A New Subfamily of Palms-The Caryotoideae

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The fishtail palms (species of *Caryota*), the sugar palms (*Arenga pinnata* and some other species) and one or two species of *Wallichia* are cultivated in the tropics of both hemispheres. Sometimes they also appear as foliage plants in greenhouses or buildings. Two other palms of this alliance are occasionally grown as species of *Didymosperma*.

These palms are distinctive, not only in their ornamental or economic nature, but in several attributes of unusual botanical interest which have led botanists to associate them together in a tribe, the *Caryoteae*, within the confines of the subfamily *Arecoideae* or arecoid palms. One of the most striking differences between the caryotoid palms and all others is the manner in which individual stems (or the whole plant in single-trunked species such as *Caryota urens* and *Arenga pinnata*) commence to flower at the top and then at successive nodes down the stem. Inflorescences sometimes appear even from nodes below the soil. When flowering has ceased, the stem or plant dies. A few other palms, notably the talipot palm (*Corypha umbraculifera*) and its related species, die after flowering, but they differ in having only a terminal inflorescence with flowering progressing upward as in other palms which bear inflorescences among or below the leaves. Other differences in flowers, fruit, structure of the leaves and anatomy of caryotoid palms are less obvious but no less important.

These differences combined are such that the genera do not fit within the circumscription accorded the arecoid palms, heterogeneous as the latter are. For several years, therefore, they have been separated in the writer's manuscript keys and treatments of palms. Further detailed study is necessary before they are completely understood but the unusual characteristics they share warrant their separation from the Arecoideae. Separation is further demanded by their acceptance as a subfamily in a chapter on the classification of palms for a forthcoming palm handbook and an encyclopedia. It would have been preferable to wait for a considered and detailed analysis of the classification of palms as a whole. Circumstances, however, require immediate action. The taxon including the caryotoid palms is therefore accorded the rank of subfamily coordinate with that accorded other major groups of palms.

Earlier Dispositions of the Caryotoideae

Part of an unpublished manuscript on arecan palms of the Old World by Odoardo Beccari was edited and supplemented by R. E. G. Pichi-Sermolli in *Webbia* 11: 1-87, 1955, under the title "Subfamiliae Arecoidearum Palmae Gerontogeae Tribuum et Generum Conspectus." Pages 10-12 of the article present a conspectus of eight subfamilies of palms accepted by Beccari, whose scheme differs from that of Sir Joseph Hooker in Bentham and Hooker's *Genera Plantarum* (1883) and from that of Otto

47. *Caryota mitis* at Fairchild Tropical Garden, illustrated here to show typical *Caryota* foliage. Photograph by Kent Gatteri.

