

PRINCIPES

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Ceroxylon quindiuense is left in pastures on steep slopes above Tenerife, Colombia. Photo by M. V. Parthasarathy. See page 127.

PRINCIPES

JOURNAL OF THE PALM SOCIETY

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In Search of Wax Palms

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In my mind's eye I have travelled often in the Andes of Colombia, taking the road between Ibagué and Cartago, which winds past mountain gorges and high waterfalls on its way up and over the Quindio Pass. There was no road over the pass when Alexander von Humboldt, one of the most renowned naturalists and explorers of all time, made his journey in 1801. Then there was only a treacherous trail, which, at higher altitudes, Humboldt referred to as "a tunnel left open to the sky" (Bombard, 1937). In a journey that probably lasted ten to 12 days, Humboldt began at Ibagué to the east of the pass at 1300 meters, crossed the Cordillera Central at an altitude of over 3500 meters, and then descended to Cartago by the Cauca River. During this time the Quindio Pass was noted for its dangers: torrential rains could leave one mired in a vertical sea of mud, and as there were no towns or even isolated dwellings along the route, it was necessary to carry supplies for a month. Even today the journey can be treacherous: the road over the pass is regularly closed due to landslides, and newly erected crucifixes are still found along the way.

On his journey over the pass, Humboldt discovered the wax palms, so named for the layer of waxy substance covering their trunks; the generic name *Ceroxylon* is derived from two Greek words, *keros* (beeswax) and *xylon* (wood). Humboldt found these palms growing at extremely high elevations, from 1500 to 3000 meters. This in itself is unusual, as the vast majority of palms occur in the warm lowlands of tropical or subtropical regions. But in addition, the wax palms of the Quindio region reach heights of over 60 meters, making them the tallest palms known: in the time of Humboldt, these trees were thought to be the tallest of living plants. Subsequent explorers described the sheer beauty of *Ceroxylon*. The wax of the trunks is said to give these palms a white, glistening quality similar to marble. Édouard André, who crossed the pass in 1876, remarked that by moonlight the wax palms looked like ". . .pillars of a cathedral; no breeze stirred the foliage of their majestic crowns, which shot up 60 meters into the air (Bomhard, 1937).

In November, 1974, Dr. Harold E. Moore, Jr. and I set out for the Quindio Pass, travelling by jeep from Bogotá. We were accompanied by Sr. Roberto Jaramillo M. of the National University in Bogotá, who was our driver and guide.

My own desire to visit the pass was simply to travel the route my imagination had taken so often, and in so doing to see in an awakened state the magificent wax palms. Dr. Moore's purposes for the trip were more concrete. André had reported two species of *Ceroxylon* in the vicinity of the pass: one on the eastern side, the other to the west. However, accompanying descriptions were not complete enough to confirm the actual identity of the two species on either side of the pass. There was further confusion concerning the specific names to be applied to the wax palms of the Quindio region, as a succession of explorers had coined a variety of epithets. These prob-

lems could only be resolved by collecting reasonably complete material from *Ceroxylon* specimens on both sides of the pass.

We arrived in Ibagué on an overcast afternoon, and from there began our ascent up the eastern flank of the Cordillera Central to the Quindio Pass. As is the rule throughout Colombia, the highland areas on either side of the pass are almost completely denuded of their natural vegetation. We saw instead extensive plantations of coffee and bananas which covered even the steepest slopes; as we ascended, these plantations were replaced by open pastures where cows and sheep grazed. Here and there new forests of introduced pines and *Eucalyptus* had been planted, but in most places the soil was laid bare to erosion. Yet even these alterations in the natural landscape could not detract from the splendor of those first wax palms we saw. As the sky began to break, they appeared across the open face of the mountains, ancient sentinels straight and unbelievably tall, their trunks glistening in the afternoon light.

Species of *Ceroxylon* and other related genera are dioecious, the male and female flowers being found on separate trees. To our joy we saw a number of female trees bearing ripe, red fruits. However, we could find no trace of flowers on either the fruiting female or the male trees. All the wax palms that we saw on our ascent stood on steep slopes at a good distance from the road (Cover). As the afternoon was half gone, we decided to postpone our collecting until the following day.

On our approach to the pass we entered a thick belt of fog. In the faded light we could barely see the gnarled outlines of stunted oaks and laurels etched against the sky, their branches burdened with epiphytes. These trees were the remnants of a cloud forest that had once covered the crests of the mountains (Fig. 1). Suddenly the road dipped down and we began our roaring descent. It was almost dark when the fog lifted and we could once again see wax palms on either side of the road. These were distinct from the palms we had seen on the eastern side of the pass: they were considerably shorter and their trunks were of a darker hue. Yet such variations could conceivably occur within disjunct populations of a single species. Variations in reproductive, rather than vegetative, characters are far more significant in differentiating species. Essentially, we needed to know whether the two apparent species were isolated reproductively, as well as geographically. In this context it was most significant that the phenology—the time of flowering and fruiting—of the palms on either side of the pass was distinct. At this time (November) we observed that the palms to the east were not in flower, while the females bore mature fruit; on the western side, both male and female trees were in flower, while an occasional female bore fruits that were green and immature. These differences in phenology made us virtually certain that there exist two distinct species of *Ceroxylon*, one on each side of the Quindio Pass.

It was midmorning of the next day when Dr. Moore and I finally reached a flowering male *Ceroxylon* near the bottom of a steep ravine (Fig. 2). We had spent several hours that morning searching for suitable trees on the western side of the pass and getting permission to fell one; most of the wax palms here were located in the midst of coffee plantations (Fig. 3), where felling a tree for botanical specimens would leave a swath of costly destruction.

Cutting a *Ceroxylon*—as indeed the case with most palms—is a laborious process: the dark fibers running through the outer cortex are like steel wires. Our



1. Remnants of cloud forest below the divide on the western side of Quindio Pass, Colombia.



2. The male tree that provided specimens of *Ceroxylon alpinum*. Photo by H. E. Moore, Jr.



3. *Ceroxylon alpinum* is left in coffee plantations on the western side of Quindio Pass at about 1900 meters elevation above Calarcá.

axe was nearly dull before the palm finally crashed to the ground, its trunk landing across a stream at the bottom of the ravine, with its crown on the other side. Using the trunk as a bridge, we crossed the stream and discovered that the palm had toppled over a *Cecropia* tree, which throughout the American tropics is well known for harboring stinging ants. This *Cecropia* was unfortunately no exception, and dissecting the crown of the adjacent *Ceroxylon* was agonizing work. For anatomical studies we obtained the entire sequence of developing inflorescenses, each one found within the axil of a leaf; in addition, we collected seven sets of open inflorescences and leaves for herbaria in South America, the United States, and Europe. All of this amounted to a sizeable load, which we hauled up the steep slope of the ravine to the jeep.

Our work was not finished for this species, as we still had to collect the fruits and flowers from a female tree. Unable to find a female *Ceroxylon* outside of the coffee plantations, we spent the afternoon in search of a tree climber. The wax palm is an almost impossible tree to climb, as it is not only tall, but smooth and slippery as well. My attempt to scale one, using a climbing rope and spikes attached to the heels of my boots, failed miserably: the sheer hardness of the trunk prevented the spikes from entering (Fig. 4). We had no better luck finding a tree climber. In the mountains we were told to inquire in the nearby town of Calarcá, located at the base of the western slope; in Calarcá people suggested that we ask in the mountains. The volunteers at the fire station could not help us, wax palms being a bit out of their line. We had heard that there were boys who climbed wax palms to collect leaves for Palm Sunday, but this was November and the priest in Calarcá would not begin recruiting until March.



4. Climbing *Ceroxylon alpinum* is slippery work. Photo by H. E. Moore, Jr.

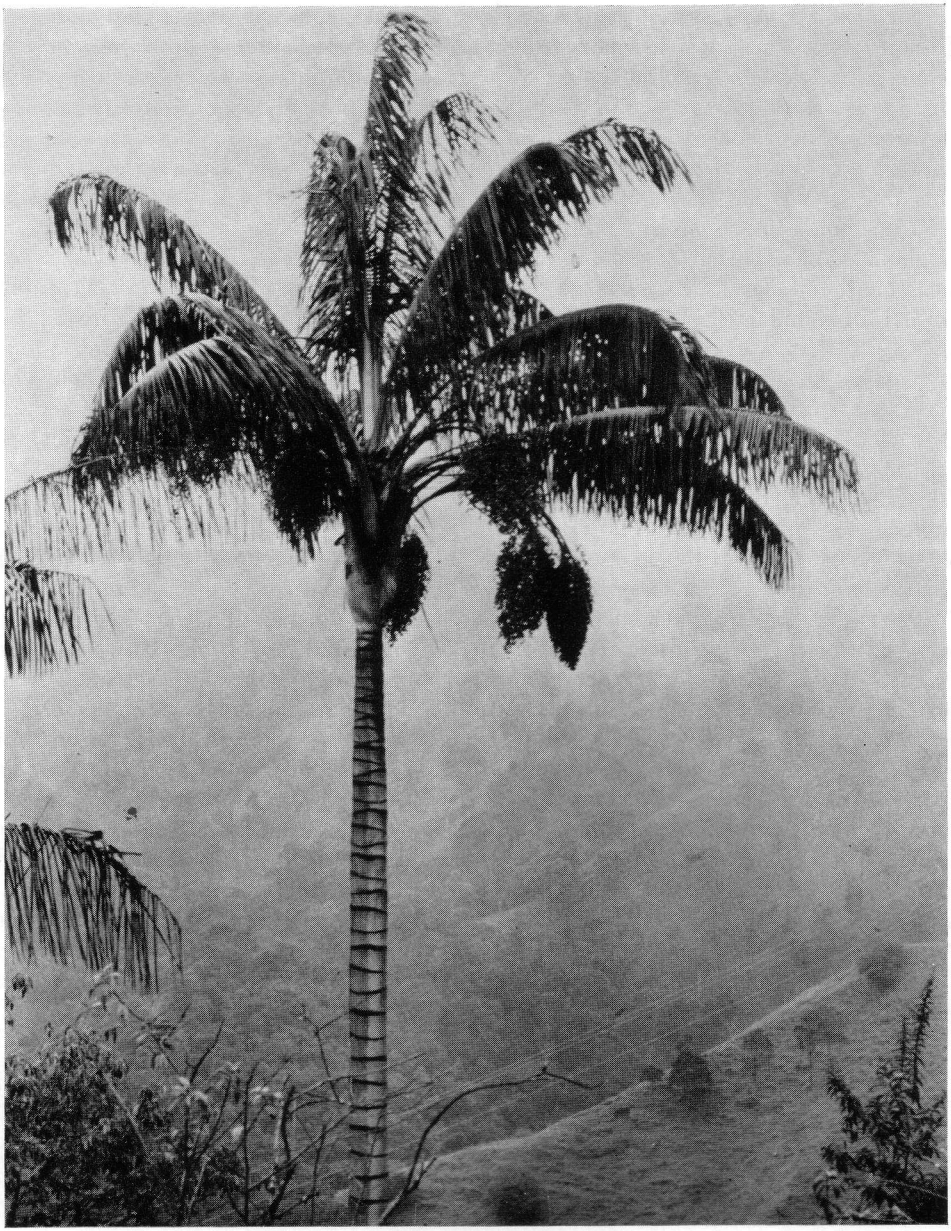
The next day our luck improved. Don Roberto found a young mechanic who was willing to attempt a climb. Ascending the western slope once again, we discovered a short female that was both in flower and fruit. Nevertheless, climbing this tree would not be easy. The man first attempted to use our climbing rope and spikes, but finding these more cumbersome than helpful, he decided to rely on his arms and legs. To our astonishment, the man worked his way up the tree almost to the crown and pulled down several racemes of immature fruit. However, he was unable to make it up to the crown where the flowers were located. Fortunately we could collect fallen flowers on the ground.

