



PRINCIPES

Journal of The Palm Society

July, 1979
Vol. 23, No. 3

THE PALM SOCIETY

A nonprofit corporation engaged in the study of palms and the dissemination of information about them. The Palm Society is international in scope with world-wide membership. All persons interested in palms are eligible for membership, and the formation of regional or local chapters affiliated with The Palm Society is encouraged. Please address all inquiries regarding membership or information about the society to the Executive Secretary.

PRESIDENT: Mr. Donn W. Carlsmith, P. O. Box 686, Hilo, Hawaii 96720.

VICE PRESIDENT: Mr. Paul A. Drummond, 9540 Old Cutler Road, Miami, Florida 33156.

SECRETARY: Mrs. Pauleen Sullivan, 3616 Mound Avenue, Ventura, California 93003.

EXECUTIVE SECRETARY: Mrs. Theodore C. Buhler, 1320 S. Venetian Way, Miami, Florida 33139.

TREASURER: Mrs. Ruth Shatz, 5901 Maggiore St., Coral Gables, Florida 33146.

DIRECTORS: 1976-80: Mr. Donn W. Carlsmith, Hawaii; Dr. John Dransfield, England; Mr. Paul A. Drummond, Florida; Mr. Myron Kinnach, California; Mr. Melvin W. Sneed, Florida; Mrs. Pauleen Sullivan, California; Mr. Ralph Velez, California. 1978-82: Dr. Byron Besse, Florida; Dr. Ernie Chew, California; Dr. Ian Daly, Australia; Mr. DeArmand Hull, Florida; Mr. Warren Dolby, California; Mr. Dial Dunkin, Texas; Dr. Harold E. Moore, Jr., New York; Mrs. Ruth Shatz, Florida; Dr. Merrill Wilcox, Florida.

ADVISORY COUNCIL: Mr. Nat J. De Leon, Florida; Dr. Walter H. Hodge, New York; Mr. Eugene D. Kitzke, Wisconsin; Mr. Dent Smith, Florida; Dr. U. A. Young, Florida.

PRINCIPES

JOURNAL OF THE PALM SOCIETY

EDITOR: Harold E. Moore, Jr., 467 Mann Library, Ithaca, N.Y. 14853.

ASSOCIATE EDITORS: Dr. John Dransfield, The Herbarium, Royal Botanic Gardens, Kew, Richmond, Surrey, England. Dr. Natalie W. Uhl, 467 Mann Library, Ithaca, N.Y. 14853.

EDITORIAL BOARD: Walter H. Hodge, Eugene D. Kitzke, Nixon Smith, Dent Smith, P. Barry Tomlinson.

Manuscript for PRINCIPES, including legends for figures and photographs, must be typed double-spaced on one side of 8½ × 11 bond paper and addressed to the Editor for receipt not later than 90 days before date of publication. Authors of one page or more of print will receive six copies of the issue in which their article appears. Additional copies of reprints can be furnished only at cost and by advance arrangement.

Contents for July

Palm Collecting in the South Pacific: Island Hopping to Australia and Back	
Melvin W. Sneed	99
A Branched Coconut Seedling in Tissue Culture	
Jack B. Fisher and James W. Tsai	128
Effect of Lethal Yellowing on Xylem Pressure in Coconut Palms	
Janet McDonough and Martin H. Zimmermann	132
Regular Features	
Palm Research	127
Letters	131
News of the Society	138
Notes on Culture	139
What's in a Name?	140
Classified	140

Cover Picture

Metroxylon upolense (foreground) flowering and fruiting in the garden at Aggie Grey's Hotel, Apia, Western Samoa (see page 126). The large, scaly fruits are 6-7 cm in diameter and begin to germinate before they fall from the tree. Photo by H. E. Moore, Jr.

PRINCIPES

JOURNAL OF THE PALM SOCIETY

(ISSN 0032-8480)

An illustrated quarterly devoted to information about palms and published in January, April, July and October by The Palm Society, Inc.

Subscription price is \$7.00 per year to libraries and institutions. Membership dues of \$12.50 per year include a subscription to the Journal. Single copies are \$1.50 each. The business office is located at **1320 S. Venetian Way, Miami, Florida 33139**. Changes of address, undeliverable copies, orders for subscriptions, and membership dues are to be sent to the business office.

Second class postage paid at Miami, Florida and at additional mailing offices.

Mailed at Lawrence, Kansas
July 31, 1979

Principes, 23(3), 1979, pp. 99-127

Palm Collecting in the South Pacific: Island Hopping to Australia and Back

MELVIN W. SNEED

8107 S.W. 72nd Avenue, 113 E, Miami, Florida 33143

My wife, Phyllis, and I had taken permanent leave from our two-acre garden in Jamaica, in March, 1977, to reestablish ourselves in Miami, Florida. Leaving our palm collection in the island, much of which stemmed from seeds furnished over the years by The Palm Society Seed Bank, as well as the gleanings of numerous collecting trips, was a melancholic experience. Yet, lack of our own garden notwithstanding and now blessed only with a patio 6×15 feet, by the fall of 1977 we had "itchy" feet and certainly had not lost our desire for palm collecting. Perhaps the itch could be assuaged with a bit of collecting for the Seed Bank and for Fairchild Tropical Garden.

Not enough praise has been given the Seed Bank, which next to the dissemination of information about palms is perhaps the most important function of The Palm Society for its members. Its inception goes back to 1957, about a year after the society was established. It was envisaged originally by Mr. Nat. J. De Leon, then an officer of the society, and subsequently implemented and managed by Mrs. Lucita Wait, the society's former Executive Secretary. She pursued this "labor of love" for two decades, assisted in recent years by Mr. DeArmand Hull and such volunteers as she could cajole into the operation, until November 1978, when Mrs. Wait retired and the function was assumed by Mrs. Lois Rossten, of Huntington Beach, California, an ardent member of the society.

The Seed Bank's main sources of accessible supply over the years have been the output of Fairchild Tropical Garden, which has the largest collection of palm species found in any of the world's recognized botanic gardens, the U.S.D.A. Plant Introduction Station here, and certain private gardens with large and varied collections, as well as donations by members. Lately, because of ravages of the lethal yellowing disease, which has devastated most coconut varieties as well as attacking certain other palms in South Florida, these traditional seed sources have been set aside until research in progress rules out the probability of transmission of this disease by seed.

In the meanwhile, the Seed Bank has relied on sources outside the restricted lethal yellowing area of Florida—not only for rather common palm species but for rare ones that never were available here. In light of this, Palm Society members, worldwide, might well communicate with the Seed Bank regarding viable seeds of palm species they may be able to collect in quantity to send in for distribution. The new address of the Seed Bank is 6561 Melbourne Drive, Huntington Beach, CA 92647, USA.

With strictly altruistic intentions, we got our gear ready for a trek into the South Pacific. The palms were there and, if we could time it properly, seeds for the Seed Bank and, we hoped, some "goodies" for Fairchild Tropical Garden. What follows is not a travelogue;



1. Dick Phillips and Phyllis at entrance to botanic garden in Suva, Fiji.

perhaps it's a "palmologue" (with apologies to Dent Smith, the Society's founder, who coined the term). It is supplemental to previous articles in *PRINCIPES* detailing the palms in places visited; it focuses on Palm Society members as well as palms they helped us collect.

Fiji

We left Miami 9 November 1977 for Fiji. After 24 hours traveling and "loss" of a day crossing the international date line, we were on the ground in Nadi (Nandi) early morning the 11th. After a bit of rest and local exploration, we flew the 135 miles to Suva, Capital of the islands. We were met there by Dick Phillips, a member of The Palm Society. An Australian, he had been in Fiji some 25 years, and lost no time getting us in a seed-collecting mood.

He started us out in the Thurston Gardens in Suva (Fig. 1) which adjoin the Government House grounds and have interesting individual plants but no extensive palm collection. Conspicuously present and thriving there, however, were several specimens of the so-called "weeping coconut" reported on by Hodge and Kiem some 20 years ago (see *Principes* 3: 140, 1959). The trees were unique and attractive (Fig. 2). We had not seen this form elsewhere.

Neoveitchia storckii is indigenous to the Rewa River Valley a few miles out of Suva on Viti Levu, the main island, and we were eager to see it. Dick Phillips drove us there over a dirt road, and we only had to trudge a short distance through low bush to start collecting. The palm is very attractive (Fig. 3) with large red fruits that look like those of most *Veitchia* species. The area gradu-



2. A "weeping coconut" at Suva.

ally is being cut over and the *Neoveitchia* may be obliterated unless protective action is taken. But when we were there, a considerable number of the trees were seen and we got seeds for the Seed Bank.

Dick took us back to Suva via a former homestead area of his to show us a fine *Balaka* species, *Balaka longirostris*. It was a beautiful, slender-trunked palm (Fig. 4) from which we collected seeds. Several of these delicate small trees had been knocked down by animals, or otherwise, and probably were doomed. We also visited a private garden which had a most attractive specimen of *Areca vestiaria* (*A. langloisiana*) with eight stems bearing orange crownshafts and loaded with unripe fruits.

We flew in a light plane the 100 miles from Suva to the small "Garden Island" of Taveuni, where other species were collected, including what we believed to be *Veitchia simulans*, the fruits of which were smaller than other *Veitchia* species



3. Collecting *Neoveitchia storckii* on Viti Levu.

with which we were familiar. Much of Taveuni was explored during three days there, though we were unable to obtain a four-wheel-drive vehicle that is necessary if one is to avoid considerable exertion getting up above the 2,500-foot level for the best palm hunting. We collected *Calamus vitensis* but had no luck with *Clinostigma exorrhiza*, whose fruits were not ripe, nor did we find *Cyphosperma trichospadix* (*Taveunia trichospadix*), high on our want list, during treks up the slopes.

Taveuni not only is a pleasant island with fine vistas but the only place in the Southern Hemisphere where one can motor across the international date line. This presents an occasion when one can



4. *Balaka longirostris* on Viti Levu.

do something utterly ridiculous today, on one side of the line, step across it and repeat the action a day later! Dick Phillips photographed the author the

day we were there and Phyllis the day before—both at the same time (Fig. 5).

Our interests were not confined to palms as we admired the wild ground

orchids and melastomas in the mountains. High in tree tops at an elevation of 3,000 feet, appearing at a distance like scarlet bougainvillea, trailed the epiphytic and indigenous *Medinilla waterhousei*. Closer examination revealed flowers containing three colors, red, white and blue. We collected interesting seeds of two seaside trees, *Hernandia peltata* and *Xylocarpus granatum*, also known as "puzzlenut" tree because the seeds are fitted into a spherelike shell and can be taken apart. We brought back a curious (though not viable) seed of the so-called *Vuni vono vono* tree, which apparently grows on but one of the smaller Fiji islands. This very hard seed looks exactly like a small turtle shell, and is a collector's item. We never saw the tree.

