

PRINCIPES

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Silhoutte in negative of a grove of *Pigafetta filaris* on Gunung Ambang, Kotamobagu, Bolaang Mongondow, North Celebes. Photo by John Dransfield. See page 48.

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JOURNAL OF THE PALM SOCIETY

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Palms in the Everyday Life of West Indonesia

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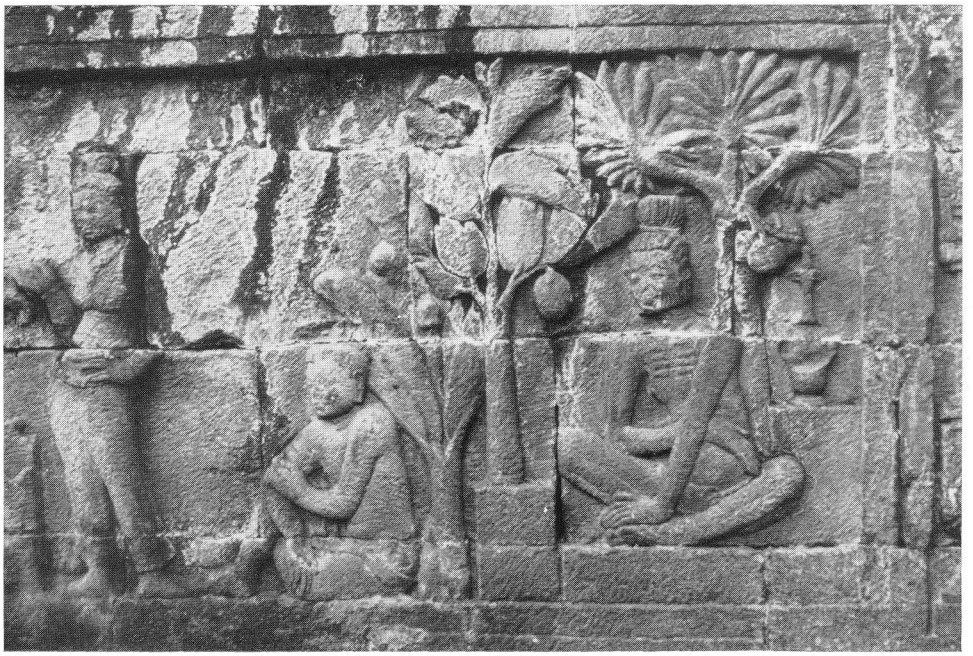
Indonesia is too vast and varied a nation to be discussed in a short article, so here I shall indicate the great range of uses to which palms are put in the everyday life of West Indonesia—that is, the area west of Wallace's Line. There is already an extensive literature on palm uses in Heyne's "De Nuttige Planten" and in Burkill's "Economic Dictionary," but what will be considered here is based on my own observations during four years spent in Indonesia.

Palms have probably been one of the major bases of livelihood for the people of Indonesia for an extremely long time; one can, in fact, imagine that Solo man may have depended quite heavily on wild Javanese palms. At any rate, by the time of the building of the temple of Borobodur, people of Central Java probably utilized palms more or less in the same way as many poor village people in remote parts of Java do today; among other economic plants to be seen on the temple reliefs (Fig. 1) are coconuts (*Cocos nucifera*), lontar (*Borassus sundaicus*), sugar palm (*Arenga pinnata*), and betel palm (*Areca catechu*). In highly cultivated present-day Java and Bali, the palms which enter everyday life are usually few in number and, especially in economically depressed areas, villagers may make very intensive use of one or two species. The coconut, sugar palm, lontar, and gebang (*Corypha elata*) are prime examples. In East Madura for example, the lontar or siwalan (*Borassus sundaicus*) is the most important local plant used for food, thatch, buckets, writing material, and many other purposes, and further east in the drier parts of the archipelago there is an almost complete dependence on these four palms for nearly every necessity of life.

The sugar palm, *Arenga pinnata*, was discussed at length by Miller (1964). This palm has an extraordinary range of uses from food (sago, sugar, wine, vinegar, and spirits) to cigarette papers, brooms, thatch, and tinder. Because of over-exploitation of sago at the present day, the sugar palm appears to be decreasing in West Java. Here is a palm of enormous potential which could be planted on a much larger scale, perhaps on the derelict "lalang" fields on hills in West Java. The gebang (*Corypha elata*) is also used for sago, thatching, raincoats, and a fine matting which is also exported as a wall covering, but because it is generally rather rare in Java, it does not enter into the lives of village people in the way that *Arenga* does.

In the moister, less cultivated areas of West Indonesia, such as Kalimantan and Sumatra, remote communities at the edge of the forest (Fig. 2) also rely heavily on palms, but the number of species involved is much higher. In one small Dayak community in the mountains of South Kalimantan, a use was ascribed to nearly every palm I found. Generally

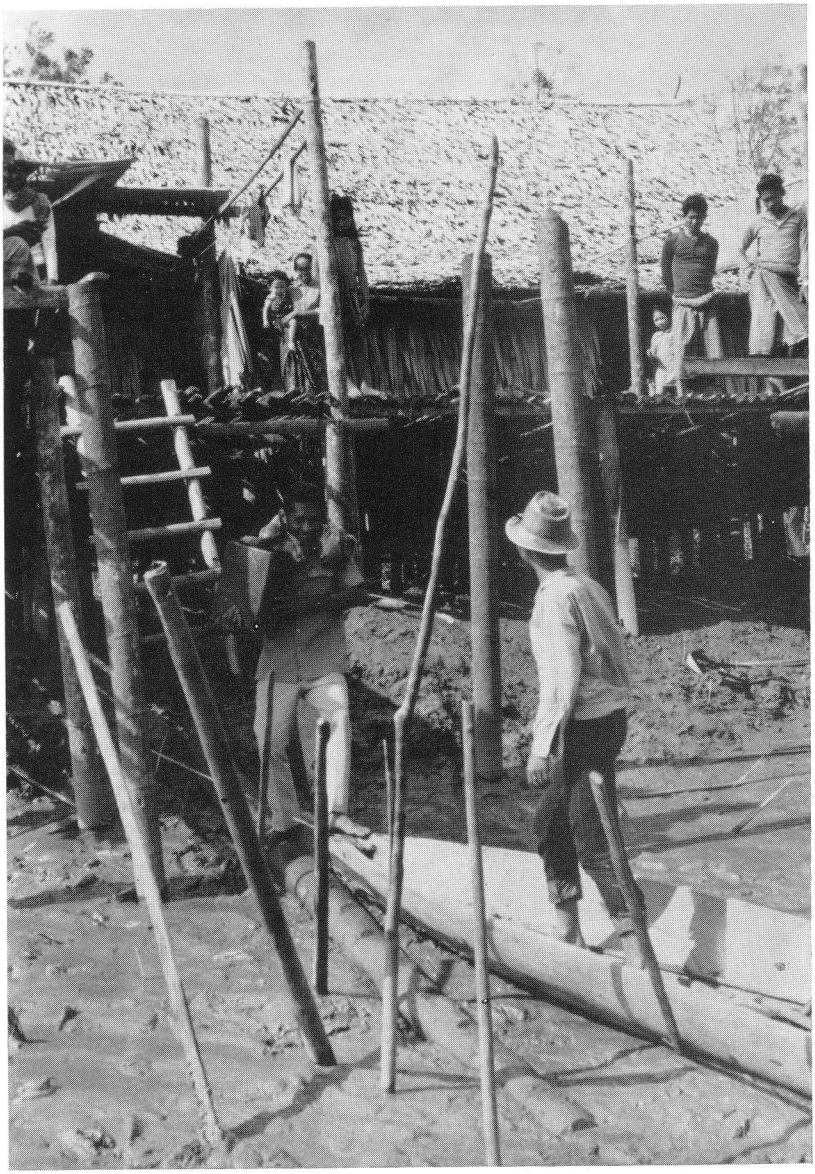
* Presented as part of a symposium entitled "The Natural History and Utilization of Palms" at the annual meeting of the Society for Economic Botany, Ithaca, N. Y., June 14, 1973.



1. Early use of palms—on the extreme right a tree of *Borassus sundaicus* with a banana and a breadfruit on the temple reliefs at Borobodur, Central Java.



2. Dayak village in the Meratus Mountains of South Borneo. Sugar palms and coconuts are by the houses. In the forest behind occur many palms all of which are used in some way.



3. Sumatran East Coast village with houses built almost entirely of palm products—piles of *Oncosperma*, flooring of *Oncosperma* or *Cyrtostachys*, walls and thatch of *Nypa* and *Pinanga patula*.

it is these pioneer communities at the forest edge who make most use of native palms. In Java, even where there are communities living at the forest edge, as on the Jampang plateau in West Java, palms are not nearly so important as bamboos, at least for construction purposes.

For construction purposes, certain palms are much sought after. For example in villages near to muddy coastal mangrove forest, *Nypa fruticans* and



4. Floating shop at Banjermasin in South Borneo—fishtraps, mats, baskets, rope, and brooms are made largely of palm products.

Oncosperma tigillarium, which occur in abundance in coastal forest, form the main building components (Fig. 3), though occasionally supplemented by timber from *Melaleuca* and *Avicennia*. *Oncosperma* trunks, with the stem spines removed, form piles and pillars (often beautifully polished by rubbing); the walls and roof may be made from "attaps" of *Nypa* leaflets folded over either a split *Nypa* petiole or a split stem of *Pinanga patula*, and secured with threaded split rattan to form a gigantic "thatch tile;" the floor is made from split and despined *Oncosperma* trunks. In other areas coconut, *Arenga*, *Borassus*, or even *Cyrtostachys lakka* stems may be used for pillars and flooring.

Thatching material also varies considerably and depends on the local flora. For simple temporary shelters in the forest any entire or broad-leafleted palm is used. The far-famed *Johannesteijsmannia* makes the best temporary shelters. In Indonesia it is only known from the area around Medan in North Sumatra —here it is used for roofing, either as whole leaves, or else sewn into "attaps" with split rattan. *Licuala valida*, an acaulescent undergrowth species from Borneo, is extensively used by the Dayaks of South Kalimantan for thatching; likewise the magnificent *Arenga brevipes* furnishes excellent thatch when the leaflets are woven into each other, producing a delightful variegated dark green and grey "attap". Entire-leaved *Iguanura* species and *Pinanga* species, and in fact almost any palm leaves, are used for temporary shelters. For more permanent housing, *Metroxylon* and *Livistona* leaves are used in some areas, and in the Batak Highlands and the Minangkabau areas of Sumatra, and in



5. Two stages in making a fisherman's basket from two interwoven leaves of *Corypha elata* (Ujung Kulon, West Java).



6. An ingenious coconut grater made from the spiny petioles of *Calamus burckianus* in Bali.

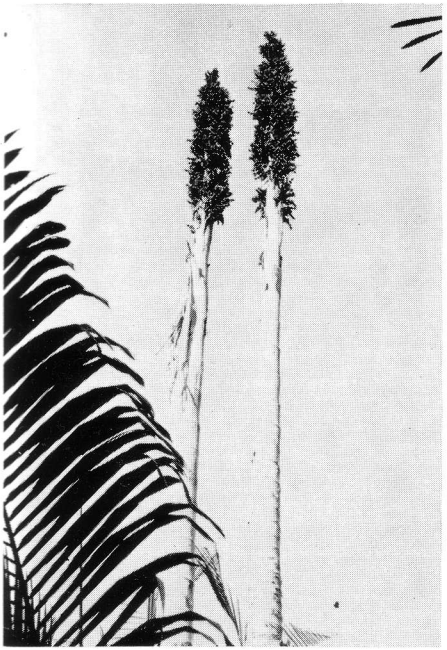
remote areas of Java, leaf-sheath fibre of the sugar palm is used. This last so-called "ijuk" is supposedly much more durable then the unpleasant corrugated iron which is almost everywhere replacing it.

Among the forest palms of West Indonesia, the rattans are some of the most important, being almost universally sought after by villagers. Their uses are legion. In size they range from giants such as *Calamus manan*, "rotan manau" one of the most important furniture rattans, and *Plectocomia elongata*, large but more or less useless as it splits too easily, to the slender rattans such as *Calamus javensis* which, in extreme forms, may be as slender as 2 mm. in diameter. They are almost all very spiny and difficult to collect—the spiny petioles are sometimes used tied to fruit trees to stop thieves from raiding the fruits, or tied to rafters to prevent bats



7. Carrying basket made from rattans, Kerinci, Central Sumatra.

and swiftlets from roosting. Some rattans reach vast lengths well in excess of 100 m.; others, even at maturity, barely exceed 1 m. in length. Generally speaking, the terminal-flowering genera such as *Plectocomia* and *Plectocomiopsis* are not very useful as the cane splits easily, but *Korthalsia* species furnish a very hard tough reddish cane known as "rotan merah" which is useful in the construction of fish traps, baskets, and cheap furniture. Split rattan is universally useful as twine. Village stores sell rattan and other palm products and are a delight to explore (Fig. 4). Here may



8. The dead stems and inflorescences of the wild Bornean sago palm, *Eugeissona utilis*, after flowering.

be found hats, fish traps, pestles from hard palm wood, coconut-shell spoons, wash buckets from *Areca* sheaths, strainers, baskets (Fig. 5), winnowing trays, shovel handles, walking sticks, rope, twine, cigarette papers from coconut, *Arenga*, *Nypa*, or rattan leaflets, and mats, nearly all made from palm products, often sewn together with rattan twine, and hung up for display on a loop of split rattan. Once I even saw a neat coconut grater made from two spiny petioles of the rattan *Calamus burckianus* bound together being used by a food seller in Bali (Fig. 6). Rattan basketry is of particular interest and beauty; in areas remote from cities, most carrying baskets are made from split rattan, but bamboo and plastics are taking over as rattan decreases in abundance. For example, in the Kerinci valley of Central Sumatra, four types of carrying basket (Fig. 7) are in constant use—large and small close-weave baskets, open-weave



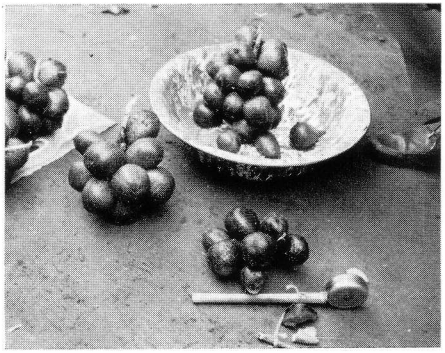
9. Coconut oil being pressed from fried endosperm through a coconut-leaf-sheath sieve with two planks of *Borassus* wood.