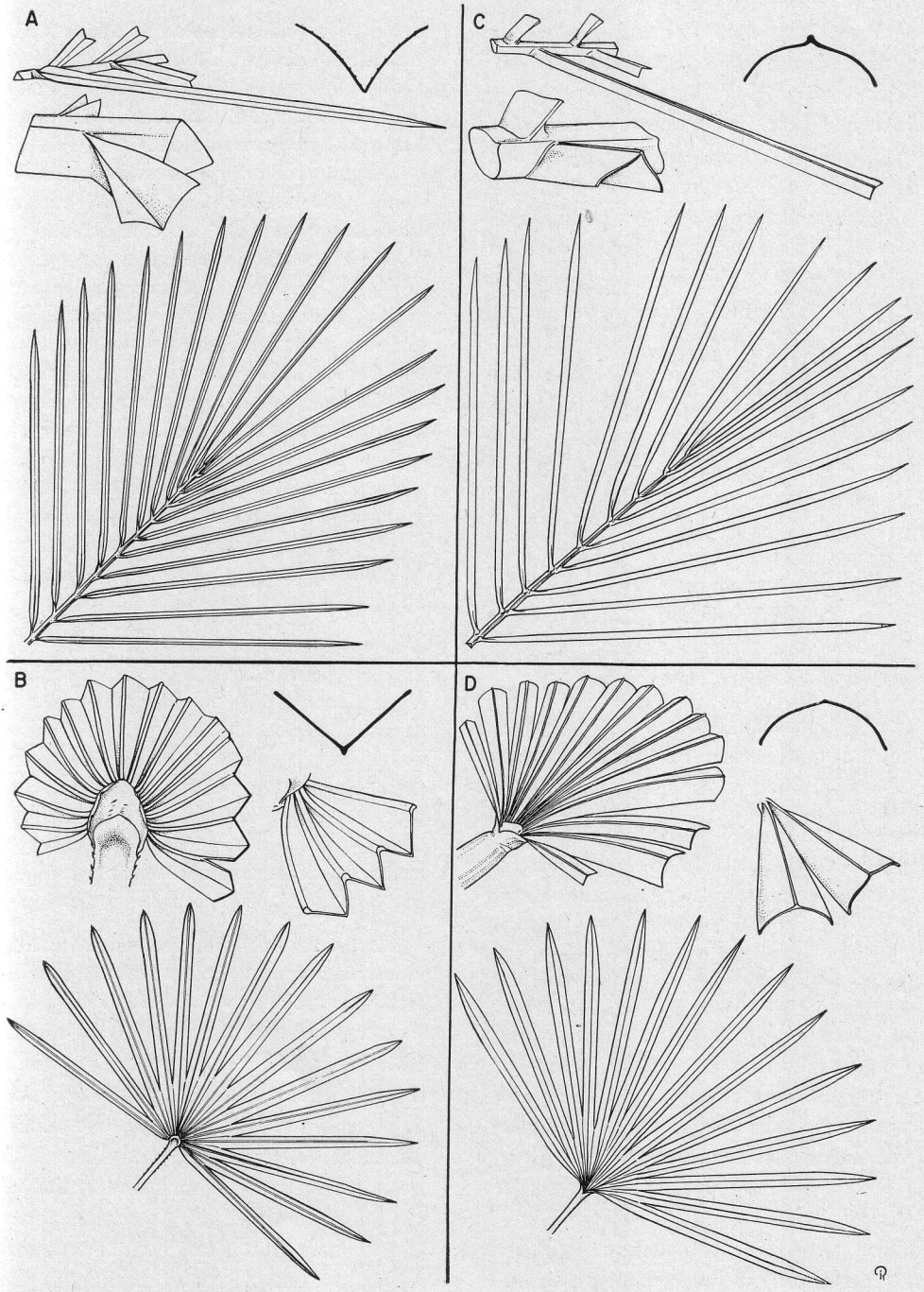
Drude in Engler and Prantl's *Die natürlichen Pflanzenfamilien* (1887) chiefly in emphasizing the important differences separating the major groups of palms and in considering *Nypa* in a subfamily of its own.

Beccari, however, included *Arenga*, *Caryota*, *Didymosperma*, and *Wallichia* in the subfamily Arecoideae where they composed the tribe Caryoteae. This taxon had been recognized earlier by Von Martius who appears to have first treated it formally as a natural group of genera. In *Historia Naturalis Palmarum* 3: 315, 1850, Martius included *Wallichia*, *Arenga* and *Caryota* in a separate unit of Arecinae which he called Arecinae Caryotinae characterized by "*Florum foem. corolla valvata, spadicum anthesis centrifuga . . .*" This subtribe was based on William Griffith's unnamed Section I of Arecinae in *Calcutta Journal of Natural History* 5: 447, 1845, and later in *Palms of British East India* 6, 8, 1850. Subsequent students of palms have continued to recognize these genera as forming a tribe or subtribe.

Reasons for removing the tribe Caryoteae from Beccari's subfamily Arecoideae and setting it on an equivalent plane are several. Chief among them is the fact, seldom observed, that the pinnae are induplicate in bud and thus fundamentally different from all other Arecoideae. The induplicate character of pinnae was used by Beccari as the primary basis for distinguishing the Coryphoideae, Phoenicoideae, and Borassoideae from the remaining subfamilies with reduplicate pinnae. Despite Drude's clear statement of the induplicate condition of caryotoid palms, Beccari apparently failed to note that his Caryoteae were similar in this respect to the above three subfamilies.

This basic difference in leaf structure is readily observed in either pinnate or palmate leaves, especially at the point where the pinnae or segments are attached to the principal axis. Segments or pinnae of induplicate palms are V-shaped at the point of attachment and in cross section, with the principal nerve below, the margins above as demonstrated by *Phoenix* (figure 48A) and *Serenoa* (figure 48B). The leaf in seedling and mature stages terminates in a single pinna or segment (except in *Caryota*) through which the principal axis terminates as the primary nerve of the segment or pinna (figure 48A). Segments or pinnae of reduplicate palms show the reverse. They are Λ-shaped at the point of attachment and in cross section, with the principal nerve above the margins as in *Butia* (figure 48C) and *Mauritia* (figure 48D). The mature blade, at least in the majority of reduplicate palms, terminates in a pair of opposite pinnae or segments (these rarely almost entirely united as in *Reinhardtia Koschnyana*, *Drymophloeus Beguinii*) and the axis terminates at the pinnae or continues in a slender threadlike filament between them (figure 48C). There are apparent exceptions to the general condition of the left tip outlined above. In some of the fan palms, in such cocoid genera as *Arecastrum* and often in *Butia* itself, in *Pseudophoenix* and perhaps a few others, the terminal pinnae are not obviously single in induplicate nor paired in reduplicate palms due to displacement or to unilateral union of axis and pinnae. Thus the gross appearance of the apex as an index to the nature of the leaf is usually useful but not as completely reliable as the attachment and cross section of the pinnae.

