



PRINCIPES

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Cover Picture

Corypha elata at the Subtropical Horticulture Research Station, Miami, Florida, with immature fruit. Photo by Dent Smith. See page 83.

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JOURNAL OF THE PALM SOCIETY

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The Flowering and Fruiting of *Corypha elata* in South Florida

P. B. TOMLINSON¹ AND PAUL K. SODERHOLM²

The flowering of a specimen of *Corypha elata* Roxb., P.I. 74425, in the summer of 1972 at the Subtropical Horticultural Research Station, U.S. Department of Agriculture (formerly United States Plant Introduction Station, Chapman Field), Old Cutler Road, Miami, Florida, the first known flowering in the continental United States, permitted the following observations on the flowering process and a detailed analysis of inflorescence construction in the genus *Corypha*. Some account of the bioenergetics of the palm is also made which allows us to assess the extent to which biomass is diverted into vegetative and reproductive processes.

Although the *Corypha* inflorescence has been mentioned frequently in botanical texts as a dramatic example of flowering because of its overall size (see also Hodge, 1961), the branching pattern has never been described in detail. The present article in part does this and affords a comparison with inflorescence construction in two other hapaxanthic (once-flowering) palms, *Nannorrhops* (Tomlinson and Moore, 1968) and *Metroxylon* (Tomlinson, 1971). The overall appearance of the inflorescence of *Corypha* is indicated by Blatter (1926) and elaborated by Douglas and Bimontoro (1956) who made a point-by-point comparison of inflorescences in

C. elata and *C. umbraculifera* L. which established useful diagnostic features. There appears to be less information concerning other species.

The Specimen

The palm in question (Fig. 1) originated from a batch of seeds from the Philippine Islands received at Chapman Field on July 17, 1927, which germinated shortly thereafter, were moved to eight-inch flower pots in 1932 and planted out in 1935. At the time of flowering in June 1971 the palm was 44



1. Overall view of specimen in flower, July 27, 1971.

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Table 1. *Corypha elata* in flower, 46 years old at time of measurement (April 1973).

Overall height	19.3 m (63' 6")
Height to lowest inflorescence branch	14.9 m (48' 10")
Height of inflorescence	4.5 m (14' 8")
Diameter breast height (3' 6")	0.86 m (2' 10")
Diameter immediately below inflorescence	0.46 m (1' 6")
Total volume of palm (calculated)	5.1 m ³
Total number of leaf scars visible on above-ground part of trunk	c. 350

years old from seed. It is not known if other palms from the same seed source are in the Miami area. As indicated below, the period of flower presentation is quite short but the fruiting process is extended; seed continued to ripen for about 18 months. In March 1973 all fruits had fallen and the palm was felled so that the inflorescence could be examined before it decomposed. Previously, in February 1972, a single first-

order branch (9ax₁—see below) was cut to obtain a measurement of fruit weight. Unfortunately, no samples of flowers were obtained; the illustrations of flowers which are included (Fig. 9E, F) are from a collection of *Corypha* sp. (*Read s.n.*) supplied via Dr. H. E. Moore, Jr. Table 1 summarizes relevant dimensions.

Foliage leaves have an encircling leaf base, split down the back in the manner

Table 2. *Corypha elata*. Sequence of events in later stages of inflorescence development, 1971.

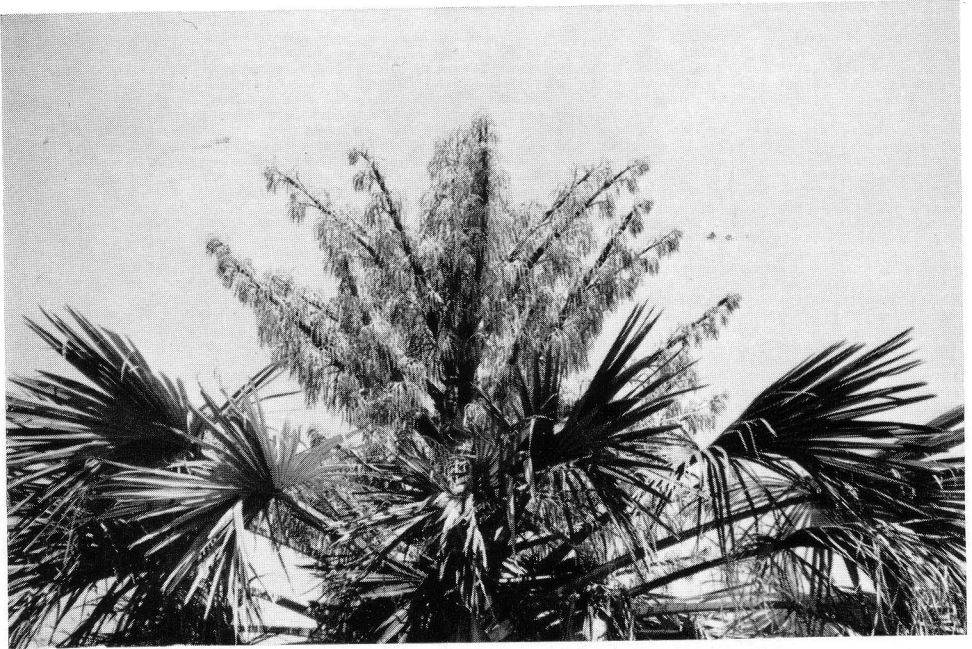
June 10	Main axis (ax ₀) extended well above crown which is still intact. First-order branches (ax ₁ 's) well extended. Few second-order branches (ax ₂ 's) exposed (Fig. 2).
June 16	First-order branches completely extended, numerous second- and third-order branches exposed; rachillae evident (Fig. 3).
June 18	Very first flowers at anthesis; crown still intact (Fig. 4).
June 21	Numerous flowers at anthesis.
June 22	Lower leaves pendulous, upper leaves beginning to droop.
June 29	Inflorescence in full flower; maximum number of flowers at anthesis.
July 2	Most leaves drooping.
July 18	Many flowers fallen, but flowering continues; some rachillae appearing bare.
July 25	Flowers still at anthesis; all leaves drooping.
July 27	Young fruits first evident (Fig. 5).
August 20	Crown completely collapsed, all leaves pendulous; young fruits conspicuous (Fig. 6).
September 15	Inflorescence densely covered with fruits of almost full size. Leaves shrivelled, no longer green.



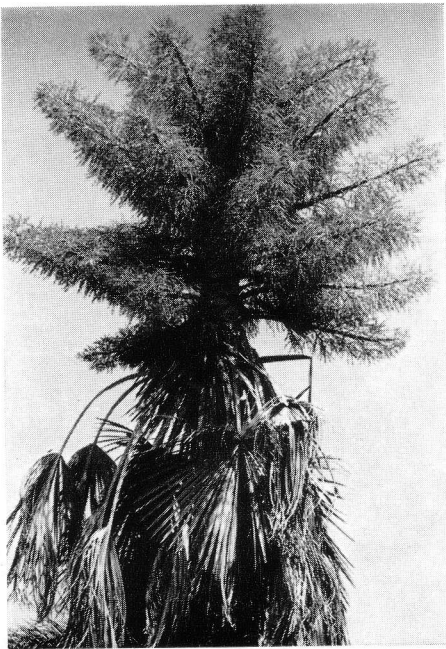
2. June 11th: first-order branches well extended and completely enclosed by tubular bracts.



3. June 17th; extension of first-order branches complete, second-order axes extended to expose the rachillae.



4. June 18th; overall view of inflorescence shortly before beginning of flower opening; crown still intact and leaves erect.



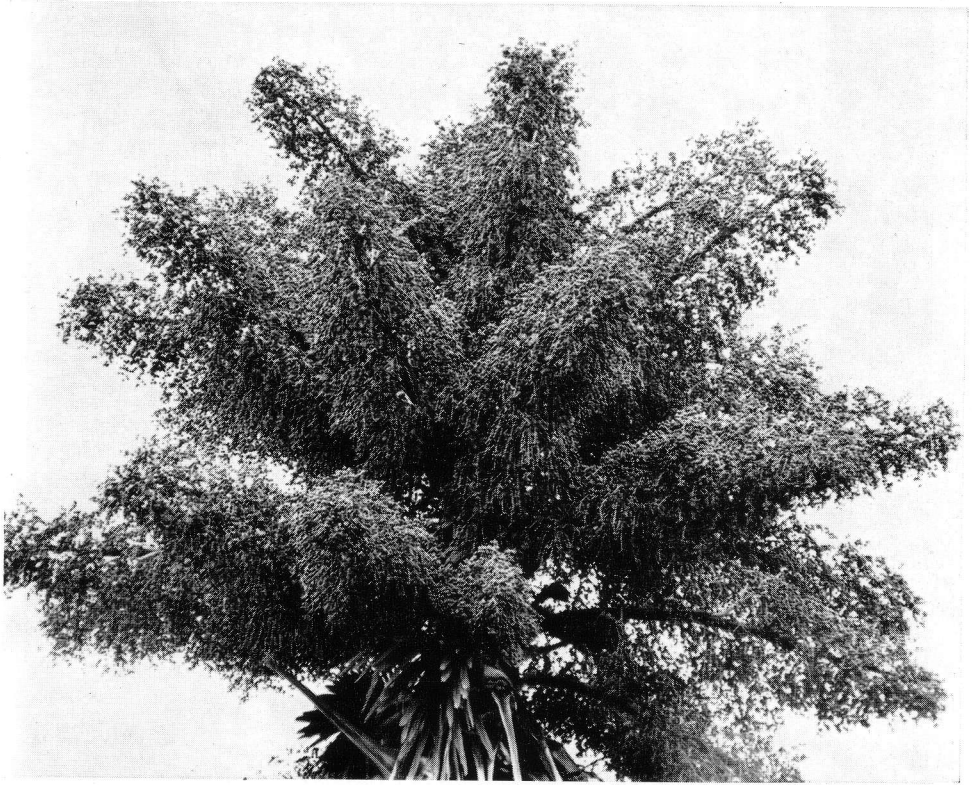
5. July 27th; late stage, most flowers fallen; crown collapsed, leaves pendulous.

of a number of fan palms (*Sabal*-type leaf base of Tomlinson, 1962). The petiole is grooved adaxially and has stout, coarse, marginal teeth, in contrast to the finer teeth of *C. umbraculifera* (Douglas and Bimontoro, 1956). The blade is costapalmate.

Flowering

The series of photographs (Figs. 1-6) illustrate the later stages of inflorescence development which began in early 1971 but for which we have no precise date. The time sequence of significant events is provided by Table 2.

These observations show that the period of actual anthesis (pollen presentation) for the whole inflorescence is quite short in comparison to the palm's total life. Beginning on June 18th, all flowers seem to have completed their expansion and pollen shedding by the end of July. *Corypha elata* is clearly self-compatible since this was the only palm in flower



6. August 20th; young fruits approaching full size.

in South Florida and viable seed was set in abundance. We have no precise knowledge of the pollinators; bees visited the flowers in considerable numbers, but the odor is described as "offensive" by Douglas and Bimontoro.

Fruiting

Fruit enlargement was rapid, but the overall fruiting period was quite lengthy. Although fruits of apparently full size were present from mid-September (three months after the peak period of anthesis) at which time the inflorescence branches were densely crowded with green fruits, these remained on the tree for another year before they began to fall, suggesting a long period of embryo maturation. We have no further de-

tailed observation to support this suggestion. The proportion of viable seeds in the crop seems very high and probably approached 100 percent. Details of total productivity are given later. An illustration of the amount of fruit on one branch of the inflorescence is given in Figure 7.

