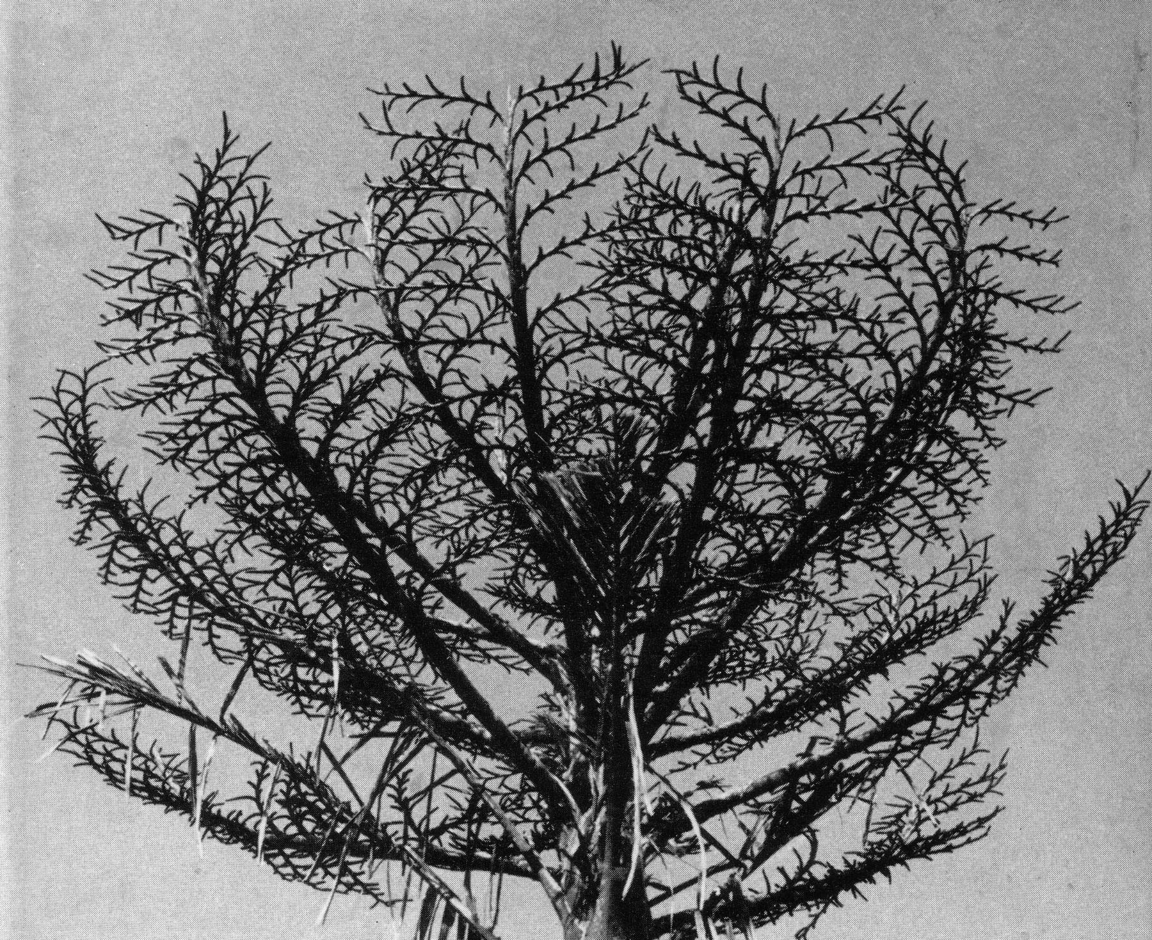

PRINCIPES

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PRINCIPES

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Contents for April

Cover Picture

Terminal inflorescence of *Metroxylon sagu* growing in North Sulawesi (N. Celebes), Indonesia. The leaves have been cut off green for thatching houses. Photo by T. A. Davis.

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JOURNAL OF THE PALM SOCIETY

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Palms in Baja California*

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No one needs a botany course to know a palm tree. The palms are such a distinctive family and "palm" such a distinctive concept that people know palms at first sight. Well, usually; and at least in Baja California, mistakes are unlikely. The palm is usually tree-size, with an unbranched trunk and a crown of large fan-shaped or feather-shaped leaves: large leaves necessarily go with an unbranched trunk to give the tree enough green spread.

The palms are a large family, with 2500 or more species, mostly tropical and so giving a tropical impression. They are most important to mankind, providing food, building and roofing materials, fibers, waxes and oils, and other products. The date and coconut palms come at once to mind as basic to the lives of countless people; but many others also are important.

Baja California has five native fan palms—four on the peninsula and one on Guadalupe Island—one extending into Alta California as our only native palm. Such eminent plants put their distinctive mark on any landscape but especially on a land of low or sparse vegetation. Their leaves are widely used in Baja California as thatch for roofs and walls, their trunks are used for timber, and their fruits may be eaten.

Coconut palms are planted on some southern beaches, as at La Paz, and a very few other exotic palms are grown sparingly in towns. But the Old World date palm is commonly seen, giving character not only to such large oases as Mulegé and San Ignacio but also to isolated and lonely springs, where some traveler long ago paused for lunch and dropped a date seed. Although dates might seem to improve any spring, they may take so much water that none is left in the spring, let alone in the summer. Dates came in Mission days and are now an important crop. Both coconut and date have feather-shaped leaves, in contrast to the fan-leaves of the native palms.

California Fan Palm

The California fan palm (*Washingtonia filifera*) occurs in the deserts of southern California at such palm-named oases as Palm Springs, Twenty-nine Palms, and Borrego Palm Canyon. It also extends to northern Baja California, in the Sierra de las Cucapás south of Mexicali and on the east side of the Sierra Juárez, and to western Arizona. Needing a stable water supply, it grows either in canyon washes or at hillside seeps, as along the San Andreas Fault. The canyon oases suffer occasional destructive floods, which may clear out a canyon and leave the alluvial fan below strewn with palm trunks.

This palm is a massive tree, sometimes reaching 90 feet, with a stout trunk and a large open crown of grayish-green fan-shaped leaves. Since palm trunks do not thicken with the years, they keep no growth-ring record of their age; but estimates from growth in known periods place the maximum for this palm at about 200 years. The dead leaves hang on the trunk as a shag or skirt, which may persist to the

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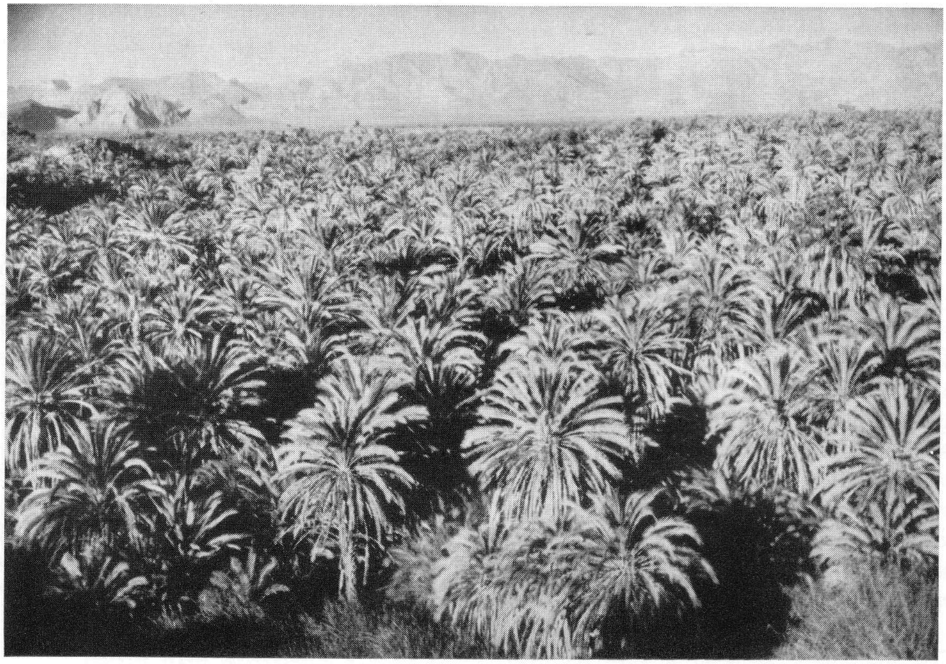


1. Old World date palms, and a few skydusters, in the oasis of Mulegé.

ground even in old trees, adding to the unique beauty of the tree (see front cover). However, the shag often has been burned from wild trees, and it commonly is trimmed from cultivated ones, at least below, partly to prevent burning by vandals. The many tiny flowers, followed by small blue-black fruits, are borne on long arching branches among the leaves.

This palm is familiar throughout southern California and in other parts of the world with similar climates. In foggy places near the coast, it is subject to crown rot; so in San Diego it is planted less than its more slender relative, the skyduster. After the coconut and date, these two Washington palms are among the most widely planted of palms.

The California fan palm was very important to the Cahuilla Indians of Alta California: it seems likely that the Yuman people of northern Baja California may have used it in some of the same ways and that other Baja California palms found similar uses. For the Cahuillas, large palm oases were permanent village sites and smaller ones campsites—with water, a milder microclimate, small game, and other useful plants besides the palm itself. Palm leaves were used for making houses and sandals and their fibers for basketry. The wood of petioles was used for implements and the pithy wood of floral branches for making fire by friction. And the abundant pea-size fruits were an important and reliable food, the thin datelike flesh eaten fresh in summer or the whole fruit dried for later grinding.

Cahuillas burned the shag of dead leaves, apparently to improve fruit yield by destroying insect pests, and perhaps burned oases to improve access: and fires still are started carelessly or deliberately by man. Fires may also start from lightning and doubtless always have. Usually the palm is not killed by burning of the shag or even by repeated burning of the oasis. However, the undergrowth and litter may become dense enough to support a fire that will injure or kill some palms. Repeated fires may reduce the thickness of the trunk and hence the water supply to and size of the crown. Nevertheless, palms are much more tolerant of fire than most associated plants, and periodic fires probably help maintain the palm grove. Removal of undergrowth and litter by fire creates the opening that shade-intolerant palm seedlings need for best growth; and though it may scorch those seedlings already present, it will not necessarily kill them. Thus the palms seem adapted to occasional fires. Also, removal of undergrowth reduces water loss, increasing spring flow and soil moisture, again helping the palm seedlings.

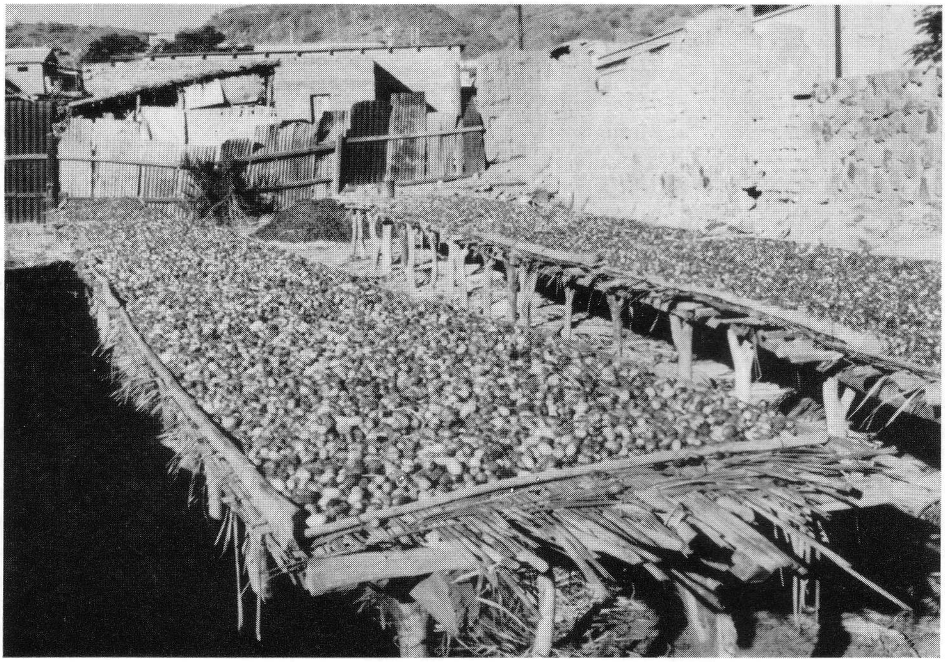
The size of the palm grove is limited by the water available over the long period: too many palms could cause a critical water shortage. Because of their longevity, the palms need reproduce only about once a century to maintain their numbers. There may be no seedlings for many years; but one year of favorable conditions, including exceptional rainfall, may produce many. Coyotes, which eat many palm fruits, are agents in spreading seeds from one oasis to another; and Indians apparently planted some groves.