New Caledonia

On November 17 we went on to New Caledonia which, despite being cut over or burned over in many areas, affords some of the world's most interesting flora, including its palms. The island is strictly and delightfully French, with fine climate and good beaches, especially in Nouméa, the capital. It is a vacation haven for New Zealanders and Australians, and has been close to the heart of our Editor, Dr. Moore, whose work has added so much to an understanding and appreciation of the palms there (see *Principes* 10: 114-121, 1965; also Kenneth Foster in *Fairchild Tropical Garden Bulletin* 33, No. 2, 15-21, 1978).

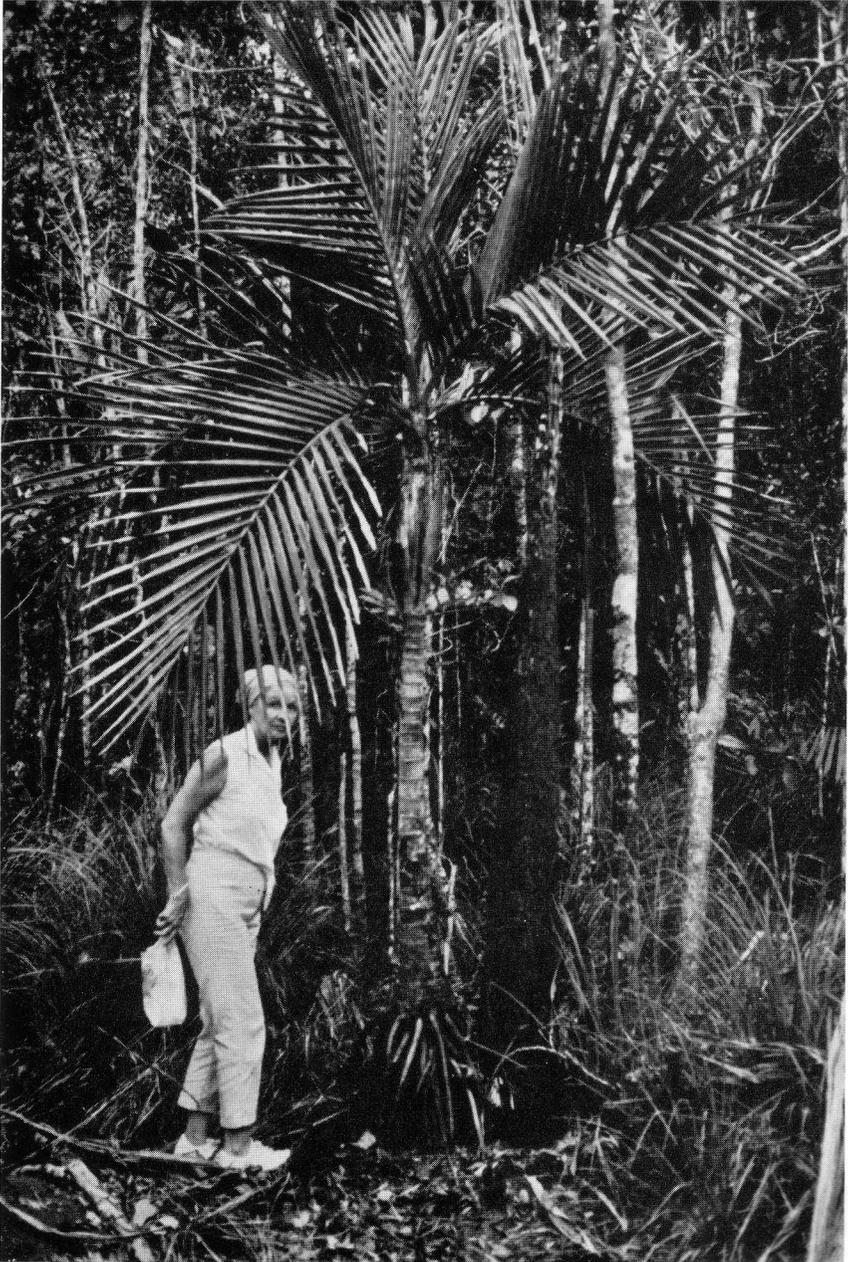
In a rented car we explored the Nouméa area and inland, fanning out in a radius of perhaps 100 miles. We had maps showing the location of palms, some of which sites we ignored because of the roads or our unwillingness to climb the slopes involved. Also our visit did not coincide with the fruiting time of some of the cherished species and we did not elect to scramble for naught. In



5. International date line marker on Taveuni, Fiji.

the principal collecting areas one must have official permission to enter the precincts, which presents no great difficulty, but is a requirement, nevertheless. M. Ph. Morat, of the Laboratoire Botanique at O.R.S.T.O.M. in Nouméa, was most helpful in this regard and we had no problem in obtaining permission to enter the areas scheduled.

On one excursion out of Nouméa we pursued the island's main highway past the airport, which is 35 miles out, to La Foa, thence on to Koh, Canala, and finally to Thio on the coast at the other side of the island, which is 250 miles long by 40 wide. Off the main highway, New Caledonia's roads are nothing to "brag about." Not only that but the available highway maps do not tell it all. They did tell us that the road from La Foa to Thio had two segments which were one-way at certain hours.



6. *Campecarpus fulcitus* in the forest reserve at Rivière Bleue, New Caledonia.

So on up into the mountains we went, and while coursing the first one-way segment—and truly it was strictly a one-way, rutted road that edged around the

outside contours—we found ourselves in a forested area of palms, tree ferns as tall as palms, and a plethora of other interesting plants. Many of the palms,

including, we believe, *Actinokentia*, were rising up out of deep ravines into which there was no easy access.

We became so enamored with the area we forgot about the one-way road time limits, although in all fairness it should be said that the road signs only announced when one could enter the stretch. No mention was made of elapsed time to be observed in negotiating the journey. Before we got through the trail, around a blind curve we came bumper to bumper with an on-comer. But it turned out all right since the author didn't understand what the startled approaching driver rather belligerently said in French, and managed to maneuver the small car into a rock depression on the cliff side enabling the opposition to proceed, albeit along the edge of a precipitous declivity. Thank goodness traffic was light; only two cars were on-coming!

We garnered various seeds most places we visited, but the best collecting and perhaps the most accessible major area was the Forest Reserve of Rivière Bleue, where permission to collect is required. This is some 80 miles in a northeasterly direction from Nouméa. Earlier, M. Morat had made arrangements for us to accompany M. Veillon and an assistant who were going to the reserve on a mission for the laboratories. They guided us all the way, some of it over an unsurfaced section of road under construction, to the reserve headquarters and on to the palm areas.

After orienting us, they went on and we went into the forest which abutted the road on each side. We had a "field day" admiring the palms but little success in collecting because of our timing. We were intrigued with *Campecarpus* (Fig. 6) but found no seeds nor early prospects of any. There were many *Actinokentia divaricata* in fruit but the fruits were green. We fell in love with

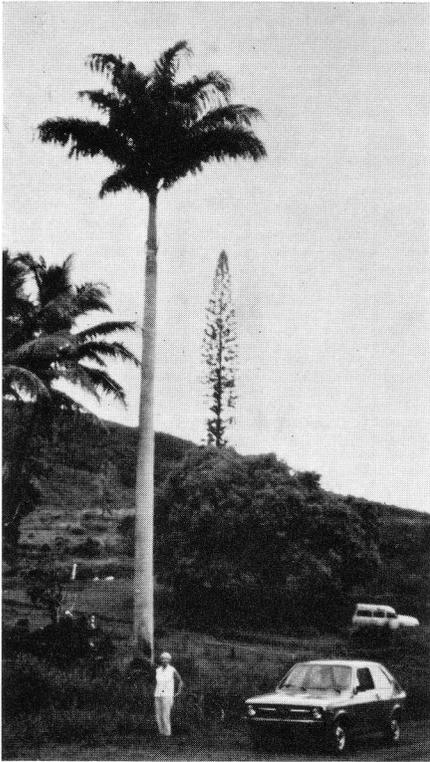


7. *Basselinia pancheri* in the forest reserve at Rivière Bleue.

Basselinia pancheri (Fig. 7) but no collecting that either.

Another thing that drew our attention in New Caledonia was the prominence of roystoneas in the landscaping—sometimes in small groups of short rows but often as individual specimens. Unlike other places we have visited where roystoneas, usually cultivated in avenues, have been prominent, the fine specimens in New Caledonia were mostly *R. oleracea*, whereas elsewhere *R. regia* has predominated. Magnificent specimens and stands of different *Araucaria* species are seen generally over the island. Not only in Nouméa, but also back into the island as well, one frequently encounters a combination of the two (as in Fig. 8).

We weren't far from "down under" and on 23 November flew to Sydney, realizing full well that if we hadn't been chained to a schedule we could have en-



8. *Roystonea oleracea* with *Araucaria* in the background along an interior road off the main highway from Nouméa.

joyed further pursuit of unfinished business in New Caledonia. But the land of kangaroos, koalas, splendid palm collecting, and helpful Palm Society members beckoned, and we eagerly answered the call.

Australia

Dr. Ian Daly, an enthusiastic member of The Palm Society, made our brief stay in Sydney a delightful experience. We began with an escorted tour of the Royal Botanic Gardens, which feature a fine palm collection of some 90 species, many of them mature and well tended (Fig. 9). Joining us here were Palm Society member Tony Rodd, Horticultural Botanist at the gardens, and Peter

Hind of the staff. Established in 1873 on 38 acres, the gardens are outstanding not only for the palm collection but also because one can see there (at least when we visited) an incongruous assemblage of plants combining flora of the tropics with that of the temperate zones. While Sydney can become quite cool, freezing temperatures are unknown. In one vista in the gardens we saw lush, blue-flowering *Jacaranda* trees, backed up with the blazing red of the Illiwarra flame tree, spirea, forsythia, iris and lilacs—punctuated with palms in fruit, such as *Archontophoenix*, *Howea* (which were numerous), *Laccospadix*, and *Microcoelum*. Ian Daly showed us natural stands of *Livistona australis* up the coast not far from Sydney, as well as his own palm collection at his new home fronting on an arm of Sydney Harbor.

We continued on to Cairns in northern Queensland on 26 November for an enjoyable visit in this very tropical area. Thanks especially to Palm Society member Maria Walford-Huggins, with whom we had corresponded and exchanged seeds over the years from Jamaica, we met other members of the Society there and were taken into the fine collecting areas that lie mostly in a radius of some 80 to 100 miles north and west of Cairns. Also, our timing was good as we found most of the indigenous species in full fruit.

Maria and her husband, Allan, are proprietors of the Kamerunga Biological Laboratories, near Cairns, furnishing specimens for teaching and research purposes. In a sturdy, four-wheel-drive truck, Maria at the wheel, we were picked up early morning for a collecting excursion to the Cape Tribulation area, some 80 miles north of Cairns. Accompanying us was Palm Society member and Cairns nurseryman Peter Woodman.

