
# PRINCIPES

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## PRINCIPES

JOURNAL OF THE PALM SOCIETY

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## Contents for July



## Cover Picture

*Hyophorbe verschaffeltii* plants by the roadside at left look like miniature royal palms, contrasting with true royal palms, *Roystonea*, at right on the campus of the University of Mauritius, Reduit, Mauritius. Photograph by H. E. Moore, Jr.


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JOURNAL OF THE PALM SOCIETY

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September 28, 1973

# Pollination in Some New Guinea Palms

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*L. H. Bailey Hortorium, Cornell University, Ithaca, New York*

During recent extensive field work in Papua New Guinea, I had the opportunity to make some observations on the phenology and pollination of three native palms. These observations were limited by time, logistics, and particularly by the infrequency of flowering in accessible specimens. They therefore are not as complete as might be desired, but they do suggest some interesting conclusions and point the way to further work by specialists in floral ecology.

*Nypa fruticans* Wurmb was observed in an extensive natural population in a brackish lagoon near Lae, Morobe District (vouchered by *Galore NGF 41101*, LAE, BH). *Hydriastele microspadix* (Becc.) Burret (cf. *Essig LAE 55001*, LAE, BH) and *Ptychosperma macarthurii* (H. Wendl.) Nichols (*Essig LAE 55195*, LAE, BH) were observed in the Botanic Garden at Lae. The former occurs there naturally, but the latter is cultivated there, some distance from its natural range in the Fly River area.

For each of the three species the sequence of flowering and related phenomena was noted, the morphology of the flowers described, and the insect visitors and their activities recorded. Specimens of the more common insects were collected for later identification.

## Ptychosperma macarthurii

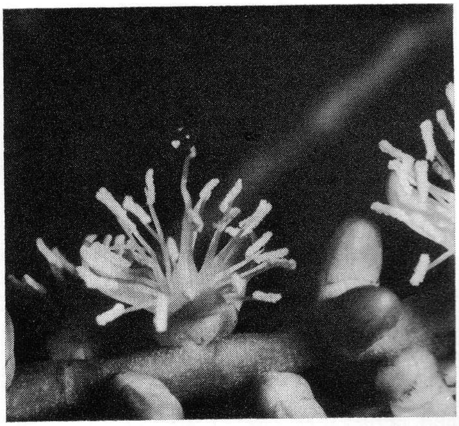
### *Morphology and phenology*

The inflorescence in *Ptychosperma* is an infrafoliar, short-pedunculate panicle, branched to two or three orders. The flowers are unisexual and borne in spirally arranged triads consisting of a central female flower flanked laterally by two male flowers. The female flower, and sometimes one of the male flowers, are generally lacking in the more distal "triads."

The male flowers (Fig. 1) are cartridge-shaped in bud, i.e., cylindrical with a round-pointed apex. The petals are very hard, valvate, and tightly closed before anthesis. The sepals are broad, rounded, and imbricate, and one-fourth to one-third the length of the petals. The stamens are numerous (c. 30–40), with long, subulate filaments and versatile anthers that bear white, moderately sticky pollen. The center of the flower is occupied by a lageniform pistillode with an elongate neck and a slightly expanded and cleft apex, from which nectar is secreted.

The female flowers (Fig. 2) are conic-ovoid with three broad, rounded, imbricate sepals and three broad, imbricate, apically subvalvate petals. The four to nine staminodes are inconspicuous, dentiform, and appressed against the lower part of the pistil. The pistil is conic-ovoid with three essentially sessile stigmas that reflex at anthesis. Three nectaries are present near the top of the pistil, alternate with the three stigmas.

The flower buds are all initiated very early in the development of the inflorescence and subsequently mature uniformly. At the time that the two outer, enclosing bracts are shed, the flowers are all the same size and very small. They



1. A male flower of *Ptychosperma.* Note the globule of nectar at the tip of the pistillode.

2. Several female flowers of *Ptychosperma.* The two at the right are at anthesis and secreting nectar.

continue to grow very slowly, fully exposed to the elements, for another three months, and only then are ready for anthesis. The very tough and tightly closed perianth protects the inner organs during this long period.

The inflorescence is protandrous, that is, all the male flowers open and shed their pollen before any of the female flowers become receptive to pollen. This effectively prevents pollination between flowers on the same inflorescence. The opening of the male flowers, though they are essentially equally mature, is staggered over a period of about two weeks. The flush of flowers that opens each day is apparently randomly distributed throughout the inflorescence, though the two male flowers in one triad seldom open at the same time. The flowers open just before dawn, and each lasts only one morning. By mid-morning the anthers are essentially empty of pollen, and by noon the open flowers have mostly fallen.

During the period of male anthesis, the female flowers on the same inflorescence remain quiescent. After the last male flower has fallen, the female flowers begin to expand, mostly vertically, pushing the tip of the pistil up between the tips of the petals. After three to four days the stigmas reflex (also in the early morning) and nectar secretion begins. This process is not always uniform throughout the inflorescence and it may take two to three days for all the female flowers to become receptive. The exact duration of receptivity is not known. The stigmas only gradually become brown and withered over a period of about two days. Nectar secretion can usually still be seen on the second day.

*Insect visitors*

Insect visitors to *Ptychosperma macarthurii* in the botanic garden were quite varied. To what extent these reflect the range of visitors in a natural population remains to be determined, but judging from the generally heavy fruit set, they include effective pollinators. The most important visitors fall into three categories: (1) bees of the families Halictidae and Apidae, (2) medium flies of the families Syrphidae and Calliphoridae, and (3) small flies of the family Drosophilidae. (All identifications by G. C. Eickwort, Dept. of Entomology, Cornell University.)

The most prominent bees were identified as *Trigona* (*Tetragona*) sp. (Apidae: Apinae), *Nomia* (*Mellitidia*) sp. (Halictidae: Nomiinae), and *Homalictus* sp. (Halictidae: Halictinae). These were all seen collecting pollen from the male flowers, but none were seen collecting the nectar on the same flowers, nor were any seen visiting female flowers during the early morning hours. Only later, toward mid-morning were any bees seen on the female flowers, and then only *Nomia*. They were fairly abundant and moved methodically from flower to flower collecting nectar. Some of them carried heavy pollen loads on their hind legs and sometimes on the thorax between the front legs. The bees often landed upon or crawled across the tops of the flowers, undoubtedly losing some pollen to the sticky stigmas.

The syrphid flies were seen on the male flowers, where they ignored the nectar of the pistillode and apparently fed on pollen. They were also found on the female flowers feeding on nectar. Flies captured on the female flowers had very little pollen on their bodies. They were less numerous than the bees and their activities were less regular. They spent much time sitting motionless on unopened flower buds and in wandering apparently aimlessly on the inflorescence. Calliphorid flies were captured from the male flowers, but their feeding activities were not observed. They are not known to feed on pollen. On two isolated occasions a different and much larger kind of fly was observed, but not captured, that very methodically moved from one male flower to another siphoning off the drops of nectar at the tips of the pistillodes. This was the only insect seen to feed on the nectar of the male flowers, but it was never observed on a female flower.

Drosophilid flies were observed in large numbers around the nectaries of both male and female flowers about mid-morning, after most other insect activity had ended. There was little pollen left in the flowers and the flies were small enough to land on the pistillodes without contacting the anthers. Consequently, little pollen was found on their bodies.

*Conclusions*

The spottiness of the data concerning insect visitors makes it difficult to arrive at very precise conclusions. The possible pollen vectors can however be narrowed down by the process of elimination.

Wind-pollination can be ruled out for two reasons. First, the pollen is too heavy and sticky to be carried an appreciable distance by the breeze. Pollen of wind-pollinated plants is very distinctive, being rather dry and powdery. Second, even in the relatively open habitat of the botanic garden, breezes were too infrequent, particularly during the early morning hours, to account for the consistently heavy fruit sets seen on the palms. Typically the air is perfectly still at the time the pollen is released. Fruit sets were equally heavy and breezes even rarer in the rainforest habitat of various species of *Ptychosperma* seen by me.

It is probably also unlikely that the drosophilid flies contribute to the pollination of *Ptychosperma*. Their small size and limited contact with pollen-bearing anthers makes them poor pollen carriers.

That leaves flies, mainly syrphids, and bees, particularly *Nomia*, as the most likely pollinators. The other flies and bees mentioned are generally too few in number or they fail to regularly contact both male and female flowers. Between the syrphids and *Nomia*, I would regard the latter as the most important pollinator at the time and place that the study was made. They regularly carry much more pollen than the flies, both on their hind legs and also adhering to other parts of the body. In addition, their movements from flower to flower seem more methodical and their activities more intensive. I should emphasize however that more observations are needed, particularly from *Ptychosperma* growing in its natural habitat. The flies, the other bees, and conceivably other unobserved kinds of insects could play important roles in the pollination of this species.

## Hydriastele microspadix

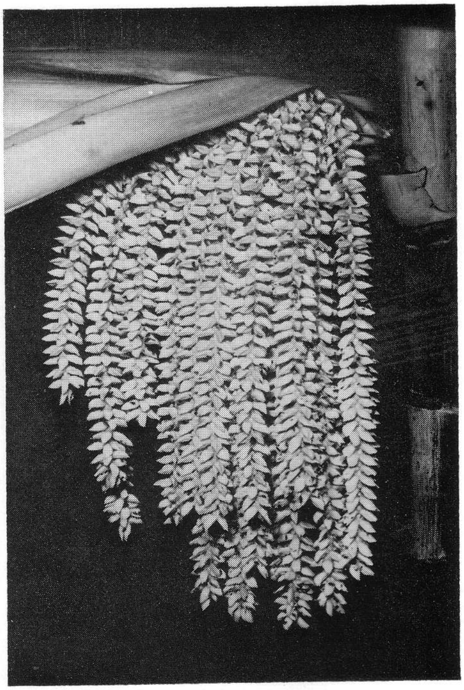
*Morphology and phenology*

The inflorescence of *Hydriastele* (Fig. 3) is an infrafoliar, short-pedunculate panicle branched to two orders. The flowers are unisexual and arranged in triads that are decussate (aligned in four vertical rows) on the elongate, drooping rachillae. The triads are complete even at the distal ends of the rachillae.

The male flowers (Fig. 4, 5) are asymmetric, with three very small, slightly imbricate sepals, and three large, soft, acute and slightly twisted petals that are only loosely valvate. There are six stamens with large, basifixed anthers and very short filaments. The pollen is white and moderately sticky. There is no nectary.

The female flowers (Fig. 4) are conic-ovoid and tightly enveloped by the more-or-less equal, broadly rounded and imbricate sepals and petals. The tip of the pistil protrudes through the top of the perianth, even in bud. The three stigmas are sessile, rounded, and slightly reflexed at anthesis. Again, no nectaries are present.

Development of the inflorescence is similar to that in *Ptychosperma* in that maturation of the flower buds is uniform after a very early stage of initiation.

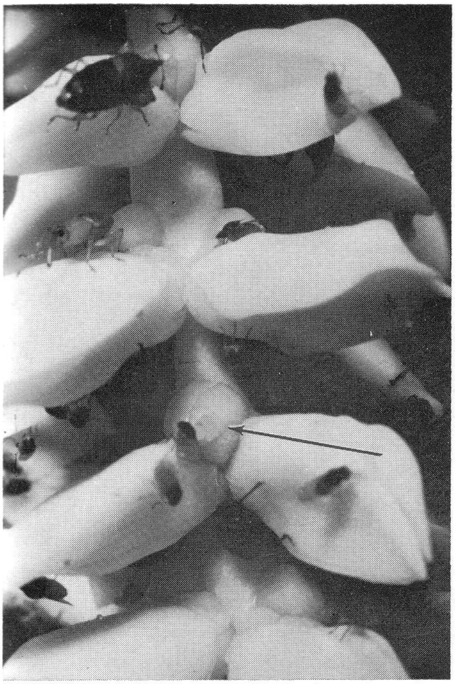


3. An inflorescence of *Hydriastele* just after emerging from its protective bracts.

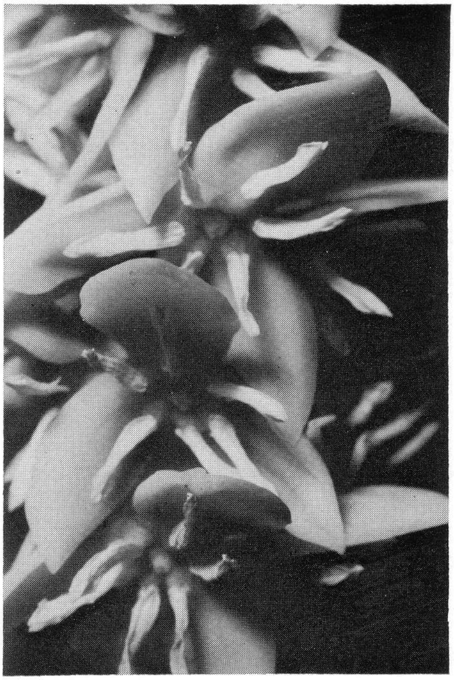
Unlike *Ptychosperma*, however, the buds are completely mature before the two enclosing bracts open. Reproductive activity begins almost immediately upon exposure of the flowers.

