, resemble *G. chlamydostachys*. The new species can be distinguished from *G. macrostachys* mainly by its leaves with the veins emerging from the rachis at a wider angle (45–50° vs 20–35°), and by the fruits being ovoid instead of subglobose. From *G. chococola*, which is a more massive palm, the new species can be distinguished, at first glance, by its much smaller leaves (rachis 45–60 cm long vs 90–140 cm long), its more slender spike (7–8 mm diam. vs 10–15 mm diam.), with pits arranged in a lesser number of vertical series (8 vs 11–12), and the much smaller and pointed fruits (10–12 mm long, ca. 6 mm diam. vs ca. 20 mm long, ca. 15 mm diam.).

Acknowledgments

I thank biologists Saulo E. Hoyos and Alvaro Cogollo for bringing the taxon to my attention. The Herbaria of Universidade Antioquia (HUA), and of Jardín Botánico Joaquín Antonio Uribe (JAUM) made possible the study of specimens for the description and illustration. Eugenia de Brieva, Instituto de Ciencias Naturales,

Universidad Nacional de Colombia,
Bogotá, made the drawing.

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PALM BRIEF

Barcella odora

In 1874 the Scottish botanist James Trail collected a palm on the Rio Padauri, a tributary of the Rio Negro in Brazil. He thought this palm was a species of the genus *Elaeis*, the oil palm, and in 1877 described it as *Elaeis* (subgenus *Barcella*) *odora*.

Actually Trail's palm is quite distinct from *Elaeis*. It is acaulescent with a few erect pinnate leaves, up to 2 m long, and with non-spiny petioles. The inflorescence is borne on a long peduncle, and although the prophyll is below ground level, the peduncular bract is erect and woody, and persists while the fruits are forming (Fig. 1). Inflorescences have either all staminate flowers or both staminate and pistillate (Fig. 2). In the latter case the staminate flowers open first, and, as noted by Trail, have a strong sweet scent which attracts numerous bees, wasps, and flies. These differences persuaded Drude, in his treatment of the Palmae for Flora Brasiliensis in 1881, to recognize this palm as a distinct genus, and so it became *Barcella odora* (Trail) Drude.

For the hundred years following Trail's discovery *Barcella odora* was only known from its original locality. However, in recent years it has been found in other

areas, and is now known to occur in certain localities over a very large area north of the Rio Negro. This area stretches from the Rio Padauri in the west almost four hundred kilometers east to the Manaus-Boa Vista road. The habitat of the palm is campinarana, a kind of low, dense, shrubby vegetation found on white sand, transitional between savanna and forest. *Barcella* is extremely abundant in the campinaranas.

The derivation of the name *Barcella* was not given by Trail. Harold Moore guessed that it may have come from the Latin word for boat in its diminutive form, "barca-ella," in reference to Trail's form of transport. It seems more likely that Trail took the name from the nearby town of Barcelos, a town more important than it is now, and just downstream from where the Padauri flows into the Negro. The common name for the palm is piassaba brava, piacaba preta, or piacabarana. The name piacaba or piassaba is usually given to another Brazilian palm, *Leopoldinia piassaba*, and to the strong fibers it yields. *Barcella* also has fibers, in its petioles, and these persist on the ground even after the leaf has died and rotted away. But the fibers of *Barcella* are of little economic value, and hence the name piacabarana, or false piacaba.

ANDREW HENDERSON



1. *Barcella odora*, inflorescence with some staminate flowers open and pistillate buds near the bases of the rachillae. Note peduncular bract among rachillae at left.



2. *Barcella odora*, inflorescence with young fruits.

The Identity of *Clinostigma onchorhynchum*¹

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Clinostigma belongs to subtribe Iguanurinae of tribe Areceae in the arecoid subfamily of palms (Dransfield and Uhl 1986). It includes 13 species which occur in islands of the South Pacific. Six species have been described from Samoa: *C. samoense* H. A. Wendl., *C. onchorhynchum* Becc. (this species was originally named as "*C. onchorhyncha*," but since the name "*Clinostigma*" is neuter rather than feminine, the specific epithet should be "*onchorhynchum*"), *C. savaiiense* Chris., *C. powellianum* Becc., *C. vaupelei* Burret, and *C. warburgii* Becc.