Though mainly a desert-oasis tree, this palm also occurs west of the mountains, at Valle de las Palmas (Palm Valley), 25 miles southeast of Tijuana. The place name puzzled me until I found C. R. Orcutt's account of 1883: "We entered Valle de las Palmas, where we made our next camp among mesquite, screwbean, and other trees—but no palms! The next morning we proceeded through the valley till we noticed at our right, in a large cañon, two novel trees which proved to be palms (*Washingtonia filifera*). On further exploration we found 20 still standing but over 50 lying dead—cut down by the enterprising ex-governor that he might cover his house with their leaves!" Four mature palms now grow in Cañada Sesma, on the south side of Valle de las Palmas—which is near the old Ensenada road and perhaps is Orcutt's canyon. In Cañada de las Palmas, to the west, 69 palms are scattered over about a mile, at 1200 to 1500 feet elevation. There seems no doubt that they are native.

If Orcutt resolved one mystery, he created another when he reported this palm at the mouth of Arroyo Socorro, on the west coast 170 miles below the border. It does not grow there today, nor is it known wild within 80 miles. The blue palm does occur farther up the arroyo and might once have extended to the mouth; but since Orcutt mentioned seeing blue palms earlier in the trip, presumably he saw something else at Socorro.

Skyduster

The second Washington fan palm (*Washingtonia robusta*) occurs farther south in Baja California, starting a quarter of the way down, and across the Gulf in Sonora. It is often called Mexican fan palm, but Mexico has so many fan palms that the distinctive name of "skyduster" seems better. It outgrows the California fan palm, with a thinner trunk, enlarged at the base, and a smaller and denser crown of shorter bright green leaves. In young plants the leaves are stiff; but mature trees have a very different appearance, with gracefully drooping leaf segments. The shag of dead leaves may persist for years, but parts of it may slip down, exposing the trunk.



2. Date crop at Mulegé.

Skydusters also are widely planted in southern California and abroad, and they are more common than the California fan palm in San Diego. They are our tallest palms, sometimes growing almost out of sight and leaving a row of trunks, like so many telephone poles, along the street below. Both Washington palms are beautiful trees, especially in groups, where there is room to admire them from a distance; but they are not for the small garden. A tall one stands across the mall just southwest of the Museum.

According to Miguel del Barco, writing two centuries ago, the Indians of southern Baja California learned from the Spaniards that the terminal buds of "palma colorada" were edible; and they soon destroyed many palm groves. Since each palm has but one terminal bud, each salad costs the life of a tree. It is not clear whether he referred to the skyduster or to the Brandegee palm. Indians of the Cape Region used leaves of the skyduster in their burials.

Hesper Palms

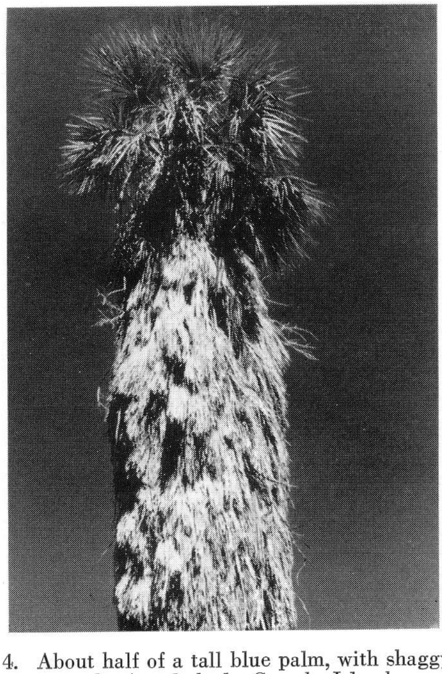
The other three fan palms of Baja California are sometimes called Hesper palms. Since one of them occurs on Guadalupe Island, far off the west coast, a genus for them was fancifully named *Erythea* for one of the Hesperides, Greek-mythological daughters of the Evening or West, who "dwelt on an island on the western edge of the world and guarded the golden apples there." It *is* hard to think up new names. And now the botanists have united *Erythea* with *Brahea*, named for Tycho Brahe (1546–1601), a Danish astronomer whose connection with the palms is probably even more tenuous.

The Hesper palms are similar to Washington palms but somewhat

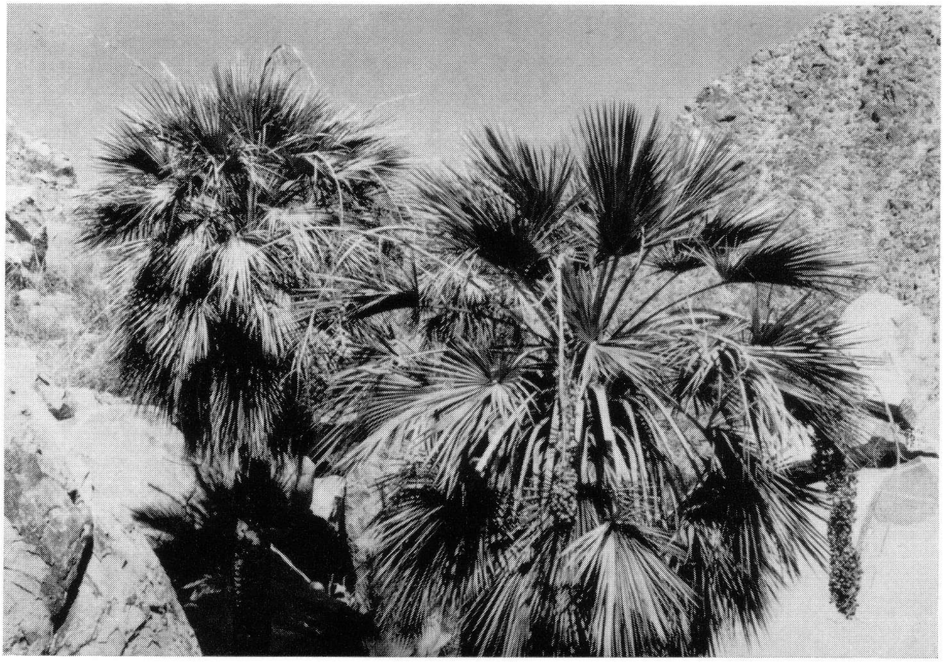
3. Skydusters towering above surrounding desert vegetation, with their feet in Arroyo Cataviñá.

smaller, with larger and more edible fruits. Though less widely grown, all three are seen in southern California, and each has special merit as a cultivated tree.

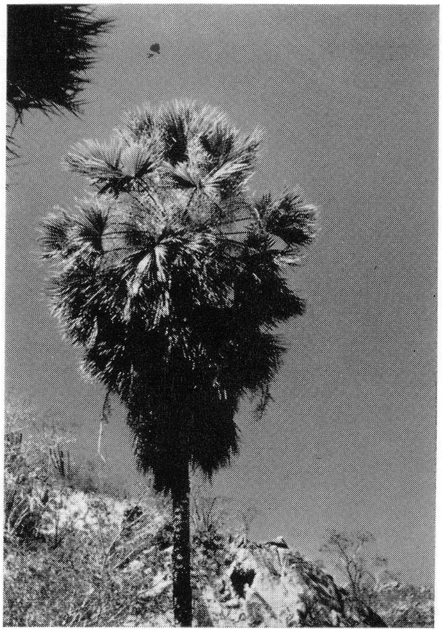
The blue palm (*Brahea armata*) is endemic to the northern half of Baja California, including Angel de la Guarda Island in the Gulf. It occurs mainly in desert canyons and arroyos, often with Washington palms; but at elevations of 4000 or 5000 feet it also grows in crevices in bare expanses of granite. It is a tree, becoming 30 to 50 feet tall, with bluish to silvery leaves and with striking feathery-branched floral stems arching out far beyond the crown. Several trees have recently been planted in the new desert garden just northeast of the Museum, and a few very fine old specimens about San Diego show the potential of this palm as an ornamental.



4. About half of a tall blue palm, with shaggy trunk, Angel de la Guarda Island.



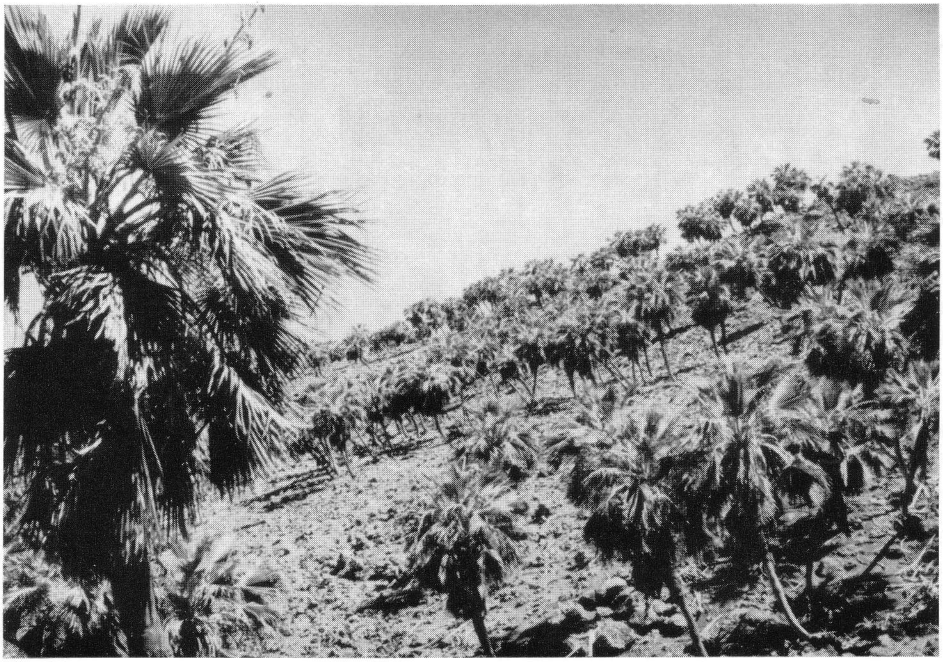
5. Blue palms with fruiting branches, in Tajo Canyon, east slope of Sierra Juárez.



6. Brandegee palm at Potrero de Almenta, in the Cape Region mountains.

The blue palm occurs in the canyons on the east side of the Sierra Juárez, at least to within 15 miles of the United States border. It may yet turn up in San Diego County, since our droll former Curator of Birds and Mammals, Laurence Huey, used to amuse himself by planting seeds on our side of the line.