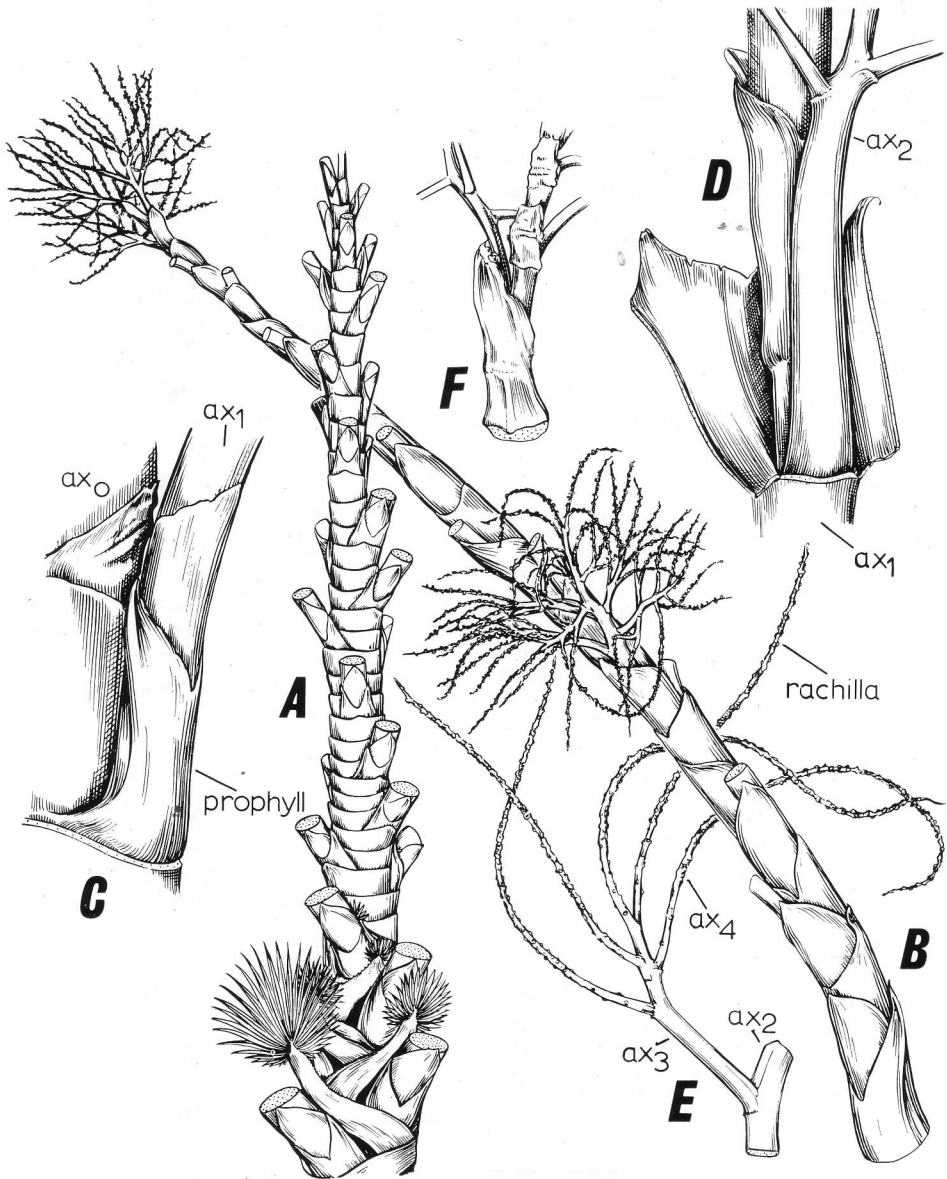
Inflorescence Construction

The *Corypha* inflorescence has the same simple principle of construction as has been described for *Nannorrhops* (Tomlinson and Moore, 1968) and *Metroxylon* (Tomlinson, 1971). The vegetative axis is continuous with the main axis of the inflorescence and there is a transition from foliage leaves through leaves with reduced petiole and blade



7. February 9, 1972; fruiting branch (9 ax_1) cut from the palm. The "crop" is in the two galvanized buckets. Photo by M. H. Zimmermann.

8. *Corypha elata*, details of inflorescence construction. A. Main axis (ax_0) of entire inflorescence, with all first-order branches cut off near their insertion ($\times \frac{1}{24}$ approx.). The distal end of this



is drawn in detail as Fig. 9A. B. Entire first-order branch (13 ax_1) with all large second-order branches except one removed ($\times \frac{1}{16}$). C. Details ($\times \frac{1}{6}$) of insertion of a first-order (ax_1) branch on the main axis (ax_0), subtending bract (br_1) removed (its scar represented by the stippled band). This shows the overlapping prophyll (1 br_2) and second bract (2 br_2), both of which are empty. D. Details ($\times \frac{1}{6}$) of insertion of a second-order (ax_2) branch on a first-order axis (ax_1), subtending bract (br_2) split down back; the base of the branch shows no modified prophyll. E. Details ($\times \frac{1}{4}$) of a third-order (ax_3) branch inserted on a second-order branch (ax_2). There are fourth- but no fifth-order branches on this system. All axes end in flower-bearing rachillae. F. Details ($\times \frac{1}{6}$) of a distally inserted first-order branch (38 ax_1) in which the prophyll (1 br_2) subtends a second-order branch (ax_2)—cf. Fig. 8C.

to modified leaves or bracts (Fig. 8A). Any of these organs, whether modified or not, that subtends a first-order branch of the inflorescence is here considered a bract for purposes of numbering. Bract is also an appropriate term to refer to modified leaves on second and subsequent orders of branching.

It is convenient to refer to the parts of this system of branches by symbols; ax for axis or branch, br for bract. Parts may be indicated by numbers, e.g. ax_0 —main axis, ax_1 , ax_2 , ax_3 . . . etc. for first, second, third . . . etc. order of branch. Bracts may similarly be designated according to the order of branch which they subtend, e.g. br_1 is a bract on the main axis (ax_0) subtending an ax_1 , br_2 would subtend an ax_2 . . . etc. Any axis can then be identified by numbering from the base, e.g. $9ax_1$, the ninth first-order branch.

Internode length along the main axis changes little in the transition from the vegetative to the reproductive phase, except that distal internodes are shortest. There is, however, a rapid decrease in diameter of successive internodes. In Figure 10 internodes have all been drawn of equal length. There is a rapid increase in rate of extension relative to the vegetative phase so that in a matter of a few months the panicle stands above the old leafy crown. The reduction in leaf size previously mentioned, resulting in tubular, sheathing bracts, is clearly correlated with decrease in internode diameter.

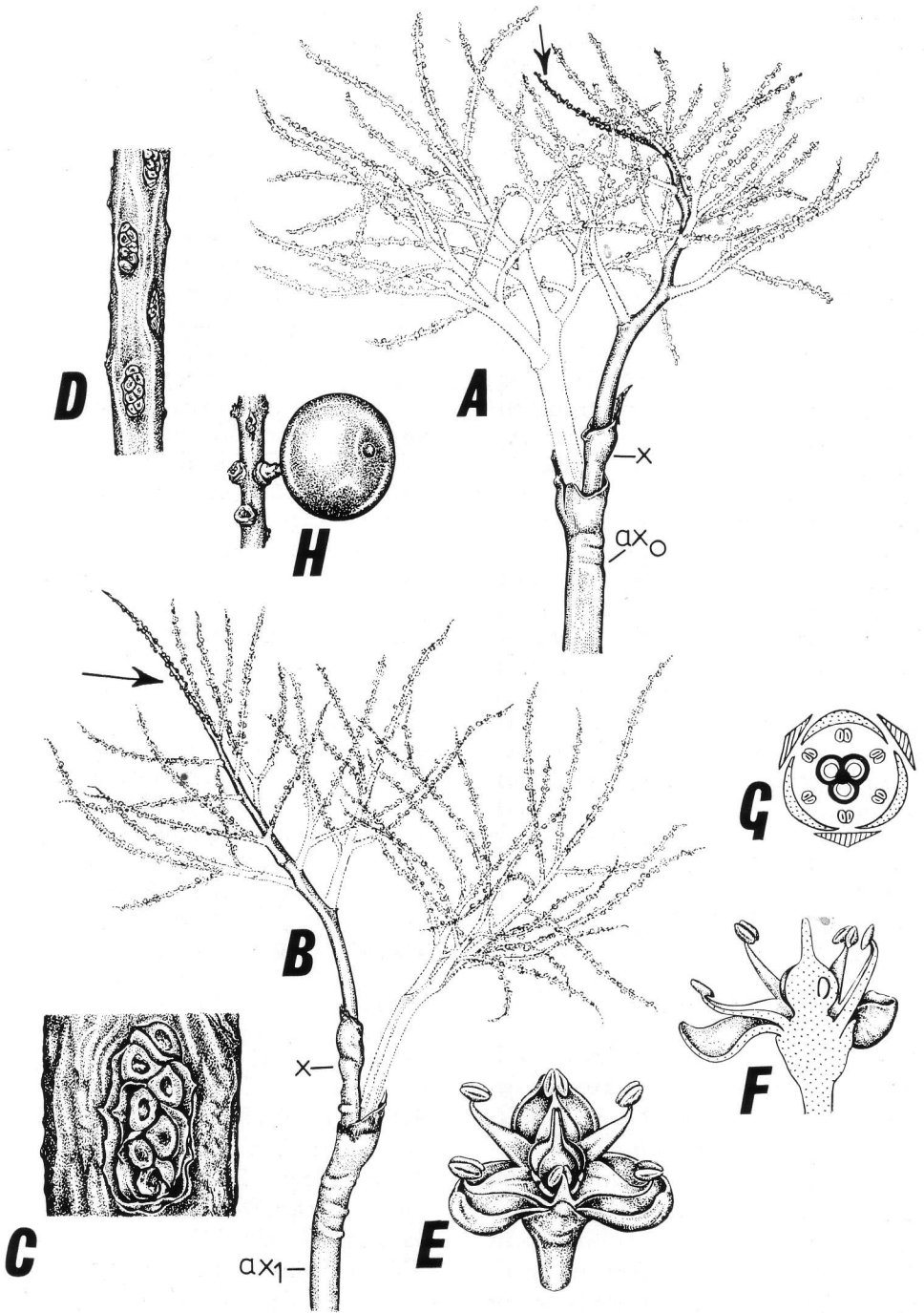
The lowest leaves on the main axis of the inflorescence have a dorsal cleft through which the subtended branch protrudes. This observation is contrary to that of Douglas and Bimontoro (1956) who emphasized that in *Corypha elata* the first-order branches protrude through the mouth of the sheath, in contrast to *Corypha umbraculifera* where they protrude through the dorsal cleft. This is probably not a good diagnostic feature by which to distinguish the two species since both conditions can occur on one axis. Bracts on the first-order branches (br_2 's) are tubular and papery, and resemble the distal bracts (br_1 's) on the main axis.

To give an accurate impression of the skeleton of the inflorescence, it is represented diagrammatically to scale in Figure 10. Here all the branches are drawn in one plane, whereas, in fact, they are arranged in a spiral which corresponds to that of the $3/8$ phyllotaxis. The most evident features of this spiral are certain parastichies. One series of these can be seen clearly in Figure 8A, which represents most of the main axis with each first-order branch cut off a little above its base. These parastichies probably correspond to those which are evident on the vegetative trunk and which serve as a diagnostic feature for this species (Douglas and Bimontoro, 1956).

Almost every bract subtends a single branch; the exceptions are empty bracts at the base of each first-order axis (Fig. 8B, C). On the proximal first-order

→

9. *Corypha elata*, further details of inflorescence construction. A. Termination ($\times 1/6$) of main axis (ax_0); its continuation into a rachilla is shown (arrow). Branches are shown in dotted outline. B. Termination ($\times 1/6$) of the first-order branch ($13 ax_1$) illustrated in Fig. 8B; its continuation into a rachilla is shown (arrow). Branches are shown in dotted outline. C. Single flower cluster ($\times 8$) with flowers represented by their scars; bracteoles evident. D. Portion of a rachilla ($\times 2$) with spirally-arranged flower clusters. E-G. Flowers of *Corypha* sp. ($\times 9/2$), from above (E), in longitudinal section (F), and as a floral diagram (G). These flowers are from a separate collection, *Read s.n.* Kingston, Jamaica. H. Ripe fruit attached to flower cluster on a rachilla ($\times 1$).



branches the first two bracts are commonly empty (Fig. 11). The first (1 br_2) is a distinct bicarinate prophyll (Fig. 8C). Second-order branches (ax_2) lack such a modified prophyll (Fig. 8D). There is an abrupt transition in bract shape from first- to second-order branches. On the first-order branches, bracts are tubular, except for distal ones; on second-order branches, the bract is represented merely by a short scale or even a ridge of tissue (Fig. 8D, E). An entire first-order branch with all but one ax_2 cut off is shown in Figure 8B; similarly, a single first-order branch is shown to scale in Figure 11, but with the second-order branches along it shown in one plane.