10. A salak orchard near Bangkalan, Madura.

baskets, and small shoulder baskets. They are made entirely from rattan except for the wooden support on the base, and the shoulder straps are made from *Hibiscus tiliaceus* bark. The large rattan used for the framework and mouth is usually *Calamus manan* and split *Calamus opacus* is used for the woven sides, both species being abundant in the nearby mountain forests. It is of particular interest to note that the form of the Kerinci baskets closely resembles that of similar carrying baskets in South Kalimantan, whereas those of the Bengkulu district further to the south are quite different, and to the north in the Padang district, big carrying baskets are largely absent—here is an interesting field for further study.

Commercial exploitation of wild rattans also enters into everyday village life



11. Madurese salak ready for peeling and eating.

as a source of cash, especially during periods of low agricultural activity. Only in Central Kalimantan are rattans cultivated on a vast scale—here whole villages depend heavily on rattan cultivation for their livelihood. The rattan species cultivated are *Calamus caesius* and *C. trachycoleus,* two relatively slender species with stems ca. 1–2 cm. diameter. For the big furniture rattans, only wild-growing sources are available and these appear to be fast diminishing.

Sago can be collected from several species of palm in times of rice shortage —for example from *Corypha elata, Metroxylon sagu, Caryota mitis,* and *Arenga pinnata.* Some of the forest nomads of Borneo, however, use sago from *Eugeissona utilis* as a staple. Palm apices are occasionally used for vegetables, *Oncosperma horridum* being very highly esteemed and so widely sought after by forest folk that mature stems of this species are often hard to find. *Arenga, Caryota, Borassodendron,* and *Licuala* apices are all delicious but *Orania sylvicola* is reputedly deadly poisonous. Apices of *Daemonorops melanochaetes* in Central Java were regarded as food specially reserved for visitors to the palaces (Kratons) of Solo and Jogjakarta; one can often buy apices of the related *D. hallierana* and *D. fissa*

in South Borneo, where they are normally cooked with coconut cream, salt fish, turmeric, chillies, garlic, onions, and other spices. The extraordinary flowers of *Eugeissona utilis* (Fig. 8) produce great amounts of pollen which according to Beccari (1904) is used as food by the Bornean forest folk. Further food uses include oil from *Cocos* (Fig. 9) and sugar, wine, and spirits, regularly made from *Arenga, Cocos, Borassus,* and *Nypa.* Rattan fruits are often eaten but are nearly always fearfully sour.

The finest local palm fruit, however, is that provided by cultivated *Salacca edulis*; this highly spiny acaulescent palm (Fig. 10) is cultivated in several widely dispersed areas of Indonesia—near Medan and Padang Sidempuan in Sumatra, Pasar Minggu and Tasik Malaia in West Java, Seleman in Central Java, Pasuruan in East Java, Bangkalan in Madura, in one area of North Celebes, and near Karangasem in Bali. Salac from Bali surpasses all others. Much remains to be clarified about the biology of this excellent fruit (Fig. 11), especially the Balinese variety, male plants of which are unknown.

Young endosperms of *Arenga pinnata,* coconut, *Borassus, Eugeissona,* and *Nypa* are made into sweetmeats and mature endosperms of some of the wild species of *Pinanga* and *Areca* are used as substitutes for *Areca catechu* endosperms in betel-chewing.

Palms enter many local cures and superstitions. *Actinorrhytis calapparia,* a common but not native palm in West Indonesian villages, is sometimes planted when a placenta is buried at childbirth, and thereafter the palm has mystical significance to the child. Sterile female salac trees in Bali are worshipped to ensure heavy cropping of the fertile trees, and the exquisite *Areca latiloba* is often planted at the head of graves in South Sumatra, the tree, gay with bright red fruit, making a fine headstone long after the wooden markers have rotted.

Finally palms are used in recreation—petioles of rattans and many other palms are used in the construction of toys, and the gigantic kites of Madura are made from split bamboo lashed with rattan, with a piece of split rattan stretched tightly across a bow to vibrate angrily in the wind as the kites soar at the ends of hundreds of meters of *Corypha* petiole-fibre cord.

It is hoped that this account, however incomplete, will give some indication of the enormous and often curious and ingenious uses to which palms are put in West Indonesia. It is further to be hoped that some work at least can be carried out in Indonesia by Indonesians on the role palms play before the onslaught of plastics is complete.

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PALM BRIEFS

A Note on the Habitat of Pigafetta filaris in North Celebes

All botanical visitors to North Celebes must have noted the great abundance of "wanga," *Pigafetta filaris*. Despite its abundance, when examined closely, *Pigafetta filaris* appears to have a very precise and, for a Malesian rain forest palm, a most unusual habitat. The visitor to the district of Minahassa will find that *Pigafetta* is apparently very rarely found below an altitude of about 300 meters and though it is abundant in the mountains it rarely seems to be present above an altitude of 1,500 meters.

Within these altitudinal limits *Pigafetta* is not uniformly distributed; in primary forest it is very rarely encountered, yet at the edge of the forest (at edges of clearings and areas of shifting cultivation) it is often extraordinarily abundant, occurring in great groves of towering individuals often to 50 m. or more in height. In primary forest, seedlings can sometimes be encountered in small groups representing the remains of animal droppings, but seedlings beyond the one-leaf stage appear to be absent. In river gravel and in other open areas, seedlings of all sizes are present. Mature *Pigafetta* palms are common on landslips around the crater of Gunung Batu Angus within the otherwise densely forested hillslopes. I observed no *Pigafetta* in the primary forest on Gunung Ambang above Kotamobagu in Bolaang Mongondow, yet outside the forest thousands of individuals were present. All these observations seem to suggest that *Pigafetta* demands high light intensity at the seedling stage; in open areas seedlings develop well but in primary forest, even though seed is present, presumably deposited with droppings by birds, squirrels, monkeys, or other animals, they appear not to progress beyond the one-leaf stage.

The phenomenally fast growth rate of *Pigafetta* in cultivation along with this apparent high light demand, suggests that *Pigafetta* is a palm adapted to colonizing temporarily open habitats and it could be called a pioneer palm. I know of no other Malesian palm, apart perhaps from *Nypa fruticans*, *Phoenix paludosa*, *Licuala spinosa*, and *Corypha elata* (all essentially maritime palms), which behaves as a pioneer. *Pigafetta* in North Celebes has almost certainly been greatly affected by man's activities there; the clearing of land by shifting cultivation has opened up a great deal of land apparently suitable to colonization by *Pigafetta*. If my hypothesis that *Pigafetta* is a pioneer palm is correct, *Pigafetta* will probably have been much rarer in the past. Suitable natural habitats are probably river banks, landslips, very steep-sided ridgetops, and old lava flows from the many volcanoes. The relatively very small seed produced in great abundance may be seen as an adaptation to increase chances of dispersal to relatively rare open habitats within rain forest. The ecology of this superb palm would certainly repay further study.

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Ecological Studies of the Cabbage Palm, Sabal palmetto. II. Dispersal, Predation, and Escape of Seeds

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In an earlier article (Brown, 1976) the floral biology of *Sabal palmetto* was considered. This article continues the ecological life history of the species by addressing problems associated with dispersal of seeds to safe sites in the environment.

According to Janzen (1970), the ability of a plant species to recruit new members is a function of the number of seeds in the area and the probability of seed and seedling survival. This is in turn determined by the number of seeds produced, the distance from the parent tree, and the efficiency of predators.

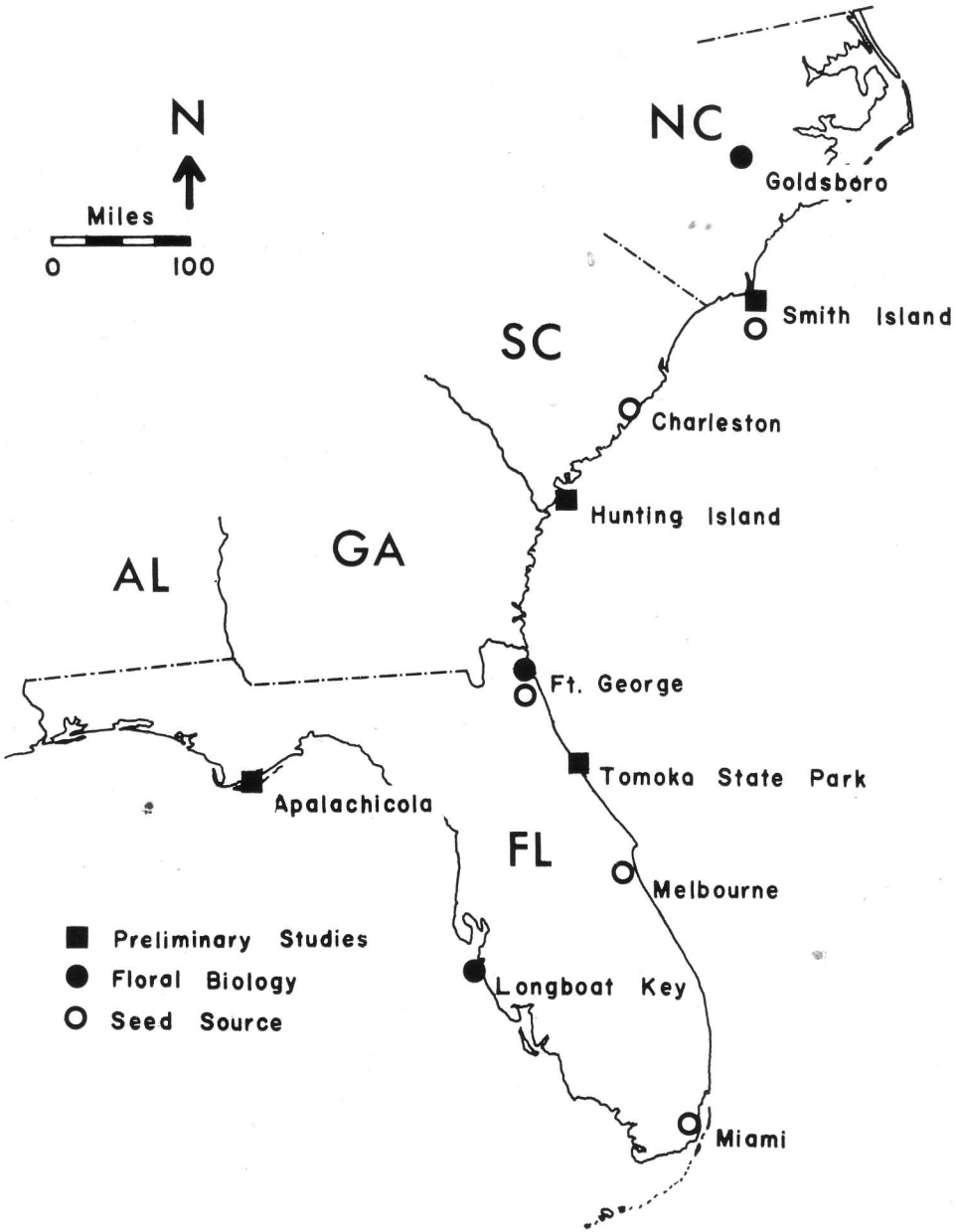
Dispersal of Seed

The mature fruit is the diaspore or unit of dispersal in *Sabal palmetto*. It contains a single seed and is spherical in shape, averaging 10 mm. in diameter. The fruit is indehiscent and persists on the infructescence during the winter. As the fruit dries, the mesocarp shrinks, as does the seed to a lesser degree, leaving an airspace within the mesocarp.

Fruit is removed from trees by external forces, such as wind during the winter and spring storms, and to an unknown degree by animals. Fish crows are reported to include the fruit in their diet (Sprunt and Chamberlain, 1970) and I have observed song birds (cardinals and blue jays) taking fruits. These species may be involved in dispersal within the local populations. However, direct dispersal to more northerly latitudes by migrating birds, as proposed by Small (1923), is discounted for two reasons. In the fall when fruits are ripe, succulent, and assumed most attractive to birds, migratory movements are to the south. In the spring when birds are moving north, palmetto fruits are dry, seeds bone-hard, and most have been dispersed from the trees.

Fruits falling to the ground are manipulated by mammals, including rodents. Squirrels were observed carrying off fruits, and on several occasions in the field I found either groups of seeds or young seedlings in dense clusters of as many as 30 or more within an area of 1.0 square meter. In some cases these were out of sight of the nearest bearing tree. I suspect that this was the result of activities of cache-hoarding mammals such as squirrels and mice. However, as with the observed birds, these animals are nonmigratory, have small home ranges, and thus offer no opportunity for direct dispersal to distant sites.

Although few palms owe their dispersal to sea currents (Ridley, 1930), such dispersal seems a distinct possibility in



1. Location of field study sites and seed sources.

S. palmetto. The plant is quite commonly found on banks of bodies of both fresh and brackish water. Therefore fruits do fall into water and are subject to being wafted away by waves, currents, or tides. While local dispersal might occur in fresh water, salt water holds the potential for direct long-range dispersal.

Table 1. Tolerance of seeds to salt water. Values given as germination percentage after indicated number of weeks in 3.5% NaCl solution. Numbers in parentheses are percentages of normal seedlings developed from seeds which germinated.