The inflorescences are protogynous, i.e., the period of female receptivity precedes the period during which pollen is shed in the male flowers. The bracts open before dawn and the first light of day finds the female flowers with stigmas reflexed and slightly moistened. Anthesis is simultaneous for all the female flowers on the inflorescence and probably lasts only a few hours. In the afternoon the stigmas become noticeably withered.

Anthesis of the male flowers follows that of the females by 24 hours and is simultaneous throughout the inflorescence. Pollen is shed rather quickly between dawn and about 8:00 A.M. By



4. Part of a *Hydriastele* rachilla soon after emerging from the protective bracts. The arrow points to the slightly expanded stigma of one of the receptive female flowers. Insects present are curculionid beetles and drosophilid flies.



5. Male flowers of *Hydriastele* at anthesis.

that time the flowers are beginning to loosen and fall.

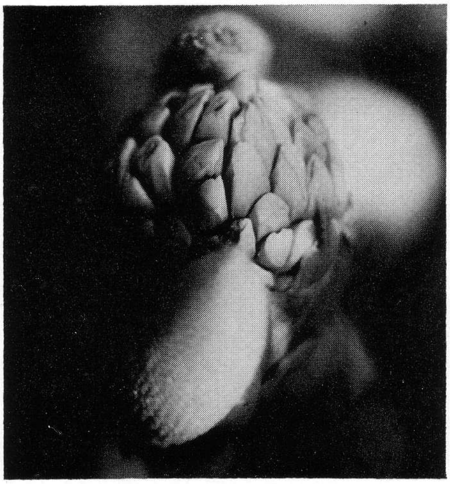
*Insect visitors*

The insect visitors to *Hydriastele microspadix* fall into three categories: (1) bees—essentially the same as those listed for *Ptychosperma*, (2) small flies of the family Drosophilidae, and (3) small flower-feeding beetles of the family Curculionidae (weevils).

The bees (*Nomia, Homalictus, Trigona*) were abundant, collecting pollen from the open male flowers. None of them, however, visited inflorescences on which there were receptive female flowers, for these lack nectar as well as pollen.

The drosophilid flies were found in some abundance on both male and female flowers. The exact nature of their feeding activity was not observed, though they were seen to move about, sometimes contacting the stigmas of the female flowers. Captured specimens from the male flowers sometimes carried a few pollen grains. Specimens from the female flowers seldom carried any pollen.

The activities of the weevils were similar to those of the drosophilids, though they were larger and carried much more pollen. They began appearing on the newly exposed inflorescences, where the female flowers were receptive, almost as soon as the enclosing bracts had opened. They are probably attracted by the musky odor of the inflorescence. The weevils apparently feed on and in the male flowers as long as they remain closed, but leave rather quickly when they open the next morn-



6. A head of female flowers of *Nypa*, with the two uppermost male spikes attached just below.

7. A male spike of *Nypa* with the flowers at anthesis. Note the exserted staminal columns.

ing. In this way, the weevils migrate each morning from an inflorescence in which pollen is being shed to one in which the female flowers are receptive.

*Conclusions*

The possibility of wind-pollination in *Hydriastele* can be dismissed for the same reasons given in the case of *Ptychosperma.* The pollen is too sticky and breezes are too rare to make this an effective means of pollen dispersal. Bees must be considered unlikely pollinators of *Hydriastele* since they virtually never visit female flowers. The remaining two kinds of insects, drosophilid flies and curculionid beetles, both have the potential to pollinate *Hydriastele microspadix.* Of the two, however, the beetles appear to carry much more pollen, and are probably the main pollinating agent for the species. It should be noted that the morphology, phenology, and insect visitors described here for *Hydriastele* are remarkably similar to those of *Bactris* (Essig 1971), an unrelated genus from tropical America.

## Nypa fruticans

*Morphology and phenology*

The morphology of the *Nypa* inflorescence has recently been described in detail by Uhl (1972). Flowers are unisexual, with male and female flowers segregated onto different parts of the interfoliar and much-branched inflorescence. The female flowers (Fig. 6) are borne in a dense globose head that terminates the main inflorescence axis, while the male flowers (Fig. 7) are borne on dense spikes that terminate the several orders of lateral branching.

The male flowers are bright orange and are composed of three separate, linear sepals, a similar whorl of three petals, and three stamens that are connate by the filaments and connectives into a single column. The pollen is also bright orange and very sticky. No nectar is produced.

The female flowers are very unusual. The perianth is essentially the same as in the male flowers but obscured at maturity by the three separate and greatly enlarged carpels. Each carpel terminates in an elongate, narrow slit, the margins and inner surface of which are stigmatic, and which opens to the locular canal below. Uhl (1972) found a gelatinous substance in the openings of some of the carpels of perserved flowers, which she considered an unusual stigmatic secretion. This was not observed in the field.

The inflorescence is protogynous, with the female head emerging first, followed closely by one or two of the uppermost male spikes. The lower male spikes follow, staggered over an apparently long time. The flowers are mature when they emerge from the bracts, and reproductive activity begins within a few days. The timing and duration of female receptivity is not known; there seems not to be any external indication of the receptive state. Anthesis of the male flowers occurs in midmorning. After about 9:30 A.M. the staminal column elongates, pushing the anthers beyond the perianth (Fig. 7), and the pollen is released.

*Insect visitors*

Only two kinds of insects were found in significant numbers on the flowers of this particular population of *Nypa*: (1) bees of the genus *Trigona*, (2) small flies of the family Drosophilidae. The bees were numerous on the male flowers, but very rare on the female flowers. The flies, however, were numerous on the male flowers and also were frequently seen on the female flowers. Flies captured from the male flowers carried significant amounts of pollen stuck to various parts of the body.

Insect larvae were found burrowing among the closely packed male flowers where there was conspicuous, but not extensive damage. Some larvae were also found beneath the bracts of the female heads, but no damage from feeding could be found there. A few of the larvae were coleopterans, but most were of one species of the dipteran suborder Cyclorrhapha, to which the drosophilids and many other common families of flies belong. They were of a new and unusual type, unlike any known drosophilid larvae, but identification as such was not completely ruled out. (Larvae were examined by C. O. Berg, Cornell University.) The connection with the adult drosophilids is logical, if not demonstrated, and it appears likely that the flies carry out their life cycle in the flowers of *Nypa*.

*Conclusions*

Wind-pollination is most conclusively eliminated as a possibility in *Nypa* by the nature of the pollen. It is very sticky and falls from the anthers in large, heavy clumps. Pollination by bees can also be considered as rather unlikely on the basis of these observations, since bees were rarely seen on the female flowers. Some selfing may occur since the uppermost male spikes sometimes emerge and flower rather soon after the female head emerges. This depends, however, on how long the female flowers remain receptive, which, unfortunately, has not yet been determined.

One logical hypothesis emerges from the data presented here: that pollination in *Nypa* is accomplished by drosophilid flies as they move about, feeding and breeding in both male and female portions of the inflorescence. Though in my all-too-brief visit to the *Nypa* swamp I failed to capture a fly bearing pollen on a female flower, two facts are clear: (1) drosophilid flies were definitely seen on both male and female flowers, and (2) the flies carry significant amounts of pollen—a marked contrast with all previously known instances of drosophilid-palm flower association. The validity of the hypothesis is partly dependent on the proper identification of the larvae found in the flowers, but the adult drosophilids seem to be good pollen carriers in any case.

## Summary

Among the palms for which careful observations have been made, there appear to be four general types of pollination strategy. The first is wind-pollination, which has long been known for the date palms (*Phoenix* spp.), and which has recently been demonstrated for the coryphoid genus *Thrinax* (Read 1967). It has also been frequently suggested for the coconut palm (*Cocos nucifera*), though there is considerable controversy about this (Menon and Pandalai 1958, p. 67). Some good evidence has also been presented for wind-pollination in the betel nut, *Areca catechu* (Murthy and Bavappa 1961), and the oil palm, *Elaeis guineensis* (Hartley 1967).

*Asterogyne martiana* (Schmid 1970a, b) and *Ptychosperma macarthurii* can be placed together in a second category, in which the flowers are pollinated by insects (flies or bees) that are alternately attracted to male and female flowers by nectar in both and by pollen in the male flowers. In these two palms considerable maturation of the flower buds takes place after the inflorescence emerges from its enclosing bracts. The buds are protected in *Ptychosperma* by the tough perianths, and in *Asterogyne* by being recessed in covered pits. The genus *Archontophoenix* (Skutch 1932) fits into this category with respect to the sequence of flowering, the presence of nectar, and the types of insect visitors. It differs, however, in that the flowers are mature and ready for anthesis when the enclosing bracts fall. All three genera are protandrous, with flowering staggered over many days.

The third category is represented by *Bactris* (Essig 1971) and *Hydriastele microspadix*. Here neither male nor female flowers produce nectar. The latter, in fact, are small and inconspicuous, seemingly without any inherent attraction for insects at all. The pollinating insects (small beetles) are attracted instead to the soft, odoriferous male flowers, which stand unopened beside the receptive female flowers, and upon which they feed. Pollination occurs as the beetles move from an old male-flowering inflorescence to a new female-flowering one. The palms in this category are protogynous, with the female flowers simultaneously receptive as soon as the inflorescence emerges from the enclosing bracts, and the male flowers opening simultaneously 24 hours later.

A fourth type of pollination strategy is that suggested herein for *Nypa fruticans*. The thick flowering axes of the inflorescence serve as burrowing-feeding sites for immature insects (in this case, small flies). The emerging adults become covered with pollen, and some of them, in search of a new site for oviposition, carry the sticky pollen to a new inflorescence in which the female head is emerging.

The striking coordination and intricate timing involved in the phenology of some of these palms is dependent upon the specialized way in which their inflorescences develop. Development can be thought of in terms of three phases: initiation, maturation, and anthesis. In many simple racemes or panicles, such as found in many orchids, lilies, and such dicotyledons as lupines and delphiniums, the three phases occur sequentially along an axis. Flowers at the base of the axis may be past anthesis and forming fruit, while at the apex new flower buds are still being initiated.

In many palms, however, including all those described here, initiation of all the flowers on the inflorescence is completed very early and subsequent maturation of the buds is uniform. The flowers all reach full size and readiness for anthesis more or less at the same time. The pattern of male and female anthesis that follows this nearly simultaneous maturation of the buds is thus independent of the sequence of initiation and maturation that might dictate the sequence of anthesis in other sorts of inflorescences.

The implications of this for pollination biology are great, for this flexibility, especially when combined with the monoecious habit, has allowed the palms to develop a variety of flowering patterns in response to various potential pollinating agents. For example, suppression of the male flowers until after female receptivity results in protogyny, while suppression of the female flowers until after male anthesis results in protandry. The flowers of one sex may all open simultaneously, or they may be staggered over many days. Flowers may open randomly throughout the inflorescence, or they may progress in some orderly fashion.

Much interesting work remains to be done on the pollination of palms. Aside from *Thrinax*, little has been done with the mostly bisexually flowered Coryphoid group, though Dransfield (1972) has suggested "mess and soil" pollination for *Johannesteijsmannia*. We have no pollination information from lepidocaryoid, borassoid or phytelephantoid palms, other than the superficial observations of some early botanists. Some work has been done on palms of the arecoid line, but this vast group has really only barely been tapped.

### Acknowledgements

Thanks are due to J. S. Womersley, Chief of the Division of Botany, Department of Forests, Lae, Papua New Guinea, for use of facilities in Lae, and to H. E. Moore, Jr., N. W. Uhl, and G. C. Eickwort for critically reading the manuscript. Field observations were made possible by support from National Science Foundation Grant GB-20348X, H. E. Moore, Jr., principal investigator.