Branching continues to the fourth order on most second-order branches (Fig. 8E); branching to the fifth order is uncommon and occurs only on the lower parts of second-order branches, as shown in Figure 12. To indicate further the constructional principles, a first-order branch ($9ax_1$) is drawn out to scale in Figure 11 while a second-order branch* is shown diagrammatically in Figure 12. Comparison of the diagrammatic figures (Figs. 10–12) with the actual representation of parts in Figures 8 and 9 should allow one to reconstruct mentally the overall architecture of this inflorescence.

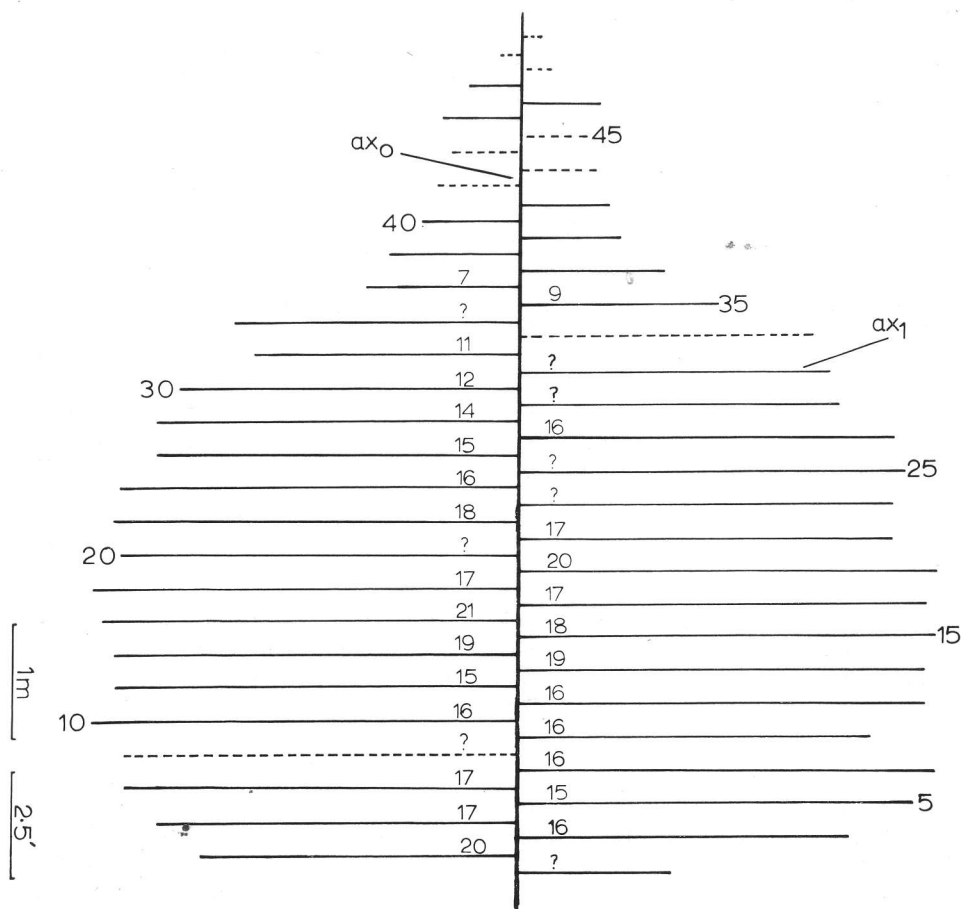
Rachillae

All axes end in rachillae, i.e. the ultimate visible flower-bearing axes, as defined by Tomlinson and Moore (1968). They are surprisingly uniform and average 25 cm. in length, which is helpful in subsequent calculation (Fig. 8E).

Distal parts of both the main axis and all first-order branches are much modified and resemble a second-order branch system, as is evident in Figures 9A, B. Similar modifications may be

seen in the first-order branches themselves. A distal first-order branch (38 ax_1) is shown in Figure 8F; here the prophyll subtends a branch and the bracts are scarcely tubular. Details of the end of the main axis (ax_0) itself is shown in Figure 9A, and of the end of a first-order branch (13 ax_1) is shown in Figure 9B to indicate the degree to which massive axes become reduced distally. There is usually a single empty bract below the ultimate branch system (x in Fig. 9A, B). Each axis terminates in a rachilla, following the rule we have pointed out; this terminal rachilla is shown in Figure 9A and 9B (arrows) with the branches in dotted outline to contrast with the parent axis. It is remarkable that the apical meristem of the palm, which in the vegetative condition generates an axis up to three feet in diameter, finally terminates in the narrow flower-bearing axis indicated by the arrow in Figure 9A.

The flowers are borne in clusters whose detailed morphology represent modified cincinni (Uhl, pers. comm.) of the type which occurs in other coryphoid palms (e.g. Uhl, 1969). The significant functional unit may be the flower cluster itself as much as the individual flower, and we largely restrict ourselves to a consideration of this unit in subsequent analysis. Flower clusters are elongated and arranged in regular spirals along the rachilla (Fig. 9C, D). Bracteoles are associated with the flower clusters, on the basis of one bracteole to one flower; the whole cluster itself is subtended by a single bract, represented by little more than a crescentic ridge of tissue. Figure 9C represents an old flower cluster from which all flowers have fallen, only their scars remaining without setting fruits. There seem to be from 5–10 flowers per cluster, but the number of functional flowers is difficult to establish.



10. *Corypha* inflorescence *in toto*. The main axis and first-order branches (ax_1) drawn to scale. The branches are all represented in one plane (not in the shallow spiral on which they are actually inserted—cf. Fig. 8A). Dotted lines represent incomplete branches or those which were not measured. Numbers to far left and right number axes successively, counting lowest as 1. Numbers near the insertion of each branch represent the total number of branched second-order branches (ax_2) on each first-order branch (ax_1), i.e. corresponding to the one drawn into Fig. 8B.

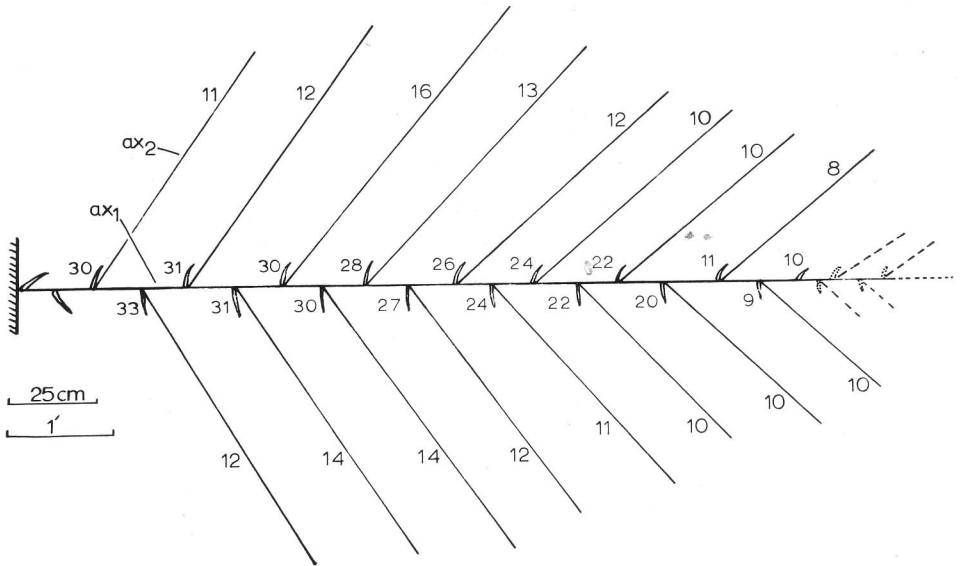
Flowers and Fruits

Flowers are perfect, with the parts in 3's but with 6 stamens. An example is shown from above, in vertical section and as a floral diagram in Figure 9E, F, and G respectively. The three carpels are fused; each contains a single ovule but normally only one of the three functions. Usually only one fruit per flower cluster matures (Fig. 9H); rarely are there two. Fruits are about 1.5 cm. in

diameter at maturity with an average dry weight of 2.3 gm. In old rachillae the sites of ripened but fallen fruits are easily identified by the persistent, enlarged and flattened calyx. These fruit scars are used in the counts presented subsequently.

QUANTITATIVE ASPECTS

So far we have established the constructional principles of the *Corypha*



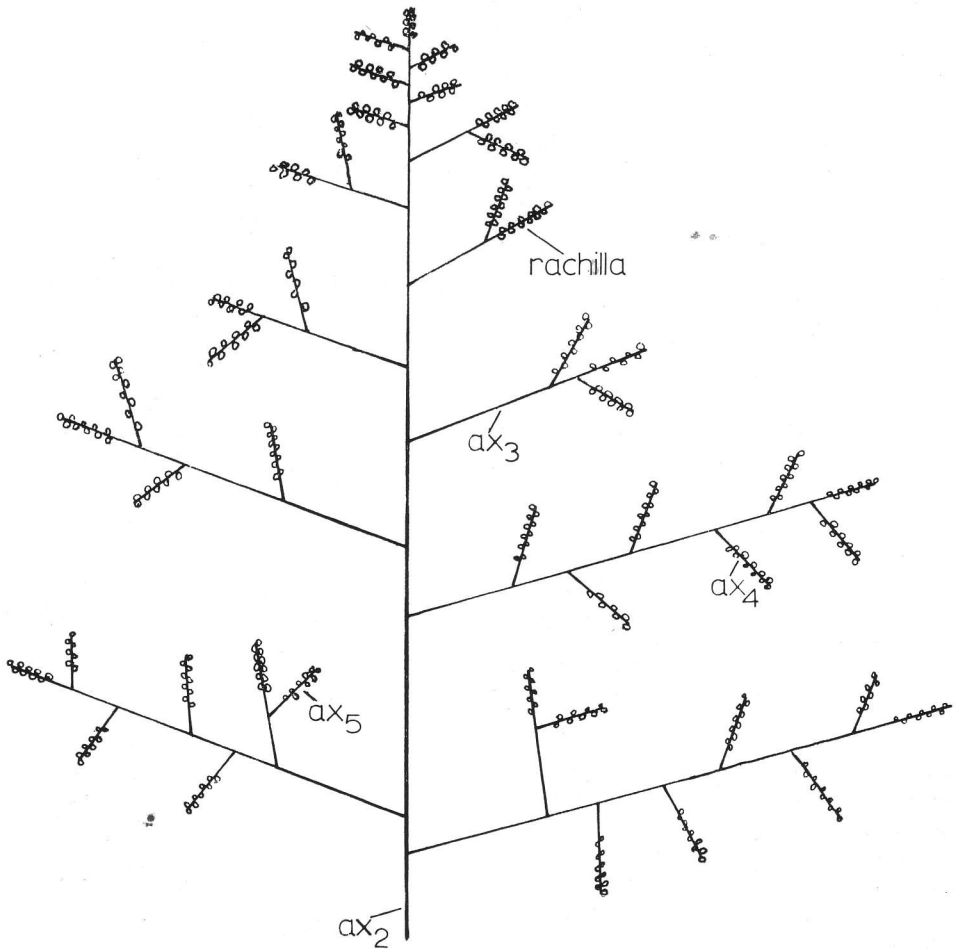
11. One first-order branch (9 ax_1) drawn to scale, showing the length of all branched second-order branches (ax_2). Branches are shown in one plane, not in the irregular spiral they actually describe. Numbers towards the end of each branch indicate the number of third-order branches (ax_3) on each second-order branch. Numbers at the base of each branch indicate the length (in cm.) of the subtending bract. This branch corresponds to the entire unit illustrated in Fig. 8B.

inflorescence on a qualitative basis. A series of measurements were made of quantitative features from representative samples which permit us, by a series of approximations, to arrive at the overall reproductive potential of this inflorescence. The calculations are a little involved, and only the results, with some indication of how they were arrived at, are included here.