In the Caryotoideae, the pinnae are not as obviously V-shaped as in *Phoenix*



48. Leaves of palms showing tips of pinnate leaves, blades of palmate leaves, attachment and diagrammatic cross sections of pinnae. Induplicate: A, *Phoenix Roebelenii;* B, *Serenoa repens.* Reduplicate: C, *Butia capitata;* D, *Mauritia flexuosa* (young leaf).

owing to the narrowed base which is reduced essentially to a thickened nerve. Examination of seedling and expanding mature leaves, however, shows their induplicate nature as does the tip of the leaf (except in *Caryota*). The tip, however, may be irregular through union of lateral and terminal pinnae on one or both sides. It should be noted here that although morphologically induplicate, the leaves of these palms are anatomically more like those of reduplicate palms as noted by Dr. Tomlinson in an accompanying article.

The following attributes are also unusual among the arecoid palms or are unique in the whole order.

(1) monocarpic habit with development of inflorescences basipetal from a terminal inflorescence toward the base and even at nodes below ground.

(2) pistillate flowers with petals united to or below the middle, valvate above, similar in this respect only to *Roystonea* among the arecoid palms.

(3) pinnae with veins not parallel but divergent, terminating at intervals in teeth along the margin. Pinnules of *Caryota* have the veins terminating in teeth at the tip but the simply pinnate juvenile foliage is quite characteristic for divergent veins.

(4) inflorescences often several at a node and then flowering centrifugally, the inner ones developing first.

(5) anatomical differences detailed on page 118.

A summary of palm cytology has been published recently by A. K. Sharma and S. K. Sarkar (*Genetica* 28: 361-488. 1956). On pages 436-441 of this article, the authors deal with two species each of *Arenga* (*A. pinnata, A. obtusifolia*) and *Caryota (C. mitis, C. urens)*. Somatic chromosome complements of 2n=32 were found for both genera, the chromosomes of *Arenga* being on an average medium to short in size compared with those of other palms as opposed to *Caryota* with chromosomes long to medium. A table of chromosome numbers, including results of other workers (pp. 459-461), lists somatic numbers of 2n=26 and 2n=32, meiotic numbers of n=13, n=16. It is of interest that numbers of 13 and 26 are recorded only in the report of Janaki Ammal for *Arenga pinnata* (which inexplicably is considered distinct from and derived from *A. saccharifera* by Sharma and Sarkar, pp. 460, 462).

The authors suggest (pp. 471, 486) that the Caryoteae should be separated from the arecoid palms and that they are ancestral to the latter. With the former conclusion I concur, but it does not seem probable that the Caryotoideae are ancestral to the Arecoideae. Rather, it seems probable that they represent a highly specialized unit that diverged early from a "pro-arecoid" stock.

The Caryotoideae are still insufficiently known, but some general conclusions may be drawn from existing evidence. The subfamily occupies an isolated position and its origin is a matter of conjecture. Its chief and superficial resemblance to the Corypheoideae, Borassoideae, and Phoenicoideae lies in the induplicate vernation of the pinnae. Otherwise it shows strong ties to some groups still maintained, perhaps for lack of understanding, in the Arecoideae, though the monocarpic habit and basipetal development of in-

florescences distinguish it from that subfamily. The several bracts of the inflorescence, the aggregation of inflorescences at each node in some species of *Arenga*, the basically trilocular ovary, the urent mesocarp of the fruit are each reminiscent of New World *Chamaedorea* and its allies. On the other hand, the monocarpic habit and the structure of both staminate and pistillate flowers are quite unlike those of *Chamaedorea*. The basic arrangement of flowers in triads is similar to that of advanced members of the Arecoideae such as the tribe Ptychospermeae. Staminate flowers in particular are very similar to those of *Ptychosperma* itself, being distinguished chiefly by the absence of a pistillode, and, in *Arenga*, by the often apiculate to aristate connective.

Hooker included *Orania* and *Sclerosperma* in the *Caryota* alliance: Drude included only *Orania*, placing *Sclerosperma* with the Geonomeae. The proper disposition of these two genera is still open to question but they must be removed from the Caryotoideae on morphological and anatomical grounds. Both have reduplicate pinnae, only two bracts on the inflorescence, polycarpic habit and other distinguishing characters. With their omission the Caryotoideae becomes a homogeneous taxon characterized as follows:

PALMAE subfamily CARYOTOIDEAE (Martius) H. E. Moore *stat. nov.*

Arecinae subtribe *Caryotinae* Martius, *Historia Naturalis Palmarum* 3: 315. 1850.