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## Addendum

The small curculionid beetles thought to pollinate *Hydriastele* have now been identified to the genus *Nodocnemus* Marshall (Erirhininae, Derelomini). This genus and the other members of the Derelomini are said to occur almost exclusively in palm flowers and are pantropical in distribution. This instance of apparent close co-evolution between palm flowers and a particular group of insects should provide the substance for very interesting further investigation.

I am grateful to R. T. Thompson of the British Museum of Natural History for providing the identification and ecological notes, and once again to G. C. Eickwort of Cornell University for assistance in getting the specimens identified.

# Palmologue
# Letters and Excerpts

*Not long ago a stray remark reached these departmental ears to the effect that the letters quoted in this department have more to do with cold weather than with anything else, and that discussions of its effects must make rather insipid reading for gardeners in the Torrid Zone. Perhaps so, but if those who strive to grow palms in the tropics have any problems half so consequential, they would not be denied an inning in these pages. Which is not to suggest that tropical palmateers have no problems. For all we know to the contrary, they may have to cultivate their palms with cobras alongside and other fauna of a sort not to be sneezed at. Besides, many countries in the torrid zones have extensive high plateaus where the winter climate is anything but torrid. Perhaps more than half the entire area of Mexico is subject to winter frosts, and chilly or cold weather visits some parts of all the continents every winter. The price of coffee rises every time the uplands are frosted in Brazil, a country with more native palms than any other. Besides, in midsummer so much talk of snow and ice helps to cool off the perspiring residents of equatorial climes, and also those of Florida, which though called subtropical, is about as tropical all summer as anyone can hope to get. (If you don't believe it, just go blindfolded any summer from Florida to Nigeria, and you'll think you're still in Florida.)*

*Presumably all the quotations printed here about cold effects have contained helpful hints to others with some interest in the subject of cold tolerance even when their conditions are quite dissimilar. Among the letters quoted below is one containing valuable tables of winter temperatures in Dallas, Texas—valuable because they will provide clues to those who will know how to apply them to their own situations.*

*It was once generally believed that hardly more than a half dozen palms could be successfully cultivated outdoors in the United States of that day, except in southern Florida, but since the formation of The Palm Society an impressive number of palm species have been established in California and elsewhere. There is now a substantial and rapidly growing activity with palms in the central parts of Florida, where because of occasional outbreaks of cold weather, no more than four or five kinds of palms were commonly planted as recently as twelve years ago. Their culture is much more extensive in Texas now than formerly, and quite possibly a greater interest will awaken in Louisiana and Georgia. Hawaii, however, where frost is confined to high elevations, has had one of the largest percentage increases in Society membership—twenty-two members at last account, which almost matches the number in Texas.*

—Dent Smith

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**From Mr. Gordon D. Hintz, Dallas, Texas, April, 1973.**

I have always thought highly of your past articles on cold tolerance of palms. Since we are in a "marginal" palm area I thought you might like to have a copy of my notes covering my observations of this past winter's effects here in Dallas.

You will probably be most interested

in the notes on *Serenoa repens*, since these are the seeds you sent to me.

In spite of the severe winter here, most species came through quite well.

*Here follow this correspondent's observations*:

## EFFECTS OF WINTER 1972–1973 ON PALMS

at 9375 Springwater Dr.,
Dallas, Texas 75228

Climatic conditions from official records U. S. Weather Service, Love Field, Dallas.

Temperatures of Freezing, or below, in degrees Fahrenheit observed on following dates:

| 1972 | | 1973 | |
|---|---|---|---|
| 11/22 | 31° | 1/5 | 31° |
| 12/4 | 29° | 1/6 | 30° |
| 12/5 | 30° | 1/7 | 29° |
| 12/6 | 21° | 1/8 | 25° |
| 12/7 | 24° | 1/9 | 20° |
| 12/10 | 24° | 1/10 | 21° |
| 12/11 | 25° | 1/11 | 22° |
| 12/12 | 31° | 1/12 | 14° |
| 12/13 | 26° | 1/13 | 24° |
| 12/15 | 31° | 1/14 | 30° |
| 12/16 | 21° | 1/24 | 29° |
| 12/17 | 27° | 1/28 | 30° |
| 12/22 | 30° | 1/29 | 24° |
| 12/31 | 32° | 2/8 | 28° |
| | | 2/9 | 28° |
| | | 2/10 | 25° |
| | | 2/15 | 30° |
| | | 2/16 | 28° |

Freezing in excess of 24 hours:

12/10, 1 a.m. to 12/11, 11 p.m., 34 hours duration (plants covered by ice).

12/5, 10 p.m. to 12/7, noon, 38 hours duration.

1/7, 7 p.m. to 1/12, 2 p.m., 117 hours duration (plants covered with 3″ snow on 1/11).

Rainfall:

| | |
|---|---|
| Oct. 1972 5.80 in. | Jan. 1973 4.02 in. |
| Nov. 1972 2.61 in. | Feb. 1973 2.32 in. |
| Dec. 1972 1.16 in. | Mar. 1973 4.26 in. |

Notes on individual species:

*Sabal minor*, 5 plants about 10 years old. No damage to these. Numerous seedlings, of which a number perished, particularly in wet areas. Some of survivors were on coldest exposure. Believe standing water with cold was fatal factor.

*Sabal texana*. 1 large 11-year-old tree, 2 ft. of trunk, no damage. 13 3-year plants (seed from Corpus Christi, Texas), moderate to severe tip-burn, no bud damage, all recovered. 6 2-year plants (seed from Dallas-grown tree), 5 plants slight tip burn, 1 moderate, no bud damage, all recovered.

*Sabal Palmetto*, 8 2-year seedlings, slight to moderate tip-burn, no bud damage, all recovered.

*Sabal causiarum*, 18 1-year plants, all burned to ground, 12 have recovered.

*Sabal Etonia*, 4 2-year seedlings, no damage.

*Trachycarpus Fortunei*. 5 plants, one with 6 ft. trunk, one with 5 ft. trunk, one with 16 in. trunk, one with 12 in. trunk, one with 10 in. trunk; slight bud damage to three, no damage to two, all have recovered.

*Jubaea chilensis*, 2 2-year plants, no damage.

*Chamaerops humilis*, 1 plant with 4-in. trunk, severe heart rot, all leaves burned, one sucker still green. 1 plant with 2-in. trunk, moderate bud damage, no burn to outer leaves, bud has since grown out. 2 2-year seedlings, moderate tip burn, both have recovered.

*Washingtonia filifera*, 2 large plants, one with 5-ft. trunk, one with 3½-ft. trunk, Dallas-grown seed, only outer leaves burned, no bud damage.

*Erythea armata*, 2 2-year plants; no

damage, but covered with plastic during two severe cold spells.

*Phoenix canariensis*, 1 plant with 1-ft. trunk, severe bud damage, all leaves burned, appears dead, had been covered with plastic during two severe cold spells. 3 2-year plants, severe burn to leaves, one has recovered, other two doubtful.

*Phoenix dactylifera*, 1 plant with 1-ft. trunk, no bud damage, but leaves burned, has since grown out. 8 2-year plants, 2 moderate burn, 6 severe burn, all have recovered. 4 1-year plants, 2 moderate burn, 2 perished.

*Butia capitata*, 1 plant with 1-ft. trunk, outer leaves burned, slight bud damage, but most of center remained green, recovered.

*Serenoa repens*, 23 1-year plants, 8 no damage, 2 moderate tip burn and recovered, 13 perished, mainly in standing water areas.

*Livistona chinensis*, 6 1-year plants, all severe burn to ground, 4 have recovered.

*Livistona australis*, 1 plant with 8-in. trunk, severe heart rot, all leaves burned, appears dead. Covered with plastic during two cold spells.

*Acoelorrhaphe Wrightii*, 1 plant with 7 small trunks, most leaves burned, covered with plastic during two cold spells, 2 trunks have recovered.

*Nannorhops Ritchiana*, 2 1-year seedlings, moderate to severe tip burn, but both have recovered. Plants came up about 6 weeks before first frost.

Remarks: This winter was one of our coldest in years. We had more ice and snow than normal, coupled with prolonged cold. The continuous freeze of 117 hours was particularly severe.

*Some of the damage reported above to very young palms might be because of the fragility that goes with their age, but not all were affected. The observations serve to confirm other reports of cold endurance or the lack of it, but several facts reported exceed expectations and are striking in themselves. Two examples of* Jubaea chilensis *but two years old were uninjured, and although this species has been known as cold tolerant, heretofore the extent of its tolerance has had to be surmised. Even if this palm at any age has endured greater cold than in Mr. Hintz's garden, which to this writer seems extremely doubtful, it has never been publicized, and thus something new has been added to any knowledge of it. Sometimes referred to as the southernmost palm in the Western Hemisphere,* Jubaea chilensis *has long been thought a hardy palm and has so proved in California, but whether it is actually the nearest native of the southern polar region is questionable.* Juania australis *seems to vie for that distinction, and it may be that southern Uruguay can claim one or two palm species.*

## From Mrs. Lucita H. Wait, Miami, Fla., June, 1973.

You asked me some questions about methods of cleaning palm seeds for the Seed Bank. This is a subject that one might write a book about. Palm seeds come in so many sizes, and enclosed in so many different materials, all the way from coconut husks to paper-thin skins, that no general rules apply. However, I shall try to answer briefly.

1. Do you attempt to clean all the seed, or only those that are pulpy? No, we do not clean all. Some seeds such as *Chamaedorea* have thin papery skins with almost no pulp under them, so a few days' drying is sufficient to prepare them for shipment. Fleshy seeds can be soaked for several days, then rubbed on a sieve, or scraped by hand with a paring knife. (This can be done while watching television.) The hardest to

clean are, in my opinion, *Elaeis* and those in the cocosoid group. They have juicy flesh and many fibers. One successful *Arecastrum* cleaner lets the fruit lie on the ground until the flesh ferments or little creatures eat the rather sweet flesh, and then it is not so hard to remove the fibers. A popular method is to soak the seeds, then put them on a paved area and rub them with a brick. One intrepid soul puts small seeds in a blender for a few seconds. This is not recommended for rare and valuable seeds, as some of them will be broken in the blender.

2. Have you any special method to make cleaning juicy and slippery fruits less of a chore? I have answered this question partly already. There is no single method suitable for all fleshy fruits. One must try different methods until the best one is hit upon. It is pleasant to find seeds on the ground that have been cleaned by some insect or crustacean, but seeds collected from the ground should be treated with insecticide, as there is danger of infestation by beetle grubs, etc. It is safer to collect them while still on the plant. Cleaning fleshy fruits is a chore no matter how it is done. I would be glad to learn of some easy method.

3. Do you dry out somewhat the dead-ripe fruits to make them less slippery and less time-consuming to clean? It is very important not to let the seeds dry out, as this affects the embryo, making it shrink and take longer to germinate (if not killing it outright). So I seldom allow the fruits to dry. It is better to soak them for a few days, then remove the pulp. Some palm fruits have easily removed pulp—*Aiphanes*, for example, but others take a lot of time and patience. Besides keeping them moist, the most important thing is to prevent mildew. In our humid climate mildew is quite a problem, so we use fungicides lavishly. We have used the old-fashioned neutral copper successfully, and it is less expensive than the newer kinds.

I am always happy to learn how other people treat their seeds, and possibly incorporate their methods with mine.

*Perhaps seed-cleaning in one respect is like the making of potting soil, in that each man is a law unto himself and his method is the best. But not so, for Lucita is surely right in pointing out that there can be no governing laws because of the diversity of palm seed. Here and there, however, someone may have discovered a special knack for cleaning certain kinds of seed, and if so, his methods should be brought to light in these pages. My own candidate for the most onerous task of all is cleaning the dead-ripe fruits of saw palmetto* (Serenoa repens), *for the gooey mess and the smell of it are not only revolting but nauseating. Back about 1780 William Bartram, in the narrative of his travels in Florida, described the taste of the* Serenoa *fruits as a "combination of rotten cheese with tobacco juice," yet the Indians were given to eating them with great relish. It is a solemn fact that all the intervening years have failed to improve the taste, or to disprove the accuracy of Bartram's assertion. A popular theory is that anything so horribly overpowering must be good for human ailments, and accordingly my Aframerican adjutant has informed me that he was once hired, together with others, to harvest* Serenoa *fruits as one ingredient of the noted patent medicine known as Hadacol, but the story comes to me secondhand and I cannot vouch for it. It is repeated here only in the hope that someone has discovered a pleasant method of ridding the palmetto fruits of their pulp and will boldly come forward with it.*

## From Mr. Otto Martens, Goleta, Calif., May, 1973.

How far the waves of enthusiasm for palm-growing have spread ever since you started The Palm Society so many years ago, became very clear to me when Mr. Fermo Albertini from—believe it or not—Prudhoe, Alaska, asked me in a letter what palms he would be able to foster in Alaska, especially on Prince of Wales Island, where it is his dream one of these days to retire to and "to make reality of his dreamy hobby."