At noon we returned over the pass to the eastern side, where the more magnificent species of *Ceroxylon* occurs. We were now able to discern additional differences between the two species. The species to the west has a silver tone to the underside of the leaves, which is yellowish in the eastern species. We further noticed that the fruit of the western species is rough and mottled in texture, while that of the eastern species is smooth. Numerous other differences were ultimately discovered upon thorough examination of the specimens at Cornell University (Moore & Anderson, 1976).

Having found no male palms in flower, Dr. Moore and I decided to collect specimens from a fruiting female located on a steep slope several hundred meters above the road (Fig. 5). Climbing at this altitude was not easy for us lowlanders, and we were already winded by the time we arrived at the foot of the fruiting palm. As we began to cut the tree, we half expected the sudden appearance of an angry landowner, though we had been unable to locate anyone to give us permission to cut. But the echoes of our axe were soon muffled by the rain that started to fall, and we were left alone. At last the palm came down as we had planned, with its crown uphill, but this did not prevent the entire tree from plowing down into a patch of forest some 200 meters below. Undaunted, we followed the palm down the mountain, collecting fallen fruits along the way. It was beginning to get dark when we finally emerged from the patch of forest, carrying leaves, fruits, and developing inflorescences. Heavily laden, our descent along a goat trail in the rain gave us some appreciation of Humboldt's experience. We arrived exhausted at the base of the slope just as the rain came to an end. We stopped to watch the sunset. A wind picked up as the light began to fade, and across the mountains there was a flicker of palm leaves.

Many unanswered questions remain concerning *Ceroxylon*. Over a dozen species ranging through the Andes from Venezuela to Bolivia have been described within this genus, mostly on the basis of incomplete materials. Collectors in the past have been confronted with two difficulties: reaching the isolated localities where species of *Ceroxylon* occur, and then obtaining complete botanical specimens upon arrival. As a result, it is likely that several species of *Ceroxylon* have been described repeatedly: at one site a collector may have based his description of a species on the leaves and fruit, while another collector at a different site may have relied on leaves and flowers to describe the same species.

In order to begin to resolve the taxonomic complications within the genus, Dr. Moore and I made every attempt to collect complete botanical specimens of the two species of *Ceroxylon* in the vicinity of the Quindio Pass, where the genus was first discovered. At a later time I returned to the region and made further collections of the wax palms, thereby assuring us a complete representation of



5. The female tree that provided specimens of *Ceroxylon quindiuense*. Photo by H. E. Moore, Jr.

the leaves, flowers, and fruits of both species. Incidentally, during this second visit I discovered that the "eastern" species actually has a few scattered representatives on the western side of the Quindio Pass. But these occur at high elevations (ca. 2800 meters), well above the uppermost range of the "western" species (ca. 2000 meters).

With complete materials of both spe-

cies now available for examination, we have been able to resolve the confusion concerning the specific names to be applied to the wax palms of the Quindio region. We found that the species predominant on the western side of the pass corresponds to a description published in 1804 of a species called *Ceroxylon alpinum*. This name is attributed to Aimé Bonpland, who was Humboldt's companion during his travels in South America. However, there has been some confusion, as Bonpland later described the same species under the name *C. andicola* in 1805. Furthermore, in 1879, André published another name, *C. ferrugineum*, and his accompanying description likewise corresponds to the species originally described by Bonpland. According to the *International Code of Botanical Nomenclature*, the first name that is validly published has precedence. Therefore, *C. andicola* and *C. ferrugineum* become mere synonyms and the correct name of the species is *Ceroxylon alpinum*. As it was the first species of the genus to be described utilizing the generic name *Ceroxylon*, *C. alpinum* is considered the type species for the genus.

We found that the wax palm which occurs predominantly on the eastern side of the pass corresponds to a species described in 1859 by another famous botanical explorer, Hermann Karsten, who assigned it the name *Klopstockia quindiuensis*. Karsten considered this species sufficiently distinct to be placed in a new genus. However, the diagnostic features of leaves, inflorescences, flowers, and fruits reveal that Karsten's *Klopstockia quindiuensis* is closely related to the *Ceroxylon alpinum* of Humboldt and Bonpland: it is clear that both should be considered members of the same genus. In 1860, a German botanist, Hermann Wendland, recognized this and transferred *Klopstockia quindiuensis* to *Ceroxylon quindiuense*. The generic name *Ceroxylon* was published before *Klopstockia*, so the last name becomes a synonym and is no longer used.

A technical description of the wax palms in the vicinity of the Quindio Pass, *C. alpinum* and *C. quindiuense*, has been provided elsewhere (Moore & Anderson, 1976). But these descriptions represent just the beginning of our understanding of this fascinating group of palms. While a number of so-called species of *Ceroxylon* may in fact be mere synonyms, it is likely that there remain others that are unknown in the vast reaches of the Andes. But without a clear idea of that which has already been discovered, how will we know for certain what is new?

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Coconut Hybridization by the Policaps and Mascopol Systems

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Coconut Industry Board, Kingston, Jamaica

The POLICAPS system for coconut hybridization uses individual POLyurethane Isolation CAPS to protect each female flower from unwanted pollen. Policaps have advantages over the large bags of plastic, terylene, or heavy canvas that have previously been used to isolate the inflorescence. Using this new system the time for pollination can be judged from ground level without the need to climb the palm or disturb the isolated flowers. The method of pollination positively ensures that pollen is applied to the stigmas and identifies which female flowers have been pollinated and which have not. With the policaps system the female flowers are not exposed to the high temperature and humidity that can occur in isolation bags, and indeed the policaps insulate the female flowers from extreme conditions. All these advantages should lead to improved fruit set from controlled pollinations.

The MASCOPOL system, or MASs COntrolled POLlination, does away with the need to isolate individual flowers or inflorescences by establishing the whole seed garden in an isolated area or by surrounding it with a screen of foliage. The application of large amounts of pollen to large numbers of emasculated palms produces hybrid seed in commercial quantities. The mascopol system allows a new hybrid to be produced simply by bringing a different pollen to the seed garden.

The policaps and mascopol systems complement one another. Policaps will be used on selected, individual palms from desirable, cross-pollinated cultivars to produce improved progenies; these will in turn provide pollen for mascopol hybrid production. It is intended that sufficient information be available here to encourage others to take a practical interest in coconut breeding.

The Coconut Palm

Unlike the oil palm, the date palm, or many other crops, the coconut palm produces very few seeds on one inflorescence. However, new inflorescences open at approximately monthly intervals throughout the year and a continuous pollination program can be maintained.

Each inflorescence bears both male and female flowers (Fig. 1). For hybridization the male flowers must be removed (emasculation) and the female flowers must be kept free from contaminating pollen (isolation) until the correct pollen for the particular cross is supplied (pollination). These three operations, emasculation, isolation, and pollination, which are the elements of controlled hybridization, have been understood and practiced by coconut breeders for many years. Recent innovations in pollen collection, storage, and application have now liberated the coconut breeder from the limitations of low seed set by allowing him to increase the number of palms which are pollinated. The commercial production of many different F_1 hybrids is a major factor in modern agricultural development schemes in countries where coconuts are grown.



1. A coconut inflorescence.

The quality of the F_1 hybrid is determined by the two parents. Improvement within a parent type and eventually, perhaps, the development of a true-breeding cultivar as good as the F_1 hybrid, calls for controlled hand-pollination of selected individuals. Here the availability of large quantities of pollen is not essential. What is needed is the ability to set an optimum number of seeds on any one

pollinated inflorescence. While investigating the factors that control the number of nuts carried on any one bunch, an improved pollination technique was developed.

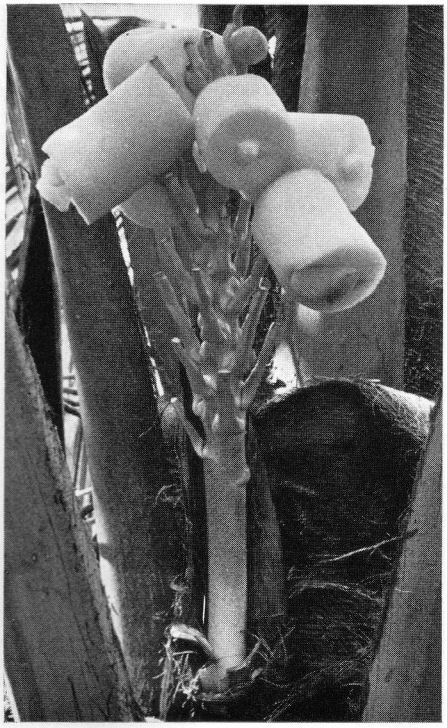
The Policaps System

Emasculation

Unless the male flowers are needed for pollen collection (see below), the best time for emasculation is the day before the inflorescence would normally emerge from its spathe. This can be judged, with experience, from signs such as the bulges at the bottom of the spathe (caused by the developing female flowers), the widening of the longitudinal groove (which is the point of weakness along which the spathe naturally splits), and the loss of the fresh color from the tip of the spathe.

At this stage the tip of the spathe is cut off with secateurs and the point of the blade is used to split the spathe vertically into two or three strips. These are cut off as low as possible. If emasculation is done a week later, when the male flowers are sufficiently developed for pollen collection, the spathe will have dried considerably and is then more difficult to remove. The inflorescence that is exposed by early emasculation is tender and must be handled carefully. The female flowers may not develop if they are damaged and the junction of the branchlets with the main inflorescence stalk is likely to tear.

Sometimes a few male flowers near the tip of the inflorescence may have opened within the spathe before it is split. The risk of pollen contamination from these is slight since the female flowers are not yet receptive. All male flowers are removed by cutting each branchlet 2–3 cm. above the female flowers. Male flowers also occur at the base of female flowers and it is essential to pick these off by hand. Branches without female flowers are completely removed. Other branches may have one, a pair, or more female flowers. Since policaps are intended to cover single flowers, any twin flowers are removed (although it would be possible to make suitable twin policaps). Damaged, insect-infested, or deformed female flowers are removed. If a very high number of female flowers are present, they can be reduced in number since pollinating all of them might require more than two or three visits. If 30 or more nuts are set, these become so heavy that they can pull the bunch out of the leaf axil before it is mature.



2. Policaps in place on all female flowers but one of an emasculated coconut inflorescence.

Isolation

All but one of the remaining female flowers are covered with policaps, which

should fit in place when slightly stretched (Fig. 2). Since different cultivars and different growing conditions affect the size of the female flower, no exact measurement will be given here; policaps of different sizes are easily made (see below). As the female flowers develop, their increase in size ensures that the policaps fit even more securely. The female flower which is not covered should be one that can readily be seen from ground level. When the policaps have been fitted, the date is marked on the petiole subtending the inflorescence and all of the male flower stalks are collected and disposed of (see below). None must be left in the leaf axils.

