PRINCIPES

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Contents for April

Cover Picture

Cast iron replica of a *Sabal Palmetto* on the grounds of the State Capitol in Columbia, South Carolina, with the front portico of the Capitol building in the background. The monument honors the state's famous Palmetto Regiment in the War with Mexico. An early sculptor, Christopher Werner of Charleston designed it. See page 43.

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The "White Palmetto"

JACK COOK

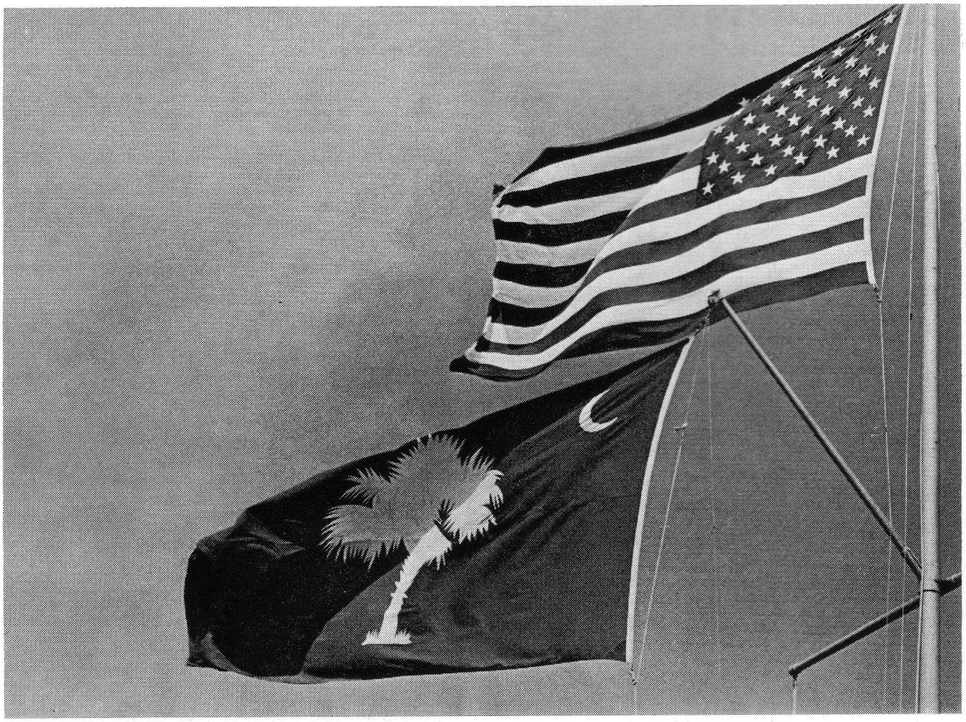
The "white palmetto" is found chiefly in the state of South Carolina, and is rarely seen outside its boundaries. In all parts of South Carolina this proud palm may be seen stirring in the breeze, its white head lifted high with never a rustle among its glistening white fronds. Long "neglected" by botanists, it has, nevertheless, evoked considerable interest from historians, as it is the palmetto that adorns the flag of South Carolina—the Palmetto State.

Sabal Palmetto, model for the "white palmetto," is found in its native habitat along the entire coastline and numerous sea islands of South Carolina, and thrives as an ornamental as far north as the sand hills; its diminutive cousin, the blue palmetto (*Sabal minor*), grows wild profusely in the "low country" and is even occasionally found in swampy areas along the fall line that separates the coastal plain from the piedmont. Not to be overlooked also is the sabal's thorny relative, the saw palmetto (*Serenoa repens*). This armed bush hog thrives on the sea islands that dot the lower coastline of the Palmetto State and makes itself at home on the mainland near the Georgia line. For none of these reasons, however, did *Sabal* earn its place on the proud flag of South Carolina.

This sturdy native American palm earned the right to fly on the flag by playing a heroic role in the defense of its native state. On June 28, 1776, a small band of South Carolinians defended a crude, incomplete fort constructed of sand and palmetto logs overlooking Charleston harbor against an attack by eleven armed British vessels. From a distance of 400 yards, the fleet's cannon began pounding the little fort at ten that morning. To the chagrin of the attacking forces, the cannon balls harmlessly imbedded themselves in the spongy palmetto logs; this kept the enemy from taking the small unfinished fortification, and the British were subsequently defeated.

A few days after the departure of the British, word was received in Charleston that the Declaration of Independence had been signed. The little fort was named "Moultrie" for its commander, Colonel William Moultrie, and the palmetto joined the crescent on the state flag. A year earlier, the revolutionary council of safety had asked Colonel Moultrie to design a flag for the use of South Carolina troops. The good Colonel chose a deep blue which matched the color of their uniforms and a crescent which reproduced the silver emblem worn on the front of their caps.

On the grounds of the State Capitol in Columbia stands what is probably the only monument in the world to a member of the palm family. It is a cast iron replica of the palmetto tree. Oddly enough, this beautiful cast iron palmetto does not honor the palmetto's role in the famous battle of Fort Moultrie, but another time when South Carolina sons proudly carried their native white palmetto in the field of battle. The monument memorializes the state's famous Palmetto Regiment that distinguished itself in the Mexican War from 1841 to 1847. During this conflict, the palmetto flag was the first to enter the Mexican Capitol. The monument was designed by Christopher Werner of Charleston



1. The flags of the United States and of the State of South Carolina. Since 1776 the latter flag has been emblazoned with a figure of *Sabal Palmetto* in white. Photo courtesty South Carolina Department of Parks, Recreation and Tourism.

and was purchased by the State for only five thousand dollars. It was damaged first by Union General Tecumseh Sherman's troops when they shelled the statehouse in 1865 during his blazing march across the state, and was broken into bits by a freak tornado in 1939. It has since been restored. Therefore, a description of South Carolina's native white palmetto by a historical botanist might read something like this:

"First described in 1776, it is by statute displayed 'upon the inside of every public school building in the state and daily except in rainy weather from a staff upon the Statehouse and from a staff upon each County Courthouse.' "Beyond the borders of its native state, the white palmetto is frequently seen but always as a devoted representative of its native state in times of peace and war."

Even though the white palmetto has ably represented South Carolina since 1776 with its place on the State Flag as well as the State Seal, legislators did not get around to naming its first cousin, *Sabal Palmetto*, the State Tree until 1939.

JACK COOK

Pelagodoxa in the Marquesas Islands

George W. Gillett
University of California, Riverside

As the plans developed for my 1970 botanical field work in the Marquesas Islands, Dr. Moore of the Bailey Hortorium and Dr. Yoneo Sagawa, Director of the Lyon Arboretum, University of Hawaii, urged me to obtain collections of the rare palm, *Pelagodoxa Henryana* Beccari. Their persuasion was welcome, for my interest in palms had brought an appreciation of the unique status of the monotypic *Pelagodoxa.*

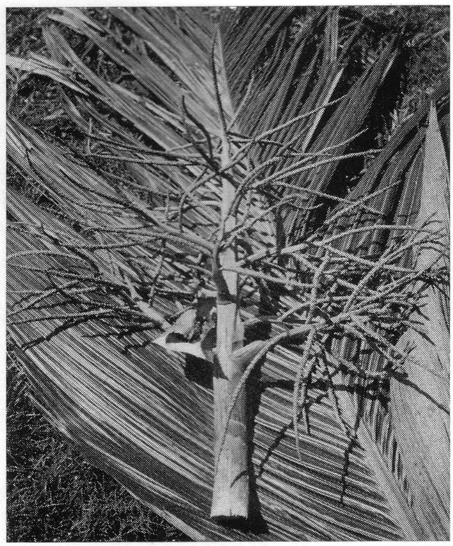
On August 18, my Marquesan guide, Tunui Puhetini, and I started from sea level on the trail that ascends the ridge back of Taiohae, Nukuhiva. Our objective was the native stand of *Pelagodoxa* in upper Taipi Valley, about 10 miles from Taiohae. The principal incentive was a spirit collection of mature flowers for Dr. Moore's laboratory. An additional incentive was a collection of fruits for propagating this species at the Lyon Arboretum. As our ponies scrambled up the rocky, slippery trail, we headed into a steady rain, the unfailing element of the Marquesan weather that time of the year. We crossed the summit between Taiohae Valley and Taipi Valley at about 2100 feet, then descended on a precipitous trail with numerous, tight switchbacks. This was the trail that Tunui had insisted was impassable. Only adamant determination had dissuaded him from that verdict and had gotten this expedition underway. The trail obviously was dangerous, but was easily negotiable with normal precautions. We passed a fine specimen of cashew (*Anacardium occidentale* L.), one of the more attractive elements in the tangle of introduced, pernicious weeds that comprise most of the vegetation below 2500 feet on Nukuhiva. Only about one-fifth to one-tenth of the original native vegetation is left on the island, this concentrated above 2500 feet. The native biota has suffered vast destruction by the browsing and trampling of thousands of wild goats and cattle that were introduced over 100 years ago. At the current rate of destruction, it is my estimate that the remaining native vegetation will be annihilated within approximately 50 years.

Descending to a tributary of Taipi Valley (the locale of Herman Melville's "Typee"), we picked our way through thickets of *Hibiscus tiliaceus* L. We paused while Tunui cut a 10-foot sucker shoot of this species. Splitting one end, he pulled off a 10-foot strip of bark. He used this to make a crupper for my saddle that had slipped forward during the 1500-foot descent. We suddenly came upon the upper Taipi River and forded it without difficulty. At the head of Taipi Valley are lovely waterfalls plunging some 1000 feet from the Toovii Plateau. The valley floor is forested with stands of the Tahitian chestnut, *Inocarpus edulis* Forster. Tunui's dog scared up a family of pigs and finally chased them into a bamboo thicket. We took note of this destructive adversary of the native biota as we approached the only known stand of *Pelagodoxa.* Finally, Tunui led us off the trail and we tethered the ponies. We were about 500 yards from the main waterfall, in dense rain forest comprised of Tahitian chestnut, *Hau* (*Hibiscus tiliaceus*), and mule's foot fern (*Angiopteris marchionica* E. Brown). We walked a few hundred yards through the rain forest and suddenly came upon a fine specimen of *Pelago-*

doxa, about 25 feet tall. While our climber retrieved inflorescences and fruits, I made a count of all trees in the population. This job was tragically simple, for the population grows on a 1-acre habitat and consists of two mature trees about 25 feet tall and 27 smaller plants from 1 to 6 feet tall. The ground is stony, with a gentle slope to the Taipi River, about 50 yards away. The habitat is 135 feet above the sea. The rain forest overtops the largest *Pelagodoxa.*

Most heartening was the evidence that *Pelagodoxa* is reproducing very well, with the population slowly expanding. The feral pigs apparently have not yet discovered this food source. The mature fruits have a thick endosperm and are about 4½ inches in outside diameter. The much-branched inflorescences are interfoliar. The erect, naked trunks of the mature trees bear stiff, pinnate leaves on the terminal one-tenth of their length. The young leaves are entire, but are irregularly torn as they mature. In examining this habitat I noticed an old Marquesan house foundation, a platform of boulders, surrounded by *Pelagodoxa.* This immediately raised the question of whether or not the population was really indigenous, or possibly adventive, a remnant of early Marquesan agriculture. Could the ancient Marquesans have utilized the coconut-like fruit of *Pelagodoxa* as food? We made specimens of leaves and inflorescences. Working in the rain, there was no opportunity for taking pictures.