The type species, *Clinostigma samoense* was described by H. A. Wendl. (1862) from a specimen collected by Pickering of the U. S. Exploring Expedition on Upolu Island in Samoa. Wendl. described the specimen as consisting of parts of a leaf, and a piece of an inflorescence with no staminate flowers, but with immature fruit. He describes the fruit as being egg-shaped, almost spherical, with the stigmatic scar not occurring at the apex of the fruit, but on the ventral side between the base and apex. Subsequently Reinecke referred a specimen he collected in Upolu (Fig. 2e) to *Cyphokentia samoensis* indicating probable synonymy with *Clinostigma samoense* (Reinecke 1898). This practice of placing specimens

in *Cyphokentia samoensis* and indicating probable synonymy with *Clinostigma samoense* was followed by Karl Rechinger (1910) who noted that a photograph of this species appeared in Schimper (1903 fig. 151).

Later Beccari (1914) described a second species of *Clinostigma* from Upolu based on a collection made by the Rev. S. J. Whitmee from Lake Lanatoo in August 1875. Beccari incorrectly reported the locality as "Lake Lamitoo," but examination of Whitmee's label on the specimen makes it clear that Beccari misread Whitmee's handwritten locality of "Lake Lanatoo." Beccari described the mature fruit as being obovoid to oblong and reflexed with a very eccentric apex. The foliar characteristics described for both species are nearly identical. In an earlier publication, Beccari stated that he had not seen the Pickering material (Beccari 1913) and hence probably described *C. onchorhynchum* without seeing the type of *Clinostigma samoense*.

Subsequent to Beccari's description, few specimens of *Clinostigma* collected from Upolu have been referred to as *Clinostigma samoense*; most have been referred to *C. onchorhynchum*. Burret (1928) placed in *C. onchorhynchum* several specimens which Rechinger (1910) had previously referred to *Cyphokentia samoensis* Warburg. Christophersen (1935) examined all of the *Clinostigma* specimens present in the Bishop Museum and found none to be conspecific with *Clinostigma samoense*. Subsequently Langlois (1976) reported finding and pho-

¹ This paper includes field work performed by both authors and reflects the general conclusions of the late Professor Moore; his tragic death occurred before this work had reached manuscript stage, however, and thus the responsibility for any errors is borne solely by Cox.

tographing (figs. 49, 50) both *C. onchorhynchum* and *C. samoense* on Upolu island at Afiamalu and Mofa (sic) Pass respectively, although collections were not cited. Voucher specimens collected by Cox (1980) near Afiamalu on Upolu in support of a study of crown relationships were also referred to *C. onchorhynchum*. I am aware of no collectors who have referred specimens to *C. samoense* since Beccari's (1914) description of *C. onchorhynchum*.

Concerned that *C. onchorhynchum* and *C. samoense* might indeed be the same species, we conducted a survey of *Clinostigma* populations in Upolu, Western Samoa. We also searched the island of Tutuila, American Samoa, for *Clinostigma* populations; Cox had previously seen a palm referable to *Clinostigma* in the mountainous interior of the island while Moore had heard reports of *Clinostigma* species in cultivation in Ilili village. These studies were a continuation of previous field work on *Clinostigma* in Samoa begun by Moore in 1971.

We found two localities of *Clinostigma samoense* in Tutuila Island, American Samoa (an anecdotal account of this discovery is found in Cox 1982). The first consisted of several trees (Moore and Cox 10538) in cultivation in the garden of Atualevao Maiu'u in Ilili village. Atualevao, age 75, told us that in about 1905 her father brought seeds of *C. samoense* from Lalomanu village in Upolu, Western Samoa and planted them in Ilili, American Samoa. He anticipated using the "niu vao" (*Clinostigma*) stems to use for substructure of huts and the leaves as thatching. Some *Clinostigma* palms were also said to have occurred in the lowland forest near Ilili (from introduced trees?) but none was seen subsequent to the clearing of the forest. The second locality on the island consisted of a single individual (Moore and Cox 10539) found about 3 km west of Aloau village at an altitude of about 760 m in primary forest. We therefore believe that *C. samoense* is an intro-

duced rather than an indigenous palm on Tutuila island; this view is in accordance with the floristic studies of Setchell, who did not report the palm from the island (Setchell 1924).