We didn't have to go all the way to Tribulation to start collecting. A splen-



9. Some of the palm collection in the Royal Botanic Gardens in Sydney, Australia. In foreground, from left to right: Peter Hind, Dr. Ian Daly, Phyllis, and Tony Rodd.

did *Livistona* sp., fruiting profusely, loomed up along the road (Fig. 10) and in no time we had bagged the seeds. Farther along we saw *Hydriastele wend-*

landiana in fruit near the road, and striving for the seeds provided an amusing incident. The metal pole we had with a cutter attached wasn't quite



10. Peter Woodman, Maria Walford-Huggins, and Phyllis collect *Livistona* north of Cairns, Australia.

long enough to reach the fruit stalk, so since this very slender-stemmed palm should be willowy enough to bend, we looped a cord around it about 15 feet up, with a view to pulling it within reach. After a few tugs on the cord the bending was insufficient, whereupon the author strode into the fray, wrapping the cord around an ample waist like the anchor man in a tug of war, and down came the fruits along with the tree! (A shallow drainage ditch alongside had undermined the roots.)

We drove on to a rugged, forested area to find *Normanbya normanbyi* with ripe fruits. Access to the place was through the homestead of an acquaintance of Maria's, whose pineapple cultivation was producing some of the largest and tastiest fruits we have en-

countered anywhere. Hills rose up about a quarter mile back of the residence clearing, laced with graceful *Ptychosperma elegans* and *Normanbya*, the latter a majestic palm with large, round and heavy, red fruits (see profile in Fig. 11). We departed with a full gunny sack of these coveted seeds.

To reach Cape Tribulation, one takes a side road to the small vehicular ferry crossing the Daintree River, which at this point, near its mouth, is wide and beautiful. Once on the other side, palm collecting was excellent. *Laccospadix australasica* was there, but it was even more abundant in the Mt. Lewis area where we visited another day. This slender, graceful palm has a strikingly attractive spadix, unbranched, five to seven feet long, with small fruits and



11. *Normanbya normanbyi* in fruit north of Cairns.

resembling a very elongated ear of hybrid corn. Similar to *Calyptrocalyx*, it is unique among palms. One can draw the long spadix through a clamp of thumb and forefinger, shelling off the fruits into a bag held underneath (Fig. 12).

We also collected *Linospadix monostachya* and *Calamus* sp. in the Tribulation area, but the pièce de résistance there was *Licuala ramsayi* (*L. muelleri*). This beautiful palm, with full-circle leaves, towers up into the forest canopy where specimens are hard to photograph. We were in a gorgeous stand of them which stretched several acres back into the forest (Fig. 13). But collecting was nil; not even a dead fruit stalk was visible, much less any oncoming new ones. Apparently the palm fruits sporadically there, perhaps in three-year cycles. As a curiosity, we photographed one that had fallen but persisted in sur-



12. The author bags fruits of *Laccospadix australasica*, Cape Tribulation area.

vival after growing along the ground to make a right-angle bend and head up again (Fig. 14).

Later, Maria and Allan arranged to take us on a hunt into the forests of the Mt. Lewis area, northwesterly out of Cairns, entailing a beautiful drive of some 70 miles up the hills into the good collecting areas. Again we persuaded Peter Woodman to accompany us.

But, palms notwithstanding, one does not visit Australia without some urge to



13. A beautiful stand of *Licuala ramsayi* in forest, Cape Tribulation.



14. *Licuala ramsayi* down but growing up again, Cape Tribulation.



15. *Archontophoenix* towers into the forest at Mt. Lewis, northwest of Cairns.

see the continent's "trade mark" marsupials. Maria and Allan took care of this, without going out of their way, by permitting Sam, their pet wallaby (it's a medium-sized kangaroo) to greet us early morning at the outer border of their palm collection, just before we mounted the truck for Mt. Lewis. He was a belligerent, fun-loving rapsca-lion who delighted, among other things, in chewing up all the reachable leaves of Maria's palms. Bless his palm-loving heart!

As mentioned above, we found *Laccospadix* as well as different species of *Linospadix*, *Calamus*, and others at Mt. Lewis. This also was a prime area for

Orania, which was loaded with immature fruits, and for *Archontophoenix* in the majesty of its habitat (Fig. 15). We collected the latter, presumably *A. alexandrae*, but came away from Cairns convinced that *Archontophoenix* needs further study and reclassification of species. Perhaps this is being done, though we have no published source of information about it. The knowledgeable Palm Society members in the Cairns area, including nurseryman Jerry Strooper, proprietor of the Urlba Nusery at Cairns, can point rather convincingly to at least three apparently different species that are growing in the area from Cairns to Mt. Lewis, alone. The traditional spe-



16. Jerry Strooper, Maria, and Phyllis in a section of his large palm nursery at Cairns.

cies *A. cunninghamiana*, *A. alexandrae*, and var. *beatricae*, in our view, should be reexamined.

Jerry Strooper has a splendid, young private collection of palms, many of them from seed, and his large nursery is devoted almost exclusively to raising popular species of palms for wholesale outlets in Australia. (See portion of nursery's seedlings area in Fig. 16).

One day we indulged in a ferry trip from the docks in Cairns for the 10-mile cruise to Green Island. This little spot of land in the northern reaches of the Great Barrier Reef is a local vacation mecca, with a good, white sand beach together with undersea viewing of some of the intrigue that goes on in the reef's environs. We saw all that, but took the trip primarily to see *Arenga australasica*, which is indigenous there. Not many of the palms are left; our hurried count, coursing the island, was 12 ma-

ture ones. Perhaps there were more—but none were in fruit.

While in Cairns we were privileged to meet Hon. Vince Winkle, a longtime associate of The Palm Society, through the Cairns City Council, and one whose practical knowledge of palms and the flora of that area may be unexcelled. Early one morning he arranged to pick us up and conduct us on a complete tour of the Cairns Botanic Garden as well as the extensive landscaping of public lands throughout the Cairns area, both of which he supervises. The public landscaping in Cairns is impressive and extensive, much of it involving palms. The older sections of the Botanic Garden have a good collection of palms and newly developed areas are emerging with emphasis on indigenous plants as well as exotics (see Fig. 17). Vince Winkle oversees one of the finest nurseries in diversity of plants we have seen anywhere. It supplies the botanic garden



17. Vince Winkle and the author with palms in new section of the Cairns Botanic Garden.

and government landscaping projects in the Cairns jurisdiction.

Vince introduced us to the Mayor of Cairns, Hon. DeJarlis, with whom we very much enjoyed visiting to discuss our impressions of the hospitality shown in Cairns. Then we went on to other compelling attractions. Of these, perhaps the most unusual were individual specimens of *Archontophoenix alexandrae*, dispersed over a two-block area in residential Cairns, which had "freaked off" into branching stems. We counted four to nine branches on some of them (Fig. 18), but left Cairns with no plausible explanation for the "freaking."

We didn't need any explanation; we would be eternally grateful for the privilege we had had of meeting Palm So-



→
18. A specimen of curiously branched *Archontophoenix alexandrae* in a residential section of Cairns.



19. A general view of palms in Brisbane Botanic Garden.

ciety members in Cairns. Our time schedule grabbed us and reluctantly we pursued it, on to Brisbane on 4 December 1977.

In Brisbane it was hot, as we were approaching the Christmas season down under, and Phyllis picked up a virus there that made her uncomfortable. Our

lodging was directly across the street from the Brisbane Botanic Garden, which we explored on two occasions. It's attractive, easy to get around in, and has a fair collection of palms, notably *Phoenix* species, *Archontophoenix*, *Jubaea* and others (Fig. 19).

Through arrangements made earlier with the Queensland Department of Forestry, we were able to acquire a good quantity of indigenous cycad seeds which we promptly mailed on to Fairchild Garden.

Also here we had easy access to a boat trip on the Brisbane River, past the University grounds, landscaped with palms, to a koala sanctuary. Still curious about Australia's marsupials, despite Sam the Wallaby's extraordinary activities at Maria's place back in Cairns, we boarded the boat. Arriving at the sanctuary's dock we were met by an obedient dog with a koala astride (Fig. 20). Unlike busybody, palm-loving Sam, the koalas hardly move at all, and they insist on eucalyptus leaves, only certain species at that, for food. They wouldn't go near a palm leaf, which casts doubt on their judgment!

Papua New Guinea

Interspersed between collecting at Cape Tribulation and Mt. Lewis, while in Cairns, we flew to Lae, via Port Moresby. Visiting the National Botanic Garden there had been high on our "must do" list, although getting advance flight reservations, even though Pan Am's efficient worldwide computer network, months earlier, proved futile. So we played it "by ear" and managed to board an Air Niugini flight, on 28 November, late afternoon, for Port Moresby, where we cleared immigration, then on to an after-dark arrival at Lae. We had left Cairns without return flight reservations, but with many friendly admonitions to get to the ticket counter "first"



20. Dog with koala jockey at sanctuary near Brisbane.

and "get onto the plane" upon our return. By limiting our stay in Lae to two days because of the infrequency of flights, we made it over there and back.

Although there were antecedent events, the superb 100-acre garden at Lae dates back only to circa 1949, after the area was bombed in World War II. Dr. Fred Essig, who has spent much time in Papua New Guinea, catalogued and photographed the garden's palms a few years ago (*Principes* 16: 119-127, 1972). There are well over 100 mature species of palms, featuring those indigenous to New Guinea, as well as a wide and exceptionally fine collection of other native flora and exotics from other tropical areas.

We met Ted Henty, of the Botany Division, Department of Forests, who welcomed us to the garden and got us started on a tour of the plants. It was a misty, humid day—Lae being some 6° off the equator, with 180 inches rainfall annually. We certainly appreciated his taking the time he did on our behalf. Later, Mr. Manu Kapu of the garden helped us find and collect seeds. He is shown along with young *Lodoicea maldivica* (Fig. 21) which has been introduced subsequent to publication of Dr.



21. Young *Lodoicea maldivica* in the National Botanic Garden, Lae, Papua New Guinea. With the author is Mr. Manu Kapu of the staff.

Essig's earlier listings. The garden had good specimens of choice ornamentals, such as *Cyrtostachys lakka* (Fig. 22), *Copernicia holguinensis* (Fig. 23), and *Latania lontaroides* (Fig. 24). The native gulubias were impressive, and *Actinorhytis calapparia* was spectacular (Fig. 25). But before leaving the garden, after two excursions through it, our hearts belonged to *Paralinospadix hollrungii*, which was fruiting but without collectible seeds (see the beauty of it in Fig. 26). From our bus returning to the airport we saw in forests back from the road some towering *Gulubia* and *Metroxylon* species, the latter of which we had seen with terminal inflorescences back in the garden.