Week	Miami	Melbourne	Ft. George	Charleston	Smith Is.
1	100 (100)	100 (100)	90 (100)	100 (100)	100 (100)
2	100 (100)	100 (100)	100 (100)	80 (100)	100 (100)
3	100 (100)	100 (100)	100 (100)	100 (100)	100 (90)
4	90 (89)	80 (75)	100 (100)	70 (100)	100 (70)
5	90 (67)	90 (89)	100 (100)	90 (78)	90 (33)
6	100 (60)	80 (50)	100 (70)	90 (67)	80 (88)
7	80 (38)	70 (71)	50 (100)	80 (75)	80 (50)
8	80 (38)	100 (60)	80 (75)	70 (71)	60 (50)

A study to determine tolerance of seed to salt water and buoyancy of mature fruit was conducted based on the methods of Stevens (1958).

To test tolerance to salt water, 100 seeds from each of the five seed source locations (Fig. 1) were placed in 1.0 liter beakers with 500 ml. of 3.5% NaCl solution. The solution was changed twice a week to maintain proper density and salinity. Beakers were stirred once a day. Viability of seeds was determined by removing ten seeds weekly for eight weeks, rinsing one minute in distilled water, then placing on moist filter paper in a petri dish and incubating at 30° C for 28 days.

Buoyancy was tested by placing 25 mature, dry fruits from each location in 1.0 liter beakers with 500 ml. of 3.5% NaCl solution. These were maintained as in the salt-tolerance test. Observations were made daily. All fruits and seeds were screened for infestation by seed predators before tests were begun. In those few cases where larvae were not initially detected, test results (percentages) reflect true values, excluding those seeds or fruits found infested.

Viability of seed in salt water is retained by some seeds for periods up to eight weeks. After three weeks no reduction in viability was noted and developing seedlings were normal in appearance in all test groups. After six weeks germination remained high at 90% (average for all locations); however, only 67% of these germinated seeds developed into normal seedlings. At the end of eight weeks average germination was still high at 78% but only 59% of the germinating seeds produced normal seedlings. Of those seeds which sprouted but failed to grow normally, about half were abortive in appearance and half succumbed to fungal attack. There was no pattern of differential response among the five populations with all showing decreased viability and survival of seedlings with increasing exposure time (Table 1).

Mature fruits from all locations were initially buoyant and a relatively high percentage remained so for one week. However, a marked tendency toward longer buoyancy occurred in the two northernmost populations wherein 50% or more remained buoyant for two weeks. The ability to remain afloat for longer periods is due to undetermined differences in the fruits, for seeds from all locations sink immediately in salt water.

Table 2. Fruit buoyancy in salt water. Buoyancy is given as percentage of fruits still floating after times indicated. Test 1 compares all populations, Test 2 the extremes of the natural range.

Time	Miami	Melbourne	Ft. George	Charleston	Smith Is.
		Test 1 (25 seeds)			
1 Day	100.0	92.0	100.0	100.0	100.0
1 Week	48.0	56.0	44.6	83.3	77.3
2 Weeks	24.0	20.0	29.1	50.0	59.0
3 Weeks	12.0	4.0	0.0	4.2	9.1
		Test 2 (100 seeds)			
1 Day	72.0				100.0
1 Week	35.0				84.9
2 Weeks	9.0				62.8
3 Weeks	3.0				45.5

A second buoyancy test using 100 fruits each from Miami and Smith Island produced results which seem to verify the tendency for longer buoyancy in the northern portions of the range (Table 2).

The ability to withstand salt water and remain viable, along with a limited buoyancy mechanism, provides *Sabal palmetto* with the potential for direct dispersal to distant sites via salt water. The rate and direction of dispersal in such a system would depend on the direction and velocity of estuarine and littoral currents along a shore line. Theoretically the fruit could be carried just over 1,000 miles in two weeks by a three-mile-per-hour current. Alongshore currents on southern Atlantic coast beaches develop a persistent northerly flow with prevailing southerly winds during late spring and summer when *S. palmetto* fruits are dry and buoyant. Currents on the continental shelf south of Cape Hatteras are also predominantly northerly, flowing at rates of up to several miles per hour during late winter to summer (Bumpas, 1955). Offshore currents along the Gulf coast are not as clearly developed or persistent as along the Atlantic. However, alongshore currents tend to be northerly along the peninsula but westerly along the panhandle coast during the spring and summer. Neither are as strong or as persistent as their Atlantic counterpart.

If one accepts southern and central Florida as the center of distribution for *Sabal palmetto* (evidence for which will be considered in a later article), then the above salt water dispersal system becomes a feasible explanation for the distributional extremities along both Atlantic and Gulf coasts. Buoyant fruits from southern populations could have begun an outward migration of the species in a series of steps along the coasts northward and westward to the current termini at Smith Island, N.C. and St. Andrews Bay, Fla. Selection for trees with buoyant fruits would have occurred naturally in such a system, with the expected result of a high percentage of buoyant fruits in remote populations. This seems to be what has occurred at Smith Island.

Table 3. Rates of seed infestation by Caryobruchus gleditsiae. *Based on the 1971 seed crop as percent infested from samples of 500 seeds.*

Sample	Miami	Melbourne	Ft. George	Charleston	Smith Is.
1	2.8	8.8	4.0	10.7	39.0
2	4.4	12.4	3.8	11.5	37.4
3	4.5	12.7	4.0	15.0	37.7
4	4.1	—	6.7	—	45.2
Average	4.0%	11.3%	4.6%	12.4%	39.8%

Predation of Seed

Whereas the herbivorous lepidopterans and other unidentified insects which attack immature fruit are local and quite periodic, certain beetles are ubiquitous with *S. palmetto* (Brown, 1976). Beetles were first discovered in seed collections obtained for germination studies, and later in the field. One, *Cocotrypes* sp. (Scolytidae), was found in small numbers on dispersed fruits in southern populations from Ft. George southward. Identification to species is still pending but it is similar to the species which Janzen (1972) has reported attacking dispersed fruits of the sierra palm, "*Euterpe globosa*" [*Prestoea montana* (Graham) Nicholson], in Puerto Rico. Rees (1963) found that *C. congonus* Eggers is perhaps the major factor limiting reproductive success in nature by the African oil palm, *Elaeis guineensis* Jacquin.

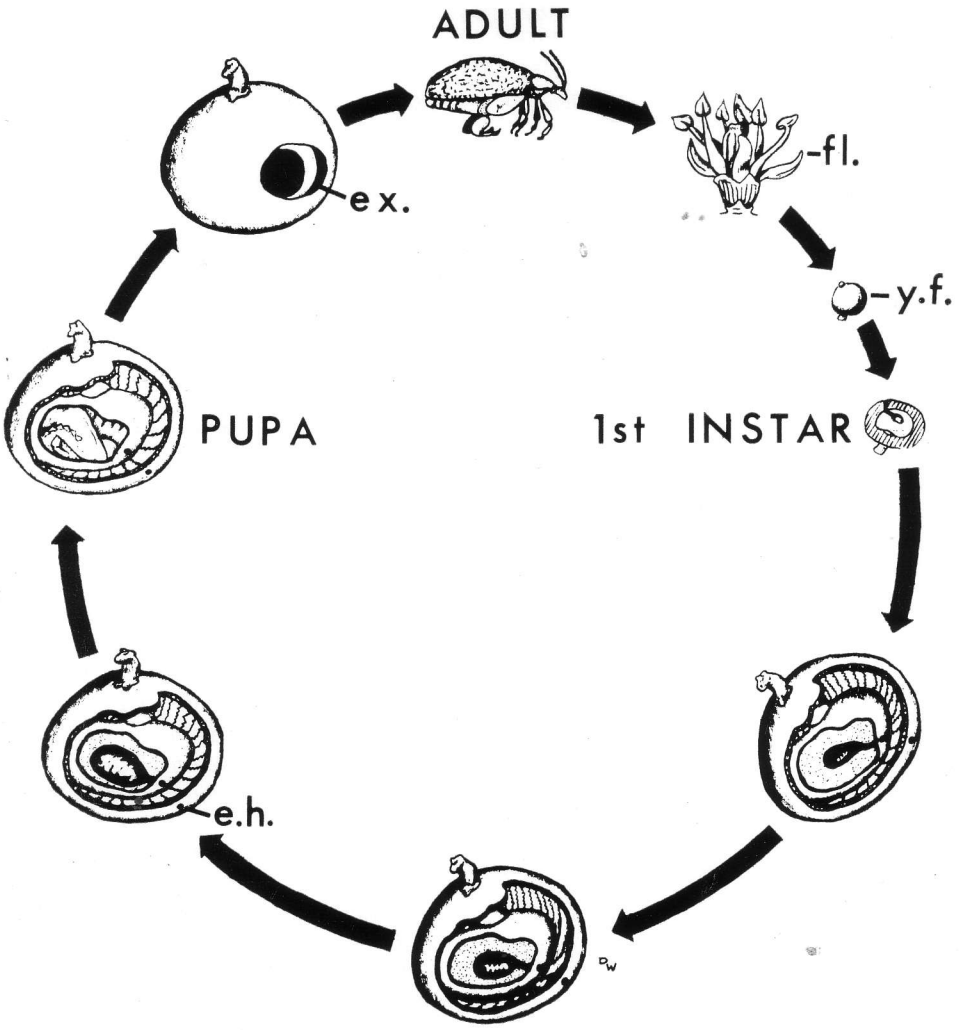
Of more interest was the discovery of *Caryobruchus gleditsiae* Linnaeus, a seed predator, present throughout the range of *S. palmetto*. My attention was first drawn to this insect in the fall of 1970 when seed lots from Smith Island were found to be about 50% infested with larvae.

The adult of the species was described and its range reported to be from Texas to North Carolina by Bridwell (1929). This range corresponds to the natural range of the genus *Sabal* in the United States. Paxson (1961) reported *C. gleditsiae* on *S. minor* (Jacquin) Persoon in Louisiana and Arkansas. First recorded reference to the beetle on *S. palmetto* was by Dury in 1881. Woodruff (1968) reports that the beetle breeds exclusively on palm seeds of several species but mentions nothing of adult feeding behavior.

To understand better the relationship between this insect and the palmetto seed, observations were begun in the summer of 1971 and continued through the summer of 1972.

Field studies revealed that adult beetles apparently take nectar during the flowering period of *S. palmetto* but no evidence of herbivory was seen. The most notable behavior of adults is their nocturnal activity. No adults were ever seen during the daylight hours. Their extreme negative response to light was typified by their evasive behavior in the presence of a flashlight beam during hours of darkness. This made observations of their total activities impossible. I was unable to observe them laying eggs on fruit but did catch them with heads down at the base of the nectiferous ovaries.

Rates of infestation on the 1971 seed crop were determined for all five seed-source populations (Table 3). Average infestation rates varied from 4.0% at Miami to 39.8% at Smith Island.



2. Life cycle of *Caryobruchus gleditsiae*, all views × 2.6: fl., flower of *Sabal palmetto*; y.f., young fruit; e.h., entrance hole; ex., exit hole.

The life cycle of this insect is incompletely understood but has a peculiar bimodal nature. There is a long-term univoltine generation (Fig. 2) which begins with egg laying on small immature fruits on the tree. The eggs are white, ellipsoid, and less than 1 mm. long. The first instar apparently hatches rapidly, tunnels its way into the seed, and establishes itself in the endosperm. At this point, development of the larva stops or at least slows down considerably. Whether this is a diapause or quiescence and what the trigger factor is are unknown, but it is an obligate phenomenon. The larva must stop growing because the immature fruit does not contain enough energy for the insect to complete development to adult stage. During late summer and fall, while the larva lies dormant,

the fruit and seed mature in size and the endosperm hardens. At this time, even though sufficient energy is stored up in the seed, cold weather apparently enforces continuance of the dormant state since the larva overwinters in the seed. Development resumes in spring followed by emergence of adults.

Timing of the development sequence in nature is unknown, but adults were observed emerging from mature fruits still on trees in early July at Smith Island. Emergence probably occurs earlier, especially in the southern portion of the range. This is supported by the fact that adults began emerging from infested fruits in the laboratory after about one month of storage at room temperature (22° C).

The second reproductive mode of this insect is multivoltine and occurs on mature, dispersed fruit. Egg laying is accomplished on fruit on the ground, and development of larvae is uninterrupted so long as climatic factors are favorable. This activity occurs primarily in late spring and summer on the fruit crop from previous years.

The utilization of the seed by the beetle is remarkably efficient. The larva converts the entire endosperm and embryo into larval tissue, then uses the seed coat as a pupal case. The emerging adult bursts the seed coat and cuts a nearly perfectly circular escape hatch in the epicarp of the fruit. Multiple egg laying is common on the dispersed fruit but never more than one adult matures in one seed. Ultimate size of the adult beetle is directly proportional to the size of the seed.

Adults reared on dispersed fruits could, theoretically, result in 100% predation, especially in the area immediately surrounding the parent tree (Janzen, 1972). In some locations such may well be the case. A survey of a plot 1.0 meter square at the Ft. George site in July 1972 revealed that of 610 dispersed fruits 561 or 92% were, or had been, infested with *C. gleditsiae*. This compares with only 4% infestation of predispersed fruit at the same location in December 1971.

Seed samples from Ft. George south showed lower predispersed infestation rates than those locations to the north (Table 3). The reason for this may be the presence of a tiny braconid wasp, *Heterospilus* Haliday (new species to be described by P. M. Marsh), which is parasitic on the larval stage of *C. gleditsiae* in predispersed fruits. This wasp was discovered emerging from stored seed and was found only in seeds from Ft. George south. No evidence of wasp attacks on larvae in dispersed fruits has been found, possibly because the ovipositor is incapable of penetrating the mature seed. Another parasitic wasp, *Eupelmus cyaniceps* Ashmead (Eupelmidae) has been found on *C. gleditsiae* in fruits of *S. minor* in Louisiana (Paxson, 1961).