Flower Number

Flower number is obtained from information about the total length of flower-bearing axes on the inflorescence; effectively an estimate of the total length of all rachillae was made. This is provided by the following information, added to an estimate of the total number of first- and second-order branches (omitting branches 49-51) taken from Figure 10, as follows:

Total number of first-order branches	=	48
Total length of all first-order branches	=	97.65 m. (320.3 ft.)
Average number of second-order branches per first-order branch	=	13.3
Total number of second-order branches	=	640
Average number of rachillae/second-order branch	=	33
Total number of rachillae	=	21,120
Average length of one rachilla	=	25 cm.
Total length of all rachillae	=	5,280 m.
Average number of flower clusters/rachilla	=	75
Estimated total number of flower clusters	=	1.58×10^6



12. *Corypha* inflorescence, ultimate branch complex, an actual example, but not drawn to scale. This corresponds to the single branch unit drawn in detail in the middle of Fig. 8B. Ultimate units (rachillae) are represented diagrammatically.

Estimated range of
 numbers of possible
 functional flowers = $3-15 \times 10^6$

The total number of flowers is not easily obtained, regardless of how precisely one is able to estimate total number of flower clusters, because the number of actual flowers in each cluster varies, but more importantly because a knowledge of the number of flowers in each flower cluster which reach functional maturity is quite imprecise (Fig.

9C suggests seven flowers on the basis of their scars). We have seen that each flower cluster normally produces, at most, one fruit, so that it may be hypothesized that the successful fertilization of one flower in a cluster causes the inhibition of further maturation of all younger flowers. In the above calculations we have used a range of 2-10 flowers per cluster in arriving at a range of final figures.

On this hypothesis the total number of flowers reaching anthesis per cluster

is simply a function of the age before successful pollination of any flower within each cluster. This is why it is biologically most meaningful to consider the flower cluster as the significant reproductive unit.

Estimating flower number on this basis we have arrived at a figure of the order of 10×10^6 for the total number of flowers per inflorescence (i.e. 10 million). This figure, having been arrived at by a series of approximations, can give us no more than an indication of the order of magnitude in the number of flowers produced, but the very large number involved can be grasped. Of particular interest is the total length of flower-bearing axes (i.e. rachillae) on this inflorescence; our figure is 5,280 m., i.e. if all the rachillae were laid end to end they would stretch more than three miles!!!

A more precise figure is obtained for the total dry weight of the fruits in this inflorescence, since a whole first-order branch (9 ax₁) with fully enlarged fruit was cut from the palm on February 1972 (Fig. 7). The total weight (wet) of fruits from this branch was measured together with the dry weight of a smaller sample. An estimate of the fraction of the total inflorescence represented by this axis is easily obtained from the information in Figure 10 and, assuming a continuous proportion between axis length and numbers of fruit borne, allows a calculation of total fruit weight (wet and dry). The value for the total fruit weight (dry) obtained in this way is 817.2 kg.

We have calculated the total number of fruits produced by two different means. On the one hand, by obtaining an average of the number of fruit scars per rachilla (11.5), and multiplying this value by the total estimated number of rachillae and, on the other hand, by dividing the average weight of a single

fruit (2.3 gm.) into our estimate of total fruit weight. The values arrived at are 242,800 and 355,290 fruits respectively. These figures are sufficiently close to suggest that our approximations represent something more than well-educated guesses and indicate that the inflorescence produced about a quarter of a million fruits. The values arrived at for fruit weights are: a) from dry weight of a large sample = 817.2 kg.; b) from an estimated 15 percent of flower clusters which form fruits = 545.1 kg.

Bioenergetics

We have so far established reasonably accurate figures for the total amount of dry matter (or "energy") which goes into the production of fruits in the flowering of this hapaxanthic palm and have produced a minimum value of 545.1 kg. It is interesting to ask "What proportion of the total biomass produced by the palm in its lifetime goes into its reproductive effort?" A series of measurements as follows gives us some indication of this value:

Total trunk biomass	= 863.5 kg.
Total leaf biomass	= 2,023 kg.
Total root biomass	
(estimated)	= 288.6 kg.
Total inflorescence biomass	= 49.3 kg.
Total biomass of fruits	= 545.1 kg.
Total biomass	= 3,769.5 kg.

These values are obtained crudely, as follows:

Trunk biomass. From an estimate of the total volume of the trunk (calculated from its dimensions and treating it as a regular truncated cone) and a knowledge of the dry weight of a small sample of calculated volume.

Total leaf biomass. From an estimate of the approximate total number of

leaves (counts of visible leaf scars, plus estimated 10 percent for leaf biomass produced in juvenile stages, i.e. before a visible trunk is developed) and a knowledge of the dry weight of a leaf taken from a cultivated specimen.

Total root biomass. A rough estimate of 10 percent of total leaf and trunk biomass.

Total inflorescence biomass. From a knowledge of the dry weight of samples of the inflorescence and the information contained in Figure 10. No account is taken of the weight of flowers, which were not available in our sample.

It is well known that starch accumulates in the trunk during the vegetative period and is rapidly mobilized and utilized during the flowering process, offering an interesting subject for study by translocation physiologists (van Die and Tammes, 1975). *Corypha* itself has been used extensively as a source of sugar and eventually alcohol by artificial tapping (Gibbs, 1911).

We can divide this mobilized reserve into that part which goes into the construction of the skeleton of the inflorescence and that part which goes into the fruits. On this basis we have the following figures:

Total biomass of the <i>Corypha</i> palm	= 3,769.5 kg.
Total biomass of fruits	= 545.1 kg.
Total biomass of inflorescence	= 49.3 kg.
Total reproductive biomass	= 594.4 kg.
Percentage of total biomass in repro- ductive biomass	= 15.77%

[If the higher value of fruit biomass (817.2 kg.) is used, the result is about 22%]

From these calculations, we can see that, if our measurements are at all reliable, the *Corypha* palm expends about 15 percent of its total energy budget on reproduction. The value should be corrected by a factor which accounts for loss of energy via respiration during the vegetative period of growth, i.e. the total biomass is underestimated by this factor but the value (e.g. 10 percent) would reduce the final percentage by a small figure.

CONCLUSIONS

From the above calculations, it can be concluded that about 15–20 percent of the total dry matter produced by the *Corypha* palm during its lifespan of about 50 years is eventually directed into its reproductive effort. These figures may seem inordinately high and could suggest that our measurements and the calculations based on them are suspect, which is possible in view of the small samples obtained and the approximations made. However, some corroborative evidence is available. Burkill (1935) records some 200 pounds (about 90 kg.) of starch in a palm which may be extracted as sago. This isolated figure seems too low to account for the dry matter which is finally incorporated in fruits but since we do not know the size of the palm measured, it is not very helpful.

The productivity of *Corypha* is more helpfully indicated by Gibbs (1911) who measured 2,699 liters of sap tapped from a tree with a volume of 2.71 cubic meters in a period of 132 days. The sap contained 252 kg. of sucrose. Average yields for other trees ranged from 180–324 kg. These values are somewhat lower than our calculated figures but it must be remembered that they are based on trees manipulated artificially in order to induce mobilization of reserves; this mobilization is likely to be less efficient

than during the natural process of fruit development. Also the tree measured in detail was much smaller than the one we have measured (2.71 cubic meters compared with 5.1 cubic meters). Our results thus seem to be of the right order of magnitude.

Furthermore, when other plants are considered, the values we have produced seem to represent gratifyingly close estimates. Long-lived woody plants which are monocarpic (once-flowering) are uncommon. The condition is familiar in a number of monocotyledons (e.g. some palms, *Agave*), a few dicotyledons (Hallé and Oldeman, 1970, p. 20), and has recently been described by Veillon (1971) for a branched apocynaceous tree, *Cerberiopsis candelabrum* Vieillard, native to New Caledonia. Otherwise, one has to turn to annual weeds for a comparable reproductive strategy. Here, since the continued survival of the species is entirely dependent on seeds, with the vegetative life span of each individual very short, a large percentage of the total biomass of each plant is expended on reproduction, i.e. the "reproductive effort" of the plant is high. For annual, weedy species, values of the order of 14–35 percent seem typical (Harper and Ogden, 1970). In perennial plants, e.g. trees, the values are much smaller than these although there seem to be no accurate measurements (Harper and Ogden, 1970). In its reproductive effort therefore, *Corypha* is comparable to an "annual" weed, but is unusual for the time span between successive flowerings (more than 40 years) and the stature that the plant achieves (about 20 m.).

It is worth making a more direct comparison with other palms. Precise figures for the African oil palm (*Elaeis guineensis* Jacq.) have been provided by Corley *et al.* (1971), Hardon *et al.* (1972) which show that higher values

(of the order of 50 percent) on the annual basis may be measured, i.e. in any one year the amounts of dry matter partitioned between fruit bunch, on the one hand, leaf and trunk, on the other, are about the same. On this scale, *Corypha* is seen to be less efficient than at least one other palm. The figures quoted for *Euterpe globosa* by Bannister (1970) are less complete but we have used them to arrive at a value of 4.5 percent for the reproductive biomass in this species.

Seed predation is known to be a significant factor in survival of plants with large seeds (Harper *et al.*, 1970). There was some evidence of beetle attack on fallen (and even attached) fruits of *Corypha*, but the high viability of seeds and the enormous numbers produced would seem to ensure survival of the palm. Production of large numbers of seeds at wide intervals is probably an effective way of combating seed predation. However, measurements need to be made on natural populations of *Corypha* with an understanding of the ecology of palms in wild sites.

For the present, our very tentative measurements suggest that despite its massive size, *Corypha* has to function essentially as an annual weed in order to survive.

SUMMARY

A *Corypha elata* palm which flowered and fruited during 1971–72 after 44 years of vegetative growth was estimated to have produced on the order of 10 million flowers on flower-bearing axes of a total length of 5,280 m. (more than three miles). The total number of ripe fruits was about a quarter of a million, with a total estimated dry weight of between 545 and 817 kg. (about 1,200–1,800 lbs.) which represented between 15 and 22 percent of the total dry weight produced by the palm during its total life span.

The palm is comparable to an annual weed in its division of biomass between reproductive and vegetative phases and its massive fruiting over wide intervals of time is probably a very effective way of surmounting seed predation.

Acknowledgements

We are indebted to Priscilla Fawcett, Botanical Illustrator, Fairchild Tropical Garden for Figures 8 and 9, to Dr. Martin H. Zimmermann, Harvard Forest for Figure 7, and to Dr. Dent Smith for the photograph which forms the cover picture. The assistance and interest of Mr. W. E. Manis, previously Horticulturist-in-Charge, U.S.D.A. Subtropical Horticultural Research Station is appreciated. Field assistance was provided by Gary Vitale and George Wilder.