The Brandegee palm (*Brahea brandegeei*) is endemic to the mountains of the southern half of Baja California, where it grows along canyon bottoms, often with the skyduster, and on north slopes. It reaches about 50 feet, with a slender trunk often covered with a shag of old leaves, and with a rather small crown. The fruits, known to the natives as "taco," become yellow, then black; when yellow they are very good to eat, tasting much like dates. The species was named for its discoverer, T. S. Brandegee, a Californian bota-



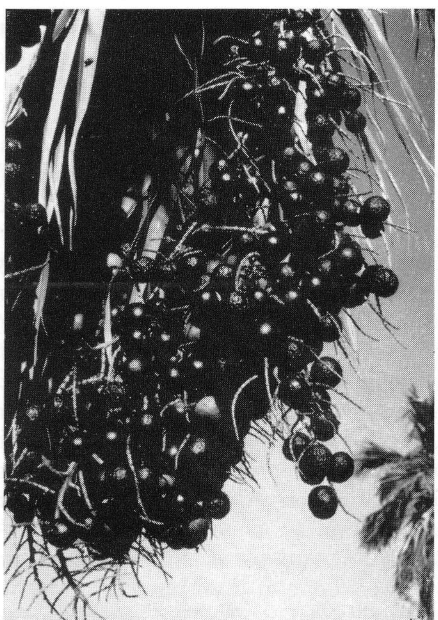
7. Palm forest high on north slope of Guadalupe Island.

nist then living in San Diego and a member of our Society, who was a pioneer botanical explorer of Baja California. The natives call it *palma de taco.*

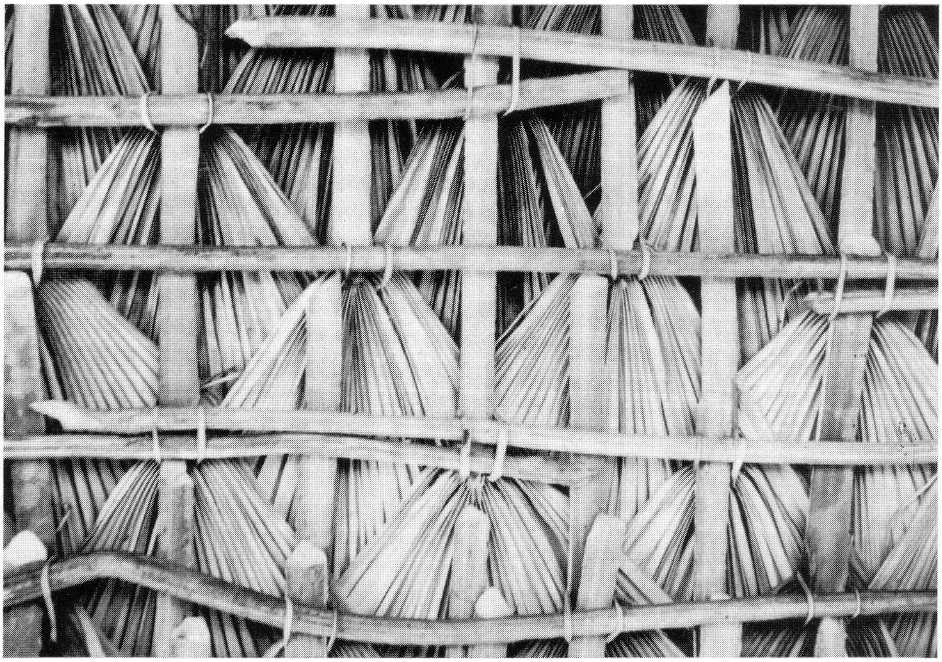
Kate Sessions, well-known San Diego horticulturist and tree planter, in 1902 went with Mr. Brandegee to the Cape Region of Baja California and by mule into the mountains. They brought back seeds of the Brandegee palm and established it in southern California. The two tall fan palms in the courtyard of the House of Hospitality in Balboa Park are from this collection; and a grove of them grows on the canyon-side below the west end of the Laurel Street bridge.

Guadalupe Island Palm

The Guadalupe Island palm (*Brahea edulis*) is native only on Guadalupe Island, 250 miles south of San Diego



8. Fruits of Guadalupe Island palm, eaten by man and beast.



9. Palm thatch makes not only an effective roof but also a beautiful ceiling. No nails or wire, just palm fronds.

and 157 miles off the peninsula of Baja California. This is a rugged volcanic island 22 miles long and 4300 feet high. Several thousand palms make a forest, with a few scattered pines and oaks, high on the north slope, in beautiful contrast to the blue waters below; and smaller numbers grow in canyons farther south. For more than a century the island has been overrun with goats, which have destroyed much of the native vegetation. Since the goats eat seeds and seedlings, only old palms survive; and if the goats remain, the palm seems doomed on its native island. Fortunately, it is securely established in cultivation—widely planted as an ornamental in southern California. A beautiful example stands across from the west door of the Museum.

In cultivation, this is indeed a handsome palm. Dr. Francesco Franceschi, a noted Italian horticulturist who spent 20 years in Santa Barbara, called this the most elegant fan palm of the North American continent—though actually it is a little off the continent, as he well knew from visiting its island home. Though it is not a towering tree like the Washington palms—reaching only 30 or 40 feet—the crown of bright green leaves is ample and symmetrical. Early fall of old leaves makes a clean trunk. The arching floral branch bears first the numerous small cream-colored flowers and later a heavy cluster of purplish-black fruit, each about the size of a plum.

The fruit was originally reported to be eaten by man, goats, birds, and mice. It is somewhat edible if caught at the proper stage between greenness and decay, when it tastes like a second-rate date that has been frightened by a prune. In fact, the word "edulis" in the name means edible. Also, this is one of many palms known as cabbage palms because the large bud of young leaves is eaten—or, in this case, used to be. And the leaves, like those of other palms, have been used for thatch. Clearly the goats are not to blame for the lack of palms in the canyon above Northeast Anchorage—site of various early settlements—where remnants of palm stumps may still be seen.

Guadalupe Island is the tip of an ancient volcano, formed by an outpouring of lava from the floor of the sea. It is thus an oceanic island, never connected with the mainland (and so part of Baja California only politically). The plant life of the island must therefore be derived from chance immigrants across the water, mostly seeds, that have floated or been carried by wind or by birds, or, most recently, in the case of weeds, by man. As mentioned above, two related palms grow on the peninsula; but how the ancestral palm seed ever reached the island is a question to ponder. Neither the seed nor the fruit of the present palm will float, even in salt water. A fruiting branch might float, but the branches remain on the tree long after fruit fall; and should a fruiting branch become detached, it would not go down a dry arroyo to the sea and could scarcely be carried by turbulent storm runoff and still retain the fruit. The seeds are almost too large to be carried by the wind or accidentally by a bird; and it would take a very enterprising bird, with great singleness of purpose, to carry a seed so far just for the future perplexity of botanists. It is true that related palms have somewhat smaller seeds and that the ancestral seed may have been smaller; but that fact scarcely diminishes the problem. Since the island is at least seven million years old and only about 10 million inches from shore, the distance works out to less than two inches per year; and almost any bird could carry, or push, a seed that far. But that, of course, is nonsense, which an alert editor should have deleted. So how the palm got to Guadalupe Island remains one of those intriguing puzzles to which you will not find the answer on page 27 of the next *Environment Southwest.*

Principes, 22(2), 1978, pp. 56–63

Pollination in Salacca edulis

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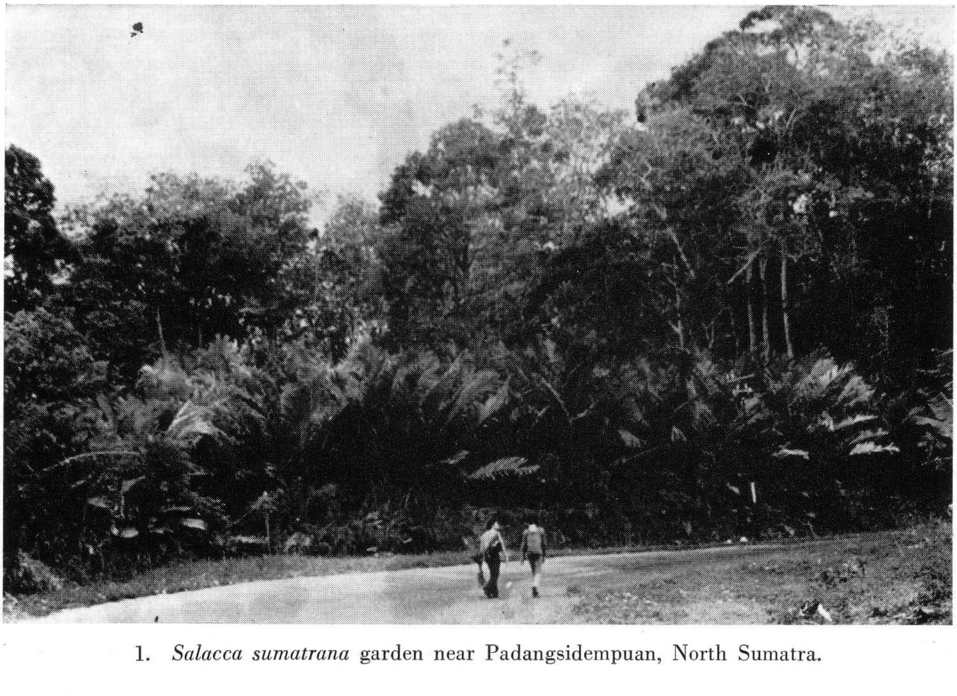
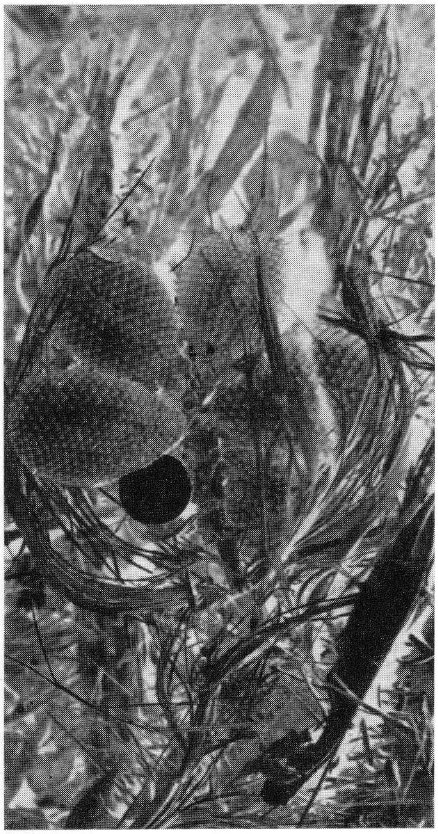
In the Old World, especially in Indonesia, *salak* (*Salacca edulis* Reinw. and *Salacca sumatrana* Becc.) is well known because of the edible fruit. This plant belongs to the lepidocaryoid palms (Beccari, 1918), as do sago palms, raphia palms, and all rattans. Amongst them, *salak* has the biggest fruits, which usually are pear-shaped, 5–7 cm long by 3–5 cm in diameter and scaly (Fig. 3). The edible part, formed from the outer integument of the seed, is fleshy and usually cream-colored, but in the one from Sumatra is sometimes reddish. Actually this plant has been cultivated for a long time, for in 1605 Clusius described the *salak* fruit when it reached Europe from Bali and called it *Baly insulae fructus aspero cortice* (Clusius, 1605). Nowadays *salak* gardens maintained in the traditional manner are still present in some localities in Indonesia, namely in North Sumatra (Padangsidempuan, Fig. 1), Java (Condet, Depok, Batujajar, Manonjaya, Sleman, Pasuruan, and Bangkalan-Madura), North Celebes (Pangu and Tagulandang), and in Bali (Karang Asem).

Staminate and pistillate inflorescences occur on separate trees. The staminate rachilla consists of many



1. *Salacca sumatrana* garden near Padangsidempuan, North Sumatra.

2. A pistillate inflorescence of *Salacca edulis*.



3. An infructescence of *Salacca edulis*; the black spot is a coin 2.5 cm long used as a scale.

pairs of staminate flowers while the pistillate ones (Fig. 2) have a pistillate and a neuter flower (a sterile staminate flower) in each pair (see Fig. 5a–c). In Condet and several *salak* gardens in Java, inflorescences are always covered with many insects.

Materials and Methods

This study was made in Condet, a *salak* garden in the south of Jakarta. The area consists of about 93% *salak* garden, covering an area of just over 150 hectares. The mean temperature of the area is 27°C, the relative humidity 80%, and the mean rainfall 2173 mm/year. The size of the garden used in this study is 90 × 30 m square, consisting of 120 trees, four of them being staminate. Only one of the staminate trees was in flower. A few of the pistillate trees were also in flower, but only the one nearest to the flowering staminate tree was used in this study.

