Palms, 43(4), 1999, pp. 161–165

Flowering and Fruiting Phenology in Certain Palms

M. H. CHAPIN

Plant Science Department, National Tropical Botanical Garden, Lawai, Hawaii 96765 USA

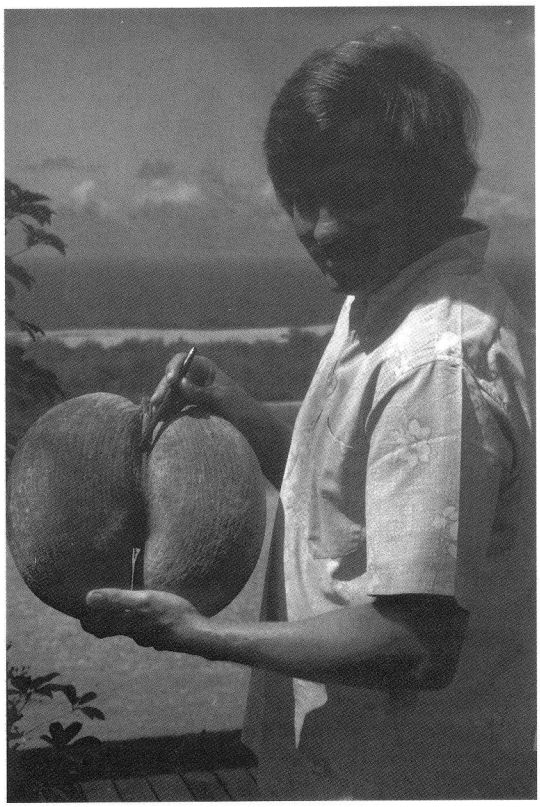
ABSTRACT

The period of time between pollination and fruit maturation is reported here for selected palm species at the National Tropical Botanical Garden Hawaii (NTBG). Mature fruit diameters are also recorded. The species studied occur in the Arecoideae, Ceroxyloideae, and Coryphoideae. Data obtained from the literature are included and discussed. The literature shows that the major economic species (the date, coconut, and oil palm) have been researched extensively, while only limited and diffuse information exists for the remaining palms. The hypothesis tested here is that the correlation between length of time between pollination and fruit maturation is proportional to fruit size in palms. Results of original data and what is found in the literature show that this correlation does not exist.

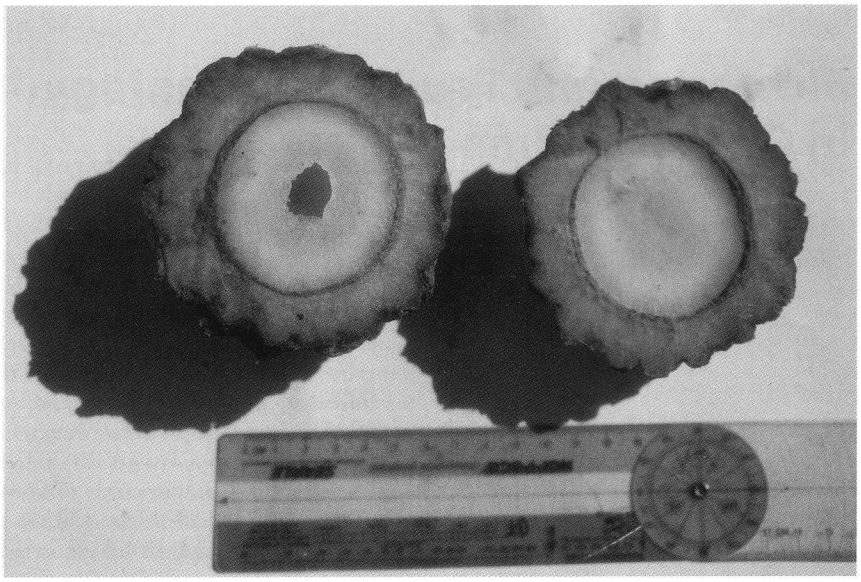
A better and more complete understanding of this phenomenon would be beneficial to botanists in organizing field collecting expeditions, and to scientists involved in pollination studies. It would help palm growers to calculate seed production, and aid them in controlled pollination work. It might also contribute to a better understanding of treating pests and diseases that are associated with either the flowering or fruiting stages of palms. Finally, it would provide a more comprehensive understanding of the natural history of palms. But existing information on palm flower and fruit phenology is limited. Access to palms in the wild is often difficult. When palms are studied in the wild it is often during a single visit, and although vouchers may record the phenological status, the entire process of fruit development from the time of pollination cannot be known.