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Brassiophoenix schumannii (Palmae)

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During the German colonization of "Kaiserwilhelmsland" (northeastern New Guinea) in the late 19th Century, German botanists carried out extensive exploration of their territory and contributed substantially to the general knowledge of the New Guinea flora. Unfortunately, most of the German palm collections were destroyed in Berlin during the second World War. Many of these specimens were types of new species from New Guinea, and we must now work with photographs and fragments in order to establish the identity of those species. One of them, *Actinophloeus schumannii* described by Beccari in 1889, has long perplexed botanists who have seen the specimens Beccari annotated as belonging in the species. These later annotators have identified the specimens as belonging to *Drymophloeus*, *Ptychococcus*, or as being mixed collections involving these two genera and *Ptychosperma*. Indeed, the specimens would appear to combine the inflorescence of a *Ptychosperma*, the leaves of a *Drymophloeus* and the fruit of a *Ptychococcus*. Max Burret, who had identified Beccari's species as belonging in *Ptychococcus*, subsequently described a new genus, *Brassiophoenix*, with the single species *B. drymophloeoides*, which was characterized by just this seemingly odd combination of characteristics. Burret apparently had forgotten about *Actinophloeus schumannii* at this time, otherwise he would surely have recognized the similarity of his new genus and species to Beccari's species. *Actinophloeus schumannii* has, in fact, now

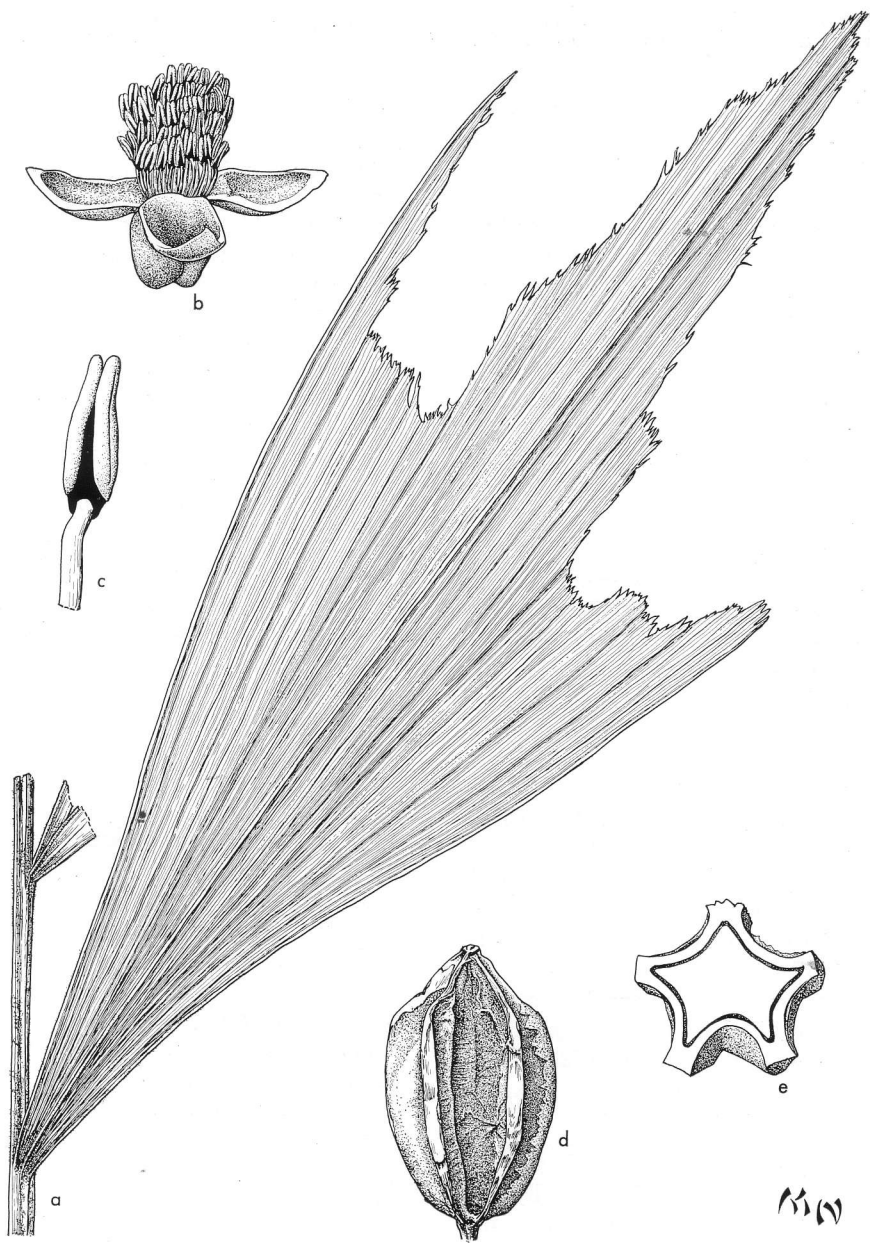
been determined to be another species of the genus *Brassiophoenix*.

Brassiophoenix is distinguished among the ptychospermate palms by a number of unusual characters. The most distinctive of these is the oddly shaped pinnae. The central pinnae of mature fronds are three-pronged. The two marginal nerves and midnerve are prolonged and alternate with two deep praemorse sinuses at the apex. In other ptychospermate genera the pinnae are convexly praemorse (e. g. *Drymophloeus*), obliquely or concavely praemorse or notched (e. g. *Ptychosperma*), or nearly acute at the apex (e. g. *Veitchia*).

Less conspicuous, but possibly of more diagnostic importance, are the basifixed anthers and small, inconspicuous pistillode of the staminate flowers. In all other ptychospermate palms, anthers are dorsifixed and versatile and in most the pistillode is well developed (exceptions occur in *Ptychosperma* subgenus *Ponapea* and in some species of *Drymophloeus*).

The fruit of *Brassiophoenix* is superficially very similar to that of *Ptychococcus* in having a thick, extremely hard endocarp, but can be distinguished anatomically (Essig, unpublished). The inflorescence is rather long-pedunculate, with the inner enclosing bract well exerted from the outer bract (prophyll) just before opening. In this way the inflorescence is more like that of *Drymophloeus* than of *Ptychosperma* or *Ptychococcus*.

The question now arises as to the relationship of *Brassiophoenix schu-*



1. *Brassiophoenix schumannii*. a, pinna $\times \frac{1}{8}$; b, staminate flower $\times 2\frac{2}{8}$; c, stamen $\times 13$; d, endocarp, external view, $\times 1$; e, endocarp and seed, cross-section, $\times 1$ (all from Essig LAE 55161, BH).

mannii with *B. drymophloeoides*. *Brassiophoenix schumannii* has priority under the rules of nomenclature if the two are to be combined. However, there does seem to be sufficient basis for recognizing two species in the genus at least provisionally. A synopsis of the differences between the two species is presented below, followed by a full description and citation of specimens for

Brassiophoenix schumannii. A list of specimens for *B. drymophloeoides* is appended for the benefit of those interested in pursuing the problem. The latter species is actually known from relatively few specimens and I would recommend that more extensive collections and field studies be made of both species before a final decision is made on their taxonomy.

	<i>B. schumannii</i>	<i>B. drymophloeoides</i>
1. Mature fruit color	pale yellow-orange	red
2. Inflorescence vesture	thickly dark-lepidote-tomentose	densely white-woolly or very sparsely dark-lepidote-tomentose

Brassiophoenix schumannii (Beccari) F. B. Essig *comb. nov.*

Actinophloeus schumannii Beccari in K. Schumann & M. Hollrung, Die Flora von Kaiserwilhemsland, 15. 1889.

Neotype: *Lauterbach 857*, FI! (Holotype: *Hollrung 264*, B, destroyed, no photograph known).

Drymophloeus schumannii (Beccari) Warburg ex K. Lauterbach & K. Schumann, Flora von der deutschen Schutzgebiete der Südsee, 207. 1901.

Ptychococcus schumannii (Beccari) Burret, Feddes Repert. Spec. Nov. Regni Veg. 24: 262. 1928.

A slender, solitary palm; stem 2–10 m. tall, 3–5 cm. in diam.

Leaves ca. 9, spreading; sheath 30–50 cm. long, densely white woolly and brown punctulate throughout, sometimes with an inconspicuous triangular appendage at the apex opposite the petiole; petiole 20–45 cm. long, densely white woolly and sparsely to moderately lepidote with brown punctiform scales and dark, irregular ramenta; rachis 130–300 cm. long, lepidote as on

rachis, sometimes very densely lepidote around and on base of the pinnae; pinnae 8–10 on each side, regularly or irregularly arranged, basal pinnae reduced and sometimes crowded, central pinnae cuneate, praemorsely 3-pronged, 38–68 cm. long on the midrib, 22–27 cm. broad just below the two deep notches, apical pinnae wedge-shaped, 3–4-ribbed, ca. half as long as central pinnae.

Inflorescence branched to 2 or 3 orders, 25–74 cm. long, 22–58 cm. wide, with peduncle ca. $\frac{1}{4}$ – $\frac{1}{3}$ as long as the rachis, complete peduncular bract twice as long as prophyll and exerted from it at maturity; axes thickly dark lepidote-tomentose and somewhat white woolly when young, glabrescent with age; upper peduncular bracts 1 or 2, very small and ribbonlike or sometimes triangular to elongate, 2–7.5 cm. long; rachillae 1.5–4 mm. thick in the middle, 9.5–28 cm. long, each bearing 28–60 triads and diads.

Flowers cream-colored or yellow-green, glabrous or sparsely punctate; staminate flowers 7–9 mm. long, 3–5 mm. wide, with calyx ca. 2–2.5 mm. high, stamens ca. 130–200; pistillate

buds ca. 6 mm. high and 4–6 mm. broad at staminate anthesis.

Fruit yellow-orange at maturity, ellipsoid, 31–35 mm. long, 17–19 mm. in diam. when dry, outer part of the fruit wall drying in close conformity to the angled endocarp when incompletely ripe, but drying apart from the endocarp when fully ripe, endocarp 5- or 9-ribbed; seed 5-grooved with the lobes squarish or acute in cross-section, endosperm homogeneous.

Distribution: New Guinea, rain forest from Sepik River Basin to Milne Bay District.

Vernacular names: None recorded.

Specimens examined: PAPUA NEW GUINEA. **East Sepik District:** Sepik River, 120 sea miles from the mouth, fruit orange-yellow, *Hollrung 264* (B, holotype destroyed, no photo known, data according to Beccari, 1889); Angoram Subdistrict, 1 mile north of Angoram on road to Gavien, alt. 50 ft., disturbed forest, *F. B. Essig LAE 55108* (BH, LAE); **Madang District:** Bismarck Mountains, 5 July 1899, *Ramu Expedition (Rødety & Krause ?)* 222 (B, destroyed: photo at BH); Gogol River, 4 November 1890, *Lauterbach 857*, (B, destroyed; FI, neotype, photos and fragments, photos also at BH); Gogol River, 9 November 1890, *Lauterbach 1535* (BH); Gogol River, swampy lowland forest about 1 mile from Forest camp, alt. 100 ft., 11 October 1971, *F. B. Essig & P. Katik LAE 55052* (BH, LAE); **Morobe District:** Lae Subdistrict, mountain slopes of the south side of the Mo River Valley, a few miles southeast of Ana Village, alt. ca. 500 ft., 28 January 1972, *F. B. Essig LAE 55161* (BH, LAE); **Northern District:** north of Ioma on walking track to Nindewari, alt. ca. 200 ft., ridge top and slopes in lowland rain forest, 2 June 1967, *M. J. E. Coode & P. Katik*

NGF 29978 (BH, LAE); **Milne Bay District:** Raba Raba Subdistrict, Biniguni camp, Gwariu River, alt. 200 m., 6 August 1953, *L. J. Brass 23853* (A, BH); Peria Creek, Kwagira River, alt. 50 m., rain forest, 17 August 1953, *L. J. Brass 24034* (A, BH); Biniguni, alt. 60 m., advanced regrowth, 27 June 1972, *H. Streimann 28561* (BH, LAE); Mt. Suckling, Mayu camp I, alt. 360 m., lowland forest, 15 June 1972, *G. Leach LAE 56015* (BH, LAE). CULTIVATED. U.S.A.: Florida, Fairchild Tropical Garden, "Rainforest," 1972, *S. Donachie s. n.* (plant # FG 3172, apparently progeny of a Brass collection from the Biniguni area in 1956) (BH).

Lauterbach 857 has been selected as a neotype since it is the best extant specimen annotated by Beccari himself as belonging in the species.

Brassiophoenix drymophloeoides

Burret, Notizbl. Bot. Gart. Berlin-Dahlem 12:345. 1935.

Holotype: *L. J. Brass 5665*, A!

Distribution: Papua, from southern Milne Bay District to Central District.

Vernacular names: *Pawa* (Mekeo language, Maipa Village, *vide* Darbyshire).

Specimens examined: PAPUA NEW GUINEA. **Central District:** Kabuna, alt. 100 m., rain forest, November 1933, *L. J. Brass 5665* (A, holotype); Kairuku Subdistrict, near Maipa Airstrip, Maipa Village, alt. 180 ft., in damp shaded position in tall forest, 17 September 1962, *P. J. Darbyshire 964* (BH); Abau Subdistrict, Mori River, Cape Rodney, forest on flat land, 20 June 1968. *E. E. Henty NGF 38558* (BH); Milne Bay District; Sagarai valley, inland from Mullins Harbour, alt. 100 ft., open understory, 9 June 1964, *J. S. Womersley NGF 19272* (BH).

