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

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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

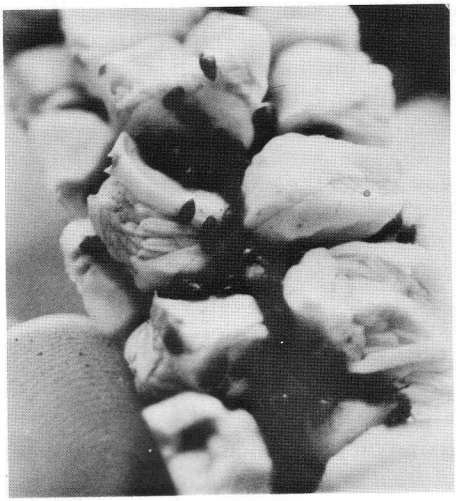
Species	Stratum of adults	Population phenology	Inflorescence phenology (sex, days duration)	Anthesis time	Floral sex ratio ♀:♂	Total # ♀	Flowers ♂	Pollinator 7
Prestoea decurrens	2	Jan–Dec 4, 5	♂, 14; ♀, 4	morning 0930–1000	1:2	8,600	17,200	bees
Iriartea gigantea	1	Jan–Apr 4, 5	♂, 10+; ♀, 4?	morning	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.

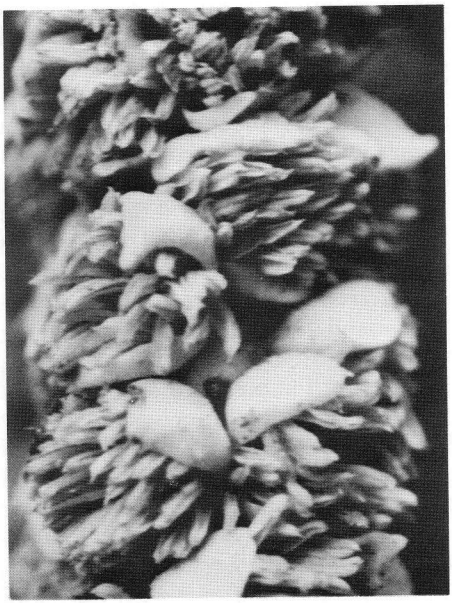
*Table 2. Identified visitors to flowers of eight palms**

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.

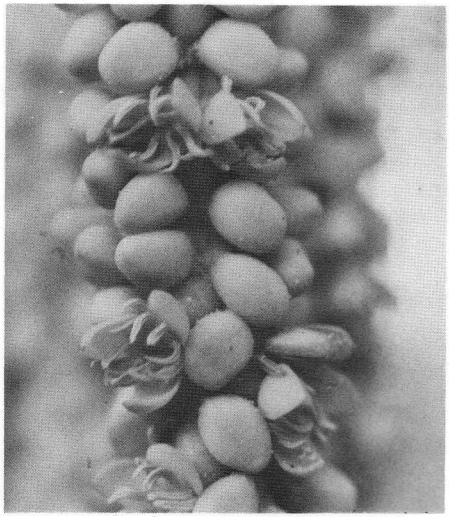
* *Welfia* is included here as several collections were made, its population and inflorescence phenology are similar to *Prestoea* but anthesis is earlier.



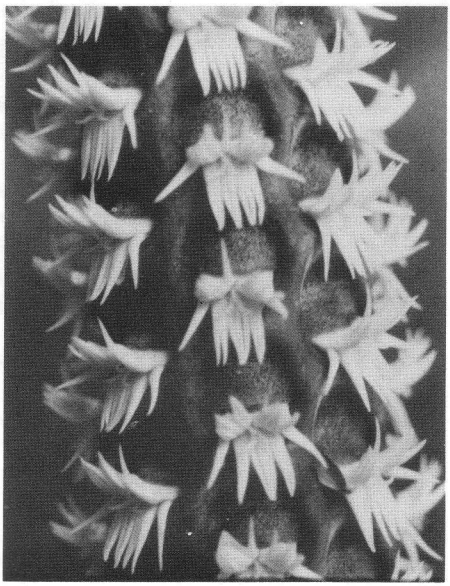
1. *Socratea* in the day between female and male flower maturation. Male buds were forced apart to show the many beetles still present. One stigma is visible in the center.



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

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