How long does it take palm fruits to develop?

Burkill (1966) reports that the biggest palm fruit belongs to the double coconut, *Lodoicea maldivica*, which weighs 20–30 kg at maturity. One might expect this giant to take longer to mature than any other fruit, since the double coconut is the largest seeded plant (Fig. 1). Corner (1966) reports that it takes six years from time of pollination to fruit maturation. Soon (1997) recorded eight years for the same species growing at Singapore Botanical Gardens. Burkill (1966) reports that ". . . the palm flowers at 15 years and as the fruits take three years to ripen, fruits first occur at 18 years." McCurrah (1960) suggests the fruit takes one year to develop to full size and five years to "mature," but the source of his information is not given. Other examples include data collected on the flowering and fruiting phenology of *Corypha umbraculifera* in the Fairchild Tropical Garden, which took 450 days to produce ripe fruit 4 cm in diameter (Fisher et al. 1987). Another study of *Corypha utan* by Tomlinson and Soderholm (1975) showed that mature fruits develop to 1.5 cm in diameter in 41 days. In Fiji, *Pelagodoxa henryana* took 2.5 years (913 days) to produce mature viable fruit



1. Dr. William Theobald with *Lodoicea maldivica* seed, National Tropical Botanical Garden, 1977.



2. *Pelagodoxa henryana* mature fruit in longitudinal section measuring 10 cm in diameter. Fruit was collected from NTBG accession #770290.001. Photo by M. H. Chapin.

in cultivation (Phillips 1996). He states, "The long delay between pollination and maturity of the seed has surprised me. Perhaps it is that these palms are not common so no one has checked this point, but I have seen nothing in any literature that commented on this long period of development." Phillips did not record the fruit size; however, my own observations at the National Tropical Botanical Garden show that fruits of *Pelagodoxa henryana* measure 10 cm in diameter at maturity (Fig. 2).

How does one establish this information for any palm? Can one test the hypothesis that the larger a palm fruit, the longer it takes to develop? The periodic flowering and fruiting behavior of palms is not well understood. Events such as the time of flowering and the length of time between pollination and fruit maturation may correlate with climatic or environmental factors such as temperature, water, nutrients, and light (Zalom et al. 1983). Here, I present some original data that provide a partial answer to the question and allow comparison with information about other palms derived from the literature.

Materials and Methods

Documentation of the flowering and fruiting stages of eight tropical palm species growing in cultivation is provided here. They grow in the tropical climate at Kauai, Hawaii in the National

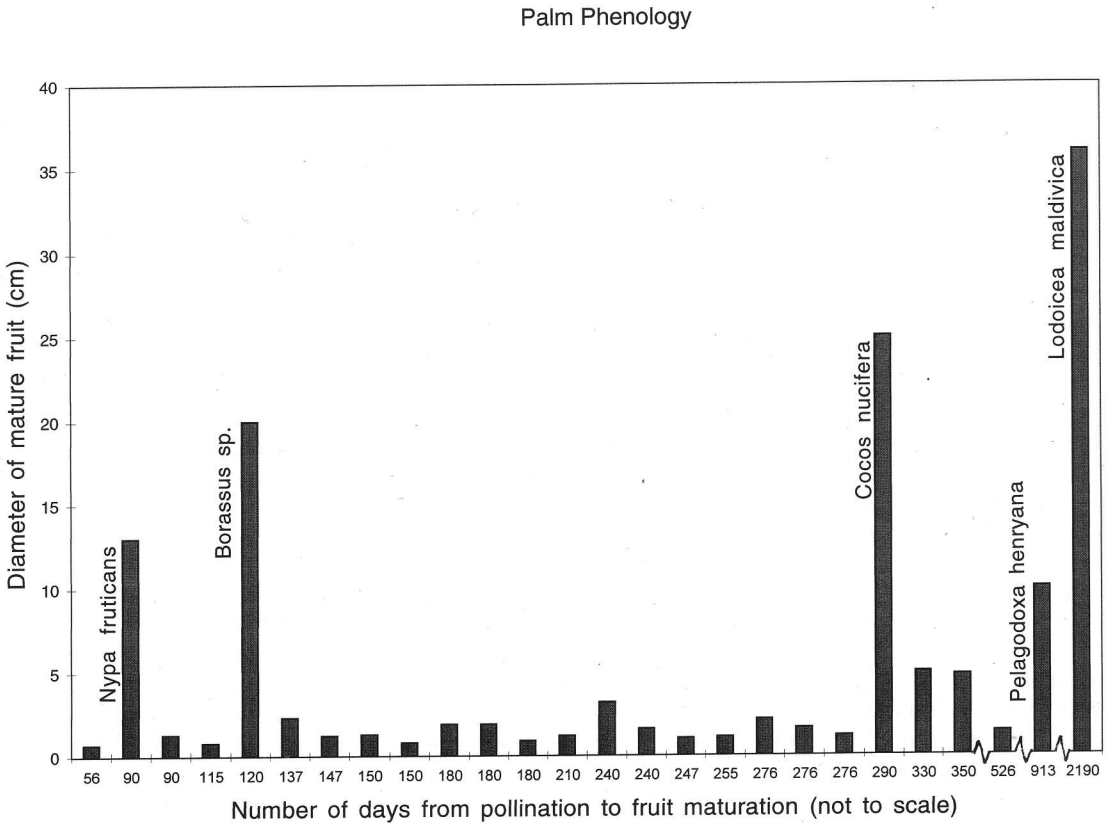
Table 1. Fruit maturation time and mature fruit size for palm species examined in this study.