The life cycle of the insects was observed by collecting some samples of inflorescences and by examining them in the laboratory. The activities of the insects during one day on staminate and pistillate inflorescences with flowers at anthesis were observed on two

Table 1. Number of the curculionid beetles on the staminate inflorescence of Salacca edulis *at different times*

June 12, 1973		June 13, 1973		June 13, 1973	
1600	74	0000	62	0800	56
15	72	15	66	15	50
30	52	30	62	30	48
45	50	45	62	45	32
1700	50	0100	40	0900	24
15	54	15	40	15	20
30	54	30	66	30	48
45	56	45	65	45	48
1800	54	0200	58	1000	46
15	60	15	56	15	54
30	68	30	56	30	72
45	68	45	56	45	50
1900	72	0300	56	1100	48
15	70	15	56	15	52
30	70	30	56	30	52
45	70	45	56	45	52
2000	70	0400	56	1200	52
15	85	15	56	15	54
30	74	30	56	30	70
45	80	45	56	45	52
2100	72	0500	56	1300	60
15	74	15	56	15	60
30	64	30	56	30	56
45	80	45	56	45	72
2200	76	0600	56	1400	84
15	74	15	56	15	84
30	76	30	67	30	84
45	84	45	67	45	76
2300	84	0700	67	1500	75
15	84	15	60	15	76
30	80	30	60	30	77
45	74	45	60	45	82

Table 2. Number of the curculionid beetles on the pistillate inflorescence of Salacca edulis *at different times*

June 12, 1973		June 13, 1973		June 13, 1973	
1600	65	0000	81	0800	18
15	65	15	52	15	16
30	78	30	52	30	13
45	78	45	52	45	20
1700	81	0100	52	0900	23
15	88	15	51	15	39
30	74	30	51	30	30
45	112	45	52	45	31
1800	112	0200	53	1000	25
15	81	15	53	15	11
30	81	30	54	30	8
45	81	45	52	45	11
1900	84	0300	52	1100	11
15	84	15	52	15	10
30	84	30	52	30	24
45	108	45	52	45	19
2000	108	0400	49	1200	19
15	101	15	49	15	20
30	83	30	49	30	26
45	94	45	49	45	27
2100	74	0500	49	1300	20
15	74	15	49	15	14
30	74	30	49	30	14
45	78	45	49	45	12
2200	78	0600	49	1400	12
15	78	15	30	15	12
30	81	30	31	30	21
45	81	45	44	45	6
2300	81	0700	44	1500	6
15	81	15	35	15	8
30	81	30	28	30	8
45	81	45	20	45	7

trees that grew ca. 20 m apart from each other. The number of the insects on the inflorescences was counted every 15 minutes (Table 1 and 2). To facilitate the counting of insects, each inflorescence was divided into eight regions with a white thread. For night observation a small flashlight with two batteries was used.

Five pistillate inflorescences were covered with 300-gauge cellophane to determine whether the flowers need cross pollination to produce fruits. These cellophane covers remained on the pistillate inflorescences for five weeks, namely from their young stage until after anthesis. The cellophane is transparent, stiff, penetrable by air, waterproof, and resistant to dry climate. It is usually used as candy paper, for cigarette boxes and for bread packages (Paist, 1958).

Results

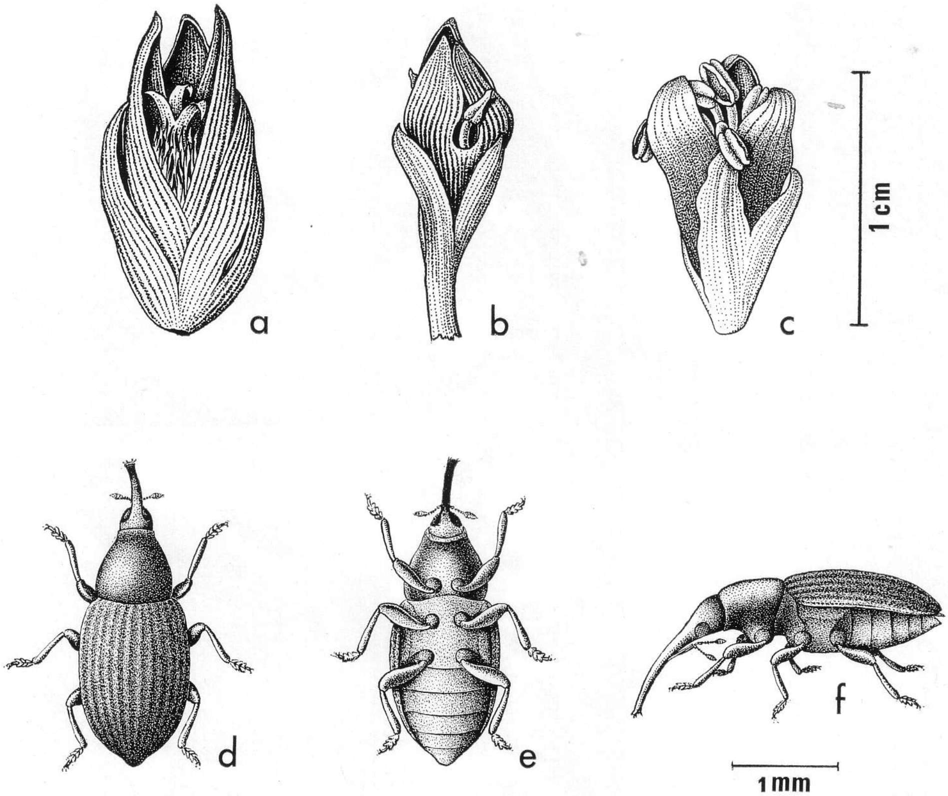
The insects found on the inflorescences were *Trigona* sp. (Hymenoptera), *Rhynchophora palmarum* L. (Coleoptera), a small dipteron 1 mm long, and a curculionid beetle (Curculionidae). The diptera were found during the day only on the staminate inflores-

4. A pistillate inflorescence of *salak Bali*; the arrow indicates a reduced rachilla. Photo by J. Dransfield.

cence, but they were not found on the pistillate inflorescence when flowers were at anthesis. *Trigona* and *Rhynchophora* have also been found on other genera and species of palms (Lepesme, 1947). However the curculionid is found on the inflorescences in large numbers, especially when flowers are at anthesis.

The curculionid beetle (Fig. 5d–f), the identity of which is not yet known, is 2–3 mm long, blackish-brown, and its proboscis is cone-shaped as in *Calandra oryzae* L., which usually can be found in rice. A secondary sexual character of this beetle is the length of snout. The female has a longer snout. The egg is oblong, 0.3 mm long, white, and is usually hidden in the petal of a young pistillate flower, but sometimes can also be found in the petal of a pistillate flower at anthesis. Two to three weeks later, the petal has dried up and died, and the larva developed from the egg has reached its last stage and shortly after formed a pupa. After two to three days in this stage, it emerges a beetle like those seen on flowers at anthesis.

The amount of insect activity on the inflorescences is shown in Figure 6. Between about 2100 hours (9:00 P.M.) and 0700 (A.M.), the insects were not active but there was a relatively con-

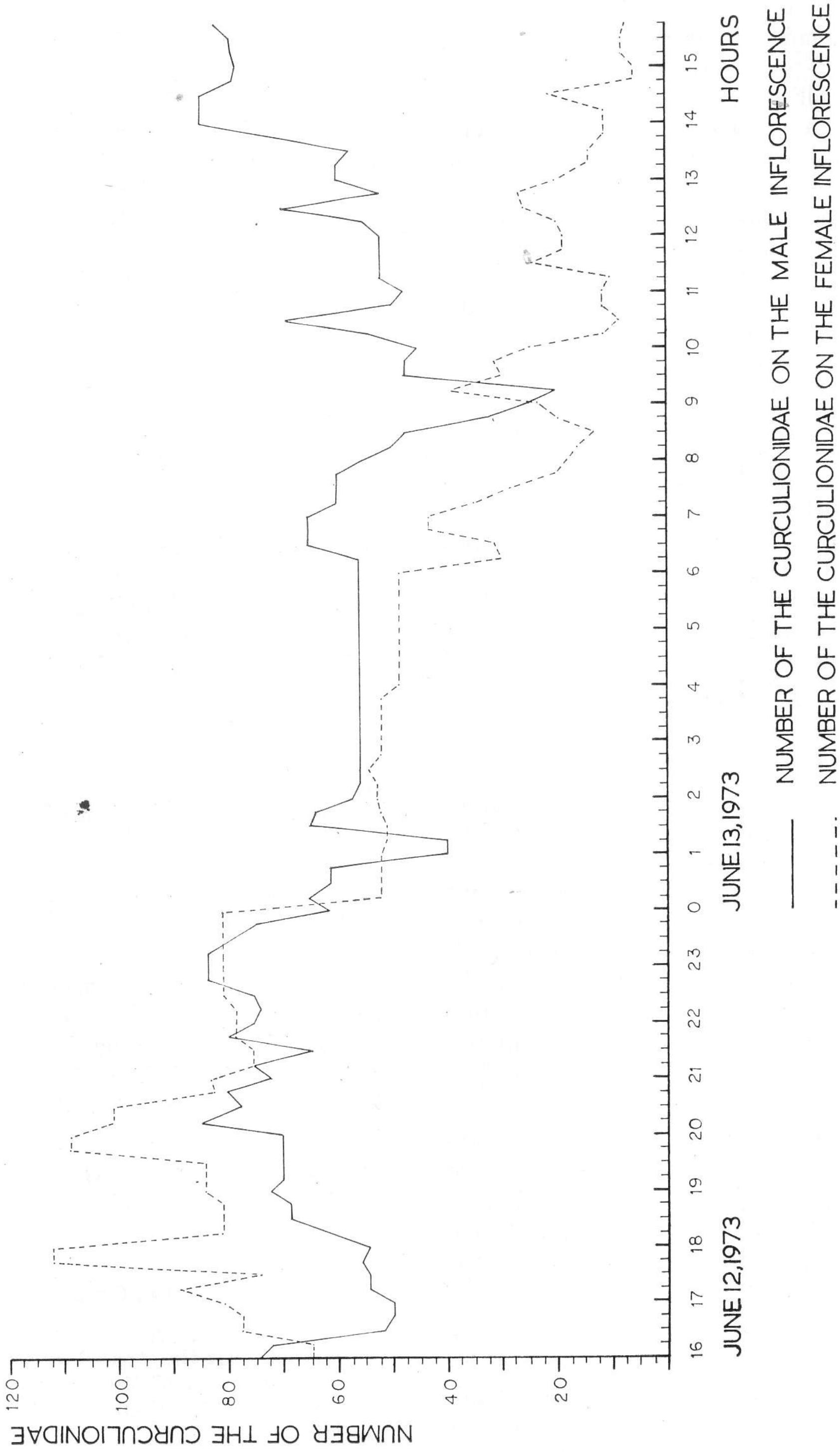


5. Flowers of *Salacca edulis* (a–c) and their visitor (d–f). a, pistillate flower; b, neuter flower; c, staminate flower; d, e, f, curculionid beetle in dorsal, ventral, and lateral views.

stant number of insects during this period. Between 0700 and 2100 the number of insects fluctuated from time to time, which suggests that the insects fly from one inflorescence to another. The time when there was the largest number of insects on the inflorescence was between 1900 and 2100 hours. The pistillate flowers are at anthesis during the night from sundown at about 1800 until early in the morning. During the night the insects fed upon a nectarlike secretion in the basal parts of petals. By morning the petals were broken by the curculionid beetle and the number of insects decreased after the petals were broken.

The staminate inflorescence remained with flowers in anthesis for three days. The basal parts of the petals are also broken, which suggests that a nectar-like substance might have been fed upon by the beetles. But it is not clear whether the beetles are also feeding on the pollen grains. Up to 1600 hours, the number of the insects in the staminate inflorescence was greater than the number of the insects on the pistillate one. But the number of the insects on the staminate inflorescence decreased after 1600 while on the pistillate one the number of the insects increased, especially between 1900 and 2100 hours.

The five pistillate inflorescences covered by cellophane developed normally for three to seven days until the stage of anthesis. One month later the flowers were dried, dead, and had not pro-



6. Numbers of curculionid beetles on staminate and pistillate inflorescences.

duced fruit. This evidence suggests that the staminate flowers in those pistillate inflorescences are truly sterile, so that no pollination could occur. On the other hand, under a monocular microscope it was found that the insects collected from uncovered pistillate inflorescences had some pollen grains of *Salacca* on their breast and hairs of their feet. This is an indication that those trees are insect-pollinated. In this connection it should be noted that some of the characteristics of this species are petals with a strong ginger (*Zingiber officinale* Roxb.) fragrance (Ochse and Bakhuizen van den Brink, 1931) that attracts the insects, and stigmas often covered with litter because of the position of short erect axillary inflorescences. The trees themselves are of a gregarious nature, living together in a compact and enclosed area, thereby preventing the entrance of wind (Faegri and Pijl, 1966).