In Upolu we studied a variety of *Clinostigma* populations including those at Afiamalu, Lake Lanoataata, Tiavi Pass, Siumu Road, Le Pupue National Park, and Mafa Pass. We found a complete intergradation of *C. samoense* fruits and *C. onchorhynchum* fruits among the individuals of each population. For example, two palms, Moore and Cox 10541 and Moore and Cox 1054, were found 50 m apart at the Le Mafa Pass population at an altitude of 360 m. Moore and Cox 10541 (Fig. 1) had a gray, lichenous trunk about 6 m tall. Three inflorescences, one in a staminate flower, one in young fruit, and an intermediate were present. The staminate flowers were cream-colored, scented of violets, with pale filaments, yellowish anthers, and a pale pistillode. The fruits were red-brown, beaked, with liquid endosperm (Fig. 2c). Although the fruit characteristics match the description of *C. onchorhynchum*, we believe this to represent a late maturation stage of *C. samoense* since the neighboring tree (Moore and Cox 1054) was nearly identical in all respects, except that it had green, rounded fruits (Fig. 2d) ascribable to *C. samoense*.

Our conclusion that *C. onchorhynchum* is merely a later developmental stage of *C. samoense* is further confirmed by careful examination of the relevant types and other specimens. The type of *C. samoense*, collected by the U.S. Exploring expedition (GH), consists of part of a leaf, part of an inflorescence, and several fruits in various stages of early maturation (Fig. 2a). The immaturity of these fruits was recognized by Wendland (1862) in his type description. They are small, ovoid to slightly obovoid with an eccentric stigma, and only slightly beaked (Fig. 2a). Our collection of greenish, immature fruit as

cited above (*Moore and Cox 10542*, Fig. 2c) corresponds in all respects with the type of *C. samoense*. The fruits of the Whitmee collection used by Beccari as the type of *Clinostigma onchorhynchum* are obovoid to oblong, somewhat curved, with an eccentric stigma and a distinct beak (Fig. 2b). This type corresponds closely with our collection (*Moore and Cox 10541*, Fig. 2d) of mature fruits as cited above. We therefore propose that *Clinostigma onchorhynchum* be reduced to synonymy with *Clinostigma samoense*.

Clinostigma samoense H. A. Wendland, Bonplandia 10: 196. 1862. Type: Samoa, U.S. Exploring Expedition 1838–1840, s.n. (Holotype GH, isotype BH 380860 (fragments)).

Clinostigma onchorhynchum Beccari, Webbia 4: 284, 1914. Type: Samoa, J. Whitmee s.n. in August 1875. (Holotype FI; isotype BH (fragments), US).
Synon. nov.