Taxon	Subfamily	Date begin/ date end	Total number of days	Mature fruit diameter (cm)
Hyophorbe lagenicaulis	Ceroxyloideae	06 Aug. 97–07 Jan. 99	526	1.4
Hyophorbe verschaffeltii	Ceroxyloideae	06 Aug. 97–09 Apr. 98	247	1.0
Licuala paludosa	Coryphoideae	06 Aug. 97–08 May 98	276	1.2
Lytocaryum weddellianum	Arecoideae	06 Aug. 97–20 Dec. 97	137	2.3
Phoenix loureiri	Coryphoideae	06 Aug. 97–28 Nov. 97	115	0.8
Pritchardia kaalae	Coryphoideae	06 Aug. 97–08 May 98	276	2.2
Pseudophoenix sargentii	Ceroxyloideae	06 Aug. 97–08 May 98	276	1.6
Sabal mexicana	Coryphoideae	12 Jul. 97–06 Dec. 97	147	1.2

Table 2. Fruit maturation time and mature fruit size (after Corner 1961).

Taxon[1]	Subfamily	Total number of days[2]	Diameter[3] (cm)
Actinorhytis sp.	Arecoideae	330	5.0
Areca catechu	Arecoideae	240	3.2
Borassus sp.	Coryphoideae	120	15–20
Coccothrinax sp.	Coryphoideae	180	1.3–1.9
Cocos nucifera	Arecoideae	270–300	20–25
Corypha sp.	Coryphoideae	270–390	3.8
Lodoicea maldivica	Coryphoideae	2,190	30.5–36
Nypa sp.	Nypoideae	90	10–13
Phoenix sp.	Coryphoideae	180	1.9
Ptychosperma sp.	Arecoideae	90	1.3
Sabal sp.	Coryphoideae	150	0.8–1.3
Washingtonia sp.	Coryphoideae	150	0.8

[1] Scientific names derived from common names after Corner (1961).
[2] Transposed from Corner (1961) yearly and monthly data.
[3] Transposed from Corner (1961) measurement in inches data.



3. The relationship between the diameter of mature fruit and the time required for fruit maturation in palm species discussed in this paper.

Table 3. Fruit maturation time and mature fruit size (Murray 1971).

Taxon	Subfamily	Total number of days	Diameter (cm)
Chamaedorea alternans	Ceroxyloideae	255	1.1
Chamaedorea pochutlensis	Ceroxyloideae	210	1.2
Chamaedorea sp.	Ceroxyloideae	180	0.9
Hyophorbe lagenicaulis	Ceroxyloideae	240	1.6
Thrinax floridana	Coryphoideae	56	0.7

Tropical Botanical Garden (NTBG), Lawai Valley, which has an average annual rainfall of 65 inches and an annual average temperature of 73.3°F (National Weather Service). Soils consist of highly weathered volcanic basalt, clay soils with iron oxides, aluminum, and magnesium. The soil pH ranges from 5.6 to 6.5.

Samples were taken from flagged inflorescences on individual palms at weekly intervals. Criteria for fruit maturity were based on the appearance of fruit changing color, dropping off, becoming pulpy, or dehiscing. Samples were fixed in FAA as they were collected, and correspond to an herbarium voucher deposited in the NTBG herbarium (PTBG). Measurements of the fruit diameters were taken at maturity at the widest point using calipers. The results are given in Table 1.

Results

The literature reflects a concentration of phenological studies of the commercially important palm species coconut (*Cocos nucifera*), oil palm (*Elaeis guineensis*), and the date palm (*Phoenix dactylifera*), but only limited and diffuse examination of the remaining taxa.