The mature fruits were divided between the French administrator in Taiohae and the Lyon Arboretum. Hopefully, successful propagation will be accomplished at both places to provide additional security for this rare and unusual genus.



2. An inflorescence with prophyll lying on a branch and the dissected tip of a leaf visible. All from the tree above.

An additional *Pelagodoxa* foray materialized when Tunui learned of a specimen growing in a private garden in Taipi Village near the mouth of the Taipi River. We hired a boat, useful for carrying back a large frond, and headed out on the open ocean for Challenger Bay and the Taipi River. The hazards of navigating a turbulent sea in a 16-foot boat were all too obvious as the outboard motor pushed us around the storm-battered headlands and the waves tossed us like a cork. In Taipi Village we readily found our specimen (Fig. 1). Our climber quickly ascended and brought down fronds and flowering inflorescences (Fig. 2). Several aborted fruits were picked up from the ground (Fig. 3). An inflorescence bract ("prophyll") was obtained, and proved to be bicarinate, satisfying one of the special requests of Dr. Moore. This time we had to pay for our

→

1. *Pelagodoxa Henryana* in the garden of Madam Clark, Taipi Village, Nukuhiva.

3. Young fruits and leaf of *Pelagodoxa*. The scale is in inches.

specimens. The charge was one gallon of red wine—cheap enough.

The above paragraphs give the status of *Pelagodoxa* in the Marquesas Islands. Several specimens are cultivated in Tahiti and in Hawaii, also (according to Dr. Moore) in Panama and Florida. I located six trees in gardens in Tahiti, and probably there are more. The production of mature fruits and at least one seedling by strongly isolated trees in Tahiti show that the monoecious *Pelagodoxa* is self-compatible.

In reporting on my botanical studies to the Governor of French Polynesia, I urged the fencing of the Taipi Valley population of *Pelagodoxa*. I also recommended that this area and the remnant of montane native vegetation on Nukuhiva be designated as natural area preserves. Finally, the removal of wild goats, cattle, and pigs was recommended to accomplish the preservation of the remarkable indigenous biota.

It seems appropriate to mention in this brief note the recent report of *Pelagodoxa* in the Solomon Islands (E. J. H. Corner, Trans. Royal Soc. London, Ser. B (800): 592–593, 1969). In May, 1970, I had a brief visit with Dr. John Peake, malacologist at the British Museum, who made this discovery of *Pelagodoxa* on the south coast of San Cristobal Island. This material was identified by Dr. Moore, to whom it was transmitted by Dr. Corner. Apparently a small population occurs at Makiri Harbor, San Cristobal. This raises the interesting question as to whether *Pelagodoxa* is native or introduced in the Solomon Islands. Corner (*op. cit.*) states that the Solomon Islanders are not familiar with *Pelagodoxa* and he gives no native name for it. This situation needs further study, but it suggests that *Pelagodoxa* has had a brief history in the Solomon Islands and may be of recent introduction there. On the other hand, the Marquesans have a name for *Pelagodoxa*. It is known to them as *Énu*. This name is familiar to older Marquesans in the Taiohae Valley and is widely familiar to the inhabitants of Taipi Valley. The Taipi Marquesans know the *Énu* well and know where it grows, suggesting that it has had a long history and perhaps a distant significance in their culture.

Appreciation is extended to the Hawaiian Botanical Gardens Foundation, sponsor of the *Pelagodoxa* collections in the Marquesas Islands and Tahiti, and to the National Science Foundation, sponsor of my botanical expedition to southern Polynesia.

Flowering in Metroxylon (the Sago Palm)

P. B. TOMLINSON

The shoot in a small minority of palms ends a long period of vegetative growth by becoming completely transformed into a flowering axis. This type of growth is in contrast to the more common condition in palms such as coconut, royal palm or oil palm, where vegetative growth is associated with the continual production of lateral flowering branches. The former type of growth has been termed *hapaxanthic* by Corner (1966) in contrast to the *pleonanthic* type of the latter palms. These are useful expressions.

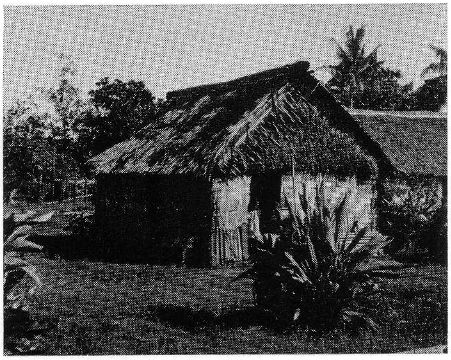
Hapaxanthic palms are often spectacular in the flowering state because the main axis bearing the reproductive branches may be raised above the leafy crown as a conspicuous terminal panicle. Perhaps the most familiar example is *Corypha*, because of its vast dimensions (see illustrations by Hodge, 1961). Species of *Metroxylon*, which include the commercially valuable sago palm, *M. Sagu*, are scarcely less striking. The sight of the Fijian species, *M. vitiense*, in the flowering state (Fig. 1) produced the following response from Berthold Seemann more than 100 years ago.

"The bold look of the flowers suddenly starting from the extremity of the trunk, and proclaiming, as it were by signal, that the time has arrived when nature has completed her task of laying up stores of nutritious starch, and that unless the harvest is at once gathered in, nothing will remain of the produce of years save the receptacle in which it is treasured up. Even the old dead trees, standing like so many skeletons amongst a host of young living ones, present an interesting appearance, reminding one of the posts with their many arms over which the wires of electric telegraphs are carried" (from *Flora Vitiensis*, 1865; p. 279).

Seemann's remark about the harvest which has to be gathered in, is of course, a reference to the large quantities of starch which accumulate in the trunk during vegetative growth, but which are metabolized during flowering. This starch, when extracted from the felled palm before it flowers, is the commercial source of sago, and also a valuable food supply in several parts of the Malay Archipelago and Polynesia (Barrau, 1959). Seemann suggests that the yield of starch is greatest just before the palm flowers. Curiously enough, he relates that the Fijians did not know how to extract starch until he and his companion Pritchard showed them how. They did use its leaves, and indeed still do so (Fig. 2) for thatching. *Metroxylon* thatch is widely preferred above that of *Nypa* and coconut in many parts of the tropics where all three palms are available together.

The scientific importance of a precise knowledge of the structure of flowering shoots of hapaxanthic palms has been revealed by the detailed analysis of the "inflorescence" of *Nannorrhops Ritchiana* carried out by Tomlinson and Moore (1968). *Nannorrhops* has a smaller and less spectacular flowering shoot than *Corypha* or *Metroxylon*, but it was possible to show a progressive reduction from normal foliage leaves to

1. *Metroxylon vitiense.* Old flowering heads from a population in a swamp at Naitosiri, Nanduruloulou, Viti Levu.



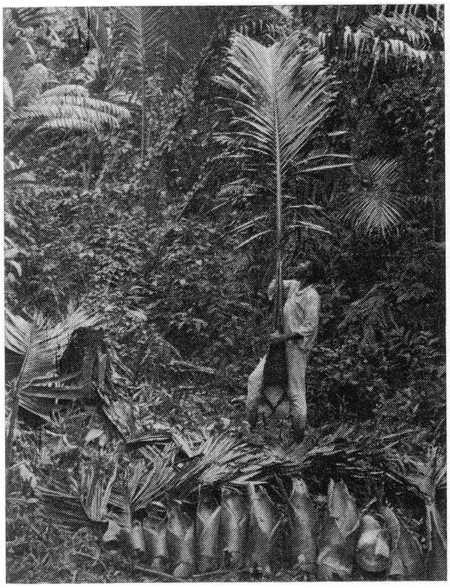
2. *Metroxylon vitiense.* Native Fijian huts using *Metroxylon* leaves for thatch.

the enveloping bracts (the so-called spathes) which are such a conspicuous feature of the flowering branches of many palms. This earlier study showed that the bract (less precisely, spathe) is equivalent to the base of a foliage leaf. It is important to have comparable information about other hapaxanthic palms. However, in view of the stature of the organisms to be studied, this is an undertaking of some magnitude. The information can only be got by studying entire plants and for this reason is not to be found in the fragmentary dried specimens by which these massive "bouquets" must, by convention, be represented in herbaria. For similar reasons, since it requires a peculiar enthusiasm for "collecting windmills," as Liberty Hyde Bailey described palm-hunting, few botanists have ventured forth in the manner of Don Quixote, and for this reason there is very little directly reported information in the scientific literature about these large flowering structures.

Recently in the South Pacific I had the opportunity to study mature specimens of two distinct species of *Metroxylon* and so to add to our knowledge of their flowering process. Flowering specimens were felled, dissected and measured in such a way that I felt that the presentation of detailed information, with the help of the accompanying photographs and diagrams would provide a more complete illustration of such palms in flower than had previously been available. Specimens of *Metroxylon* are rare in cultivation, so a lengthy introduction to an unfamiliar group is justified.

Taxonomy

A starting point for such a study is provided by the account of *Metroxylon* in the elaborate and beautifully presented monograph of the Lepidocaryeae (the scaly-fruited palms) which was produced in 1918 by an Italian botanist, Odoardo Beccari, one of the greatest students of the palms. Beccari travelled extensively in the Malaysian tropics and undoubtedly was very familiar with *Metroxylon.* He had dissected flowering specimens and understood their morphology well. Unfortunately his description relies on a terminology which is not

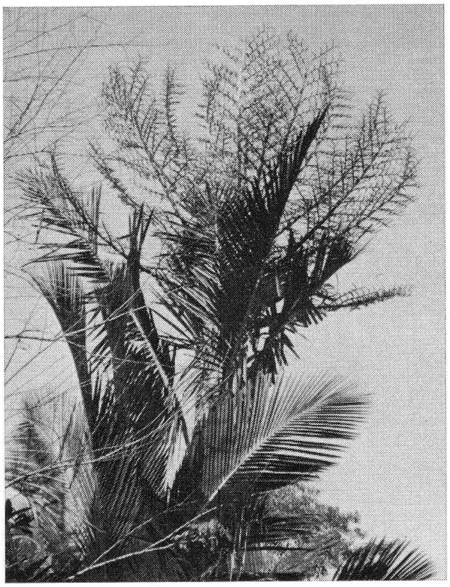


3. *Metroxylon vitiense.* Isikeli Kuruvoli holds an adult foliage leaf to contrast with the reduced leaves (bracts) of the flowering axis, at his feet. Juvenile leaves of saplings behind.

4. *Metroxylon vitiense.* Detached first-order branches held erect, the naked flowering part of the main stem is to the left.

used very precisely and is rather difficult to follow without first-hand familiarity with the palms themselves. In addition, I find that my observations differ in some significant details from those of Beccari and for this reason I have felt it necessary to make a close comparison between his description and terminology, and my own so that readers may see where we diverge. This is important since Beccari's great monograph is not easily available. Apart from these details, my account, which refers to only two species, substantiates that of Beccari which, of course, deals with the whole genus.