He specially has a fancy to raise *Lepidorrhachis Mooreana*, of which he learned in my article on Lord Howe Island and assumed they must be hardy if growing on top of Mt. Gower. But, alas, how far he is from the truth! Although endemic on the highest areas of Mt. Lidgbird and Mt. Gower on Lord Howe Island and probably cold-hardier than the two species of *Howeia* and *Hedyscepe Canterburyana*, they still are subtropical palms. We have a nice crop of them coming on in a hotbed and hope that our introduction into the Southern California landscape will have the same success we have had with the most beautiful *Hedyscepe*.

Another palm that Fermo Albertini is "very much in love with, is the *Ceroxylon* that grows in Ecuador." Well, so are we. But the only human being in So. Cal. who has one of impressive size is the veterinarian in Vista, Mardy Darian. What does he *not* have?

Fermo knows of *Rhapidophyllum hystrix* from Mr. William Manley in Georgia. I have suggested a few other hardy species besides, and also a small greenhouse to make his dreams *last* in Alaska. Then I asked him to write to us when he begins his retirement on Prince of Wales Island, and hinted that perhaps some Palm Society friends and myself can help him to start a little palm collection. How about it? Fermo is our only Palm Society member in Alaska.

*How about it? Gladly! I would try to assist even Dangerous Dan Megrew if he wished to grow palms in Alaska, and the same goes for Yukon Jake "who was tough as steak" and "would rake the dive with his forty-five." Mr. Albertini's project would be a satisfying and unique hobby, and seems to me feasible and eminently sensible. The palms could be grown outdoors during the short warm season and brought into the house or greenhouse before the onset of cold weather. And that, by the way, is something that could be done—one might say "should" be done—in many another state. There are vogues in house plants just as in furnishings, and perhaps the day will come when palms in temperate climates are no longer principally confined to hotel lobbies.*

## From Mr. David Barry, Jr., Los Angeles, Calif., June, 1973.

In putting together an article for *Principes* with my Japanese friend on the culture of *Rhapis* in Japan, I have learned that a Japanese professor of botany and an authority on *Rhapis* states that there are 17 valid species of the genus—all described. As I do not think that this figure includes the two species from Thailand that I wrote about in the January, 1973, issue of *Principes*, then there should be 19 valid species to date. Our fellow Society member, Toshihiko Satake, has just about all of these species. His list of *Rhapis* comes to 40 kinds. This includes named clones of varieties of *R. humilis* and of *R. excelsa*, and perhaps three other species mixed in with a group that collectively comprise the palms that are cultivated so assiduously in Japan.

The plants with variegated leaves are the ones that are held in such high esteem, and, I should add, at such high prices. Most of the variegated plants that have been introduced into the United States soon lose their variegation. The Japanese call such plants the weak ones, and they do not bring the big prices. To my way of thinking they are actually the strong plants, strong enough, with a balanced fertilizer, to throw off the virus that causes the variegation. To the Japanese the strong plants keep their variegation. In my theory these are too weak to overcome the virus. I now have the chance to make a few experiments with both the strong and weak kinds, as I recently imported both kinds in the two species, *R. humilis and R. excelsa.*

With further help from my very able collaborator in Japan, I hope to complete my article later on this summer. I have photographs to submit showing auctions of *Rhapis* for professional buyers only, and exhibitions of plants at shows where the only plants are *Rhapis* palms. The more that I learn of this culture, the more fascinating it becomes.

*Fascinating to be sure, but to this writer it is even more astonishing than fascinating. In a postscript Mr. Barry goes on to say, "Try to buy some* Rhapis! *Most nurseries have minimum orders of $1,000, and the plants would all go in one flat. . . .I have current nursery catalogs partly translated that have prices of $1,500, $3,000 and $4,500 per plant!" All of which is somewhat reminiscent of the 17th century tulipomania in Holland, when thousands in dollar equivalents were sometimes paid for single tulip bulbs, but in Japan the inference is that the high prices are paid by fanciers rather than by undisguised speculators as in Holland.*

## From Mrs. Theodore C. Buhler, Miami, Fla., April, 1973.

You may recall my showing you a letter from Mr. C. C. Coons of Venice, Fl., who wrote an article about the hybrid "Queen Pindo" palm for the Sarasota *Herald Tribune.* He stated that this was no ordinary palm, it was a cross between the Queen palm, commonly called *Cocos plumosa,* and the Pindo palm, *Butia capitata.* "It is a very handsome palm combining the best qualities of both," the article said. "A natural hybrid has been about for many years . . . . those originating from the old Reasoner Brothers' Royal Palm Nursery were from growing the two kinds of palms together in the same blocks. . . . In the past fifteen years or so, most of this cross seems to come from Indian Rocks Nurseries in western Pinellas County. The owner, Virgil Meares, had planted a large *Arecastrum* with three smaller butia palms underneath. . . . He has a good thing going, realizes it, and will talk very little about the origin, but will gladly sell them. . . . If you are young, plant three Pindos under a Queen, wait until they bloom at the same time, plant the seed that may take six months to germinate, baby them along until they are salable size, and sell them."

My answer was as follows:

It would not be too difficult to pollinate a butia even if the two palms were not grown together; all that is necessary is to observe when a Queen palm is shedding pollen (often a fine yellow powder falling on the leaves below indicates this stage), cut that inflorescence off and shake it over a butia that is also in bloom, first ascertaining that the female flowers are at the fertile stage. It is not too difficult to preserve palm pollen for months, even a year. Simply shake the pollen into a paper bag (not a plastic one) and store in the refrigerator until it is needed and then apply to the female flowers. A camel's hair brush is often used for this; the pollen seems to stick to the hairs of the brush, and thus can be easily transmitted to the individual female flowers. Many palms are dioecious, such as the species of *Chamaedorea* (I have in mind *C. metallica*, *C. Seifrizii*, *C. erumpens* and others, too) and don't produce pollen at the same time female blooms are receptive. Female flowers are apt to feel sticky to the touch when receptive, or else one can see a tiny drop of nectar in the flowers. Often, early morning sun striking the nectar will make it look as if each flower had a drop of dew. I have used this method—early morning observation—to determine when my latania palm is ready to be pollinated and had great success with the resulting seeds. Of course, one would have to be sure the butia had not already been pollinated by butia pollen, perhaps by cutting off any male blooms before they shed pollen, or else keeping the female spike encased in a bag until properly pollinated. Once pollinated the blooms change shape fairly rapidly as the ovary starts to swell. Unpollinated blooms fall off rather quickly as a rule.

*The source of most examples of this hybrid now found on the east coast of Florida and inland from that coast has been, either directly or indirectly, the Florida Nursery and Landscape Co. at Leesburg, but this supply has come to an end. The late Mr. Ross Lafler, manager of the nursery, advised me that all their* Butia *hybrid plants were accidental and never planned. No fruits of the hybrid have contained viable seed, or at least none have been reported to me, nor have there been any reports of successful propagation following hand-pollination. This is not to say that it has not been done, nor that it cannot be done with success, just as Mrs. Buhler suggests.*

*Whether one accepts it or not, Glassman has united* Arecastrum *and* Butia *with the genus* Syagrus, *and his treatment of the hybrid* (Syagrus × fairchildensis Glassman, hybr. nov.) *appears in* PRINCIPES 15:79–88. *This hybrid by whatever name is much handsomer than its* Butia *parent, of much more rapid growth and fully as cold-tolerant, which I can attest to because of having lived with four of the palms for sixteen years.*

*Mrs. Buhler's correspondent was quite correct in observing that this "natural hybrid has been around for many years" —elucidated by Fredrick C. Boutin, "Further Notes on Arecastrum × Butia,"* PRINCIPES 16:63.

# The Formation of Endocarp in Palm Fruits *

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## Abstract

Three types of endocarps are distinguished among palm fruits on the bases of time of differentiation, cell layers involved, and mode of development. The simplest consists solely of the modified locular epidermis; another involves a region of variable thickness separated from the locular epidermis by several cell layers of parenchyma; the most complex includes the inner fibrovascular bundles, the locular epidermis, and the intervening parenchyma. The taxonomic distribution of the types of endocarps and their possible significance are discussed.

Palm fruits are known and used by many peoples throughout the tropics, but anatomy and development have been studied in only two fruits, the coconut (Winton, 1901) and the date (Lloyd, 1910; Long, 1943). Factors contributing to this lack of information include the usually long developmental period between pollination and ripening, the geographical inaccessibility of most palms, and the frequently intractable nature of the fruits themselves.

Mature palm fruits characteristically have a specialized, usually sclerotic, layer known as the endocarp in the inner portion of the fruit wall near the locule. Its formation may involve the locular epidermis only or, more commonly, several to many layers of cells in the inner portion of the gynoecial wall. When the fruit is mentioned in specific descriptions, the endocarp usually receives passing reference as being "stony" or "fibrous" or "papery" with no mention as to its histological nature or its developmental history. As part of a larger study, the development of the endocarp has been followed in the fruits of a number of species of palms.

* This study is part of a doctoral thesis submitted to the Graduate School of Cornell University, Ithaca, New York. The author wishes to acknowledge the advice and assistance of Dr. H. P. Banks, Dr. N. W. Uhl, Dr. P. B. Tomlinson, Dr. Harold E. Moore, Jr., and the late Mr. C. A. Donachie, Jr., who made many of the collections at the Fairchild Tropical Garden.

## Materials and Methods

Periodic collections were made of developing fruits of 12 species and mature fruits of six additional species were added resulting in a total of 13 genera examined. Six of the approximately 15 (depending upon author) groups into which palms have been classified (Table 1) were represented. Collections were made from plants growing at the Fairchild Tropical Garden, Miami, Florida, or in the greenhouse at Cornell University, Ithaca, New York. Voucher specimens are located in the L. H. Bailey Hortorium at Cornell University.

The developmental stages and the mature fruits were fixed in FAA, dehydrated, embedded in "Paraplast" and sectioned serially. The sections were stained with Heidenhain's hematoxylin, 1% safranin, and 0.5% aniline blue, modified from Johansen (1940). To insure penetration of the dehydrating and embedding fluids, the younger fruits were slashed through the fruit wall nearly to the locule and the larger fruits

*Table 1. Palms described with documentation and with position in two systems of classification indicated.*

| Moore, 1973 without rank[a] | Potztal, 1964 as subfamilies |
|---|---|
| Coryphoid palms | Coryphoideae |
| *Coccothrinax* sp. (*FTG:P-2209*) | |
| *Livistona chinensis* (*Read 712*) | |
| *Pritchardia pacifica* (*Read 9581*) | |
| *Rhapidophyllum hystrix* (*BH-60-858*) | |
| *Thrinax* sp. (*FTG:101A*) | |
| Caryotoid palms | Caryotoideae |
| *Caryota mitis* (*Read 1429*) | |
| Chamaedoreoid palms | Arecoideae tribe Chamaedoreeae |
| *Chamaedorea* sp. (*Moore & Bunting 8913*) | |
| *C. alternans* (*BH-61-1177*) | |
| *C. microspadix* (*FTG:P-4083*) | |
| *C. pochutlensis* (*BH-60-819*) | |
| *Mascarena lagenicaulis* (*Read 770*) | |
| Arecoid palms | Arecoideae |
| *Ptychosperma macarthurii* (*FTG:RM872A*) | |
| *P. lineare* (*Essig 710122-1*) | |
| *Veitchia arecina* (*Read 9583*) | |
| *V. merrillii* (*Read 1235*) | |
| Cocosoid palms | Cocosoideae |
| *Arecastrum romanzoffianum* (*Read 911*) | |
| *Arikuryroba schizophylla* (*Read 812*) | |

[a] Categories are informal and used in an interim classification of palms.

were cut into small pieces. Dehydration and embedding times also had to be greatly extended. Sections of mature endocarps of the cocosoid fruits were cut on a diamond-edged rock saw, ground by hand on carborundum paper until translucent, and mounted in HSR without staining.