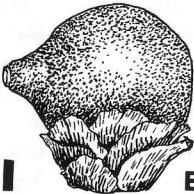
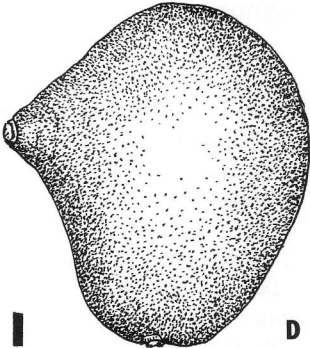
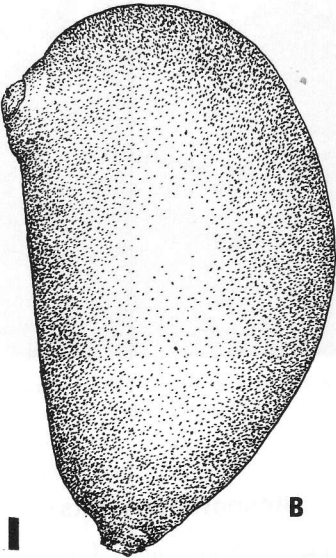
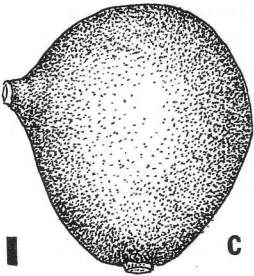
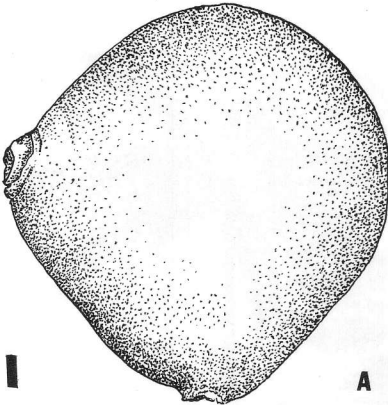
SPECIMENS EXAMINED. WESTERN SAMOA, UPOLU: U.S. Exploring Expedition, 1838–1840 (GH). (fragments from type fruits are also found in BH as BH 380860); Lake Lanotoo, 2,100 ft. alt., Whitmee (US); Lake Lanotoo, Reinecke 322 (US); hilltop on edge of fernland east of Tiavea, Whistler 4196 (US); Apia-Siumu road, south side of ridge, elevation 1,500 ft., Bristol 2179 (US); Mt. Fia Moe, Cox 153 (GH); Sauniatu inland from Salafuata, Moore and Fasavalu 9983 (BH); ridge above Tiavi at highest point on road from Apia to Siumu, 740 m alt., Moore, Fasavalu, and Haskell 9978 (BH); Le Mafa Pass, 360 m alt., Moore and Cox 10541 (BH); Le Mafa Pass, 360 m alt., Moore and Cox 10541 (BH); Le Mafa Pass, 360 m alt., Moore and Cox 10542 (BH). AMERICAN SAMOA, TUTUILA: Ilili, in garden of Atualevao Maiu'u, Moore and Cox 10538 (BH); west of Aloau village on ridge, Moore and Cox 10539 (BH).



1. *Clinostigma samoense* at Le Mafa Pass, Upolu, Western Samoa

Acknowledgments

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seum (BISH), and the Gray Herbarium (GH) for loans and numerous courtesies.

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2. a. Fruit from type of *Clinostigma samoense* Wendland. In this and all other drawings, the bar is equivalent to a length of 1 mm. b. Fruit from type of *Clinostigma onchorhynchum* Beccari. c. Fruit from *Moore and Cox* 10542. d. Fruit from *Moore and Cox* 10541. e. Fruit from *Reinecke* 322

The Largest Desert Fan Palm Oases

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The desert fan palm, *Washingtonia filifera* (Fig. 1), is restricted in its natural distribution to 116 seeps, springs, and streams in the Sonoran Desert of south-eastern California and northeastern Baja California, and two seep areas in south-western Arizona (Cornett 1985). Because of the limited range of *W. filifera* and its reliance on rare desert water resources, wild populations are vulnerable to both natural and man-caused alterations of the environment. Recently, in Riverside Co., CA, two of the largest palm oases were proposed as sites for commercial developments (Cornett 1982, 1984). These proposals have dramatized the need for more information concerning the relative significance of individual oases. In this paper the largest oases in which *W. filifera* occurs are listed and the relationship between their size and location is discussed.

Palm oasis size was determined by direct counts of mature desert fan palms in all but 4 of the 118 palm oases. (None of the uncounted groves were thought to contain more than 30 palms.) The counts were completed between 1983 and 1985. In addition, published reports of specific palm oases were reviewed with three references being of significance in the preparation of this report (Henderson 1948, 1951, 1955).

The naturally-occurring populations of mature desert fan palms total approximately 20,983 individuals. The largest

palm oases are listed in Table 1. The top nine account for 56% of the palms found in the wild yet represent only 7.6% of the palm oasis sites. Each of these palm oases occurs along the eastern base of the Peninsular Ranges in southern California and northern Baja California. The second most significant region of palm populations straddles the San Andreas Fault within the Coachella Valley of Riverside Co., CA. Half of the largest palm oases in the U.S. occur here, including Willis Palms and Thousand Palms. There are approximately 3,589 adult desert fan palms along the fault representing 17% of the known wild population.