DeMason et al. (1989) reported that *Phoenix dactylifera* reaches fruit maturation after 200 days, while Corner (1966) documented 180 days. Ikemefuna et al. (1984) and Corner (1966) found that *Elaeis guineensis* takes 180 days from pollination to produce mature fruit. Corner (1966) reported *Cocos nucifera* required 300 days from flower to fruit maturation. Although many of the remaining species of palms are also important commercially in the landscape industry and have great value as minor economic plants, less information is available on their flowering and fruiting periods. Scariot (1995), for example, conducted a detailed study on the phenology of *Acrocomia aculeata*. He focused on the relationship of the flowering time to fruit set over the reproductive season. His results indicated that *Acrocomia aculeata* took 90 days for its fruit to ripen after pollination. Corner (1966) reported on a variety of palm species, and included the time it took them to produce mature fruit, as well as the width of the fruit (Table 2). His sources were not cited. Murray (1971) collected data on five species. Their fruiting phenology is shown in Table 3.

Discussion

Although a great deal of phenology research has been conducted on the three most important commercial species within the Arecaceae, the remainder of the family (composed of over 2,650 species) has had only a diffuse and limited amount of study. With the limited data available, it is still possible to draw some conclusions. Of the species included in this study and those cited, we can see that a correlation does *not* exist between maturation time or the length of ripening time and fruit size (Fig. 3).

Although carrying out studies of this nature is difficult in wild populations, botanical gardens and palm nurseries are ideal laboratories for detailed and controlled experiments on palm flower and fruit phenology. More studies are required to understand what similarities and differences exist between species grown in cultivation and palms in the wild, while factoring in other variables such as climate, soil, water, and temperature.

Palms have a great deal to offer humankind as food, medicine, oils, and other products, yet much remains to be understood about their natural history. Although the taxa reviewed here represent only a fraction of the entire palm family, it is hoped that this information will contribute to the work of those who study, grow, and seek a better understanding of these extraordinary plants.

Acknowledgments

This study was supported in part by a grant from the International Palm Society Endowment

Fund. Acknowledgment is given to Professor P. B. Tomlinson for valuable help during this study, and to the National Tropical Botanical Garden for providing materials and facilities.

Literature Cited

BURKILL, I. H. 1966. A dictionary of the economic products of the Malay Peninsula. Second edition, Volume II. Ministry of Agriculture and Cooperatives, Kuala Lumpur, Malaysia.

CORNER, E. J. H. 1966. The natural history of palms. University of California Press, Los Angeles, California, USA.

DEMASON, D. A., K. N. C. SEKHAR, AND M. HARRIS. 1989. Endosperm development in the date palm (*Phoenix dactylifera*) (Arecaceae). Amer. J. of Bot. 76(9): 1255–1265.

FISHER, J. B., R. W. SANDERS, AND N. EDMONDSON. 1987. The flowering and fruiting of *Corypha umbraculifera* in Miami, Florida. Principes 31(2): 68–77.

IKEMEFUNA, J. AND I. ADAMSON. 1984. Chlorophyll and carotenoid changes in ripening palm fruit, *Elaeis guineensis* [during different developmental stages]. Phytochemistry 23(7): 1413–1415.

MCCURRACH, J. C. 1960. Palms of the world. Harper and Brothers, New York, New York, USA.

MURRAY, S. G. 1971. The developmental anatomy of certain palms. Ph.D. dissertation. Cornell University, Ithaca, New York, USA.

PHILLIPS, R. H. 1996. *Pelagodoxa henryana* in Fiji. Principes 40(3): 148–151.

SCARIOT, A., E. LLERAS, AND J. HAY. (1995). Flowering and fruiting phenologies of the palm *Acrocomia aculeata*: patterns and consequences. Biotropica 27(2): 168–173.

SOON, A. T. C. 1997. Seychelles nut, coco-de-mer, or double coconut, a spectacular palm in the gardens. Gardenwise: the newsletter of the Singapore Botanic Gardens. Volume IX, July 1997, ISSN 0129-1688.

TOMLINSON, P. B. AND P. K. SODERHOLM. 1975. The flowering and fruiting of *Corypha elata* in South Florida. Principes 19(3): 83–99.

ZALOM, F. G., P. B. GOODELL, L. T. WILSON, W. W. BARNETT, AND W. J. BENTLEY. 1983. Degree-days: the calculation and use of heat units in pest management. University of California Division of Agriculture and Natural Resources Leaflet 21373, Davis, California, USA.