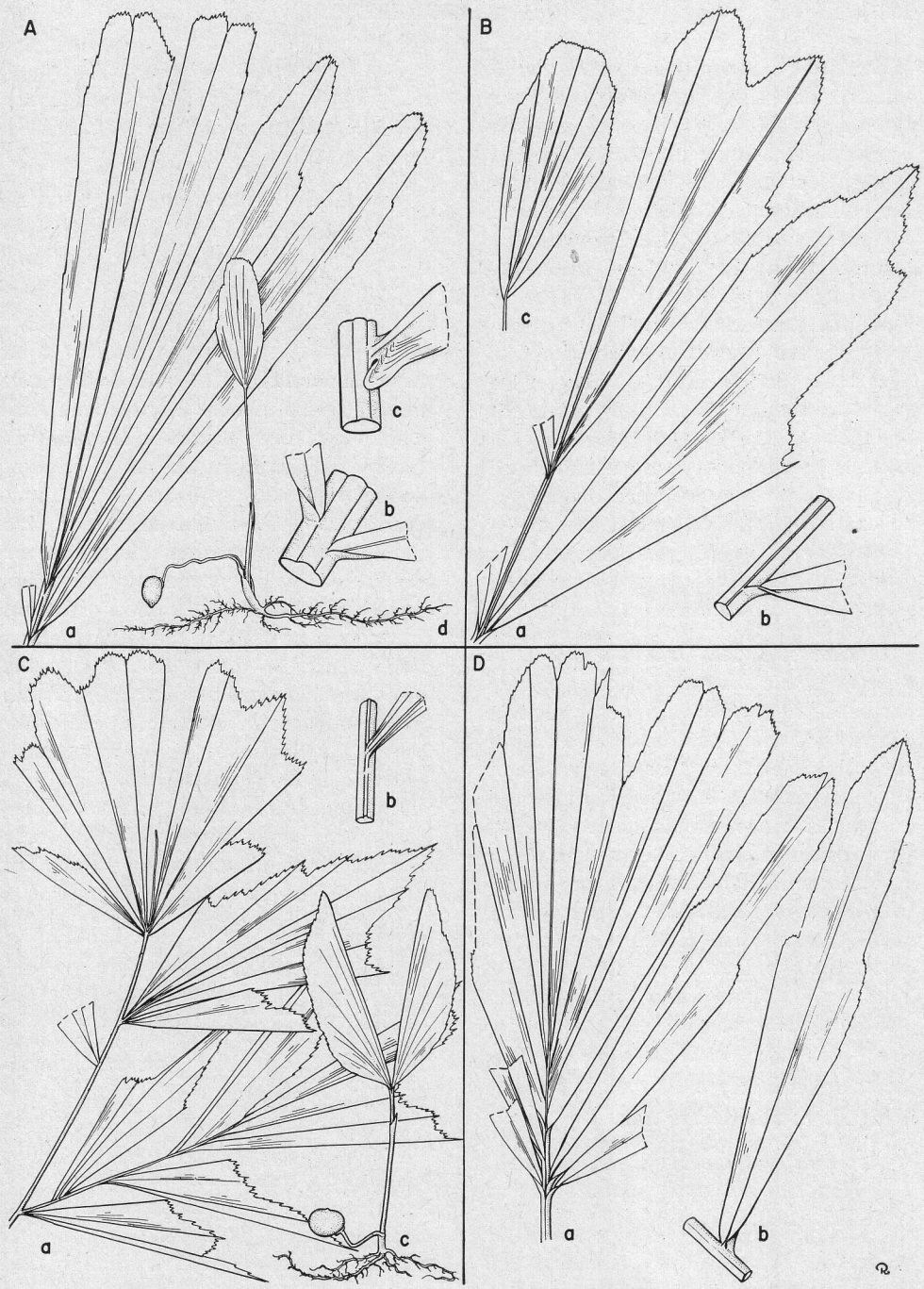
Areceae subtribe *Caryotoideae* J. D. Hooker in Bentham & Hooker, *Genera Plantarum* 3: 872, 878. 1883 (excluding *Orania, Sclerosperma*).

Arecinae subtribe *Caryoteae* Drude in Engler & Prantl, *Die natürlichen Pflanzenfamilien* 2(3): 27, 53. 1887 (excluding *Orania.*).

Arecoideae tribe *Caryoteae* Beccari, *Webbia* 11: 15. 1955.