Pollination

When the inflorescence opens, each female flower continues to develop and after about two weeks the ovary begins to emerge between the close-pressed perianth lobes. The exact time for pollination receptivity depends on the cultivar and the growing conditions and occurs when the three-pointed stigma is reflexed, moist, and white. Nectar is produced at this time. If isolation bags are used, receptivity cannot be observed and has to be guessed at, the palm climbed, and the bag opened. With policaps the stage of receptivity of the female flowers can be seen from the one which was not covered (Fig. 3). Only when it is becoming receptive, need the palm be climbed. The other flowers are then inspected by removing and replacing one plug at a time. Each receptive flower is pollinated. The bunch is labelled, on the occasion of the first visit, with a tag identifying the pollen parent *and the exposed flower is cut off.*

For pollination it is convenient to collect pollen in advance and store it. In this way a fresh supply of pollen can be taken each day in a small, semiopaque vial, stoppered with a polyurethane policaps plug and kept out of the direct sun. When a receptive female flower is found, the plug is removed from the policap, and the pollen vial is shaken to deposit pollen on the end of its plug. This is then removed from the vial and pushed into the policap to bring the pollen in contact with the receptive stigma. The projecting end of the plug is tucked well into the policap to hold it firmly, and the plug that was removed from the policap now serves to close the vial and act as a pollen brush for the next receptive female flower. When there are many flowers on an inflorescence, they will not all be receptive at the same time, and second and third visits may have to be made. On these later visits, to avoid disturbing the pollinated female flowers, the different positions of the plugs serve to distinguish unpollinated from pollinated flowers. Before pollination the plug should be folded into a U-shape in the policap thus exposing the two ends. After pollination, both ends of the plug are tucked well into the policap.

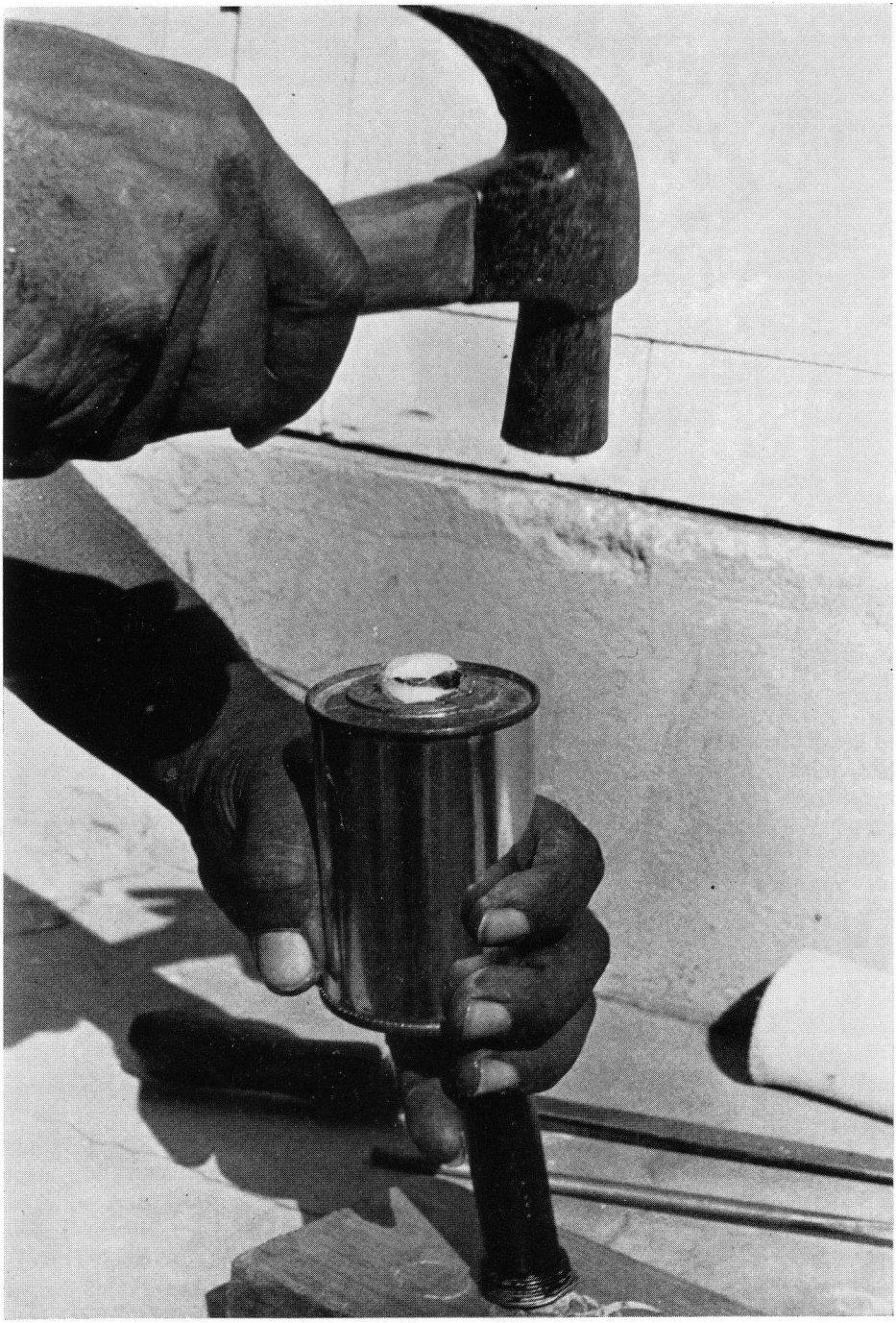
Coconut palms flower regularly throughout the year and it is often possible to take fresh pollen from one palm to use immediately on others. A convenient way to do this is to pull off a handful of male flowers from an unemasculated bunch which has been open for a week or two and, cracking each flower between finger and thumb, drop them into a 10% sugar solution in a small plastic bottle. The bottle has a cap with a small hole or tube through which drops of sugar solution carrying suspended pollen can be directed onto each receptive stigma. This method is convenient where only a few pollinations are to be made or when a small quantity of pollen has to be extended. It is important to remember that the pollen will begin to germinate in the sugar solution and will only be viable for a few hours before it must be discarded.



3. Exposed female flower becoming receptive.

If during a visit it is seen that a policap has fallen off due to wind, rats, or careless placing of the ladder, the flower concerned should be cut off. Contrast this with damage to an isolation bag where the entire inflorescence has to be sacrificed. If after two or three visits a sufficient number of pollinations have been made and a few flowers remain, these may be cut off to save a further visit.

At a later visit to the same palm to emasculate or pollinate the subsequent inflorescence the policaps may be removed. The developing fruit will have expanded the hole in the policap and it will be stiff with dry nectar. It can be washed for reuse or discarded. Records of emasculation, isolation, pollination and, in due course, of nuts reaped, can be made daily in a pocket notebook. To check on the emasculator's efficiency,



4. Making policaps.

occasional bunches can be left unpollinated or pollinated with dead pollen.

When changing from one pollen type to another, it is essential to avoid cross contamination. Hands, arms, and equipment may be safely sprayed with 70% alcohol or a 10% solution of calcium hypochlorite (bleach), which will kill pollen. Some workers may also feel that the female flowers should be similarly treated before the policaps are put on but since pollen is only viable for a day or so, this should not be necessary when policaps are put on two weeks before females are receptive. However, if the bunch is being used for pollen collection, which is not done until the inflorescence has been open for one or two weeks, the later isolation allows a risk of pollen contamination and, therefore, requires sterilization, for which alcohol or bleach is quite suitable.

Making Policaps

Soft polyurethane foam is widely used commercially for packing and insulation and domestically for mattresses and furnishing and it can be cut easily. A suitable size is 5 cm. × 5 cm. × 7.5 cm. long but this can be changed as necessary, perhaps to make use of factory offcuts.

To make a hole in the foam any metal tube of suitable diameter (approximately 2–3 cm.) can be used, the diameter depending on the size of the female flower of the particular variety to be isolated. The block of foam is compressed against the end of the tube (a suitable holder may be made from a can) and struck sharply with a hammer around the circumference of the tube, cutting the foam (Fig. 4). The metal tube needs to be kept in good shape and smoothed with a file, but a sharp edge is not essential. The plug of foam removed is folded into a U-shape and replaced to make the policap ready for use.

Control of pests

Small ants may find a way into policaps when nectar is being produced. If no male flowers are present on any inflorescence of the palm, then the risk of accidental pollination is negligible. Nevertheless, to eliminate ants, cockroaches, and eryophid mites the policaps need only to be soaked in an insecticide such as chlordane and allowed to dry before use. Rats may also be attracted to the nectar and rats or squirrels may sometimes take the polyurethane for nesting purposes. They can be controlled by baiting.

The emasculator/pollinator can also be a source of trouble if he carelessly knocks off or damages maturing fruit. It is also possible that, if a long ladder is used in a young tree, damage done to the young spear leaves by the end of the ladder can cause the bud to rot.

The Mascopol System

The mascopol system, or mass controlled pollination in Jamaica, is essentially the same as "pollination assistée" in Ivory Coast. Hybrids are produced in commercial quantities by blowing or dusting pollen onto the receptive female flowers of some hundreds or thousands of palms daily (Fig. 5).

Isolation

Individual isolation of so many female flowers would be prohibitively expensive. Isolation is achieved by planting the seed garden in an area where no other coconuts grow or by surrounding it with a screen of foliage. This screen should be 200 to 300 meters wide, and it can consist of other tree crops or even emasculated coconut palms. This last method is less satisfactory but because of the extensive nature of coconut plantings it may have to be commonly adopted. These emasculated guard rows



5. Mascopol pollination. Photo by Wendy Hunt.

should be pollinated with the same pollen being used in the seed garden, but unless suitable color markers are involved, the resulting fruit may be suitable only for copra (see color markers).

Emasculation

For the mascopol system, emasculation is done in the same way as described above for the policaps system. There is no need to remove twin or excess flowers

as long as the male flowers around these are removed. Since the female flowers are not individually isolated, it is essential that emasculation be done efficiently so that no inflorescence is allowed to open and shed pollen and no single male flower is overlooked. One male flower produces thousands of grains of pollen. Although only some of the palms need to be emasculated on any one day, and the number depends on the time of year and the prevailing weather, all palms in the seed garden have to be inspected for six days out of seven. If done properly, no inflorescence should open on the seventh day. Allowance must also be made for working during public holidays. One man may be made responsible for about 400 six-year-old palms. Again, the exact number will vary with the season and also with the terrain over which ladders have to be carried.

The male flowers removed at emasculation must be disposed of. On sandy soil this can be done by burying them. Burning is difficult, because the material is fresh and cannot be dried before burning since pollen may be released. Bottomless steel drums with lids can be used. When full, the drum is dragged to one side to allow some of the decomposing flowers at the bottom to spill out. There must be enough drums to hold the male flowers long enough for them to decompose, and the lid must be kept in place at all times to prevent insects visiting and then carrying pollen back to the emasculated palms.

Pollination

At certain times of the year, one bunch is ready for emasculation when another on the same palm is just receptive. The emasculator can, therefore, be supplied with a hand pollen-blower with which to pollinate these. Otherwise, pollination is carried out as a separate operation by blowing a pollen:talc mixture (1:8 parts by weight) from a hand-held blower operated from the ground. If pollen is in short supply, then hand application of undiluted pollen to individual female flowers will give excellent fruit set, but it does involve increased labor costs. To produce a different F_1 hybrid combination it is best to prepare two to three weeks in advance by clearly marking newly emasculated inflorescences with colored ribbon or a splash of paint. One week before these marked inflorescences become receptive, all pollination is discontinued. When the female flowers on these inflorescences become receptive, pollination is resumed using the new pollen parent.