Beccari in his monograph admits 9 species of *Metroxylon*, some much less well known than others. He divided the genus into two groups, *Eumetroxylon* with 3 species which included *M. Sagu*, and *Coelococcus* with 6 species. *Coelococcus* had been considered by some authors



5. *Metroxylon Sagu.* Panicle of old flowering specimen.

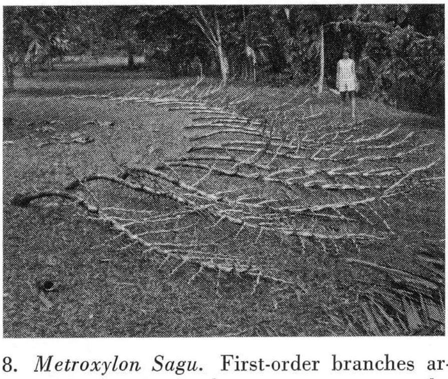
6. *Metroxylon Sagu.* Flowering part of main axis divested of its leaves (first-order bracts) and branches. The stumps of these branches are conspicuous.

7. *Metroxylon Sagu.* First-order bracts from the main stem, in series.

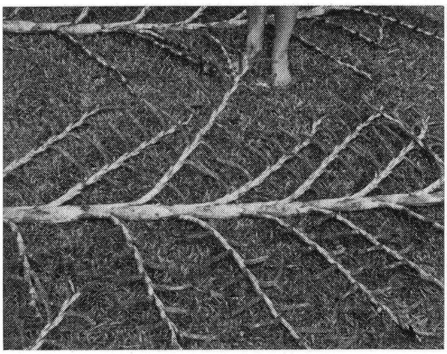
to be sufficiently divergent to merit segregation as a distinct genus, but Beccari showed that the differences were not important. Species were separated by Beccari largely on the basis of fruit characters, together with features of the ultimate major branches of the inflorescence, and this inevitably reflects those parts of these plants which were available to Beccari in the form of herbarium specimens. Species within *Coelococcus* may be largely recognized by their geographical distribution, one species each being endemic to the New Hebrides, Samoa, Fiji, the Caroline Islands, the Solomon Islands and Bougainville Island (see Barrau, 1959) Within *Eumetroxylon* there is the commercially valuable species *M. Sagu* which is widely distributed from the Malay Peninsula to New Guinea and the Philippines. The wide distribution of this species is undoubtedly largely due to its agricultural importance and many varieties, as described by Beccari, are known. Another member of the subgenus, *M. squarrosum*, is localized and little known.

Material examined

I had the opportunity to study two different species in detail. One was *Metroxylon vitiense*, the Fijian species to which Seemann refers (Figs. 1, 3–4). A natural population at Naitosiri, Nanduruloulou on Viti Levu was visited and a plant which proved to have mature but



8. *Metroxylon Sagu.* First-order branches arranged in order, the lowest nearest the camera.



9. *Metroxylon Sagu.* Detail of one first-order branch, showing distichous arrangement of second- and third-order (flower-bearing) branches.

unopened flower buds was felled. This provided material for measurement, photographs and the specimens used in the black-and-white illustrations (Figs. 17–28). On a later occasion I was provided with an old specimen of *Metroxylon Sagu* in the lowland part of the Botanic Gardens at Lae in the Territory of New Guinea (Figs. 5–9). *Metroxylon* is habitually a palm of swamps but in both localities I was able to work in relatively pleasant surroundings and with able assistants (see Acknowledgments).

General features of flowering

The overall construction of the flowering shoot is shown in Figure 11. The terminology used in this article is indicated largely by symbols in this diagram. A key to these symbols and a comparison with the terminology used for the same parts by Beccari is shown in Table 2. Flowering involves a major change in the axis. Foliage leaves are progressively reduced in size (Figs. 10b–f). The uppermost series of these progressively reduced leaves have branches developed in their axils. These branches are branched obviously twice again (Figs. 13 and 14), so that we may speak of first-, second- and third-order branches (ax_1, ax_2, ax_3). The third-order branches (ax_3) are the conspicuous flower-bearing parts of the panicle (Figs. 12, 18). All branches bear modified leaves (bracts) throughout. These bracts are progressively reduced in size along each branch. Bracts on the main axis may be referred to as first-order bracts (subtending first-order branches) and so in order we have second-, third-, . . . up to fifth-order bracts (br_{1-5}). The rule of branching is very simple; each bract subtends a single branch. Branches are sometimes partly adnate to their parent

TABLE 1. *Representative dimensions (cms) of 7th first-order branch of* M. vitiense *(cf. Fig. 13)*

Bract number	Bract length	Length of internode below	Diameter at node of insertion	Sterile or fertile	Fusion with main axis
1 (Prophyll)	16	8	5.5	Sterile	
5	18	18	3.5	Sterile	
6	14	13	3.5	Fertile	Not adnate
10	13.5	11	2.5	Fertile	Not adnate
15	14	12	2.2	Fertile	Adnate
20	9	8	1.0	Fertile	Adnate

TABLE 2. *Terminology for inflorescence parts of* Metroxylon *(Fig. 11)*

Symbol	This article	Beccari
ax	axis	
br	bract	"spathe"
ax_0	main axis	main axis*
ax_1	first-order branch or axis	"partial inflorescence" or "primary branch"
ax_2	second-order branch or axis	"spike-bearing branch" or "secondary branch" or "first division of main axis*"
ax_3	third-order branch or axis (rachilla)	"spike"
br_{1-4}	bracts of first to fourth order	
	bract subtending flower pairs	"spathel"
	bracteole	bracteole
	peduncle (unbranched basal part of ax_1)	"peduncular part"
	naked part of ax_3	"pedicel"

* *Footnote*: Beccari uses main axis for the main trunk of the palm, but also to describe the axis of the first-order branch.

axis, so that the branch does not always arise directly at the node. Exceptional bracts which subtend no branch are called sterile or empty bracts and a number occur at the base of each first-order branch and again towards the end of each axis (Figs. 13, 14). This unbranched basal part of the first-order branch can be usefully referred to as the peduncle, and so we may speak of bracts in this region as peduncular bracts. The diagram which forms Fig. 11 and which illustrates all these features cannot represent the three-dimensional arrangement of leaves. This is, however, very simple. Leaves, bracts and first-order branches are spirally arranged on the main axis but bracts and branches of second and third order are distichous (two-ranked). Bracts of the fourth order are again spirally arranged.

We may now proceed to examine the branches of successive order in detail, quoting measurements to indicate size. *Metroxylon vitiense* will be described first and the ways in which *Metroxylon Sagu* differs will be described separately in appropriate places.

Metroxylon vitiense

(a) *Main axis.* The progressive change in leaf size as the axis proceeds to flowering is indicated by the measurements plotted in Fig. 10g. Adult foliage leaves are of the order of 5 m. long (Fig. 10b) and consist of a long pinnate blade, with the segments in one plane. There is a short and rather indeterminate petiole. A long naked petiole is very obvious only in seedling leaves (Fig. 10a). The long sheathing base is at first a closed tube but during the late stages of leaf development it is widened. First-order inflorescence branches protrude through a wide split in the *back* of their subtending bract (shown diagrammatically in the inset of Fig. 11). From the dimensions for successive leaves plotted in Fig. 10g it is evident that the petiole disappears first, followed by the rachis and ultimately the blade. Examples from this sequence are illustrated in the series Fig. 10c–f. Distal leaves are represented by tubular structures without any visibly differentiated blade.

Changes in the dimensions of the main axis itself are also represented in Fig. 10g and show a gradual and more or less progressive reduction in length and diameter of internodes. Such an axis with the appendages removed is seen in the left part of Fig. 4. No measurements of the length of first-order branches were made but their position is indicated (Fig. 10g, subtended by fertile bracts). There were 14 of them in the axis I examined with an aborted vestigial branch in the axil of the leaf below the first bract (leaf 11 in Fig. 10g). At the end of the main axis is a short series of empty bracts followed by bracts which subtend branches bearing in turn flower-bearing branches. At this level, in fact, the main axis has the structure of a first-order branch (distal part of Fig. 11). The main axis finally ends as a short appendage with aborted bracts.

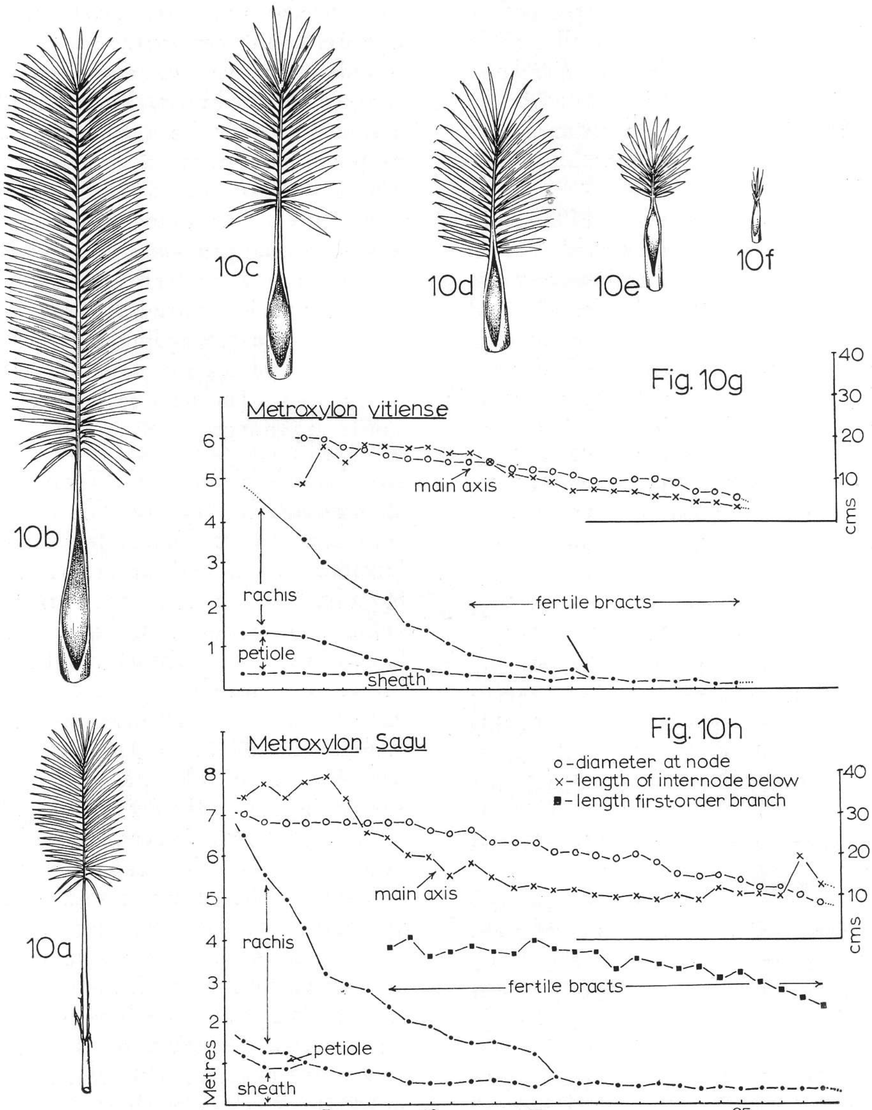
We may briefly compare measurements for the flowering shoot of *Metroxylon Sagu* represented in the same way in Fig. 10h. This species is more robust than *M. vitiense*, so that overall dimensions are somewhat larger; this is evident in Fig. 6. Several features remain the same, however. This shoot had 22 first-order branches and their lengths are plotted, showing a gradual reduction corresponding more or less to the decrease in dimensions of the main axis.