Indigenous Royal Palms in the Bahamas

WILLIAM T. GILLIS,¹ GEORGE R. PROCTOR,² AND GEORGE N. AVERY³

"*Roystonea regia* (H. B. K.) O. F. Cook, Royal palm, recorded from the Bahamas, is known to us in the archipelago only as a planted tree." This is the reference to royal palm in the Bahamas from Britton and Millspaugh's *Bahama Flora* (1920). Until now, the statement was thought to be true. Recently, a population of royal palms was discovered on Little Inagua, a rhombic island about seven miles on a side off the northeast tip of Great Inagua (Fig. 1). The island was never inhabited, and was cultivated only to the extent of grazing goats and donkeys by residents of the northeastern tip of Inagua in the last century. With the development of the solar salt industry on Inagua, all settlements disappeared but the main one at the southwest corner of the island at Matthew Town, and Little Inagua became once again isolated from the activities of man.

The third author spotted the royal palms on Little Inagua during an overflight in February 1973. Their presence was confirmed by all three authors in June 1974, again from a plane (Fig. 2). The palms are restricted to the northwest quadrant of the island, and number between 30 and 40 individuals. They are restricted to sinkholes which presumably are somewhat moist as contrasted to the surrounding exceedingly dry scrub. Rainfall records for Little Inagua are unknown, but parts of Inagua for which records are maintained receive generally

less than 20 inches per year. That the sinkholes are refugia for moisture-requiring plants is evident from the associated *Sabal* species in the sinkholes with the *Roystonea*: sabals are always indicators of somewhat wetter soils in the southern Bahamas. There are from one to eight royals per sinkhole.

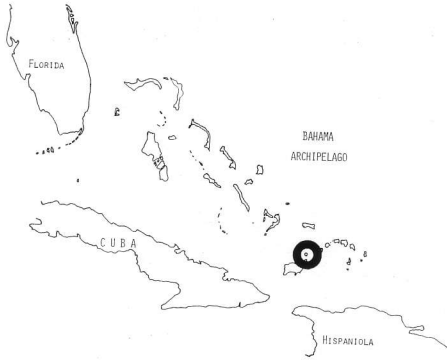
It was not possible, of course, to determine the species of *Roystonea* from the air, but we believe that they are *R. regia*, disjunct from Cuba which is 110 miles to the southwest. (All distances are checked according to "Tactical Pilotage Chart J-26B," an air pilot map covering the southern Bahamas.) We cannot account for the presence of royals on Little Inagua and their exclusion from other islands of the southern Bahamas and the Turks and Caicos Islands, especially Inagua itself. Until we are certain of the species, we cannot speculate on the point of origin. Hurricanes or birds are possible vectors (Guppy, 1917). They could, of course, be relics from wetter periods of the past, but there is no evidence presently available to suggest that these islands were ever more mesic.

How is it that these palms were not discovered before? Only two botanical expeditions have ever visited Little Inagua in the past, that of George V. Nash and Norman Taylor in October, 1904, and that of Percy Wilson in 1907. They landed by boat at the only good anchorage which is Moujean Harbor, two to three miles to the west of the southeast corner of the island. Nash (1905) reported that they then visited Northwest Point by boat, and also made a landing at the midpoint of the west shore to examine a *Coccothrinax*. He reported a

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1. Map of northern West Indies, showing Bahamas and adjacent lands. Circle denotes Little Inagua.

25-foot plateau beyond them. It is likely that this ridge interrupted his view to the interior or he might have seen the palms. The palms were surely present seventy years ago. Another possible obstruction to Nash, Taylor, and Wilson, is an east-west ridge which runs across the southern quarter of the island. Although we have no proof, we can surmise that they did not cross far beyond the ridge in the short time they were present on the southern shore of the island. Even if they had, it is doubtful whether they could have seen the palms four miles away across the scrub. Because of the droughty nature of the island, it was not wise for an explorer to venture too far into the interior without a substantial water supply. It remained for reconnaissance by air to locate the royal palms in Little Inagua.

We wish to thank Turks and Caicos Airways, its managers, and especially pilot Berkeley Barron for cooperation in making the flights referred to above. Research was sponsored in 1973 by a generous grant to the Arnold Arboretum of Harvard University by an anonymous



2. Royal palms in sinkhole on Little Inagua, Bahamas.

donor interested in the flora of the Bahamas. The visit in 1974 was underwritten by a grant to the first author by the National Geographic Society for botanical exploration in Inagua and the Turks and Caicos Islands.

Since this paper was submitted for publication, Mr. Donald Buden of Louisiana State University has visited Little Inagua for purposes of studying the vertebrate species present on the island. At our urging, he worked his way to the royal palm populations and shot some fruits out of one of the trees for verification purposes. Dr. Robert W. Read has graciously examined the specimens and confirmed that these trees are indeed *Roystonea*, and not exceedingly large examples of *Pseudophoenix*. These specimens are deposited at US and IJ.

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Hermaphroditism in *Borassus flabellifer* from South India

I. HENRY LOUIS¹ AND V. EUGENE MARY²

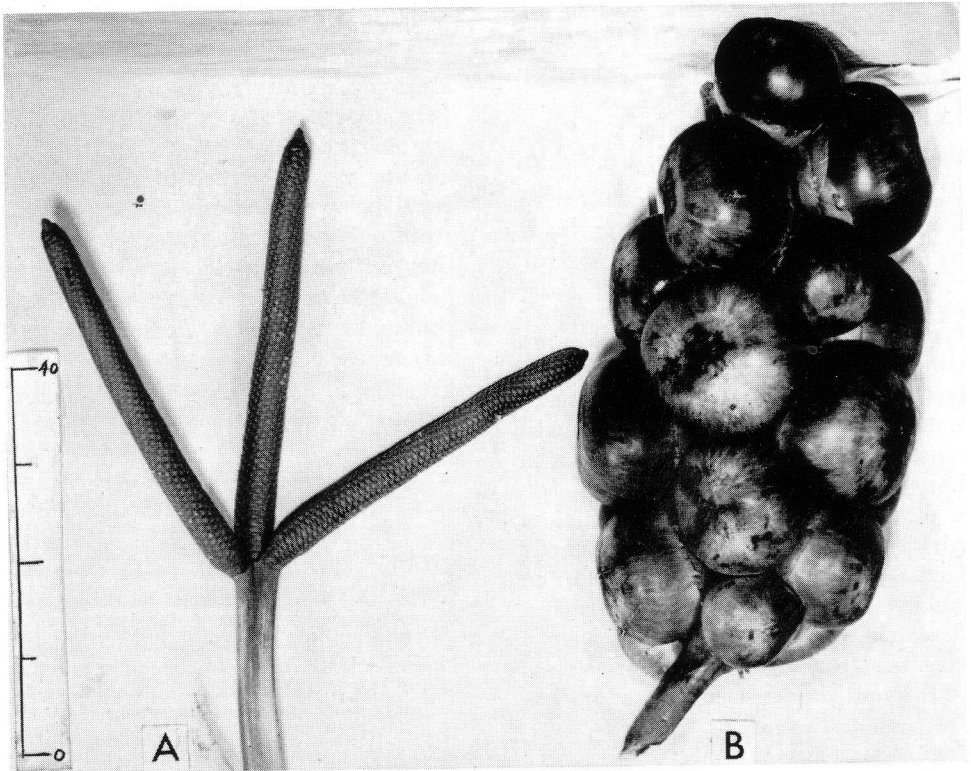
The authors have come across a palmyra palm (*Borassus flabellifer* L.) at Nagercoil, Kanyakumari District (Tamil Nadu), which exhibits hermaphroditism. The tree is 20 meters (more than 60 feet) high and is estimated to have an age of 40 years. It is tapped for sweet toddy by chopping the tender

inflorescences regularly. Occasionally one or two inflorescences are left unchopped.

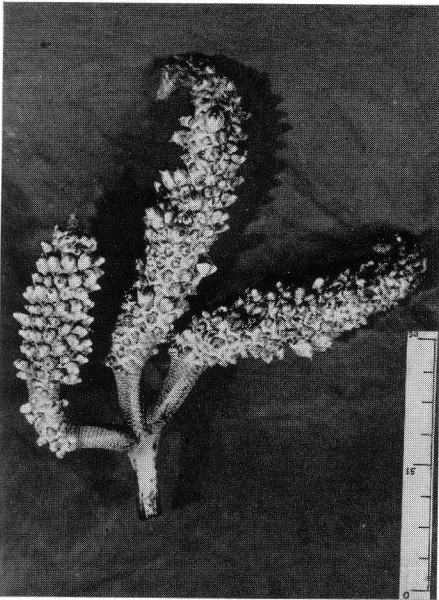
The palm produces spadices with branches which appear from a distance to be typical of a male tree of the usual *Borassus flabellifer* which is a dioecious palm. Hence the unusual nature of this tree escapes the notice of a casual observer from the ground. This apparently normal kind of inflorescence, coupled with the prevalent practice of

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1. Normal inflorescence parts of *Borassus flabellifer*: male spikes (A) and a female spike in immature fruit (B).

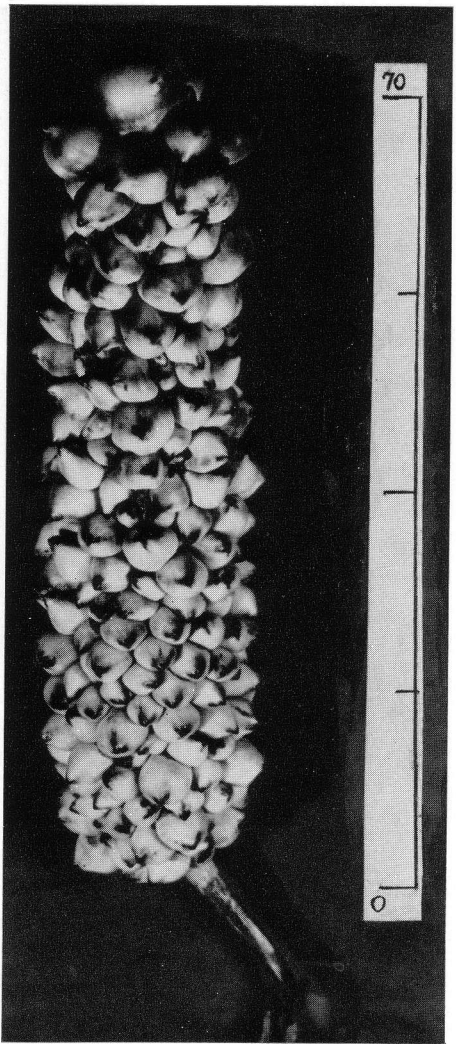


2. Primary peduncle of a hermaphroditic individual having three spikes, each with a basal sterile portion.

tapping, handicaps the observer looking for similar palms in other localities. However, intensive search is being made in the same district and also in other neighboring districts to see if there are other palms with hermaphroditic flowers.

Each primary spathe accommodates five to seven peduncles and each peduncle has a secondary spathe. Two or three (or sometimes only one) cylindrical spikes are borne digitately at the apex of the peduncle in a manner characteristic of the male inflorescence of a normal individual. The spikes are 30–40 cm. long and 2–3.5 cm. across, slightly tapering towards the apex. Flowers are embedded in concavities concealed by bracts.