Reaping Seed

Coconut fruit does not mature until 11–15 months from pollination, depending on cultivar and season. Apart from the inflorescence branchlets that were shortened or removed during emasculation, the pollinated inflorescences look no different from normal bunches nor do the reaped fruit (seednuts) look any different. It is not until germination and subsequent growth that hybrids can be recognized (see color markers below). On the first sign of the fruit maturing, when they begin to lose their fresh color and turn dry brown, the policaps-pollinated nuts should be carefully reaped by hand, marked according to the tag on the bunch, and set in nursery beds similarly identified. Mixing of seed or young plants can lead to confusion that will undo all the careful work of the pollinator a year before. Mascopol nuts can be reaped by the bunch instead of individually since they will all be of one type. However, when changing from one hybrid to another, as indicated by the marked bunches (see above), care should be taken to see that the bunches marked differently are set separately.

Table 1. Color inheritance in hybrid seedlings of coconut (simplified).

SEED PARENT	POLLEN PARENT				
	Yellow	Red	Green	Bronze	
Yellow	Yellow	Red	Green	Bronze	
Red	Red	Red	Green	Bronze	HYBRID SEEDLINGS
Green	Green	Green	Green	Bronze	
Bronze	Bronze	Bronze	Bronze	Bronze	

Choice of Parents

On the basis of present knowledge, the most suitable F_1 hybrids will be those resulting from a cross between selected dwarf and tall parents, since these will combine the precocity and high nut number of the dwarf with the larger nut size and robustness of the tall. If the 'Malayan Dwarf' is used, then the hybrid will have some resistance to lethal yellowing disease, the level depending upon the male parent.

Color markers

Accidental self-pollination, or pollen contamination due to inefficient isolation, could possibly go unnoticed for five years or more until the presumed hybrid plants come into bearing. Fortunately, this can be largely prevented by making use of the knowledge of color inheritance when choosing parent palms. The colors referred to can be identified on leaf stalks of seedlings and mature palms and on developing fruit, and are shades of yellow, red, green, and bronze, which can be easily distinguished with a little practice. The dwarf is either yellow, red, or green, and the tall is either green or bronze (the exceptions to this general rule need not confuse us here).

In crosses involving two different colors, one color predominates in the hybrid as shown in Table 1.

The table is simplified in so far as it does not take into account the fact that all colors except yellow can be either homozygous, i.e. they breed true for the particular color, or heterozygous, i.e. they produce plants mainly one color but with a proportion of one of the other colors. Intermediate shades are also found. For the purposes of this introduction to coconut hybridization, it is sufficient that either the yellow or red dwarf forms be chosen whenever possible as the seed parent. In this way, seedlings produced by accidental self-pollination or contamination from other dwarfs can be distinguished from dwarf × tall hybrids as soon as they germinate in the nursery. Green dwarf is less satisfactory as a seed parent, because confusion may arise if hybrids are likely to be green as a result of the pollen parent color. Contamination from neighboring tall varieties, if these are not the same as the tall pollen parent that is being used, *will not* be recognizable in the nursery so that close attention must be given to effective isolation in such situations.

Other advantages are gained from using a dwarf seed parent, because it comes into bearing early, does not grow out of reach as quickly, and is capable of producing a high number of nuts.

In contrast to the advantages of the dwarf as a seed parent, the greatest disadvantage of using the tall as a seed parent is simply that seed from all pollinations, whether legitimate hybrids, contamination from foreign pollen, or accidental self-pollination, will germinate

to show the dominant tall color and no selection will be possible in the nursery.

Apart from F_1 hybrid production, breeding work may involve crossing tall × tall or dwarf × dwarf where color inheritance cannot always be of assistance. In such cases, it is possible only to ensure that all operations are carried out as carefully as possible.

Handling Pollen

Male flower collection

When the inflorescence opens naturally most of the many male flowers are not mature. Each day, over a period of two to three weeks, some open, shed pollen and fall off. One or two weeks after the inflorescence opens, when about a quarter of the male flowers have fallen, most of the remaining male flowers are sufficiently mature to give viable pollen. The branchlets carrying the male flowers are cut off, and the flowers stripped from the stalks. If the palm is not being used for policaps hybridization, there is no need to remove all the male flowers, and fruitset on these nonisolated, partially emasculated bunches is not reduced and may be enhanced.

For policaps hybridization, palms may be treated individually, in which case the male flowers from one inflorescence are put into individual labelled bags. For mascopol hybridization, male flowers from selected individuals of any one cultivar are bulked.

Flower drying

Pollen is readily released by drying the male flowers, which may be left on a bench at room temperature for some days, put in an oven or a specially constructed drying room at 40° C for 24–40 hours, or in a fluid-bed dryer at 40–60° C for three or four hours. The method chosen will depend upon the facilities available and the location of the pollen parents in relation to the place the flowers are to be processed or to where the pollen is to be used. It is essential to keep a flow of dry air passing over or through a thin layer of flowers. The flowers may be given an initial cracking to expose the drop of nectar secreted at the base of the anthers and are then dried for the appropriate period. After drying, they are sieved, cracked a second time, and sieved again. This method will get an amount of pollen equivalent to 1.5 to 2.5% of the fresh weight of the flowers with a viability of around 40%.

Pollen Storage

Once collected, pollen can either be used immediately or stored in a closed container for a few weeks in a refrigerator or a few months in a deep freeze. Longer-term storage at room temperature following vacuum freeze-drying is also possible.

Pollen Viability

Whether or not pollen has been stored, it is wise to test its viability before use. This can be done by preparing a culture medium composed of sugar, unflavored gelatin and distilled water (in the proportions by weight 2:7:20) mixed in a container which in turn is put in a pan of boiling water to dissolve the gelatin. The thinnest possible layer of jelly is poured, while still hot, into clean petri dishes, which are immediately covered to retain the condensation. When the jelly is cool, pollen is lightly dusted on it from a small brush and the lid replaced. After incubation for 1–5 hours at 30° C, germination can be observed under a low-power microscope. Pollen which germinates poorly is discarded. This technique is simple to follow and satisfactory for routine pollination work. It can be refined, and accurate counts may be made if desired. Sterility of glassware etc., as

in a pathology laboratory, is of minor importance since pollen will naturally carry spores of saprophytic fungi that will contaminate the whole germination medium if, for instance, it is left overnight. Sometimes poor viability is due to the loss of humidity above the pollen or to contamination of the glassware by detergent.

The biggest contamination risk in all work with pollen is from other pollen and it is essential to avoid mixing different lots. Care must be taken to label the flower bags and the pollen containers. Only one lot of pollen should be opened for use at any one time, and the cleaning of hands, arms, equipment, and surfaces with 70% alcohol between dealing with different lots of pollen is essential.

Attention

Neither the policaps nor the mascopol systems can eliminate operator error. Should there be any doubt about the parent palms used, the pollen collected, the efficiency of emasculation or pollination, or the legitimacy of the subsequent palms produced, the only safe procedure is to abandon the doubtful material.

Acknowledgments

This practical guide to coconut hybridization draws freely on the publications of other coconut breeders whose work is gratefully acknowledged. The specific information about the policaps and mascopol systems is published by permission of the Coconut Industry Board, Jamaica.

Ecological Studies of the Cabbage Palm, Sabal palmetto.

IV. Ecology and Geographical Distribution.

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Habitats

Sabal palmetto is found in a diversity of coastal and inland habitats within its geographical range. These habitats incorporate broad ranges of substrate pH and salinity, extremes of moisture conditions from high dry areas to periodically flooded areas, and topography ranging from level coastal plains to gently rolling hills.

In the coastal zone, *S. palmetto* is found in three major habitats. It is often the dominant vegetation on low marsh islands and mainland marsh shorelines. In the maritime forest *S. palmetto* is a scattered but permanent reproducing member of the oak-dominated mature forest. Within the dune system *S. palmetto* often stands alone or in association with another palm, *Serenoa repens* (Bartram) Small, on the fore dune area. On the lee side of dunes the species is an emergent member of the shrub thicket community (Fig. 1).

Populations in the coastal zone throughout the range are undergoing an imposed migration due to rising sea level. In estuarine areas, where salt marsh is encroaching on land, it is not uncommon to find mature trees surviving in the marsh, often several meters from shore. How long these mature individuals can persist in the marsh is unknown but reproduction does not take place there. Along the ocean side, the rising sea is causing the dune system to migrate landward with resulting encroachment of dunes into the maritime forest and salt marshes. Mature *S. palmetto* is more resistant to salt water intrusion and salt spray than any other native arborescent species and therefore persists in place as the dunes migrate inland. This explains the presence of *S. palmetto* in the beach zone where periodic attrition of the trees occurs during storm tides. Reproduction on the fore dune and beach face is conspicuously absent, probably due to the erosional nature of the rising sea and frequent storm tides, but reproduction does occur on the lee side of the dunes, where the mature trees are emergent from the shrub thicket. In this protective environment seeds are subject to burial by accumulating organic matter or sand and thus apparently escape predation.

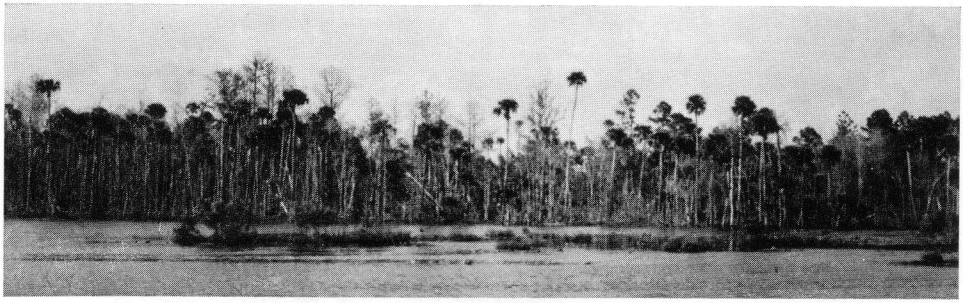
All inland populations are found in peninsular Florida with the few exceptions cited in the section on distribution to follow. Only on the peninsula is the full dimension of ecological amplitude expressed. In the lowland savannas adjacent to the coastal zone *S. palmetto* occurs as a subdominant with slash



1. *Sabal palmetto* as an emergent species in the shrub thicket on Smith Island, N. C.



2. A pine-palm (*Sabal palmetto*) savanna in the coastal plain of Charlotte County, southwest peninsular Florida.



3. Flood plain forest with *Sabal palmetto* at the mouth of Cabbage Creek (now Rodman Reservoir), Putnam County, Florida.

pine (Fig. 2). On relic inland dune ridges the species is locally common in the long leaf pine-turkey oak community. Along many large creeks and rivers it is a locally dominant tree in the flood plain forest (Fig. 3). In the mixed deciduous forest in the rolling highlands of central Florida it is widely scattered on ridges, to locally common along streams. In the southern interior peninsula on hammocks in the Kissimmee Prairie it is a co-dominant or dominant tree in a monotonous forest with live and laurel oaks (Fig. 4). Further south, in the Big Cypress, Everglades, and Keys, *S. palmetto* shares dominance with various species in subtropical hammocks (Fig. 5).



4. Hammock with oaks and *Sabal palmetto* in Kissimmee Prairie, Glades County, peninsular Florida.



5. A subtropical hammock with *Eugenia* species, *Sabal palmetto*, and *Roystonea elata*, Royal Palm Hammock, Collier County, southwest peninsular Florida.