(b) *First-order branch.* Returning to *M. vitiense* we may now describe the structure of a single first-order branch such as is represented in Fig. 13. Information presented in Table 1 for one of these (the one at the position indicated by an arrow in Fig. 10g) gives some idea of parts and dimensions.

This axis has 20 distichously arranged, tubular bracts. The first is two-keeled and may be referred to as a prophyll. It is above a short internode. The first 5 bracts, including the prophyll, subtend no branch, so that there is a long basal peduncle. The remaining 15 bracts each subtend a second-order branch which protrudes through the mouth of the subtending bract. Distal branches are partly adnate to their parent axis. The axis ends in a short, sterile appendage.

(c) *Second-order branch.* From the 15 second-order branches of this axis one, from near the middle of the series, is illustrated in its entirety in Fig. 17. It has a basal prophyll and one sterile bract (other second-order branches sometimes have a further sterile bract). Subsequent bracts are distichously arranged and each subtends a third-order branch which is adnate basally to the parent axis. The axis as a whole ends in a short appendage (indicated by the arrow in Fig. 17).

An important difference in the second-order branches between *Metroxylon vitiense* and *M. Sagu* is reflected in the appearance of the flowering specimen as a whole. In *M. vitiense* these branches are pendulous but in *M. Sagu* they are rigidly horizontal throughout the flowering process. Sketches of the general appearance of entire first-order branches in the two species are shown in Figs. 13 and 14. These differences are further evident in the photographs of Figs. 1 and 4 compared with 5, 8 and 9. This difference is not constant between species in the two sections *Coelococcus* and *Eumetroxylon* which were recognized by Beccari. For example *M. warburgii* in the section *Coelococcus* has much the habit of *M. Sagu* in the section *Eumetro-*



10. *Metroxylon.* Dimensions of main axis and leaves at inflorescence. a–g, *Metroxylon vitiense.* a–f, leaves (× 1/25). a, juvenile leaf with long petiole. b, adult leaf with petiole indistinct from distal part of sheath. c–f, leaves or bracts from main flowering axis showing progressive reduction in all parts. 10g, measurements of leaf size, internode length and stem diameter along a main flowering axis. 10h, *Metroxylon Sagu.* Details of this species as for previous figure with addition of overall length of first-order branch axes.

xylon (H. E. Moore, personal communication).

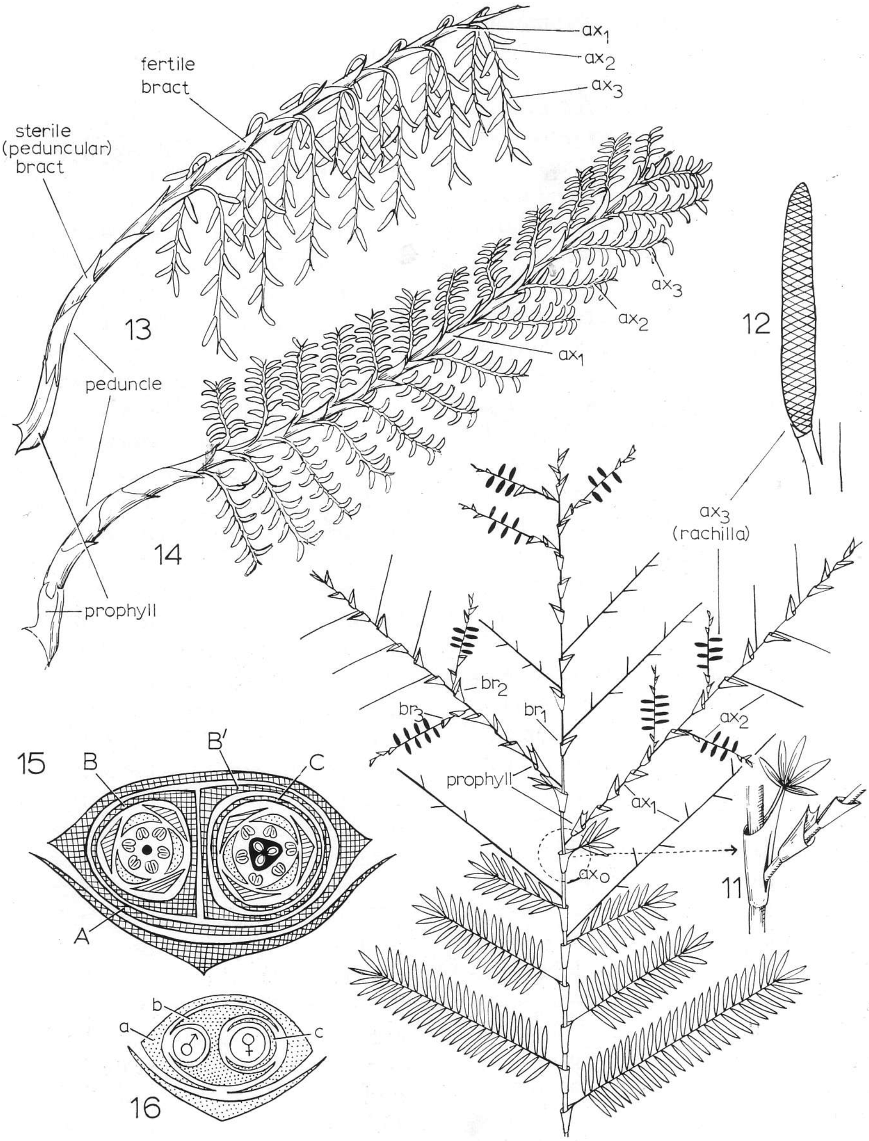
(d) *Third-order branches.* An average second-order branch supports about 8–9 third-order (flower-bearing) branches, each called a rachilla. The relation of these to the panicle as a whole is shown in Fig. 12. Before the flowers open they each resemble a rather irregular corncob (Fig. 18). Beccari referred to them as "spikes," which in a strict morphological sense is a misnomer, because the flowers are not all borne directly on the same axis as will be seen later. The number of these "spikes" recorded on each second-order branch by Beccari seems very low in comparison with my own observations and this is probably because he only had incomplete branches to examine when drawing up his descriptions.

Each rachilla has a short naked stalk (called a pedicel by Beccari). It lacks a bract modified as a prophyll, the first bracts are sterile scales clustered beneath the first flowers (Fig. 19). Each later bract subtends a pair of flowers, but this is not obvious because the flower buds at a late stage of development obscure the subtending bracts. Overall there are 13 longitudinal files of flowers. The axis again ends in a sterile appendage with a cluster of reduced, empty bracts (arrow in Fig. 18).

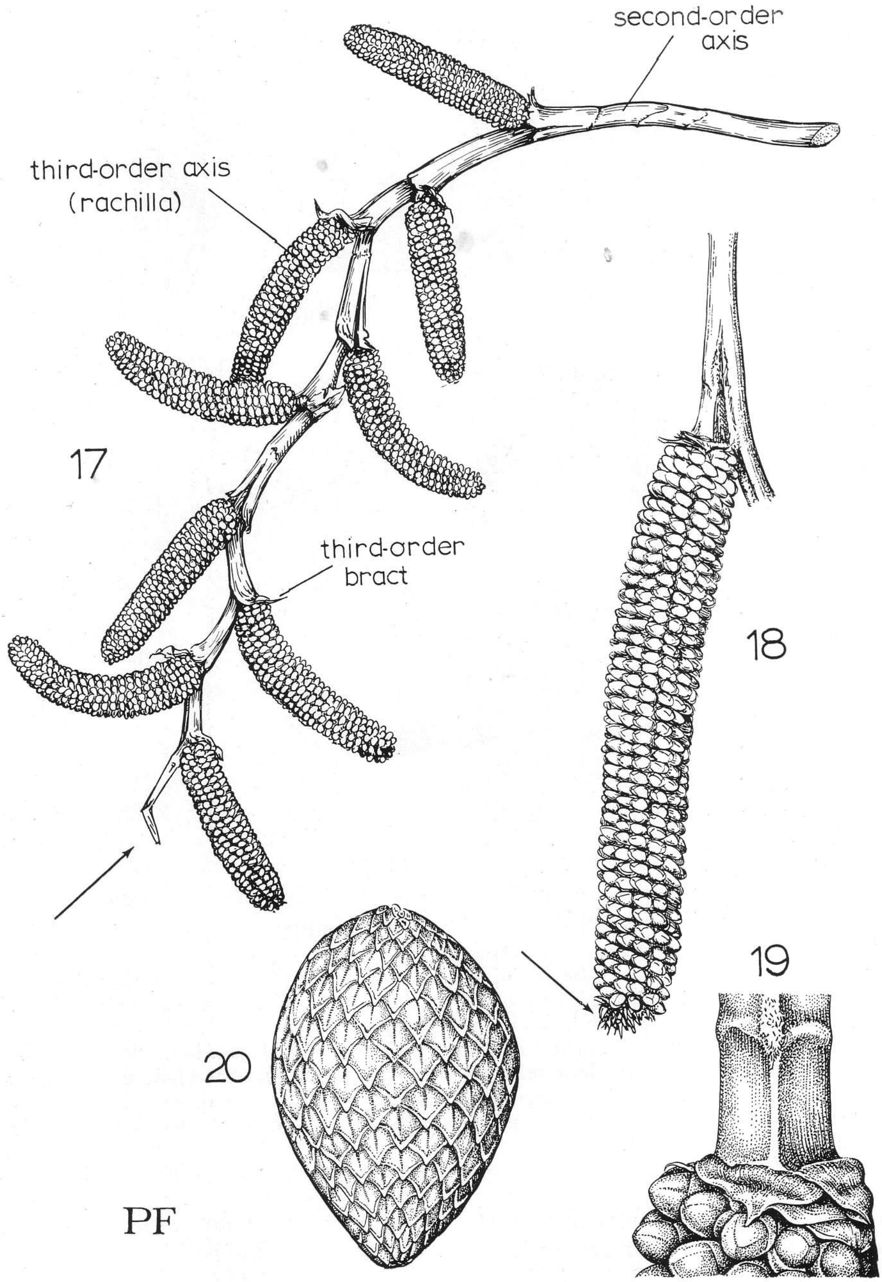
(e) *Flower pairs.* The pair of flowers enclosed by each of these fourth-order bracts (spathel of Beccari) represents a structure which is a good deal more complicated than is at first apparent (cf. Figs. 15 and 21). They represent a reduced branch system. The description of the flower pair presented here is based on a ciné analysis provided by Dr. N. W. Uhl of Cornell University. It agrees with that of Beccari in major features, but shows some significant differences. The reason why microscopical analysis is necessary is because the bracts associated with the flowers (bracteoles) are small and fringed with hairs so that they lack precise limits. The smallest (15C, 16c), indeed, may be represented by little more than the fringe of hairs. Without thin sections and high magnifications it is scarcely possible to recognize these reduced structures.