Type genus: *Caryota* L.

Three genera of small to large solitary or caespitose unarmed monoecious monocarpic palms flowering basipetally. Leaves imparipinnate, the rachis terminating in a single pinna, or bipinnate or rarely undivided, the sheaths fibrous at least marginally and more or less tubular at first, petioles short to long, pinnae induplicate in vernation, the pinnae or pinnules linear to cuneate, with veins mostly narrowly to widely divergent from the base or from the midnerve and terminating in short teeth along the often undulate or irregular margin, the base cuneate or auriculate. Inflorescences interfoliar, developing basipetally, solitary or several and then flowering centrifugally at each node, subtended by several coarse strongly fibrous acute bracts, simply branched or more rarely spicate, the flowers usually in protandrous triads of a central pistillate and 2 lateral staminate flowers at least on lower portion of rachillae, paired or solitary staminate by abortion above, or more rarely flowers of only one sex appearing on an inflorescence, the staminate and pistillate inflorescences then more or less different in aspect (*Wallichia*). Staminate flowers lacking bracteoles, with 3 rounded imbricate sepals or the sepals united in a 3-lobed tube, petals 2-3 times as long as the sepals, distinct, navicular, and valvate, or united in a deeply 3-lobed tube; stamens 6-many, inserted on the corolla tube or usually with filaments united basally in a solid stipe and adnate



49. Foliage of caryotoid palms. A, *Arenga:* a, tip of leaf × 1/3; b,c, attachment of pinnae × 1/3; d, seedling × 1/6 (a,b, *A. Engleri;* c, *A. Ambong;* d, *A. pinnata).* B, *Arenga porphyrocarpa:* a, tip of leaf × 1/3; b, attachment of pinna × 2/3; c, seedling leaf × 1/3. C, *Caryota mitis:* a, tip of leaf and lateral pinna with pinnules × 1/3; b, attachment of pinnule × 2/3; c, seedling × 1/3. D, *Wallichia disticha:* a, tip of leaf × 1/6; b, pinna × 1/9.

to the petals, distinct and short above, not inflexed at the apex in bud, anthers linear, sagittate basally and apically acute, bifid, apiculate or aristate, introrsely dehiscent by longitudinal slits, the pollen, 1-sulcate, pilate to spinulose; pistillode not developed. Pistillate flowers smaller than the staminate, subtended by 2 prominent bracteoles; sepals 3, rounded, imbricate; petals 3, longer than the sepals, connate basally or to above the middle, valvate and acute above; staminodes 0-3 between the corolla-lobes (rarely more in *Arenga?*); pistil with prominent trilocular ovary or the ovary functionally 1-2-locular by reduction with 3-1 erect compressed ovules borne basally on the axis or inner surface of the locule, style lacking, stigmas 3-1, sessile. Fruit globose, ellipsoid or trigonous, small to moderate, with smooth exocarp, fleshy urent mesocarp and cartilaginous or papery endocarp sometimes with imbedded fibers surrounding and often strongly adherent to each seed; stigmatic remains apical or subapical; seeds 1-3, with homogeneous or ruminate endosperm and lateral embryo, the hilum basal, the raphe branched and impressed.