All palm seekers adventuring into the far reaches of the Western Pacific should include Lae on their itinerary, not only to visit the garden but to explore beyond its confines. Perhaps it might

be expeditious to plan in advance to proceed there from Brisbane, which is a better hub than Cairns for possible flight connections. Our regrets were that failure to obtain advance reservations, undoubtedly due to Air Niugini's inability to respond to international communications, made it impossible for us to spend more time in Papua, and yet adhere to our commitments ahead.

New Zealand

On 8 December, about one-third of the way nonstop from Brisbane to Auckland, we passed Lord Howe Island, the source of palm seeds that have been the mainstay of commercial nurserymen for many years. We weren't prepared to parachute from about 30,000 feet, nor did we have a visa for official scrutiny upon landing. But it was tempting (see the island from above, in Fig. 27 and re-



22. A fine cluster of *Cyrtostachys* in the garden at Lae.

fer to Dr. Moore's succinct and interesting treatment of the palms there in *Principes* 10: 13-21, 1966).

We arrived in Auckland to be met at

the terminal by Mrs. Joy Amos, Horticultural Advisory Officer for the Ministry of Agriculture and Fisheries, and currently a most helpful member of The



23. *Copernicia holguinensis* at Lae.

Palm Society. We had corresponded, but it was a delightfully unexpected surprise to have her greet us upon landing, then take us on a very thoughtfully arranged orientation drive around the Auckland environs.

Not only that, but knowing our interest in palms, she lost no time maneuvering us to an easily accessible stand of *Rhopalostylis sapida*, the only palm, albeit another of our favorites, indigenous to New Zealand. The trees in Figure 28 were fruiting but seeds would not be viable until perhaps February, some two to three months beyond our visit. Two other species of this "feather duster" palm are indigenous to outlying islands: *R. baueri*, in Norfolk, and *R. cheesemannii*, in the Kermadecs.

Although we ran into untimely rainy weather during our week in New Zealand it didn't dampen our spirits. Thanks to

Joy Amos we met other members of The Palm Society there, and were privileged to visit with New Zealanders who are more knowledgeable, and perhaps more enthusiastic, about plants and flora of all kinds than any other group of people, collectively, we have encountered.

Dick Endt, now a member of The Palm Society as well as the International Rare Fruit Council, went out of his way to show us his interesting cultivations several miles out of Auckland. Brian Roome, an early Palm Society member there, showed us his young collection, which we thoroughly enjoyed, and presented us with two of his fine recordings. Brian not only likes palms but spends the rest of his time directing New Zealand's most popular dance band.

Most knowledgeable of the flora, not only of New Zealand but also South Africa, from whence came many introductions into New Zealand, Dr. Max Goody, taking time from his busy practice, along with Mrs. Goody, showed us outlying environs and introduced us to flora unfamiliar to us. It was a most rewarding experience.

Enslaved by our flight schedule, we prepared to go on. It was apparent to us that the environment of North Island, certainly in the Auckland area and beyond, would support numerous palm species which never have been introduced. We came away thinking that the many friendly people there, so enthusiastic about the potential of growing palms, needed a steady source of seeds. We hope that The Palm Society, through facilities of the Seed Bank, can help in this regard.

We left New Zealand, not only with a desire to return, but with special gratitude to Joy Amos, whose helplessness through introductions and otherwise had made our visit so worthwhile (see Fig. 29).



24. *Latania lontaroides* at Lae.

Tahiti

Our flight to Papeete, 12 December was full of anticipation. Had things changed much since we visited Tahiti and the outer Society Islands, in 1974 (*Principes* 18: 140-143)? There had been changes, of course, but none that bothered us, and having been there previously we felt quite "at home" upon arrival. The beauty of Tahiti, in our view, rarely (if at all) is excelled by tropical islands elsewhere in the world. The coconut palms fringing the sea and lagoons provide a continuous panorama of tropical grandeur, as in Figure. 30.

In terms of palms, Tahiti, for us, is

Pelagodoxa henryana which, as one of the world's most beautiful palms, is high on our list of favorites. Yet our enthusiasm for it should not be taken as encouragement for many palm lovers to try to cultivate it. The palm is hard to grow in many environments. Seeds not only are scarce but relatively difficult to germinate. It will not survive low temperatures, nor does it like too much sun or wind. Fairchild Garden recently lost a good specimen sheltered in its Rare Plant House, perhaps because of cold temperatures, although the few specimens protected in private collections in the Miami area seem to have survived.

It was indeed homecoming when we



25. The handsome crown of *Actinorhynchus calapparia*, Lae.

were welcomed by Michel Guerin, Director of the Botanic Garden at Papeari and a member of The Palm Society, whose hospitality had so endeared us to Tahiti when we were there before. Numerous improvements had been made and he had other developments in process in the garden, but knowing our fondness for *Pelagodoxa*, Michel set out at once to show us the status of the garden's collection, with an eye out for mature fruits.

We started out with a *Pelagodoxa* specimen not far from the garden's entrance, which was thriving, although in a more exposed location than others back in more protected sections (Fig.

31). We photographed them all, including the oldest *Pelagodoxa* in the garden, which had soared up into the canopy to some 30–35 ft. This palm was planted early in the garden and may date back to circa 1920, or earlier. It is the tallest *Pelagodoxa* we have seen. Other younger but mature ones in the garden were more attractive than those photographed, our purpose being to record the dispersal as well as appearance of these palms in Tahiti.

Since we were looking for viable seeds, only five of which had been collected in coursing the half-dozen fruiting trees in the garden, we crossed the road to an adjoining area where, though pri-



26. *Paralinospadix hollrungii* in the garden at Lae.

vately owned, Michel had permission to collect. There were some six additional mature trees here along the base of an inclining hillside. One of the oldest of

these yielded another four or five fallen fruits, and we gleaned two others a little farther on. It wasn't a very big haul to mail back, knowing the appetite of the



27. A high-flying bird's-eye view of Lord Howe Island.

Seed Bank and Fairchild Garden's need to get new starts to replace lost ones.

So Michel arranged to accompany us back into Papeete to canvas the other known specimens in an effort to add to our small collection. There are some half-dozen older, mature trees scattered around the town which, if one is there at the right time, can yield a few ripe fruits.

We stopped at an abandoned public park area, whose limited grounds supported an early botanic garden, antedating the government's development of the present site at Papeari. Several old palms dotted this rubble-filled area across from a hospital, including a soli-

tary *Pelagodoxa* that apparently had survived maltreatment, or just lack of care, for many years. A few fruits were up in the crown and we gleaned one on the ground.

At the downtown home of a retired seaman, an acquaintance of Michel's, was another old specimen, albeit sunburnt and windblown, which, thanks to their generosity and help of the whole family, yielded another half dozen fine seeds (Fig. 32). At the backyard garden of another downtown property was another one in full fruit, where we acquired two or three more seeds.

After our all-out collecting effort for this palm, with Michel's knowledge-



28. *Rhopalostylis sapida* at Auckland, New Zealand.

able assistance, we had assembled and cleaned exactly 20 seeds for mailing. All of the 18 to 20 mature trees, which essentially comprise the *Pelagodoxa* pop-

ulation in Tahiti, were fruiting. But it is sheer futility to pluck green fruits off the stalks for the mere sake of acquisition, as almost invariably these will not ger-



29. Mrs. Joy Amos welcomed the author to New Zealand.

minate. One must collect only the fallen fruits, and all of these will not germinate.

Michel continues to estimate, as he did earlier, that he cannot anticipate collecting more than some 150 seeds annually. At least 50 or more of these he sets out for ultimate distribution of plants in Tahiti. He receives numerous requests for quantities of the seeds, often from persons impatient to grow this beautiful palm but with no realization of the limitations on seed supply.

We explored the Botanic Garden where Michel has opened up new planting areas and saw the new nursery which will be beneficial to government and the people of Tahiti. In the garden we also collected quantities of *Socratea durissima* and *Corypha elata* for the Seed Bank. The latter palm had fruited some time before and the ground literally was blanketed with seeds. As before, Michel's hospitality endeared him and Tahiti ever more to us.



30. Palms along the beautiful shore line of Tahiti.



31. Michel Guerin with the author and *Pelagodoxa* make it a "homecoming" in the Botanic Garden at Papeari, Tahiti.

Samoa

Backtracking a bit because of airline schedules, we flew into Pago Pago after dark, 18 December, our first visit to Samoa. Somerset Maugham knew the area well when he wrote *Rain*. It rained when we landed, kept on raining (at least off and on) while we were there, and it was still raining as we left. We even stayed at the Rainmaker Hotel in Pago Pago, which was directly across the beautiful harbor from Rainmaker Mountain. (Also see palms in the rain, Fig. 33).

We had expected it would be a bit wet there at the time we were to arrive but hardly realized that rain could fall as continuously as it did. Anyway, we weren't much concerned about collecting in American Samoa, since there isn't much there in the way of palms, but the



32. Fruits from *Pelagodoxa* on private property in downtown Papeete.

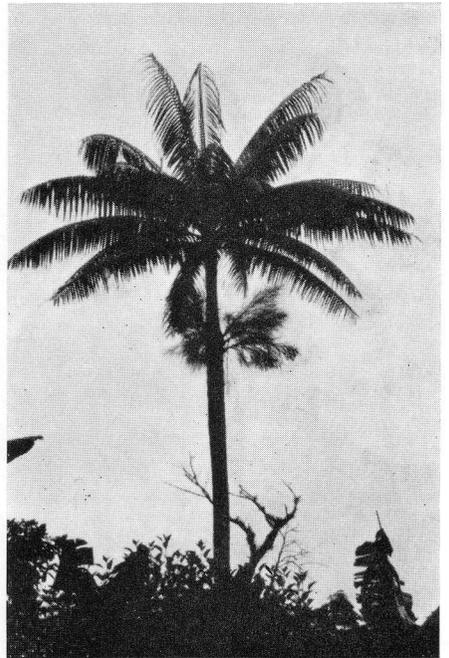


33. Palms with Rainmaker Mountain in background, Pago Pago, American Samoa.

rain did handicap us trudging downtown to mount some of the small, truck-bedded busses that transport everyone around the pretty coastline to settlements along the way.

We had planned to fly on to Apia, in Western Samoa, which we did after the weather cleared up enough to make flying less hazardous in small craft. The ride between Faleolo Airport and Aggie Grey's Hotel in Apia takes longer than the flight time between the islands. Aggie Grey's is unique, as admirers of Robert Louis Stevenson who have visited his home and burial ground near Apia may attest. Not only does the place have an interesting history, but the grounds of the newer additions are beautifully landscaped with palms (see cover) and well attended.

Here we wanted to do some palm collecting and fortunately, the weather cooperated enough to permit it. Hiring a driver, we headed out early one morning



34. *Clinostigma* in fruit, low mountains west of Apia, Western Samoa.

to seek *Clinostigma* and anything else we might find worth collecting. As we drove into the low mountains, not much in the way of palms was seen. Later, at higher elevation, going on by way of the existing through road (which we believe is an extension of the road reported as ending, in 1966, by Mr. Langlois in *Supplement to Palms of the World*, p. 46) we found beautiful stands of *Clinostigma* all over the area.