The concentration of large palm oases at the base of the Peninsular Ranges surely results from the large and reliable water resources provided by storm runoff from the mountains. Several peaks in these ranges exceed 3,000 m in elevation and many of the canyons contain perennial streams. Summer surface flows of 260 acre feet per month have been recorded in Andreas Canyon (Riverside Co. Flood Control, 1981). None of the other palm oasis sites boast year-round surface flows.

Palm oases along the San Andreas Fault receive an abundant supply of underground water that comes to the surface along the fault. The origin of this water undoubtedly represents underground flows from the Transverse Ranges immediately to the north and west (P. Saint, pers. comm.). Subsurface flow to lower, south-



1. Palm Canyon, near Palm Springs, California. Copyright photograph by Stephen Willard.

erly elevations is prevented when this water reaches impermeable layers of sediment (fault gouge) at the fault. At this point the water is dammed underground and eventually rises to the surface (G. Meyer, pers. comm.). Although other Sonoran Desert localities have earth faults

and accompanying palm oases, none are of the magnitude of the San Andreas Fault.

Acknowledgment

This study was made possible through a grant from the Richard King Mellon Foundation of Pittsburgh, Pennsylvania.

Table 1. Largest *W. filifera* oases. R^1 refers to the overall ranking. R^2 refers to the ranking within the U.S.^a

# Mature <i>W. filifera</i>	Name and Location	Latitude (N)	Longitude (W)	R^1	R^2
2,511	Palm Canyon Riverside Co., Ca.	33°44'12"	116°32'16"	1	1
2,250*	Cañon Palomar Baja California Norte	31°55'30"	115°42'56"	2	—
1,715*	Cañon Santa Isabel Baja California Norte	31°54'05"	115°41'20"	3	—
1,076	Andreas Canyon Riverside Co., Ca.	33°45'41"	116°33'00"	4	2
1,000*	Cañon de Agua Caliente Baja California Norte	31°40'08"	115°38'30"	5	—
896	Cañon del Tajo Baja California Norte	32°15'41"	115°51'25"	6	—
791	Cañon de Guadalupe Baja California Norte	32°09'08"	115°45'09"	7	—
790	Borrego Palm Canyon San Diego Co., Ca.	33°16'49"	116°25'54"	8	3
688	Murray Canyon Riverside Co., Ca.	33°44'42"	116°33'06"	9	4
612	Willis Palms Riverside Co., Ca.	33°49'40"	116°19'49"	10	5
549	Thousand Palms Riverside Co., Ca.	33°50'15"	116°18'29"	11	6
457	Cañon de los Tanques Baja California Norte	32°22'31"	115°50'30"	12	—
438	Pushawalla Canyon Riverside Co., Ca.	33°49'16"	116°17'05"	13	7
421	Cat Canyon Riverside Co., Ca.	33°41'47"	116°26'20"	14	8
376	Macomber Palms Riverside Co., Ca.	33°47'59"	116°15'28"	15	9
362	Biskra Palms East Riverside Co., Ca.	33°47'29"	116°15'08"	16	10

^a Palm counts from Henderson, see literature citations.

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Germination Induction of Pygmy Date Palm Seed

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ABSTRACT

Three groups of 121 seeds each of *Phoenix roebelenii* O'Brian were either water-soaked for 24 hours, scarified at the micropylar end, or left untreated. After 72 days, 53.7% scarified seed, 38% non-scarified seed, and 20% of the 24-hour water-soaked seed germinated.

Phoenix roebelenii O'Brian, the pygmy date palm, has slender, soft, pinnately compound leaves and a trunk that rarely reaches 2.7 m (McCurrah 1960, Bailey and Bailey 1978), which, together with its good tolerance of low light levels, makes it well suited to interior spaces. However, small plants are usually in short supply, largely due to the fact that seedlings take a long time to attain marketable size. Often, growers must germinate their own seed to obtain plants for potting up into larger sizes. The germination of seeds is slow and erratic and the small plants are slow-growing.

There are a number of methods described for the germination of palm seeds and a few selected references important to this paper will be described here. Poole and Conover (1974) recommend planting *Chamaedorea elegans* Mart. as soon as the seeds are mature. The medium should be well aerated, approximately 1 cm deep and moist but not wet, with germination temperatures of 23.9 to 26.7° C. Schmidt and Rauch (1982) suggested that although no chemical inhibitors have been found in

palm seeds to date, presoaking *Chrysali-docarpus lutescens* H. Wendl (Areca) palm seeds in water and gibberellic acid accelerated germination.