Heterospilus n. sp. has characteristics of an efficient parasite: a sex ratio of 10 females to one male, and ability to rear as many as 30 young on a single beetle larva. Such a parasite could play a major role in limiting numbers of a host insect, as it apparently does on that portion of the population of *C. gleditsiae* which lays eggs on immature fruit.

A most perplexing question is how predispersed fruit escape with as little predation as they do when dispersed fruits are so heavily infested. Clearly, the interrelationship between *Caryobruchus gleditsiae*, the braconid wasp, and *Sabal palmetto* is complex and will require considerably more investigation to understand fully.

Escape of Seed

Sabal palmetto reveals distribution patterns in dry forest situations similar to those of many species in tropical

forests; i.e., widely and randomly scattered. Janzen's (1970) theory on distribution of rain forest species may apply to this case. Fruit falling on dry ground is subject to considerable predation by beetles. This is especially true near the tree where most fruit falls and insects are attracted in greater numbers. Any seed which is carried to areas away from seed-bearing trees would have a greater probability of escaping predation. The activities of small mammals or birds appears to accomplish this in *S. palmetto*. Seedlings in these remote areas would also be more likely to escape destructive insect activities associated with larger trees. Survival of one such seedling could then start the cycle over and further increase the chance for slow outward migration over land. This certainly seems to be borne out by the distribution patterns of *S. palmetto* which I observed in the maritime forests of Smith Island and at Ft. George.

On the other hand, seeds falling into water seem to escape predation by the beetles. This may explain the great density of trees commonly found along creek banks, on the shores of salt and fresh water marshes throughout the range, and in alluvial floodplains of many rivers in Florida. A key to the escape of these water-borne seeds may be in their frequent covering by sand and organic debris. I was able to observe this phenomenon at Ft. George where dispersed seeds were covered with sand and debris washed in by storm tides during late winter of 1971–1972. These seeds were uncovered in the survey of a second plot 1.0 meter square in July 1972. Of 753 seeds, 514 or about 68% had escaped by burial. Of the 188 exposed seeds, 173 or 98% had been attacked by *Caryobruchus gleditsiae*. In a similar fashion, Wilson and Janzen (1972) found that some fruits of *Scheelea rostrata* (Oersted) Burret, a Costa Rican palm, escaped predation by *Caryobruchus buscki* Bridwell when covered by forest floor litter.

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Second Meeting of the International Council on Lethal Yellowing

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This meeting was held concurrently with the fourth session of the F.A.O. Technical Working Party on Coconut Production, Protection, and Processing, in Kingston, Jamaica. The Technical Working Party ran from September 15th to 25th, and covered coconut introductions and breeding, agronomy and nutrition, physiology, management, extension work, pests, diseases, processing, and by-products. The period September 22nd to 24th was devoted entirely to lethal yellowing disease.

The technical papers (which it is hoped will be published in full in *Oleagineux*) showed the great progress made in knowledge of various aspects of the disease since the Lethal Yellowing Symposium held in Miami in September 1973 through the sponsorship of the Tourist Development Authority of Miami Beach (see *Principes* 17: 151–159. 1973).

The spread of the disease in new areas of Florida enabled a study to be made, showing that rate of spread depends upon the number of palms already affected. Electron microscope studies have built up evidence of the presence of mycoplasmalike bodies in spear leaves and inflorescence stalks of diseased palms, but without any such bodies being detected in healthy palms. These bodies have been found in diseased palms in Ghana but could not be detected in Togo palms. The layman should understand that the technique used in preparing the sample is a critical factor in detecting the presence of mycoplasmas.

The use of tetracycline antibiotic to give palms temporary protection has been a boon in Florida, and has been used in Jamaica and Togo to help to incriminate mycoplasmas. The search for the insect vector has had many man-years of work put into it, commencing in 1962, and was made easier by the discovery of mycoplasmas in 1971 as the search could then be confined to phloem-feeding insects. Since 1971, most common phloem feeders have been tested without success, and the search will now have to turn to uncommon insects.

The early stages of serological work have been successfully carried out, giving hope that the mycoplasmalike bodies associated with lethal yellowing might be distinguishable from those in other plant diseases and vectors, as they all look alike under the electron microscope.

Although the resistance of 'Malayan Dwarf' is proving to be very high in Jamaica, where several million dwarfs are successfully growing in the diseased area, there are doubts about the resistance in West Africa. Could there be another strain of the disease, or were the dwarfs of a different strain?

Each of the abstracts below deals with only one small facet of the lethal yellowing problem, but it is quite clear that much progress has been made. Dealing with this disease is more complicated

than simply formulating a method of control for an affected palm. A picture is now emerging where a home owner with one palm of, say, *Veitchia*, or a country with small farmers whose only crop—coconut—is threatened by death, can already call on drugs, insecticides, quarantine, or resistance for a solution of sorts. As information continues to accrue from research, the package of control measures will improve.

At the second I.C.L.Y. meeting it was obvious that a dedicated and productive body of researchers exists, and this is due to the financial and moral support which they receive from palm owners, coconut farmers, and government authorities.

Abstracts of Papers

Lethal yellowing in Florida. By C. P. Seymour and C. Poucher (Division of Plant Industry, Gainesville, Florida 32601, U.S.A.). Lethal yellowing was first reported in the United States in 1955 in Key West, Florida. At that time, Key West had the appearance of a beautiful tropical island with its streets, parks, and beaches lined with an estimated 20,000 coconut palms. By 1968, 75% or 15,000 of these palms had been destroyed by this disease. For several years, the disease was confined to Key West and Stock Island. In 1970, it was identified in coconut palms in Key Largo, 100 miles from Key West. In 1971, the disease was discovered on the mainland in the Coral Gables section of Miami and during May 1973 was detected in Broward County near Fort Lauderdale, 25 miles north of Miami. Later this same year, Palm Beach County at Boca Raton was found infested. By 1974, the disease reached Martin County in its northward spread along the Florida east coast and finally to Collier County on the west coast of Florida near Naples. Fifty-seven diseased trees were found in the Coral Gables outbreak in September 1971. By the spring of 1975 an estimated 200,000 coconut trees had been lost on the mainland to lethal yellowing. Florida is estimated to have a population of one and one-half million coconut palms. The heaviest losses have occurred around Miami, Florida, an area of dense population of palms. Coconut and other palms are of inestimable esthetic value to the State of Florida and are directly related to the economic importance of tourism. The effect of such losses on tourism would be significant but difficult to measure. The activities of the Division of Plant Industry and Florida Department of Agriculture and Consumer Services are described.

Comparative epidemiology of lethal yellowing. By R. E. McCoy (University of Florida Agricultural Research Center, Fort Lauderdale, Florida 33314, U.S.A.). The spread of any contagious disease is a dynamic process that begins slowly, affecting only a few individuals, then moves faster and faster as more individuals become diseased. The actual rate of spread of lethal yellowing (LY) was measured in the field in Florida and compared to the rate of spread of LY in Jamaica and to the kaïncopé and cadang-cadang diseases of West Africa and the Philippines. The rate of spread of any disease is based on the cumulative number of apparent infections in the population and can be described by Van der Planks equation—$dx/dt = rx_t\ (1-x_t)$—where the change in amount of disease, x, with time, t, is equal to a rate value, r, times the proportion of disease present at any time, x_t, times a factor $(1-x_t)$ to account for the fact that the population under study is finite. Data collected by the Florida Department of Agriculture during the first 1.5 yr of the Miami epidemic produced a rate value of $r = 0.21$/unit/mo when the logarithmic transform $\ln [x/(1-x)]$ was plotted

against time in months. The r values in groups of coconut palms in Miami were calculated over a 16-month period and were found to vary from 0.15 to 0.42/unit/mo. The highest values were recorded in those groups receiving the highest cultural maintenance practices. The lowest r values occurred adjacent to the ocean. Rate values calculated from Coconut Industry Board data for a coconut plantation in Jamaica were 0.31 and 0.28/unit/mo, calculated over a five-month period. These rate values, taken from within an affected plantation, are quite comparable to the rate of spread of LY in Florida. For a further point of comparison, the r value calculated from data in the literature for the kaïncopé disease was 0.25/unit/mo, whereas r calculated for cadang-cadang was 0.03/unit/mo in individual plantations in West Africa and the Philippines. The similarity of the rates of spread of LY and kaïncopé supports the possibility that these two diseases may be coidentical. However, cadang-cadang is sufficiently different in symptomology and rate of spread that a different pathogen-vector system is suggested.

Possible hosts of lethal yellowing. By D. L. Thomas (University of Florida Agricultural Research Center, Fort Lauderdale, Florida 33314, U.S.A.). Several members of various palm species have died in those areas of southern Florida which have experienced severe outbreaks of lethal yellowing on coconut palms (*Cocos nucifera* L.), while regions of Florida free of lethal yellowing have suffered no abnormal losses of the same palm species. Affected palms often exhibited premature fruit loss, necrosis of unopened inflorescences, frond discoloration, and/or water-streaking in young leaflets. Samples from unemerged frond bases of palms in various stages of decline were collected for electron-microscopic investigation. Mycoplasma-like bodies similar to those observed in coconut palms infected with lethal yellowing were observed in mature sieve elements from declining specimens of *Arikuryroba schizophylla* (Mart.) L. H. Bailey, *Borassus flabellifer* L., *Caryota mitis* Lour., *Chrysalidocarpus cabadae*, H. E. Moore, *Corypha elata* Roxb., *Dictyosperma album* (Bory) H. Wendl. & Drude ex Scheffer, *Mascarena verschaffeltii* (H. Wendl.) L. H. Bailey, *Phoenix canariensis* Hort. ex Chabaud, *Phoenix dactylifera* L., *Phoenix reclinata* Jacq., and *Trachycarpus fortunei* (Hook.) H. Wendl. The concentrations of mycoplasmalike bodies in the phloem of affected palms was often low but never lower than the concentrations within similar tissues of coconut palms infected with lethal yellowing. The geographic coincidence of the various palm declines with lethal yellowing, the similarity of symptoms between the palm declines and lethal yellowing, and the presence of mycoplasmalike bodies within the declining palms add support to the hypothesis that all of the above palm species are hosts of the lethal yellowing pathogen. However, final proof of the coidentity of the different palm declines must come from transmission studies.

Preliminary studies on the ultrastructure of phloem in coconut palms affected by "hartrot" in Surinam. By M. V. Parthasarathy (Division of Biological Sciences, Section of Genetics, Development & Physiology, Cornell University, Ithaca, New York 14853, U.S.A.). The "hartrot" disease of coconut palms in Surinam presents many of the external symptoms of lethal yellowing. However, the coidentity of lethal yellowing with "hartrot" has not been clearly established. Electronmicroscopic examination of phloem in the young leaves and inflorescences of four coconut

palms at different stages of the disease has revealed the presence of flagellated organisms in many mature sieve elements of all four. The flagellates are about 1.5μ–2.5μ in diameter and 12μ–18μ in length. On the basis of the size, structural characters, and the host, the organisms have been tentatively classified as protozoans belonging to the Order Kinetoplastida, Family Trypanosomatidae, Genus *Phytomonas* Donovan. Neither hyperplasia nor necrotic obliteration is apparent in the phloem affected by the disease. However, a more detailed study is needed to draw any conclusion regarding phloem degeneration. Phloem in young leaves and inflorescences of a healthy palm collected in the same area as the diseased palms has thus far not revealed any flagellate or any other microorganism in sieve elements. The absence of pathogens other than the flagellates in the earliest symptoms of the disease, and the correlated increase and spread of the flagellates in sieve tubes as the disease progresses, suggest that the flagellates may be the causative agents of the "hartrot." Thus the present study indicates that although there are similarities of diagnostic symptoms between lethal yellowing and the "hartrot," the causal agent of the two diseases may be quite different.

Hartrot disease in Surinam. By W. G. van Slobbe (Landbouwproefstation, P. O. Box 160, Paramaribo, Surinam). 'Hartrot' has been indicated as present in Surinam since 1906, sometimes causing the death of thousands of palms in the coconut district of Coronie. In recent years the number of cases has been estimated at about 2% of the palm population. In June 1975, 91% of all three colour varieties of 'Ceylonese Dwarf' (planted 1969), 59% of 'Surinam Dwarf' (planted 1971), and 26% of 'Malayan Dwarf' (planted December 1972) had died in one experimental field. In another field 22% of the 'Surinam Dwarf' (planted 1970) and 10% of 'Malayan Dwarf' (planted 1970) had died. In no other plantation have dwarfs been affected by the disease until now. Other names used for 'hartrot' in Surinam are unknown disease, lethal yellowing, bronze leafwilt and Coronie wilt. Symptoms: (1a) root tips and soft parts in the roots are blue; (1b) the leaflets on the top of the youngest five leaves may hang down somewhat; (2a) necrotic patches sometimes, but not always, appear at the top of the rachillae of the unopened inflorescences; (2b) the inner surface of the top of the spathe is brown-black; (2c) at the same time, yellowing or orange-yellowing starts in the oldest green leaves at the top and moves trunkwards. Sometimes the oldest leaves break down at the middle of the leaves but still remain hanging on the tree; (3a) blackening of the flowers and very young nuts occurs; (3b) the spear has a few little brown patches; (4a) oldest leaves hang along the trunk, all nuts fall down, and yellowing moves higher upward; (4b) the spear can be pulled out and smells offensive. Remarks: (1) on rather heavy clay soils, when the ground water level is rather high the whole year (between 60 and 30 cm below moving field), most of the palms seem to develop symptoms in the rainy season. On a sandy soil with an impenetrable layer at 50 or 60 cm deep, the disease seems to start at the end of the dry season; (2) palms are attacked in all growth stages, but mainly when they start bearing; (3) during the last year the 'Malayan Dwarf' has also been affected; (4) the disease from the beginning up to the final rot of the cabbage takes from one to three months; (5) there are some indications that there exists a correlation between the disease and/or badly drained soils and

bad management such as no weeding, no fertilising.