The region gradually is being cut over and palms are disappearing. In an area of a tremendous gorge, which has a very high waterfall opposite, these palms are abundant and, in the gorge at least, may be safe for some time to come from transgressions of the bulldozer. *Clinostigma* is a very handsome palm (Fig.

34) and we revelled in collecting what we thought would be enough seeds to get the palm started everywhere. Alas, not so! Thousands of these small, ripe fruits we brought in didn't produce one viable seed out of a hundred!

We saw many fine *Metroxylon upolense* and collected seed, but not for Seed Bank distribution, since these fruits are much too large and heavy for mailing.

Back to Pago Pago for Christmas, we welcomed Santa Claus between rain drops (but no snow!), cheered him on his rounds, and then prepared to make our own way back to Miami, grateful for the opportunity given us to meet and to know some of our Palm Society members over the far reaches of the South Pacific.

PALM RESEARCH

CHARLES P. DAGHLIAN, University of Connecticut at Storrs, is conducting investigations of Tertiary palms. Current research is concerned with the fossil record of coryphoid palms in North America based on foliar anatomy and morphology.

The following investigators at the University of Florida Agricultural Research Center, 3205 S.W. 70th Avenue, Fort Lauderdale, FL 33314 are conducting research on lethal yellowing of coconut palms and similar or identical diseases of other palm species. The group has a broad interest in palm culture and diseases and insect pests of palms. Some members of the group have recently completed studies of sudden wilt of African oil palm.

H. G. BASHAM, Plant Pathologist and Physiologist, is investigating the physiology of lethal yellowing and palm lethal decline.

H. M. DONSELMAN, Ornamental Horti-

culturist, is conducting horticultural research with the objective of finding palms suitable for replacing palms lost to disease.

F. W. HOWARD, Entomologist, is conducting studies to identify the insect vector of lethal yellowing and lethal declines, and studying ecological factors related to the distribution of lethal yellowing and its suspected vectors.

R. E. MCCOY, Plant Pathologist, is studying the etiology, epidemiology, and methods of control of palm diseases.

J. A. REINERT, Entomologist, has recently completed some studies of host plant relationships of a suspected vector of lethal yellowing.

J. H. TSAI, Entomologist, is conducting studies of insect vector transmission of lethal yellowing and lethal declines, and studying the biology of suspected vectors and related insects.

D. L. THOMAS, Plant Pathologist, is studying the ultrastructure of microorganisms pathogenic to palms and the ultrastructure of infected palms.

A Branched Coconut Seedling in Tissue Culture¹

JACK B. FISHER AND JAMES H. TSAI

*Fairchild Tropical Garden, Miami, Florida 33156; and Agricultural Research Center,
University of Florida, Fort Lauderdale, Florida 33314*

As a part of the research effort to combat lethal yellowing disease of palms, we have been working on methods for growing coconut (*Cocos nucifera* L.) seedlings in tissue culture (Fisher and Tsai, 1978). Our objective was to grow healthy germ-free coconut plants that could later be used for inoculation with the casual agent of lethal yellowing, presumably a mycoplasma-like organism. Such a germ-free system will be very useful in demonstrating whether a mycoplasma-like organism causes lethal yellowing and determining which insect, if any, transmits the disease.

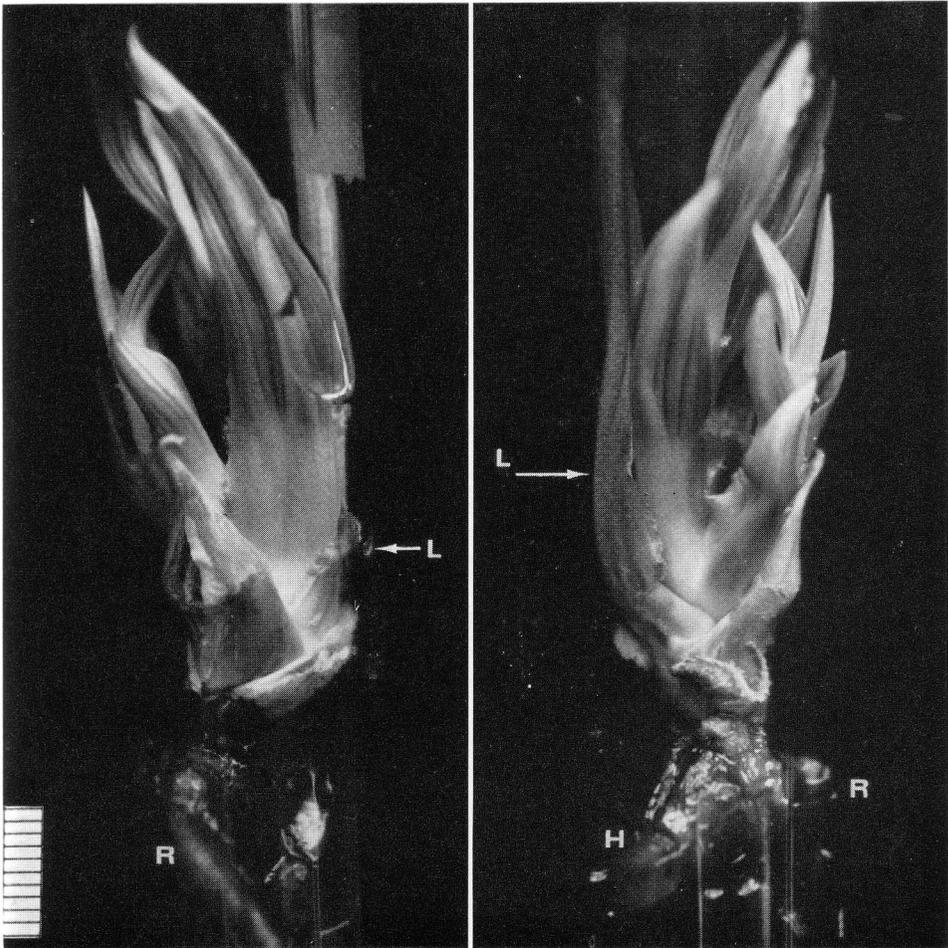
While growing isolated coconut embryos in test tubes, we discovered that one out of approximately 238 embryos formed twin shoots as shown in the figure. This branched seedling indicates that one original growing point has divided into two separate growing points after five scale leaves were produced by the original embryonic axis. The two branches were unequal in size and number of leaves when the seedling became contaminated with mold after its transfer to fresh medium. Two genetically identical twin palm trees would have developed had this seedling continued to grow.

There have been reports of coconuts that branch above ground, usually as a

result of injury (Davis, 1969; Ridley, 1907). In addition, the rare development of two or, even more rarely, three seedlings from one coconut has been observed. Such "twins" or "triplets" are usually derived from two or three separate seeds present in one nut (one fruit) instead of the usual one seed. Evidence for this is the fact that each seedling comes from a different "eye" of the coconut, indicating that two or three carpels of the female flower each produced an embryo. Each embryo forms its own separate endosperm (meat) as noted by Davis (1979; Fig. 5). Therefore, such "twins" or "triplets" are not genetically identical. They are equivalent to fraternal twins in man. On the other hand, polyembryony or the presence of more than one embryo per seed has been reported in palms. Such rare triplets contained within the endosperm of a single nut have been illustrated by Davis (1979; Fig. 5). They are presumably derived from a single fertilized egg cell and are, therefore, genetically identical.

The experimental induction of twin palm seedlings was attempted by Davis (1968) with limited success. He sliced the shoot tips of germinating coconut seeds with a razor and found that a small percentage formed two shoots, after recovering from the injury, similar to the branched embryo described here. It is possible that our branched embryo resulted from an injury unknowingly in-

¹Florida Agricultural Experimentation Station Journal Series No. 1491.



1. Branched coconut seedling growing on agar medium in test tube: two views, showing haustorium (H), root (R), and leaf immediately below the point of branching (L). Scale marked in millimeters.

flicted during the dissection of the embryo from the seed. If this is the case, then cutting the apex of the germ-free embryo might be a more efficient and successful method of inducing identical twin palms. Balaga (1975) carried out this procedure but with little successful induction of twin shoots. If refined, this method could be a new and significant tool for clonal propagation of coconuts and other palms.

An interesting side note is a recent ob-

servation made at Fairchild Tropical Garden. A newly germinated seed of *Rhyticocos amara* (Jacq.) Becc. (FTG #77-288) had three separate cotyledonary stalks arising from the same "eye." Each stalk bore a normal seedling apex. This indicates that either a single carpel had three separate embryos, or a single embryo divided to produce identical triplets. Multiple embryos may occur rarely in the date palm (*Phoenix dactylifera* L.) according to Dr. O. Reu-

veni who observed this phenomenon in Israel (Reuveni, personal communication).

For the present, branched or twin embryos are mainly a curiosity. However, the fact that they can occur naturally, even though extremely infrequently, does indicate that there is a potential for the cloning of palms by embryo multiplication. An annotated bibliography on embryo and tissue culture of palms is presented below for those interested in learning more about these techniques.