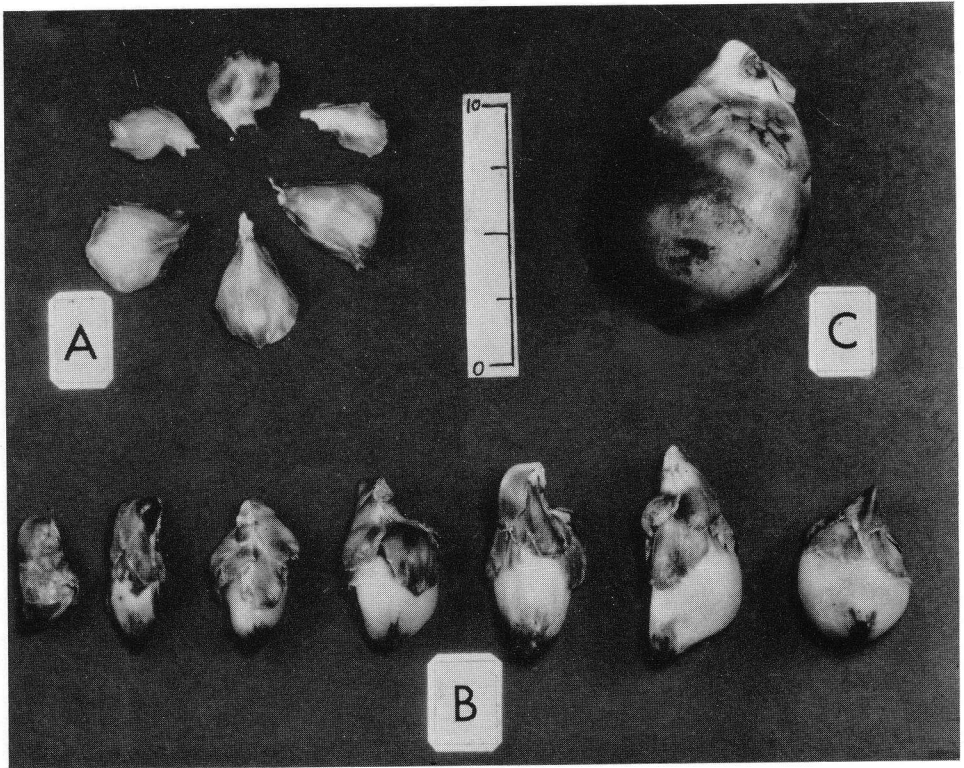
A few days after opening of the spathe, the spikes swell slightly and minute conical bisexual flowers appear, pushing the bracts from the pits and commencing from the apex but later



3. A primary peduncle of a hermaphroditic individual with a single spike of young fruits.

randomly throughout the spike. The bracts are auricular and persistent. Flowers are sessile with a perianth of three sepals and three petals loosely imbricate and persistent around the ovary at its base.

It is interesting to note that flowers exhibit dimorphism in the development of stamens. Some stamens have long filaments and large anthers (about one-



4. Flowers and fruits from a hermaphroditic individual of *Borassus flabellifer*: perianth parts at A; flowers at different stages of development at B; immature fruit at C.

third of the total flower) and the rest have short filaments and small anthers. As a whole, the stamens are much longer than in the normal male flowers of the dioecious palm. Perianth segments are obovate, cuneate at the base, and only one-fifth as long as those of normal female flowers. Stamens are six with filaments broadened towards the base and touching the contiguous ones. Anthers are linear, bilocular, and longitudinally dehiscent. The gynoecium is syncarpous, formed of three or four carpels. The conical ovary has a very short style with stigmatic lobes.

The authors counted as many as 300-600 hermaphroditic flowers in different spikes in contrast to 50-70 female flowers of a normal pistillate inflores-

cence which is quite large and conspicuous and can be distinguished even before its emergence from the primary spathe. The normal female spike is solitary and the female buds, covered by large bracts, can be located many days before their emergence from the spathe by their enormous size. The hermaphroditic buds, as previously noted, are concealed by bracts and become visible only when they completely emerge.

Fruits on the hermaphroditic individual are numerous, congested, oblong to ovoid, about 8 cm. across, and with three or four seeds. These seeds germinate with ease and the seedlings, though small, are vigorous in growth.

Hermaphroditic inflorescences appear

regularly in this tree which seems to be good material for geneticists and taxonomists to explore further, hence worthy of immediate protection and propagation. The development of female floral organs apparently from the male spike is interesting from the point of view of evolution of sex differences in palms. The hermaphroditism observed here suggests a reversion to an ancestral stage in the evolution of the present-day dioecious palmyra palm. Cytological studies are being conducted to throw light on the taxonomic status of the new find. Similar but slightly modified cases of abnormal inflorescences have also been brought to the notice of the authors and they are being studied critically. It may be noted that in the coconut palm, *Cocos nucifera* L., male and female gametophytes are borne on the same sporophyte, but intermediates between hermaphroditism and monoecism, and again between monoecism and dioecism have been reported by various workers (Beven, 1891; Davis, Anandan and Menon, 1954; Gopal Rao, 1948; Jacob, 1941; John and Narayana, 1942).

Summary

The occurrence of hermaphroditism in *Borassus flabellifer*, normally a dioecious palm (Blatter, 1926; Chathukutty Nambiar, 1954), is reported for the first time. The hermaphroditic flowers are produced in spikes more comparable to

the male spikes than to the female ones of normal unisexual individuals. The bisexual flowers produce fertile seeds from which seedlings have been raised.

Acknowledgments

The authors record their thanks to professors Sri P. V. Marappan and Sreerangaswamy, Tamilnadu Agricultural University, Coimbatore for encouragement, and to the Botanical Survey of India, Coimbatore for help in the critical study of the material and in the preparation of this note.

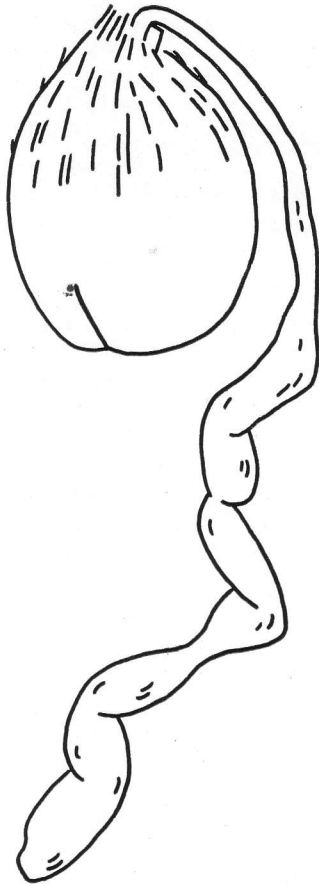
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PALM QUESTIONS AND ANSWERS

Q. I am interested in planting several gingerbread (*Hyphaene*) and *Borassus* seeds. I have been told that they must be planted in deep pots because of their tap root system. Is this necessary? Can I plant them in the ground and transplant them later?

A. The borassoid palms (the genera *Bismarckia*, *Borassodendron*, *Borassus*, *Hyphaene*, *Latania*, and *Lodoicea* as we know them horticulturally) are a peculiar group when it comes to germination and transplanting. They



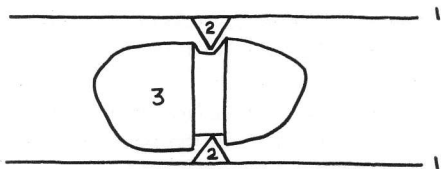
1. Germinating seed of *Borassus* with sinker.

have a fleshy cotyledon (sinker) which, when allowed to descend into the ground, usually cannot be moved successfully. For this reason, these palms are not grown in field nurseries to be dug and sold later. An exception are the latanias which can be moved, but the percentage of mortality is high unless they are handled carefully.

The seeds of the borassoid palms need not be planted in deep pots. They can be germinated in shallow containers with the seed partially buried and kept moist. As soon as they germinate they must be planted in the ground or in regular-sized containers. Restricting the downward movement of this sinker usually results in the shoot being produced earlier. Many times the cotyledon will coil around in the container, but still produce a shoot. A *Borassus* seed and its sinker are illustrated (Fig. 1).

Q. I have never had any success in germinating seeds of the cocosoid palms such as *Parajubaea*, *Astrocaryum*, *Polyandrococos*, and *Scheelea*. Do you know an easy method to germinate them?

A. Cocosoid palms are notoriously difficult and slow to germinate, since the endocarp enclosing the seed is woody and moisture does not penetrate readily. Dr. Merrill Wilcox, a professor at the University of Florida, has devised a method of "shelling" the seeds of *Parajubaea cocoides* to increase germination and yet not cause damage. His method, rarely injuring the seed, is illustrated (Fig. 2). A vise is slowly closed, forcing pieces of a triangle file into the endocarp which has been cut about 3/32 inch deep. This method of penetrating the endocarp allows for entrance of moisture and ensures faster germination. Sim-



2. Cracking the endocarp of *Parajubaea coarctata*. The endocarp (3) is cut on the small circumference about 3/32 inch deep with a hack saw. The halves are then broken apart by closing a vise (1) slowly on pieces of a triangular file (2) with grooves ground off and edges sharpened. This method rarely injures the seed.

ply cracking the endocarp with a hammer will do the same, but the seed inside is then usually damaged.

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PALM LITERATURE

DRANSFIELD, JOHN. Notes on the palm flora of central Sumatra. *Reinwardtia* 8(4): 519-531, 1974.

Dr. Dransfield, like Dr. Read (see below), has been privileged to study palms over a long period, he in Malaysia and Indonesia. This account of five weeks spent studying rattans and other palms in central Sumatra provides an insight into the palms of diverse habitats on an island which has been much less explored than its neighbor, Java. Dr. Dransfield and his associates collected or observed about 115 kinds of palms, some of which appear to be new to science.

READ, ROBERT W. The Genus *Thrinax* (Palmae: Coryphoideae). Smithsonian Contributions to Botany, Number 19, i-iii, frontispiece, 1-98, figures 1-57, tables 1-5. Smithsonian Insti-

tution Press, Washington, D. C., 13 March 1975. For sale by the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. 20402. \$2.40 (paper cover).

The publication of this monograph of *Thrinax* represents a first and highly successful attempt to study palms of the New World using a biosystematic approach based on intimate experience with the genus over a period of years and most especially during two years of residence in Jamaica where three of four species are native. It was this residence that enabled Dr. Read to make detailed analyses of variation, observations on ecology, the breeding system, the effects of attack by fungus and insects, and studies of cytology that supplement information from morphology and anatomy in *Thrinax*. Accounts of these, together with a history of the genus, precede a detailed systematic section in which four species, one with two subspecies, are accepted.

One of the most satisfying results of this study is the demonstration that quantitative differences are of little real importance but that qualitative differences in leaf sheath, leaf blade, color and puberulence of the inflorescence, and color of flowers are those which must be relied upon to distinguish species. A study of leaf anatomy made clear the identity of *Thrinax radiata*, a wide-ranging species, which has been known variously as *T. floridana*, *T. wendlandiana*, *T. martii*, and by the misapplied names *T. pumilio*, *T. parviflora*, *T. excelsa*, and *T. multiflora*. True *Thrinax parviflora* and *T. excelsa* are restricted to Jamaica. The only species not found on Jamaica is *Thrinax morrisii* from the Lesser Antilles to Florida and the Bahama Islands which has a lengthy synonymy including the names *T. microcarpa*, *T. keyensis*, and *T. ponceana* used in floras and in horticulture.

REITZ, RAULINO. Flora Illustrada Catarinense. Parte I. Palmeiras. 189 pp., 67 figs., 12 maps. Herbário "Barbosa Rodrigues," Itajai, Santa Catarina, Brasil. 30 August 1974.

Treatments of all species of the eight native genera—*Trithrinax*, *Butia*, *Bactris*, *Astrocaryum*, *Euterpe*, *Attalea*, *Geonoma*, *Arecastrum*—are augmented by accounts of the principal cultivated palms to a total of 25 genera and 35 species. Photographic illustrations accompany the text which is in Portuguese. Keys to species, ample descriptions, data on times of flowering and fruiting, common names, ecological observations (by Roberto M. Klein), distribution, and uses are given for the native palms, and cultivated palms are nearly as completely treated.

JOURNAL OF PLANTATION CROPS. Published by The Indian Society for Plantation Crops, Central Plantation Crops Research Institute, Kasaragod 670 124, Kerala, India. \$10.00.

This is a new journal intended ". . . for speedy publication of original articles and invited reviews on all aspects of all plantation crops including spices and condiments." Each volume will consist of about 125 pages in two numbers. Articles may be on agronomy, genetics and breeding, diseases and pests, processing and marketing. The first issue, published in 1973, contains two articles on palms: a study of somatic chromosome complements of tall and dwarf coconuts (*Cocos nucifera* L.) and its bearing on intervarietal variation and evolution in coconuts by T. G. Raveendranath and C. A. Ninan; and a study of control of the red palm weevil on coconut by P. V. Subba Rao, T. R. Subramanian, and E. V. Abraham. It is likely that more articles will follow since coconuts and arecanuts (*Areca*

catechu L.) are important plantation crops in India.