A diagrammatic comparison between Beccari's interpretation (Fig. 16) and the one by Dr. Uhl (Fig. 15) is given, although the latter must still be regarded as only tentative. Beccari describes 3 scale-like structures associated with the flower pair, but Dr. Uhl recognizes 4 since the single structure b in Fig. 16 is represented by B and B′ in Fig. 15. The two larger scales (Fig. 15A and B′) are conspicuous (Fig. 27), the two smaller ones (B and C) quite obscure so that they do not appear in Fig. 27 but can be represented in Figs. 15 and 16. Both these diagrams show the single cup-like scale (A or a) which encloses both flowers (referred to as the outer bracteole in Figs. 15 and 27). Beccari, however, describes this single structure as two fused bracteoles and represents it open on the side away from the main axis (Fig. 16a). There is no microscopic evidence to support this.

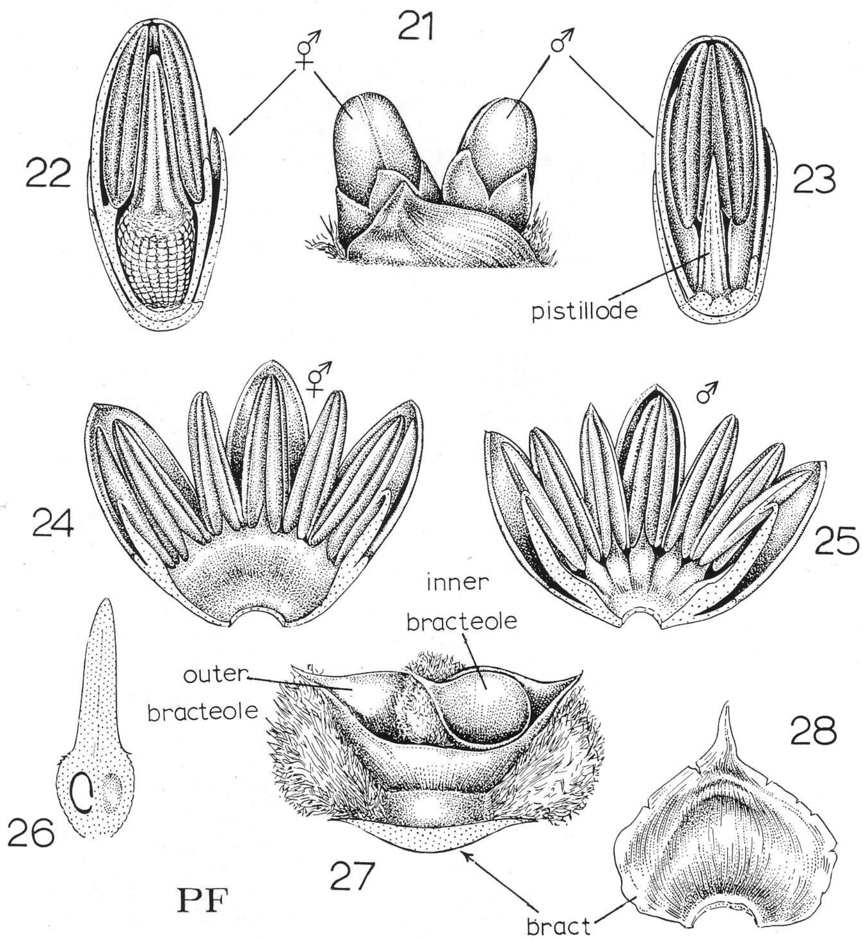
Beccari then refers to two further bracteoles (b and c in Fig. 16). The outermost (b) represents the bases of two bracts shown separate in Fig. 15B and B′. The larger of these bracts (B′) is shown as the inner bracteole in Fig. 27. The smaller (B) is obscure but encloses the staminate flower. The remaining structure described by Beccari is a very reduced scale, c in Fig. 16, and is equivalent to C in Fig. 15. Therefore one flower (the right-hand one in Fig. 15) is enclosed by two bracteoles (B′ and C), the other by one (B). Bracts B and C are so small that they are not visible in Fig. 27, which shows



11–16. *Metroxylon.* Diagrams of flowering parts annotated to explain terminology. 11. Simplified diagram to represent branching pattern and arrangement of parts. The branches are all represented in one plane since the natural spiral cannot be represented readily. The axillary position of the branches. is distorted for clarity; in fact first order branches protrude through the back of their subtending bract, as shown in the inset figure. 12. Diagram of third-order branch, which forms the ultimate visible unit of the panicle, with spirally-arranged bracts. 13. Entire first-order branch of *M. vitiense* to show characteristic pendulous second-order branches (cf. Fig. 4). 14. Entire first-order branch of *M. Sagu* to show stiffly horizontal second-order branches (cf. Figs. 8, 9). 15. Ultimate flower pair, as currently interpreted (cf. Figs. 21, 27). It should be noted that the male flower can be either to left (as shown) or to the right of the perfect flower. 16. Reproduction of Beccari's illustration which shows his different interpretation of the flower pair (see text).



17–20. *Metroxylon vitiense.* Details of distal branches and fruit. 17. Entire second-order branch (× 1/3). The two lowest bracts have been removed. The axis ends in a terminal sterile appendage (arrow). 18. Detail of third-order (flower-bearing) branch (subtending bract removed) with mature flower-buds concealing their fourth-order bracts (× 1). The distal scaly appendage indicated by an arrow. 19. Base of specimen shown in Fig. 18. (× 3). 20. Mature fruit (× 1).



21–28. *Metroxylon vitiense.* Details of flowers and flower-pairs. 21. Flower pair from without (× 6). 22. Left-hand (perfect) flower bud with outer parts cut away (× 9). 23. Right-hand (male) flower bud with outer parts cut away (× 9). 24. Perfect flower opened out, pistil removed, to show insertion of stamens (× 5). 25. Male flower opened out, pistillode removed, to show insertion of stamens (× 5). 26. Pistil from perfect flower in L.S. (× 9). 27. Arrangement of bracteoles in a flower pair, flower buds removed and subtending bract cut away (× 6). 28. Isolated bract (fourth-order) subtending flower pair (× 6).

a flower pair with the subtending bract cut off (this bract is shown from within in Fig. 28) and the two flower buds removed.

It may be wondered why it is necessary to have such precise knowledge about these flower pairs, but the structure of these ultimate units in the lepidocaryoid palms is likely to provide fundamental information about the taxonomy and evolution of the whole group. For this reason the study of a genus must be related to knowledge from other genera. Eventually Dr. Uhl expects to offer a meaningful interpretation of this part of the inflorescence in all scaly-fruited palms. The present account serves only to draw attention to the problem.

(f) *Flowers*. Although the flowers of each pair appear alike in bud (Fig. 21), dissection reveals that they are dissimilar, one is perfect (Figs. 22, 24), the other male (Figs. 23, 25). The male flower may be on the left (Fig. 15) or on the right (Fig. 21). Each flower has 3 short sepals, 3 valvate petals and 6 stamens. Beccari refers to the one I have called perfect (Fig. 22) variously as "female" or "pseudohermaphrodite" but gives no further evidence as to why he considers the stamens in the complete flower to be non-functional. Stamens in both flowers appear identical and according to Dr. Uhl their pollen is the same. Their manner of insertion is somewhat different, depending on the space made available by the presence or absence of a well-developed pistil (cf. Figs. 24 and 25). In the male flower the filaments are distinct (Fig. 25) but they are scarcely evident in the perfect flower (Fig. 26). This may lead to differences in the way in which the anthers are presented and this may be why Beccari believed them to be non-functional in this "female" flower. The male flower has a short pistillode, which is much smaller than the trilocular ovary and short style of the perfect flower (Fig. 26). The scales which develop into the conspicuous covering of the ripe fruit (Fig. 20) are evident on the ovary in the flower bud (Fig. 22).

I was unable to make any observations on the method of pollination. It is clear from Beccari's notes, however, that the male flowers open first and are followed after some interval by the perfect flowers.

From the counts made on the specimen I dissected it is possible to obtain a reasonable estimate of the total number of flowers on such a panicle. In the ultimate visible units there are about 40 flowers in each vertical series and usually 13 series. The average number of third-order (flower-bearing) branches per second-order branch is 9, of each second-order branch per first-order branch is 14 and there were 14 first-order branches in the specimen I felled. Multiplying this out ($40 \times 13 \times 9 \times 14 \times 14$) gives a value of 917,280. On a somewhat more robust specimen of *Metroxylon vitiense* than the one I examined there would therefore be about a million flowers developed. On *M. Sagu* this number might be double, because of the larger size of all parts and the greater total number of branches. We thus have some idea of the productivity of such a structure. Only half of these flowers are perfect and capable of setting fruits but nevertheless the wastage is considerable since only a minority of the flower-bearing branches produce as much as one ripe fruit.

Conclusions

It is hoped that these notes will have added to our knowledge of the flowering process in this economically important group of palms. Furthermore, they have suggested that additional observation would clarify certain disputed points. A useful purpose will have been served if this article stimulates an interested observer to add to it and possibly make corrections.

Acknowledgments

It is a pleasure to acknowledge the facilities laid at my disposal during the dissection of these specimens in Fiji by Mr. John W. Parham, Government Botanist and in the Territory of New Guinea by Mr. John S. Womersley, Chief of the Division of Botany, Department of Forests. I appreciate also the help in the field given by Isikeli Kuruvoli in Fiji and Michael Galore in Lae. Illustrations other than photographs are the work of Priscilla Fawcett, Botanical Illustrator at Fairchild Tropical Garden. The visit to New Guinea was made possible by a grant from the National Science Foundation, supplemented by a travel allowance from Fairchild Tropical Garden. Helpful suggestions by Drs. Natalie W. Uhl and H. E. Moore, Jr., during the preparation of the manuscript are greatly appreciated.