Progress towards the isolation and characterization of the lethal yellowing pathogen. By R. E. McCoy and R. Charudattan (University of Florida Agricultural Center, Fort Lauderdale, 33314; and Plant Pathology Department, Gainesville 32611, Florida, U.S.A.). Intensive efforts to culture an MLO from lethal-yellowing-diseased tissue from Florida have been made in Fort Lauderdale and by R. E. Davis in Beltsville, Maryland. Numerous media have been utilized, using as a base either Difco PPLO broth plus serum fraction or the spiroplasma media used for growth of the citrus stubborn and corn stunt disease agents. O_2 concentration, serum content, osmotic potential, and various media components have been varied but no organism has yet been cultivated. In the absence of pure cultures of the LY agent, isolation of the agent from exuded phloem sap is being attempted. Phloem sap from diseased and healthy coconut palms is being characterized serologically by injection into rabbits. Phloem exudates are filtered through 0.45μ filters, dialyzed to remove excess sucrose, and used as antigens. In gel diffusion tests, 2–3 common precipitin bands, probably due to host proteins, were formed between healthy coconut (HC) and lethal yellowing (LY) antigens (Ag) and antisera (As). One Ag was specific for the homologous LY reaction. This reaction occurred for Ag prepared from numerous diseased trees. Tests with absorbed As showed a further antigenic difference between LY and HC Ag's. when reacted against LY Ag, LY As reacts strongly, HC As shows only the common bands present in both the HC and LY reaction, HC Ag absorbed with HC As produced no band as the common component is eliminated, LY Ag absorbed with HC As produced no band as the common component is absorbed, LY Ag absorbed with LY As produced no bands; however, HC As absorbed with LY As produced only the LY specific band by eliminating the common, presumably host protein component. In addition, Ag prepared from declining *Veitchia* palms reacted strongly with LY As but only weakly with HC As indicating that the LY specific component present in LY Ag was also present in *Veitchia* Ag prepared in the same manner. Finally, reciprocal reactions of LY As with Ag's from PPLO broth, *Acholeplasma laidlawii*, and *Spiroplasma citri*; and LY Ag with As from *S. citri*, and *Mycoplasma gallisepticum*, showed no relationship to one another, indicating the specificity of these reactions. The nature of this antigenic difference has not been determined; however, if the LY specific As is a result of the causal agent of LY, a new tool of great value for studying LY will be available.

Effects of lethal yellowing on growth of coconut palms. By S. J. Eden-Green and A. J. Dabek[1] (O.D.M. Lethal Yellowing Team, Coconut Industry Board, P. O. Box 204, Kingston 10, Jamaica; and Botany Department, University of the West Indies, Mona, Kingston 7, Jamaica). Results of two experiments are described which indicate that growth changes occur before the appearance of lethal yellowing symptoms in palms developing the disease. In the first experiment ("Transfer Experiment"; Dabek, *Phytopathologische Zeitschrift*, in press), the extension of spear and young leaves of two–three-year-old 'Jamaica Tall' palms were recorded at approximately two-week intervals after palms had been exposed to natural LY infection for controlled periods up to

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three months. Similar measurements were recorded at approximately monthly intervals in a series of bearing palms about 14 years old growing in an area of active disease. Rates of extension of spear and, in the case of bearing palms, three to four youngest leaves as well, were approximately linear while the palms remained healthy, but usually declined rapidly in young palms before or at the onset of LY. In bearing palms, a much slower decline in growth rate was noted, commencing several weeks after symptoms appeared. Close comparison of growth rates of diseased palms in both experiments with those that remained healthy (controls) revealed that growth decline was often preceded by an increase in growth rate, as much as 40% above that of controls. Results of previous workers are compared and the possible significance of these findings is discussed.

Bole rots in pre-bearing coconut palms apparently affected by lethal yellowing disease. By S. J. Eden-Green (O.D.M. Lethal Yellowing Team, Coconut Industry Board, P. O. Box 204, Kingston 10, Jamaica). A high incidence of bole or basal stem rot has been found in pre-bearing palms showing early symptoms of lethal yellowing; this condition has apparently not been previously reported in association with this disease. Oldest tissues at the tip of the bole appear to be affected first, but rots extending over the whole root attachment area have been found in palms showing more advanced frond yellowing. Decayed tissues are dark brown or black, usually firm and water-soaked, with well-defined margins, and may extend more than 30 cm up the trunk. Bole rots appear to be quite distinct from the slimy heart or cabbage rots that develop above the growing point; direct connections between the two have been seen only in very small palms showing advanced symptoms. Although common in young palms, bole rots are not a consistent feature of LY and have not so far been found in bearing palms even in advanced stages of the disease. Characterisation of a variety of bacteria and fungi isolated from affected palms is in progress and supports the view that rots result from secondary invasion by soil microorganisms. The possibility that young palms are affected by a primary "bole rot disease," with symptoms outwardly similar to lethal yellowing, cannot be ruled out and pathogenicity tests are in progress.

Preliminary studies on sap transport in coconut. By J. A. Milburn, M. H. Zimmerman, and P. B. Tomlinson (Department of Botany, University of Glasgow, Glasgow G 12 8 QQ, Scotland; Harvard Forest, Petersham, Mass. 01366, U.S.A.; and Harvard Forest, etc.). It is generally agreed that lethal yellowing disease of coconut is transmitted, from some point of infection to the apical meristem which is killed, via the sieve tubes of the phloem within the vascular system. Yet we lack fundamental information concerning (a) the intricate vascular structure and (b) the mechanism of transport via sieve tubes, which is essential to understanding the mode of pathogen infection and transmission. It is also essential for efficient application of control measures such as injection of insecticides or antibiotics. This paper reports preliminary experiments on *Cocos* at the Jennings Estate in Miami, Florida, in October 1973 and May 1974. Diurnal cycles of xylem water potentials, measured in fronds using a pressure bomb, were found to vary from about –2 bar by night to –10 bar by day. Occasionally lower potentials were found, down to –14 bar, apparently caused by brief periods of sunshine. This evidence indicated the efficient regulation of water

supplies in response to slow changes in soil water potential over several days, but not to rapid changes within a few hours. Osmotic potentials of sieve tube exudates were deduced from hand refractometer readings on phloem sap collected by repeated slicing of immature inflorescences. Sieve-tube turgor pressures, measured in the same tissues with different types of manometers, were found to range up to at least 8 bar. Since osmotic potentials ranged from –10 to –22 bar our results are compatible with the view that sieve tube transport is driven by turgor pressure gradients which are the resultant of phloem-osmotic and xylem-water potentials. In *Cocos*, as in other plants, sieve-tube turgor pressures seemed to be maintained if the water potential changed slowly but not if it changed suddenly within a few hours. These results imply that infection, either artificial or natural, could be promoted by sudden water stress which might lower the turgor pressure of sieve-tube sap from about 8 bar towards atmospheric pressure (0 bar) or less. Indeed this may be necessary for infection. Injection of pathogens or drugs by syringe should be possible, especially if manipulation and reslicing are used to enhance the conductive capacity of the sieve tubes, and water stress is used to decrease their turgor pressures. These interpretations of our results could also explain the observation that shaded palms are much less likely to become infected than palms in full sunlight, furthermore why attempts to transmit the suspected pathogen under greenhouse or similar conditions may have failed.

Antibiotic treatment of lethal yellowing in Florida. By R. E. McCoy (University of Florida Agricultural Research Center, Fort Lauderdale, Florida 33314, U.S.A.). Oxytetracycline-HCl (OTC) has been approved by the United States Environmental Protection Agency as a control agent for lethal yellowing (LY) in Florida. Treatment of diseased palms prior to foliar yellowing has resulted in a reduction or cessation of symptom development for periods lasting from four to seven months. Doses as low as 100 mg can have a definite effect on LY, although doses of 1–3 g are recommended for the best ratio of response. Doses as high as 20 g OTC induced remissions lasting as long as one year. Such therapeutic treatments have induced a full remission (complete cessation of symptom development for four months or more) in 50% of all treated trees. Yellowing symptoms continue to progress in the remaining trees although most of these produce healthy new fronds and inflorescences for a period of time, and half of these may reach full remission with continued treatment. Retreatment at four-month intervals can keep diseased palms in a state of remission. Protective treatment of healthy palms with 1 to 3 g OTC has reduced the apparent rate of spread of LY by three to five times when repeated at four-month intervals. It is possible that threatened palms could be kept in production for four to five additional years with OTC treatment, sufficient to allow underplanted 'Malayan Dwarf' palms to come into bearing. All treatments were administered through trunk injection. Sprays or soil drenches had no effect. The persistence of injected OTC in foliage was approximately two months with a half life of two weeks. Each g of OTC injected produced a foliar residue of 1–3 μg/g (PPM). Very little OTC was translocated into trunk, fruit, or root tissues. Virtually no OTC residues are found in coconut milk (water) although 12% of the nuts from treated trees had detectable residues in meat. Meat residues decreased with time and were not detectable in nuts

harvested one month after treatment. Other declining palms responding to OTC treatment are *Pritchardia thurstonii*, *P. pacifica*, *Trachycarpus fortunei*, and *Arikuryroba schizophylla*.

Insecticidal treatments for lethal yellowing of Cocos nucifera and Veitchia merrillii. By J. A. Reinert (University of Florida Agricultural Research Center, Fort Lauderdale, Florida 33314, U.S.A.). Coconut palms, *Cocos nucifera*, and Christmas palms, *Veitchia merrillii*, are the two palms most severely attacked by the lethal yellowing disease. Both species have been tested with soil drench application of systemic insecticides. Only healthy-appearing trees in diseased areas were used in randomized tests and treatments were reapplied every six weeks. In a test involving *Cocos*, 50–60% of trees treated with dimethoate were still alive after 16 months of treatment, while only 20% of untreated trees remained healthy. In two tests with soil applications of carbofuran and dimethoate on *Veitchia*, 20–57% ($\bar{x} = 39.2\%$) of treated trees were alive after 18 months while only 18% of the untreated trees remained. In the first of these tests only 29% of treated and 14% of untreated trees remained after 30 months. In a third test with *Veitchia*, soil treatments of aldicarb were significantly better than other treatments after 18 months. Even though the vector(s) has not been positively identified, from these data it appears that palms can be protected from lethal yellowing by soil applications of systemic insecticides. These data add more evidence that a vector is involved in the transmission of lethal yellowing.

Transmission studies of suspected vectors of lethal yellowing of coconut palm. By J. H. Tsai (University of Florida Agricultural Research Center, Fort Lauderdale, Florida 33314. U.S.A.). An overall approach to transmission studies in lethal yellowing research includes several major divisions. These divisions include toxins which may be induced by the pathogen or invertebrates, dodder transmission of the pathogen, and pathogen-vector-host relationships. In the dodder transmission studies, attempts were made to transmit the lethal yellowing agent from the coconut palm to periwinkle by parasitic dodder. Constant attention was required to establish the dodder on palm leaflets. The pathogen-vector relationships were based on the premise that the pathogen is a mycoplasma or mycoplasma-virus complex. The emphasis of the transmission studies for the vectors was placed on homopteran insects since a few species of planthoppers and leafhoppers have been experimentally proven to feed on coconut palms and veitchia palms. *Haplaxius crudus* was found to be a predominant planthopper. The developmental study of this insect has been compared at 15°, 24°, and 30° C. Techniques have been devised to facilitate the biological study and to rear relatively pathogen-free *H. crudus* without the use of soil. Other plants such as lettuce, tomato, periwinkle, pepper, aster, marigold, and carrot were used as test plants in hopes of finding an alternative host for the pathogen. For the vector transmission studies, processed and unprocessed phloem sap was utilized along with direct feeding of the insects *H. crudus*, *Oncometopia nigricans*, *Macrosteles fascifrons*, and *Hortensia similis* on the diseased palms. The unprocessed sap was artifically fed and needle-injected into adults and nymphs of *H. crudus*, *O. nigricans*, and *M. fascifrons*. These insects were then allowed to feed on healthy palms. The processed sap was used for feeding and injection of *H. crudus* and *M. fascifrons* which were then allowed to feed on healthy palms, asters, and celery.

A review of the vector experiments in Jamaica from 1962 to 1971. By C. G. Johnson (O.D.M. Lethal Yellowing Team, Coconut Industry Board, P. O. Box 204, Kingston 10, Jamaica). Between 1962 and 1971 it is estimated that between 0.25 and 0.50 $\times 10^6$ insects, collected in the field, were tested, mainly as mixtures of species. Apart from one dubious positive result with whiteflies, there were definitely four and possibly seven infections in the 358 palms used to test leafhoppers and planthoppers. These results have hitherto been neglected, being regarded merely as accidental. An assessment of aerial densities of leafhoppers and planthoppers in the field, of the approximate number likely to "bombard" palms, and of natural infection rates, suggests that the so-called accidents in the past experiments may well have been experimental transmissions. The significance of this is discussed.