The Genera of Caryotoideae

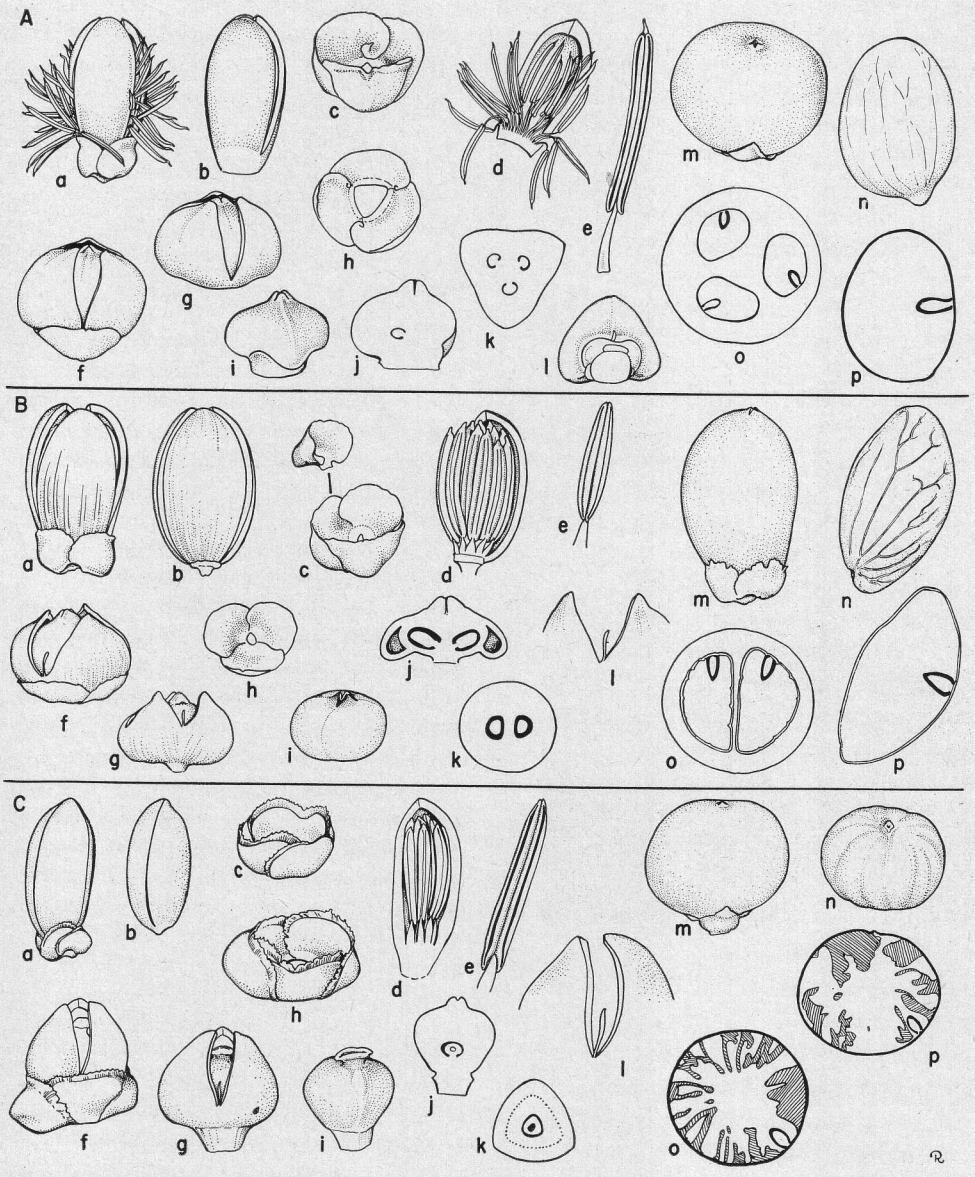
In addition to *Caryota* and *Wallichia*, each of which is distinct and readily defined, *Arenga* and *Didymosperma* have been maintained separately since the latter genus was formally described by Sir Joseph Hooker in 1883, some five years after the name first appeared in the "Index Général" of Kerchove's *Les Palmiers*. Hooker distinguished the genera as follows:

71. DIDYMOSPERMA. *Fl. masc.: Calyx cupularis, 3-lobus; stamina ∞. Albumen aequabile. Palmae humiles, foliis simpliciter pinnatisectis.*—Asia trop.

72. ARENGA. *Fl. masc.: Sepala 3; stamina ∞; albumen aequabile. Palmae monocarpicae, foliis simpliciter pinnatisectis, segmentis linearibus basi auriculatis.*—Asia et Austral. trop.

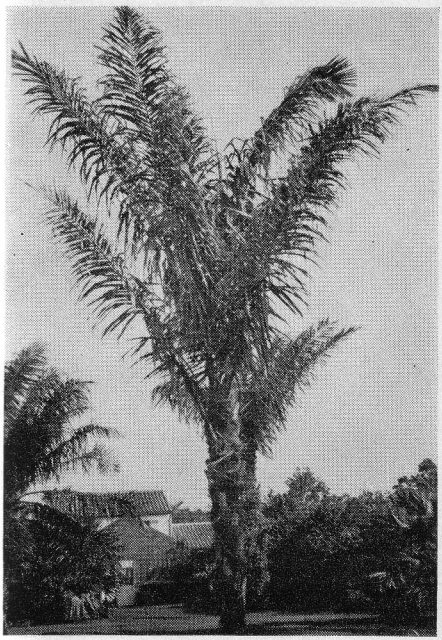
When material or descriptions of all the species presently included in these two genera are examined, it becomes evident that differences are more apparent than real and the genera are united here. There is diversity in the number of stamens (even within a single species) and in the development of an apiculate or aristate connective in *Arenga*. The pinnae of the majority of species are not auriculate and stems, though generally robust, are often low. More uniformity is found in *Didymosperma* which has canelike stems, undivided or variously and usually deeply lobed pinnae which are cuneate at the base, and small, little-branched or usually spicate inflorescences. Staminate flowers have generally fewer stamens, these never aristate.