Nagao and W. S. Sakai (1979) reported increased germination of *Archontophoenix alexandrae* [F. S. Muell], H. Wendl, and Drude seeds by presoaking in water for 24 to 72 hours. They also found that treatments of 100 or 1,000 ppm gibberellic acid further enhanced the effect.

Nagao, Kanegawa, and Sakai (1980) stated that accelerated germination of *Ptychosperma macarthurii* H. Wendl Nichols seeds was achieved following scarification or presoaking in 1,000 ppm gibberellic acid (GA). Greatest acceleration occurred when scarification, GA presoak and bottom heat were combined.

Although the data were not statistically analyzed, Koebernik (1971) indicated it took 38 days to germinate *P. roebelenii* O'Brian seed. He suggested using fresh seed and planting in perlite for best results.

The purpose of this study was to determine if scarification or presoaking in water for 24 hours plus the use of bottom heat would enhance *P. roebelenii* O'Brian seed germination.

Materials and Methods

Seed treatments. Three hundred and sixty-three seeds that were available for use were divided equally into three groups, one group scarified with a file at the micropylar end, cutting deep enough to break the seed coat (approximately 0.5 to

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² Professors.

Table 1. The Chi Square Test of Independence 3×2 contingency table for *Phoenix roebelenii* O'Brian palm seed germination, scarified vs. non-scarified vs. 24-hour water soak seed treatment after 72 days.

Treatments	Germination	%	Non-Germination	%	Total
Scarified	65	53.7	56	46.3	121
Non-scarified	38	31.4	83	68.6	121
24-hour soak	20	16.5	101	83.5	121
Total	123	33.9	240	66.1	363

$\chi^2 = 37.849^{**}$; $\chi^2 .05$, 2 df = 5.99; $\chi^2 .01$, 2 df = 9.21

1 mm deep). Another group was immersed in tap water for 24 hours, then planted, including all seeds whether floating or not. The third group was planted without treatment. All were planted in a medium consisting of equal parts by volume of screened sphagnum peat moss and No. 2 grade vermiculite, covered with about 6 mm of the medium and bottom heated to maintain 24° C.

Results and Discussion

Fifty days after planting 41 of the scarified seeds and only 9 from the non-scarified group germinated. Seven seeds which underwent the 24-hour water presoak and sank germinated as opposed to none from the presoaked group that floated.

After 72 days, 65 of the scarified seeds and 38 of the non-scarified seeds germinated. Nineteen seeds that sank germinated and only one that floated germinated from the 24-hour water presoak group.

A Chi Square Test for Independence in a 3×2 contingency table was calculated for the total number of seeds germinating in each treatment. There was a highly significant difference between seed treatment ($\chi^2 = 37.849^{**}$, Table 1).

When the scarified seed treatment was compared with the non-scarified seed treatment in a Chi Square Test for Independence in a 2×2 contingency table, there was a highly significant difference between seed treatments, with scarified seeds germinating better (Table 2).

When the scarified seed treatment was compared with the 24-hour water presoak treatment, in the same statistical test, there was a highly significant difference between seed treatments with scarified seeds germinating better (Table 3).

To determine if there were significant differences between germination of 24-hour water presoak floating seeds compared to those seeds that sank, a one-tailed Fisher Exact Test was calculated.

Table 2. The Chi Square Test of Independence 2×2 contingency table for *P. roebelenii* O'Brian palm seed germination, scarified vs. non-scarified seed treatment after 72 days.

Treatments	Germination	%	Non-Germination	%	Total
Scarified	65	53.7	56	46.3	121
Non-scarified	38	31.4	83	68.6	121
Total	103	42.6	139	57.4	242

$\chi^2 = 12.32^{**}$; $\chi^2 .05$, 1 df = 3.84; $\chi^2 .01$, 1 df = 6.63

Table 3. The Chi Square Test of Independence 2×2 contingency table for *P. roebelenii* O'Brian palm seed germination, scarified vs. 24-hour water soak seed treatment after 72 days.