Recent attempts to find a vector associated with lethal yellowing of coconut (Cocos nucifera L.). By M. Schuiling (F.A.O.), C. G. Johnson, S. J. Eden-Green and H. Waters (O.D.M. Lethal Yellowing Team, Coconut Industry Board, P. O. Box 204, Kingston 10, Jamaica). Assuming that lethal yellowing of coconut (LY) is caused by a mycoplasmalike organism (MLO) the most likely vectors appeared to be phloem feeders, especially leafhopper *sensu lato*. Surveys of the fauna of coconuts showed that five species (all Fulgoridae) were common, were phloem feeders, and were able to survive on detached pinnae for several days. Two transmission hypotheses were tested. Firstly, that adults acquired MLOs from leaves or flowers of LY-diseased palms and transmitted to leaves. Adults of *Haplaxius crudus* Van Duzee, *Antillixius* sp. (Cixiidae) *Omolicna* spp. (*cubana* Myers and *proxima* Fennah ?) (Derbidae), *Colpoptera elevans* Walker (Issidae) and *Psenoflata brevis* Van Duzee (Flatidae) were collected in the field and allowed acquisition feeds on either excised leaves or inflorescences from LY-infected palms for 2–4 days in the laboratory, or for two weeks on the spear leaves of diseased palms in the field. All species were subsequently placed on the young leaves of test palms 2–4 years old. Survival after acquisition and on the test palms was poor and it was thought that most adults of these species would not survive for sufficient time to acquire, incubate MLOs, and transmit. Consequently, a second hypothesis was tested, that MLOs were acquired during the nymphal stages and transmitted by the adults. Nymphs of *C. elevans* and *P. brevis* were collected from sea grape (*Coccoloba uvifera*) and from young palms, allowed acquisition feeds on the spear leaves of LY-diseased palms in the field for 2–5 days, and transferred to the spear and first expanded leaves of test palms. Several thousand insects have been tested but none of the 122 test palms has become infected.

Feeding behaviour of a putative vector of lethal yellowing, Haplaxius crudus Van Duzee (Homoptera, Cixiidae). By H. Waters (O.D.M. Lethal Yellowing Team, Coconut Industry Board, P. O. Box 204, Kingston 10, Jamaica). For the studies summarized here the mycoplasmal etiology of lethal yellowing (LY) of coconuts has been assumed correct. Based on this assumption the vector of LY is probably a phloem-feeding homopteran. Of the putative vectors under investigation in Jamaica by the O.D.M. Lethal Yellowing Research Team, the feeding behaviour of *Haplaxius crudus* has been studied in detail both in the adult on leaves and the nymph on roots of *Cocos nucifera*. Adults and nymphs of

H. crudus leave stylet tracks within the host tissues after feeding: these tracks can be made visible by staining with Johansen's safranin or 2% aqueous acid fuschin. The sites at which adults have fed can be recognised after the insect has departed by surface-staining the leaf with lactophenol cotton blue which, after rinsing with distilled water, leaves the labial imprint clearly defined on the leaf surface. Nymphs do not leave well-defined labial imprints, probably because of differences in the labial apices between nymphs and adults. Adults were shown to feed on the phloem of leaves, and nymphs to feed on the phloem of roots. Adults showed a preference for the stomatal surface as a feeding site. A majority of the feeding probes were associated with the stomatal guard/subsidiary cells. Using the technique of labial imprinting, other adult putative vectors of LY were shown to be phloem feeders—viz. *Antillixius* sp. *Colpoptera elevans* Walker, *Omolicna cubana* Myers and *Psenoflata brevis* Van Duzee and *Proana hilaris*. This work was funded by the U. K. Ministry of Overseas Development under the Technical Assistance Scheme R2635.

"Root acquisition" transmission tests with Haplaxius crudus (Hom : Cixiidae) and Proarna hilaris (Hom : Cicadidae). By S. J. Eden-Green and M. Schuiling (O.D.M. Lethal Yellowing Team and F.A.O., Coconut Industry Board, Kingston, Jamaica). *H. crudus* and *P. hilaris* are potential vectors of lethal yellowing; larval stages of both are subterranean. Nymphs and adults can feed on phloem in coconut roots and fronds respectively. This work sought to test the hypothesis that nymphs acquire the pathogen from roots of diseased palms and transmit to the aerial parts of healthy palms on emergence as adults. All stages of *H. crudus* nymphs, either mass-reared on St. Augustine grass (*Stenotaphrum secundatum*) or collected in the field, were caged for up to five days on specially prepared fine secondary roots left attached to coconut palms showing early symptoms of LY. High mortalities prevented longer acquisition periods in the field, and surviving nymphs were reared to maturity on St. Augustine grass in the laboratory. Adults were transferred to large bags on test palms where some survived for over four weeks. In addition to controlled acquisition feeding, nymphs were collected from around LY-affected coconut palms, reared in a similar manner, and introduced directly to a second series of test palms. Results so far have been negative. Although nymphs of *P. hilaris* have been collected in the field, similar transmission tests were not practicable as the nymphs were difficult to handle and were thought to have a long life cycle. Tests were thus confined to direct introductions of adults collected from diseased areas; at one site where lethal yellowing was active, up to 40 adults per collector were caught regularly at dusk for over a year. Survivors were transferred to young opened fronds or spear leaves of test palms and feeding was frequently observed. Most insects died within one week, although survival of over two weeks was noted. A limited survey of the distribution of *P. hilaris* in coconut-growing areas, using white fluorescent light traps, was carried out in June–July, 1974. Results indicated that this cicada was quite widely distributed but only locally abundant. In view of the difficulties of transmission tests, further study of the biology and distribution of this species is desirable in order to assess its possible association with lethal yellowing.

Insects associated with the coconut palm in South Florida. By N. L.

Woodiel (University of Florida Agricultural Research Center, Fort Lauderdale, Florida 33314, U.S.A.). During a two-year study at the University of Florida Agricultural Research Center in Fort Lauderdale, several sampling methods were used to study the insects moving in and around palm groves. Rotary nets were operated at three heights around the groves to determine what was moving between the trees. Pole sticky traps and board sticky traps were used to sample what was within the trees. A light trap and D-Vac machine were used to gather supplemental data. Over 80 species of Homoptera (Auchenorrhyncha) were collected during the study with many being common to both Jamaica and South Florida. *Haplaxius crudus* was a species of major importance, and indications are that it reaches its peak numbers in the trees during June through September. It may be present around the trees in a stable population but congregates in the trees during this time. Work in Jamaica indicates that both the Florida and Jamaica populations tend to show this massing. Other work on the rate of development of the palm inflorescence and disease problems with young 'Malayan Dwarf' in Florida will also be reported.

A survey of insect populations on Cocos nucifera. By M. Schuiling (F.A.O., Coconut Industry Board, P. O. Box 204, Kingston 10, Jamaica). A survey of the insect fauna of young coconut palms was conducted at six sites on the east coast of Jamaica over two years. The object was to study the incidence of leafhoppers and planthoppers since these appeared to be the most likely groups to contain the vector of lethal yellowing (LY) disease of coconuts if it is caused by a mycoplasmalike organism. Evidence was also required on the distribution of Fulgoridae used in LY transmission tests and also to test whether any species fitted the Heinze and Schuiling (1973) hypothesis that palms in Jamaica are more likely to be infected with LY during February to August and should have corresponding vector incidence. LY had occurred at all the sites studied and appeared to be still active in the area. Forty palms were examined at each site every two weeks and all insects on all leaves recorded. Cicadoidea were rarely found on palms, but six Fulgoroidea were common. If the vector of LY is a common palm-feeding insect at sites where the disease is presumed to be active, then only *Omolicna* spp. (*cubana* Myers and *proxima* Fennah, ?) appeared to fulfil this criterion, being common at all sites, with population peaks during August and September. *Cedusa* sp. aff. *flavida* Van Duzee does not appear to be a candidate since its distribution both within and between sites was very uneven, and individual survival on *C. nucifera* was limited (adult survival is essential to allow acquisition, incubation, and transmission if palm-to-palm transmission by adults occurs). *Antillixius* sp., although having an uneven distribution, occurred at all sites, with population peaks during July to September. *Colpoptera elevans* Walker and *Psenoflata brevis* Van Duzee occurred at all sites, but had alternate hosts and no well-defined peak populations. *Haplaxius* spp. [*crudus* Van Duzee and *cocois* (*Fennah*)] had an uneven distribution and population peaks in September to November. The survey did not indicate when migration occurred, which is the important factor in identifying the vector of LY.

Insects and their incidence collected by suction trapping in coconut plantations. By J. A'Brook and M. Schuiling (O.D.M. Lethal Yellowing Team and F.A.O. Expert, Coconut In-

dustry Board, P. O. Box 204, Kingston 10, Jamaica). The vector of lethal yellowing disease (LY) of coconuts ought to have certain characteristics which should aid in its identification. Previous studies in Jamaica have indicated that LY must be transmitted by a mobile vector, capable of migration over a distance ("jump-spread") as well as to adjacent palms. The vector must be a phloem feeder since, if mycoplasmalike organisms (MLO) are the cause of the disease, they have only been found in phloem tissue of LY-infected palms. By analogy with other plant diseases with MLO etiology, the vector is most likely to be a leafhopper or planthopper, though other Hemiptera cannot be excluded. The vector, or a close relative, should occur in the northern Caribbean and Florida where LY is epidemic and probably also in West Africa. The spread of LY (i.e. through Jamaica and Florida) may be due to the dispersal of the vector though not necessarily so. The vector should feed on the 12 genera of palms known to be susceptible to LY. Heinze and Schuiling (1973) have suggested higher rates of LY infection during February to August in Jamaica, and the vector ought to show corresponding peaks of migratory activity. To study some of these characteristics, suction traps were operated at 1.5 and 7.0 m above ground in a coconut plantation in conjunction with a survey of insects on palms. In contrast to the survey on palms, more Cicadoidea than Fulgoroidea were found present in the air at both heights. The results suggest that if the vector of LY is a common palm feeder, *Haplaxius* spp. [*crudus* Van Duzee and *cocois* (Fennah)] are possible candidates, since they appear to have a migratory flight during the Heinze and Schuiling "susceptible" period. If the vector is a common palm feeder but rare migrant, *Omolicna* [*cubana* Myers and *proxima* Fennah, ?] appear to be candidates. Alternatively, since all the common palm-feeding insects have been tested with negative results, the vector may be a common insect but rare palm feeder, in which case the suction trapping suggests that *Dawnaria* sp., *Empoasca* spp., and Psylloidea might repay further study.

Studies on the kaïncopé disease of coconut palms in Togo. By K. G. Steiner (Service de la Protection des Vegetaux, Lome, Togo). The kaïncopé disease of coconut palms was observed in Togo the first time in 1932. By 1964 the disease had destroyed approximately 50% of the coconut plantations in the coastal region. Since 1974 the disease has disappeared completely from the coast and is now spreading further inland. 'Malayan Dwarfs' planted in 1963 do not produce satisfactorily, probably due to little rainfall and poor soils. Hybrids of 'Malayan Green Dwarfs' and local palms are more promising. The symptoms of the kaïncopé disease are similar to those of lethal yellowing in the Caribbean, but up to now no mycoplasmalike organisms have been identified. From July 1974 to May 1975, 52 palms were treated with Chlortetracycline-HCl and Tetracycline-HCl. Amounts of 100 mg, 2 g, 3 g and 4 g/l were injected by gravity. The injection of 100 mg/l gave response only with one of eight palm trees. But 41 to 44 palm trees treated with amounts of 2 g and 4 g/l tetracycline gave a distinct response. The development of the disease was slowed considerably. In 16 of 21 palm trees treated in an advanced stage of the disease a remission of symptoms in the form of new growth was observed. The palms produced healthy inflorescences again. Yellowing was only observed in 15 of 37 palms. The results

support the hypothesis that the kaïncopé disease is identical with lethal yellowing in the Caribbean and has a mycoplasma-like etiology.

Results of a recent survey of Cape St. Paul wilt of coconut in West Africa. By C. G. Johnson and H. C. Harries (O.D.M. Lethal Yellowing Team, Jamaica; and Coconut Industry Board, P. O. Box 204, Kingston 10, Jamaica). The results of a recent visit to Ghana and Togo are described briefly. There are great similarities between Cape St. Paul wilt in Ghana, maladie de kaïncopé in Togo and Dahomey, kribi disease in Cameroon, and lethal yellowing disease in the Caribbean area. A relatively new outbreak of Cape St. Paul wilt at Cape Three Points in Ghana now threatens the extensive coconut areas in western Ghana and in the Ivory Coast. The situation is more serious because both the 'Malayan Dwarf', which is planted as a resistant variety in the Caribbean area, and the 'Cameroon Dwarf', which withstands the disease in Cameroon, appeared to succumb to the disease at one trial at Dzelukope in Ghana. It is our considered opinion that there is a widespread intercontinental epidemic of great destructive power, and probably of similar etiology, among those varieties of coconut that are common to both sides of the Atlantic Ocean, namely the 'West African Tall' and the 'Jamaica Tall', as distinct from those varieties in South East Asia and the Pacific.

International Symposium on Coconut Research and Development

The Indian Society for Plantation Crops has organized an international symposium on coconut research and development to mark the diamond jubilee year of coconut research in India. The symposium is to be held at the Central Plantation Crops Research Institute, Kasaragod, Kerala State, India, 28–30 December 1976. It will include six sessions on genetics and physiology, agronomy and soil sciences, biochemistry and technology, pests and diseases, fundamental investigations, and diseases of unknown etiology, as well as special discussions on development programs in various countries. Persons wishing to attend the symposium should contact I. K. Satyabalan, Convener, Organising Committee, ISOCRAD, Central Plantation Crops Research Institute, Kasaragod–670 124, Kerala State, India. Persons wishing to present papers should write N. M. Nayar, Chairman, Programme Committee, ISOCRAD, CPCRI Regional Station, Vittal–574 243, Karnataka State, India.

CLASSIFIED

WANTED TO BUY: New or used books and publications on palms and their culture. James Benzie, 1597 N. Santiago Blvd., Orange, California 92667.

FOR SALE. Field grown specimens of *Acoelorrhaphe wrightii*, *Phoenix reclinata*, *P. rupicola*, *Rhapidophyllum hystrix*. $25.00–$75.00. W. L. Bidlingmayer, 553 SE 17th St., Vero Beach, Fla. 32960.

PLEASE HELP. Where can I find a live specimen of CALAMUS in the United States? In California? I'd like to buy seeds or seedlings. What's available in the rattans? Jim Widess, 2408 McGee, Berkeley, Ca. 94703.