Discussion

Schmid (1970), in his observation of the pollination of *Asterogyne martiana* (H. Wendl.) H. Wendl. ex Hemsley, wrote that the number of insects on the inflorescences increased when the flowers produced nectar. Based on this phenomenon one may suggest that the production of a comparable substance in the staminate and pistillate inflorescences of *Salacca edulis* occurred at different times. The highest concentration of insects on the staminate inflorescence was between 1200 and 1600 hours, and on the pistillate inflorescence between 1900 and 2100 hours. As shown in the graph, during this latter period the number of insects decreased on the staminate inflorescence and increased on the pistillate one, indicating a migration from the staminate to the pistillate inflorescence. It is suspected that during this period the insects pollinate the pistillate flowers.

In Bangkalan-Madura the curculionid beetles on the inflorescences are few in number. Here pollination is carried out by man by cutting and moving parts of the staminate inflorescence with flowers at anthesis to the pistillate inflorescences.

Tan (1953) reported that according to Mahjoedi the *salak* in Bali is monoecious, which implies that the staminate flowers on the pistillate inflorescences are fertile. During a field study on *salak* gardens in Karang Asem in May 1973 together with Dr. John Dransfield, no male tree was found. What the local people had thought was a *salak laki-laki* (a male tree) was, in fact, a female plant that had never produced fruit. *Salak Bali* actually is different from the common ones, because it has erect leaves and the pistillate inflorescences often have some reduced rachillae near their bases (Fig. 4). The Balinese *salak* is generally regarded as the best *salak* of all and its seeds are fertile, but the mechanism of its fertilization is still unknown.

Acknowledgments

I am greatly indebted to Dr. John Dransfield (Kew), who generously supervised me during these observations. I also wish to express my thanks to Dr. Mien A. Rifai and the staff of Herbarium Bogoriense for their assistance during the preparation of this paper, and to Mr. Abdullah (Condet) for his permission to conduct this study in his salak garden.

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Principes, 22(2), 1978, p. 63

NOTES ON CULTURE

Parajubaea cocoides seeds have a reputation with at least a few growers of being rather slow and difficult to germinate. I recently had a very fast and successful germination of a number of these seeds. Freshly collected fruits from Quito, Ecuador, arrived still reeking of fumigant from the U.S.D.A. station. They were intact, with the fibrous fruit coat around the bony endocarps, and were quite dry and hard. I soaked them for about two days in a weak fungicide solution, after which the fibrous fruit coats softened and came away easily. I moistened some very loose, porous, commercial planting mix in a large plastic container and placed the endocarps with enclosed seeds on top of the soil, covering them with only a layer of loose moist sphagnum. When the sphagnum became completely dry, I watered lightly. The container was kept loosely covered in my garage, which maintains a temperature of about 60° F at night and 80° by day rather consistently. Within four weeks the seeds began germinating, and after six more weeks approximately 80% had sprouted.

I believe the good results came from having the endocarps exposed to fresh air while at the same time surrounded loosely by a slightly moist medium. They never became overly wet, and the day-night temperature variation may also be important. Their native habitat is one of large day-night temperature differences.

That these conditions were conducive to good germination was proved by the fact that a number of *Parajubaea* fruits that I collected myself in Quito had never germinated under similar condition except that they were completely buried in soil for over eighteen months. I removed them to the above container with more air and they began germinating also. It is possible that, as with *Jubaeopsis caffra*, there is a growth inhibitor that is overcome in the presence of oxygen. This would certainly be of survival advantage to the seed. So long as the fruit coat remains intact, a condition approximated by the fruit being completely buried, the embryo remains dormant. With the arrival of a wet season, the fruit wall quickly decomposes, exposing the endocarp with its seed to air, and the seed can germinate.

Parajubaea cocoides is a beautiful tree and should be adaptable to most of coastal California as well as mild areas inland. But it has been extremely difficult to obtain plants. I hope the above information may help change that situation.

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The Number of Wide Vessels in Petiolar Vascular Bundles of Palms: an Anatomical Feature of Systematic Significance

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Abstract

The most frequent number(s) of wide vessels per large vascular bundle was determined in transverse sections of petioles from 213 species of palms, representing all of the major taxonomic groups. Most palms display one or two or a combination of one and two wide vessels per bundle. Relatively few species commonly have more than two wide vessels per bundle. The coryphoid major group is the most variable, but the variation follows the subdivisions of the group. Most of the other major groups are more uniform in this feature, and many can be characterized by a specific number of wide vessels in the bundles of their petioles. This character supports some previous conclusions about relationships among the major groups.

Introduction

Certain anatomical features of the vegetative organs of palms are of diagnostic value in distinguishing among the taxonomic groups of palms (Tomlinson, 1961, 1969; Parthasarathy, 1968; Klotz, 1977). Some of these features help to clarify systematic relationships among extant groups of palms (Moore, 1973), and may possibly provide a basis for assessing the taxonomic affinities of fossil palms.

The present study is a survey of one anatomical feature—namely, the number of wide vessels per vascular bundle in transverse section of petiole. The objective of the study is to observe the degree to which the taxonomic groups of palms can be characterized with regard to this feature.

Materials and Methods

The data were obtained from transverse sections made with a razor blade or sliding microtome. Two hundred thirteen species in 153 genera were examined. Most of the species were represented by only one specimen. Thus, the meaningful sampling is more at the level of the taxonomic group than at the level of individual species, and the results presented here should be considered tentative. A list of the species examined and collection data on the specimens are available (Klotz, 1977).[2]

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The author is grateful to Drs. M. V. Parthasarathy, H. E. Moore, Jr., and N. W. Uhl for their guidance and assistance during the course of this project. Figures 2 and 4 were photographed from the slide collection of Dr. P. B. Tomlinson.

[2] Data from the following additional specimens (all from Colombia) are included in Table 1:

Catoblastus radiatus (Cook & Doyle) Burret (*Moore & Dransfield 10223*); *Phytelephas* sp. (*Moore & Dransfield 10224*); *Socratea* sp. (*Moore & Dransfield 10228*); *Syagrus sancona* (HBK) Karsten (*Moore & Dransfield 10218*).

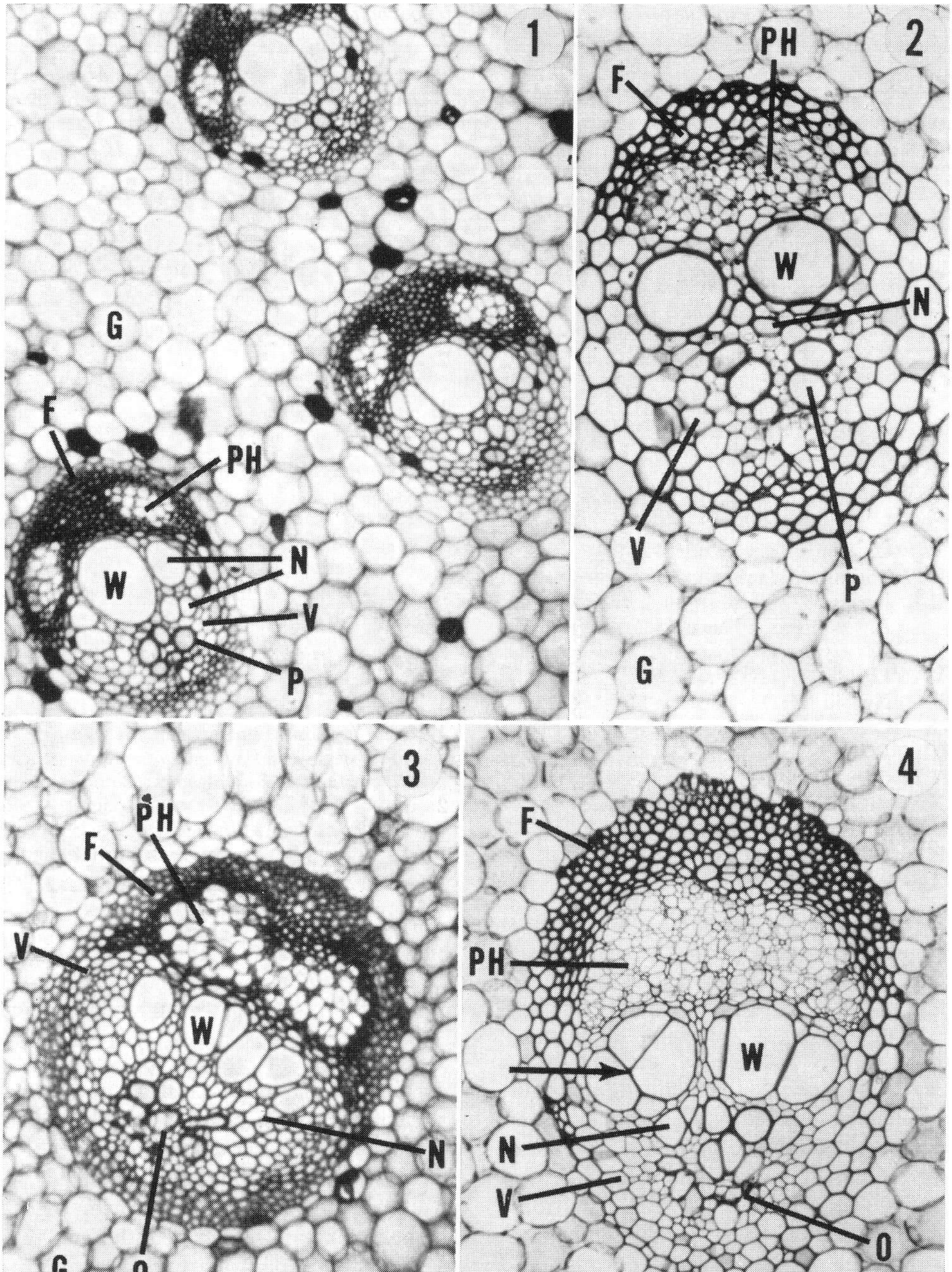
Table 1. Most frequent number(s) of wide vessels in petiolar vascular bundles of palms

The classification is that of Moore (1973). The number of species (or of genera and species) examined is given in parentheses after the name of each group. In groups in which more than one condition was observed, the number of specimens for each condition is indicated as a superscript in parentheses.

I. Coryphoid major group	
A. *Trithrinax* alliance	
i. *Trithrinax* unit	
Trithrinax (2)	2
Rhapidophyllum (1)	2–5
Trachycarpus (1)	1–4
Chamaerops (1)	1
ii. *Chelyocarpus* unit (3:4)	2
iii. *Schippia* unit (1)	2
iv. *Rhapis* unit (3:3)	1
v. *Thrinax* unit (3:5)	2
B. *Livistona* alliance (12:14)	1
C. *Corypha* alliance	
Nannorrhops (1)—two specimens	2; 1–4 (most frequently 2–3)
Corypha (1)	1
D. *Sabal* alliance (1:2)	1; 1–3
II. Phoenicoid (1:2)	2
III. Borassoid	
A. *Borassus* alliance (4:4)	$1^{(2)}$; $1–2^{(2)}$
B. *Hyphaene* alliance (2:2)	2
IV. Lepidocaryoid (19:33)	$1^{(32)}$; $1–2^{(1)}$
V. Nypoid (1:1)	1
VI. Caryotoid (3:6)	$1^{(5)}$; $1–2^{(1)}$
VII. Pseudophoenicoid (1:2)	2
VIII. Ceroxyloid (2:3)	1–2 & clusters; 1–3 & clusters; 2
IX. Chamaedoreoid (6:14)	2
X. Iriarteoid (6:11)	$1–2^{(2)}$; $2^{(9)}$
XI. Podococcoid (1)	1
XII. Arecoid (44:45)	$1^{(36)}$; $1–2^{(3)}$; 1 & clusters$^{(1)}$; 1–2 & clusters$^{(1)}$; $1–3^{(1)}$; $2^{(2)}$; 2–3 & clusters$^{(1)}$
XIII. Cocosoid (26:38)	$1^{(37)}$; $2–5^{(1)}$
XIV. Geonomoid (6:11)	$1^{(2)}$; $1–2^{(5)}$; $2^{(4)}$
XV. Phytelephantoid (3:4)	2

The petioles were sampled at about mid-length, except in 10 specimens that lacked pronounced petioles. In these specimens, the proximal part of the rachis was sampled, between insertions of the pinnae. The data from these specimens fit the patterns of their respective groups.