LITERATURE CITED

- BALAGA, H. Y. 1975. Induction of branching in coconut. *Kalikasan* (Philipp. J. Biol.) 4: 135-140.
- DAVIS, T. A. 1968. Difficulties in the genetic improvement of the coconut: a promising alternative method. *Indian J. Genet. Plant Breed.* 28A: 154-164.
- . 1969. Clonal propagation of the coconut. *World Crops* 21: 253-255.
- . 1979. Some unusual formations in palms. *Principes* 23: 80-83.
- FISHER, J. B. AND J. H. TSAI. 1978. In vitro growth of embryos and callus of coconut palm. *In Vitro* 14: 307-311.
- RIDLEY, H. N. 1907. Branching in palms. *Ann. Bot.* (London) 83: 417-422.
- CORLEY, R. H. V., J. N. BARRETT, AND L. H. JONES. 1977. Vegetative propagation of oil palm via tissue culture. *Oil Palm News* (Tropical Products Institute) 22: 2-7.
- General view of production of clonal seedlings from callus and how these seedlings behave in the field; methods for plantlet production given in Jones, L. H. 1974. *Oil Palm News* 17: 1-8. First report of successful cloning of a palm on a commercial scale.
- EEUWENS, C. J. AND J. BLAKE. 1977. Culture of coconut and date palm tissue with a view to vegetative propagation. *Acta Horticulturae* 78: 277-286.
- Callus produced from explants but no subcultures or organogenesis; young inflorescences produced roots and "shoot-like" structures.
- EEUWENS, C. J. 1978. Effects of organic nutrients and hormones on growth and development of tissue explants from coconut (*Cocos nucifera*) and date (*Phoenix dactylifera*) palms cultured *in vitro*. *Physiol. Pl.* (Copenhagen) 42: 173-178.
- This paper, together with an earlier one (*Physiol. Pl.* (Copenhagen) 36: 23-28, 1976), examines in detail the nutritional requirements of tissue explants in culture; roots produced from explants and subcultured.
- FISHER, J. B. AND J. H. TSAI. 1978. In vitro growth of embryos and callus of coconut palm. *In Vitro* 14: 307-311.
- Embryos successfully cultured; a vigorous callus with an unusual chromosome number (aneuploid) did not form organs.
- AMMAR, S. AND A. BENBADIS. 1977. Multiplication végétative du palmier-dattier (*Phoenix dactylifera* L.) par la culture de [sic] tissus de jeunes plantes issues de semis. *Compt. Rend. Hebd. Séances Acad. Sci.* 284D: 1789-1792.
- Callus and inflorescences produced from embryos; callus regenerated roots and shoots; some regenerated plants transferred to soil.
- APAVATJRUT, P. AND J. BLAKE. 1977. Tissue culture of stem explants of coconut (*Cocos nucifera* L.) *Oléagineux* 32: 267-271.
- Callus produced from subapical bud explants; no subculturing or organogenesis.
- GUZMAN, E. V. DE, A. G. DEL ROSARIO, AND E. C. EUSEBIO. 1971. The growth and development of coconut "Makapuno" embryo *in vitro*. III. Resumption of root growth in high sucrose media. *Philipp. Agric.* 53: 566-579.
- Third part in a series dealing with embryo culture of this variety which cannot normally be germinated (Part II. *Philipp. Agric.* 53: 551-564, 1971; Part I. *Philipp. Agric.* 53: 65-78, 1969; and an earlier paper: *Philipp. Agric.* 48: 82-94, 1964); these papers are the most complete studies of coconut embryo culture.
- HODEL, D. 1977. Notes on embryo culture of palms. *Principes* 21: 103-108.

Embryos of *Pritchardia kaalae* and *Veitchia joannis* were successfully cultured on agar.

RABÉCHAULT, H., J. P. MARTIN, AND S. CAS. 1972. Recherches sur la culture des tissus de Palmier à huile (*Elaeis guineensis* Jacq.). Oléagineux 27: 531-534.

Callus derived from leaf bases, small roots and shoot buds differentiated from this callus, but plantlets not produced. Rabéchault and his French co-workers have produced a series of studies on culture of oil palm embryos, i.e. in Oléagineux 28: 333-340, 1973; 27: 249-254, 303-305, 1972; 25: 519-524, 1970; 20: 79-87, 1965; and in Compt. Rend. Hebd. Séances Acad. Sci. 270D 3067-3070, 1970. The most recent paper is in: Oléagineux 31: 159-163, 1976.

REUVENI, O. AND H. LILIE-KIPNIS. 1974. Studies of the *in vitro* culture of date palm (*Phoenix dactylifera* L.) tissues and organs. Pamphlet No. 145. Agricultural Research Organization, Bet Dagan, Israel. 40 pp.

Final report on extensive studies on propagation of date palm, only embryos were successfully cultured.

SMITH, W. K. AND J. A. THOMAS. 1973. The isolation and *in vitro* cultivation of cells of *Elaeis guineensis*. Oléagineux 28: 123-127.

Vigorous callus derived from embryos; apical shoot meristem and roots in agar and liquid cultures; roots regenerated from callus were diploid although callus had many aneuploid cells; no shoots formed.

STARITSKY, G. 1970. Tissue culture of the oil palm (*Elaeis guineensis* Jacq.) as a tool for its vegetative propagation. Euphytica 19: 288-292.

Excised parts of the apical bud produced leaves and roots, probably part of original apex. Small male inflorescences also expanded in culture.

TISSERAT, B. 1979. Tissue culture of the date palm. J. Heredity 70: (in press).

Embryoids derived from callus produced from either shoot tip explants or embryos; green shoots and roots formed in culture but not yet transplanted into soil.

WANG, P.-J. AND L.-C. HUANG. 1976. Beneficial effects of activated charcoal on plant tissue and organ cultures. In Vitro 12: 260-262.

Growth improved by adding charcoal to medium; embryos of *Hyophorbe lagenicaulis* (*Mascarena lagenicaulis*), *H. verschaffeltii* (*M. verschaffeltii*), and *Caryota urens* grown.

LETTERS

Editor, Principes

Dear Sir,

The question by Mr. Savage on the *Licuala* seeding habit (*Principes* 22: 142, 1978) may be an environmental one.

I remember looking for seeds in the *Licuala* forests near Cardwell in late December 1976 (early summer) but without success. Only days later I collected *Licuala* seeds in quantity in tropical rainforest south of Cooktown.

The fruiting *licualas* were scattered individuals in relatively open situations where light conditions were better than

average. The non-fruiting ones in question grew in dense palm bogs in a relatively low rainfall area.

Licuala ramsayi (*L. muelleri*) can be grown outside in my area at 35° 30' South where the mean winter temperature is 50°F. But here it needs a suitable microclimate and is not a palm for exposed positions.

As an indoor plant it is undemanding and outright beautiful.

Yours faithfully,
EIKE JAKDBASCH
8 Derribong Ave.
Bateman's Bay, N.S.W. 2536
Australia

Effect of Lethal Yellowing on Xylem Pressure in Coconut Palms

JANET McDONOUGH AND MARTIN H. ZIMMERMANN

Harvard University, Harvard Forest, Petersham, MA 01366

Abstract

Pressures in the xylem of leaflets of healthy coconut palms vary from ca. -1 bar at night to ca. -10 bars at midday in sunshine. There is little diurnal pressure variation in palms showing lethal yellowing symptoms; midday pressures do not drop below ca. -4 bars. This seems to indicate stomatal closure. High pressures were also found in an apparently healthy tree which began to show symptoms two weeks later. Unusually high midday xylem pressures may therefore be the earliest recognizable symptom of lethal yellowing.

Lethal yellowing (LY) of coconut palms was first recognized in Jamaica in 1891. Over the years Jamaican economy has been greatly affected by the essentially complete elimination of the 'Jamaican Tall' cultivar from the cultivated fields (Romney, 1972). The disease arrived on the Florida mainland in 1971 and is now found in seven counties of South Florida. In Florida the palm is largely valued as an ornamental, so its rapid death has caused devastating changes in the state's landscape (Fisher, 1975).

Research into the disease implicates a mycoplasmalike organism (MLO) as the causal agent. Large numbers of MLO have been found in sieve tubes in sink areas (young developing or storage areas) of infected trees (Beakbane *et al.*, 1972; Parthasarathy, 1974; Plavsic-Banjac *et al.*, 1972).

Disease symptom remission has been observed after oxytetracycline injection (McCoy, 1975). Furthermore, symptom

development has been prevented in oxytetracycline-treated healthy trees (McCoy, 1976b). Based on studies of disease spread (McCoy, 1976a), evidence suggests that a phloem-feeding insect vector introduces the MLO into the sieve tubes.

Most often the MLO have been observed in sieve tubes from areas of rapid growth (phloem sinks). Young inflorescences are wrapped in a very substantial bract; their phloem is thus inaccessible to phloem-feeding insects. The leaves are obvious sites for insect feeding. This would indicate long distance movement of the pathogen from the site of the original infection (most likely the leaves) to the sink areas (young inflorescences) via the sieve tubes. Studies of translocation are therefore very desirable in order to learn more about the nature of the disease. Few such studies have been published (Milburn & Davis, 1973; Milburn & Zimmermann, 1977; Zimmermann, 1973).

There is a close relationship between the movement of food in the phloem and the flow of water in the adjacent xylem (Zimmermann, 1969). Both translocation compartments need further investigation. Measurement of the parameters of phloem movement, particularly in intact plants, is difficult (Milburn & Zimmermann, 1977), while a few techniques have been developed that have made xylem measurements possible (Boyer, 1969; Kanemasu *et al.*, 1969; Talbot *et al.*, 1975).



1. The senior author measuring xylem pressure in the crown of a coconut from a bucket truck.

This paper describes an investigation of water pressures in the xylem before and after infection. It is a very brief extract from the thesis of the first author (McDonough, 1977).

Methods

The diurnal variation in xylem water tension in leaflets of coconut palm has been examined with the Scholander pressure chamber (Scholander *et al.*, 1965).

Before measurement, the basal 2.5 cm portion of the lamina of the leaflet to be measured was trimmed from both sides of the midvein at the point of its insertion on the leaf rachis. The leaflet midvein was then cut cleanly with a razor blade. The leaflet was rolled and inserted into the pressure chamber with the midvein protruding slightly. The crowns of tall palms were reached with a bucket truck (Fig. 1). The results given in Figures 2 and 3 are based on well over a thousand measurements, each taken in triplicate.

Results and Discussion

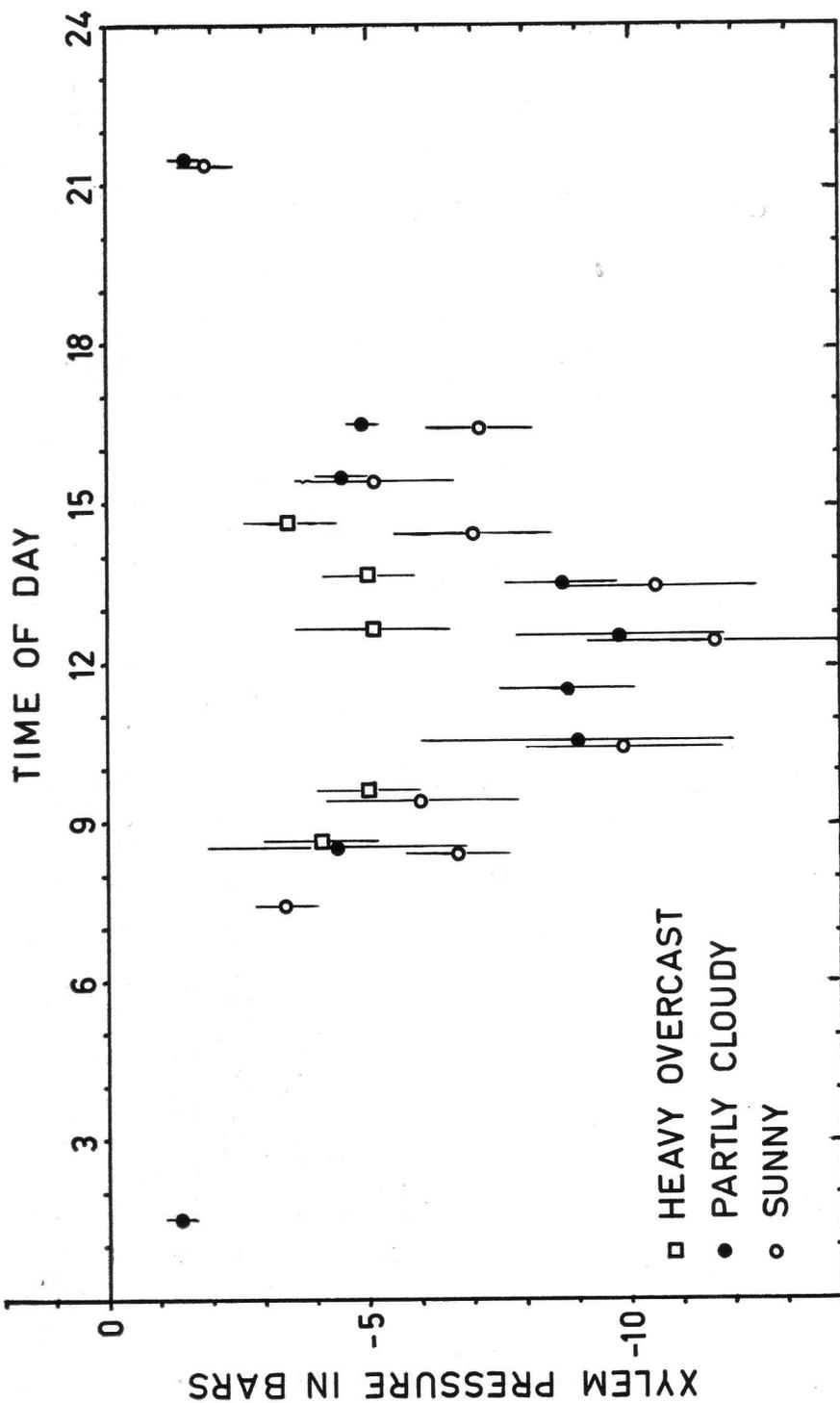
Initial xylem pressure measurements were obtained from healthy, young (3 m tall) trees in an area where LY had not been reported. Typical diurnal patterns are shown in Figure 2. Pressures were high at night, they dropped after sunrise, reaching their lowest point between 10:00 and 14:00 hours. The lowest pressure obtained during any one day was dependent on environmental conditions. Figure 2 shows that lowest pressures were reached on warm, sunny days; pressures were slightly higher on warm, cloudy days, while under heavily overcast to rainlike conditions, lowest pressures were significantly raised.