In *Arenga pinnata* and species associated with it, the ovary is apparently always trilocular, triovulate and the fruit usually 3-seeded. *Didymosperma porphyrocarpum* also has a trilocular ovary but only two cells bear ovules; the third remains conspicuous though smaller and sterile. Were two fertile locules constant for species associated vegetatively with *D. porphyrocarpum*, two genera might be retained. *Didymosperma Hookerianum* and *D. caudatum* however, have three fertile locules in the ovary with fruit 1-3-seeded. Thus they connect the two extremes.



50. Details of caryotoid flowers. A, *Arenga* sp.: a,b,d × 2/3; c,f-l,n,p × 1; e × 1½; m,o × ½. B, *Arenga porphyrocarpa:* a-k,o × 3; l × 5; m × 1½; n,p × 2. C, *Caryota* sp.: a,b,o,p × 1½; c,d × 2; e,l × 4; f-k × 3; m,n × 1. a-e staminate flower: a, flower; b, corolla; c, calyx; d, flower in vertical section; e, stamen: f-l pistillate flower: f, flower; g, corolla; h, calyx; i, pistil; j, pistil in vertical section; k, ovary in cross section; l, detail of staminode; m, fruit; n, seed; o, seed in cross section; p, seed in vertical section.

The only differences between *Arenga* and *Didymosperma*, therefore, are vegetative—in the slender habit and usually rather distinctive pinnae of *Didymosperma*. These differences seem scarcely of generic order when the diversity of habit and foliage in such genera as *Bactris*, *Chamaedorea*, *Ptychosperma*, *Reinhardtia*—to note only four—is considered. Beccari had apparently come



51. *Arenga pinnata* on the estate of Mrs. A. R. Jennings, Coconut Grove, Florida. Photograph by G. H. M. Lawrence.

to a similar conclusion although he maintained *Didymosperma* in his manuscript on arecoid palms. In *Webbia* 3: 207, 1910, after describing *Didymosperma caudatum* var. *stenophyllum ('stenophylla')* he wrote [freely translated]:

> "Differs from the typical form only by the very narrow linear segments which, in miniature, have exactly the form of those of *Arenga saccharifera* . . . The one character that might serve to distinguish *Didymosperma* from *Arenga*, that of the form of the segments, is lacking in this variety, which seems to form a passage between the two genera. The trilocular rather than bilocular ovary seems to have little importance in this group of palms. The curiosity of this palm is, then, that the typical form should be a *Didymosperma* and the variety an *Arenga*."

Thus no character or combination of characters serves to separate *Arenga* and *Didymosperma*. They are, therefore, united under *Arenga*, the older name.

Although three adequately distinct genera may now be recognized with facility, the species of these genera are very poorly understood. Botanical specimens are often scanty — the two or probably three species of *Arenga* from New Guinea, for example, were so incompletely characterized that more ample recent collections cannot be referred with certainty to any one species nor to the possibly identical *Saguerus australasicus* from Australia. Nor can some cultivated material be readily identified with any known species. This is particularly true in *Caryota*, to a lesser extent in *Arenga*. Casual observation in gardens suggests that hybridity plays a role here. Variation in the number of stamens even on a single plant (Hance found 110-154 in flowers of *Caryota ochlandra)*, variation in the size of fruit according to the number of seeds produced, and variation in the pinnae or pinnules all combine to make any attempt to identify much material completely frustrating. These genera must be studied long and carefully in their native habitats throughout their range

and characterized fully before plants and specimens can be identified with confidence.

Within the Caryotoideae, *Arenga* appears to be the most primitive genus in its simply imparipinnate or undivided leaves, often aggregate inflorescences, distinct sepals and petals in staminate flowers, numerous stamens, trilocular ovary with 2-3 fertile locules, and homogeneous endosperm.

Caryota shows advance in further cutting of the adult foliage (juvenile foliage is imparipinnate), in solitary inflorescences, in reduction of fertile locules to 1-2, and in the development of ruminate endosperm. Pistillate flowers, however, have petals less united than those of *Arenga*.

Wallichia is advanced in usually having separate staminate and pistillate inflorescences, the latter usually terminal on the plant and stiffer than the lateral staminate inflorescences, in the union of perianth parts of the staminate flower, in the reduction of stamens to 6 in most species.

It is difficult to place the Caryotoideae in any direct line of relationship within the Palmae. The subfamily as a whole is markedly advanced over any putative common stock of the palms. The significance of induplicate vernation, monocarpic habit and basipetal production of inflorescences has yet to be understood. In comparison with advanced arecoid tribes, the Caryotoideae are relatively primitive in the number of bracts on the inflorescences, in the basically trilocular, triovulate ovary and 3-seeded fruit. Yet the subfamily shows specialization in the arrangement of flowers on the inflorescence, in union of petals in pistillate flowers, in monocarpic habit, in basipetal development of inflorescences, in bipinnate leaves. It is apparent that, if derived from a basic arecoid stock, evolution has long proceeded independently.