Treatments	Germination	%	Non-Germination	%	Total
Scarified	65	53.7	56	46.3	121
24-hour soak	20	16.5	101	83.5	121
Total	85	35.1	157	64.9	242

$\chi^2 = 36.71^{**}$; $\chi^2 .05$, 1 df = 3.84; $\chi^2 .01$, 1 df = 6.63

Of the 121 seeds presoaked, 99 sank and 22 floated. Of the 99 seeds that sank, 19 germinated. Likewise, of the 22 seeds that floated, 1 germinated. The Fisher Exact Test was used rather than the Chi Square Test because the number of floating seeds expected to germinate was less than the number required for the Chi Square Test. Under the Null Hypothesis, of no relationship of germination to sinking or floating, the probability of obtaining germination of either 0 or 1 of the seeds that floated was at the .079 level. These data suggest that 92.1 percent of the time floating seed will not germinate. However, it is not statistically significant at the 95 or 99 percent level.

This study indicated that seed scarification did enhance germination but 24-hour presoak treatments did not. Although not statistically significant at the 0.05

probability level, floating seeds did not germinate as well as seeds that sank.

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Principes, 30(2), 1986, pp. 87-88

PALM BRIEF

The Hawaii Tropical Botanical Garden has opened to the public in the lush setting of Onomea Bay on the Island of Hawaii. This 17 acre Nature Preserve is the newest Botanical Garden in the Hawaiian Islands and shows promise of being an outstanding example of tropical horticulture.

Among the collections presently on inventory at the Garden is a surprisingly diverse collection of palms. With the help of many friends and supporters the collection includes *Areca triandra*, *Elaeis guineensis*, *Hyophorbe lagenicaulis*, *Reinhardtia gracilis*, and *Veitchia winin*. At press the inventory showed 44 genera represented by 74 species. A further inventory of currently unidentified species

will increase the listing as well as the steady acquisition of other species adaptable to the cultural conditions of this tropical valley.

The Hawaii Tropical Botanical Garden began in 1978 as the dream of Dan and Pauline Lutkenhouse. Retiring to Hawaii from San Francisco they fell in love with the unspoiled charms of the 'Big Island' (Hawaii) and made plans to preserve at least a small part of it for future generations. Establishing the Nature Preserve and Botanical Garden required hundreds of hours of dedicated labor and a considerable amount of money (nearly a million dollars). As the years went by the garden began to emerge from an untamed jungle into a series of micro-climates enhanced by the ever-growing collections of tropical and exotic species. Graceful palms created overstories for other genera and highlighted the paths and ponds in the Garden. Literally hundreds of plants were collected from the gardens of Asia, donated by residents of Hawaii, and acquired from institutions across the United States. Finally, in 1984 the Garden had reached the state where it could be opened to the visiting public. In the few months it has been open, the Garden has been enjoyed by several

hundred visitors from the United States and nearly every other country in the world.

The Garden is a federally approved Non-Profit Organization funded entirely by donations and admission donations. A restriction on the number of visitors that are allowed in the Garden each day helps to preserve the peaceful environment of the Garden while still providing the finance needed for basic operations. All expansion projects and special programs are based on other donations.

A permanent staff of four oversees the Garden operations. Gary A. Powell, formerly of the Waimea Falls Park on O'ahu, has accepted the position of Curator for the new Garden and Terence Takiue, who has overseen the physical development from its inception, is the operations manager.

Dan and Pauline Lutkenhouse remain as the Directors and are very active in the day-to-day affairs of the Garden. Their foresight and dedication will enable future generations to enjoy and perpetuate the beauty of Onomea Bay and the Hawaii Tropical Botanical Garden.

LOIS ROSSTEN

The 1986 Biennial Meeting

1) The agenda for the 1986 Biennial was enclosed with your January issue of *Principes*. Please emend the schedule to include a tour of the Dr. Mardi Darian Botanical Garden, one of the best in the U.S., Saturday, June 28, 12-4 pm.

2) For the Biennial tours we need to know: will you need transportation or will you have room for extra persons and if so how many? Please respond on the registration form or phone: Jim Wright, (619) 276-5295.

3) Please submit your registration form promptly.