In the next phase of the study, readings were taken on mature trees (6-7.5 m tall) in an area of high LY infection, where trees in various stages of disease development were available. All readings were taken on warm, sunny or partly cloudy days in order to observe the maximum daily changes in water pressure. Xylem pressures in all diseased (symptom-showing) trees measured remained high throughout the day (Fig. 3 □) as compared to healthy trees. This seems to indicate water conduction from roots to leaves, but blockage of water loss from the leaf surface. This is best explained by stomatal closure.

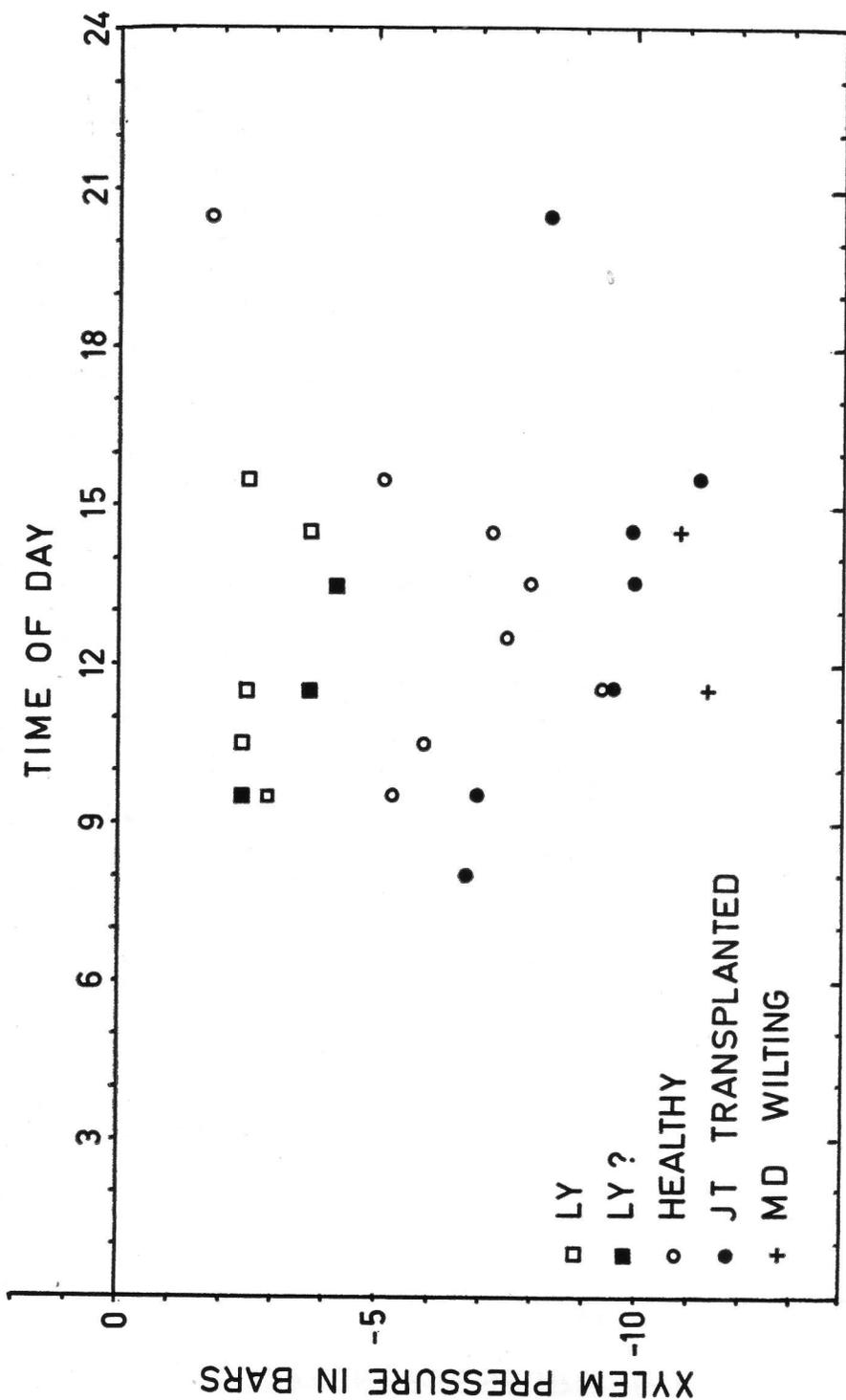
In the same area two apparently healthy trees were selected. One of these (Fig. 3 ■) followed the diurnal pattern associated with diseased trees. Two weeks after these measurements typical LY symptoms began to develop. In another tree (not shown) tensions were slightly reduced (pressures raised) at the time of first measurement. A January frost, approximately one month after measurements were begun on this tree, may have affected subsequent observations. However, over a period of about three months, midday measurements remained high (as compared to values of non-diseased trees). Finally, after three months the first symptom of LY development (premature nut fall) was observed. Unfortunately, the tree's removal prevented confirmation of LY.

A final aspect of this study was the measurement of a coconut palm of the 'Malayan Dwarf' cultivar whose foliage appeared very wilted (Fig. 3 +). This variety is considered highly resistant to LY and is often used to replace the 'Jamaican Tall' cultivar. In contrast to LY-diseased trees, xylem pressures of this tree remained low even during the evening hours (e.g. -8.3 bars at 20:30 h) when transpiration normally ceases and pressures increase. High xylem tension (low pressure readings) can be explained by excessive water loss or desiccation, a disruption of water transport commonly associated with the wilt syndrome. A recently transplanted 'Jamaican Tall' showed similar low pressures (Fig. 3 ●).

These observations are interesting for two reasons. First, they indicate that LY is the opposite of a wilt disease. The pathogen seems to produce a metabolite that ascends in the xylem and causes stomata to close. Second, xylem pressure measurements seem to permit disease recognition at least two weeks ear-



2. Comparison of diurnal pressure variations in the xylem of leaflets of young (3 m tall), healthy coconut palms on sunny (○), cloudy (●), and heavily overcast (□) days. Lowest pressures are reached in bright sunshine. Cloudy weather raises the low midday pressures. Vertical lines indicate standard deviations.



3. Xylem pressures in leaflets of mature coconut palms (6-7.5 m tall), measured on sunny days. Palms showing symptoms of lethal yellowing, had unusually high pressures (□ LY). Xylem pressures in an apparently healthy tree nearby were also high (■ LY?); this tree showed nut fall two weeks later, and typical LY symptoms continued to appear over the next few months. An unhealthy-looking coconut palm planted on a golf course a few years after LY-diseased 'Jamaican Tall' coconut palms had been removed, showed very low xylem pressures, typical of wilting (+ MD). A recently transplanted 'Jamaican Tall' coconut palm (● JT) also showed excessive tensions in the xylem, particularly notable late in the day. The diurnal pressure variations of two healthy, mature coconut palms from a noninfected area are indicated for comparison (○ Healthy). Scatter of results was similar to that shown in Figure 1; vertical lines are omitted for the sake of clarity.

lier than the previously recognized first symptom (nut fall). This is of practical importance because early oxytetracycline treatment raised the percentage of trees that responded favorably to treatment to 90% (McCoy, 1976b).

The severe frost of 20 January 1977 interfered with the continuation of these measurements. Most coconut palms lost many leaves, and measurements of xylem pressure on palms with greatly reduced crown size are not very meaningful. It is hoped that future studies will confirm our findings and that pressure measurements can be correlated with other observations such as stomatal opening. It would also be interesting to see if other yellows diseases cause stomatal closure and to examine possible relationships between leaf yellowing and stomatal closure.

Acknowledgments

The authors wish to express their gratitude to the University of Florida Agricultural Research Center in Fort Lauderdale, Florida, whose staff members helped during this program in every way. Financial support from the Bullard Foundation of Harvard University, and from the Petersham Branch Alliance is gratefully acknowledged.