## Results

CORYPHOID PALMS. Approximately half of the 31–32 genera have flowers with apocarpous gynoecia and five of these, here represented by *Thrinax*, have only a single carpel. Flowers of the remaining genera are tricarpellate with carpels connate by their styles, here

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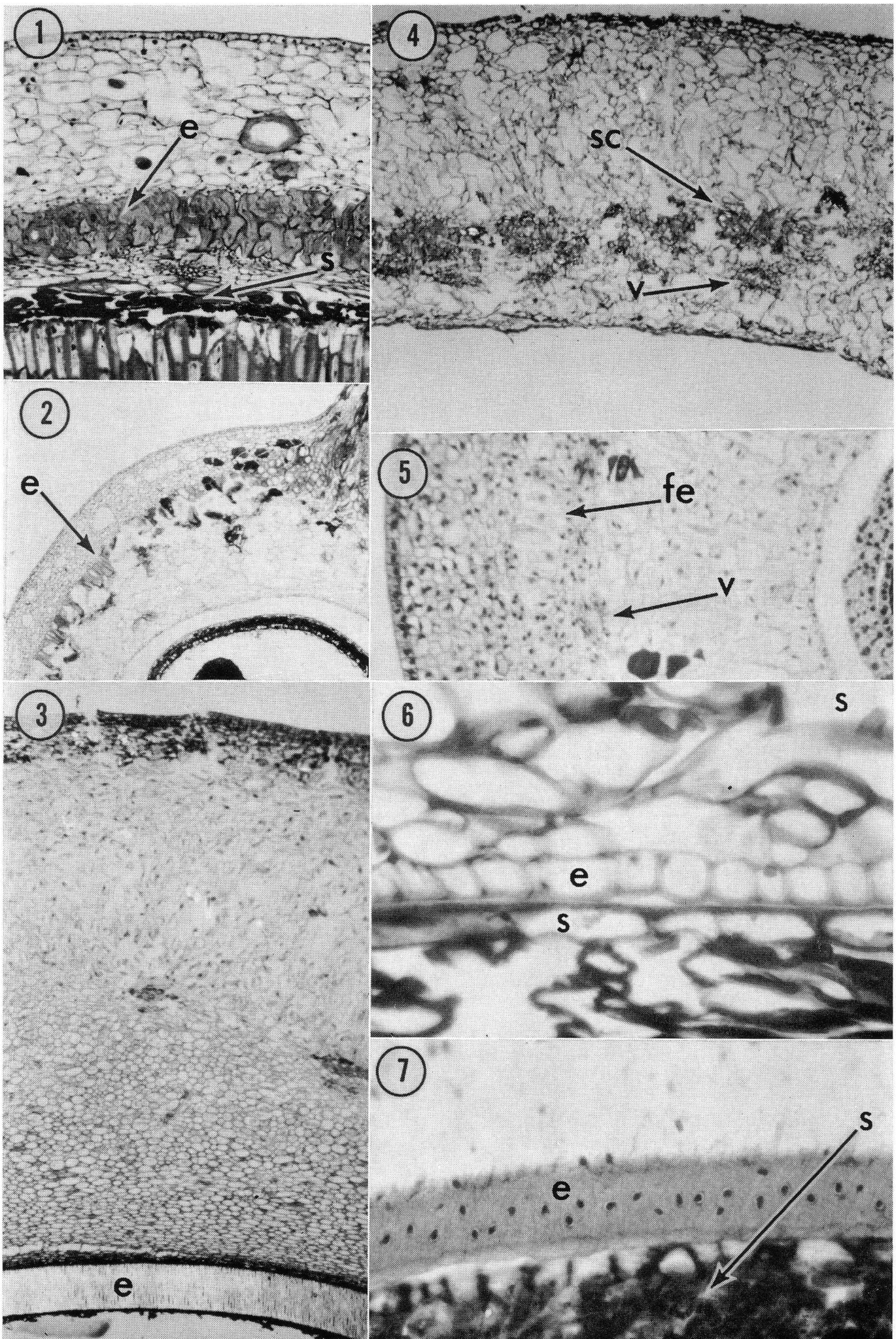
1–7. Structure of carpel and fruit wall. a. *Thrinax* sp., mature fruit wall × 76: e = endocarp; s = seed coat. 2. *Thrinax* sp., developing fruit wall × 31: arrow indicates endocarp (e). 3. *Pseudophoenix sargentii*, mature fruit wall × 31: e = endocarp. 4. *Coccothrinax* sp., mature fruit wall × 31: v = vascular bundle; sc = group of sclereids. 5. *Thrinax* sp., carpel wall × 95: v = developing vascular bundle; fe = radially elongate cells of future endocarp. 6. *Chamaedorea alternans*, mature fruit wall × 300: s = outermost layer of cells of seed coat; e = cell of endocarp. 7. *Caryota mitis*, mature fruit wall × 200: dark area at bottom (s) is seed coat; e = endocarp.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represented by *Pritchardia*, or syncarpous to varying degrees.

*Thrinax* sp. The one-seeded fruit develops from the single uniovulate carpel. At anthesis, the carpel wall consists of an outer zone of small, isodiametric cells separated by a single ring of procambial strands from an inner zone of larger cells, many of which contain raphides. The endocarp is partially differentiated as a layer of radially elongate cells outside the ring of procambial strands (Fig. 5) in the distal portion of the carpel. The tissues are less well differentiated toward the base but as the fruit ages, this difference in degree of maturation disappears. The endocarp is well differentiated and the cell walls are sclerified (Fig. 2) within seven days of pollination. The sclereids tend to separate as the fruit continues to enlarge and the resulting spaces are filled by the enlargement of adjacent parenchyma cells. These intrude among the existing sclereids, assuming highly irregular shapes, and subsequently become sclerified. In this manner the endocarp is maintained as a continuous layer throughout the development of the fruit. No mitotic figures have been observed in the parenchyma cells mixed with or adjacent to the endocarp and no silica is deposited in the endocarp sclereids. The growing seed eventually crushes the inner zone of large cells and presses the vascular bundles against the endocarp so that the endocarp appears to lie next to the locule in the mature fruit (Fig. 1). The intervening vascular bundles, however, indicate that the endocarp has a more superficial origin.

*Related taxa*. *Thrinax excelsa* Loddiges ex Grisebach, as described by Uhl and Moore (1971), is very similar in the structure of the gynoecium, but fruits of the age examined showed no evidence of the endocarp. The closely allied genus, *Coccothrinax*, is similar in the structure of the gynoecium (Uhl and Moore, 1971). Unlike *Thrinax*, the endocarp is not complete but is represented by patches of sclereids separated by groups of parenchyma cells (Fig. 4). The sclereids occur mostly in association with the vascular bundles. No silica occurs in the endocarp sclereids.

*Pritchardia pacifica* Seemann & H. Wendland. A one-seeded fruit develops from one of three uniovulate carpels that are initially connate by their styles. The aborted carpels are distal on the mature fruit. The endocarp is not differentiated in the carpel wall at anthesis, but within nine days of pollination it differentiates from a region of large parenchyma cells three to four cells away from the locule and interior to the developing vascular system. During fruit enlargement, the sclereids tend to separate from one another, and parenchyma cells immediately outside the endocarp, as well as those mixed among the sclereids, enlarge and intrude among the previously differentiated cells, often assuming highly irregular shapes (Fig. 10). Occasional divisions in the adjacent parenchyma cells add to the endocarp until 25 days after pollination, when all divisions have ceased and silica is deposited. Starting at about 46 days, the silica-containing cells become sclerified, thus increasing the radial extent of the

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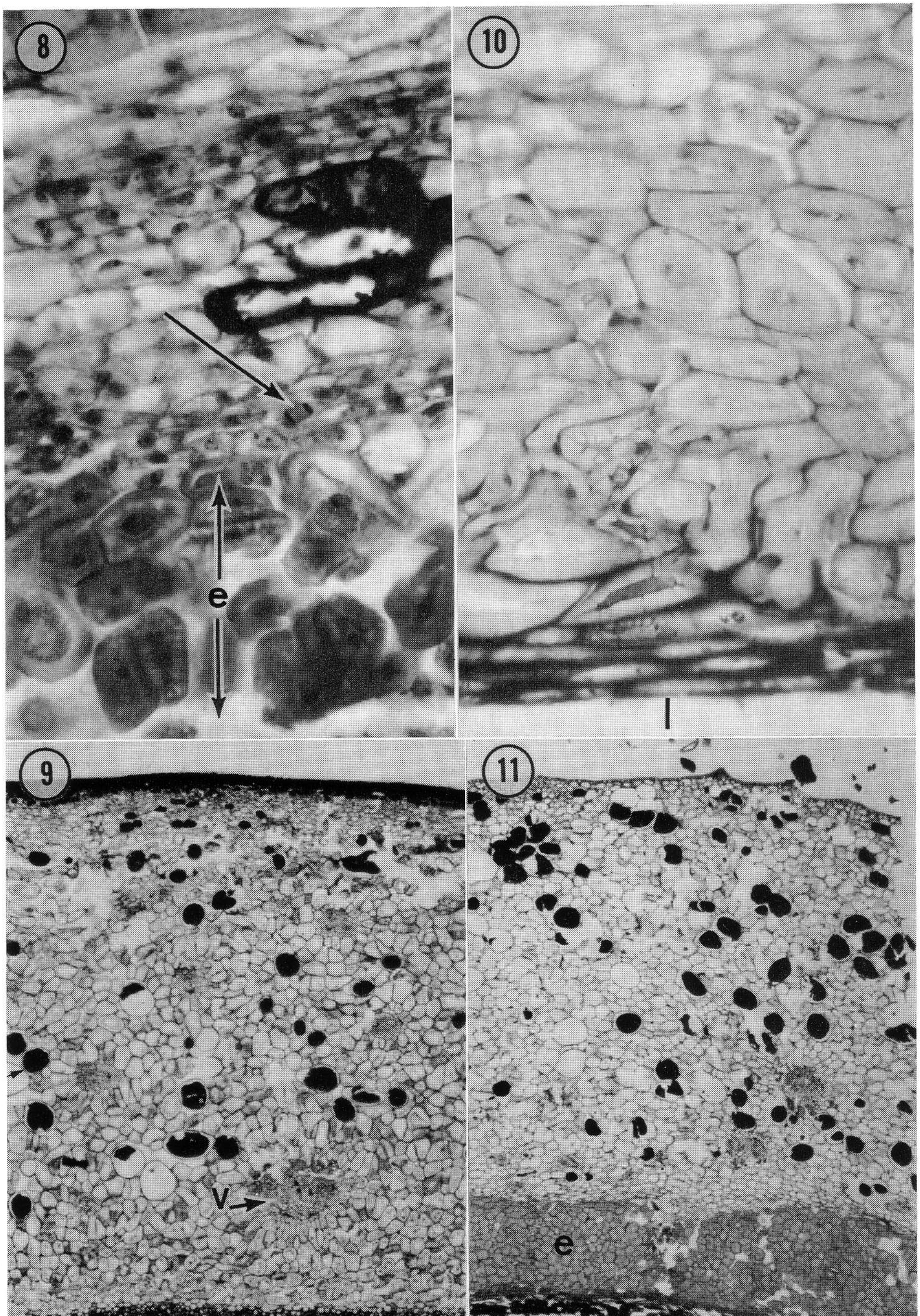
8–11. Structure of fruit wall and endocarp. 8. *Livistona chinensis*, developing fruit wall × 600: endocarp (e) at bottom; plain arrow indicates mitotic figure in meristematic zone. 9. *Livistona chinensis*, mature fruit wall × 31: e = endocarp; v = vascular bundle. 10. *Pritchardia pacifica*, cells of mature endocarp × 600: note thick cell walls and irregular shapes of some of the cells; l = locule. 11. *Rhapidophyllum hystrix*, mature fruit wall × 31: e = endocarp; s = seed coat.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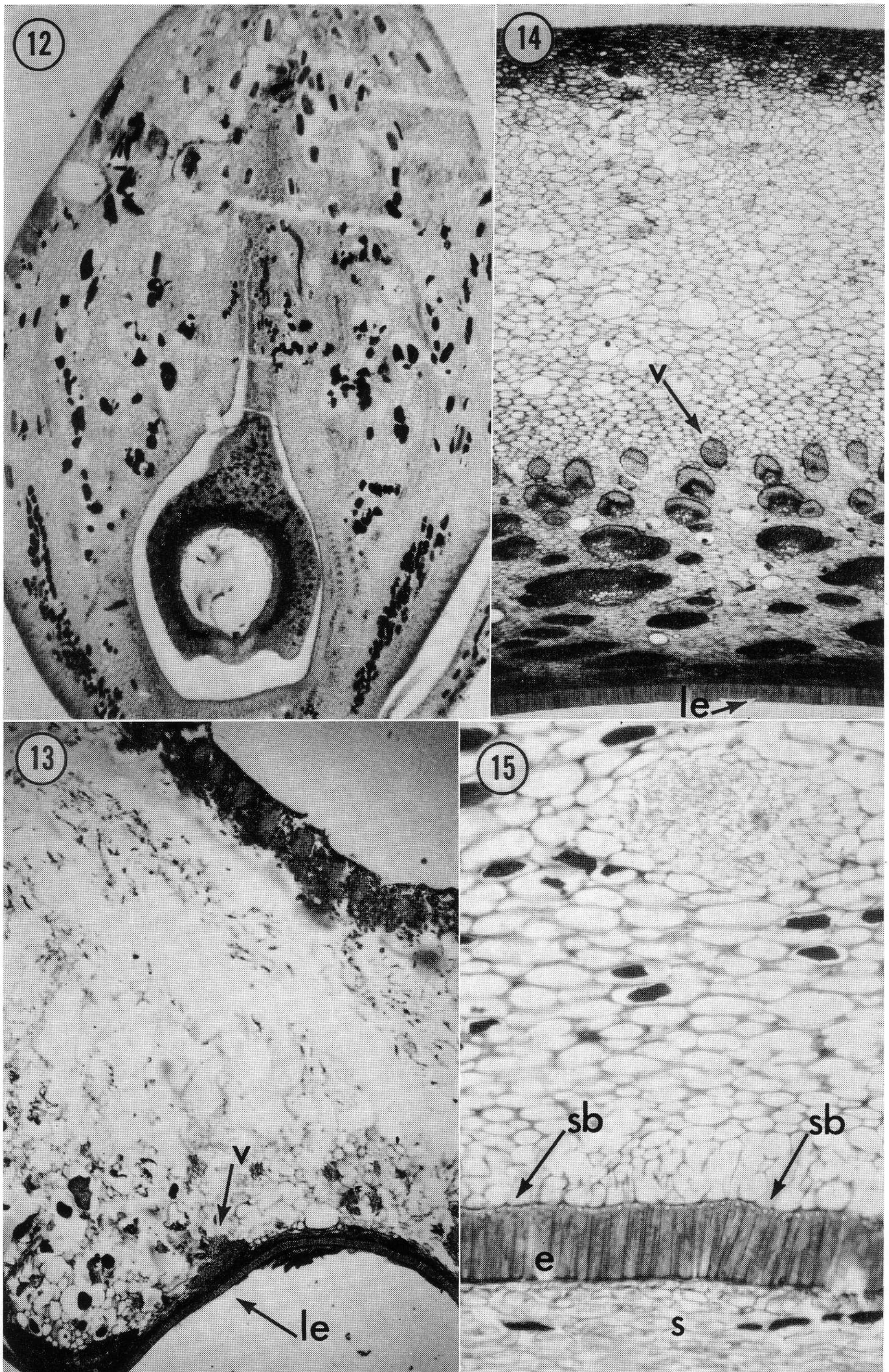
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endocarp without an increase in either cell size or cell number. The endocarp is approximately 240$\mu$ thick and lies almost immediately adjacent to the locule (Fig. 10) in the mature fruit.