PROCEEDINGS OF THE FIRST NATIONAL SYMPOSIUM ON PLANTATION CROPS, DECEMBER 8-9, 1972, TRIVANDRUM, KERALA. Journal of Plantation Crops Volume 1 (Supplement). 1973 [1974]. Available from The Secretary, Indian Society for Plantation Crops, Central Plantation Crops Research Institute, Kasaragod 670 124, Kerala, India. \$20.00.

Seven sessions of this symposium were devoted to genetics and plant breeding, agronomy and soil science, physiology and biochemistry, plant pathology, entomology, technology, and a panel discussion. Seventeen articles or abstracts of papers presented relate directly to the coconut and arecanut.

H. E. MOORE, JR.

WHAT'S IN A NAME

Phoenix (féé nix) (f.) is a Latin transcription of the Greek *phoinix* (date palm, palm) and thus is feminine in gender, unlike the masculine gender of *Phoenix* when used for a fabulous bird or for a companion of Achilles in Greek legend. The name has been used in combination with other words, probably in the sense of "palm," in the following generic names which are also feminine in gender: *Acanthophoenix* (see *Principes* 12: 142, 1968 for explanation), *Archontophoenix* (see *Principes* 3: 143, 1959 for explanation), *Beccariophoenix*, *Brassiophoenix*, *Chamaephoenix*, *Chunioophoenix*, *Cyphophoenix*, *Englerophoenix*, *Phoenicophorium*, *Pseudophoenix*, *Rehderophoenix*, *Tessmanniophoenix*, *Toxophoenix*, *Vitiphoenix*.

Beccariophoenix (bek áre ee o féé nix) combines with *phoenix* the name of Odoardo Beccari (1843-1920), an

Italian botanist and one of the great students of palms. Beccari spent several years in the Old World tropics and later worked on palms for many years at Florence. His monographs of lepidocaryoid palms in particular are exceptionally useful because of their excellent descriptions and photographic illustrations. A biographical note (in Italian) appeared in *Webbia* 5: 295-343, 1921.

Brassiophoenix (bráss ee o fée nix) honors the late Leonard J. Brass (1900-1971) whose exceptional collections of palms in New Guinea and the Solomon Islands provided the materials which served for the description of numerous species. An appreciation of Dr. Brass with photograph appeared in *Journal of the Arnold Arboretum* 52: 695-698, 1971.

Chamaephoenix (kám ee fée nix) comes from the Greek *chamai* which means "on the ground," thus dwarf or low-growing, combined with *phoenix* to give dwarf palm or dwarf date palm. The name is a synonym for *Pseudophoenix*.

Chuniophoenix (chún ee o fée nix) honors W. Y. Chun who was Director of the Botanical Institute, College of Agriculture, Sun Yatsen University, Canton, China about 1937 when Burret described the genus.

Cyphophoenix (sí foe fée nix) was not explained but is taken from the Greek *kyphos* (bent, humped, hunch-backed) and *phoenix*. Possibly the fruit, which has a prominent terminal stigmatic residue, accounts for the name.

Englerophoenix (éng ler o fée nix) uses the name of Heinrich Gustav Adolf Engler (1844-1930) in combination with *phoenix*. Engler was a German botanist who initiated and edited a series of ambitious botanical works dealing with plants on a world basis and following a system largely devised

by himself. Today the name is treated as a synonym of *Maximiliana* which has been conserved by international action.

Phoenicophorium (fée nik o foí ee um) (n.) combines *phoenix* with the Greek *phorios* (stolen), hence stolen palm or, as sometimes put in English, thief palm. The story was told by J. Smith, once Curator of the Royal Gardens at Kew, who is quoted in *Curtis's Botanical Magazine* 119: plate 7277, 1893, as follows: "In 1857 Mr. Wendland, Director of the Royal Gardens Herrenhausen, Hanover, visited Kew, and was anxious to obtain a plant of this rare palm; I had marked one of the plants for him and on taking him to the nursery pits to show it to him, it was not to be found. This led to a strict inquiry, and it was found that it had been stolen by a German gardener then employed in the gardens, and it afterwards appeared in a private garden in Berlin; and some years afterward I heard that it had grown to be a fine plant." Although in the past this name was considered inappropriate, it has priority and must be accepted under the International Code of Botanical Nomenclature. It was Wendland, himself, who quite understandably coined the name published in 1865. Because of the ending, this name is neuter in gender.

Pseudophoenix (súe doe fée nix) or false date palm, usually known as cherry palm in English because of the red, cherrylike fruits, combines the Greek *pseudo* (false, or resembling but not equalling) with *phoenix*.

Rehderophoenix (ráy der o fée nix) commemorates Alfred Rehder (1863-1949) who was for many years associated with the Arnold Arboretum and who was the author of a *Manual of Cultivated Trees and Shrubs* among other works.

Tessmanniophoenix (téss man ee o féé nix) honors Günter Tessmann (1884-), a German descriptive anthropologist now living in Brazil, who studied and wrote about peoples of West Africa (*Die Pangwe*, 1913) and of eastern Peru (*Die Indianer nordost-Perus*, 1930). In Peru, he collected specimens that served as the basis for a new genus which is now considered a synonym of *Chelyocarpus*, as is also *Tessmanniodoxa* (téss man ee o dóx a). The last combined Tessmann's name with the Greek *doxa* (glory), thus glory of Tessmann.

Toxophoenix (tóx o féé nix), now considered merely a synonym of *Astrocaryum*, was given its name by Schott because indigenous peoples of Brazil made their bows from the wood of the palm, *toxon* being the Greek word for bow.

Vitiphoenix (véé tee féé nix), now a synonym of *Veitchia*, is taken from Viti Levu, largest of the Fiji Islands, and *phoenix*, thus a palm of Viti Levu.

Chelyocarpus (chéel ee o cár puss) (m.) was so named by Dammer because the surface of the fruit of the species he knew is checked, much like the carapace of a turtle. *Chelys* is the Greek word for tortoise or turtle, *carpus* a Latin adaptation of the Greek *carpos* (fruit) or *-carpus*, a suffix meaning -fruited; the two together might be translated as "turtle-fruited."

H. E. MOORE, JR.

NOTES ON CULTURE

In August, 1971, I was in the north of Mozambique looking for cycads and other interesting plants. I knew of a place where *Raphia farinifera* palms were growing, so I visited the location to collect some seed and a few seedling plants. The seedlings, about 18 inches high, lasted bare-root in damp newspaper for six days before I was able to

plant them; they have all grown successfully since.

I collected quite a lot of seed which had fallen very recently so it was really fresh. Having seen how some older seed had germinated after just being pressed into the moist soil, I planted my seed in moist sand in a shadehouse, first removing the very attractive outer shell. The seed stayed like this for about 12 months when I came to the conclusion that there was not enough heat for the seed to germinate, so I filled a shallow box with sand and just pressed the seed into it. I then covered the box with a sheet of clear polythene and put it in a sunny place where it stayed for another year and still none germinated. I was getting tired of seeing them lying around, so I took all the seed, put them in a black polythene bag, poured in a little water, tied the top, and put it in a glass-roofed propagating house. The temperature in the house gets quite high so in the polythene bag it must have been really hot, 100°F. or more.

After about six months, I looked into the bag and was amazed to see some of the seed growing. Seeds continued to germinate until now about 75 percent have grown. I leave them in the polythene bag until roots are formed, then plant them into individual polythene bags. I wonder why they took so long to grow?

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From John Brudy in Cocoa Beach, Florida comes the following:

In March 1970, when at the botanical garden in Bogor, Java, I collected and shipped home 18 seeds of *Socratea durissima*, identified by A. Dilmy in whose personal company I was at the

time of collection. I planted these in a large pot which contained another plant (*Strongylodon macrobotrys*) and covered them with coarse mulch. The resident plant received generous watering. Nothing happened. In November 1972 I spent two months in the Windward Islands and no care was given to the plant/seed combination. I returned in January 1973 . . . again watered as usual, but in March 1973 removed the *Socratea* seeds and put them in plastic bags of moist peat and exposed the bags to the sun. Temperatures of 139 degrees F. and higher were produced. Each month I felt the seeds for evidence of sprouts. Last week—(the letter was written March 28, 1974) . . . four years from harvest . . . the first seed sprouted . . . a very strong break-out with plumule and radicle about equal in volume . . . each about two inches in length. Quite a performance.

From Panel Discussion at Biennial Meeting, June 1974, by Otto Martens, Panel Member.

For palm propagation not only the rooting medium is essential, but equally important is the environment under which propagation is to take place. Whereas, previously we put seeds into electric hotbeds controlled to 75° soil temperature we have now three fiberglass quonset houses 30' × 100' with Modine overhead heaters. Heat is forced into a plastic tube with 2" holes blowing hot air onto the rounded walls of the quonsets, circulating on it, under and around elevated propagation benches. This gives an even temperature of 1 to 3 degrees below house temperature to the beds. Total results markedly improved.

Rooting medium:

- 1) 50% Perlite, 50% peat, or
- 2) 50% Perlite, 50% leafmold, or

- 3) 50% Perlite, 50% volcanic rock grit.

Best performance is with leafmold, seeds two years on bench yielding 75 to 80 percent germination, best we ever had on howeas, our main crop.

LETTERS

Recently a friend and I "went bush" north of here and travelled around much of the Cape York Peninsula areas looking at aboriginal paintings, some over 20,000 years old, and we constantly came across palms in the most remote places. In the drier savannah country the giant *Corypha elata* lines secluded lagoons where crocodiles and water lilies abound. We found one plant that had finished flowering and died but no seed could be found. It would have been over 50 feet tall. The size of these palms is still impressive to think about. Also we found a natural hybrid between the common *Livistona australis* and the rare *L. humilis*. Another exciting find was a perfect *Caryota rumphiana* near Iron Range and a strange *Licuala muelleri* that was as small as an ancient bonsai.

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I visited the Cook Island archipelago in the South Pacific last February, and when in Avarua on the main island of Rarotonga, I was told of this native curiosity. It is a cocospalm that has grown seven majestic trunks from a single seed. This was brought over from Takutea in 1906 and planted in Avarua and under ideal climatic conditions has developed into this beautiful cluster. The location here is at 23 degrees south of the Equator, directly under the Tropic

of Capricorn, with steep sun, brilliant light at 10,000 footcandles, and a comfortable daytime temperature of 80–88° F. (27–30°C.). This island is lush and green and unspoiled, with white sand beaches sheltered behind a coral reef, and the Polynesians at home here are friendly, smiling, and bedecked with tropical blooms—a romantic place to be.

I wanted to send you a photo of a unique coconut palm as you or the Society might be interested in its story, unless it is already common knowledge.

A. B. GRAF
Julius Roehrs Company
Rutherford, N. J.



NEWS OF THE SOCIETY

The turnout for the Southern California Chapter meeting at the Los Angeles County Arboretum in Arcadia on March 16 was smaller than usual with

only about 50 members as it had rained that morning, though the sun came out later. After touring the palm garden and having lunch, members looked at Mardy Darian's slides of the many rare (for California) palms growing outside his home in Vista, California. Among them is his *Pigafetta filaris* now four years old and grown from seedling to 30-ft. size. The plant is in his enclosed pool area but has grown so that he has cut a hole in the roof for the top to have room to keep growing.

* * *

The Northern California Chapter planned their Annual Dinner Meeting for April 6 at the Claremont Hotel in Berkeley where they could wander through the tropical gardens of the hotel, enjoy the palms and the view of the Bay. Some members detoured to the nearby University of California to visit the Botanical Garden there. Then all gathered to meet friends, talk about palms, browse through a good selection of palm books available for purchase at cost and look over the palms to be raffled off after dinner. Everyone received a rare palm seedling as a favor. After dinner and the business meeting, news about palm hardiness in northern California was the topic, and plans were made for a chapter project. Slides of "The Great Gardens at Bogor, Java" were then shown.

* * *

You will all be happy to hear that De Hull, who has done so much to help with the Seed Bank and to bring in many rare seeds, is well on the road to recovery from a serious bout of hepatitis. By the time you receive this we hope he will be back at work after two months of inactivity.

TEDDIE BUHLER