The samples included only the large vascular bundles from the central part of the petiole. Peripheral vascular bundles were not considered. In certain specimens, irregular clusters of vessels occurred in the position of the wide vessels in some vascular bundles (Fig. 4). This condition was indicated in Table 1 as "clusters." However, occasional pairs of laterally contiguous vessels were simply interpreted to represent intervessel contact areas and were counted as one vessel in the sample. Care was also taken not to count two vessel elements separated by a perforation plate as two distinct vessels. Deter-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mining the most frequent number or numbers of vessels in vascular bundles was difficult or uncertain in some specimens because information on the three-dimensional arrangement of vessels in petiolar vascular bundles is lacking. However, bundles apparently near the point of branching or anastomosing were not included in the sample.

The numbers in Table 1 indicate the condition for the majority (≥¾) of the vascular bundles in the sample.[3] If no single number comprises a ¾ majority, the codominant values are listed.

The delimitation of the categories of bundles (one-vessel, two-vessel, several-vessel) is somewhat arbitrary. For example, *Serenoa repens* (Bartr.) Small (Fig. 1) exhibits configurations intermediate between one and several wide vessels but is classified as having one wide vessel per vascular bundle. In general, if one or two wide vessels are markedly wider than the other vessels in the vascular bundle, only these widest vessels are considered in classifying the vascular bundle.

Results and Discussion

One (Fig. 1) or two (Fig. 2) wide vessels are observed in transversely sectioned vascular bundles of the petiole in the majority of species examined (Table 1). Only a few species characteristically display several (more than two) wide vessels per vascular bundle (Fig. 3). Some of the major groups are relatively uniform in this feature and possibly have a characteristic number of wide vessels per vascular bundle in the petiole—e.g., the lepidocaryoid and chamaedoreoid major groups. Other major groups are quite variable —e.g., the coryphoid, borassoid, arecoid, and geonomoid major groups.

The coryphoid major group was observed to be the most variable major group in this character. The variation follows the pattern of the coryphoid generic alliances and generic units. Variability is greatest in the most primitive generic alliance (the *Trithrinax* alliance) and within the most primitive generic unit of this alliance (the *Trithrinax* unit). The *Trithrinax* unit contains species [*Rhapidophyllum hystrix* (Pursh) H. Wendl. & Drude, *Trachycarpus fortunei* (Hook.) H. Wendl.] with more than two wide vessels per vascular bundle. This configuration approaches the "type I" vascular bundle of Cheadle and Uhl (1948), which these authors believed to be the most primitive in the monocotyledons. The New World genera of the *Trithrinax* alliance (*Trithrinax, Rhapidophyllum*, and the *Chelyocarpus, Schippia*, and *Thrinax* units) generally have two wide vessels per bundle whereas the Old World genera of this alliance (*Trachycarpus, Chamaerops*, and the *Rhapis*

[3] This criterion was not strictly followed by Klotz (1977). Thus, some of the values reported in that work were altered for this publication, but the basic trends and conclusions regarding the major groups have remained unchanged.

←

1–4. Transverse sections of petiolar vascular bundles. 1, vascular bundles mostly with one wide vessel—*Serenoa repens*, × 120; 2, vascular bundles mostly with two wide vessels—*Iriartea ventricosa* Mart., × 140; 3, vascular bundles with several (about four) wide vessels—*Nannorrhops ritchiana*, × 130; 4, vascular bundle with an irregular cluster of vessels (indicated by arrow)—*Orania appendiculata* (F. M. Bailey) Domin, × 110. Details: *f*, fibers; *g*, ground parenchyma; *n*, narrow tracheary elements of metaxylem; *o*, obliterated tracheary elements of protoxylem; *p*, tracheary elements of protoxylem; *ph*, phloem; *v*, parenchyma of vascular bundle; *w*, wide vessel of metaxylem.

unit) generally have one wide vessel per bundle. The *Livistona* alliance is much more uniform than the *Trithrinax* alliance in this character, but the *Corypha* alliance is variable: *Corypha umbraculifera* L. has one wide vessel per bundle whereas two is the modal number for the composite of both samples of *Nannorrhops ritchiana* (Griff.) Aitch. (Although the two samples of *Nannorrhops* differ from each other quantitatively, they both exhibit a similar range of numbers.)

The other major groups are more uniform than the coryphoid major group. Two wide vessels per bundle prevail in the species of *Phoenix* examined. The borassoid palms are more variable, with one or two or a mixture of one and two wide vessels per bundle. The lepidocaryoid, nypoid, and caryotoid palms mostly have one wide vessel per bundle. In contrast, the following series of three closely related major groups—pseudophoenicoid, ceroxyloid, and chamaedoreoid—is largely characterized by two wide vessels, as is the iriarteoid major group, which bears other morphological resemblances to the chamaedoreoid major group (Moore, 1973). The podococcoid, arecoid, and cocosoid palms are mainly of the "one-vessel" type, but there are exceptions in the latter two groups—notably the cocosoid *Jubaea chilensis* (Mol.) Baill. (two to five vessels), and three of the five triovulate arecoid species examined. These species are considered to be relatively primitive within their respective major groups (Moore, 1973). The geonomoid palms exhibit the same variety of configurations as the borassoid palms. The phytelephantoid palms have two wide vessels per bundle.

Most of the relevant data for comparison with those of the present study are from the works of P. B. Tomlinson (1961, 1966, 1969). His list of genera "mostly with 2" wide vessels per vascular bundle (Tomlinson, 1961) agrees well with that of the present study (with the possible exception of *Sabal*), and his claim that the remaining groups that he examined mostly have one vessel per bundle also agrees. However, in his list of genera "mostly with several (more than two)" vessels per vascular bundle, only *Rhapidophyllum* and *Jubaea* are in agreement with the present observations. The others in his list were observed to have only one or two wide vessels per vascular bundle in the present survey. This discrepancy may be due to the fact that Tomlinson (1961) obtained his sections from the upper part of the petiole, just below the insertion of the lamina or lowest leaflet. At this level, the bundles (and vessels within the bundles) might exhibit branching related to the departure of traces into the lamina or pinnae.

Tomlinson's (1966) observation of two wide vessels per bundle in petiole of *Asterogyne spicata* (H. E. Moore) W. Boer (as *Aristeyera spicata*) is in agreement with the present data for the geonomoid palms. In the ceroxyloid major group, Tomlinson (1969) observed mostly two wide vessels per bundle in *Ceroxylon* sp. and *Ravenea* spp., but in *Juania australis* (Mart.) Drude ex Hook. f. he observed more than two per bundle—perhaps about three to five, according to photomicrographs. Thus, the ceroxyloid major group is variable in this character, although two may be the modal number for the group.

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PALM QUESTIONS AND ANSWERS

Q. The trunks of my coconut palms appear to be bleeding. What is wrong?

A. The stem bleeding disease of the coconut palm is more common in South Florida than most people realize. The fungus, *Endoconidiophora paradoxa* (Dade), is associated with the stem bleeding disease and is reported to be a wound parasite entering the host plant through wounds or growth cracks on the stem. Stem injuries such as those inflicted by knives or those produced by steel climbing spikes are important areas of entry for the fungus. It is also believed that the activity of termites can serve as an entry area for the fungus. Palms damaged physiologically by heavy fertilization followed by a drought or excessive rains followed by a drought also tend to be more susceptible to disease entry. This disease has also been reported in the palmyra palm and the arecanut palm.

The actual bleeding is characterized by the exudation of a dark reddish-brown liquid from the growth cracks and wounds on the stem trickling down for a distance of several inches to several feet.

One of the recommendations for control of the stem bleeding disease is to completely excise the infected area on the trunk followed by dressing with pruning paint and a copper fungicide. The use of steel climbing spikes should be avoided where possible in order to reduce the mechanical wounds that serve as a primary means of entrance for the fungus.

Applications of a fungicide to the stem of a coconut may provide adequate protection. Also, thoroughly disinfecting climbing spikes with Lysol, Clorox, etc., between trees should help reduce the spread of the disease. Reducing stem cracks can bring about a reasonable degree of disease control by judicious attention to horticultural practices by avoiding extremes in moisture and fertilization which influence the quality and quantity of stem cracks of the coconut palm.

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Coconut Research and Development

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The palm family (Arecaceae), more commonly known as Palmae, is one of the largest in the plant kingdom, though it is mostly restricted to the tropics. Among the palms, the coconut (*Cocos nucifera*) is the most widely distributed. Most economic botanists agree that the coconut palm is the most useful tree to man because every part of this palm finds an active economic use. Further, this palm means much to the people of certain tropical countries because of its greater concentration there. The Philippines, Indonesia, India, and Sri Lanka are the principal coconut-growing countries of the world. Coconut also occurs as a cultivated or naturalized plant in several tropical countries of the New World.

The coconut palm is best known for the oil that its endosperm gives. Until about four decades ago, coconut oil was the most widely traded of all vegetable oils. Today, it ranks sixth in the world in terms of production and fourth in international trade following soya bean oil, palm oil, and safflower oil. It is also now one of the most expensive edible vegetable oils. The reason for this has been the more organized and aggressive research and development methods that have gone into the utilization and improvement of other oil-yielding plants and in their oil technology while those of the coconut palm have remained at best stagnant. Though the FAO has been organizing some working party meetings on coconut production, processing, and utilization, its impact on research and development efforts in the coconut has been possibly only marginal.

It is against this background that the Indian Society for Plantation Crops and the Indian Council of Agricultural Research organized an International Symposium on Coconut Research and Development, the first of its kind on this palm, at Kasaragod (Kerala State, India) from 27–31 December 1976 to mark the diamond jubilee year of coconut research in India. Coconut research was first begun in India (and for elsewhere in the world) in 1917 at Kasaragod, Nileshwar, and Pilicode by the Madras Agriculture Department. The symposium attracted over 320 scientists from India and several important coconut-growing countries of the world. The mark the occasion, the Indian Posts and Telegraphs Department issued a commemorative stamp depicting an early-bearing, heavy-yielding, hybrid coconut palm symbolizing the most notable research achievement of the last six decades (Fig. 1). A philatelic competition and exhibition on two themes "Coconuts on Stamps" and "Plants on Stamps" was also organized at this time, possibly for the first time, along with a scientific program of this nature.

Dr. M. S. Swaminathan (Director General, Indian Council of Agricultural Research, New Delhi) inaugurated the symposium with a keynote address "Coconut research—the next phase." He identified the major research problem in coconut as breaking the yield barrier which has remained consistently sta-

1. Facsimile of the commemorative stamp issued by the Indian Posts and Telegraphs Department on 27 December 1976 to mark the Diamond Jubilee Year of Coconut Research in India.

tionary with 30–40 nuts annually in cultivators' plots while some "super" palms have been observed that are capable of yielding over 600 nuts annually. He made a gap analysis of the problems involved in breaking this yield barrier. He also called for finding a solution to the root (wilt) disease of Kerala State, which is responsible for an annual loss of Rs.300 million (about US $35 million).

The symposium was organized in nine sessions in which 80 papers were presented. In the session on Genetics and Plant Breeding, 10 papers were presented. Of these, seven related to selection and breeding, and one each on cytogenetics, seed production, and sampling. Coconut has a long juvenile phase. It takes about 10 years under ordinary management conditions to come to stabilized yield. Several papers related to developing methods for identifying high-yielding and prepotent palms at the seedling stage or from seedling characters of the progeny. Satyabalan and Jacob Mathew (CPCRI, Kasaragod) presented data which showed some possibilities for identifying potentially high-yielding palms in the fifth month based on leaf number and girth at collar.

Ninan (Kerala University, Trivandrum) and Bavappa and Sukumaran (CPCRI, Kasaragod) called for intensifying research on utilizing "dwarf" palms and their hybrids with "tall" palms. Rognon and de Nuce de Lamothe (IRHO, Paris and Port Bouet) presented data on xenia and combining ability in the coconut palms. Balingasa and Carpio (Philippine Coconut Authority, Davao City) discussed the prevalence of wide variability occurring in the natural populations in the Philippine Islands. This is understandable as the Philippines possesses the largest area under coconuts in the world and is also considered by some authors as its center of origin.