LITERATURE CITED

- BEAKBANE, B. A., C. H. W. SLATER, AND A. F. POSNETTE. 1972. Mycoplasmas in the phloem of coconut, *Cocos nucifera* L., with lethal yellowing disease. *J. Hort. Sci.* 47: 265.
- BOYER, J. S. 1969. Measurement of the water status of plants. *Annual Rev. Pl. Physiol.* 20: 351-364.
- FISHER, J. B. 1975. Environmental impact of lethal yellowing disease of coconut palms. *Environmental Conservation* 2: 299-304.
- KANEMASU, E. T., G. W. THURTELL, AND C. B. TURNER. 1969. Design, calibration and field use of a stomatal diffusion porometer. *Pl. Physiol. (Lancaster)* 44: 881-885.
- MCCOY, R. E. 1975. Effect of oxytetracycline dose and stage of development on remission of lethal yellowing in coconut palm. *Pl. Dis. Reporter* 59: 717-720.
- . 1976a. Comparative epidemiology of the lethal yellowing, kaincope, and cadang-cadang diseases of coconut palms. *Pl. Dis. Reporter* 60: 498-502.
- . 1976b. Field control of coconut lethal yellowing with oxytetracycline hydrochloride. *Phytopathology* 66: 1148-1150.
- MCDONOUGH, J. 1977. An investigation of xylem pressure in coconut palm with reference to lethal yellowing. Master's Degree Thesis, Harvard University, Harvard Forest, Petersham, MA 01366.
- MILBURN, J. A., AND T. A. DAVIS. 1973. Role of pressure in xylem transport of coconut and other palms. *Physiol. Pl. (Copenhagen)* 29: 415-420.
- MILBURN, J. A., AND M. H. ZIMMERMANN. 1977. Preliminary studies on sap flow in *Cocos nucifera* L. *New Phytol.* 79: 535-541, 543-558.
- PARTHASARATHY, M. V. 1974. Mycoplasma-like organisms associated with lethal yellowing disease of palms. *Phytopathology* 64: 667-674.
- PLAVSIC-BANJAC, B., P. HUNT, AND K. MARAMOROSCH. 1972. Mycoplasma-like bodies associated with lethal yellowing disease of coconut palms. *Phytopathology* 62: 298-299.
- ROMNEY, D. H. 1972. Past studies on, and present status of lethal yellowing disease of coconut. *Pest Articles & News Summaries (Centre for Overseas Pest Research, London)* 18: 386-395.
- SCHOLANDER, P. F., H. T. HAMMEL, E. D. BRADSTREET, AND E. A. HEMMINGSEN. 1965. Sap pressures in vascular plants. *Science* 148: 339-346.
- TALBOT, A. J. B., M. T. TYREE, AND J. DAINTY. 1975. Some notes concerning the measurements of water potentials of leaf tissue with specific reference to *Tsuga canadensis* and *Picea abies*. *Canad. J. Bot.* 53: 784-788.
- ZIMMERMANN, M. H. 1969. Translocation velocity and specific mass transfer in the sieve tubes of *Fraxinus americana* L. *Planta* 84: 272-278.
- . 1973. The monocotyledons: their evolution and comparative biology. IV. Transport problems in arborescent monocotyledons. *Quart. Rev. Biol.* 48: 314-321.

NEWS OF THE SOCIETY

News from California

The Northern California Chapter had a meeting on February 4, 1979 at the Claremont Hotel in Oakland. It was a dinner meeting with Lucita Wait as speaker. Chairman Dick Douglas told of his experiences with hybridization of chamaedoreas and showed some of the resulting plants, several of which are outstanding. There were other lovely palms on exhibition and a question and answer period was of interest to all. President Donn Carlsmith had come from Hawaii and greeted the group, introducing the other Board members present.

President Carlsmith had called a Board Meeting for February 3, also at the Claremont. The society is now large enough that there is more business than can be handled at one Board Meeting every two years at the Biennial, as has been the custom in the past. Present in addition were: Paul Drummond, Vice-President, Ruth Shatz, Treasurer, Pauleen Sullivan, Secretary, and Directors Ernie Chew, Warren Dolby, De-Armand Hull, and Dr. Merrill Wilcox. Teddie Buhler, Executive Secretary, also attended.

The main purpose of the Board Meeting was to discuss and set up the following committees: Ad Hoc Committee to evaluate and recommend the structure of the organization; Temporary Seed Bank Committee to propose a permanent setup for the Seed Bank; Classes of Membership Committee to consider if membership dues should be raised and if additional membership categories should be instituted; Nominating Committee, Gertrude Cole, Chairman; and a Constitutional Committee to review on a short and long-range basis our articles of incorporation and bylaws in order to provide an adequate framework within

the organization can operate successfully. The Publications Committee, which had been formed at the Biennial last July, added a member and reported on a meeting it had held earlier. Chairman Warren Dolby welcomes suggestions and articles from the membership.

Since President Carlsmith had to be in the Miami area, he called for a follow-up Board Meeting on March 31 to hear reports from the various committees and to work out further details. As definite results are reached the membership will be notified. Another Board Meeting has been called for October 13, 1979, in California.

Because of the out-of-town Board Members, the Northern California Meeting was a particularly enjoyable and festive one and those who had come from afar had the pleasure of meeting the local members. The hospitality shown to the visiting Officers and Directors was quite beyond the call of duty but was greatly enjoyed.

Frank Ketchum, Secretary, reported that the Southern California Chapter held a meeting on March 10, 1979, at the San Diego Wild Animal Park. It was the first time a meeting had been held there but it may become an annual affair. Members brought their own lunches. A brief meeting was held. Chapter members displayed a beautiful array of palms. Individual entries were judged and there were many happy winners. Jim Gibbons, horticulturist at the Park, then gave a short talk and led the members on a hike to the site of the future palm garden.

News from Florida

The South Florida area members also brought their own lunches on February 24 to the Kampong, home of Mrs. E. C. Sweeney. The Kampong was originally the home of Dr. David Fairchild and still contains a large number of the

plants set out by him, though regrettably many of the palms have died over the years. It is a fascinating and historical spot and we enjoyed the privilege of being able to see it even though our hostess had to be out of town while we were there. We were ably guided by Larry Shockman who led us on a very informative tour.

It is always a pleasure when news comes of the impending visit of a member from afar. In Miami we enjoyed August Braun, botanist, from Venezuela and author of *Cultivated palms of Venezuela*. Some of our Australian friends have also put in an appearance. Last fall Douglas Wadewitz came and then went on to California. He was great fun to be with. In January Ed Bunker and family attended a Nurserymen's meeting but had little time for visiting with members. At this writing we look forward to seeing John Covacevich who is to spend several days in Miami. We all learn from one another and visits are enjoyable when we can be among fellow palm enthusiasts.

TEDDIE BUHLER

News from Hawaii

The members of the Hilo Chapter of The Palm Society are a hearty group. After three inches of rain in the morning, and under threatening skies, about 25 members and guests gathered at the Hilo Nursery Arboretum one Sunday afternoon in February with everyone wondering if anybody besides himself would appear. But they did appear, and for several reasons. One was that we had a guide, Bunichi Usugawa, who had worked at the Hilo Nursery Arboretum for many years. Second was that the "Tree Nursery," as it is known, is a facility of the Forest Department and so is usually open only during regular working hours, not on weekends. Third

was that it was an opportunity to see many mature specimens of palms not commonly planted in Hilo. Some of the palms that we saw were of the genera *Aiphanes*, *Borassus*, *Elaeis*, *Gaussia*, *Latania*, *Licuala*, *Livistona*, *Metroxylon*, *Phoenix*, *Pinanga*, and *Thrinax*.

We had do-it-yourself door prizes. Any seeds or seedlings that could be reached could be taken home in plastic bags. The *Gaussia* and *Livistona robinsoniana* were the most readily available, and there were enough for everyone who wanted them. Two sharp-eyed and lucky people picked up *Metroxylon amicarum* seeds, or "alligator eggs," while everyone else turned green. Ever hear of a gallon coconut? It is a variety of coconut from the Philippines that is three or four times as large as a common coconut and weighs a good 25 pounds. Only one person found a gallon coconut, but a few settled for a half-gallon coconut.

Even those who did not go home with souvenirs thought that they had added to their knowledge, and also to their ability to recognize some of the more uncommon (to us) palms. And maybe everybody didn't get home before it started to rain, but everybody was on his way home, at least, before it started to rain again.

JANE ROBINSON

NOTES ON CULTURE

Windmill Palms in Bonn-Bad Godesberg (Germany)

As a member of The Palm Society, I was interested in the notes on a windmill palm in a Maryland garden (*Principes* 22: 111-112, 1978). I am a lover of palms, keeping *Washingtonia filifera*, *Chamaerops humilis*, and *Caryota mitis*, which grow from April till October outside in my garden. Since 1977 I have kept two windmill palms, *Trachycarpus*

fortunei, outside all year. One is small, only two feet high, the other about three feet high.

Bonn-Bad Godesberg is at latitude 50° N, situated on the River Rhine, where the climate, influenced by the Gulf Stream, is mild throughout the year. The average temperature in January is 2°C (34°F) and in July we have temperatures of 18°C (66°F) with a humidity of about 70 percent. But the average climatic range is sometimes extreme, going from -15°C (5°F) in a winter like 1978-79 to 40°C (104°F) in summer for a few days.

The two palms are still growing very well without any protection in winter. There are some other subtropical plants in my garden, for example *Eucalyptus gunnii*, *Ficus carica*, and *Passiflora coerulea*. In my neighborhood a *Trachycarpus fortunei* five feet tall has grown outside since 1976, another is seven feet tall, and in the Botanic Garden in Bonn two *Trachycarpus fortunei* have also grown outside since 1977 without any shelter.

CHRISTOPH-ANDREAS RAEHMEL
Im Pfirsichgarten 33
5300 Bonn-Bad Godesberg

WHAT'S IN A NAME?

Bactris (bák triss) was not explained by Jacquin, who first used the name, but according to C. A. Backer (*Verklarend Woordenboek*) it may have come from the Greek *baktron* (stick, cane, staff) because of the slender stems.

Bejaudia (bay zhó dee a) was named for Marcel Bejaud, a French forester once Chief of the Forest Service of Cam-

bodia, in appreciation of the specimens of woody plants and notes about them that he forwarded to the Muséum National d'Histoire Naturelle in Paris.

Campecarpus (kám pee cár puss) was coined by Hermann Wendland but has not been explained by any of the authors using it. Presumably, the name was taken from a Latinization of the Greek *kampe* (a curve, bend) and *karpos* (fruit) because of the slightly curved fruit.

Chambeyronia (shám bay rée nee a) was dedicated by Vieillard to Charles-Marie-Léon Chambeyron (1827-1891), a French naval officer and hydrographer, who mapped much of the coast of New Caledonia and who assisted Vieillard in exploration of the island.

1980 Biennial Meeting

The next Biennial Meeting of the Palm Society will be held in Hawaii during the period 14-22 June, 1980. A suggested program was drawn up at a meeting of the Board of Directors in Miami on March 31, 1979 and is published for members who wish to plan ahead. More details will be forthcoming in future issues of **PRINCIPES**.

14 June—Arrival in Hilo, Hawaii (the Big Island).

15 June—Check in. Board of Directors Meeting in the morning, General Meeting in the afternoon.

16 June—Visits in and about Hilo.

17 June—By bus from Hilo to Kona.

18 June—Tour of Kona.

19, 20 June—Open.

21 June—Reunion on Oahu (Honolulu).

22 June—Departure.

CLASSIFIED

HAWAIIAN PALMS AND PLANTS. Special for Palm Society members. Five *Caryota mitis*—dwarf fishtail palms—\$10.00 postpaid. Send stamp for free brochure. HANA GARDENLAND, PO Box 248PS, Hana, HI 96713.