*Livistona chinensis* (N. J. Jacquin) R. Brown ex Martius. The one-seeded fruit develops from one of three uniovulate carpels connate by their styles. The aborted carpels abscise. The endocarp, not apparent in the carpel at anthesis, is differentiated shortly after pollination as a tough layer of sclereids mixed with parenchyma, three cells removed from the locule. The endocarp is maintained as a continuous layer throughout fruit enlargement by the activity of a distinct meristematic layer immediately outside it (Fig. 8). The individual sclereids are separated from one another as the fruit enlarges. Cells produced to the inside of the meristematic zone intrude into the sclerotic layer and fill the gaps between the pre-existing cells, often assuming highly irregular shapes. Most of these later-formed sclereids contain silica bodies, which the earliest ones lack. Cells are also added to the endocarp by division of the associated parenchyma and of the cells between the endocarp and the locule. With the ripening of the fruit, the endocarp thickens rapidly, due entirely to the sclerification of the cells on both sides of it. The endocarp is approximately 300$\mu$ thick in the mature fruit and lies to the interior of the vascular system almost immediately adjacent to the locule (Fig. 9).

*Rhapidophyllum hystrix* (Pursh) H. Wendland & Drude. The one-seeded fruit develops from one of three uniovulate carpels. The endocarp and, in fact, the entire fruit structure resemble closely the fruits of *Livistona* and *Pritchardia*. No data are currently available on the development of the endocarp in *Rhapidophyllum*, but the endocarp lies between the vascular system and the locule (Fig. 11) in the mature fruit. Cells of the thick (approximately 450$\mu$ wide) endocarp are more or less isodiametric and contain silica.

CARYOTOID PALMS. The three genera of this group have flowers with tricarpellate, syncarpous gynoecia. All three carpels enter into the formation of a one- to three-seeded fruit.

*Caryota mitis* Loureiro. The one-seeded fruit develops from the one- to three-locular syncarpous gynoecium. The endocarp is not formed until the fruit is nearly ripe. At that time the previously isodiametric cells of the locular epidermis elongate radially to a maximum diameter of 50$\mu$, become sclerotic, and form the thin endocarp which tends to adhere to the seed (Fig. 7). Minute grains of silica occur, embedded in the walls of the endocarp cells. In the mature fruit, the "papery" endocarp (Moore, 1960), consists solely of the sclerotic cells of the locular epidermis.

*Related taxa.* The structure of the fruit wall of *Caryota urens* Linnaeus as described by Rao (1959) is similar to that of *C. mitis*. The histology of the gynoecium of *C. mitis* at anthesis is like that of *Arenga* (Uhl and Moore, 1971).

←

12–15. Structure of gynoecium and fruit wall. 12. *Ptychosperma macarthurii*, longitudinal section through gynoecium × 31. 13. *Ptychosperma lineare*, mature fruit wall × 31; le = locular epidermis; v = vascular bundle. 14. *Veitchia arecina*, mature fruit wall × 31; le = locular epidermis; v = vascular bundle at outer limit of endocarp zone. 15. *Mascarena lagenicaulis*, mature fruit wall × 150: e = endocarp; s = seed coat; small white bodies indicated by arrow, sb, are silica bodies in the endocarp cells.

PSEUDOPHOENICOID PALMS. The single genus has flowers with a tricarpellate, syncarpous gynoecium.

*Pseudophoenix sargentii* H. Wendland ex Sargent. Each lobe of the one- to three-lobed fruit develops from one of the three uniovulate carpels. The endocarp is derived from the locular epidermal cells which begin to elongate radially at 29 days after pollination and which reach a maximum length of 240$\mu$ in the next 60 days. The cell walls then become sclerified and the layer forms a hard endocarp which is appressed, but not adherent, to the seed (Fig. 3). No silica occurs in the cells of the endocarp.

CHAMAEDOREOID PALMS. The six genera in this group all have flowers with a tricarpellate, syncarpous gynoecium.

*Mascarena lagenicaulis* L. H. Bailey. The one-seeded fruit develops from one of the three uniovulate carpels; seeds do not develop in the other two carpels which remain small in the fruit. At about 16 days after pollination, the previously isodiametric cells of the locular epidermis begin to elongate radially. A single silica body is deposited in the outer end of each cell at about 44 days and the cells continue to elongate, reaching a final length of approximately 70$\mu$. Sclerification of the cells does not occur until the fruit is essentially full size and the endocarp consists solely of the sclerified locular epidermal cells (Fig. 15) in the mature fruit.

*Chamaedorea* sp. (BH-61-1178). The one-seeded fruit develops in the same manner as that of *Mascarena lagenicaulis*. Approximately 25 days after pollination, a single silica body is deposited in each cell of the locular epidermis. There is no further differentiation of these cells which remain unsclerified in the mature fruit. The final structure in this species is similar to that illustrated in Figure 6 for *C. alternans* except that the cell walls are thinner.

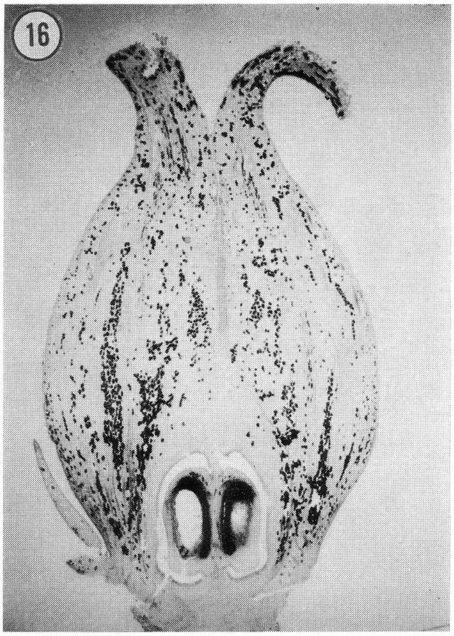
*Related taxa.* The locular epidermal cells of *C. microspadix* Burret, *C. alternans* H. Wendland, and *C. pochutlensis* Liebmann ex Martius are similar to those of the *Chamaedorea* species described above in that they are isodiametric and contain a silica body (sometimes more than one in *C. microspadix*). However, at least some of the cell walls are sclerified in these species and the endocarp thus formed is more definite than that in *Chamaedorea* sp. The structure of the carpel wall of *C. metallica* O. F. Cook ex H. E. Moore and *C. ernesti-augusti* H. Wendland at anthesis as described by Uhl and Moore (1971) is similar to that in *Chamaedorea* sp. (BH-61-1178). The only significant difference in gynoecial histology between *Mascarena* and *Chamaedorea* is the presence of a large number of tannin-containing cells in the former.

ARECOID PALMS (*Ptychosperma* alliance). All eight genera of this alliance have flowers with tricarpellate, syncarpous gynoecia which are pseudomonomerous and contain solitary ovules.

*Veitchia arecina* Beccari. The limits of the sterile carpels are not evident in the one-seeded fruit. In the inner portion of the ovary wall at anthesis, longitudinally oriented procambial strands encircle the locule, separated from it by several cell layers of parenchyma. Extensive fibrous sheaths are differentiated around the bundles but are not sclerified. Silica is present in cells surrounding the bundles only in the more mature distal part of the ovary. Maturation is basipetal and centripetal. Fourteen days after pollination, silica has been deposited in cells of the bundle sheaths as far as mid-locule and after 24 days, when sclerification of the fibrous sheaths of the outer bundles has begun in the region of the locule, silica is present in the bundle sheath cells at the base of the locule. The basipetal maturation of the tissues from a diffuse basal meristematic zone occurs at a rate equal to the growth of the fruit during most of the developmental period, thus the only part of the fruit devoid of sclerotic tissue is the area encased in the persistent perianth. Cell divisions in the basal zone occur in all planes, and early in development may occur as high as mid-locule, but later are restricted to the approximate level of the locule floor. When the fruit has reached nearly full size, the parenchyma layer between the locular epidermis and the fibrous zone shows considerable tangential stretching and crushing of the cells. Subsequently, in the ripe fruit, the parenchymatous zone, the locular epidermis, and the fibrous zone are all sclerified, forming a tough endocarp (Fig. 14).

*Related taxa.* The structure of the gynoecium and the development of the endocarp in *Veitchia merrillii* (Beccari) H. E. Moore are essentially identical to those of *V. arecina* described above. The more extensive fibrous sheaths on the outermost bundles form a more evident outer boundary of the endocarp in *V. arecina,* but otherwise the fruits of the two species are very similar.