The session on Agronomy and Soil Science transacted 10 papers. In a paper on the effect of moisture stress and irrigation on yield, Abeywardena (Coconut Research Institute of Sri Lanka, Lunuwila) attempted to establish a quantitative relationship of high predictability between drought index and coconut yield. Relevance of soil and leaf analysis in relation to the nutrition of high-yielding coconut genotypes was brought out by Kamala Devi et al. (CPCRI, Kasaragod) by using data on changes in both total and available nutrition. Several reasons, as the long juvenile phase, the wide planting distance of 7.5 m^2, the almost stagnating yield, and the ever-increasing pressure on land, have made it imperative to develop methods to increase the productivity of coconut gardens. Two papers dealt with this aspect (Ramadasan et al., MARDI, Kuala Lumpur; Sahasranamam et al., CPCRI, Krishnapuram), the former relating to intercropping coconut gardens with cacao, and the latter to a mixed farming program consisting of fodder grasses and legumes planted in interspaces of coconut, maintaining milk cattle, and recycling cattle wastes. These and such other systems are already being practised by the coconut farmers from time immemorial, but more as a way of life rather than as an efficient economic activity as was sought to be presented here.

Nine papers were presented in the session on Biochemistry and Physiology. Three dealt with chemical properties of coconut products like toddy, coconut water, and copra. Samarajeewa et al. (Coconut Research Institute of Sri Lanka, Lunuwila) presented a practical and easily workable method for efficient fermentation of toddy. In a paper that was read in absentia, Milburn (University of Glasgow) discussed the vascular physiology of this palm. More than anything else, it showed how little was known about the basic physiology of the coconut palm despite its considerable economic importance. Milburn proposed that sap concentration in this palm was maintained homeostatistically to a considerable extent as in other plants, and sap was driven through the sieve tubes by pressure.

The session on Technology saw the presentation of eight papers. The underlying current of most of them was stressing the need for making concentrated efforts to improve the yield and quality of oil by developing efficient and cheap methods for drying coconut kernel into copra and for reducing spoilage of both copra and oil during storage. This session called for developing a technique for extracting part of the oil from fresh endosperm. This would permit both recovery of some oil and also use the partially "spent" endosperm for culinary purposes. Timmins (Tropical Products Institute, Culham) gave an account of the traditional and modern methods of wet-milling fresh coconut kernel. Nambiar (Chemical Construction Company, Madras) presented the economics of the "Solvol" process. The other papers presented in this session related to the industrial utilization of coconut husk for manufacture of coir and coir products as foot mats, mat filters, upholstery, carpets, etc. (Prabhu, Central Coir Research Institute, Alleppey), the microbiological processes involved in the retting of coconut husk (Bhat, Kasturba Medical College, Manipal), and production of activated carbons from fiber pith (Aslam Ali, Karnataka Carbons, Bangalore), and prestressed building materials from coconut husk and byproducts (George, Indian Plywood Industries Research Institute, Bangalore).

In the session on Basic Studies, seven papers were presented. Two related to efforts being made for the vegetative propagation of coconut palm (Schwabe, Wye College, Kent) and the characteristics of bearing palms raised by embryo culture (de Guzman, University of Philippines, Los Banos). Tissue culture offers considerable potentiality in a tree like the coconut palm with its long juvenile phase and obligate sexual reproduction. There was a consensus that work on this aspect should be intensified, especially in view of the recent success obtained in oil palm by the Unilever Laboratories in Sharnbrook, UK. In a paper on the association of coconut foliar asymmetry with latitude, Davis (Indian Statistical Institute, Calcutta) presented data on the spirality of over 60,000 palms recorded from 38 countries in both hemispheres, which were found to be 52% left-spiralled. Asymmetry was also shown to increase with increasing latitude in both hemispheres.

Origin of the coconut palm is a highly controversial point and considerable arguments have been put forward in support of both Old World and New World origins. Nayar (CPCRI, Vittal) argued that there was no need to assume the existence of a truly wild coconut palm either now, or in the immediate past, since, as with many other tropical plants used by man, the present-day coconut palm does not also appear to have made any significant evolutionary advancement as a result of deliberate cultivation by man. The germ plasm collections made from around the world, including the numerous islands in the South Pacific and Indian Oceans, do not show the presence or prevalence of genuinely primitive and advanced characters for even the economic attributes.

The highlights of the symposium were the two sessions on Diseases and Diseases of Uncertain Etiology. Unlike most other economic plants, the coconut palm is affected by a number of diseases of uncertain etiology like the cadang-cadang disease of the Philippines, the thattipaka and root (wilt) diseases of India, kaïnkopé disease of tropical West Africa, and lethal yellowing of the West Indies. There are also other maladies like the red ring, bud rot, stem bleeding, and hartrot diseases for some of which etiology has been only "vaguely" determined if at all. The 14 papers presented in these two sessions, however, brought out the feeling that the intensive, often international, cooperative research efforts underway on many of these diseases are beginning to bear fruit and that the workers are "closing in," as was termed by Swaminathan, on determining the etiology of some of them. For instance, Giannotti (Station de Recherches Cytopathologiques, St. Christol les-Ales) obtained evidence to suggest that the coconut yellow disease of West Africa was caused by microplasmalike organisms. Randles' (University of Adelaide, Glen Osmond) paper pointed out that in cadang-cadang disease, he discovered two low-molecular weight RNA species, which were structurally similar to two of the known viroids—potato spindle tuber and citrus exocortis viroids. Tsai and McCoy (both of the University of Florida, Fort Lauderdale) presented data on the attempts to transmit lethal yellowing of coconut palms by suspected vectors and the successful use of oxytetracycline for prophylactic and therapeutic treatment. Maramorosch (Rutgers, New Brunswick) gave an overview on the present status of rickettsialike and mycoplasmalike diseases of plants and their relevance to the coconut palm diseases. Regarding the etiology of Kerala wilt, he proposed that interactions between disease agents, plant hosts, and insect vectors could be manipulated to prevent the spread of the disease even if the etiology were uncertain. The need to determine the role of the burrowing nematode *Radopholus similis* in the root (wilt) disease was stressed by Ramakrishnan (University of Agricultural Sciences, Bangalore), especially since it has been found to cause extensive root damage in this palm.

In the session on Pests, seven papers were presented and they generally emphasized the need for adopting improved methods to control the various pests. The serious damages caused by rhinoceros beetle and the leaf-eating caterpillar in many coconut-growing countries were stressed in several papers.

In the session on Developmental Programs in India and other Countries, 16 papers were read. Six papers pointed out, more than anything else, the large gaps existing between the research findings obtained in the laboratories and the practices adopted by the farmers and the inadequacies of present extension methodology in transferring the knowledge to the farmer community. In this context, Venkataraman (Directorate of Agriculture, Madras) recommended for adoption by other coconut-growing countries the organizational structure for research and development of Sri Lanka and Jamaica.

In the Plenary Session, the delegates recognized the need for maintaining and strengthening the contacts made by the coconut research workers during the symposium. It was decided to form an international secretariat with its headquarters at Kasaragod (Kerala State, India) for the present for this purpose. All the delegates agreed that this symposium, the first of its kind on coconut, was successful in bringing together a large number of coconut research workers from several countries of the world. It also took note that others had been invited but that travel expenses for several other foreign delegates had not been forthcoming.

The proceedings of the symposium will be published in late 1978 by Wiley Eastern Limited, New Delhi.

Principes, 22(2), 1978, pp. 74–76

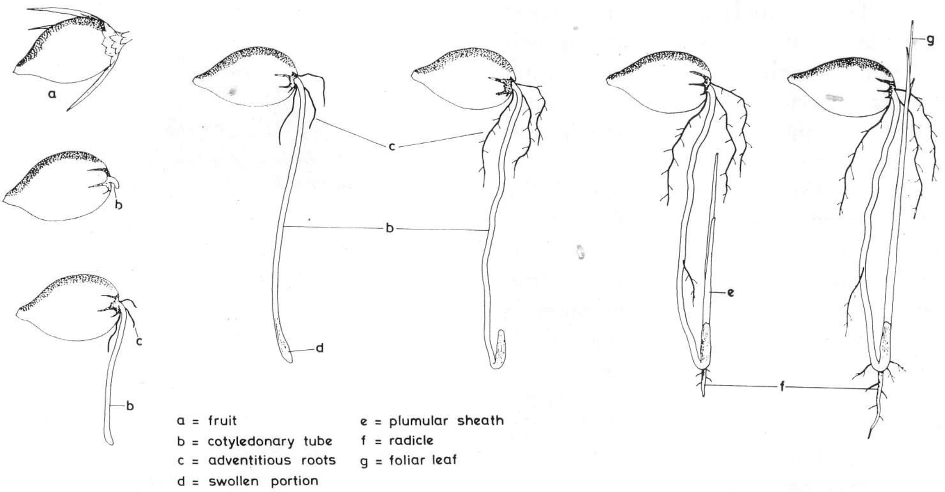
PALM BRIEFS

Mode of Germination in *Eugeissona tristis* Griff.

The lepidocaryoid genus *Eugeissona* with five species occurs only in the Malay Peninsula and Borneo. The species *E. minor* Becc., *E. insignis* Becc., and *E. utilis* Becc. are all Bornean. The two Malayan species are *E. brachystachys* Ridl., which is endemic to the National Park, Pahang, and *E. tristis* Griff., the common bertam (Fig. 1) occurring throughout dryland forests in the lowland and to about 2,500 ft in the mountains. There is little variation within the species *E. tristis* and only one variety (var. *gracilis* Dransfield) has been described from specimens collected in Johore.

The germination pattern of *E. tristis* does not conform to the variations described by Tomlinson (1960) for palm seedlings. Perhaps it is worthwhile here to present the sequence of events observed for discussion.

1. The clump-forming, "stemless" *Eugeissona tristis* at the fringe of the forest.



2. Sequence of germination of *Eugeissona tristis.*

The first sign of germination is a small protrusion formed by the cotyledon bursting through the micropyle at the basilar end of the palm fruit. This protrusion, which is positively geotropic, elongates and forms the extension or cotyledonary tube extricating the plantlet (radicle and shoot apex) from inside the seed to well below the soil surface. Lying within the seed in endosperm the remaining half of the cotyledon becomes modified as a suctorial organ that swells to fill the entire cavity of the seed. The cotyledonary tube grows to a mean length of 21.86 ± 0.69 cm before orientating itself upright. The apex of the tube, which continues to push itself upwards in the soil, enlarges slightly. The plumule lies inside this swollen portion. The first plumular leaf or eophyll, which consist of a protective sheath, breaks through the apex and soon emerges

Table 1. Germination pattern of seedlings for 18 weeks after initiation of growth

	Cumulative percentage of total seedlings recorded			
Weeks*	Cotyledonary tube orientates upright	Appearance of swollen apex	Plumular sheath develops	First eophyll comes above ground
0	—			
2	—			
4	—			
6	25.00			
8	58.33			
10	83.33	20.83		
12	100.00	58.33	0.04	
14	—	91.66	41.66	
16	—	100.00	83.33	16.66
18	—	—	91.66	33.33

* Time as recorded from the first signs of germination.

above the ground level. Subsequent foliar leaves or eophylls issue through this protective sheath and are compound and pinnate, not unlike the adult fronds except that the number of leaflets per frond is less.

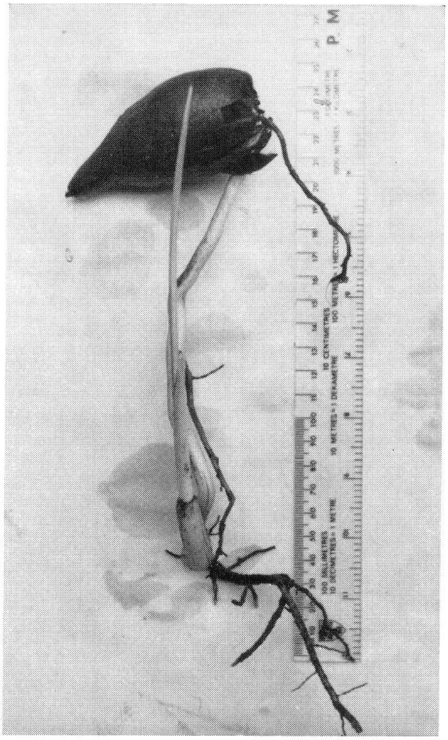
Shortly after the emergence of the cotyledonary tube, a few adventitious roots develop from near the orifice of the pericarp and grow downwards into the soil. The appearance of the plumule is preceded by that of the radicle, which develops from the base of the 'hook' where the cotyledonary tube turns negatively geotropic. More roots follow the development of the radicle at the base of the growing shoot.