Current Distribution

While a broad range of habitats has long been realized (Small, 1923; Bailey, 1944), the detailed geographical distribution of *S. palmetto* has not been precisely documented. Small (1923) quotes several early accounts which incorrectly indicated *S. palmetto* far north of its present range. Sargent (1922)

had reported the species in the neighborhood of Cape Hatteras. These early authors may have mistaken robust plants of *S. minor* for *S. palmetto* in areas north of Cape Fear. The two are sympatric on Cape Fear and in early stages are often quite difficult to distinguish. I have not been able to substantiate these records and therefore agree with M. A. Curtis (1867) that *S. palmetto* is to be found from Cape Fear southward (Fig. 6).

Sabal palmetto is also on the mainland along the coast west of Smith Island, N. C. Coker and Totten (1945) mention a small population of 12 trees near Gause Landing, N. C., seven miles north of the state line. Although I have not relocated this population, I did find six mature trees in the maritime forest near Shalotte Inlet (Fig. 6A). Although this population at Shalotte Inlet is the northernmost substantiated location for *S. palmetto* in the wild, the plants on Smith Island represent the maximum extension of the range along the coast.

The range map of *S. palmetto* by Little (1971) is the most recent for the species. It shows a major disjunction between the continuous range in South Carolina and the Cape Fear area of North Carolina with intermediate isolated populations around Shalotte and Gause Landing. One small population exists at Oak Island, across the Cape Fear River from Smith Island (Fig. 6A). Another single small tree has also been reported from Battery Island in the Cape Fear River, but I have not been able to substantiate this report.

The hiatus in the natural range in South Carolina occurs on the immediate coast between the Georgetown area and the North Carolina populations (Fig. 6B). Large numbers of trees are common from the south side of North Inlet southward; however, to the north their numbers dwindle rapidly. Six mature trees were found in the maritime forest adjacent to the upper marshes of De Bordieu Creek about two miles north of North Inlet. These are now thought to be the northernmost trees occurring naturally on the South Carolina coast.[1]

According to Gurdon Tarbox,[2] two populations north of North Inlet have been either completely removed for landscaping purposes or otherwise destroyed since 1930. A small group of trees near North Litchfield Beach at Midway Inlet were removed in the early 1960's. At Murrells Inlet a much larger population on Drunken Jack Island was removed beginning in the early 1930's. This extinct population represents the northernmost modern extension of the species on the South Carolina coast and the true beginning of the disjunction prior to man's disruption.

Climatic differences cannot explain this disjunction, for the average and extremes of climate are not materially different in the area not inhabited. Further, horticultural plantings of *S. palmetto* do quite well in this area. There is a major difference in land form, however. The portion of the coast not inhabited by *S. palmetto*, which extends for approximately 35 miles, is comprised of a mainland strand beach. In adjacent areas where *S. palmetto* does occur, the physiographic situation is one of barrier islands or peninsulas, with bays or sounds separating the beach from the mainland (Fig. 6B). It was noted above that *S. palmetto* never becomes established on beaches but rather on the bay side of islands and adjacent mainland.

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[1] Green, Fred; Developer, De Bordieu Colony, Georgetown, S. C.; personal communication.

[2] Tarbox, Gurdon; Curator, Brookgreen Gardens, Murrels Inlet, S. C.; personal communication.

The obvious conclusion is that *S. palmetto* is absent in nature from the northern South Carolina coast because of the lack of habitats suitable for germination and seedling establishment.

The distribution pattern along the rest of the southern Atlantic coast through South Carolina, Georgia, and into Florida is an essentially unbroken series of populations in dunes, maritime forests, and on the edge of marshes. The first truly interior population appears to be that at Magnolia Bluff along the Big Satilla River in extreme southeastern Georgia (Fig. 6C). This population is documented in the Georgia Natural Areas Council Activities Report of 1970, Appendix X. One other isolated, but considerably larger, interior population is in Georgia about 40 miles southwest of Magnolia Bluff on the St. Marys River (Fig. 6C).

In northern Florida this widely scattered, isolated pattern continues with a population about 20 miles further upstream on the St. Marys River at the mouth of and extending up Cedar Creek several miles. There are three mature and two juvenile trees at O'Leno State Park on the Santa Fe River and a few young nonreproductive trees were sighted along the Suwanee River near Branford. All of these interior populations in Georgia and Florida are along rivers and all are below 100 feet elevation. Their existence may be due to initial dispersal by birds such as fish crows which are known to feed on the fruit and occasionally fly up coastal plain rivers for feeding and nesting activities.[3]

On the Atlantic side of north Florida the continuous range of *S. palmetto* remains in the coastal zone and extends up rivers no further than there is obvious tidal activity. On the St. Johns River plants can be found as far inland as Jacksonville. Very little inland movement by the species has occurred but a few young trees are beginning to appear in pine flat woods adjacent to tidal rivers and marshes.

Plants are often found in very heavy concentrations in low swale areas parallel to the beach and up to several miles inland. These are populations which have become established in old lagoons shut off from the ocean by shoreline dynamics. As a lagoon fills in from erosion and accumulation of debris, plants along the banks provide seed to populate the entire depression with palms.

On the Gulf coast side of northern and western Florida, the continuous range also remains in the coastal zone; however, some movement into upland mixed hardwood forests adjacent to coastal habitats has occurred. Forest management practices of clearing all "undesirable" plant growth and replanting with pines has eliminated any original *S. palmetto* from many areas and continued management discourages reestablishment. It is only in hardwood forests that have obviously been left undisturbed for many years that *S. palmetto* is making advances into the uplands away from the coast. Such areas are more frequent in western Florida. Even in areas of advance into uplands, *S. palmetto* is seldom seen in nature more than five or ten miles from the sea.

The natural range becomes somewhat less than a true continuous distribution west of Apalachee Bay for probably the same reason it does in northern South Carolina. The western terminus, according to Little (1971), is the eastern

[3] Additional field observations since 1973 have revealed another significant isolated population in interior northeast Florida. This reproducing population extends for at least one mile along either side of the Ortega River in western Duval County in the vicinity of U. S. Highway 90 and Interstate 10.

shore of St. Andrews Bay; however, careful investigation in that area revealed several reproducing trees on the west side of the bay along marsh borders on the peninsula at St. Andrews State Park.

Determination of where the continuous range crosses the peninsula of Florida was somewhat difficult. From field observations it appears that a line can be drawn from Cedar Key on the west coast to Gainesville, on to St. Augustine on the east coast. With some certainty one can say that south of this line *S. palmetto* can be found frequently at all elevations and in most habitats (Fig. 6C).

Immediately south of this line *S. palmetto* is most frequent on the slopes of the central ridge at all elevations. In the neighborhood of the line the plant is conspicuously absent from areas north of and above the 100-ft contour except for a few scattered individuals on slopes near Hawthorne and Melrose which are adjacent to the 100-ft contour. The 100-ft contour approximates, with a few exceptions due to surface and subterranean erosion, the shoreline of the Wicomico Sea, an interglacial sea of middle Pleistocene (Cooke, 1939). This old shoreline approximates the interior northern limits of continuous distribution for *S. palmetto* in peninsular Florida as the species is not found in natural stands to the north (inland) side of this elevation.

Thus it seems that the current continuous distribution of *S. palmetto* across northern peninsular Florida correlates better with a fossil shoreline than it does with current climatic conditions.

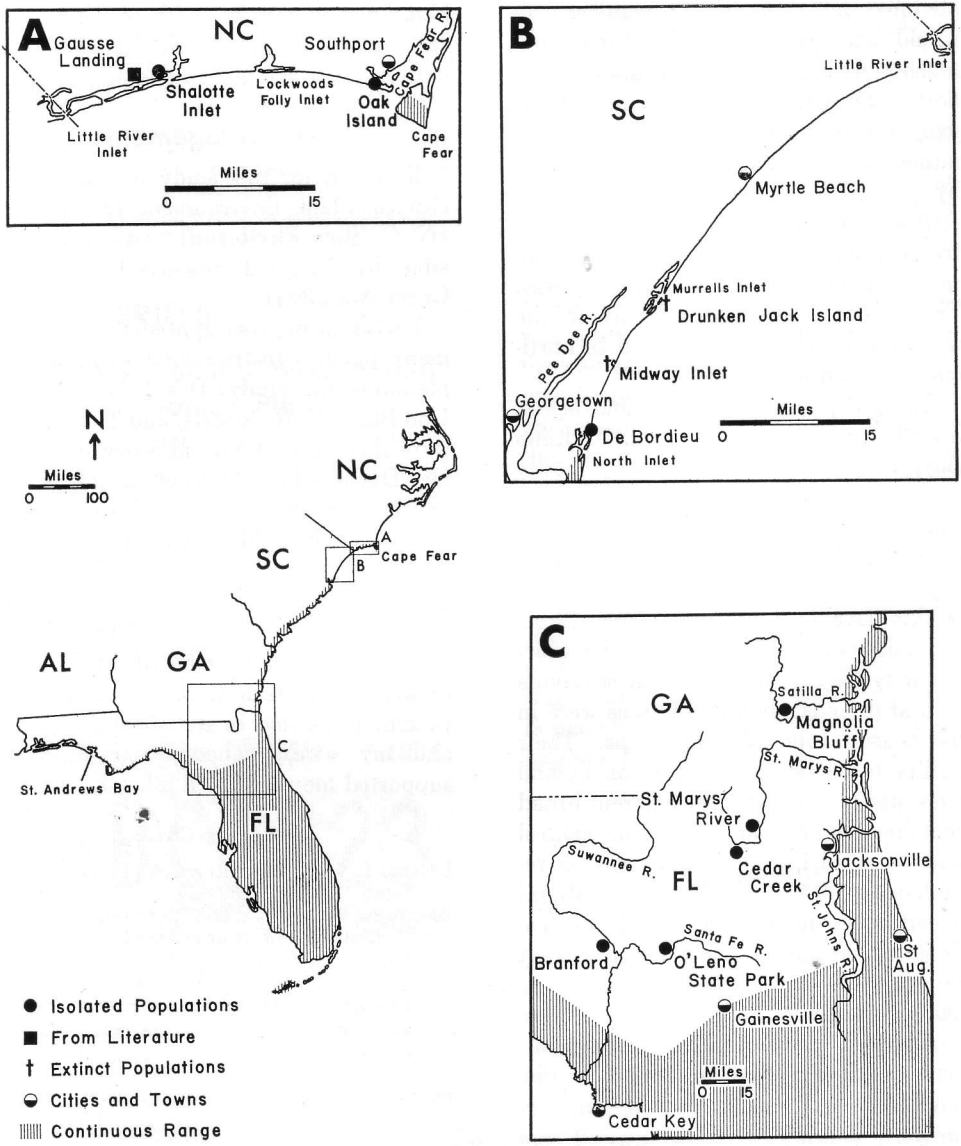
Unfortunately time did not allow detailed study of the inland populations, although examples of all inland habitat types were visited at least briefly. As in the coastal zone, inland populations associated with constant or periodic water flow display the greatest reproductive potential. This is assumed to be due to the same factors, such as efficient dispersal by water, debris and soil accumulation and subsequent escape from seed predators.

In addition to the mainland and barrier islands of the southeastern United States, the geographical range of *S. palmetto* includes the Bahama Islands and certain of the Florida Keys. According to Small (1913) the range includes the lower (Miami limestone) keys from No Name and Little Pine Keys to Key West, with a disjunction from the mainland on the middle (coral) keys and upper (sand) keys. In the Bahama Islands, Britton and Millspaugh (1920) reported the species on the "borders of marshes and in rocky soil throughout the Archipelago."