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Right-handed, Left-handed, and Neutral Palms

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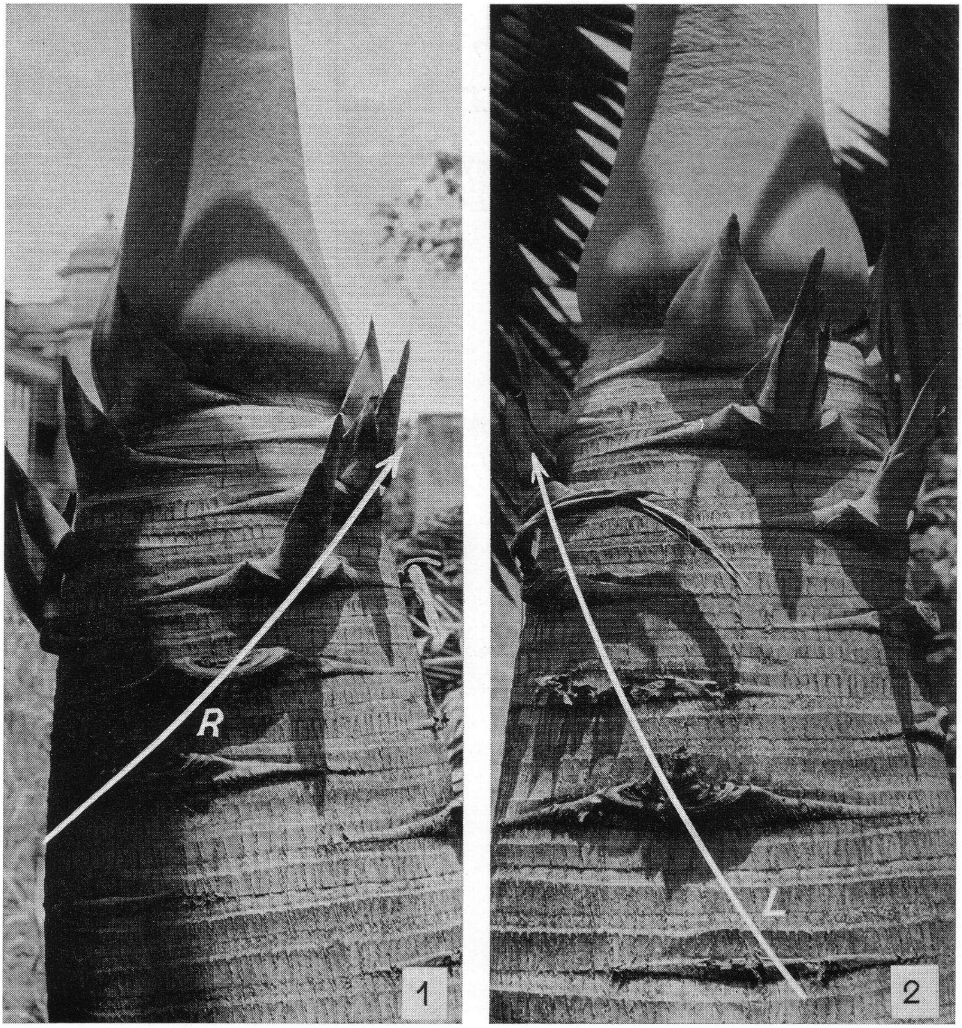
Standing under a palm bearing over two dozen leaves, if one looks up at the stalk of the leaves carefully, one may be able to see the leaves arranged in three or more spirals veering upwards in clockwise or counter-clockwise direction. All the spirals of a crown (which number is constant for a species) either veer to the right or to the left. The clockwise palm may be regarded as "left-handed," and the counter-clockwise, "right-handed." In Figs. 1 and 2, "right-handed" and "left-handed" *Mascarena Verschaffeltii* palms are depicted. The young inflorescences, arranged in three spirals (one of them not visible), represent the three foliar spirals in this species since one inflorescence is produced in the axil of each leaf. The number of the obviously visible foliar spirals per species varies. Thus, for example, *Mascarena Verschaffeltii* has three spirals, the coconut (*Cocos nucifera*) has five spirals and the African oil palm (*Elaeis guineensis*) has eight spirals. The direction of the foliar spirals of a palm can also be made out by examining the persisting leaf bases (in palms like the African oil palm) or even from the leaf scars as in Canary Island palm (*Phoenix canariensis*).

The leaves of all species of palms are not arranged in spirals. Thus, in *Wallichia disticha* (Fig. 3), they are arranged one vertically above the other along two opposite rows. This arrangement is similar to that of the leaves in the travellers' palm (*Ravenala madagascariensis*) of the banana family, or more commonly as in sugarcane and other grasses. Here, any two consecutive leaves are produced at a deflection of 180° from each other. In the three-sided palm, *Neodypsis Decaryi* (Fig. 4), the leaves fall along three vertical rows, and the successive leaves are formed at a constant angular deflection of 120°. In the case of most individuals of *Syagrus Treubiana* (Fig. 5), five impressive vertical rows of persistent leaf bases which merge with the green leaves at the apex may be seen. The angular deflection between any two consecutive leaves will be 144° (narrow angle). In Fig. 6, the trunk of a *Butia* sp. shows eight rows of leaves, and the angle between any two successive leaves will be 135°. These four species may be regarded as neutral palms since their leaves do not show any spiralling tendency either to the right or to the left. However, in some exceptional individuals, especially of *Syagrus Treubiana* and *Butia* sp., the leaves may show spiral arrangement.

Number of Spirals per Palm

Among palms that show foliar spirals, different species display different numbers. In *Areca Catechu* (Fig. 7) or *Ptychosperma Macarthurii*, the leaves are arranged in only a single spiral. In such palms, there are only a few green leaves present at a time. Moreover, the internodes (distances between starting places of two consecutive leaves) in such palms are much longer in proportion to the thickness of the stem. Palms like *Calamus* sp., *Chamaedorea costaricana* are other good examples of single-spi-



1–2. "Right-" (1) and "left-handed" (2) *Mascarena Verschaffeltii.*

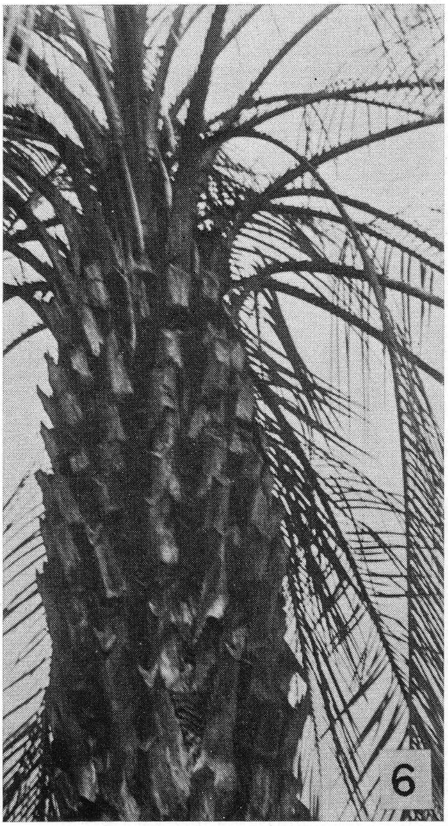
ralled palms. The Indonesian sugar palm, *Arenga pinnata* (Fig. 8) has two spirals. From any point on this trunk, the first spiral will merge with the third and the second with the fourth, and so on. The palmyra palm (*Borassus flabellifer*) (Fig. 9), which is very common in South India, has three distinct spirals. Three spirals may also be noticed in *Corypha elata* and a number of other species. The coconut palm (Fig. 10) has five distinct foliar spirals which number is shared by a number of other species. The African oil palm (Fig. 11), the wild date and some other species have eight spirals each. In most palms that show higher numbers of foliar spirals, it is often possible to trace out more than one set of foliar spirals. For example, the oil palm is regarded as having eight spirals and the particular individual in Fig. 11 is "left-handed" since the eight spirals veer

3–5. *Wallichia disticha* with two vertical rows of leaves (3) ; *Neodypsis Decaryi* with three vertical rows of leaves (4) ; trunk of *Syagrus Treubiana* with five rows of leaves (5) ; photos courtesy Acta Botanica Neerlandica.

to the left. However, a set of five spirals moving to the right can also be noticed on this stem. Another example given is *Copernicia prunifera* (*C. cerifera*) (Fig. 12) which normally has eight spirals but also shows the five spirals moving to the left which is opposite to the eight spirals. Also the three spirals moving to the right are marked on this trunk. The Canary Island *Phoenix* palm (Fig. 13) shows thirteen spirals. If some stouter trunks of this species are critically examined, one is likely to trace out twenty-one spirals also. On the trunk in Fig. 12, foliar spirals numbering 8, 5, and 3 are also indicated. Compared to the *Areca* palm which has only 8 green leaves, the Canary Island *Phoenix* bears about one hundred leaves. Thus, palms having a larger number of leaves show higher numbers of foliar spirals. I do not know any palm species which displays more than twenty-one spirals. However, if one is interested in observing higher numbers of spirals in plant organs, the sunflower head will reveal 34, 55 or even 89 spirals in the arrangement of flowers, according to the diameter of the head.

Distribution of Rights and Lefts

The direction of leaf spirals in palms is not genetically controlled. That is, when "right-handed" seed parents (coconut) and "right-handed" pollen parents



6. *Butia* sp. with eight vertical rows of leaf-bases.

were bred under control conditions, about 50 per cent of the progeny happened to be right-spiralled and the rest left-spiralled. Similarly, the progenies of the parental combinations, Left × Left, Left × Right and Right × Left all showed a one to one ratio indicating thereby that they are not influenced by their parents for their foliar arrangement (Davis, 1962).

In any locality if one has the time and patience to examine several individuals of the same species, one is likely to find that the "right-handed" and "left-handed" palms are distributed equally. To cite an example, I had collected (personally and with the help of colleagues) data on the foliar spirality of 50,296 coconut palms from 36 countries/regions around the tropics of which 25,589 were "left-handed." The slight excess for the "left-handed" (50.877%) is not statistically significant (Davis, 1963).

Fibonacci Numbers and Palm Spirals

A thirteenth century Italian mathematician, Leonardo da Pisa, nicknamed Fibonacci, formulated a sequence which runs thus: 1,1,2,3,5,8,13,21,34,55,89, 144. . . . Any of these numbers (excepting the very first one) is obtained by adding the two previous numbers. The considerable mathematical importance of this sequence can be imagined from the fact that a Journal (Fibonacci Quarterly) and a Society have sprung up in California exclusively for the Fibonacci numbers. No doubt Fibonacci numbers have a special affinity to palms.

If we take a second look at the palms, *Areca Catechu*, *Arenga pinnata*, *Borassus flabellifer*, *Cocos nucifera*, *Elaeis guineensis* and *Phoenix canariensis* respectively display foliar spirals numbering 1,2,3,5,8 and 13 which are all surprisingly consecutive numbers in the Fibonacci sequence. It is also strange that there is no palm species which clearly shows 4,6,7,9,10,11 or 12 foliar spirals. Even in the palms which do not