The germination of *E. tristis* seems to comprise three phases:

i) the extrication of part of the embryo from the seed in an undifferentiated state within the cotyledonary tube,
ii) the cotyledonary tube plunges to a length of several centimetres in the soil before turning upright and
iii) the plumule breaks through the distended region of the cotyledonary tube, and the first eophyll emerges from it above ground, the radicle elongating in the opposite direction below (Fig. 2).

Table 1 records the approximate time sequence of the various stages in the germination process. About half of the seedlings observed in a trial had produced a cotyledonary tube that began to grow upright by the eighth week. Towards the sixteenth week (Fig. 3) about a third of them had produced their first eophyll above ground. Thus, although the seeds had germinated for sometime they normally do not appear on the soil surface till another four months or so in the field.

Throughout the first year of its existence the seedling produces three to four leaves with an average length of 64.00 ± 0.54 cm. The first foliage leaf appears about five months after germination of the seedlings, followed by the second and third leaves in about another four to five months later.



3. Seedling of *Eugeissona tristis* 16 weeks old.

Literature Cited

Tomlinson, P. B. 1960. Essays on the morphology of palms. I. Germination and the seedling. Principes 4: 56–61.

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NEWS OF THE SOCIETY

News from California

The regular meeting of the Southern California Chapter was held on Sunday, October 16, 1977 at the home and garden of Loren Whitelock, a member in Los Angeles. There, well over 100 people had the opportunity of seeing the finest private cycad collection in the USA. Loren has many rare and mature cycads planted out in a beautifully landscaped two-acre garden on a hillside. While he admits that palms are not his first love, nonetheless he has many very beautiful and mature specimens, particularly of *Caryota, Rhapis, Trachycarpus,* and *Chamaedorea.* A plant sale was held with the sellers donating 20% of their gross proceeds to the Chapter; this benefited the treasury by the amount of $210.

The Southern California Chapter had a dinner meeting on January 21, 1978, at the Cafe del Rey Morro in the midst of San Diego's famous Balboa Park. Speaker was Ernie Chew, Chief Horticulturist of the well-known San Diego Zoo and in charge of what is being developed to become probably the most extensive public palm collection in California. His talk was excellent and greatly enjoyed by those present. A big palm raffle was held beforehand, with proceeds to be added to the Biennial Meeting fund.

According to reports, the Annual Dinner Meeting of the Northern California Chapter on February 5, 1978, was an unqualified success with some 60 people in attendance. A short afternoon business meeting at 3:30 was followed by a most successful plant sale and auction. Afterwards the dinner was held at His Lordship's Restaurant on the Bay at Berkeley. Guest speaker here too was Ernie Chew, and the audience thoroughly enjoyed his talk describing the Zoo plantings and his plans for the future there. Those attending the Biennial Meeting in July from other parts of the country will have a chance to see the San Diego Zoo and its plantings under the guidance of Ernie Chew on Monday, July 10.

The Palm Society salutes member Theresa Yianilos who almost single-handedly has taken on the San Diego Unified Port District, which suddenly had cut down 42 palms on the waterfront near Pacific Highway and Market Street at the tidelands area. She was told this was to make way for a "beautification project," but she felt the palms should have been left and incorporated into the new plantings planned there. These palms were 60 to 80 feet tall and probably 75 years old. Apparently Mrs. Yianilos' efforts were successful as the tree cutting has been stopped, at least for the time being. She also protested the cutting or removing of palms in front of the Chula Vista City Hall. At this time we have no word on how this second project came out, but we will be able to find out for ourselves when we attend the Biennial Meeting. It does seem odd that a city like San Diego, in a region where palms are indigenous, should resort to removing palms and replace them with other types of trees. After all, San Diego could and should pride itself on its tropical look and plant more palms rather than less. We congratulate Theresa Yianilos and hope she succeeds in her crusades.

News from Florida

The Miami area members were treated to a show of slides by Mel Sneed on February 23 at Simpson Memorial Garden Center. The Sneeds had taken a trip to Australia, New Zealand, New Caledonia and Fiji in late fall so their slides were about that fascinating trip. We enjoyed also seeing pictures of members in those areas whom we knew only by name. The Sneeds said their trip had been greatly enhanced by these members whom they visited along the way. Hospitality and help given by members to each other are proving to be an increasing pleasure to those who travel far from their own home areas.

TEDDIE BUHLER

David Barry, Jr. 1897–1978

One of our most dedicated charter Palm Society members, David Barry, Jr., died February 1, 1978, at his home in Santa Monica, California. He leaves his wife, Emilie, a daughter, Mrs. Charles T. Munger, a son, David Barry III, a sister, Helen Barry, and nine grandchildren.

Mr. Barry was born in Houston, Texas, but from 1902 on made his home in the Los Angeles area and Honolulu, Hawaii. After graduation from Stanford University in 1920, he joined his father in the Wilshire District real estate firm of David Barry & Co. After service with the Office of Price Administration during World War II, he moved the firm to Brentwood, where he owned and developed business property until 1953, when he became relatively inactive in this field. In the early 50's, Mr. Barry's plant hobby was commercialized as California Jungle Gardens, a nursery specializing in the introduction of tropical plants new to California. He was a past President and Director of The Palm Society, and was also a member of the American Horticultural Society, The Bromeliad Society, American Plant Life Society, and the Los Angeles Garden Club.

Mr. Barry's interest in palms began in 1930. His love of the tropics was so strong that, when he could not visit them, he introduced palms from the tropics as a substitute. His devotion was such that in the days before the overseas airplane he used tins as shipping containers for palm seeds, enclosed with moisture-retaining packing. For many years he operated an "International Palm Seed Exchange Service," with his tins going back and forth from botanical gardens and collectors. When on a trip around the world in 1957, he saw mature palms from his seed in such places as Panama and Durban, South Africa.

His intense efforts over the years to introduce cold-hardy palms into California will never be forgotten, as today in gardens, both botanical and private, there are many specimens that are living memorials to his dedication and interest, such as *Caryota ochlandra*, *C. urens*, *Chamaedorea brachypoda*, *C. fragrans*, *C. klotzschiana*, *Chambeyronia macrocarpa*, *Jubaeopsis caffra*, *Linospadix*, *Neodypsis baronii*, and many others.

Mr. Barry's enthusiastic interest was not in palms alone, as he had a keen interest in bromeliads, cycads, and a variety of tropical plants. In the early 50's he introduced *Philodendron selloum*, followed by many hybrids of his own. But he must be considered "the grand old dad" of California palm people.

PAULEEN SULLIVAN

Biennial Meeting

If you have not already done so, there is still time to sign up for the Biennial Meeting in San Diego and Los Angeles, California, July 8–14. An entertaining and instructive series of talks and garden tours has been arranged, as well as optional tours to the San Francisco Bay Area, Baja California, and Costa Rica. For a leaflet containing programs and cost schedules, write to Jim Wright, 2151 Burghener Blvd., San Diego, CA 92110.

PALM LITERATURE

FOX, JAMES J. 1977. Harvest of the palm: ecological change in eastern Indonesia. Harvard University Press, Cambridge, Massachusetts and London, England. 290 pp.

In this book Fox brings ecological, economic, and historical perspectives to support the surprising conclusion that on two islands of eastern Indonesia, present day gatherers have a major advantage over the agriculturists with whom they are now competing. The focus of the study is on drier regions, specifically on Sumba, Savu, Roti, and Timor, four of the Lesser Sundas, an arc of seven islands lying to the east and south of Sumatra, Java, and the other islands of the main Sunda chain.

The book is divided into three unequal and dissimilar parts. Part One examines the economies of Roti, Savu, and to a lesser extent the small island of Ndoa, and contrasts these systems with the slash-and-burn or swidden agriculture practised on the larger islands, Sumba and Timor. The economies of Roti and Savu are found better adapted to present ecological conditions and have the capacity to support far higher population densities than can the traditional economies of either of the large islands. The economic pivot on Roti and Savu is the gathering or tapping of the inflorescences of the *lontar* palm, *Borassus sundaicus*. The juice obtained is drunk fresh or made into syrup, sugar, or gin. Other parts of the *lontar* and of the *gewang*, *Corypha elata* are also utilized. The author finds that, "By nature of their palm economies, both populations (Roti and Savu) had the means to support educational specialization, the social discipline to accept it, and youth with enough free time to take advantage of it."

Part Two, the longest section of the book, provides a chronicle of events on the four islands over the past 300 years to show how the economies of the islands have developed. Two chapters of this section discuss the intricate background of island relations and the effects of the Dutch East India Company. Two parallel chapters consider the Rotinese and Savunese in the nineteenth century, and a fifth chapter deals with ethnic relations in the twentieth century.

Part Three presents an introduction to the *Borassus* palm and compares the *Borassus* economies represented by 1) Roti and Savu, 2) Madura and, 3) Ceylon and South India. The book is excellently documented with quotations from many sources, and ten tables, three figures, and eight maps giving population figures, geographic, and historical data. Nineteen halftones illustrate palm usage and Rotinese and Savunese peoples. A section of notes and an appendix provide further explanation for the text.

The arguments are based on an impressive amount of careful research. Fox's studies began in 1962, involved learning Dutch, Indonesian, and several island dialects, long periods of field studies on the islands, and extensive work on archives in Holland. In this book, a prelude and base for further studies, he has skillfully interwoven detailed information on current practises with the historical circumstances that fostered them. The result is certain to be valuable to anthropologists, economists, and historians, and provides a fascinating chronicle for those interested in palms.

Parts One and Three deal intensively with the palms. Frequent references to the palms are also made in Part Two and some of these are extremely interesting, such as the long description and many quotes from Captain Cook's account of the uncharted Savu islands as he encountered them in 1770. Fox writes, "Certain palms are inextricably involved in human history. For centuries they have offered various peoples of the world a means of sustenance and, at times, of near-total subsistence. Whole cultures can legitimately be described as adaptations to certain species of palm . . . ." *Harvest of the Palm* provides an intriguing account of this involvement for *Borassus*, a genus still poorly known, but second only to the coconut in numbers of individuals in the Old World.

NATALIE W. UHL

DUGAND, A. 1976. Palmarum Colombiensium elenchus. Cespedesia 5: 257–336, figs. 79–88.

A posthumous listing of the palms of Colombia revised by and with a preface and list of synonyms by R. W. Read and with a list of vernacular names by V. M. Patiño. This was published with a reprint of Dugand's "Palmas de Colombia," which originally appeared in 1940 and is now out of print.

FISHER, J. B. AND H. E. MOORE, JR. 1977. Multiple inflorescences in palms (Arecaceae): their development and significance. Bot. Jahrb. Syst. 98: 573–611, figs. 1–76.

Multiple inflorescences in six major groups of palms are considered in the context of morphology, development, and taxonomic and biological significance.

GLASSMAN, S. F. 1977. Preliminary taxonomic studies in the palm genus *Orbignya* Mart. Phytologia 36: 89–115.

A preliminary key to 18 species of *Orbignya* and three related species is accompanied by an aphabetical listing of species with synonyms, types, specimens examined, and comments but no descriptions.

GLASSMAN, S. F. 1977. Preliminary taxonomic studies in the palm genus *Scheelea* Karsten. Phytologia 37: 219–250.

Twenty-eight species of *Scheelea* are treated as for *Orbignya* above, except that one species is not included in the key.

Twenty-year Index to Principes

The index to the first 20 volumes of Principes (1956–1976) was prepared by the editor to provide ready access to information in these volumes. The contents have been cross-referenced in 68 pages printed separately and available at $3.00 each from Mrs. T. C. Buhler, Executive Secretary, 1320 S. Venetian Way, Miami, Florida 33139. The index was published as a service to members of The Palm Society and is priced to cover cost and mailing. In the following sample, volume numbers are followed by a colon and a page number, and entries are separated by a semicolon.