Key to Genera

1. Staminate flowers with distinct imbricate sepals and valvate petals; stamens sometimes only 6-9 but generally 15 or more.
   2. Leaves imparipinnate or rarely undivided; inflorescences solitary or several at each node; pistillate petals connate to about the middle; fruit 1-3-seeded, the seeds with homogeneous endosperm ..... *Arenga*
   2. Leaves bipinnate at maturity; inflorescences always solitary at each node; pistillate petals connate to about one-third their length; fruit 1-2-seeded, the seeds with ruminate endosperm. ..... *Caryota*
1. Staminate flowers with sepals united in a low cylindric 3-lobed or undulate calyx, the petals united in a short to long, more or less solid, cylindric base with valvate lobes; stamens generally 6, rarely 9-12-15; fruit 1-3-seeded, the seeds with homogeneous endosperm. ..... *Wallichia*

ARENGA Labillardiere in A. P. DeCandolle, *Bulletin des Sciences, par la Société Philomathique, Paris* 2(45): 162. 1800 [conserved name].

Dwarf to large solitary or caespitose monoecious palms with imparipinnate or rarely undivided leaves, the pinnae cuneate to auriculate at the base, nearly

linear to irregularly undulate-elliptic or panduriformly lobed with margins and apices variously toothed and nerves divergent from the base and often from

52. *Arenga pinnata* with a flowering inflorescence below and spent inflorescences above at Coconut Grove, Florida. Photograph by G. H. M. Lawrence.

the midnerve. Inflorescences several and flowering centrifugally or more rarely solitary at each node, simply branched or more rarely spicate, the flowers arranged in protandrous triads of two lateral staminate and a central pistillate at least basally, more rarely inflorescences unisexual through abortion of flowers of one sex. Staminate flowers with 3 imbricate sepals exceeded by 3 distinct valvate navicular petals, stamens numerous with filaments basally connate and adnate to the petals, short and distinct above, the anthers basally sagittate, apically acute to bifid or sometimes with an apiculate or aristate connective; pistillate flowers with 3 imbricate sepals, 3 valvate petals connate to about the middle; staminodes 3-0 (or sometimes many *fide* Hooker) or rarely the staminodes in some flowers partially fertile*; pistil with trilocular ovary containing 2-3 fertile locules and 2-3 sessile stigmas. Fruit orange-yellow to red or rarely white, small to moderate, globose, trigonous or ellipsoid, 1-3-seeded, the seeds with homogeneous endosperm.

Distribution: perhaps 20 species from New Guinea to the Himalaya region of India and the Philippine Islands.

Vegetative differences suggest the division of *Arenga* into two sections characterized as follows:

Stems low to moderate, always more or less robust; pinnae linear, elongate-cuneate or elongate-elliptic and sinuately or undulately margined, acute to auriculate at the base; inflorescences with numerous simple rachillae; ovary trilocular with 3 fertile locules; fruit generally 3-seeded.
Section *Arenga*

Stems low, arundinaceous; pinnae cuneate at the base, more or less rhombic in outline, sometimes panduriformly lobed above the middle, or rarely the leaves undivided; inflorescences spicate or with few simple short rachillae; ovary trilocular with 2-3 fertile locules; fruit 1-3-seeded.
Section *Didymosperma*

ARENGA section ARENGA

Arenga Labillardiere in A. P. DeCandolle, *Bulletin des Sciences, par la Société Philomathique, Paris* 2(45): 162. 1800.

**Didymosperma borneense.* The flowers then apparently pseudohermaphrodite, larger than the pistillate, smaller than the staminate, with 2 filaments anthiferous, 3 partially or completely sterile.

Saguerus Steck, *De Sagu* 15. 1757.

Gomutus Correa, *Annales du Museum d'Histoire Naturelle, Paris* 9: 288. 1807.

Blancoa Blume, *Rumphia* 2: 128. 1843.

Type: *Arenga pinnata* (Wurmb) Merril *(A. saccharifera* Labillardiere). Additional species: *A. Ambong* Beccari, *A. brevipes* Beccari, *A. Engleri* Beccari, *A. gracilicaulis* F. M. Bailey, *A. Listeri* Beccari, *A. microcarpa* Beccari, *A. obtusifolia* Martius, *A. tremula* (Blanco) Beccari *(A. mindorensis* Beccari), *A. undulatifolia* