PRINCIPES

Journal of The Palm Society

July, 1981
Vol. 25, No. 3

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

Contents for July

Cover Picture

Archontophoenix cunninghamiana in rain forest, Mt. Glorious, Maiala National Park, Queensland, Australia (see page 130). Photo by W. H. Hodge.

PRINCIPES

JOURNAL OF THE PALM SOCIETY

(ISSN 0032-8480)

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

Subscription price is $9.00 per year to libraries and institutions. Membership dues of $15.00 per year include a subscription to the Journal. Single copies are $3.00 each. The business office is located at **P.O. Box 368, Lawrence, Kansas 66044.** Changes of address, undeliverable copies, orders for subscriptions, and membership dues are to be sent to the business office.

Second class postage paid at Lawrence, Kansas

Mailed at Lawrence, Kansas
July 13, 1981

Principes, 25(3), 1981, pp. 91–100

The Sago Palm and its Exploitation on Siberut Island, Indonesia

ANTHONY J. WHITTEN AND JANE E. J. WHITTEN
Sub-Dept. of Veterinary Anatomy, University of Cambridge, Tennis Court Road, Cambridge CB2 1QS, U.K.

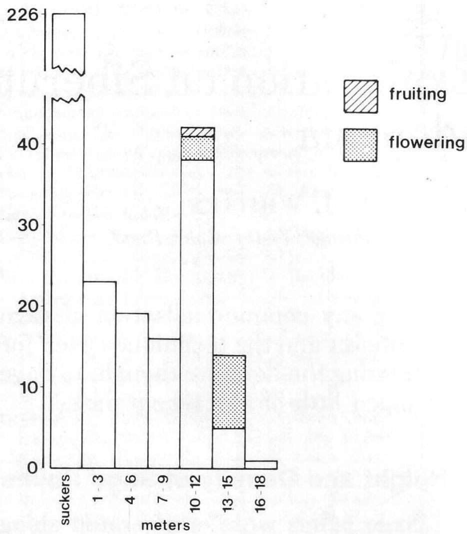
Starch from the sago palm *Metroxylon sagu* is the staple food of the majority of people living on Siberut Island, the most northerly of the Mentawai Islands in Indonesia (see map, Principes 24: 146). We lived on Siberut for two years between 1976 and 1978 studying aspects of wildlife ecology (e.g. Whitten 1980a), but in early 1978 we undertook some subsidiary work on sago. Sago palms are found throughout the island in inland swamps and some were also seen growing in brackish water near the east coast. The most common form of the palm had a smooth petiole but those with a thorny petiole were also present.

The indigenous people arrived on Siberut about 3,000 years ago (R. Schefold pers. comm.), and their cultural level is essentially Neolithic with some Bronze Age influences, unaffected by Buddhism, Hinduism or Islam. The local name for sago is *sagu* (*tagu* in the northwest) which suggests that the palm was introduced relatively recently; prior to this the taro root *Colocasia esculenta* would have been the staple.

There are descriptions of sago processing from many areas in the Old and New Worlds (see Ruddle, Johnson, Townsend, and Rees 1978 for references) but no description of the rather different methods employed on Siberut has been published. Despite the high production potential of sago and its suitability for storage, there is hardly any commercialization of sago on Siberut and the techniques used for extracting the flour are thought to have changed little in the recent past.

Height and Density of Sago Palms

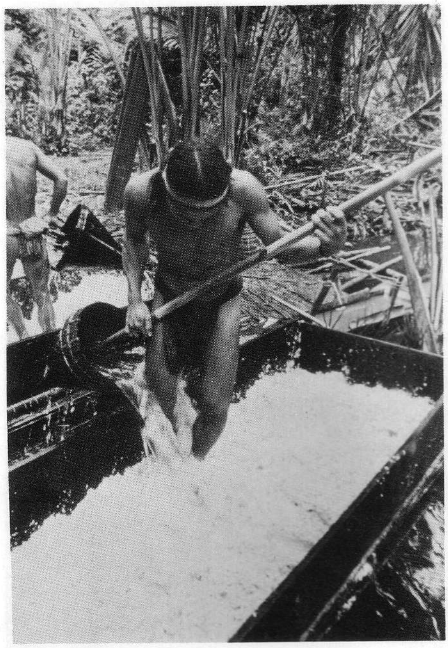
Sago palms were enumerated along a 25 × 352 m transect (0.88 ha) in the swamp near camp, and notes were made of their reproductive state. A camera fitted with a 400 mm lens was used to measure trunk heights above 6 m (see Whitten 1980b for a description of this method). Below this, heights were estimated by eye. The results are shown in Fig. 1. The shape of the histogram suggests that growth is rapid up to about 10 m by which time there is less competition for light, and energy can be diverted to increasing food stores prior to flowering. Other published data on the heights of *Metroxylon* are sparse, but it would appear that those on Siberut are very tall. Whitmore (1973) reports 9 m to be a common height and the two trees described by Lea (1964) were about 10 m. About a quarter of the trees over 10 m in our transect had been allowed to flower, suggesting there are more trees than the people need. The data are insufficient to calculate the number of trunks felled per hectare per year, but the figure is probably between seven (found by Edwards 1961 as cited in Townsend 1974, and Townsend 1969) and 10–15 (found by Morris 1953).



1. Distribution of trunk heights of sago palms along a 25 × 352 m (0.88 ha) transect.

3. View of *pusaguat*.

2. Chopping the pith.



4. Treading the pith.

5. Using the conical bucket.

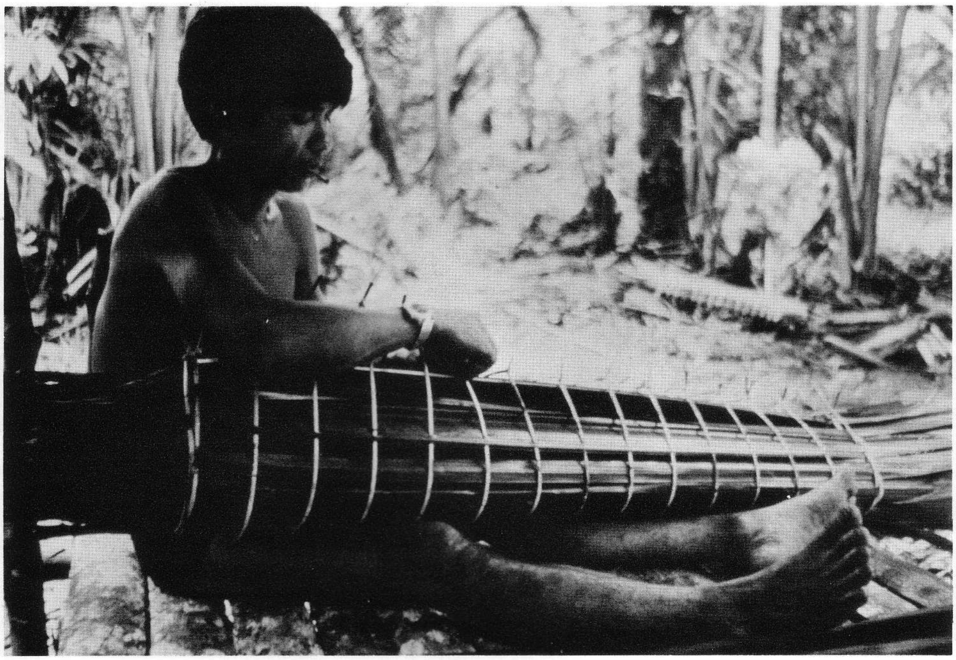
Selection of Trees

Not all sago palms are processed for their flour. Those standing in free water tend to have yellow tips to their leaves and if cut ooze water. Experience has shown the people that such trees yield less flour than others and its taste is less acceptable. These trees are used for grubs or for feeding to stock. Trees felled for flour generally exceed 12 m, are found in damp drained ground, and have a dry pith. Similar correlates are reported by Townsend (1974).

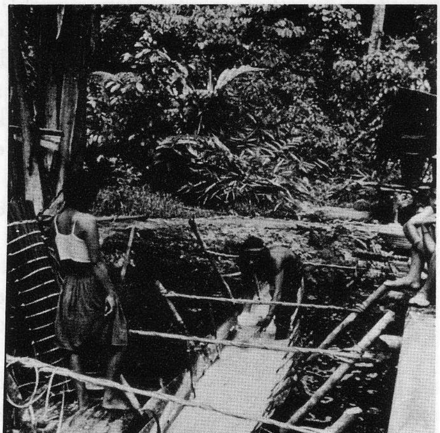
Preparation and Processing

Climbing plants such as orchids and the pandans, *Freycinetia sumatrana* and *F. klossii*, are cleared from the lower trunk before a broad-bladed *parang* is used to cut the bark on the felling side. The pith is cut out using a heavy axe and when a wedge penetrating halfway into the trunk has been cut, the tree is viewed at a distance to check precisely where the trunk will fall. Sago leaves are lain at right angles to the angle of fall to prevent the trunk sinking into the swamp, and then the final cuts are made with the large *parang* on the opposite side of the trunk just above the wedge.

A *repah*, the breadth of outstretched arms, is measured from the base of the trunk and the bark is cut along the top of the trunk to this point and around as far as possible. A *repah* is about 1.4 m. The bark is peeled back either side of the trunk and used as a platform to work from. The pith is grated using a hewn curved plank studded with dozens of stout nails. This is drawn back and forth across the pith and the gratings collected. These are chopped finely by using broad and standard *parangs* (Fig. 2) and when ready, are placed in large

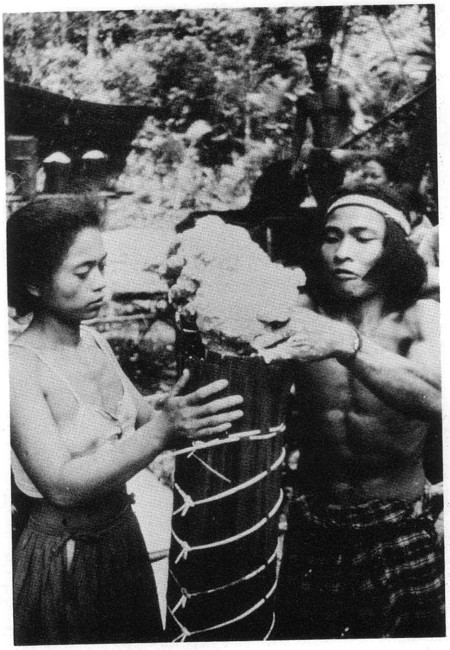


6. Man making a *tappri*.



7. The dugout canoe full of flour.

8. Scooping up the flour.



9. Filling a *tappri*.

10. Storing *tappri* of sago below the swamp.

carrying baskets, or *bolokboks*, made from sewn sago leaf bases.

The fine pith is carried to the site of flour extraction, or *pusaguat* (Fig. 3), where the flow of water through the swamp has been dammed to form a pool of deep water. Over the pool is built a platform which supports a sieve about 2 × 1 m, the base of which consists of fibres from the petiole of the forest palm *Arenga obtusifolia*. Below the platform are screens of sewn sago leaflets which divert water falling through the sieve into part of a dugout canoe. This channels water into a complete canoe which is anchored firmly to stakes driven into the ground.

A basketful of pith is tipped into the sieve and a man treads up and down on this while pouring water over his feet (Fig. 4). Water is collected in a conical bucket made from sewn sago-leaf bases, which is attached to a length of bamboo (Fig. 5). As the pith is rubbed and crushed, milky water flows into the canoe. The flour sinks and the water flows over the edge.

While the canoe is being filled with flour, sago leaflets are collected to make the flour containers or *tappri*. These are made by overlapping the leaves and sewing them together, thereby making a double-walled container, which is tied at one end (Fig. 6). When the canoe is full (Fig. 7), any remaining water is removed and the sticky flour is gathered in handfuls and dropped into the *tappri* (Figs. 8, 9). When a *tappri* is full it is put on one side and hit with a flat piece of *Oncosperma horridum* wood, a *popopo*, to settle the flour and to remove air and water before being tied at the top.

Storage

The *tappri* are stored in mud below free water in the swamp (Fig. 10). This

Table 1. Nutritional breakdown of sago flour produced from the sample tree. Analysis performed by Balai Penelitian Kimia, Bogor

	% Contents
Moisture	39.5
Ash	0.35
Protein	1.44
Carbohydrate	57.8
Crude fibre	0.14
Fat	0.48
Ca	0.11
P as P_2O_5	0.18
Calorific value	265 per 100 g

is an anaerobic environment and there is no noticeable deterioration after a year. The people find dried sago distasteful and *tappris* are only taken from the swamp when required.

Cooking

Three methods of cooking were observed. First, the flour was sifted and a handful placed on the lower half of a sago leaflet. The upper half was brought down on top and the long, thin parcel, or *purut*, was bound with a strip of leaflet. These were cooked at an angle over an open fire until the outside of the flour 'sausage' became crisp and slightly brown, and the inside slightly glutinous. A second approach similar to the above used a long-noded bamboo, or *obbuk*, to hold the flour. Sago cooked in this way did not become crisp. Third, the flour was tossed in a *wok* until separate and dry. In all these methods grated coconut and salt were sometimes added to the flour while it was being sifted.

Productivity

The processing of one tree was followed in detail. The part of the trunk that was processed was 15.3 m long and had an average pith diameter of 43 cm. The volume of pith was therefore 2.22 m^3.

The length of time spent working each day varied between 30 min and 10.5 hrs, and up to three men and two women assisted. The work period lasted twenty days but this included interruptions caused by bad weather and festivals not associated with sago making. The man-hours (excluding breaks and walking) involved in the different stages were as follows:

Activity	Man-hours
Preparing site and felling palm	2.5
Processing pith	218.0
Making, filling and storing *tappri*	16.0
Overall	236.5

The flour produced filled fourteen *tappri* which had a mean internal height of 105 cm and an internal diameter of 22 cm. Thus, 0.56 m^3 was retained representing 25% of the original pith volume. The total weight of the *tappri* was 618.8 kg (allowing for the weight of the leaves).

The leaflet parcel (*purut*) varied little in size and was used therefore in calculation of consumption. The mean weight of the contents of a *purut* was 62 g ($n = 30$) (s.d. 1.5), and so the one tree we examined would have provided $\pm$10,000 *purut*. During a day of hard labour, a man may consume 20 *purut*, assuming there were no alternative sources of starch such as taro, banana, or rice. The minimum number of man-food-days the tree would supply is 500.

A sample of sago flour was analysed (Table 1) and the high starch/low protein composition found by Peters (1957) was confirmed. The efficiency of sago processing has been expressed by Townsend (1974) as the man-hours

11. Splitting a sago palm to attract weevils.

12. A bucket of weevil larvae.

required to produce one million kcals (kilocalories). The processing of the trunk on Siberut required 146 man-hours/million kcals which is very similar to the figures of 154 and 157 found in New Guinea by Lea (1964) and Townsend (1974) respectively. Detailed quantitative comparisons are invalid because of the variation in flour moisture (Ruddle et al. 1978), and the different study methods used.

Sago as a Source of Protein

Insects

Sago palms are sometimes used to grow weevil larvae (Anon. 1977). On Siberut, palms unsuitable for flour production are split along one side either after felling or while they are still standing (Fig. 11). In the latter case, splitting begins at the base and the tree is bound at intervals with rattan cane. The split is held open with wooden wedges in both cases. The aroma of the pith attracts adult weevils (*Rhynchoporus ferrugineus*) which lay their eggs in it; only this one species was found.

We assisted in the extraction of grubs from a standing tree that was felled 55 days after being split. (Trees that are felled before being split are said to take longer before the grubs are ready.) The trunk was 12 m long and 1380 grubs weighing a total of 11.7 kg were collected from its fermenting pith (Fig. 12).

The process entailed 10 man-hours of work. Protein comprised 25% of the grubs' dry weight and they had a calorific value of 591–675 kcals per 100 g (two samples of the edible portion; the inedible heads comprised only 0.3% of the weight). This represents an efficiency of 133 man-hours/million kcals.

Stock

Trunks were cut into roughly meter lengths and divided into quarters which were soaked in the rivers and fed to domestic pigs and in a few areas to buffalo. Domestic fowl also feed on these but raw sago, *soirappik,* is often grated and mixed with grated coconut for them and their chicks.

Organization of Work

Men fell the palms and grate and tread the pith (Fig. 5). None of the work of producing sago flour appears to be performed exclusively by women but they help to chop the pith and fill the *tappri* (Figs. 2, 9). Cooking sago in a family context is a female reserve.

Other Uses of Sago

As over much of Southeast Asia, sago leaflets are bent around split bamboo and bound with split rattan canes for making units of thatch. A handful of leaflet rachides are bound and used as a broom. The sago trunk is said to be the best firewood available on Siberut and it is also occasionally used for house walls. The leaf bases are stripped and sewn together to make a range of handbags, baskets, and rucksacks. Sago pith is used as bait in two ways; raw pith attracts Mentawai macaques *Macaca pagensis* into traps built in the forest, and a handful of pith from a trunk felled for grubs is bound in sago leaflets and placed in fish traps. Both baits are said to work extremely well.

Myths

We collected only one story relating to the gathering of sago (Whitten, in press). It tells how, one day before sago palms grew on Siberut, a girl and her mother went prawn fishing in a stream. The girl began to sob and when asked by her mother what was wrong, cried that she wanted to eat sago. The mother was mystified because she had no idea was sago was. However, the girl kept crying out for sago and refused all other food. Back at their house, the father tried to comfort the girl but with no success. Eventually the girl's unabated demands for sago so infuriated the father that he flung her onto the ground where she died.

That night a sago palm grew out of the girl's body and by noon the next day it was full-grown. It spoke to the parents explaining to them that what they saw was a sago palm. It told them that if a hole were cut in the trunk near the base, sago flour would flow out and could be collected in a *tappri.* When more flour was required, the section above was to be pierced, and so on up the trunk, using a ladder to reach the top.

One day the mother was returning from the sago palm with a *tappri* full of flour when she tripped over a root, causing her *tappri* to split open, spilling and wasting the contents. She was so angry that she hit the sago palm, blaming it for tripping her up. She made another *tappri* and made another hole in the trunk but no flour flowed out. This made her even angrier, and taking an axe she felled the sago palm. The other sago palms that had grown up were so horrified that they vowed they would neither release their flour so easily again nor let the women extract it, and so they instructed men in the process of gathering sago that is employed today.

The themes of sago palms arising from dead humans and of sago starch originally flowing from the palm without human effort are common motifs in sago myths (see Adrian and Kruyt 1951, Schlesier 1965, Schuster 1965, Townsend 1969, Haberland and Seyfarth 1974).

Conclusions

Throughout the whole of insular Southeast Asia there has been a shift away from sago to rice in the human diet (Ave 1977). While we were on Siberut we found that local government officials discouraged sago as human food and encouraged rice to be eaten in its place, the major argument given being that sago flour lacked protein. In the villages which have had the longest contact with local government it was hard to find sago flour and youths there were said to have no sago-making skills. The high rainfall (±4300 mm p.a.), the lack of a true dry season (Whitten, 1980b), and the inability of most of the people to afford the means of defending rice crops from the many potential rice pests, make rice an unsuitable crop on Siberut at present.

The processing of sago palms for their flour demands very little capital investment in tools and equipment and, although the flour is indeed poor in protein, it requires such little effort to extract in comparison with other foods (Townsend 1974, Ruddle et al. 1978), that additional protein may easily be gathered. People living in coastal and riverine habitats who use sago supplemented by fishing and/or horticulture are able to exploit the full potential of sago as a basis for economic intensification and to lead a more sedentary life. The Province of West Sumatra, of which Siberut is part, currently imports starch from West Malaysia for use in the manufacture of animal food stuffs (G. Persoon, Pers. comm.). It is to be hoped that Siberut sago might one day be substituted for these imports and thereby contribute to the provincial economy.

Acknowledgments

We were sponsored in Indonesia by the Indonesian Institute of Sciences, the Office of the Governor of West Sumatra, and the Faculty of Life Sciences, Andalas University.

We are grateful to the Director of the Balai Penelitian Kimia in Bogor for arranging the analysis of sago samples and to Dr. Soenartono Adisoemarto, Director of the Zoological Museum in Bogor, for identifying the weevil specimens. Drs. John Dransfield, Gerard Persoon, and Kenneth Ruddle made helpful comments on the manuscript.

Most of all, however, we are grateful to Aman and Bai Bulit, and Aman and Bai Taklebangan for their tolerance of our timing them, weighing their food, and asking them interminable questions.

Literature Cited

Adriani, N. and Kruyt, A. C. 1951. De Bare's Sprekende Toradjas van Midden-Celebes. Vol. 3. Konoklijke Nederlandse Akademie van Wetenschappen, Amsterdam.

Anonymous. 1977. Sago-worms. (Rhynchoporus sp.). In Sago-76 (Koonlin Tan, ed.), Kemajuan Kanju, Kuala Lumpur.

Avé, J. B. 1977. Sago in insular Southeast Asia: Historical aspects and contemporary use. In Sago-76 (Koonlin Tan, ed.), Kemajuan Kanju, Kuala Lumpur.

Haberland, E. and Seyfarth, S. 1974. Die Yimar am Oberen Korowori (Neuguinea). Studien zur Kulturkunde 36. Franz Steiner, Wiesbaden.

Lea, D. A. M. 1964. Abelam Land and Sustenance. Ph.D. dissertation, Australian National University.

Morris, H. S. 1953. Report on a Merlanau Sago Producing Community in Sarawak. Colonial Research Studies No. 9. Colonial Office, London.

Peters, F. E. 1957. Chemical Composition of South Pacific Foods—An Annotated Bibliography. South Pacific Commission Technical Paper 100, Noumea.

Ruddle, K., Johnson, D., Townsend, P. K., and Rees, J. D. 1978. Palm Sago: A Tropical Starch from Marginal Lands. East-West Center, University Press of Hawaii, Honolulu.

Schlesier, E. 1965. Sagogewinnung auf Normanby Islands, Sudöst-Neuguinea. Baessler-Archiv 13:1–39.

Schuster, M. 1965. Mythem aus dem Sepik-

Gebiet. Basler Beiträge zur Ethnologie 2: 369–384.
TOWNSEND, P. K. 1969. Subsistence and Social Organizations in a New Guinea Society. Ph.D. dissertation. University Microfilms, Ann Arbor. (1974). Sago production in a New Guinea economy. Human Ecology 2: 217–236.
WHITMORE, T. C. 1973. Palms of Malaya. University Press, Oxford.
WHITTEN, A. J. 1980a. Arenga fruit as food for gibbons. Principes 24: 143–146.
———. 1980b. The Kloss gibbon in Siberut rain forest. Ph.D. dissertation, University of Cambridge.
———. (in press). The Gibbons of Siberut. Dent, London.

NEWS OF THE SOCIETY

Southern California

The Southern California Chapter held its fifth annual banquet at Sam's Seafood in Seal Beach. A no host bar preceded the very fine buffet dinner including terriyaki beef, barbecued chicken, rice, salads, and fresh fruit. One hundred and two people attended.

Following dinner the new officers were introduced. Allan Bredesen from San Diego became our chairman. New Subchairman are Walter Frey in Orange County, Louis Hooper in Los Angeles County, and John Tallman in Ventura County. Ross Wagner remains as treasurer and Frank Ketchum as secretary.

Guests at the banquet were Dick Douglas, Jim Mintkin, and Walter Haught of the Northern California Chapter. Dick was our guest speaker and gave an excellent slide presentation on chamaedoreas. His information on pollinating and propagating was of great interest to all those present. Past chairman Jim Wright presented a plaque to Lois Rossten for her outstanding work as chairman for the past two years. Concluding the program was a raffle of many beautiful palms.

The home of Dr. Phil Bergman in beautiful San Diego was the scene of our March 28th meeting. An estimated one hundred people came to see his magnificent hillside garden and enjoy his short talk on its development. The steep hillside presented many problems when installing decking and planting the palms.

Leland Hollenberg from the University of Redlands was our guest speaker and gave a very informative talk on how variegated *Raphis* palms are propagated and raised to specimen plants.

A plant auction was held to raise chapter funds. Al Bredeson and Walt Frey were excellent auctioneers.

FRANK KETCHUM

Principes, 25(3), 1981, pp. 101–105

Notes on the Phenology of Inflorescences and Pollination of Some Rain Forest Palms in Costa Rica

Stephen H. Bullock
Botany Department, San Diego State University, San Diego, CA 92182, U.S.A.

Individual palms usually do not maintain both "male" and "female" functions throughout the blooming period of a population, but overlap of these functions between or within individuals is obviously crucial to successful breeding. The spatial relationship of the sexes is diverse in palms, with hermaphroditic, monoecious, and dioecious species (Moore 1973). Also, the flowers may be massed on a few branches. An individual palm generally produces few—less than ten—inflorescences per year, and more than one inflorescence may or may not be active at the same time on one plant. Timing of flowering events on these branches and among them is important in the biology of palm reproduction.

In this paper I focus on the maturation of individual inflorescences. Notes are summarized in Table 1 including the sequence and duration of the sexual phases, the anthesis of flowers, and the ratio and number of flowers of each sex. What little is known of insects visiting the flowers is also presented, and the identified species are listed in Table 2. These notes are based on incidental observations made during December 1978–September 1979 at Estación Biológica La Selva in Costa Rica (10°25′N, 81°1′W, ca. 50 m altitude). None of the eight species has been studied in great detail, and the sample size for most statements here is small. However, the important distinctions and problems are clear. A study of the frequency of flowering by individual palms (P. A. Opler in prep.) includes some of the species mentioned here. Population, individual, and inflorescence phenology has been studied in the dioecious *Chamaedorea exorrhiza* at the same site (J. Perkins in prep.).

In *Prestoea* and *Iriartea* flowering of each inflorescence lasted about 2–3 weeks, with male flowers presented for the initial 10–14 days (in *Prestoea*, counts showed that early and late days had fewer male flowers opening). In both species there followed about two days with no flowers opening, and finally the females all bloomed over a period of about three days. Flowers of both sexes were diurnal (but females of *Iriartea* were not observed at close range), and the males abscised a few hours after anthesis. In *Prestoea* female flowers apparently lasted two days. This general pattern certainly applies to other palms in the same forest (e.g. *Welfia georgii*, Fig. 4, pers. observ.). The sex ratios among flowers were very close to 1 female:2 male, reflecting the basic triad flower cluster. The number of flowers per inflorescence was relatively large (ca. 25,000–88,000). The pollinators were probably bees in these palms.

Table 1. Some flowering characteristics of seven rain forest palms

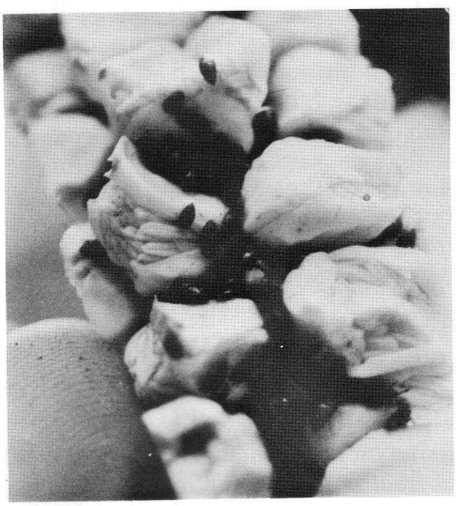
Species	Stratum of adults	Population phenology	Inflorescence phenology (sex, days duration)	Anthesis time	Floral sex ratio ♀:♂	Total # ♀	Flowers ♂	Pollinator 7
Prestoea decurrens	2	Jan–Dec 4, 5	♂, 14; ♀, 4	morning 0930–1000	1:2	8,600	17,200	bees
Iriartea gigantea	1	Jan–Apr 4, 5	♂, 10+; ♀, 4?	morning	1:2	29,500	59,000	bees
Socratea durissima	1	Jan–Apr 5	♀, <1?; ♂, <1	night?	1:2	1,420	2,840	beetles
Cryosophila albida	2	Jun–Jul 4, 5	♀, <1; ♂, <1	night	bisexual flowers	no data		beetles
Bactris wendlandiana	3	Jan, Mar, Aug 5	♀, <1; ♂, <¼	evening	1:15	85	1,200	beetles
Bactris longiseta	3	Feb, Jun? 5	♀, <1; ♂, <¼ 6	evening	1:25	no data		beetles
Astrocaryum alatum	2	Apr–May, Aug 5	♀, <1; ♂, <½ 6	night	1:27	80	21,600	beetles

NOTES: Stratum of mature trees, 1, canopy, subcanopy; 2, understory; 3, near ground. Source of population phenology notes, 4, Frankie et al. 1974; 5, pers. observ. 6, Male flowers do not abscise. 7, See also Table 2.

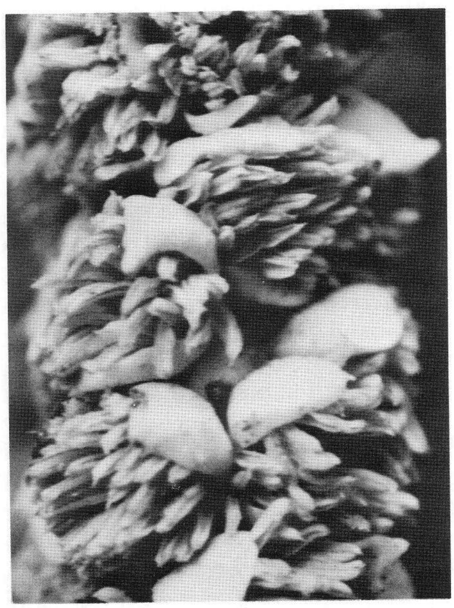
*Table 2. Identified visitors to flowers of eight palms**

Species	Identified flower visitors
Prestoea decurrens (Wendl. ex Burret) H. E. Moore	bees: *Trigona tataira mellicolor* Packard; *T. testacea musarum* Cockerell; *Neocorynura* sp.; *Lasioglossum* sp.; Halictidae sp. 1.
Iriartea gigantea Wendl. ex Burret	bees: *T. tataira mellicolor*; *T. testacea musarum*; *T. silvestriana* Vachl.; *T. nigerrima* Cresson; *T. jaty jaty* Smith; *T. testaceircornis perilampides* Cresson.
Socratea durissima Wendl.	bees: *T. testacea musarum*; *T. silvestriana*; *T. fulviventris fulviventris* Guérin.; *T. fuscipennis* Friese; *Melipona fasciata* Latreille; *Epipona* sp.
Cryosophila albida Bartlett	bees: *T. testacea musarum*; *T. silvestriana*.
Bactris wendlandiana Burret	beetles: *Cyclocephala stictica* Burmeister; *C. amazona* (L.); *C. brittoni* Endrodi; *Mimeoma acuta* Arrow.
Bactris longiseta Wendl.	beetles: *M. acuta*.
Astrocaryum alatum Loomis	beetles: *C. stictica*; *M. acuta*. bees: *T. tataira mellicolor*; *T. testacea musarum*; *T. silvestriana*; Halictidae sp. 2.
Welfia georgii Wendl. ex Burret	bees: *T. tataira mellicolor*; *T. testacea musarum*; *T. silvestriana*; *T. fulviventris fulviventris*; *T. corvina* Cockerell; *Trigona* sp. nov.

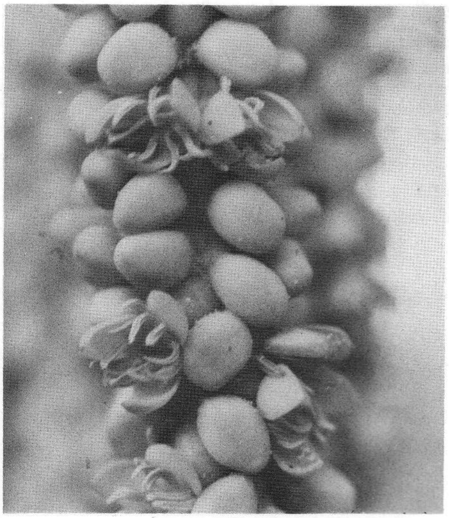
* *Welfia* is included here as several collections were made, its population and inflorescence phenology are similar to *Prestoea* but anthesis is earlier.



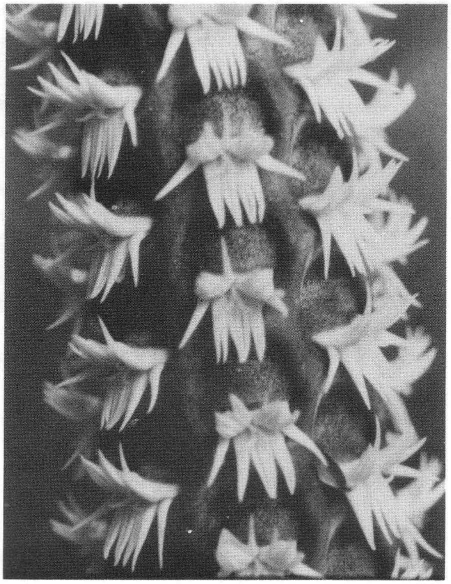
1. *Socratea* in the day between female and male flower maturation. Male buds were forced apart to show the many beetles still present. One stigma is visible in the center.



2. *Socratea* in the morning after anthesis of all male flowers; they will abcise within a day.



3. *Iriartea* in the male phase; 10% or less of the males open on any one morning and abcise the same afternoon.



4. *Welfia* in the female phase, with all flowers open; they may be receptive for two days.

In the other five species flowering of an inflorescence lasted only two nights. All the female flowers were receptive the first night (Fig. 1), and all males produced pollen the second night (Fig. 2). Individual flowers lasted a few minutes to hours. The pattern is known also in *Astrocaryum mexicanum* (J. Sarukhan and A. L. Pedroza pers. comm.), and in other *Bactris* species (Essig 1971, J. Beach pers. comm.). Except for the hermaphroditic *Cryosophila*, the floral sex ratios ranged from 1 female:2 male to 1:270. In *Bactris* the ratio is effected by interspersed single male flowers among the triads (Moore pers. comm.) and by abortion of females in distal triads. In *Astrocaryum* the branches bear only male flowers, with a single female in a triad at the base of each branch (Moore pers. comm.). The total number of flowers was relatively small, however, numbers were not counted in *Cryosophila*, and *Astrocaryum* had abundant male flowers.

Female anthesis is not well known in any of the second group of species, but is nocturnal. In *A. mexicanum* the spathe opens about 0400 hrs and female flowers are receptive then. Male anthesis in *Socratea* occurred before 0515 hrs; in both *Bactris* species it was between 1715 and 1800 hrs; and in *Astrocaryum alatum* most male flowers opened between 0000 and 0200 hrs.

Beetles were prominent visitors of flowers of the nocturnal species, but few insects have been identified. *Socratea* attracted hordes of small beetles of several forms (Fig. 1), but *Cryosophila* seemed to draw only a small weevil. Both species of *Bactris* and *Astrocaryum* were visited by a small weevil, staphylinids, and large scarabs. The latter were consistently found on both female and male flowers of *Bactris* species but only on the male phase of *Astrocaryum*. During the day bees were conspicuous at the male buds and flowers of *Socratea* and *Astrocaryum*, but unlike the beetles they did not crawl between the tightly-packed buds or branches to contact the female flowers.

It is remarkable that all the species presented here show maturation of all flowers or organs of one sex throughout the inflorescence before any parts of the other sex mature. Moreover, the two phases are non-overlapping: in the protandrous inflorescences the separation is about two days; in the protogynous inflorescences the separation is less than one day. Detailed tests are needed to clarify the receptive period of females in protogynous species. It is probable that over an entire year, flowering of an individual palm does not amount to ten days in these protogynous species, nor to much more than two weeks for the female phase of protandrous species. Thus it is a significant problem to find the bases of successful pollination in synchronization between individuals, pollinator movement, pollen longevity, self compatibility, or other mechanisms. The notable patterns abstracted here for the several species are the associations of several characters into two groups: 1) protandry, inflorescence longevity of two weeks, diurnal anthesis, bee pollination; and 2) protogyny, inflorescence longevity of two nights, nocturnal anthesis, and beetle pollination. The least certain element is the identity of the important pollinators. Moreover, even if these patterns hold up to further scrutiny, they are not exhaustive of the inflorescence or flower phenology, or pollination, of the 27 or so species of palms at La Selva (Schmid 1970, Perkins in prep., pers. observ.).

Acknowledgments

The field work was supported by National Science Foundation grant DEB 7725558 to K. S. Bawa. The insect identifications were kindly made by A. Wille, Universidad de Costa Rica (bees), and B. Ratcliffe, University of Nebraska (scarabs). The manuscript benefited from comments by H. E. Moore, Jr., R. Schmid, and an anonymous reviewer.

Literature Cited

Essig, F. B. 1971. Observations on pollination in *Bactris*. Principes 15: 20–24, 35.

Frankie, G. W., H. G. Baker, and P. A. Opler. 1974. Comparative phenological studies of trees in tropical wet and dry forests in the lowlands of Costa Rica. J. Ecol. 62: 881–919.

Moore, H. E., Jr. 1973. The major groups of palms and their distribution. Gentes Herbarum 11: 27–141.

Schmid, R. 1970. Notes on the reproductive biology of *Asterogyne martiana* (Palmae). I. Inflorescence and floral morphology; phenology. Principes 14: 3–9.

CLASSIFIED

Principes, 25(3), 1981, pp. 106–119

Pigafetta and Other Palms in Sulawesi (Celebes)

MELVIN W. SNEED
8107 S.W. 72nd Ave., 113-E, Miami, Florida 33143

Pigafetta was Dr. David Fairchild's favorite palm. Yet apparently he never got it established in his home garden "The Kampong" back in Miami, Florida. Dr. Fairchild first saw *Pigafetta* in Sibolangit, "a little garden" (later a branch of Bogor Garden), near Medan, in northern Sumatra, in 1926. The palm is not indigenous in Sibolangit, and for more about *Pigafetta* there see Dransfield in *Principes* 17: 105–107, 1973. Then in 1940 during his memorable voyage on the "Cheng Ho," as recounted in his *Garden Islands of the Great East*, Dr. Fairchild visited the Celebes and had this to say:

"One of my great desires in coming to Celebes was to see, in its native haunts, a most beautiful palm which I had first seen in Sumatra in 1926, in the little Botanic Garden of Sibolangit, and had been trying ever since to establish in Florida. It is *Pigafettia elata*, named after Pigafetta, the companion of Magellan and the historian of his trip around the world. I searched through the parks of Manado for it the day we landed, thinking it must certainly be planted there, but found only Cuban royals; nobody seemed to know what I was talking about. I thought they might know it as the Rattan palm, which it is sometimes called, but that name was new to them too. Perhaps it might be the 'Wanga', someone suggested; that was a very tall palm that occurred along the road we were to take. We were all eager to be the first to see one, and at every turn of the winding road we searched the roadside. At last Marion exclaimed, 'There it is, there's your *Pigafettia*.' Fully eighty feet high it stood and straight as an arrow, even more beautiful than my memory of it. The tree was twenty years old, according to the villagers near by. It was the only one in sight, but we knew there would be more of them farther on."

And farther on, Dr. Fairchild added:

"The rain stopped after we reached the guesthouse, and in the lovely light of the setting sun Mrs. Archbold, Marian and I walked up the mountain road to the top of the divide and found there two clumps of *Pigafettia* palms, one with its crown so close to the bank that the full beauty of its leaves could be studied easily. Long slender spines of golden brown covered the bases of the leaves. The sunlight guilded them and made them very beautiful indeed, set off as they were against the dark green trunks marked with grey rings where the leaves had fallen off. From that moment I became unreasonable in my admiration for this tree, and I have remained so to this day."

Phyllis Sneed and I have been intrigued by *Pigafetta* from the very first time we heard of it, but it was years before we ever saw a mature one growing. When living in Jamaica we tried to grow it, thanks to seeds received from The Palm Society Seed Bank. These seeds were supplied to the bank by John Dransfield, who had collected them in Sibolangit. We had no success: red spider mites, wind, and wilt finally claimed all our many seedlings. Also we didn't know that *Pigafetta* likes an elevation of 1,500 to 3,000 feet above sea level, and we only had about 400 feet in our garden in Jamaica.

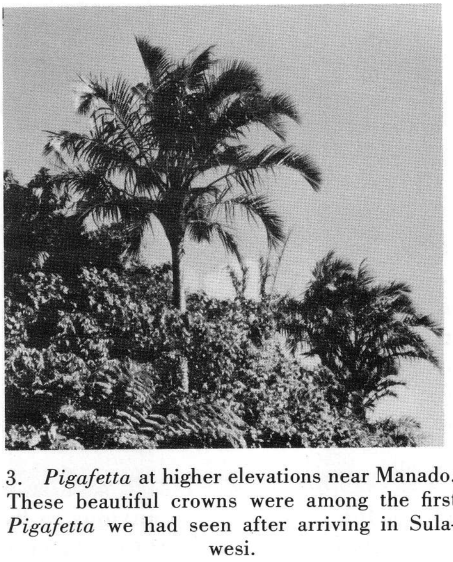
For some time we had planned to single out Sulawesi (formerly the Celebes) as a travel destination with a view to seeing *Pigafetta,* as well as other palms there. After attending the splendid biennial meeting of The Palm Society in Hawaii in mid-June, 1980,

1. Crown of coconut palm producing "bulbils" and climber ascending to recover one, all a part of Dr. T. Antony Davis' current research program in North Sulawesi. See pp. 124–129.

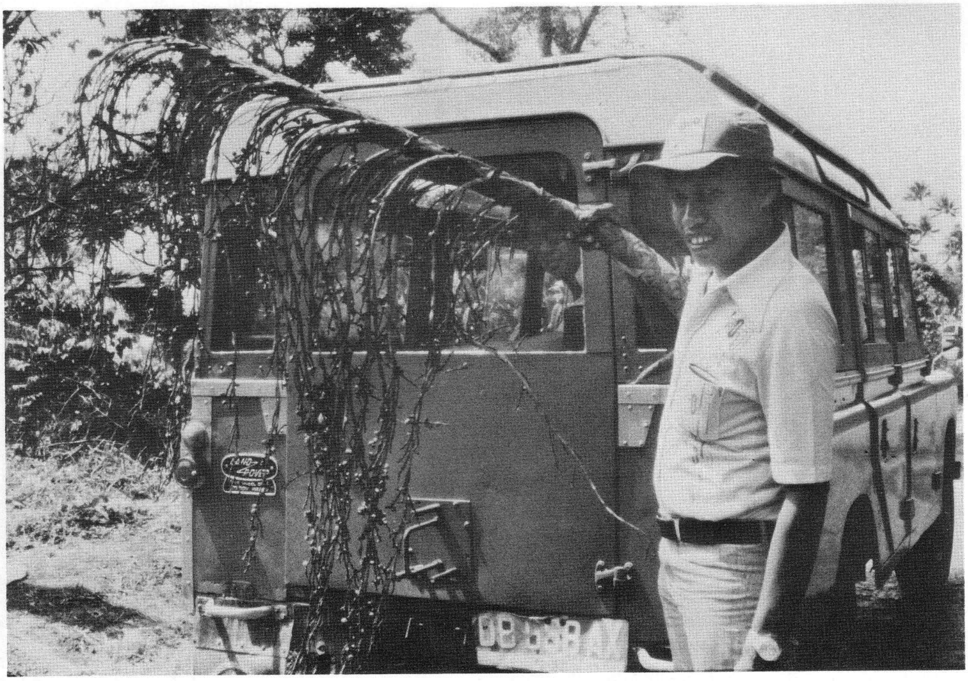
2. "Bulbil," just severed from the "mother" tree, looks like a coconut palm on its way to maturity. Antony Davis, Phyllis Sneed, and men at the research station admire the offspring.

we continued on to areas in Southeast Asia and the Western Pacific, with Sulawesi as our main objective. In this beautiful land of friendly people we found palms in numbers and varieties far beyond our expectations. And the tens of thousands of *Pigafetta* growing naturally overwhelmed us.

After some rather rugged overland traveling in upper Luzon in the Philippines, all of it interesting and well-worth doing, and more of the same in Sabah and Sarawak, Borneo, which is outside the scope of this article, we flew into Bali, Indonesia, for a bit of relaxation. Then we went on north across the Flores Sea to Ujung Pandang to begin our trek into Sulawesi. Ujung Pandang, on Makassar Strait, is in the lower southwest leg of Sulawesi, which may be the most peculiarly-shaped island in the world. To some it might resemble an orchid, or an octopus, or even a prehistoric animal with a dragon-like tail. Appearances



3. *Pigafetta* at higher elevations near Manado. These beautiful crowns were among the first *Pigafetta* we had seen after arriving in Sulawesi.



4. *Pigafetta* infertile inflorescence near Manado.

can be deceiving, for it is a large island (well over 70,000 square miles) encompassing a seemingly infinite coastline; much of the land is mountainous with large areas still unspoiled by loggers and other desecrators.

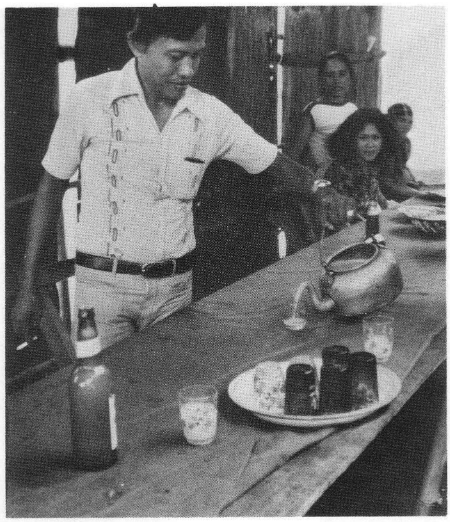
Ujung Pandang is a name relatively new on our maps, as the same site was known for centuries as Makassar, a place with very ancient connotations. It is capital of the Island as well as of Southwest Sulawesi, one of four administrative provinces comprising the whole southwestern peninsula, and in itself a large metropolitan area of some 600,000 population. Although no Mecca for one in quest of palms, it is an unavoidable hub for flights and land transport to other destinations one may wish to visit in the island.

After two days of exploration, in and out of the city, we were anxious to fly on to Manado, which is at the extreme northeastern end of the province of North Sulawesi (Minahasa). Contrasts of the two areas were significant: Manado was lush and beautiful while Ujung Pandang had been dry and largely unattractive, although both were sea ports.

We were elated when welcomed at the Manado Airport by Dr. T. Antony Davis, a long-time member of The Palm Society in India, then serving as FAO Coconut Agronomist on assignment in Manado, where he had been conducting and overseeing some unusual and fascinating experiments in coconut culture (see *Principes* 24: 127–129, 1980, and pages 124–129, this issue for a discussion of Dr. Davis' work in North Sulawesi).

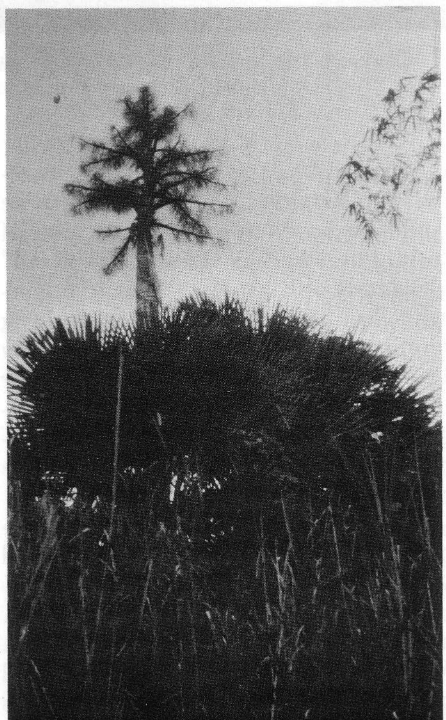
After seeing us registered in our hotel, Antony Davis and colleagues conducted us through the very extensive experimental coconut plantings, which

5. *Areca vestiaria* down a ravine adjoining Watu Pinawetengan monument, in highlands out of Manado.



6. "Saguir" (fermented from *Arenga pinnata*) was poured for us in a village gathering, highlands, out of Manado.

were admirable. Then we were privileged to see two tall trees which successfully have responded to Antony's "vegetative propagation" research efforts. This is akin to "cloning." Instead of fruits, the "mother" trees with a bit of nursing and proper care produce "bulbils," which in effect are plants ready to set out. This contrasts with the traditional process of germinating the nuts. Some 25 "bulbils" had been removed from one of the trees, 16 from the other. As we watched, a climber went up after a "bulbil" (Fig. 1) and by the time he returned with it we had been joined by a group of Antony's friends and coworkers to marvel at a ready-made coconut palm which got a life start in a somewhat different way than most—literally in its mother's arms (see Fig. 2).



7. *Corypha utan* with old inflorescence in background, young trees in foreground.

8. Can an outrigger sink? We believed it might. Antony Davis helps Phyllis and Eunice off; the author, of course, already had deserted the "sinking vessel."

What will be the effect of this selectivity? Certainly much growing time could be saved toward production of fruit, but whether these "off-shoots" ultimately will produce fruit is uncertain. Yet the process has promising implications, and we are sure Antony Davis will be on center stage whenever the answer is known. Coconut production is of first importance to the economy of North Sulawesi, with the clove crop second.

Next day, 13 July 1980, Antony, accompanied by his delightfully helpful wife, Eunice, Mr. Toar who had welcomed us at his home the day before, and another friend picked us up early. We headed out of Manado, at sea level on the Sulawesi Sea, to outlying areas in the nearby mountains which harbor a long line of volcanic cones, craters, and other interesting vistas. Along the way, Eunice pointed out facial mud packs worn by many girls walking along the road. As we passed clove plantations with their neat rows of small symmetrical trees, bright green with scarlet new leaves, the air had a spicy scent. Often alongside the road, on drying areas or mats, similar to those for rice or coffee elsewhere, were the handpicked buds of the clove blossom, from a green to dark brown stage. We saw *Livistona rotundifolia* and beautiful *Arenga pinnata* in fruit, as well as occasional *Salacca edulis* along roadsides, *Thrinax* in yards as an ornamental, many *Metroxylon,* and *Rattans*.

So far, from Ujung Pandang to Manado, we hadn't seen anything resembling a *Pigafetta,* which we were impatient to find as it is indigenous to Sulawesi. Antony Davis, of course,

9. Phyllis was grateful to her friends on Old Manado for their help in acquiring *Areca* seedlings.

knew of our interest in this palm and he headed our excursion into the higher elevations where we could find it. After perhaps an hour's drive in the land rover we saw the first ones looming up from the deep ravines and magnificently silhouetting the clear skies on upper slopes (Fig. 3). Overly eager to collect, we saw a magnificent tree deep in a ravine, loaded with fruit. But after a most agreeable and agile volunteer climber, knife in belt, brought it in, we found the fruits to be from an infertile female inflorescence (Fig. 4). We saw many other trees fruiting, most of which were unreachable. So we were to explore other areas of Sulawesi before collecting sizeable quantities of these seed. Locally, *Pigafetta* is called *Wanga,* as had been reported to Dr. Fairchild on his visit years earlier.

Antony Davis, aided by Mr. Toar who knew the road, took us on up in the highlands to Watu Pinawetengan, an interesting monument to the earliest inhabitants, which featured a huge ensconced stone bearing strange, uninterpreted glyphs. It is believed that this stone marks the place where original tribes convened many centuries ago to divide the land. The name of the leader for this area was Toar, an ancestor of our companion on the trip. Nearby down a slope were clustering specimens of *Areca vestiaria* (Fig. 5), but we didn't collect any viable seeds.

Driving on through attractive, small villages we noticed charming and original orchid containers constructed in most yards, from which a thriving business exists selling local orchids to tourists. We passed sulphur springs, a lake in the center of an old volcano crater, and experienced for us a unique lunch of barbecued gold fish.

10. Vista of the magnificent forest between Palu and Parigi, Central Sulawesi. (See *Pigafetta* in center foreground; this palm is prominent all through the forest farther than one can see.)

These carp are spawned in fresh water ponds on the place and dipped out for cooking after customer selection. Farther along we were given an effusive welcome in a village where we were urged to sample a foamy, milky-looking local drink called Saguir, made from the flowers of *Arenga pinnata* into a fermented sour cider (Fig. 6). Returning to Manado from the east coast we passed through areas with clusters of *Corypha utan* (Fig. 7). We had not seen this species previously and, in fact, didn't know it existed in Sulawesi. We were dropped back at our quarters in late evening, with an admonition that next day would begin early and be a long one.

It proved to be both early and long, as well as utterly delightful. We were going to outer islands in an outrigger to look for palms, see beautiful coral sea gardens in crystal-clear waters, and meet some delightful and helpful people living on the islands.

Alas! After all seven in our party had waded out to mount the outrigger, and floated off shore about 30 yards, the contraption started drawing water, and frantic bailing to the contrary, began settling deeper than the outriggers seemed willing to support. So we jumped off in shallow water and waded back to shore (Fig. 8).

Replacing the initial outrigger with one more seaworthy, we re-embarked to stop at several points enroute to Old Manado, a distant conical-shaped island which we were told harbored the population of the Manado area many years before, when volcanic activity drove the people away from the mainland. Waters were rough as we tried to find landing spots, but after wading

11. *Areca* sp. in center of photograph, Palu to Parigi forest area. Note the rugged vista.

over some abrasive coral we got ashore at the island's main village where everyone had smiles and a cordial welcome for their visitors.

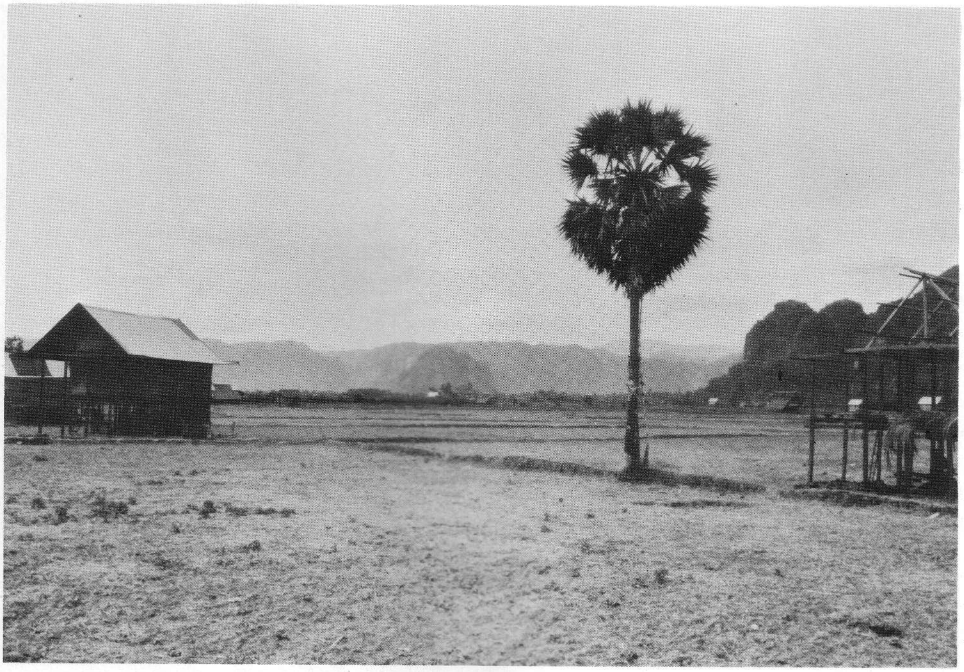
We found an *Areca* there, about 30 ft tall, trunk 7 inch diameter with prominent rings, green crownshaft, which at first glance seemed to be *catechu* (betel nut) and probably was, although the leaves, inflorescences and seeds appeared to differ significantly. Once the village learned of our interest in this palm, several of the delightful people there, of all ages, hurried up the slopes behind and soon reappeared with a liberal collection of seeds and seedlings, some of which are shown in Fig. 9.

That evening Eunice and Antony Davis had us visit their home in Manado, after which we all walked over to call on Mr. and Mrs. H. Sudasrip, who live nearby. He is Chief of the Industrial Crops Research Institute and an enthusiastic member of The Palm Society. Mrs. Sudasrip presented us with a generous supply of dried cloves, and was interested in our explanation of the use of pomander balls made with clove buds.

12. Climber goes for seeds on steep slope above road between Palu and Parigi. We couldn't identify the palm species.

Antony Davis saw us off at the airport next day, for an early morning departure to Palu, and we certainly hope he knows how grateful we were for his help in introducing us to Manado.

Palu, seat of government for Central Sulawesi, is hard to find on some maps of the island. Earlier its name was "Paleo." It is on the west side of the narrow neck of the island at the end of a bay reaching in from the Makassar Strait, which separates Borneo from Sulawesi. Palu is a small city almost straddling the equator and not particularly exciting. But it is the hub for areas, especially to the east and south, which may be without parallel for palm seekers. We never had heard of the place, but through a fortunate and opportune bit of correspondence with Dr. John Dransfield, then at his home base in Kew Gardens, England, a sugges-



13. *Borassus* in rice plains which extend some 100 miles north of Ujung Pandang.

tion from Mrs. Dransfield was passed on to us that if we were going to visit Sulawesi we might find it interesting to go to Palu and proceed from there to Parigi, across the isthmus to the east coast at Tomini Gulf. She said, "The area is rich in palms."

This advice we "took to heart" and included Palu on our itinerary, although airline flights in and out of there were, and are, infrequent from some places. The area proved not only "rich in palms," it was "loaded" with palms!

On a "prop" plane, Palu was a two-hour flight from Manado, and the area certainly is not on any routine tourist circuit. Upon landing we deplaned from the small craft, went to the baggage area for our two bags, and then waited a long while to retrieve them. But we waited with respect as the Indonesian Armed Forces conducted a ceremony honoring two deceased soldiers whose bodies had been flown back on our flight, for interment.

Most helpful to us in Palu was Mr. Budi T. Tumewu, Manager of Viscana Tours & Travel as well as of our Viscana Hotel. We explained our mission, which was to see palms and hopefully collect seeds. He responded by furnishing us a driver of the hotel's car, who was native to the key areas we wanted to visit and had some knowledge of palms, and also an assistant who later went down into the deep ravines and scaled the slopes collecting seeds.

The four of us left Palu early morning, 16 July, to cross the isthmus to Parigi. Not much of interest loomed up until after about an hour's driving, we ascended through foothills on up to the mountainous areas some 1,500 to 3,000 ft elevation. Then it became ex-

14. Beautiful clump of *Pigafetta* in highlands between Ujung Pandang and Toraja Land, Sulawesi.

citing; it seemed that we had arrived in palm "heaven." Dense forests completely covered the ravines and slopes as far as we could see from the single-lane, often rough, bumpy, and sometimes slippery road. Wisps of clouds, sometimes heavier ones, or mist floated over the vistas giving an eerie effect. Palms were everywhere in this rain forest—all along the narrow roadside, towering up from valleys some of which plunged 500 to 1,000 ft straight down! (See Fig. 10.) Then, as we expected from earlier sightings, we saw *Pigafetta* all over the area, rising up magnificently from the obscured depths and towering high on the slopes. Down one ravine we saw what possibly could be an unidentified *Areca*, although we couldn't get close (Fig. 11). Mature *Pigafetta* of 80 ft and more were visable everywhere with their unique grey rings distinctive on shiny green trunks. Our amateurish estimate is that there are at least 500,000 *Pigafetta* in this area, and a census, if possible, might well make the count a million or more. So the palm in this area which apparently had not been logged out or otherwise greatly disturbed, is safe from destruction at least for a while.

Although our main theme is *Pigafetta*, we want to stress that the Palu to Parigi area has numerous other palms, some species of which very likely have not been named. There are arengas, arecas, pinangas, single-trunked caryotas, licualas, and a host of rattans. Genera and species of the latter always have been an identification enigma for the author. At the lower elevations *Metroxylon*, *Corypha* and *Nypa* palms were plentiful. We saw arecas with red and orange crownshafts (see Fig. 12) and pinangas with lacquer-red crownshafts. Also, a complete stranger to us, an apparent *Pinanga* with a brown crownshaft, down a deep ravine and surrounded by so much vegetation we were unable to photograph it successfully. Our climber could not recover any fruits.

Another day our escorts drove us south out of Palu to Kulawi, a two-hour drive over another very narrow, one-way dirt road. We passed through some rice and tobacco fields, and coffee plantings on the way into a forested area at higher elevation which had exciting palm populations. *Arenga undulatifolia* were fruiting, and again we caught glimpses of brilliant red and deep orange crownshafts in ravines which we were unable to photograph. The Indonesian Government intends to make a national park out of a large rugged area beginning at Kulawi and extending south, to be called Lore Kalamanta National Park. We saw a map of this projected national preserve and

15. Toraja Land granaries and houses rest on posts which are trunks of the *Pigafetta* palm.

believe the area should be a "venturesome" palm collector's destination, especially when better access is provided into the forest.

We flew from Palu back to Ujung Pandang. We wanted to go to "Toraja Land," which actually as the crow flies is closer to Palu than Ujung Pandang, but neither roads nor air flights could get us there from Palu.

Toraja is situated some 240 miles north of Ujung Pandang, and we reached the town of Rantepao, the main hub of the district, after an eight hour ride in a jeep. The first three to four hours of the route, before getting into the highlands, goes through areas of extensive rice fields which sport some palms, here and there, such as the *Borassus*, in Figure 13. Sulawesi exports rice. Some of the road skirts the sea coast before veering on up into the highlands. The narrow road was surfaced most of the way, and the trip was picturesque. Coming down from one range of the hills we saw a beautiful clump of mature *Pigafetta* around a bend in the road (Fig. 14). It was a fitting introduction to a land and culture which literally has been "supported" by the trunks of *Pigafetta* palms. Although we saw other palms through this populous area, *Pigafetta* not only predominated, it was used and revered by the people.

The Dutch, who controlled the area before World War II we were told, only discovered the existence of the Toraja tribe of people about the turn of the century. They had been there for many centuries pursuing their own ideas about life and death—and today, these remain largely unchanged. It is fascinating that the Toraja community (the district has over 350,000 population) places great faith in their ances-

16. Betel nut venders, Rantepao market, Toraja Land.

tors, go to great pains to bury them, and indeed extend the memory of their earthly form through effigies installed above tombs chiseled into the sides of cliffs. Plans and provisions for such interment are the objectives of a lifetime, and great celebrations commemorate the burial occasions, which may not take place for several years after death.

But what does Toraja have to do with palms? Here we found magnificent specimens and stands of *Pigafetta* and discovered that the *Pigafetta* palm is inextricably interwoven into the culture and architecture of the age-old inhabitation of Toraja. The ancestors of the Toraja people came from Indo-China by ship, perhaps beginning about 2500 B.C. Hence they build their houses to resemble boats and face them northward from whence the ancestors came. Tradition dictates that houses must be built so they can be moved from one place to another without coming apart; the materials used for building must come from the vicinity (wood, rattan, bamboo); iron nails and hinges are tabu, and the building must be of tongue and groove construction. The houses rest on six to eight foot sturdy pillars, which from a distance appeared to be concrete, but later proved to be trunks of the *Pigafetta* palm (Fig. 15). Considering the numerous villages and homes constructed over the centuries in Toraja tradition we could appreciate the importance of this palm to their culture and observe the part it has played in their lifestyle.

Toraja has been more cut-over than the Palu area, but large stands and frequent specimens of *Pigafetta* are still so numerous over much of Toraja Land as to lead one to believe that the

17. Children in Toraja Land, Sulawesi, trundling logs of *Pigafetta*, which have served their ancestors so very well.

region originally must have hosted very extensive forests dominated by this palm. But John Dransfield has a theory about the ecology of *Pigafetta* which flies in the face of this supposition (see *Principes* 20: 48, 1976).

At the time of our visit, 19 July, many of the trees were loaded with ripe fruit and were in accessible locations, some bordering rice paddies or even along the roadside. With the help of a climber we were able to collect easily a large quantity of fruit, but spent many hours cleaning the seed for mailing to The Palm Society Seed Bank. We weren't the only people interested in palm seeds in Toraja Land. In the fascinating market in Rantepao we saw an utterly delightful group of young salesladies, albeit a bit camera-shy, peddling their betel nuts (Fig. 16).

Many people would like to grow *Pigafetta*; some have succeeded over the years and some haven't, often for reasons mentioned early in this article. We have seen the palm growing in some numbers at Bogor Gardens in Indonesia, and, far afield, in the Botanical Garden in Rio de Janeiro. Long-time Palm Society member, Bob Wilson, started an avenue of them at his place "Las Cruces" in Costa Rica, and Palm Society member, Augusto Braun, has it growing in the Botanical Garden in Caracas. Also, after some failures over the years, Fairchild Tropical Garden in Miami has a specimen that has survived, and other botanical gardens have it.

Members of The Palm Society, over the years, have had some success and a lot of failures. We have no way of knowing what has happened all over the world. We saw beautiful specimens at "Onomea," home of past-president Donn Carlsmith, in Hilo, Hawaii. Here in Florida, former executive secretary Teddy Buhler had a fine 6-year-old specimen 30 ft tall, that was blown over and broken off by wind which didn't affect other tall palms in her garden. She thinks it was not planted deeply enough when set out. Current Palm Society president, Paul Drummond, has a good specimen in his garden, some 30 to 40 ft tall, and it seems to be surviving the rigor of a near sea-level elevation, although the palm does not do its best at low elevations. Earlier, Dent Smith, founder of The Palm Society, had one growing up north in Florida at Daytona Beach, which often is affected with cold weather. The *Pigafetta* grew rapidly up to some eight feet, out in the open. Dent donated it and had it transplanted to the Florida Institute of Technology's fine collection of palms in Melbourne, Florida. Unfortunately cold weather descended on Melbourne, which is some 250 miles north of Miami, and the *Pigafetta*, along with other "tender" palms, did not survive.

There is a solid ending to our story about *Pigafetta*. The people in Toraja Land have used the palm's wood for centuries for water conduits and to support their houses and granaries above ground. The very hard and durable wood literally has "upheld" the tribe (see logs awaiting use in Fig. 17). As well as its usefulness, surely the beauty of this palm has enriched their lives, even as it excited "unreasonable admiration" in Dr. David Fairchild.

Note: Quotes on p. 106 were reproduced with the permission of Charles Scribner's Sons, New York, NY.

Principes, 25(3), 1981, pp. 120–123

Notes on Salacca wallichiana

JOHANIS P. MOGEA
Herbarium Bogoriense, LBN-LIPI, JL, Raya Juanda 22-24, Bogor, Indonesia

On my return from Holland in August 1975, I made a stopover to visit the Herbarium of the Royal Forest Department, Bangkok, Thailand to study specimens of *Salacca* there. Professor Tem Smitinand and his staff provided excellent hospitality allowing me to visit a small swampy forest at Rayong about 105 kilometers southeast of Bangkok, where we found *Salacca wallichiana* growing wild. On this visit I found an unusual variant of the species which I think is worth recording. Furthermore, the species epithet has often been incorrectly cited and confused, so I think it is also worthwhile to add some notes on nomenclature.

The genus *Salacca* is a member of the large and diverse group of lepidocaryoid or scaly-fruited palms. The 10 species of this genus are distributed throughout the Indo-Malaysian region. In a recent unpublished study of the genus, more than 10 species are described from the Malay Peninsula, Sumatra, Borneo, and the Philippines.

The Correct Name of Salacca wallichiana

Salacca wallichiana presents a complicated nomenclatural problem. In 1831, Wallich described and illustrated a species from Burma, of which he had fruiting material and staminate plants in the Calcutta Botanic Gardens, said to be from Sumatra, although the species has never been found there again. First he had intended to name it *Zalacca rumphii*, inscribing the plates with that name, but withdrew the name in the text, placing the species incorrectly under *Z. edulis* which is actually a different species. He then acknowledged Martius for the suggestion. However, a few years later, Martius (1838) himself recognized that Wallich's specimens represented a new species and described it under the name *Z. wallichiana*. The type is therefore neither in Kew nor Munich, but in Brussels where much of Martius' personal herbarium except for Brazilian plants is housed (H. E. Moore, Jr., pers. comm.). Later Blume (1843) incorrectly tried to validate Wallich's abortive name *Z. rumphii* over *Z. wallichiana*. A complication developed when just those pages of Martius' work dealing with *Salacca*, were published again in 1845 with additions. The additions Martius made were largely taken from an important paper published by Griffith also in 1845. Griffith adopted *Z. edulis* in Wallich's sense (our *S. wallichiana*), adding three unnamed varieties; these in my opinion cannot be maintained. Confusion in this genus was also caused by the dioecious habit, such that when Griffith described four other new species of *Salacca*, one of them, i.e. *Z. macrostachya* from Malacca, was unfortunately the staminate plant belonging to *S. wallichiana*. Martius retained the name *Z. macrostachya*, but part of the fruits he figured actually belong to *S. affinis*. In Martius' habit drawing of plate 119, it seems that he copied the second fruiting branch as well as the fruit and the detailed figures 20–23 from Wallich's plate 224, adding the third pistillate rachilla with all details himself. The pistillate inflorescence may have been constructed by Martius or more likely Martius had it on loan from someone. Many botanists still cite the name of these taxa incorrectly. Even a recent publication by Whitmore (1973) still used *S. rumphii* instead of *S. wallichiana*. The distribution of this species throughout Sumatra and Bangka is questionable since in my extensive study of the genus, I have never seen herbarium specimens of this species from those localities. Whitmore's *S. edulis* fruit on figure 98 b, as also indicated by Dransfield (1973), is probably the fruit of *S. wallichiana* which is quite common in the Malay Peninsula.

The nomenclature of *S. wallichiana* may be cited as follows:

Salacca wallichiana Mart., Hist. Nat. Palm. 3: 201, ed. 1, t. 118, 119. 1838; *Zalacca*, Kunth, Enum. Pl. 3: 203. 1841; Mart., op. cit. ed. 2. 200. 1845; Kurz, For. Fl. Br. Burma 2: 511. 1877; Becc., Malesia 3: 66. 1886; *in* Hook. f., Fl. Br. Ind. 6: 476. 1893; Ridl., Mat. Fl. Mal. Pen. (Monoc.) 2: 170. 1907; Becc. *in* Ann. R. Bot. Gard. Calc. 12, 2: 83. 1918; atlas pl. 50, 50 A, 51. 1921; Blatt., Palms Br. Ind. Ceylon: 265, fig. 33, pl. 50. 1926; Gagn. Fl. Gen. Indo-China 6: 1006, fig. 97: 1, 2.—*Zalacca edulis* Wall. non Reinw., Pl. As. Rar. 3: 14, t. 222–223, 224. 1831; Griff. *in* Calc. J. Nat. Hist. 5: 7. 1845, incl. the three unnamed varieties; Griff., Palms Br. Ind.: 10, pl. 175. 1850; BR's specimens phot. BH 3207. var. a; phot. BH 3208, 3213 var. b; phot. BH 3214 var. c.—*Zalacca rumphii* Wall. (on plate 1 c. but withdrawn in text) *ex* Bl. Rumphia 2: 161. 1843; Furtado in Gard. Bull. Singapore 12: 393 (descr.), fig. 5. 1949, *Salacca*; Whitmore, Palms Mal. 107, fig. 99. 1973.—Type: hb. Wallich 5000 [lectotype BR (photo. BH 3206)]; isolectotypes E, G, K, M, origin uncertain; staminate fl., suggest Calcutta Garden, but origin of the plant supposedly from Sumatra (as indicated by Roxburgh in 1814) but unlikely as the species is otherwise unknown there.

Zalacca macrostachya Griff. *in* Calc. J. Nat. Hist. 5: 13. 1845; Mart. Hist. Nat. Palm. 3, ed. 2: 202, t. Z 21, fig. V 3, 4, 5 (the rest is *S. affinis*). 1845; Griff. Palms Br. Ind.: 15, t. 178 A–C (apical leaflet perhaps wrongly drawn). 1850; Becc. *in* Malesia 3: 66. 1886.—Type: *Fernandez*? hb. Griffith (BM, isotype), from Malaya, Malacca, Ching, pistillate fl. + fr. no date, 'rungum.'

Zalacca beccarii Hook. f., Fl. Br. Ind. 6: 474. 1973, fruits only; Becc. *in* Ann. R. Bot. Gard. Calc. 12(2): 72. 1918, under 'excluded.'—Type: *McClelland* (K), from Burma, Rangoon, pistillate fl. + fr.; the leaves are *Calamus longisetus*.

Salacca edulis Whitmore non Reinw., Palms Mal. 98 b. 1973. The Riau record referred to is probably *S. sumatrana*.

Zalacca wallichii Miq. non Mart. 1861 is *S. sumatrana*.

An Unusual Form of Salacca wallichiana

The common *S. wallichiana* is distributed south of about 19°N in Burma, in the central part and further south in Thailand, and in most states of the Malay Peninsula. In Burma the fruit is reported to be edible and in Bangkok the fruit is sold in markets and is probably used as a substitute for tamarind fruits as a cooking ingredient.

Salacca wallichiana is dioecious,

1. Habit of *S. wallichiana* in Bogor Botanical Gardens.

and about 6–7 m tall (Fig. 1), with stems tufted, erect and to 0.5 m long and ca. 10 cm diam., or creeping on the ground up to 2 m long with many adventitious roots, the tip erect, often producing leafy shoots at the base. Leaves 5–7.5 m long, pinnate, leaflets tending towards an upright position, their bases divergent compared with the whole leaf, often giving an impression of being whorled, the apical part of the leaf more or less obtriangular with small sigmoid acute lobes at the upper margins. Spines flat, linear-triangular, patent or pointing upwards, very rarely pointing downwards, on the leaf sheath and petiole arranged in regular series of oblique combs.

Inflorescences unisexual, axillary, piercing the subtending back of the leaf sheath base. Staminate inflorescences hanging or sometimes nodding, up to 1 m long, with many rachillae, after flowering sometimes producing leafy shoots at the top of inflorescence that act like suckers, flowers in the rachillae red (Fig. 1). Pistillate inflorescences like the staminate ones, often running along the ground, up to 1.5 m long, flowers pale pink to red. Fruits orange-brown.

In the swampland of Rayong–Baneseleui, I found three unusual plants of *S. wallichiana* growing together with the more usual form. This noteworthy form of *S. wallichiana* is very similar to the usual one except for the complete absence of spines on the leaf sheath, petiole, and rachis as compared with the very spiny *S. wallichiana*. The existence of this unarmed form among the conspicuous spiny ones is still a puzzle. It is not known whether this form is found elsewhere in Thailand.

Acknowledgments

A short visit to the Herbarium of the Royal Forest Department, Bangkok, Thailand was supported by a grant from The Netherlands Universities Foundation for International Cooperation (NUFFIC) which was kindly arranged by Mr. J. F. Jongipier and Dr. M. Jacobs to whom I tender my thanks. The latter also supervised me during my study of *Salacca* in Rijksherbarium, Leiden, Holland. Professor Tem Smitinand and his staff should be mentioned here for their hospitality in making it possible for me to stay and arranging my visit to Rayong. The late Sdr. Damhuri, artist of Herbarium Bogoriense, prepared Figure 1 of the habit of *S. wallichiana*. Finally, with pleasure I wish to thank Dr. J. Dransfield for some suggestions and corrections in the preparation of this manuscript.

References

BLUME, C. L. 1843. Rumphia 2: 161. Leiden, Amsterdam.

DRANSFIELD, J. 1973. Palm literature, book review of Palms of Malaya by T. C. Whitmore 1973. Principes 17: 103–105.

FARR, E. R., J. A. LEUSSINK, AND F. A. STAFLEU. 1979. Index Nominum Genericorum 3. Dr. Junk, Den Haag.

FURTADO, C. X. 1949. Palmae Malesicae—X. The Malayan species of *Salacca*. Gardens' Bulletin Singapore 12: 378–403.

GAERTNER, J. 1791. De fructibus et seminibus plantarum 2: 267, t. 139. Stuttgart.

GRIFFITH, J. 1845. The Palms of British East India. Calcutta J. Nat. Hist. 5: 1–103.

MARTIUS, C. F. P. VON. 1838. Historia Naturalis Palmarum 3. Part 7, ed. 1. Leipzig.

———. 1845–1849. Historia Naturalis Palmarum 3. Part 7, ed. 2. Leipzig.

REINWARDT, C. G. C. 1826. Sylloge plantarum novarum. 2. Ratisbon.

ROEMER, J. J. AND J. A. SCHULTES. 1830. Systema vegetabilium 7. Stuttgart.

RUMPHIUS, G. E. 1747. Herbarium Amboinense 5. Amsterdam, Den Haag.

STEENIS-KRUSEMAN, M. J. VAN. 1950. Cyclopaedia of Botanical exploration in Malaysia. Fl. Males. I. (1).

WALLICH, N. 1831. Plantae Asiaticae Rariores 3(9). London.

WHITMORE, T. C. 1973. Palms of Malaya. 132 pp. Oxford University Press, Kuala Lumpur, Singapore, London.

WILLDENOW, C. L. 1799. Linnaeus, Species Plantarum ed. 4(2). Berlin.

Principes, 25(3), 1981, pp. 124–129

Bulbil-Shoot Production from Clonally Propagated Coconuts

T. A. Davis, H. Sudasrip, and H. Azis
Industrial Crops Research Institute, Manado, North Sulawesi, Indonesia

Abstract

Twenty-two bulbils from coconut palms growing in an experimental garden of the Industrial Crops Research Institute, Manado, Indonesia were successfully air-layered, separated from the parent palms and planted as clones. Eleven months after transplanting, some of the bulbil-clones began producing bulbil-shoots, but none of the clones bear normal flower bunches. Trials are under way to attempt to reverse some of the bulbil-clones to bear fruit.

Bulbil Production in Palms

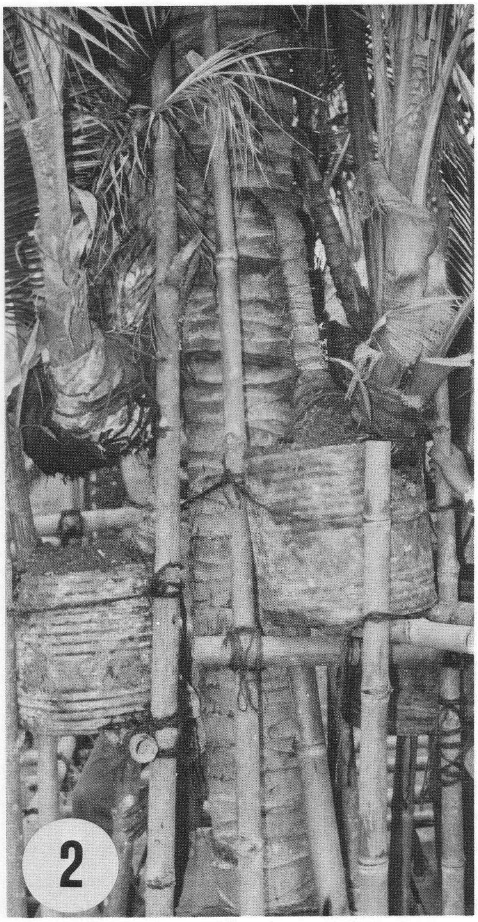
A few species of palms have reportedly produced vegetative shoots in place of inflorescences, rachillae or individual flowers, which resemble somewhat the bulbils in many species of Liliaceae and Agavaceae. Hence such vegetative shoots occurring in exceptional palms are also known popularly as "bulbil-shoots." Many such instances have been reported in *Cocos nucifera* (Ridley 1907, Burkill 1915, Hunger 1920, Furtado and Barreto 1920, Iyengar 1922, Sands 1927, Thomas 1961, Davis 1948a, 1948b, 1967, 1968b, and Sudasrip et al. 1978). This phenomenon has also been reported in *Areca catechu* (Murthy and Bavappa 1959, Davis 1968a), *Arenga pinnata* (Sudasrip 1980), *Borassus flabellifer* (Davis and Basu 1969), *Cocothrinax argentata* (Davis 1981), *Elaeis guineensis* (Davis 1959, Nair and Pillai 1959), and *Phoenix* sp. (Swingle 1927, Padmanabhan 1976).

Bulbil-Producing Coconut Palms in Indonesia

At the Kayuwatu experimental farm of the Industrial Crops Research Institute, Manado, there are two coconut palms planted in 1958, that continuously produce large vegetative shoots in place of inflorescences. These palms have exhibited the abnormality for the past 15 years, from the onset of "flowering". These unusual palms are the open-pollinated progeny of a common parent (No. 55e IIa) at the Mapanget experimental farm near Manado, which continues to produce normal flower and fruit bunches. Apart from these two abnormal palms (Nos. 1037 and 1586), there are 69 other progeny from the same parent which are growing with the bulbil-palms at Kayuwatu, but none of them has shown any tendency to produce bulbils. The bulbil-palms have not produced any fruits, although occasionally some bulbils have partially developed into spadices bearing diminutive abnormal flowers. The crowns of the two palms are very crowded because of many bulbils at different stages of development (Fig. 1). The bulbils remain attached to the crown for 5–6 years, after which they dry and fall off.

Layering of Bulbil-Shoots

For the first time, bulbil-shoots of a palm have been successfully air-lay-



1. Bamboo scaffolding erected on a bulbil-producing coconut palm at the Kayuwatu farm near Manado for and layering operations on the bulbils; 2. Close-up view of the coconut crown where layering operations on a few bulbils have been completed.

ered and propagated as clones. To achieve this, elaborate bamboo scaffoldings and wooden ladders were built around the two bulbil-coconut palms of Manado in November 1977. The crowns were cleared of all dry bulbils and sheaths of leaves. The older bulbils were also cleaned of all spathes and dry leaves. The old live bulbils bore 20–30 leaves including the dry ones. As the bulbils originate as inflorescences, their attachment to the stem is exactly like that of an inflorescence. However, because of the increased weight of its own crown, and due to the crowded condition of the crown of the parent palm, the older bulbils grow slanting downwards with their tips turning upwards (Fig. 2).

As the initial step the curved, bulged portion of the bulbil was wound tightly with paddy straw twisted into rope. This straw insulation was provided to retain moisture and to enable the rooting zone to maintain a temperature slightly higher than that outside. A mixture of pulverized volcanic ash, compost, and fertilizer (urea, triple superphosphate, muriate of potash and kieserite) was moistened with water, made into a paste, and daubed around the bulbil, which was then wrapped with a perforated plastic sheet. The plastic jacket was covered with jute gunny. Finally, the curved portion of the bulbil was firmly tied with strips of jute gunny and further reinforced by coconut coir rope. Since the weight of the bulbils increased considerably after completion of the operation, they were supported by bamboo pieces resting on the wooden platform. The bulbils were numbered and provision made to moisten them daily. Artificial watering of the bulbils was dispensed with once the peak monsoon season, December to February, set in. A close-up view of the crown of one of the palms on completion of the layering operations is shown in Figure 2.

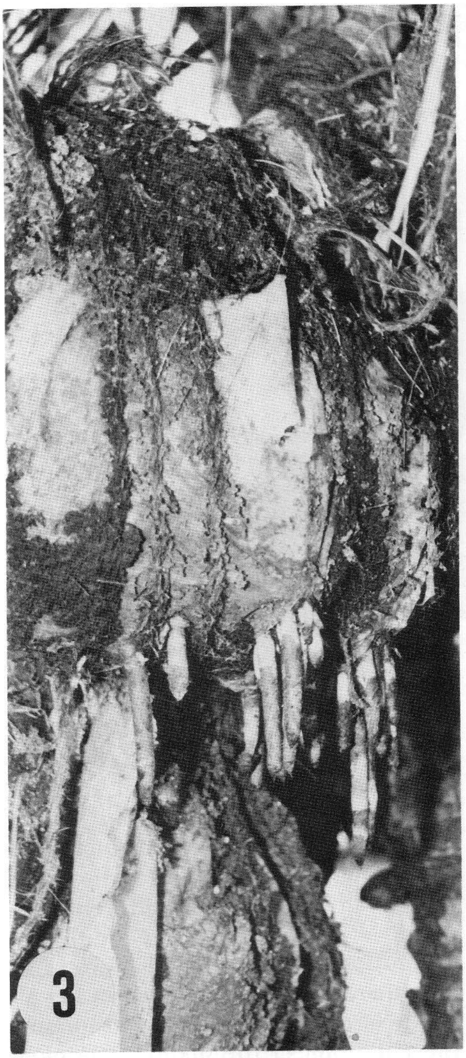
A total of 22 older bulbils from the two palms were prepared for layering. Continuous rains that followed the operation eliminated the need to moisten the bulbils manually. At the end of three months, roots were seen piercing through the gunny wrapper of most of the bulbils. One such bulbil with more than 15 roots emerging from the covering is shown in Figure 3. At this stage, small metal drums filled with rich soil medium were put in place so that the bulbils could develop a better root system and attain independence from the parent palm.

Separation of Rooted Bulbils

Two rooted bulbil-shoots were severed from the parent palm as clones 147 days after the commencement of layering operations (Fig. 4) and planted in a special nursery. The rest of the bulbils were subsequently separated from the parents at appropriate times, the last one 309 days after the commencement of operations. The bulbil-plants were planted in three rows at the Mapanget experimental farm of this Institute on 14 November 1978. The young palms were given optimum growth conditions by supplying them with liberal quantities of NPK and Mg fertilizers and attending to cultural operations. In mid-October, 11 months after transplanting, two bulbil-progeny of parent palm No. 1037 commenced producing "inflorescences." At the early stage, these shoots closely resembled normal flower bunches, but as they grew they differed from normal inflorescences by remaining thin and lanky. Moreover, the outer bract split at the tip allowing another bract to emerge partially from it. This was followed by the emergence of subsequent bracts. The tips of the subsequently-formed bracts develop small pinnae. The lamina portion of the bracts increases, with the production of new bracts/leaves. By the end of September 1980, 14 bulbil-progeny had commenced producing vegetative shoots, some of them bearing as many as six (Fig. 5).

Possible Reversal of Bulbils to Fruit Production

By early 1981, the remaining clones are also expected to "flower," and it is possible that all the plants will turn out to be bulbil producers. However, we hope that at least some of these bulbil-palms can be reversed to normal condition by inducing them to produce flowers and bear fruit by using simple treatments. It should be remembered that the two parent palms germinated from fruits of a common parent palm (No. 55e IIa) and have several "sibling" palms that behave normally. There are records that some of the bulbil-producing palms have re-



3. New roots piercing the jute covering of a bulbil; 4. One of the rooted bulbils separated from the parent palm.

versed to flower production without any treatment. One of the *Borassus flabellifer* palms reported by Davis and Basu (1969) produced bulbils for a single season, then reverted to producing fruits and has done so for a continuous ten-year period. In a coconut palm that had lost its growing point, a young inflorescence was reported to have reversed into a vegetative shoot which took the place of the main stem and produced fruit bunches (Quisumbing 1927). Some of the bulbils of the *Elaeis* reported by Nair and Pillai (1959) reversed again to normal condition. In another very young *Elaeis guineensis* palm, both flower bunches and bulbils were produced (Davis

5. One of the bulbil-clones bearing numerous bulbil-shoots in place of inflorescences.

1980), but after a year some of the older bulbils produced regular inflorescences. A somewhat similar phenomenon was also reported occurring in *Phoenix dactylifera*, *Arenga pinnata*, and *Cocothrinax argentata* (Davis 1981). The phenomenon recorded by Sudasrip (1980) opens the possibility of reversing inflorescences into vegetative shoots artificially by simple treatments like controlled pruning of leaves. Normally, the terminal bud of *Arenga pinnata* ends up as a female inflorescence, after which the buds in the axils of lower leaves develop basipetally one after another into inflorescences. But if the palm is decapitated just before the first flowering, the axillary buds are stimulated to develop into vegetative shoots. Three such palms have been observed around Manado. It is further surprising that some of these shoots once again reversed to the normal flowering condition.

Schwarzenbach (1956) demonstrated that such simple treatments as change of temperature, light and altitude reversed the grass *Poa alpina* from fruiting condition to the state of producing regular bulbils. His trials clearly showed that at different altitudes, *P. alpina* produced different proportions of bulbils and flowers, so much so that one could predict the altitude of a region merely by examining the condition of the plants. The clonally-propagated coconut bulbils are still very small and too young to be subjected to environmental changes to induce permanent or temporary changes in their reproductive behavior, but some trials have been initiated by administering plant hormones. When significant results become available, they will be published.

An unexpected development in one of the parent coconut palms that produce bulbil-shoots (No. 1586) is likely to provide some additional information on the capacity of a bulbil to grow into the main stem. In March 1979, the crown of the palm was infested with red palm weevil (*Rhynchophorus* sp.) and its growing point permanently damaged. Fortunately some bulbils which had developed from below the point of pest attack escaped damage. The topmost bulbil, although younger than the others, is growing the fastest and it appears that this shoot will take the place of the main stem. Nevertheless one cannot predict whether it will produce normal flower bunches or continue to produce the vegetative shoots.

Literature Cited

Burkill, I. H. 1915. An abnormality in the coconut palm. Journal of Royal Asiatic Society, Straits Br. 69: 15.

Davis, T. A. 1948a. Abnormal palms of Travancore. III. A bulbiliferous coconut palm (*Cocos nucifera* L.). Journal of Bombay Natural History Society 47: 527–529.

———. 1948b. Proliferation in two coconut palms. Indian Coconut Journal 2: 11–17.

———. 1959. Foliation in certain spadices in an African oil palm (*Elaeis guineensis* Jacq.). Science and Culture 25: 332–333.

———. 1967. Foliation of coconut spadices and flowers. Oleagineux 22: 19–23.

———. 1968a. Phyllody of the spadix in *Areca catechu* Linn. Science and Culture 34: 456–458.

———. 1968b. Difficulties in the genetic improvement of the coconut: a promising alternative method. Indian Journal of Genetics and Plant Breeding 28A: 154–164.

———. 1980. Double reversal of spadices in an African oil palm. The Planter 56(6): 212–216.

———. 1981. Reversal of palm spadices and flowers into vegetative shoots. Phytomorphology, in press.

——— and S. K. Basu. 1969. Two cases of bulbil-bearing *Borassus flabellifer* Linn. Journal of Indian Botanical Society 48: 198–201.

Furtado, C. X. and P. C. Barreto. 1920. Abnormal inflorescences. Poona Agricultural College Magazine 12: 81–83.

Hunger, F. W. T. 1920. *Cocos nucifera*. Amsterdam.

Iyengar, M. O. P. 1922. Note on a bulbiliferous coconut tree from Malabar. Journal of Indian Botanical Society 3: 289–291.

Murthy, K. N. and K. V. A. Bavappa. 1959. Abnormalities in arecanut. Arecanut Journal 10: 97–107.

Nair, R. G. and R. V. Pillai. 1959. A note on the abnormal developments in an oil palm. Indian Coconut Journal 12: 77–81.

Padmanabhan, D. 1976. Rare axillary shoots in *Phoenix*. Principes 20: 91–97.

Quisumbing, E. 1927. Branching in coconut. Philippine Agriculturist 15: 3–11.

Ridley, H. N. 1907. Branching in palms. Annals of Botany, London 21: 415–422.

Sands, W. N. 1927. Abnormalities in the coconut palm. Malay Agricultural Journal 15: 290–293.

Schwarzenbach, F. H. 1956. Die Beeinflussung der Viviparie bei einer grönlandischen Rasse von *Poa alpina* L. durch den jahreszeitlichen Lichtund Temperaturwechsel. Berichte der Schweizerischen Botanischen Gesellschaft 66: 204–223.

Sudasrip, H. 1980. Reversal of *Arenga pinnata* spadices into vegetative shoots and its relevance to the origin of coconut bulbils. Principes 24: 147–153.

———, H. Kaat, and T. A. Davis. 1978. Clonal propagation of the coconut via bulbils. Philippine Journal of Coconut Studies 3(3): 5–14.

Swingle, W. T. 1927. Vegetative and fruiting branches in the date palm and sterile intermediates between. Memoirs of Horticultural Society, New York 3: 213–214.

Thomas, C. A. 1961. Coconut bulbils with roots. Indian Coconut Journal 14: 132–134.

Principes, 25(3), 1981, pp. 130–132

PALM BRIEFS

Some Notes on Two Native Palms of Southeastern Australia

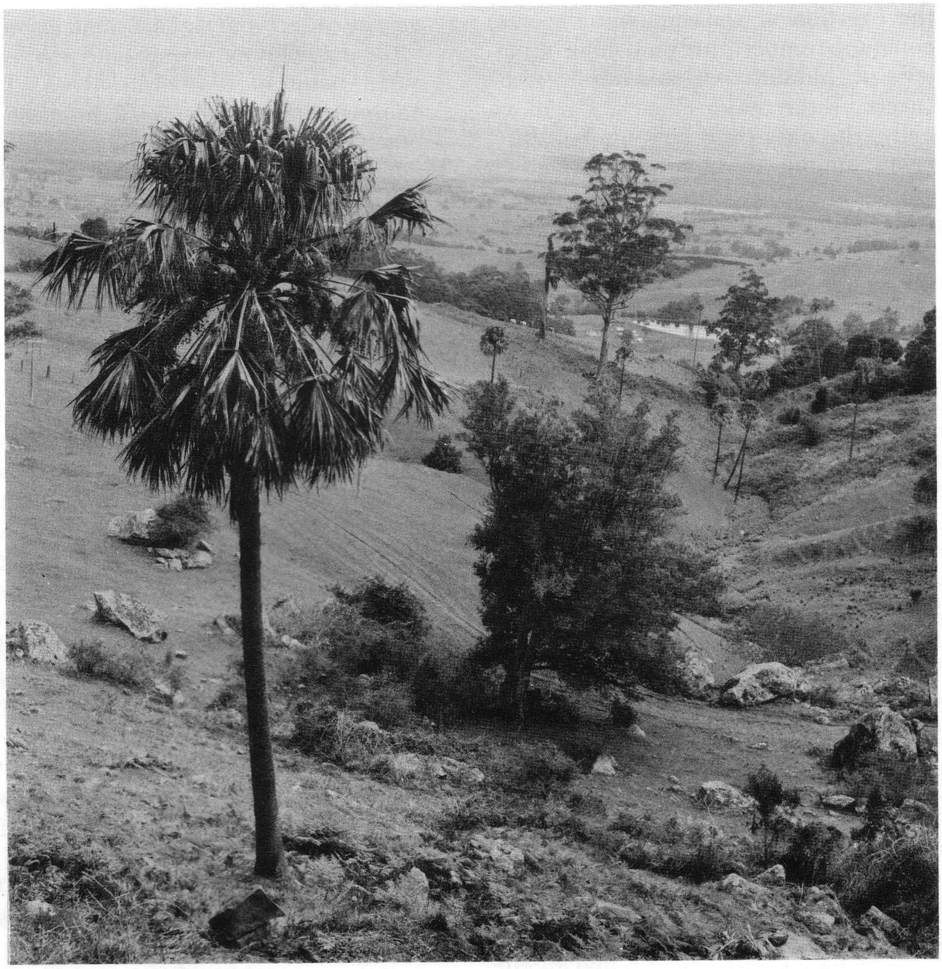
The far south coast of New South Wales is today one of the least disturbed areas on the Australian east coast. Thus, studies of the natural vegetation can still be a fascinating and rewarding experience in this region. This report centers on an area surrounding the township of Batemans Bay with special emphasis on two palms of the district which are widespread and often locally abundant.

The two principal species that occur naturally in the region are the bangalow *Archontophoenix cunninghamiana* (cover) and the cabbage tree palm *Livistona australis* (Fig. 1). They are different from each other in appearance as well as habit, and must be regarded as two of the grandest palms of our landscape in Australia. A botanist in search of rare or unusual species would probably find North Queensland more rewarding (see *Principes* 22: 88, 23: 106, 24: 99) but nothing can really surpass the powerful aura of a virgin rain forest filled with bangalows of all sizes from ground level to the canopy high above (see cover). And such is the realm of the bangalow at its southern limits.

The cabbage tree palm by contrast belongs to the more open eucalypt forests wherever soilwater is sufficient for its requirements. It will never—repeat never—penetrate the rain forest which has a more constant temperature, much lower light intensities, and higher humidity than the surrounding sclerophyll forest, where tall eucalyptus trees and a dense groundcover of cycads reaching about two meters in height are the dominant features. If you find a bangalow and a cabbage tree palm growing side by side, you have found the last bangalow and the first cabbage palm or vice versa.

Thus, the bangalow is a rain forest inhabitant while the cabbage palm shows strong adaptations to a more temperate and seasonal environment. The bangalow is a much faster grower and it often forms a considerable proportion of the canopy or of B storey trees as they are called. Some trees like the Illawarra fig or the giant stinging tree, however, soar to much greater heights. At forest floor level well developed plank buttresses are the most conspicuous evidence of the presence of these forest giants. The bangalow obviously competes very successfully with all other vegetation of the rain forest. From the gloomy depth of the forest floor where the very slender prickly tree fern is the dominant feature, the young bangalow is constantly striving towards the light high above, with widely spaced ringscars indicating extension of the stem between developing leaves. As light intensity gradually increases around the steadily ascending crown, the distance between the individual ringscars decreases and the crown remains within the shelter of the surrounding forest. More energy appears diverted towards consolidation of the trunk below, which may double its diameter in the process due to the thickening of the cell walls and increase in cell size and number within the trunk. In delayed thickening of the stem, the palm somewhat compensates for its lack of ability to add more cells to the outside of the trunk as do its main competitors, the dicotyledonous trees.

At a height of ten or more meters the bangalow may look very much like a mature palm but will not flower unless the desired light level has been



1. *Livistona australis* between Noura and Cambewarra Mountain Pass, N. W. S., Australia. Photo by W. H. Hodge.

reached. When flowering occurs, each inflorescence unfolds as a lower leaf falls, and it is not uncommon to see flowers, young and mature fruit all on the same tree. This is perhaps one of the most spectacular and colorful sights to be seen in the rain forest anywhere in Australia. The bangalow with its flowers and fruits well below the crown on a bare trunk apparently has devised its own resemblance to cauliflory, which is very common in the realm of the rain forest. Inflorescences that have flowered in autumn may take twice as long to mature as those flowering later in spring so that most of the fruit matures nearly at the same time the following autumn. In North Queensland, however, the fruiting season of the bangalow is early summer.

There seems to be no evidence that the southern bangalow is more cold tolerant than the more northern populations. Walking through these bangalow forests at any time of year will inevitably bring about some mild perspiration, undoubtedly aggravated by the exertion of walking, but the ever constant temperature and high atmospheric humidity of this forest must surely be the major causes. Paradoxically, the only time I remember shivering among the bangalows was in summer in the Eungella Ranges in North Queensland. Caught in a torrential downpour while a cyclone was raging some distance away, I had the car heater on full blast for about half an hour before I fully recovered from the excursion.

The height to which the bangalow grows is greatly influenced by the average height of the forest canopy and may vary considerably from place to place. The bangalow cannot be separated from all other elements which combine to form its unique habitat. Significantly the southern limit of the bangalow is also the southern limit of the subtropical rain forest. There are other types of rain forest further south and at higher elevations but at closer examination these will be found to be quite different from the type referred to above. The bangalow seems to be much more uniform throughout its range than Alexandra Palm, *Archontophoenix alexandrae*, the only other species of the genus.

In sharp contrast to the above, the cabbage palm retains all its flower spikes within the bud over a period of two years to be pushed out all at the same time in spring every second year. The strictly seasonal flowering as well as the interfoliar inflorescences conform astonishingly well with the seasonal habit of temperate trees. The cabbage palm also has a number of near relatives in other states and to the north of Australia. During the first twenty or so years of its life, before a substantial trunk is formed, the local species must be regarded as the ornamental palm par excellence. It is most attractive and most adaptable to indoor cultivation and other fan palms would be hard pressed to match a young cabbage palm, growing on the shady side of a building in association with ferns and other shade and moisture loving plants. Seeds ripen in autumn under local conditions and usually hang on throughout the winter. Germination begins at the following warm season and continues for three successive summers. This, plus the slowness of the seedlings during the initial stages, must be at least partly responsible for the relative rareness of this palm in florist shops and nurseries in Australia. The cabbage palm is considerably more frost hardy than the bangalow. One large specimen is growing luxuriantly in the Canberra Botanic Gardens at an elevation even higher than the city itself.

EIKE JAKOBASCH
8 Derribong Avenue
Batemans Bay
New South Wales 2536
Australia

Principes, 25(3), 1981, pp. 133–139

The Raposa Palm Plantation Revisited*

DENNIS JOHNSON
University of Houston, Houston, Texas 77004

The Raposa plantation near Fortaleza, Brazil, was a research facility of S. C. Johnson & Son, Inc., from 1937 to 1970. During that period research was conducted on the native carnauba wax palm (*Copernicia prunifera*) and 14 introduced congeners, in an attempt to identify high wax-yielding palms for plant breeding. In 1970 S. C. Johnson ended their research on waxy palms and donated Raposa to the Federal University of Ceará in Fortaleza. On the occasion of the gift, a terminal report of botanical research conducted and a detailed survey of the plantation were completed (Johnson 1970). Short papers about Raposa were published in *Principes* by Kitzke (1970) and Johnson (1971). The purpose of this paper is to report the findings of a follow-up survey of Raposa in August 1980, which focused on survival and growth rates of the introduced species of *Copernicia*.

At Raposa the introduced palms are planted in eight individual fields, which were established from 1947 to 1955. Currently they are in fair to good condition in terms of undergrowth. Almost all of the palms are tall enough so that they are not experiencing competition for light, but undoubtedly are experiencing some competition for soil moisture. Precipitation in Northeast Brazil was below normal for both the 1979 and 1980 rainy seasons, and the condition is being described as a mini-drought.

* S. C. Johnson & Son, Inc., Racine, Wisconsin, supported this research by providing travel expenses to Brazil. I am indebted to E. D. Kitzke for his suggestions and encouragement.

The survey included enumeration of the fields of introduced species to ascertain the losses which had occurred since the previous survey in July 1970. Some palms had died and their remains were destroyed completely by decay, while others were dead and still standing. Palms exhibiting a stunted growth form, judged by an absence of trunk development after a minimum of 25 years or by abnormal trunk form, were counted as losses. Stunted palms apparently never reach botanical maturity and do not live as long as normal specimens. Selected palms which had been photographed during the 1970 survey were rephotographed to obtain an approximate record of the rate of growth.

Losses among the introduced palms are listed in Table 1. Total losses for the ten-year period are overstated somewhat because certain specimens counted as viable in 1970 already were exhibiting abnormal characteristics; these same palms were considered as losses in 1980 even if still alive. The species names in Table 1 have not been changed from those used in 1970 (Johnson 1971). However, two species misidentifications now are evident from the character of mature trees. The palms designated as *Copernicia tectorum* appear to be *C. fallaense*; the palms identified as *C.* × *vespertilionum* do not resemble that species and possibly are *C. Burretiana*. More detailed botanical study is needed to resolve these problems. Accurate identification of several species is difficult because they are or may be natural hybrids.

Table 1. Losses of introduced Copernica *palms by species, 1970–80*

Species	1970 Population	1980 Population	Losses	Percentage Lost
Copernicia alba	286	263	23	8.0
C. Baileyana	62	58	4	6.5
C. Burretiana	2	2	0	0.0
C. Cowellii	23	16	7	30.4
C. Curtissii	10	10	0	0.0
C. glabrescens	41	40	1	2.4
C. hospita	853	774	79	9.3
C. macroglossa	47	47	0	0.0
C. rigida	2	1	1	50.0
C. × Shaferi	28	24	4	14.3
C. tectorum	2	2	0	0.0
C. × textilis	14	14	0	0.0
C. × vespertilionum	2	2	0	0.0
C. Yarey	89	81	8	9.0
Total number of specimens	1,461	1,334	127	8.7

For discussion purposes, the introduced species can be divided into three groups: Group 1—no losses; Group 2—losses of 1–8 percent; Group 3—losses of 9 percent or greater.

Group 1 consists of *C. Burretiana, C. Curtissii, C. macroglossa, C. tectorum* (?), *C.* × *textilis* and *C.* × *vespertilionum* (?). These palms are healthy in appearance and perfectly adapted to the climate of coastal Northeast Brazil. Figure 1 shows a specimen of *C. Burretiana* which increased its trunk height from about 1.1 m in 1970 to 2.5 m in 1980. The palm in the photograph is 25 years old and ultimately may reach a height of 4–5 m (Dahlgren and Glassman 1963). All specimens of *C. Curtissii* are producing suckers vigorously, whereas in the native habitat in Cuba they are described as occasionally producing them (Dahlgren and Glassman 1963). The more vigorous suckering habit could be some type of environmental response.

C. macroglossa is the showcase palm at Raposa and seed reportedly has been collected for ornamental plantings in the Fortaleza area. A few of the palms now are large enough to show an exposed trunk beneath the dense skirt of adhering dead leaves. Figure 2 provides photographic evidence for the redesignation of *C. tectorum* as *C. fallaense*. Over the ten-year period, the palm has produced a trunk of about 1.4 m in height.

C. × *textilis*, one of the natural hybrids, is pictured in Figure 3. This specimen has increased its trunk height from about 1.5 m to 3.0 m. One specimen of *C.* × *vespertilionum* (?) was measured and showed an increase in trunk height from 1.0 m to 3.3 m in ten years.

Group 2 includes *C. alba, C. Baileyana* and *C. glabrescens*. The second largest number of specimens at Raposa belongs to *C. alba*. Wide variation in size is found among the trees, with no apparent pattern which can be related to environmental factors. The occurrence of stunted palms is random; no plant parasites were observed to account for the stunted growth. Figure 4 shows a mature *C. alba* with trunk height of about 8.0 m in 1970

1. *Copernicia Burretiana*. a. 1970. Man is 1.76 m tall; b. 1980. Man is 1.65 m tall; 2. *Copernicia tectorum* (*fallaense* ?). a. 1970; b. 1980.

3. *Copernicia* × *textilis*. a. 1970; b. 1980; 4. *Copernicia alba*. a. 1970; b. 1980.

5. *Copernicia Baileyana*. a. 1970; b. 1980; 6. *Copernicia hospita*. a. 1970; b. 1980.

and 10.7 m in 1980. In Paraguay the palm reaches up to 30 m in height (Dahlgren and Glassman 1961).

C. Baileyana also shows considerable variation in size at Raposa. The palm in Figure 5 increased its trunk height from 4.5 m to 5.7 m in ten years. Other specimens are even taller, with two reaching 10 m, as tall as those in Cuba (Dahlgren and Glassman 1963). *C. glabrescens* is described as occasionally producing suckers in Cuba (Dahlgren and Glassman 1963), but all specimens at Raposa are suckering vigorously. Once again, this could be some type of environmental response. Despite the loss rates within Group 2, the presence of numerous mature healthy specimens indicates that the species are adaptable to coastal Northeast Brazil.

Group 3 consists of *C. Cowellii, C. hospita, C.* × *Shaferi, C. rigida* and *C. Yarey.* With losses of over 30 percent, *C. Cowellii* is the least successful of the species introduced to Raposa. Several of the plants have reached botanical maturity, but the largest is only 1 m tall, although it is 30 years old. Normally this species in Cuba reaches a height of 1.2–2.5 m (Dahlgren and Glassman 1963).

C. hospita represents more than one-half of the introduced specimens at Raposa. A loss rate of over 9 percent indicates that some problems of adaptation exist. Losses due to death or stunted growth appear to be random except in Field C where a group of six large palms had recently died. Accounting for this concentration may be the recent drought conditions and very sandy soils of the field, but a plant parasite cannot be ruled out. Figure 6 shows a specimen in another field which increased its trunk height from 0.6 m to 1.9 m. Other specimens of *C. hospita* at Raposa are over 3 m in height. This species represents the most promising waxy palm in the collection. Despite the losses experienced, it does appear to be adaptable to the environment providing it is planted in more favorable sites.

C. × *Shaferi* also has suffered relatively high losses at Raposa. A few specimens are botanically mature, but all are rather small in stature. The largest plant has a trunk about 1 m tall, whereas in Cuba this natural hybrid reaches heights of 2.0–3.5 m (Dahlgren and Glassman 1963). This species does not appear to be well adapted. The loss of one of the two specimens of *C. rigida* occurred recently in the same field where the group of *C. hospita* also died, and probably for the same reason. The surviving palm appears to be healthy, but with only a single specimen no conclusions can be drawn.

C. Yarey had a loss rate of 9 percent, but one-half of the losses occurred in Field C where conditions are most severe. Measurement of a specimen in another field showed an increase in trunk height from 1.1 m to 2.8 m. Like *C. hospita,* this species appears to be adaptable to more favorable sites in coastal Northeast Brazil.

In conclusion, it should be mentioned that the Raposa plantation is the largest collection of cultivated *Copernicia* palms known, and its species list is exceeded only by the Fairchild Tropical Garden in Miami. At least three species are unique to Raposa. Much could be learned about the nature of spontaneous palm hybrids and other aspects of *Copernicia* species through careful study of the research records and living specimens in the collection.

Literature Cited

Dahlgren, B. E. and S. F. Glassman. 1961. A revision of the genus *Copernicia*. I. South American species. Gentes Herbarum 9(1): 1–40.

———. 1963. A revision of the genus *Copernicia*. 2. West Indian species. Gentes Herbarum 9(2): 41–232.

JOHNSON, D. 1970. Development of an improved waxy palm. Unpublished report of S. C. Johnson & Son, Inc., Racine, Wisconsin.

———. 1971. Some notes on palms of the genus *Copernicia*. Principes 15(4): 127–130.

KITZKE, E. D. 1970. Research plantation gift. Principes 14(2): 68–71.

Principes, 25(3), 1981, pp. 139–140

LETTERS

Dear Editor,

I am sure that many members of the Palm Society will be interested to hear the findings of the special Meeting on the Future of Lethal Yellowing Research held 1–2 September 1980 in Kingston, Jamaica, which was cosponsored by the International Council on Lethal Yellowing and the Coconut Industry Board, Jamaica. This meeting was convened because the financial and technical support for the U.K. Overseas Development Administration LY Research Team in Jamaica will come to an end in March 1981, after nine years of work. The Coconut Industry Board also indicated its desire to withdraw its support. The aim of the meeting was to review research on LY to date, decide what future research was needed, and attempt to identify sites and financial support for this research.

Participants in the meeting included representatives from ODA, FAO, Univ. Fla., Univ. W. Indies, Coconut Industry Board Jamaica, Caribbean Development Bank, European Communities Commission and Ministries of Finance and Agriculture Jamaica.

To update all the participants, the following Background Papers were circulated previously:

(1) Global Significance of LY (L. Chiarappa)
(2) Outstanding Scientific Problems—The Need for Continued Research on LY (S. J. Eden-Green)
(3) LY and Lethal Declines of Palms in the United States (W. B. Ennis)
(4) Brief Review of Research on LY (D. H. Romney)
(5) Variety Resistance to LY—Current Situation (B. O. Been)

In addition, Policy Statements on LY were received from Central Plantation Crops Research Institute, India; Coconut Research Institute, Indonesia; Institut pour Recherches en Huiles et Oléagineux (IRHO), France; Ministry of Agriculture, Jamaica; Philippine Coconut Authority; Royal Tropical Institute, The Netherlands; Council for Scientific and Industrial Research, Ghana; Coconut Industry Board, Jamaica; and the National Coconut Development Project (GTZ), Tanzania. All of these territories/organizations stressed the need for continuation of research into LY.

The meeting concluded that priority work should be pursued in two major fields of research:

A. International testing of coconut varieties to find practical resistance in each territory and to identify where diseases are co-identical. A project was drawn up that delineates the varieties to be tested and the criteria for running the experiment. Statistical advice is being obtained from E. Malling Research Station, U.K. It is hoped that trials can be established in Nigeria (Awka wilt), Philippines (Socorro disease and Cadang-cadang), Jamaica (LY), Malaysia and Sumatra (stem necrosis), New Hebrides (unnamed disease), India (root wilt), Solomon Islands (unnamed disease), Sri Lanka (leaf scorch), Guyana (cedros wilt) and Trinidad (red ring). Such variety testing for resistance is included in an array of global coconut research proposals currently being considered by UNCTAD for funding. It is proposed that *Veitchia merrillii*, *Pritchardia thurstonii*, *Washingtoniafilifera* and *Arecastrum romanzoffianum* be included in the trials as representatives of palm species that are known to be susceptible or resistant to lethal declines in Florida and Jamaica. It should be explained that coconut variety and hybrid testing are already in hand for Cape St. Paul wilt in Ghana, Kaincope in Togo, Kribi in Cameroon and LY in Haiti (by the Institut pour Recherches en Huiles et Oléagineux, France) and for a disease resembling LY in Tanzania (by German Technical Aid).

B. Research into culture of LY MLO, the characterization of the disease by serology and electrophoresis, and development of a controlled transmission technique using contrived leaf-hopper vectors. Success in these fields might yield methods of positive screening for resistance and of disease control, also an understanding of resistance mechanisms. The University of the West Indies (Jamaica campus) hopes to carry out this work as a regionally important project, and has approached the European Economic Commission for aid. Some inputs are expected from the Ministry of Agriculture, Jamaica.

The Coconut Industry Board will continue its work on selection and breeding of coconut varieties for LY resistance and adaptability to different growing conditions. By the end of this year, the Board will have established six new field trials to test nine new hybrids from disease-resistant parents against the time-tested Malayan Dwarf and Maypan hybrid.

The meeting specially acknowledged with grateful thanks the ongoing scientific contribution of the University of Florida to the LY problem: continuation of this research is now even more vital than before. The meeting also commended the continued interest and support from The Palm Society which fostered the formation of ICLY in 1973 and ICLY meetings subsequently.

Preparations are now proceeding for the fifth biennial scientific meeting of ICLY to be held probably in Texas in the second half of 1981. You will hear more of this.

DAVID H. ROMNEY
Co-chairman
International Council on
Lethal Yellowing