The same basipetal and centripetal pattern of maturation is evident in the fruits of *Ptychosperma macarthurii* (H. Wendland) Nicholson (Fig. 12). The locular epidermis is sclerified, as are a few cell layers of parenchyma and the fibrous sheaths of the vascular bundles which lie near the locule. However, the entire zone is far less developed than in the *Veitchia* species. The structure of the mature fruit of *P. lineare* (Burret) Burret (Fig. 13) is similar to that of *P. macarthurii.*

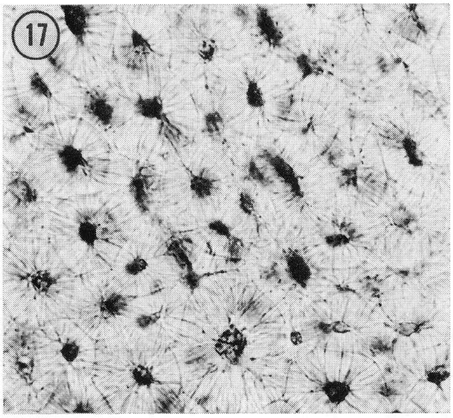



16. *Arikuryroba schizophylla,* longitudinal section through gynoecium × 14.

As described by Uhl and Moore (1971), *Paralinospadix,* of the *Linospadix* alliance, and *Areca,* of the *Areca* alliance, of the arecoid palms show a similar arrangement of longitudinally oriented vascular bundles in the ovary wall and exhibit basipetal and centripetal maturation of the tissues.

COCOSOID PALMS (*Cocos* alliance). The genera of this alliance have flowers with tricarpellate, syncarpous gynoecia always containing three (or rarely more) ovules at anthesis.

*Arecastrum romanzoffianum* (Chamisso) Beccari. A one-seeded fruit is formed from all three carpels; the two aborted ovules are crushed against the inside of the endocarp. At anthesis, the endocarp is differentiated as a region of isodiametric, thin-walled parenchyma cells between the locular epidermis and the longitudinally oriented procambial strands of the fibrous zone. The distal



17. *Arecastrum romanzoffianum*, sclerified endocarp cells × 320.

portion of the gynoecium contains fully mature tissues and some sclerified cells in the fibrous bundle sheaths, whereas the basal portion remains meristematic (Fig. 16). Maturation of the tissues is basipetal and centripetal and keeps pace with the enlargement of the fruit from the base, so that only the portion enclosed within the persistent perianth remains without sclerotic tissue. When the fruit has reached about two-thirds of full size, sclerification begins in the distal portion of the parenchyma zone. Sclerification proceeds basipetally and the cell walls become increasingly thick and hard (Fig. 17). In the mature fruit, the sclerification has extended slightly into the parenchyma surrounding the bundles of the fibrous zone and thus the endocarp includes the innermost fibrous bundles.

*Related taxa.* The gynoecial structure and development of the fruit of the closely related *Arikuryroba schizophylla* (Martius) L. H. Bailey are essentially identical to that described for *Arecastrum.* Uhl and Moore (1971) note the similar maturation of the distal tissues in gynoecia of *Bactris*, *Butia*, and *Elaeis.*

## Discussion

The number of genera and species included in this study is so small that only tentative conclusions can be drawn, but the results obtained suggest that the structure and development of the endocarp correlate sufficiently well with other morphological characteristics that they may be useful in indicating relationships and may also be of diagnostic value in some groups.

Among the fruits studied, three endocarp types are distinguishable on the bases of time of differentiation, cell layers involved, and mode of development.

*Type I.* The Type I endocarp is the simplest and is derived solely from the cells of the locular epidermis which may be isodiametric or radially elongate and are usually sclerotic and contain silica. Differentiation and sclerification of the endocarp do not occur until the fruit has reached essentially full size. The Type I endocarp has been observed in the chamaedoreoid, pseudophoenicoid, and caryotoid groups of palms.

*Type II.* The Type II endocarp differentiates from the inner portion of the fruit wall early in development. The locular epidermis is not involved in the formation of the endocarp, which is several layers removed from it. After sclerification of the earliest differentiated cells, the endocarp is maintained as an intact layer throughout the growing period by the enlargement and intrusion of adjacent parenchyma cells into the spaces left as the sclereids separate. The Type II endocarp has been observed only in the coryphoid palms.

*Type III.* The Type III endocarp is the most complex and variable. The endocarp consists of three tissues: the sclerified locular epidermis, the sclerified and sometimes confluent sheaths of the inner vascular bundles, and the intervening parenchyma, also sclerified.

In the cocosoid palms, the parenchymatous zone is greatly exaggerated and may be almost as thick as the rest of the fruit wall. When the endocarp of a cocosoid fruit becomes sclerified, so do the parenchyma cells surrounding the innermost vascular bundles which thus become included in the endocarp. Fruits of the *Ptychosperma* alliance of arecoid palms have a far thinner zone of parenchyma between the locular epidermis and the fibrous zone. In gynoecia having a Type III endocarp, the parenchymatous and fibrous zones are differentiated at the time of flowering. Sclerification of the fibrous bundle sheaths first occurs distally and proceeds basipetally, as does sclerification of the parenchymatous zone. The Type III endocarp has been observed in fruits of cocosoid and arecoid palms.

## Comparisons and Relationships

The intrusion of parenchyma cells into an adjacent sclerotic zone and their subsequent sclerification in a manner similar to that which occurs in the Type II endocarp of the coryphoid palms was noted by Lloyd (1910) and Long (1943) in fruits of the date (*Phoenix dactylifera* Linnaeus). The sclerotic zone in the date is located near the outer surface and has been termed an "exocarp" (Lloyd, 1910; Long, 1943). The phoenicoid and coryphoid palms are considered to be closely related (Drude, 1887; Potztal, 1964; Moore, 1973) and a similar mode of growth of a sclerotic zone is not unexpected.

Within the coryphoid group, *Rhapidophyllum* has been placed in the *Trithrinax* alliance of the apocarpous genera along with *Thrinax* and *Coccothrinax* (Moore, 1973) but the position of the endocarp to the interior of the vascular system is more similar to that of *Livistona* and *Pritchardia* of the *Livistona* alliance of syncarpous genera. The location of the endocarp relative to the vascular system needs to be determined for more coryphoid fruits before its significance can be determined. The enlargement of a sclerotic endocarp by a meristematic zone, such as occurs in *Livistona chinensis*, has not been reported elsewhere.

The pseudophoenicoid and chamaedoreoid palms are generally considered to be closely allied (Drude, 1887; Potztal, 1964; Moore, 1973) and their fruits are very similar, especially with regard to the development and mature form of the endocarp. Among the chamaedoreoid palms studied, the five species can be arranged in a series based on the degree of differentiation of the locular epidermal cells: those cells are isodiametric with unmodified walls in *Chamaedorea* sp., isodiametric with the locular tangential and radial walls slightly sclerified in *C. microspadix*, isodiametric with the same walls thicker and more heavily sclerified in *C. alternans*, isodiametric with all walls very thick and heavily sclerified in *C. pochutlensis*, radially elongate and with all walls very thick and heavily sclerified in *Mascarena lagenicaulis*. Although the *Mascarena* endocarp appears distinctive, it is only a further expression of a trend evident among the species of *Chamaedorea*. The endocarp of *Pseudophoenix sargentii* could be added to the series in that it differs from the others only in its cells being more elongate.

Among the cocosoid and arecoid palms, the progressively basipetal maturation of the sclerotic tissues is apparently related to the presence of a basal meristematic zone from which the fruit grows. Uhl and Moore (1971) noted in the material they studied that the basal and central ovarian regions were immature relative to the hard and variously protected stylar regions. In the arecoid and cocosoid species examined, cell divisions were observed to occur in the basal portions of the ovary until the fruit had reached about half its final length. Thereafter, enlargement was due to increase in cell size. The similarities in the development and growth of the endocarp in the arecoid and cocosoid fruits are striking, but it is not wise to draw any conclusions as to the significance of these similarities from the limited data currently available.

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## CLASSIFIED SECTION

# PALM LITERATURE

## Palms of Malaya

WHITMORE, T. C. Palms of Malaya. i–xv, 1–132, figures 1–106, plates 1–16. Oxford University Press, Kuala Lumpur, Singapore, London. 1973. M$35.

The publication of a book concerned entirely with palms is a rare event and deserves notice. Oxford University Press has finally produced *Palms of Malaya* by T. C. Whitmore, apparently three years after the submittal of the manuscript. It is most regrettable that we have had to wait so long for this book, especially as there have been advances in Malayan palm botany since the manuscript was submitted that render parts of the book out of date.

This book is described by the author in the preface as a broad outline of the palms of Malaya—it is not intended to be exhaustive. For whom the book is intended, however, is not clear.

The volume is slim, printed on good paper in clear type, and contains numerous sketches and silhouettes and some fine photographs. The text is divided into two parts—Part One, entitled Introduction, has chapters dealing with the palm scene, palm construction, palm cultivation, palms of local interest, the palm subfamilies, and keys to Malayan palms and distinctive characters. In the second part, a selection of Malayan palms is described. Part One is preceded by a glossary, acknowledgements, contents, and lists of illustrations, and Part Two is followed by text notes, references, a check list of Malayan palms, and indices.

The first impression the book gives is favourable and many members of The Palm Society, after a short inspection, will no doubt wish to purchase the book. There are, however, grave mistakes and omissions which in the end prevent the reviewer from recommending the book without reservations. The danger of the book is that so few people know the Malayan palms in any detail at all that the book will be accepted as the authoritative introduction to the Malayan palms; the present review is intended to qualify such acceptance.

The selection of palms described is open to criticism—some genera are given a far more complete treatment than others and one or two genera are hardly mentioned at all. For instance, *Actinorhytis calapparia*, an extremely elegant palm sometimes planted in Malay villages, especially by villagers of Javanese ancestry, is not described at all. Five trees can be seen between Seremban and Kuala Lumpur alone, and because of its superficial similarity to the betel palm, it can be confused with the latter—it is certainly far commoner than *Lodoicea* and *Phoenicophorium* which are apparently added only as spice to the book. The treatment of *Ptychosperma* gives the impression that the species of the genus are easily identified; and no mention is made of *Ptychosperma elegans* which is quite a common ornamental. The rattans receive little attention apart from an interesting general introduction—the individual rattan genera are described and little more. This is a matter for great regret—here was an excellent opportunity to provide some details of the commoner rattans which are by no means difficult to identify. For *Licuala*, the reader is referred, as for the rattans, to Furtado's works, which are not by any means easy to obtain; yet *Livistona* receives a detailed treatment. *Iguanura* receives a "complete" treatment, though no mention is made of the fact that research has been carried out on the taxonomy of the genus in Malaya by Mrs. Ruth Kiew. *Pi-*

*nanga*, with a total of about 25 species, has 12 species keyed and described. This sounds more complete than *Licuala*; yet of the eight species of *Pinanga* common on Gunung Panti in Johore, the nearest fine forest to Singapore, only four of them are described. The naturalist visiting Gunung Panti is therefore not much helped in identifying the *Pinanga* species. The scope, as in any non-definitive treatment, is bound to seem somewhat arbitrary, and this would have been more forgivable if the factual matter presented were reliable.

Unfortunately there are many errors, often of a gross nature. For example, Figure 3 is not *Pinanga malaiana* but *Nenga pumila* var. *malaccensis*. On plate 3, the plant illustrated is not *Daemonorops longipes* (in this species the bracts drop at anthesis—the plant illustrated is an anomalous species within section *Cymbospatha*). In plate 9, close examination will reveal that the plant illustrated as *Ptychoraphis singaporensis* has compound terminal leaflets and a crownshaft—these two features preclude its being *Ptychoraphis singaporensis* and suggest *Nenga* or *Pinanga*. In Figure 67, *Nenga macrocarpa* should read *Nenga pumila* var. *malaccensis*—in *N. macrocarpa* the sepals do not exceed the petals in the male flower, and they are more obtuse. In Figure 75, the fruit of *Orania sylvicola* is shown to be one inch in diameter, but the ripe fruit observed by the reviewer in Malaya is about two inches in diameter. In Figure 89, the fruit of *Plectocomia griffithii* is shown as being smooth—yet even the ripe fruit is covered with upward-pointing, fimbriate, almost spiny scale tips. In Figure 98, the fruit illustrated does not represent that of *Salacca edulis*, which in the text is referred to as being top-shaped. Three times in the text, the tissues of the caryotoid palms are referred to as being poisonous—the fruit pulp of these palms is certainly filled with irritant needle crystals, but the "cabbage" is delicious; in parts of Borneo, for example, the giant *Caryota no* is nearing extinction because it is so much sought after for its apex. In the diagnosis of *Korthalsia*, rosette and basal leaves are described as being with entire terminal leaflets, yet some species have a terminal pair of leaflets. *Cornera* is described as being a pachycaul rattan—yet *C. conirostris* is a slender climbing rattan with inflorescences longer than the leaves. These represent a sample of some of the errors.

The book is filled with stimulating comments on the structure of palms; when pondered on, however, many of these comments become more and more nebulous. For instance, the leaf of *Salacca rumphii* is described as having "the leaflets not only displayed spirally but also inserted spirally right up to the leaf tip." This is an extraordinary statement to make without substantiation, especially as this would make the leaf unique among the palms. Other speculations appear to be derived from Corner's *Natural History of Palms*, to which the book is indebted for much of the introductory chapters.

The keys seem to work reasonably well, though details such as the description of inner leaflets of *Licuala* and *Rhapis* as induplicate instead of reduplicate could have been corrected with careful proof-reading. The list of distinctive characters is very incomplete and the reviewer would not recommend its use in the identification of Malayan palms in the field. Details of distribution are often incomplete—Malayan so-called endemics such as *Myrialepis*, *Iguanura wallichiana*, *Pinanga disticha*, and *P. limosa* are also known in Sumatra, and *Orania sylvicola* and *Oncosperma horridum* are also known in Sumatra.

The illustrations, apart from the attractive plates, are disappointing. The silhouettes of palms intended to clarify their habit, with one or two exceptions more often than not obscure it. Line drawings would have been preferable to the silhouettes—the difference between the leaflets of *Oncosperma horridum* and *O. tigillarium* is not emphasized in the silhouettes, for example, and would have been better elucidated by diagram. Even the sketches are not all reliable; for example, the sketch of the ocrea of *Korthalsia echinometra* misleads the reader into thinking that the stem is swollen beneath the ocrea.

Despite the cumbersome nature of the name *Johannesteijsmannia* this is the correct name for *Teysmannia,* and it is not justifiable to continue to use this old name when other newer combinations such as *Rhopaloblaste singaporensis* are adopted in the text notes.

One of the really useful features of the book is the check list of Malayan palms—this list is likely to be of interest to Palm Society members in the preparation of desiderata lists for seed collectors.

In summary, many of the deficiencies of this book could have been eliminated by consultation with other palmologists and more careful proof-reading; the book gives the impression of having been written in isolation and in a hurry. Despite these comments, this is the only modern partial introduction to Malayan palms, but the interested naturalist will still have to use the works of Furtado, Beccari, and Ridley to identify Malayan palms with confidence. The price of M$35 will probably put the book beyond the reach of Malayan students but Palm Society members may wish to purchase it, if only for the beautiful plate by Mr. Ho Sai Yuen of *Johannesteijsmannia magnifica* and *J. lanceolata.*

JOHN DRANSFIELD
*Herbarium Bogoriense,*
*Bogor, Indonesia.*

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## PALM BRIEFS

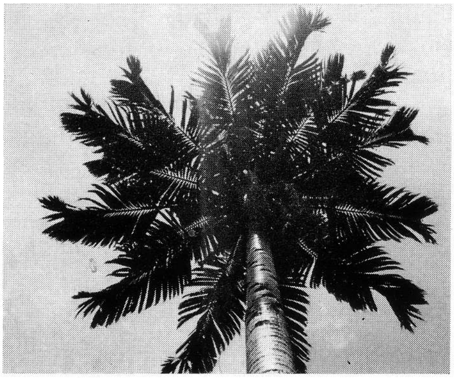
### Pigafetta filaris in Sibolangit

In relation to Dr. M. E. Darian's article on *Pigafetta* in PRINCIPES 17(1), the following note is presented.

Sibolangit Botanic Garden in North Sumatra, Indonesia, lies about 40 kilometers (25 miles) southwest of Medan on the road to the hill resort of Berastagi and at about 500 meters (1640 feet) altitude. It covers an area of about 20 hectares (49 acres) and is fringed on one side by a small nature reserve about 100 hectares (247 acres) in extent. The Garden was founded in 1914 as a branch of the Bogor Botanic Gardens. Owing to economic difficulties, the Bogor Gardens relinquished control of the Garden after the Second World War, and since then the Garden and the Nature Reserve have been run by the Department of Nature Conservation. The Garden at the moment is in an agreeable state of neglect, with only the main paths kept open from the virulent stinging shrub *Laportea.* It is hoped that the Bogor Gardens will soon be able to take over the running of Sibolangit Garden again and begin to re-establish it as a scientific garden. I very much hope so, if for no other reason than that this garden is, to my knowledge, the only place where mature trees of *Pigafetta filaris* Becc. can be found in abundance in cultivation.

*Pigafetta filaris,* native in Minahassa (N. Celebes) and New Guinea (including Irian Jaya), was regarded by David Fairchild as his favourite palm. It cer-

1. *Pigafetta filaris.* These trees were planted at Sibolangit Botanic Garden in 1958.



2. Sunlight is reflected from the highly polished trunk of *Pigafetta filaris.*

tainly is very beautiful, but in my opinion is outshone in grace by *Actinorhytis calapparia* (which, incidentally, is also common in Sibolangit). When I first visited Sibolangit in 1971, I could find no ripe seed of the *Pigafetta*, though seedlings were so abundant as to form swards under the female trees. I brought back seedlings to Bogor to try to reestablish this glorious palm in Bogor, where until recently grew two trees. The seedlings brought back grew extremely fast but proved to be very susceptible to fungal attacks at the base of the stem when repotted, and also to red spider attacks on the leaf. Of this original introduction, some 40 plants still survive and we have recently planted out four, and hope shortly to plant an avenue of *Pigafetta* in front of the new laboratory buildings. In March, 1973, I was able to revisit Sibolangit and this time was able to collect many ripe fruits which were distributed to the Seed Bank under the collection number *Dransfield* 3404.

In all, there are 25 trees of *Pigafetta filaris* at Sibolangit in various stages of maturity. The trees in the accompanying photograph (Fig. 1) were planted in 1958 from seed from another tree in the Garden and are already 20 meters (about 65 feet) or more in height. Other trees are apparently self sown. The original introduction was from the Celebes but I have been unable to find more details of this. The trunk is about the size of the trunk of a coconut but differs markedly in the beautiful shiny, green-brown surface—almost as if the trunk had been wax-polished. The elegant arching leaves are densely golden-brown thorny along the midrib and on the leaf base. Inflorescences are axillary, highly branched, and somewhat reminiscent of a very slender partial inflorescence of *Metroxylon.* The white scaly fruit is surprisingly small (ca. 8 mm. × 6 mm. or ⅓ × ½ inch) and the sarcotesta around the endosperm is soft and sweetish. Fruit, when produced, is in vast quantity, but because of the high polish on the trunk, the tree is virtually unclimbable, and I had to be content to collect fallen fruit.

Sibolangit is easily reached and palm enthusiasts visiting South East Asia can fly to Medan and then take a taxi or bus for the one-hour journey to the Botanic Garden. Despite the state of neglect in the Garden, the sight of many regal *Pigafetta* palms growing so luxuriantly is most memorable.

JOHN DRANSFIELD
*Herbarium Bogoriense,*
*Bogor, Indonesia.*

## NEWS OF THE SOCIETY

Mr. Wayne W. Parish, a member of The Palm Society, offered two *coco-de-mer* (*Lodoicea maldivica*) to the Society if we had a place to plant them. It was suggested that he donate them to Fairchild Tropical Garden, especially since he also belongs to that organization. He and Mrs. Parrish had been to the Seychelles where they had made arrangements with the local government and BOAC to procure viable nuts and to ship them to him. He then was planning to bring them to Miami himself from his winter home in Hobe Sound. However, there was a mix-up in the delivery which caused quite a delay—the nuts went to Brussels and a carton destined for Brussels was shipped to Mr. Parrish. He finally got the nuts and dispatched them to Dr. Popenoe at Fairchild Garden. It now appears that at some point someone cut the hypocotyls of these nuts and they will not grow. It certainly is a big disappointment to all concerned to be so frustrated but we do thank Mr. and Mrs. Parrish for all the effort and expense they went to for this exciting and special gift.

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On May 11, 1973 the South Florida members enjoyed a covered dish supper in the garden of Mrs. Lucita Wait. Guest of honor was Professor Dr. T. A. Davis of the Indian Statistical Institute in Calcutta. He showed slides to illustrate the way the Fibonacci progression of numbers appears in nature, including the palm family. This progression is plotted by adding the highest number to the one immediately preceding it—1, 1, 2, 3, 5, 8, 13, 21, 34, 55 etc. ($1 + 0 = 1$; $1 + 1 = 2$; $2 + 1 = 3$; $3 + 2 = 5$, etc.) Most of the audience was not familiar with this system, nor its apparent application in the plant family so it caused great surprise and interest.

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### Save The Palms Committee

Members of the Palm Society in South Florida have been working closely with the Save the Palms Committee (to combat lethal yellowing of coconut palms). Paul Drummond, Chairman of the South Florida Area Members, is Vice-chairman of the Save the Palms Committee and has been of great help to Mrs. Murray McQuaid, Chairman. Mrs. McQuaid, who recently joined the Palm Society, was dismayed to find coconuts dying all around her new home when she moved to Coral Gables a year ago. Single-handedly she called together a group of citizens and formed them into the Save the Palms Committee. It is due to the efforts of this committee that additional funds have been appropriated by the State of Florida to further the work of the (State) University of Florida Research Center on Lethal Yellowing located in Fort Lauderdale. On May 29th, 1973, at a meeting in Coral Gables, Dr. Bryson James, head of the Research Center, announced that Terramycin may soon be available in Florida on a limited basis under strict control. If two grams of this antibiotic are injected under pressure into a coconut trunk before the disease has progressed too far, it will cause a remission of the disease for up to six months. Of course, so far no cure or preventative for the disease has been found. If the disease progresses at the present rate, it will have killed 20,000 coconuts by October, 1973, in the South Florida area.

## Palm Sale

The Palm Sale held by the South Florida members on April 28, 1973, was such a success that all concerned are still elated. Plants to be sold were collected beforehand on an empty lot where they were grouped, priced and named when possible. Members were given a chance to buy plants the evening before the sale and sold some $700 worth of plants to each other! Early next morning trucks and cars conveyed the remaining plants to a lovely grassed area under mango trees on the grounds of the Museum of Science, to which the public was invited. Buyers started arriving an hour before opening at 10 a. m. and all but the smallest and least desirable seedlings were gone by 11. A truckload of 312 dwarf Malay coconuts, on consignment from a nursery, was sold out by 11:30. Many disappointed customers were turned away.

Part of the credit for the success of the sale must be given to the Save the Palms Committee which had been getting a great deal of publicity resulting in an increase in palm consciousness in the community. However, much credit also goes to the many members who contributed their time, effort and plants. Without them there would have been no sale at all. From the proceeds of the sale a generous donation was made to the Save the Palms Committee. Fairchild Tropical Garden was given another herbarium case for its palm collection. The Palm Society will also benefit when it is determined how much money remains after all bills are paid.

## Hardiest Palms

The reprint of an article entitled The Hardiest Palms is now available to members of the Society. The article, by Dr. John Popenoe, Director, Fairchild Tropical Garden, starts with the quotation from a letter by a Palm Society member in Tennessee who is growing an amazingly large number of palms outdoors. Dr. Popenoe goes on to tell of other reports of cold hardiness and, what makes the article so valuable to members of the Society, he lists volume and page references in PRINCIPES.

Dr. Popenoe suggests there may be areas in Pennsylvania, New Jersey and the environs of New York, perhaps even further north, where at least two palms can be grown outdoors. Reports from members who may be trying their luck with palms in cold locations will be of interest so that an even more comprehensive list can some day be compiled. Members who have fruiting palms in these border areas would do a service to make any seeds they may have available to the Seed Bank with notations concerning the climatic conditions the particular plant has withstood. These seeds then can be tested further in cold areas.

The reprint is available for 50¢, which includes postage. Payment in U. S. stamps is acceptable, or coins. Foreign members can add this amount to money sent to the Seed Bank or to next year's dues. Please send your order to the office of the Palm Society, 1320 S. Venetian Way, Miami, FL 33139, USA.

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