Dispersal Dynamics and Current Distribution

Experimental results reported in a previous article (Brown, 1976a) indicate a dispersal mechanism in *Sabal palmetto* related to coastal zone water movements. Thus the chief vector for direct long-range dispersal from existing populations to outlying areas for this species appears to be salt water. Perhaps of more importance, salt water offers a dispersal vector for rapid colonization of nearby unexploited coastal zone habitats. There is also the possibility that tropical storms and hurricanes might disperse the fruit or seed great distances in relatively short periods of time. This may explain the existence of some insular distributions mentioned above.

The extension of the range to the population at Smith Island, North Carolina, can be looked upon as the logical product of such a dispersal mechanism. However, Cape Fear apparently presents



6. Geographical distribution of *Sabal palmetto*. A, distribution in North Carolina. B, distribution in northern South Carolina. C, distribution in southeast Georgia and northeast Florida.

an insurmountable natural barrier to further salt water dispersal, probably due to the prevailing southward-moving alongshore current north of the cape. No climatic or land form features exist which would exclude the survival of the species immediately north of Cape Fear. Thus, there exists the possibility for outward migration over land in this area.

Although seed dispersal appears to be the immediate factor controlling the northward extent of *S. palmetto*, it seems

obvious that low winter temperatures would become the limiting factor not much farther north than the present horticultural range. The control by low temperatures may be expressed at germination and seedling stages as indicated by the experimental evidence (Brown, 1976b). In addition, ice storms and freezing winds could also be a limiting factor in the survival of mature trees. This effect is seen periodically in the more northern populations and in horticultural plantings.

The few plants established and beginning to reproduce west of St. Andrews Bay, Fla., are the vanguard of a slowly expanding range on the Gulf Coast. Further dispersal westward along the Gulf Coast can be expected to continue at a slow rate since littoral currents are weakly developed and inconsistent there.

Inland populations in peninsular Florida may be descendents from survivors of past periods when those areas were in the coastal zone of higher seas. Their ability to remain and thrive on upland sites attests to the species inherent broad ecological amplitude. It is the central and southern Florida populations, as revealed by the Melbourne and Miami experimental material and field observations, which harbor the greatest amount of variability in external morphology and seed-germination response. These populations possess the genetically diverse material typical of centers of distribution and necessary to support outward migrations to distant and ecologically diverse habitats.

Sabal palmetto may well have had a long evolutionary history, possibly dating back to early Tertiary or before (Berry, 1916, 1917, 1924; Cooke, 1945; LaMotte, 1952; Read and Hickey, 1972). It has taken a conservative course in the strategy of reproduction and possesses the broad ecological amplitude of a heterogenous species, both of which are features of a species well fitted to long existence in various habitats.

Acknowledgements

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I wish to express appreciation to the many persons instrumental in the completion of this study: Drs. J. W. Hardin, Udo Blum, G. R. Noggle, and T. L. Quay were members of my advisory committee; David Schiller assisted in field work and photography; Dr. T. B. Mitchell and David Stephan identified insects; Dr. Jerome Keuper, Scott Donachie, and John Hunter provided collections of seeds; my mother, Gertrude Brown, prepared many thousands of seeds for experiments; Herb Kirk and Don McCrimmon assisted in statistical analysis; and my wife, Jeanette, and children supported me through it all.

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PALM BRIEFS

South Carolina's Bicentennial License Plate

Tropical and subtropical lands for many years have landscaped their streets and highways with handsome, stately palms. This year, streets and highways in South Carolina are literally teeming with palms. The explanation—South Carolina's Bicentennial license plate carries a reproduction of the state tree, *Sabal palmetto* (Fig. 1). Artistic license was taken, however (no pun intended); the palmetto is colored a bright red, numerals and letters blue on an off-white background. While far from being authentic, it comes across as both attractive and unique.



1. South Carolina's license plate carries a reproduction of the state tree, *Sabal palmetto*. Photo courtesy South Carolina Highway Department.

There have been occasional references in PRINCIPES to palm enthusiasts who make a hobby of collecting postage stamps bearing reproductions of palms. As part of the United States Bicentennial observance, South Carolina's state flag, which also pictures the palmetto, is depicted on one of the stamps in the nation's Bicentennial series.

JACK COOK

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International Symposium on Coconut Research and Development

The second circular of information on the above symposium has been received. The symposium is to be held at the Central Plantation Crops Research Institute, Kasaragod 270 124, Kerala State, India, on December 28–31, 1976, in celebration of the Diamond Jubilee of Coconut Research in India. Papers are to be presented in nine sessions, and exhibits, a commemorative stamp, and sight-seeing tours are associated with the symposium. Details may be obtained from I. K. Satyabalan at the above address.

Various Observations on Ceroxylon klopstockia

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The southerly, precipitously sloping, evergreen forests of Avila, Federal District, Venezuela, are the natural habitat of a wax palm, *Ceroxylon klopstockia* Martius, where the author regularly sought to determine the life rhythm of this palm species over a period of 12 years. A strange accident in 1971 brought with it the loss of all documents and notes about studies accomplished in the preceding year. Thus, the author is no longer in a position to restore these data for the year-long study. Consequently, the other investigations that are remembered as well as the last data from 1973 and 1974 will be given on these pages.

The highest-situated specimen of this wax palm, a staminate plant, is found about 60 m. before the entrance to the mountain railway station at Avila, and the lowest-situated specimen, a pistillate plant, is found on the slopes of Los Venados at 1650 m. elevation. The investigations on seedling development, leaf development, and growth were made in this last forest at about 1850 m. in a place called Las Palmas. Stem measurements, ring measurements, and observations on the rhythm of flowering and fruiting were made on older plants found at a somewhat lower elevation of about 1650 m. between the western part of the forest at Guyabe Moche and the eastern part at Zamurero, a distance of about six kilometers.

All young palms are found without exception within the shaded forest belt and are not evident outside it. The old plants, in contrast, overtop the crowns of the rest of the tree flora and are visible from a distance, on the one hand because of their contrasting pinnate leaves, and on the other because of the grey color of their crowns. In all, there were 16 old plants as subjects for controlled investigation, of which nine were staminate and seven pistillate. The observation region at Las Palmas with its large stand of seedlings and young palms has become very much used by careless visitors to the forest; thereby more of the plants under observation were senselessly chopped off so that certain end results were frustrated.

Climatic Conditions of the Observation Zone

The wax palms occur in the evergreen forest region of the true cloud forest zone. The cloud forests are dependent on temperature and frequency of mists. The forest regions with the study palms were kept under daily observation by the author in 1973 and 1974 with reference to the state of their cloud cover. The results are indicated in Tables 1 and 2.

The annual precipitation is 1300–1700 mm. and falls, as Tables 1 and 2 show, mostly in the months from June to December. The humidity in these montane forests is very high even without the mists and drops to 60% only in the dry period from January to June during a few hours each day; otherwise the humidity is always between 70% and 100%.

The temperature is also more or less constant. The average daily temperature is between 14° C and 18° C. In the win-

Table 1. Mist cover and rainfall at observation site during 1973

Month	Type*	Days			
		Covered all day	Covered half the day	Bright and sunny	Rain fell
Jan	T	1	1	29	1
Feb	D	1	6	21	1
Mar	D	0	8	23	0
Apr	D	2	3	25	3
May	D	0	12	19	0
June	D	4	14	12	6
July	D	1	16	14	2
Aug	R	5	14	12	16
Sept	R	9	13	8	16
Oct	R	6	18	7	10
Nov	R	21	0	9	17
Dec	R	7	9	15	8
Totals		57	114	194	80

* T = transitional from rainy to dry; D = dry; R = rainy

Table 2. Mist cover and rainfall at observation site during 1974

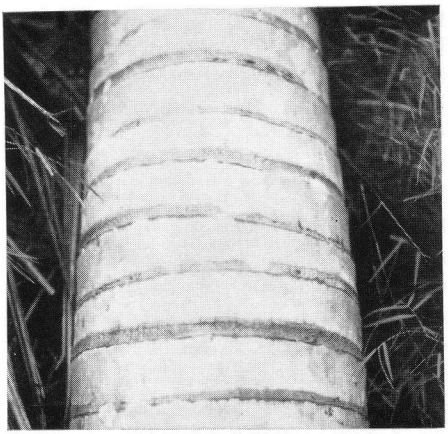
Month	Type*	Days				
		Covered all day	Covered half the day	Bright and sunny	Not observed	Rain fell
Jan	T	6	13	12		5
Feb	D	1	12	15		1
Mar	D	2	19	10		2
Apr	D	1	16	13		2
May	T	1	17	13		12
June	R	8	0	22		6
July	R	4	11	16		12
Aug	R	8	12	11		12
Sept	R	2	14	13	1	15
Oct	R	3	16	12		16
Nov	R	3	17	10		10
Dec	R	6	13	12		7
Totals		45	160	159	1	98

* T = transitional from rainy to dry or dry to rainy; D = dry; R = rainy



1. An old fruiting plant of *Ceroxylon klopstockia* about 25 m. high.

ter months (December–February), the temperature can drop occasionally to 8° C during the early morning hours; it climbs, however, later in the day to 14°–18° C. In the hot and dry time of the year (February–May), the temperature during the day occasionally can exceed 20° C for a few hours. Climatically considered, the wax palms are decidedly montane palms bound to high atmo-



2. Rings more or less equally spaced on the trunk of a palm about 50 years old.

spheric humidity and moderate temperature.

The Rhythm of Flowering

In the course of the long years of investigation, special attention was paid to the flowering rhythm of the species. This palm forms new inflorescences always after a lapse of four to six months from the time the plant produced its last ripe seed. In two extreme cases, however, I can state that new inflorescences were already appearing on two pistillate individuals that still bore fruit. There were evidently no staminate plants blooming at that time and no pollination took place so there were no little fruits a month afterward. The flowering period lasts about one month so that an individual with four inflorescences produces one at weekly intervals until all inflorescences have reached anthesis. The flowering cycle is the same, of course, for both sexes. The number of inflorescences in each sex amounts to 3–4–5, seldom fewer, never more. The staminate inflorescences are of a violet color at anthesis; the pistillate, on the contrary, are more whitish-yellow.



3. A section of trunk of an old palm with unequally distant rings.

I have determined that plants do not come into bloom every year, though the pistillate plants as a rule come into flower almost every year and are interrupted only every four to five years. One staminate example, apparently an unusual exception, flowered only once during seven years.

Climatic influences of 1973 have clearly demonstrated that after a long dry period of seven months, the fewest palms come into flower. Of the 16 control plants, only a single pistillate individual flowered. Also, all the other palms of this forest section failed to flower in this year, or produced only very few

flowers. The last ripening of fruit on pistillate plants was in February 1973; from this time on no control plant flowered until September 1974, with the exception of a single pistillate plant. After this date, first most of the staminate plants followed in a surprising way and somewhat later the pistillate, but so that these were still pollinated.

I have not been able to determine with complete accuracy at what age this palm species comes into bloom for the first time. All the recorded flowering examples are already old plants at least 80–150 years old. I am at present convinced that *Ceroxylon klopstockia* does not come into bloom before 80 or probably 100 years.

The Rhythm of Fruiting

As a rule, it is 12 months from the time of pollination until full ripening of fruit. Without pollination, the pistillate flowers fall off one to two months after the flowering time. From the preceding year I was also able to determine that fruit ripened after ten months. Still a great exception occurred in 1974 in a pistillate individual situated at El Papelon. The plant produced ripe fruit eight months after pollination and these fruits began to germinate after seven months. The different infructescences of a plant do not ripen simultaneously but according to their dates of pollination. When the first infructescence of a plant, for instance, lets its seeds fall from over-ripeness, the slow ripening of the last infructescence, which also was pollinated some weeks later, is only beginning. The fruit of all pistillate plants of a forest region ripens more or less at the same time.