PALM BRIEFS

Palm Longevity

How long a cultivated palm will live is an intriguing question, but unfortunately one that seldom can be answered because of the absence of accurate records of the planting and natural death or destruction of individual palms. Several accounts of very old palms have been published in PRINCIPES. The Editor's Corner (2: 40, 1958) recounts the felling of a *Phoenix* sp. in San Diego that was 188 years old. A note by Morley (19: 76, 1975) documents a *Trachycarpus fortunei* growing at the National Botanic Gardens at Glasnevin, Dublin, which is more than one hundred years of age. According to Russell (6: 60, 1962), Kew Gardens may have two palms over a century old, a *Jubaea chilensis* and a *Trachycarpus fortunei.*

On a recent visit to the Jardim Botânico in Rio de Janeiro, I learned of another example of extreme palm longevity. When the garden was founded in 1809, a ceremony took place which included the planting of a royal palm (*Roystonea oleracea*) by the Portuguese King Dom João VI, and the placement of a marble plaque to mark the event. The "palma mater," as the palm was known, became the symbol of the garden and other ceremonial plantings of the same species took place in the same general area of the garden, always utilizing plants grown from seed from the original palm. The "palma mater" is shown in Fig. 1. Unfortunately the exact date of the photograph is not known. Royal palms were also used for the magnificent promenades of the Jardim Botânico (See Hodge, *Principes* 4: 17–20, 1960).

In late 1972 the "palma mater" was struck by lightning and, despite an heroic effort by the botanists at the garden to save the tree, it died at 163 years of age. When the tree was felled, measurements showed that it had reached a height of 38.7 m. (127 ft.), and at the base had a diameter of .90 m. (3 ft.) and a circumference of 2.83 m. (9.3 ft.). The same measurements taken at the midpoint of the trunk were .46 m. (1.5 ft.) and 1.45 m. (4.8 ft.), and at a point just below the crown .35 m. (1.2 ft.) and 1.10 m. (3.6 ft.).

The base of the trunk was treated with preservatives and today stands floor-to-ceiling in the entrance hall of the administration building of the garden. Included in the display is a description of the palm, and the reassembled marble plaque which had been shattered by the lightning strike that killed the tree.

To replace the dead palm, a new planting was made on the same site in 1973 with the transplanting of a six-year-old plant which had been derived from seed of the "palma mater." Another ceremony was held and a new plaque, this one of metal, placed at the location. The new palm is referred to as the "palma filia."

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1. *Roystonea oleracea* planted in 1809 at the Jardim Botânico, Rio de Janeiro. Photograph courtesy of Carlos T. Rizzini.



Palm Tree Place Names in Southern California

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Trees and other forms of native vegetation have provided innumerable place names in all parts of the world. Settlements, streams, springs, mountain ranges, canyons, and other features often have names derived from the vegetation of the immediate area. Such names are given official status when recorded as part of surveying and mapping operations. In some cases subsequent urbanization or agricultural activities may destroy the vegetation which gave the particular place its name. In such instances, place names can provide historical information on the former distribution of certain types of plants.

In southern California, palms are widely cultivated ornamental plants, and many residents and visitors alike assume that palms must be an important component of the native vegetation. However, only the California fan palm (*Washingtonia filifera*) is native to California, and its natural range is restricted to the area of the Colorado Desert which lies in the arid southeastern portion of the state to the west of the Colorado River.

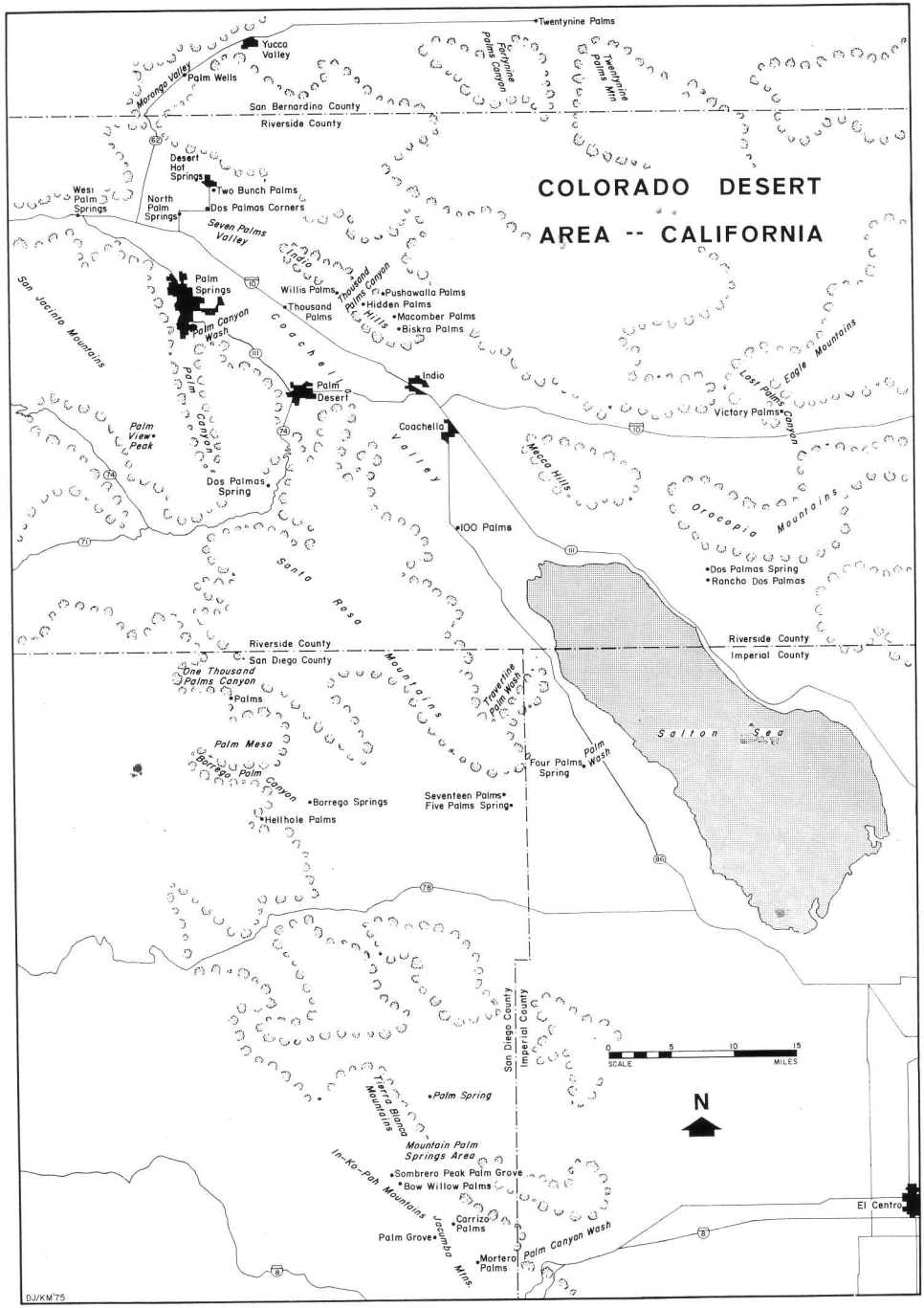
The purpose of this study is to examine place names which contain the word "palm" in southern California, here delimited as the portion of the state below 35 degrees North Latitude, and to determine whether or not they owe their existence to the occurrence of native palms. Place names were collected from the U.S. Geological Survey topographic maps of the scale 1:62,500, and from the larger scale 1:24,000 maps where they have been published. Names of streets, highways, schools, parks, canals, and other such cultural features were excluded from consideration.

Information on the origin of place names was obtained largely from Gudde's *California Place Names* (1969), books on the desert areas of southern California by Jones (1911), Chase (1919), and Henderson (1961), an article on the California fan palm by Smith (1958), U.S. Geological Survey Water Supply Papers by Mendenhall (1909) and Brown (1920), and numerous articles in *Desert Magazine*, published in Palm Desert, California.

The place names collected were divided into two groups. Those found in the Colorado Desert area are shown on the map in Figure 1 and listed on Table 1. In those instances where similar place names are located in the same area, only the most important is included on the map, but all names appearing on topographic maps are listed in Table 1.

The second group of place names includes those found elsewhere in southern California. They lie beyond the limits of Figure 1, but are listed in Table 2.

Riverside County has 26 palm place names which appear on topographic maps. Best-known is the City of Palm Springs, which is located east of the San Jacinto Mountains at a site of hot mineral springs and native palms, and whose official name dates back to 1890 when a post office was established there.



1. Map of Colorado Desert Area, California.

Table 1. Palm tree place names in the Colorado Desert area

Place name	Location	Grid reference*
	Riverside County	
Biskra Palms	Indio Hills	T.4S., R.7E.
Dos Palmas Corners	S. of Desert Hot Springs	T.3S., R.5E.
Dos Palmas Spring	E. of Palm Canyon	T.6S., R.5E.
Dos Palmas Spring	S. of Orocopia Mts.	T.7S., R.11E.
Hidden Palms	Indio Hills	T.4S., R.6E.
Lost Palms Canyon	Eagle Mts.	T.5S., R.12E.
Lost Palms Oasis	Lost Palms Canyon	T.5S., R.12E.
Macomber Palms	Indio Hills	T.4S., R.7E.
North Palm Springs	N. of Palm Springs	T.3S., R.4E.
100 Palms	S. of Coachella	T.7S., R.8E.
Palm Canyon	S. of Palm Springs	T.4,5,6,7S., R.4E.
Palm Canyon Wash	S. of Palm Springs	T.4S., R.4,5E.
Palm Desert	W. of Indio	T.5S., R.6E.
Palm Springs	E. of San Jacinto Mts.	T.4S., R.4E.
Palm View Peak	San Jacinto Mts.	T.6S., R.4E.
Pushawalla Palms	Indio Hills	T.4S., R.7E.
Rancho Dos Palmas	S. of Orocopia Mts.	T.8S., R.11E.
Seven Palms Ranch	Seven Palms Valley	T.3S., R.5E.
Seven Palms Valley	N. of Palm Springs	T.3S., R.5E.
Thousand Palms	E. of Palm Springs	T.4S., R.6E.
Thousand Palms Canyon	Indio Hills	T.4S., R.6E.
Thousand Palms Oasis	Thousand Palms Canyon	T.4S., R.6E.
Two Bunch Palms	S. of Desert Hot Springs	T.2S., R.5E.
Victory Palms	Lost Palms Canyon	T.5S., R.12E.
West Palm Springs	NW. of Palm Springs	T.3S., R.3E.
Willis Palms	Indio Hills	T.4S., R.6E.
	San Diego County	
Borrego Palm Canyon	W. of Borrego Springs	T.10S., R.5E.
Bow Willow Palms	In-Ko-Pah Mts.	T.15S., R.7E.
Carrizo Palms	Jacumba Mts.	T.16S., R.8E.
Five Palms Spring	E. of Borrego Springs	T.11S., R.8E.
Hellhole Palms	W. of Borrego Springs	T.11S., R.5E.
Mortero Palms	E. of Jacumba Mts.	T.17S., R.8E.
Mountain Palm Springs Area	Tierra Blanca Mts.	T.15S., R.7E.
One Thousand Palms Canyon	NW of Borrego Springs	T.9S., R.4,5E.
Palm	Mountain Palm Springs Area	T.15S., R.7E.
Palm Grove	Jacumba Mts.	T.16S., R.7E.
Palm Grove Bowl	Mountain Palm Springs Area	T.15S., R.7E.
Palm Mesa	NW. of Borrego Springs	T.10S., R.5E.
Palm Spring	E. of Tierra Blanca Mts.	T.14S., R.7E.
Palms	NW. of Borrego Springs	T.9S., R.5E.
Seventeen Palms	E. of Borrego Springs	T.10S., R.8E.

Table 1 (*continued*)

Place name	Location	Grid reference*
Sombrero Peak Palm Grove	In-Ko-Pah Mts.	T.15S., R.7E.
Travertine Palms	Travertine Palms Wash	T.9S., R.8,9E.
Travertine Palms Wash	Santa Rosa Mts.	T.9S., R.8E.
	San Bernardino County	
Fortynine Palms Canyon	SW. of Twentynine Palms	T.1S., R.8E.
Fortynine Palms Oasis	Fortynine Palms Canyon	T.1S., R.8E.
Palm Wells	Morongo Valley	T.1S., R.4E.
Twentynine Palms	NE. of Palm Springs	T.1N., R.9E.
Twentynine Palms Mountain	SE. of Twentynine Palms	T.1S., R.10E.
	Imperial County	
Four Palms Spring	Palm Wash	T.10S., R.9E.
Palm Canyon Wash	E. of Jacumba Mts.	T.16S., R.8,9E.
Palm Wash	W. of Salton Sea	T.10S., R.9,10E.

* San Bernardino Base Line and Principal Meridian

The City of Thousand Palms, east of Palm Springs, also owes its name to a sizeable grove of native California fan palms. The settlements of Palm Desert, North Palm Springs, and West Palm Springs to the southeast, north and northwest, respectively, are of post World War II origin and reflect the urbanization of the desert and the choice of attractive names for real estate development rather than the occurrence of native palms in those locations. A small settlement located on the highway south of Coachella is 100 Palms, which was named for the date palms cultivated in that area. The Coachella Valley is the predominant date-growing area of the United States, but there is only this single place name in the valley related to that activity. The reason, of course, is that date cultivation began early in the present century, well after the naming of natural features and the establishment of many of the settlements.

Of the natural features in Riverside County bearing palm place names, most prominent is Palm Canyon, directly south of the City of Palm Springs. The stand of native palms in that canyon is said to be the largest in California, con-

Table 2. Palm tree place names outside the Colorado Desert area

Place name	Location	Grid reference*
Date City	Imperial County	T.16S., R.16E.
La Palma	Orange County	T.4S., R.11W.
Palm City	City of San Diego	T.18S., R.2W.
Palmdale	Los Angeles County	T.6N., R.12W.
Palms	City of Los Angeles	T.2S., R.15W.