→

7–11. A "left-handed" *Arecha Catechu* (7); two-spiralled trunk of *Arenga pinnata* (8); stem of *Borassus flabellifer* with three spirals (9); crown of *Cocos nucifera* showing "left-handed" foliar spirals (10); trunk of *Elaeis guineensis* displaying eight and five spirals (11); photos courtesy Acta Botanica Neerlandica.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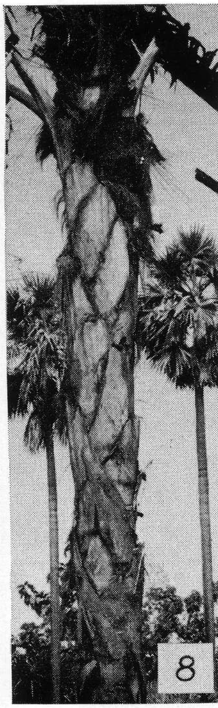
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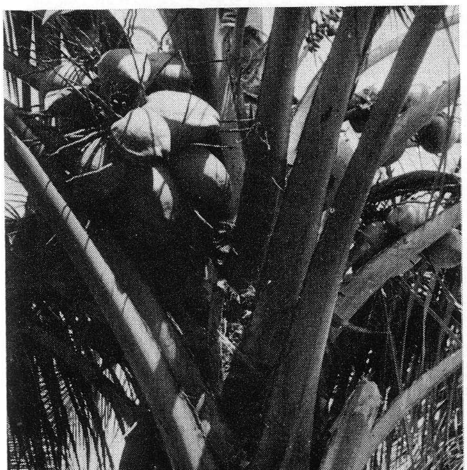
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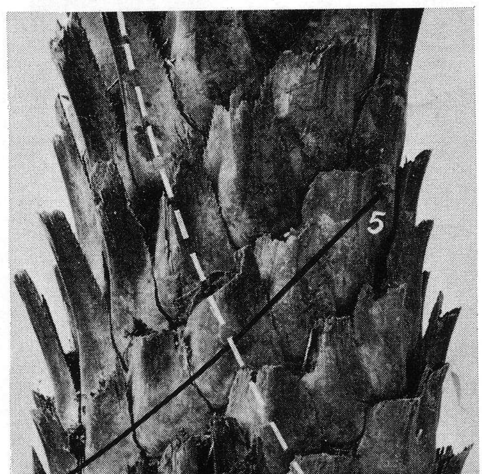
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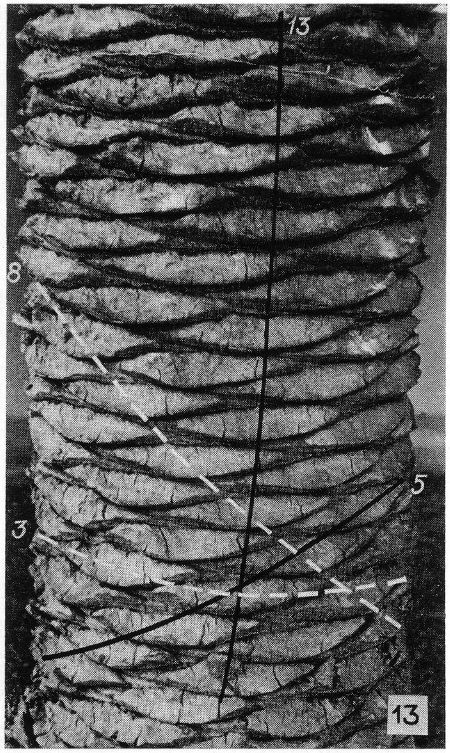
12. Trunk of *Copernicia prunifera* whose leaf-bases show eight and five spirals.



13. A stout trunk of *Phoenix canariensis* displaying prominent leaf-scars.

display a spiral mechanism but have their leaves arranged vertically, the number of rows of leaves per species, i.e. two (*Wallichia disticha*), three (*Neodypsis Decaryi*), five (*Syagrus Treubiana*) and eight (*Butia* sp.) are all Fibonacci numbers (Davis, 1970).

The photographs in Figs. 3, 4, 5, 12 and 13 were taken at the Fairchild Tropical Garden, Miami. I thank the authorities for allowing me to photograph the palms.

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Notes on Sabal in Cultivation

A review of the status of *Sabal* in cultivation has led to some reassessments of specific limits in the light of more ample collections and emphasis on correlation of vegetative, floral, and fruit characteristics rather than on differences in size and shape of fruit alone. Although *Sabal* is far from being properly understood as a whole, certain species may now be more readily defined. It seems wise to comment on the changes in nomenclature to be reflected in corrections to "An annotated checklist of cultivated palms" (*Principes* 7: 119–182, 1963) and to note reasons for them.

Sabal Blackburniana Glazebrook ex J. A. & J. H. Schultes, Syst. Veg. 7(2): 1488. 1830 (*'Blackburnianum'*).

S. Blackburnia Glazebrook in Loudon, The Gardener's Magazine and Register of Rural and Domestic Improvement 5: 52, 1829, provisional name.

The plant to which this name applies has not yet been definitely determined but Mr. J. R. Sealy of the Royal Botanic Gardens, Kew, England suggests that the name *S. Blackburnia* is provisional and not acceptable, no matter what plant is identified ultimately with these names.

Sabal mauritiiformis (H. Karsten) Grisebach & H. Wendland in Grisebach, Flora of the British West Indies 514. 1864.

S. glaucescens Loddiges ex H. E. Moore, Gent. Herb. 9: 287. 1963.

S. nematoclada Burret, Repert. Sp. Nov. 48: 256. 1940.

Satisfactory distinctions do not seem to exist between *Sabal mauritiiformis* from continental northern South America (Venezuela, Colombia) and *S. glaucescens* from Trinidad nor, in fact, from *S. Allenii* L. H. Bailey from Panama or *S. Morrisiana* H. H. Bartlett ex L. H. Bailey and *S. nematoclada* Burret from British Honduras despite the apparent absence of the species from Costa Rica and Honduras. Viewed conservatively, *S. mauritiiformis* is a species readily recognized by its leaves which are deep green above, markedly paler below (varying from silvery to glaucous), soft for the genus, and divided in an unusual fashion. Most species of *Sabal* have leaves that are divided more or less regularly into one-nerved segments. These segments are usually deeply bifid at the apex except in *S. minor*. The depth of division varies in a single leaf, tending to be deepest at the base, shallowest toward the apex.

Leaves of *Sabal mauritiiformis*, and *S. Yapa* like it, are unevenly divided. Along each side of the costa, pairs of segments are separated nearly to the costa, but within each pair, the segments are united by their inner margins for some distance and thus appear to be three-nerved (Fig. 1). The inflorescense of *S. mauritiiformis* is also distinctive. It normally extends beyond the leaves and is the most highly ramified of all species in the genus. The primary branches are again divided three times into slender short rachillae which represent branches of the fifth order, and branches of the first to fourth orders bear a two-edged prophyll at the base. Other species of *Sabal* have rachillae which are branches of the fourth order or less and have prophylls on branches of the first to third order only. Flowers are not dissimilar from those of the majority of species but are small, as are the globose fruits with strongly protracted base. Complete series of flowering material from the entire range of this species as here broadly interpreted are not yet available for the kind of de-

1. A leaf of *Sabal mauritiiformis* at the Fairchild Tropical Garden demonstrating the deep and unequal division of the blade. Photo by M. V. Parthasarathy.

tailed comparison required for further refinement of concepts. There is a substantial range in height of plants which may, however, be affected by age and/or ecological conditions.

The spelling of the epithet has been corrected to *mauritiiformis* to conform with recommendations of the *International Code of Botanical Nomenclature.*

Sabal mexicana Martius, Hist. Nov. Palm. 3: 246 [ed. 1]. 1839.

S. guatemalensis Beccari, Webbia 2: 68. 1907.

S. texana (O. F. Cook) Beccari, Webbia 2: 78. 1907.

The distinctions drawn by Bailey between *Sabal mexicana* and *S. texana* do not hold when larger series of specimens are examined and there is essential continuity of range from the Rio Grande Valley in Texas through eastern Mexico to Guatemala and to Oaxaca and perhaps further north in western Mexico. *Sabal mexicana* is characterized by regularly divided leaves with one-nerved segments, by relatively large fruits vary-

2. A leaf of *Sabal causiarum* at the Fairchild Tropical Garden showing the more usual and essentially regular division of the blade. Photo by M. V. Parthasarathy.

ing to some extent in size and shape, and by the flowers which have petals separated at the base by a stamen-filament and free lobes which, when dry, tend to be ascending, subcucullate, with inrolled margins and very prominent nerves. The calyx-lobes are usually provided with a thin mebranous margin lacking the brownish tip characteristic of *Sabal Palmetto* and many West Indian species not yet studied further.

Sabal Palmetto (Walter) Loddiges ex J. A. & J. H. Schultes, Syst. Veg. 7(2): 1487. 1830.

S. viatoris L. H. Bailey, Gent. Herb. 4: 403. 1944.

Examination of the type of *Sabal viatoris* described from cultivation shows it to be only a form of *Sabal Palmetto* with the leaf somewhat more deeply divided than usual but matched by specimens from the wild state.

Sabal princeps Hort. ex Beccari, Webbia 2: 59. 1907.

S. Beccariana L. H. Bailey, Gent. Herb. 4: 397. 1940.

Sabal princeps was validly published by Beccari based on specimens from a tree cultivated at Palermo, Italy. That the name may have been applied in horticulture to more than one species does not negate its validity nor permit the use of a later name in its place according to the *International Code of Botanical Nomenclature*. Authentic material of *Sabal princeps* has not been adequate to fix its identity clearly with respect to other plants bearing the name in horticulture.

Sabal Yapa C. Wright ex Beccari, Webbia 2: 64. 1907.

S. mayarum H. H. Bartlett, Carnegie Inst. Publ. 461: 35. 1935.

S. peregrina L. H. Bailey, Gent. Herb. 6: 400. 1944.

S. yucatanica L. H. Bailey, Gent. Herb. 6: 418. 1944.

The epithet for this species was first published validly with the above form. Earlier but invalid uses—as a name only without description and on specimens distributed by Wright—were as *Japa.* The vernacular name is given as *cana japa* by León in *Flora de Cuba* 1: 248, 1946, and it seems evident that Beccari erred in using *Yapa.* Bailey continued the use of *Yapa* but León used the "corrected" form *Japa.* To use *Yapa* seems preferable in view of the provisions of Note 4, Article 73, *International Code of Botanical Nomenclature* (1966) which reads: "The liberty of correcting a name must be used with reserve, especially if the change affects the first syllable and, above all, the first letter of the name." A comparable example is that of the generic name *Lespedeza* which was intended to commemorate Cespedez.

Sabal Yapa is another very distinctive species. The leaf is divided into "three-nerved" pairs of segments as in *S. mauritiiformis*, but the blade is uniformly green, of much thicker texture, and the inflorescence is divided into rachillae of the fourth order of branching. The flowers of this species are unlike others in the genus in that the petals are marginally connate at the base without an intervening stamen-filament, and the free lobes are soft, broadest at the base, little or not inrolled along the margin when dry, and usually reflexed. The sepals are united in a three-angled calyx with short rounded lobes and a solid base. Fruits are often two- to three-seeded.

I have examined the type specimens of *Sabal peregrina* L. H. Bailey, *S. mayarum* H. H. Bartlett, and *S. yucatanica* L. H. Bailey. In each the distinctive leaf division is associated with the same kind of flower (deduced from reflexed petals in fruits of *S. yucatanica*) as that of

S. Yapa. There is substantial overlap in the size of the hastula (which to me does not serve as a trustworthy characteristic for distinguishing species), the size of plants can scarcely be used as a valid criterion for species, and the distribution pattern of western Cuba, Isle of Pines, and Yucatan Peninsula suggests additionally that we are dealing with but a single species.

HAROLD E. MOORE, JR.

LETTERS

January 21, 1971

Mr. Dent Smith
Director
The Palm Society
P. O. Box 7008
Daytona Beach, Florida

Dear Dent,

As South Carolina's only member of The Palm Society (at least according to the last directory that I have) I was delighted to see the pictures taken by my friend, Bill Manley of the palms at the old Fant place in Anderson, in the issue of "Principes" I recently received.

Manley and I correspond and he had written of them and sent some pictures along so I was familiar with them. Although a lifelong South Carolina resident, I had never seen them or heard of them until Bill Manley described them.

Your accompanying notes in your easy and often humorous style that I have so enjoyed in "Principes" over these past several years was most enjoyable.