The Distribution of Sexes

The wax palms are dioecious plants; each plant produces either staminate or pistillate inflorescences. The sex of all the control plants was determined in the first years of observation. Likewise, plants not kept under observation over a wide forest region were also determined to sex so far as this was possible. So I believe I can say with some certainty that 60% of the existing plants are staminate and about 40% pistillate. The distribution of the sexes is unlike. At one place I checked a distance of about 600 m. and found almost exclusively staminate plants; I have not up to now found larger groups of pistillate plants. As a rule, however, the sexes appear rather mixed. In spite of the long distances between the two sexes, there is mostly productive pollination. The pollen is transported by the wind and reaches to almost hidden plants.

Except by floral characters, the sexes of plants cannot otherwise be determined. Once I thought I was sure that there were two to three more leaves on most staminate plants than on the pistillate plants standing nearby. Further investigation, however, showed a reduced number of leaves on staminate plants so that no attention can be given to leaf number. Likewise, I can find no real difference in their appearance at the somewhat drier edge of the forest region.

On the Germination of Ceroxylon Seeds

I can here only extrapolate germination results for these mountain palms from the palm culture of the botanical garden at Caracas. To be sure, I have followed the ripening of seed during many years at certain forest places in the mountains. Unfortunately, I was never able to follow germination in a natural habitat; all seeds disappeared after a certain time and I concluded that mice had removed them.

The germination of palm seed requires much patience and in addition good luck,



4. Seedlings of *Ceroxylon klopstockia* with undivided eophylls; the one with four leaves is 15 months old.

as well, in many cases. Whoever has to do with the sowing of palm seeds knows how important good fresh seed is for sucessful germination. Palm seeds which have lain about dry for a long time—I mean weeks and months—can fail to germinate. What happens, however, with the *Ceroxylon* seeds that lie about for months at a time in the mountains without rain falling? We might be justified in believing that only the seeds that were distributed during the rainy season (May–December) are able to germinate. That *Ceroxylon* seeds are able to pass through a long dry period, however, I was able to demonstrate in culture by sowing seed intentionally kept dry for a long time but which subsequently germinated, even though in reduced number. Seedlings in the mountains can manage for many months without rain. It appears to me that the nightly freshening of the forest in the dry season makes extensive survival possible.



5. Seedling with the first cleft leaf blades between three and four years old.

The end of February 1973 was the last great seed fall of this palm species in the coastal mountains. As already pointed out, 1973 was an extremely dry year in all Venezuela. Vainly I sought seedlings in these forests up to the end of 1974. Consequently, we must also accept that not every year are seeds able to germinate under limiting conditions as the preceding example has shown.

From the germination results of our own propagation I can here state that *Ceroxylon* seeds are slow to germinate. In previous years I noted the germination of this species from six to nine or ten to 16 months and more. Typically, the first flush of germination constitutes only a small percentage. The second flush of germination follows, mostly with greater numbers, and appears naturally about a month after the first. Delayed germination can also appear even after two years.

Leaf Development and Determination of Age

After germination, the seedling develops a first undivided eophyll, which in the course of months becomes many times enlarged. The seedling now develops three undivided blades in each of two successive full years; of these blades,



6. Two leaves of this young palm have developed pinnae.

the last three are somewhat longer than the first three. In the third year, three further blades unfold; these are not only much larger than the others but are also deeply cleft. In rare instances, the young palms form six cleft leaves, but usually the first pinnae appear on the fifth additional blade. The first pinnate leaf forms only 3–4 pinnae. Each successive new leaf doubles the number of pinnae. The pinnae at the tip remain united for many years. I have myself observed leaves on an old plant with pinnae united at the tip. In the fifteenth year, the palm forms leaves with the complete number of 120 pairs of pinnae. The number of leaves from this age on is between 9 and 18, the same as on an old plant; usually, however, the number of green leaves is between 12 and 15.

These *Ceroxylon* palms develop three leaves each year as a rule. Thus the age of these palms can be reckoned with considerable accuracy. I have already established the time from seedling to the first ring on the stem. Now it is only necessary to determine the total number of leaf rings. For this, the total height of the stem must be figured. Thereafter the number of meters must be multiplied according to the number of rings per



7. The pinnae at the tip of a leaf of a ten-year-old plant are still united.

meter. Here it is important to add that the distance between rings can differ from plant to plant. The lowest basal rings always stand closer than those which follow. The rings in the last two meters or more near the crown of an old plant (more than 100 years) also are closer.

On a young example with a stem height of five meters, I counted 83 rings; measured from the stem base in units of a meter upwards, there were 26 rings in the first meter, only 16 rings in the second meter. On an old plant there were 19 rings in a length of 115 cm. (second meter from the base) with the following distances between successive rings: (in centimenters) 8, 14, 8, 5, 5, 3, 5, 4, 3.5, 4, 5.5, 5, 6, 6, 5, 9, 6, 5, 8.

Once the count of leaf rings is determined for a plant, then the number can be divided by three (leaves per year) to give the age of the stem, to which must



8. A stand of young *Ceroxylon klopstockia* at about 1900 m. elevation in the cloud forest of Venezuela.

be added 15 years of youth during which no visible rings are formed. At the last, come the five years for the formation of the crown which as a rule has 15 leaves. For one example of 30 m. height (and such a height occurs only exceptionally in the region of this investigation), I determined the age from the following measurements: the first 20 meters with about 12 rings per meter totalled 240 rings and 10 meters at 16 rings on the average totalled 160 rings, a grand total of 400 rings. These divided by three made 133; to which 15 years of youth and five years of crown formation can be added. Thus the age of the palm can be estimated with some certainty as 153 years.

Inventory of Some Young Palm Stands in a Natural Habitat

At Las Palmas, I selected a tract of 100 square meters on December 22, 1973, and made the following inventory:

Seedlings with only one undivided leaf blade—6

Seedling with the first three undivided leaf blades—9
Young palms with the first three cleft leaf blades—5
Young palms with the first pinnate leaf—1
Young palms with the first three pinnate leaves—3
Young palms with six pinnate leaves —3
Young palms with more than six pinnate leaves—13

There were also 41 young palms on the 100 square meters. Two of these had leaves with 80 pairs of pinnae. Also in the wider region of this investigation many young palms in older classes were found. It is still not clear how this rich distribution came about in this piece of forest. No mother plants were found in the immediate vicinity. I suppose that birds are responsible for the major part of this palm distribution. In previous years I have also investigated the emerald toucanet (*Aulacorhynchus sulcatus sulcatus* Swanson) and found that these hunted after these fruits the whole day when they were ripe. After the birds eat the fleshy pericarp they let the seeds fall. I can give mice only an unclear role in the distribution of the palm species. They search after the endosperm and in this case store the seeds. Only exceptionally, when mice leave the seeds, determining them green, can this be useful in reproduction.

Translated from the original German by the editor with approval of the author.

NEWS OF THE SOCIETY

For the May International Flower and Garden Show in the Miami Beach Convention Hall, jointly sponsored by the National Council of State Garden Clubs and the Miami Beach Parks Department, Alan Fernandez set up a very striking exhibit that won an honorable mention. Alan used quite a few specimen plants, including *Chamaedorea*, *Licuala*, *Howea*, *Chrysalidocarpus*, *Coccothrinax*, and others, but the thing that drew most attention was the background of two enormous fronds of *Orbignya* with a huge *Corypha* leaf in the center as a sort of roof over the plants below. These leaves had been donated by Fairchild Tropical Garden and were real show-stoppers.

The Southern California Chapter has again distinguished itself by winning a second place award in the society exhibits category in the Annual Exotic Plant & Fern Show at the Los Angeles County Fairgrounds in Pomona, California on July 31–August 1, 1976. The exhibit was directed by Lois Rossten, with plants or labor being donated by the Ketchums, Magnusons, Millikens, Hughes, Mark Foster, Jerry Goodman, Jim Benzie, Robert Greenberg, Pauleen Sullivan, and Kurt Rossten. Not only was the exhibit beautifully designed, but it contained specimen plants of *Phoenix roebelenii*, *Howea*, *Linospadix*, *Neodypsis*, *Chamaedorea*, *Licuala*, cycads, and many others.

Slide Collection

Mr. Jim Menge, 4608 Peachtree Circle E., Jacksonville, Florida 32207, has volunteered to take charge of the society's slide collection. Some slides have disappeared over the years and others are no longer in good condition. Jim would be happy to have copies of interesting slides that might be used to refurbish the collection so that it can be made available again. Anyone willing to share is urged to send slides to Mr. Menge.

TEDDIE BUHLER

Treasurer's Report—Biennial 1976

	As presented
Income:	
Contributions (dues)	$14,736.88
Subscriptions (incl. back issues)	1,334.10
Gifts, etc., special	35.15
Tax refund, U.S.	18.22
Seeds (Seed Bank report separate)	1,831.25
Interest, Biscayne Federal	27.12
Interest, Security Federal	560.06
	$18,522.78
Expenses:	
PRINCIPES, printing	$10,049.96
Seed Bank	827.83
Salaries—Exec. Secretary, Bookkeeper	3,700.00
Office rent	240.00
Taxes (SS) (Workmen's Comp)	117.40
Office expenses:	
Petty cash, typewriter repairs, etc., extra postage for special mailings	826.56
Bank charges for foreign checks processed	23.00
Address plate maintenance	132.01
Printing, stationary, dues notices, etc.	615.96
Roster, printing and typing	477.70
Lethal yellowing contribution	300.00
Dues—Amer. Hort. Soc.; Fairchild Garden, etc.	85.00
Workmen's Comp. Insurance Premium	33.00
Miscellaneous, gifts, flowers, etc.	126.74
	$17,540.42

Income, total	$18,522.78
Expenses, total	17,540.42
Excess	$ 982.36
In Savings Account, Security Federal	9,075.88
Total Financial Worth	$10,057.24

BIENNIAL MEETING

Minutes of the Biennial Meeting, June 20, 1976

The eleventh Biennial Meeting of The Palm Society was held at the Florida Institute of Technology, Melbourne, Florida on June 20, 1976. The meeting was called to order by President U. A. Young.

The minutes were read and approved.

Mrs. T. C. Buhler, Executive Secretary, read the financial report in absence of the Treasurer. She then read the report of the Executive Secretary. Both reports were approved as read.

Dr. Joseph Weil, assistant to Dr. J. P. Keuper, President of F. I. T., made some announcements, and was warmly thanked

by President Young for his successful efforts in arranging for the Biennial Meeting.

The President then called upon the nominating committee for its report. Mrs. Ruth Shatz, chairman, presented the following slate:

For President: Mr. Myron Kimnach
For Vice-president: Mr. Donn Carlsmith
For Secretary: Mrs. Pauleen Sullivan
For Treasurer: Mr. Paul Drummond
For Directors, 1976–1980:
The officers and
Mr. Billings McArthur
Mr. Ralph Velez
Dr. John Dransfield
Mr. Melvin W. Sneed

The Advisory Council will consist of ex-presidents Dent Smith, Walter Hodge, David Barry, Jr., Nat de Leon, E. D. Kitzke, and U. A. Young. Three ex-presidents are still members of the Board and will become members of the Advisory Council upon expiration of their terms.

The President called for nominations from the floor. There being none, the slate was unanimously elected.

There being no further business, the meeting was turned over to the program committee.