* San Bernardino Base Line and Principal Meridian

sisting of over 3,000 trees strung along fifteen miles of canyon in individual groves. The canyon is part of the Agua Caliente Indian Reservation and the palms are protected. Visitors may pay a fee to hike and picnic in the canyon. Extending eastward from the entrance of Palm Canyon is Palm Canyon Wash.

Directly west of Palm Canyon in the San Jacinto Mountains is 7,000-foot-high Palm View Park. Located about four miles from Palm Canyon, it should be possible to see the palms from the peak and that probably accounts for its name. Just east of the upper portion of Palm Canyon is a watering place called Dos Palmas Spring.

The Indio Hills east of Palm Springs have six locations named for native palms. Most noteworthy is Thousand Palms Canyon, within which is located Thousand Palms Oasis. To the west of the canyon is a small group of palms known as Willis Palms; to the east are similar places called Hidden Palms, Pushawalla Palms, Macomber Palms, and Biskra Palms.

North of Palm Springs are four locations with authentic palm place names: Seven Palms Valley, with Seven Palms Ranch within it; Two Bunch Palms, just south of Desert Hot Springs, and Desert Hot Springs.

Riverside County has a second Dos Palmas Spring, south of the Orocopia Mountains, which was once an important watering place on the old road between San Bernardino, California, and Yuma, Arizona. Immediately south of the spring is Rancho Dos Palmas.

Lost Palms Canyon, a fairly isolated group of native palms, is located in the Eagle Mountains. Within the canyon can be found Lost Palms Oasis and Victory Palms. Lost Palms Canyon lies within Joshua Tree National Monument and therefore the trees are protected.

Within Riverside County there exist some historical palm place names not included on topographic maps. The valley area around Palm Springs, for example, was once referred to as Palm Valley. In the late Nineteenth Century, a settlement named Palmdale was laid out a few miles southeast of Palm Springs, but an inadequate water supply forced the abandonment of the site. In the Indio Hills, Curtis Palms is reportedly located near Biskra Palms, but does not appear on topographic maps, nor does Burnt Palms Spring in the Mecca Hills, nor Lone Palm at the entrance of Andreas Canyon, off Palm Canyon.

San Diego County topographic maps contain eighteen palm place names, all within Anza-Borrego Desert State Park. All the names refer to landscape features and appear related to native California fan palms.

Borrego Palm Canyon, west of the settlement of Borrego Springs, is the best-known of the county, and near its mouth is the main camping area in Anza-Borrego Desert State Park. North of Borrego Palm Canyon is One Thousand Palms Canyon, a name found on the 1939 topographic map of the area, but changed to Salvador Canyon on the later edition. The name change may have been effected to avoid confusion with the canyon of nearly the same name in Riverside County.

Other place names in San Diego County are Palm Mesa, north of Borrego Palm Canyon, and, farther north, a location simply called Palms. Hellhole Palms is located in the next canyon south of Borrego Palm Canyon. In the extreme northeastern corner of the county is Travertine Palms Wash wherein lies Travertine Palms. To the south of that location are two small groups of palms which bear the names Seventeen Palms and Five Palms Spring.

Southeastern San Diego County has nine places named for palms. Palm Spring, located east of the Tierra Blanca Mountains, figures in the history of California as a watering station on the Butterfield stage line. Mountain Palm Springs Area in the Tierra Blanca Mountains is made up of seven palm groves; only two, however, have names containing the word "palm"; Palm Bowl Grove and Palm.

The In-Ko-Pah Mountains have locations called Sombrero Peak Palm Grove and Bow Willow Palms; the Jacumba Mountains, farther south, have three named palm groves—Carrizo Palms, Palm Grove, and Mortero Palms.

A historical place name in San Diego County, not included on the topographic maps, is Una Palma, one mile west of Five Palms Spring.

San Bernardino County has only five palm-related place names. The City of Twentynine Palms takes its name from the northernmost native palm group in California, and the same name is applied to the mountain southeast of the city. In the Morongo Valley is the settlement of Palm Wells, a post World War II desert development whose name is not related to a natural occurrence of palms. A few miles southwest of the City of Twentynine Palms are Fortynine Palm Canyon and Fortynine Palms Oasis which were named for native palms. This canyon is also protected since it lies within Joshua Tree National Monument.

Imperial County topographic maps contain but three native palm place names. In the northwestern part of the county, Palm Wash drains eastward toward the Salton Sea. Four Palms Spring is located within the wash. To the south is the similarly named Palm Canyon Wash which extends eastward from the Jacumba Mountains and is partially in San Diego County.

In general throughout the Colorado Desert area, other place names associated with native palms have been used but remain a part of desert lore and are not of sufficient stature to be included on topographic maps.

The place names listed in Table 2 are clearly not related to native California palms. The small settlement of Date City, located about five miles southeast of Holtville, was no doubt named for the date cultivation carried on to a limited degree in Imperial County.

To the northwest of the Colorado Desert, in the Mojave Desert, is the City of Palmdale. The place name, although chosen to reflect vegetation, was incorrect, for the German settlers of the 1880s who founded the settlement mistook the native Joshua trees of the area for palms.

Along the coast of southern California are three palm place names which derive from cultivated palms. Palms, located a few miles south of the University of California, Los Angeles campus, is a neighborhood name within the City of Los Angeles; La Palma, a small Orange County city situated twenty miles southeast of downtown Los Angeles; and Palm City, a neighborhood designation in the southern part of the City of San Diego.

In conclusion, the study of vegetation-related place names is an interesting aspect of both plant geography and botanical history. As shown in this paper, place names can, in certain instances, contribute useful information toward the determination of natural vegetation distribution, especially in areas where vegetation maps have not been compiled.

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NEWS OF THE SOCIETY

Ralph Velez has sent the following about the first 1976 meeting of the Southern California Chapter which was held at Dr. Mardy Darian's place and was very successful. It is always a treat to survey the many rare and unusual palms in the Darian collection. There was no auction but many palms were purchased from Darian and others. Pauline Sullivan brought 30 *Syagrus weddelliana* and sold them at cost to her. In the best future interest of the local chapter, it is felt that if a member sells plants for personal gain at a meeting the Chapter should receive 20% of the sale, especially as these private sales may have an adverse effect on our auctions, which are the main source of our Chapter funds. Four Northern California members attended the meeting and said they now have carte blanche to plant palms anywhere in the San Francisco Golden Gate Park. Their main obstacle is the lack of palms and money. We wish them every success. In our own area we have finally been given the green light to start a palm garden in the Orange County Mile Square Regional Park in Fountain Valley. The proximity of the park to the coast allows for a wide range of the more tender palms. Hopefully, the thousands of people using the park will learn a little more about palms and the role they could play in landscaping. Plans for developing a committee to handle the landscaping of public parks will be discussed at the next meeting. We regret to inform our members of the sudden death on December 17, 1975 of John Brunton. It was mostly due to his efforts that The Palm Society was able to participate in the Los Angeles County Fair, a most successful exhibit during which many new members joined the society. Some of our members may not know that Joe Sullivan, who, with his wife Pauleen, was on a trip to the far East last spring, died unexpectedly in Malaysia. Both these men who were very active members will be sorely missed by the society.

* * *

On May 25, 1975, all Florida members were invited to see the magnificent and large palm collection of Bill Bidlingmayer just south of Vero Beach. This collection is already mature though Bill keeps adding new plants. His wife Moffie collects bromeliads, beds of which add greatly to the landscaping. Bill has promised us an article about his place to which we look forward since he has an outstanding collection in an unusual setting. After a noon picnic lunch and a short business meeting, the group moved on to the fascinating property of Joe Michael at Wabasso, a few miles north of Vero Beach, along the Indian River. The effect of the plantings and buildings is of a tropical island since it is really surrounded by water and swamps. An area that had been filled with mulch showed how differently palms grow when they have good soil and moisture as against another group growing on poor soil nearby. Joe regaled the group with historical tales about the property and all

felt the day well spent seeing sights not usually available to a tourist, and being impressed with what Palm Society members have achieved.

* * *

On January 17, 1976 the Miami area members had the good fortune to see the many fascinating slides taken by Mel and Phyllis Sneed on their early fall trip to the Pacific Islands, Malaysia and Thailand. They also had pictures of some of the society members in that part of the world which now makes those members seem more than just a name in the roster.

Paul Drummond informed the group that the *Latania* has just been added to the list of the palms known to be infected and dying of the dread lethal yellowing disease. This now brings the total number to sixteen names, and there is good indication that *Arenga* sp. will be added shortly. The complete list is as follows at this time, February 1, 1976: *Arikuryroba* sp., *Borassus flabellifer*, *Caryota mitis*, *Chrysalidocarpus cabadae*, *Cocos nucifera*, *Corypha* sp., *Dictysperma album*, *Latania* sp., *Mascarena verschaffeltii*, *Phoenix canariensis*, *P. dactylifera*, *P. reclinata*, *Pritchardia pacifica*, *P. Thurstonii*, *Trachycarpus fortunei*, *Veitchia merrilli*.

* * *

Our member Jane Robinson from Hilo, Hawaii writes: I would like to share with you a program that The Palm Society in Hilo recently had that was delicious, delightful, and different and the same program can be duplicated by any other group. We featured *Phoenix dactylifera* in a program of slides and date-tasting.

Shields Date Gardens (80-225 Highway 111, Indio, CA 92201) has a set of slides and tape which tell about the date palms, the raising of dates, and many interesting facts. They use these slides in their showrooms to sell dates so there is some "selling" involved but they are still very interesting. To us in Hilo, this information was all new. The program takes about half an hour. Slides and tape are free but we paid the postage.

We bought from Shields a pound of each of their four gourmet dates: Nedjool, Quality (Deglet Noor), Brunette, and Blonde. A pound has about 25 dates in it. In addition, we bought the 3-lb. box of bread dates. Also we bought a pound of dates from the grocery store. This assortment gave us six very distinct dates to examine and taste and compare. The cost was just over $12.

Shields also sells a pamphlet with additional information for 75¢ and in addition there is the Agricultural Information Bulletin No. 207 entitled Growing Dates in the United States, which is very interesting.

* * *

Over the years one of the most difficult questions to answer has been a request for sources of palms. This usually is asked by new members especially those in northern areas. If seeds are wanted our Seed Bank is the obvious answer, but plants are another matter since we know of no nursery offering a wide variety of palms, properly identified, who will ship. Many nurseries from time to time may have certain palms in stock, but the society cannot handle such a list as it would need constant revision. Hence we suggest that the potential buyer contact other members in his vicinity to find how they acquire plants and additionally, write those who live farther away. Often members will have grown more seedlings than they themselves need or want and are happy to trade or sell. From time to time notices appear in various publications offering palms for sale; it is wise to check carefully into the skill, knowledge, and reputation of a plant seller with whom one plans to deal. As we

know, it is often impossible to identify the juvenile form of a palm so one must rely on the integrity of the seller. We urge all members to tread with caution, buy from a reputable dealer, or be willing to take the consequences.

TEDDIE BUHLER

WHAT'S IN A NAME?

Alfonsia (al fón see a), now considered a synonym of *Elaeis*, was named in honor of Alfonso II (1533–1597) of the House of Este. Alfonso was the fifth and last Duke of Ferrara and patron of Torquato Tasso, greatest Italian poet of the late Renaissance.

Ancistrophyllum (an síss tro fíll um) combines the Latinized *ancistro-*, from the Greek *ankistron* (grapplehook, fishhook), with a Latinization of the Greek word *phyllon* (leaf), because of the hooklike terminal pinnae which, like those of *Desmoncus*, enable individuals of this African genus of rattans to climb.

Deckenia (dek én ee a) was named after Baron Karl Klaus von der Decken (1833–1865), an explorer of Africa. He and a geologist were the first Europeans to climb Mt. Kilimanjaro to its glacier. He was murdered while attempting to navigate the Juba River.

Dictyocaryum (dik tee o ká ree um) was taken from the Greek *diktyon* (a net) and *karyon* (nut, kernel) because of the reticulate branching of the raphe on the seed.

Didymosperma (did ee mo spér ma) was characterized by two seeds in the fruit, hence the generic name meaning twin-seeded from the Greek words *didymos* (double, twin) and *sperma* (seed).

Eremospatha (eh reh mo spáy tha), according to Mann and Wendland, was taken from the Greek words *eremos* (destitute of) and *spathe* (spathe) because no bracts or spathes were evident on the inflorescence.

Oncocalamus (on ko cál a mus) combines two Greek words, *onkos* (a hook) and *kalamos* (reed, cane), but was not further explained by its authors.

Podococcus (po do kók kus) has a stalked fruit and this characteristic is suggested by the name which combines the Greek word for foot (*pous*, *podos*) and a Latinized form of *kokkos* (grain, seed, berry).

Sclerosperma (scleh ro spér ma) was so named by Mann and Wendland because of the very hard endosperm in the seed. The name combines *sclero-*, from the Greek *skleros* (hard), and *sperma* (seed).

H. E. MOORE, JR.

Biennial Meeting June 19–22

Don't forget the biennial meeting which will be held at the Florida Institute of Technology, Melbourne, Florida, June 19–22. The program is as follows:

Saturday, June 19

Visits to home of Dr. U. A. Young in Tampa, Cypress Gardens, and arrival in Melbourne.

Sunday, June 20

Palm Society board meeting at 10:00 a.m., biennial meeting at 1:30 p.m., banquet at 7 p.m.

Monday, June 21

Side trips to 1) Cape Kennedy or 2) Disney World or 3) gardens in Vero Beach or 4) relaxing on beach or campus at Melbourne or 5) slide show (bring your own slides).

Tuesday, June 22

Trip to Miami via Jensen Beach, Palm Beach, Fort Lauderdale, followed on Wednesday and Thursday by visits to gardens in the Miami area. A proposed field trip to Jamaica is scheduled for Friday, June 25.