The only bone of contention I could pick would be that in your eagerness to make a convincing story of the rarity of these palms in Anderson and surrounding area, you made the rest of South Carolina outside of Charleston sound like a southern extension of the Yukon territory.

I'm jesting of course, but actually Anderson is only a scant forty odd miles from the northern limits of *Sabal minor* as defined by Bailey in *Gentes Herbarum*, and from my limited observations hereabouts, correctly so, as far as South Carolina is concerned.

My contention is this:—no state in our great union is more palm conscious than South Carolina. Why? Our nickname is the "Palmetto State," the palmetto tree is depicted on our state flag and state seal, and we have (as far as I know anything about it) the only statue in the shape of a palm—a cast iron replica of a *Sabal Palmetto* on our State house grounds in Columbia.

Palmetto is in the name of countless firms of all descriptions from "Palmetto Beauty Salon" to "Palmetto Exterminating Company"—which incidentally seeks to wreak its havoc on termites not sabals, to the corporate name of the Radio TV firm where I'm employed as News Director—Palmetto Radio Corporation.

Four of the thirteen native American palms are native to our state, (*Sabal Palmetto, Sabal minor, Serenoa repens,* and the *Rhapidophyllum hystrix*). Only the *Sabal minor* is native to the Columbia area, however. Around Charleston and along the immediate coast to the Georgia border *Washingtonia filifera, Phoenix canariensis, Phoenix Roebelinii* are cultivated along with an occasional *Livistona chinensis*.

Only in the coldest winters is there damage. Last winter (January 1970) Charleston recorded 11° F. above at the airport on January 9 and all the palms listed above were damaged—many completely defoliated; but by spring and early summer the majority had apparently completely recovered.

That Eskimo of the pinnate palms, *Butia*, abounds in all of the state from the sandhills to the coast, roughly to a line bounding North Augusta, Columbia and Florence. My home city of Columbia has hundreds of butia's and they are often damaged by the very severe winters and many of them killed, but miraculously most recover and thrive anew.

Columbia recorded 4° F. above December 12, 1958, 6° F. above December 13, 1962 and 7° F. in January 1966. In each of these instances most all of the jelly palms were badly damaged—large numbers killed outright—but nevertheless many had apparently recovered by the summer with little or no permanent damage.

Last January's prolonged cold was the most damaging of all. It dropped below freezing on the late afternoon of Wednesday January 7th and didn't rise above freezing until about noon of Saturday January 10th. Official low for the morning of the 8th was 12° F. above, the 9th 6° above, the 10th 5° above and the 11th 18° above.

I know of only two of the hundreds of butia's that escaped apparent injury and they were near brick homes and shielded by the buildings from the cold accompanying north winds. Many never recovered, some have recovered but still look puny, other's by summer were again shouldering their graceful tapestry of green fronds and showed no sign of injury. A number even sported clusters of gray orange fruit in the early fall—but not as many as usual.

The palm community in Columbia is made up of *Sabal Palmetto, Sabal minor,* windmill's (*Trachycarpus*), an occasional needle palm (*Rhapidophyllum*), an occasional European fan palm (*Chamerops humilis*) and *Butia.* The butia's are the only ones to suffer any great amount of cold damage. Cold damage is extremely rare in the other varieties. In the unusual cold of last January a few *Sabal Palmetto* seemed to suffer some injury.

We have just completed our first cold spell of the new year. Yesterday morning (Jan 20th) we had a low of 14° above and this morning a 15° above. The weather bureau teletype we have installed in my newsroom here at the TV station told me you were having your troubles with the weather also. It listed an official low of 23° for Daytona Beach and I'm sure it caused you some heartaches as well as loss of sleep.

I've rambled on in a much greater degree and much less entertainingly than a certain author of "In the Palm Garden" in the very early issues of "Principes." The hardy *Butia* from my experience in Columbia can take and did in the winter of 1967 a 9° above without injury. None of the many here were injured by that blast or by an 11° above in 1969, so I have come generally to regard 10° F. as the figure to watch for; 10° or above, I don't worry about the butia's—under that I do.

Believe it or not . . . the real purpose of this lengthy epistle was to enclose the accompanying article . . . "The White Palmetto" for consideration in a future issue of my favorite periodical—"Principes."

Although it admittedly contains a "tongue in cheek" quality, the facts are, I believe, accurate and the information researched from reliable sources. I am submitting it in the hope that it will alert palm lovers the world over, to the important place that sturdy, stubby *Sabal Palmetto* has had in the history of our great state.

The second purpose is to relay to you a very belated but heartfelt thanks for the courtesy you once showed to me and the large part it played in whetting my interest in the palm family.

In the summer of 1965, I made my

first visit to Miami and South Florida. At the bookstore at Fairchild Gardens, I purchased a bound copy of the edition of the America Horticultural Society's magazine that devoted its entire issue to palms. This contained your Cold Tolerance article on the great freeze of 57–58.

I pored happily over this tome the entire fall, winter and spring of 65–66, and come vacation time, hit the trail for Miami and Fairchild Gardens once more. On this occasion, the bookshop at Fairchild was liberally stocked with old copies of "Principes" at 50 cents per copy. I bought all that were not duplicated and happily headed north with a winter's worth of reading material.

On the return trip, I found a nursery at Daytona Beach that stocked many of the hardy palms we grow here in South Carolina in small cans I could squeeze into the floor of the back seat of my car. The nurseryman knew you and seeing my obvious interest in palms, suggested I stop by and see you, and assured me I would be welcome.

Following his directions, I found your house and drove up just as a thunderstorm broke. You and an old Negro man were standing by the garage and you motioned me to drive on over. I pulled up in the garage out of the downpour and you and I chatted about palms for at least a half hour.

On finding out I was from South Carolina, you mentioned Bill Manley in Atlanta. You then ducked into your house somewhere and quickly procured the issue of "Principes" containing Manley's hilarious "Palm Letters from Georgia." I gladly accepted your offer to take the magazine with me and added another copy of the magazine to my young collection. I still have the article by the way. Later, I joined The Palm Society and enjoy the articles so very much. I also have since met Mr. Manley and we correspond about palms quite regularly.

For your courtesy and kindness to me—thank you so much.

Gratefully,

JACK COOK
(John R. Cook)

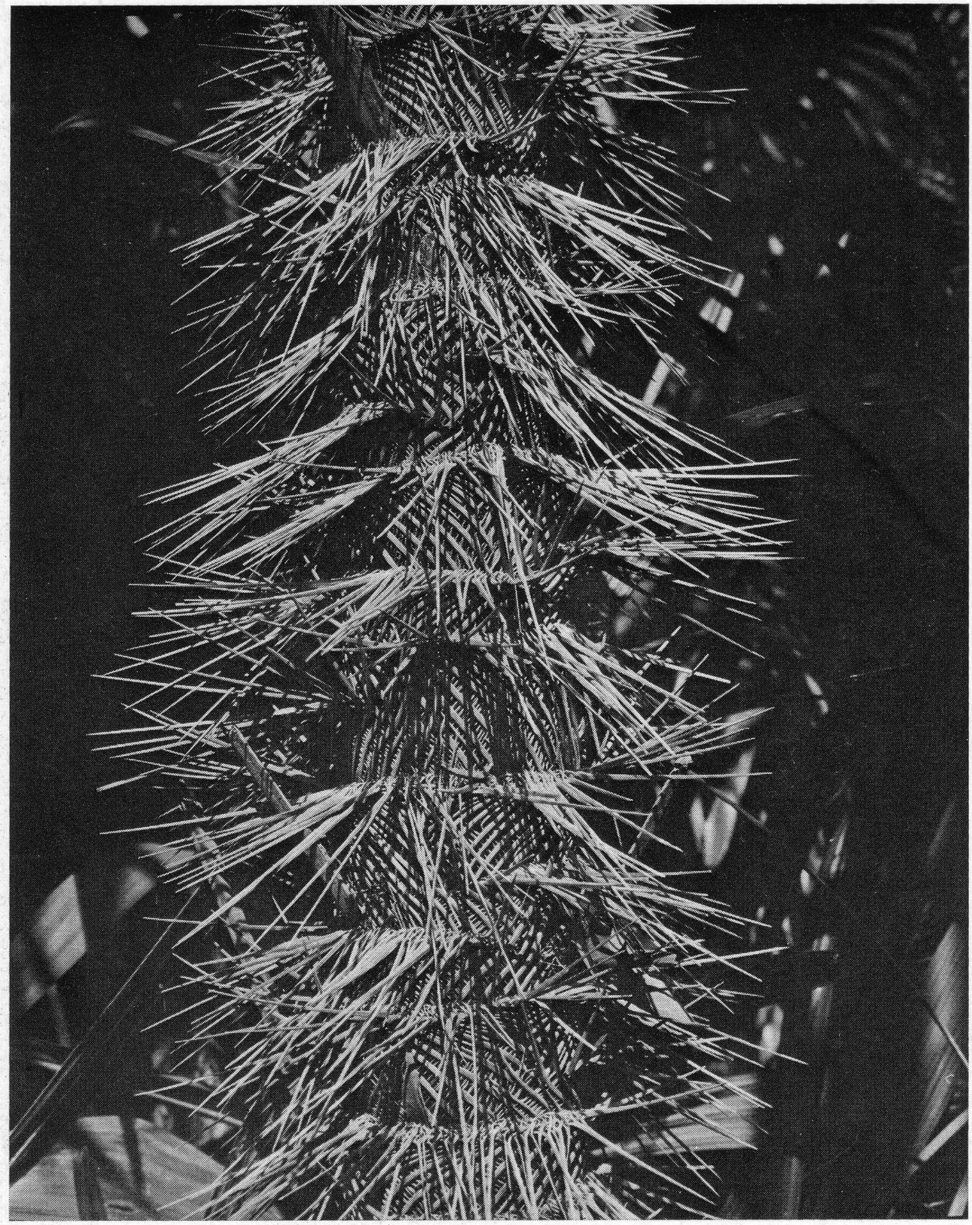
PALM BRIEFS

Our hard-working editor, Dr. H. E. Moore, is on much-deserved sabbatic leave this year, and has embarked on a palm-collecting adventure that will take him around the world. Before he left in late February, he assembled material for this and the next issue of PRINCIPES, leaving the routine editorial details in my hands. With a little bit of luck, these issues will come out in good shape and reasonably close to the scheduled date of publication. Tidbits of palm information and photographs are still invited and welcome from all Society members to fill in the remaining holes in the issues to come.

Dr. Moore's seven-month itinerary will take him to Ghana, Gabon, Nigeria, Ethiopia, French Somaliland, Madagascar, Mauritius, Reunion, Bangkok, Bogor and Kalimantan in Indonesia, Fiji, and Samoa! He will undoubtedly return with many fascinating, new, and rare palm treasures. I'm sure I speak for the entire Palm Society in wishing him the best of luck on his trip and in saying thanks again for the many years of service.

FRED ESSIG

PHOTO GALLERY



Palm collectors beware of *Zombia antillarum*, a native of Hispaniola and one of the most formidably armed of all palms. The spines of *Zombia* are part of the persistent leafsheaths rather than of the stem itself. (See article by Nat de Leon in *Principes* 1: 148–150, 1956.) Photo taken in Fairchild Tropical Garden by M. V. Parthasarathy.