Respectfully submitted,
LUCITA H. WAIT, *Secretary*

Report of the Executive Secretary —June 1976

What can one report about such a job as this? First, of course, is the daily mail which can run as high as 30 pieces when dues are first being paid, to three during a more quiet time of year. The mail consists of dues payments and new memberships which must be processed, changes of address notices, inquiries from potential new members, issues of PRINCIPES returned because of change of address, requests for back issues, and, naturally, requests about sources of seeds, seedlings, and plants. We get requests for information about the society for listing in books or other publications. Sometimes long distance calls come with the widest possible range of questions asked. It is a fascinating job requiring typing and filing skills, care in processing all the various records that must be kept, and sometimes asking for information from those more knowledgeable. Fortunately, there are many in Miami to whom one can turn for information about palms.

Here are a few facts about the composition of your society. We have members in 38 foreign countries and in 39 states as well as in the District of Columbia, U.S.V.I., and Puerto Rico. Our membership grows at the rate of about five a week with many of the new members from Australia, and, of course, California and Florida. And we are getting a surprising number of members in northern areas who obviously must be growing their plants indoors. As of today we have a total membership of 956, having lost about 200 this year who had paid dues in 1975. These first six months of the year we have had almost 200 inquiries about the society of which 47 have resulted in new memberships.

The society also has subscribers. These are institutions who receive PRINCIPES but not the roster, nor may they use the Seed Bank. There are 150 of these subscribers around the world—botanical gardens, universities, arboreta and government agencies like the Smithsonian Institution.

As you know this year we finally had the first 11 issues of PRINCIPES reprinted. A few of the other issues are running out so they, too, are being reprinted. We

feel this is a service to the membership and that the cost is thus justified. It is quite an expense for a new member to try to buy all back issues at once. We have one member who is buying them at the rate of a volume a week! This has the added advantage that it means less work in the office for shipping a big package of back issues takes quite careful packing and a trip to the Post Office.

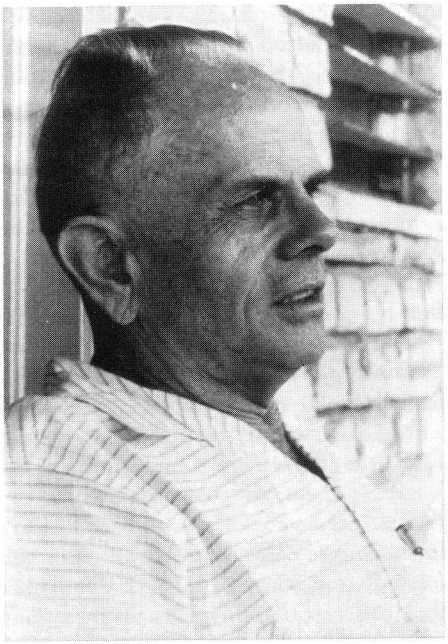
While the job is challenging and sometimes seems more than can be done in a given time, nevertheless it has been interesting and a pleasure to serve the society.

Respectfully submitted,
TEDDIE BUHLER
Executive Secretary

Harold F. Loomis 1896–1976

Harold F. Loomis, known to many as Loo, died July 5, 1976 in South Miami Hospital in his 80th year. Born in Mertensia, N.Y. on December 23, 1896, he joined the U.S. Department of Agriculture in 1914 and served with it actively until his retirement in 1958. He continued his association informally until shortly before his death, using an office that had been put at his disposal at Chapman Field.

Loo worked on cotton improvement in Arizona for several years, but moved to Miami in 1931 where he was associated with the U.S. Plant Introduction Garden at Chapman Field, serving as director from 1945 to 1958. Before and during World War II he was concerned with production of natural rubber. His other interests ranged from palms and orchids to beetles and millipedes, on which he was an acknowledged authority. Mr. Loomis participated in expeditions to China, Central America, Haiti, Trinidad, Guyana, and Surinam. He was a collaborator with the National Museum of Natural History for many years and was a Fellow of the Smithsonian Institution. He was also a charter member of the Fairchild Tropical Garden, serving for many years on the Executive Committee of its Board of Directors, a member of the South Florida Orchid Society, and The Palm Society.



1. Harold F. Loomis about 1972. Photo by Nell Causey.

His wife Edith (Sis), whom he married in 1922, his son James C., and daughter Mrs. Margery Krome survive him. His influence in the world of palms was wide as following paragraphs suggest.

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My memories of Loo Loomis will always be pleasant ones for it was he more than anyone else in South Florida who first introduced me to the horticulture and horticulturists of the Greater Miami area. That was some 25 years ago when Loo was in charge of the U.S.D.A. Federal Plant Introduction Garden ("Chapman Field") in Coral Gables. As

one of the administrators of field activities at the Beltsville, Maryland headquarters of the Division of Plant Exploration and Introduction, it was my pleasant duty to visit annually the various plant introduction centers throughout the country. As a resident of the North I naturally planned my visits to Chapman Field for the winter and often combined same with a short vacation with my family. On several occasions around Christmastime the Hodge family "camped" in one of the old unused buildings in the Introduction Garden close to where Loo and Sis Loomis then resided. Loo was personally familiar with the wealth of plant germplasm maintained in the garden and he saw to it that I didn't miss seeing it all as well. The palm collection was outstanding. I remember that one of Loo's favorites in the group was *Nannorrhops ritchiana* from Afghanistan. At that time The Palm Society was yet to be born. Chapman Field's primary activities then were in the maintenance of clonal collections of *Hevea* rubber trees—one of Loo's wartime specialties—and of disease-resistant coffees, but particular emphasis was also being given to an evaluation of potential new crop species in the genera *Dioscorea* and *Strophanthus*, of value in the then-urgent search for possible plant sources of steroids useful in synthesizing cortisone. Thanks to Loo our family camping trailer, once it headed north, was usually laden with a variety of avocados from the garden—"second-rate, fit only for raccoons," according to Loo, but first class as far as the Hodges were concerned! By the late fifties Loo had retired from government work and I had moved on to new activities at Longwood Gardens. It was Dent Smith and the new Palm Society that brought me together with Loo again. Among the Society's early activities was the cooperative preparation and publication (with the American Horticultural Society) of a special handbook, "Cultivated Palms." With his past experience with the palms of Chapman Field, Loo was a "natural" to assist in getting together useful material for the volume.

A year ago my wife and I, after a long hiatus, again had the pleasure of a brief visit with the Loomis family. Welcoming us at their front door was a fine specimen of a lovely *Chamaedorea*; obviously with his many other favorites Loo still admired palms.

WALTER H. HODGE

I think I first met Loo Loomis in the early 30's at one of the botanical gatherings at the Kampong in Coconut Grove, the home of Marian and David Fairchild. They drew everyone interested in tropical plants to them and since Loo was Director of Chapman Field, Plant Introduction Garden, he and Sis, his wife, and



2. Loo stands beside *Socratea durissima* on Barro Colorado Island, Panama, March, 1958. Photo by Edith Loomis.

the Fairchilds were very close friends. It was always stimulating to be around those enthusiastic plantsmen. Loo was a charter member of the Fairchild Tropical Garden and a member of the Board for many years. He contributed his wide knowledge of palms and tropical plants to the very young tropical garden. As time went by Loo always helped count the money on Ramble days. He was always faithful in attending Executive Committee and Board meetings of the FTG and in his quiet way added to the firm foundation that the Garden now enjoys. His many friends will surely miss him.

NELL JENNINGS

It must be well over 40 years ago when we first met Loo Loomis. He accompanied Dr. David Fairchild on a visit to Nassau and they came up to see our garden, which at that time was boasting a fair collection of palms (mostly in the juvenile stage) Suddenly Loo exclaimed with delight. He had just seen a millipede, apparently a new one. We thought at the time what a strange hobby to have. In later years when we went to Florida, we visited with him at Chapman Field, and although he was a busy man, he was always gracious and showed us over the gardens. At that time, or possibly later, he gave us a nice young plant of *Hexopetion* (now *Astrocaryum*), pictures of which will be seen in *Supplement to Palms of the World.*

Our very latest association with him was about seven or eight years ago when we went to Florida to try to obtain certain palm pictures for the book. He gave us some very fine pictures of *Haitiella* taken on the island of Beata, which will be seen when the book is published. We will always think of Loo Loomis as a kindly, gracious man, ever eager to share what he had with others.

MARGARET AND ARTHUR LANGLOIS

When I first started studying the diversity of palms in the Miami Region, Loo Loomis made me welcome at Chapman Field, permitted me to stay in one of the buildings then used as a guest cottage, where my collections were often strewn on lawn and passageways, and shared his wealth of knowledge about palms in general and those of Chapman Field in particular. Some were from seed that he had collected on various expeditions; others had been introduced by O. F. Cook and were harbored in a special walled garden. Loo knew their history as well as their characteristics and his enthusiasm for palms as for his other interests was infectious—I often found myself looking for both palms and millipedes when travelling, though my collection of millipedes proved to be few. The questions he asked and the information he provided have enriched my study of palms and will continue to do so, for all his questions are not yet answered. And a generation of palm growers is indebted to him for seed distribution from Chapman Field.

HAROLD E. MOORE, JR.

In the very beginning of The Palm Society, Harold F. Loomis—"Loo" to his friends—was one of its mainstays. When I first broached to him, in 1955, the intention to form a palm society, his interest was immediate and keen, and he supplied me with the names and addresses of a dozen or more palm enthusiasts who, when solicited, became some of the outstanding members of the fledgling organization, among them David Barry, Jr. of Los Angeles and the late Frank R. May of Miami, of whom Loo said, "You couldn't keep him out if you tried." When the first meeting of the Society was held early in the following year, Loo himself was elected to that first board of directors.

As head of the United States Plant Introduction Garden at Chapman Field, Loo had an inside track to the names of a good many palm fanciers and growers, for they had corresponded with him about obtaining palm seed from the Garden, which contained plantings on a large scale of adult palms from both hemispheres. It was then the practice at the Garden to mail packets of available seed to those on an approved list, and hence Loo was aware of some very avid palm-gardeners. His knowledge stood the new society in good stead, for the lack of it would surely have retarded its progress. All of which is another way of saying that we have every reason to be thankful for having had Harold F. Loomis with us back then, and for years afterward besides.

Dent Smith

Harold Loomis was a *valuable* man. During the 45 years of our friendship he was constantly contributing something of value: a bit of information, or some product of his unique sense of humor, or an interesting photograph. In the early days of The Palm Society he offered much good advice, drawn from his years of experience with palms and from his close association with David Fairchild. He also contributed articles and pictures to our first publications. I feel privileged to have known such a valuable man.

Lucita H. Wait

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Errata

Volume 7

Page 87, legend sub Fig. 65: for *Phoenix canariensis* read *Butia capitata*

Page 133, column 1, line 1: for *javanicus* read *javensis.*

Page 146, column 2, line 1: for *Howeia* read *Howea*

Page 147, column 2, lines 37, 40: for *Howeia* read *Howea*

Page 177, column 1, lines 21, 22: for *Howeia* read *Howea*

Volume 9

Page 71, column 1, line 23: for *frutescens* read *fruticans*

Volume 19

Page 102, column 1, line 17: for *Lauterbach 857* FI! read *Lauterbach 857* L!

Page 153, column 1, line 23: for husk read endocarp

Page 153, column 1, line 42: for husks read husk and endocarp

Notice to Institutions and to Persons Who Bind Principes

A cumulative index to PRINCIPES volumes 1–20 is in preparation for publication in late 1976 or early 1977.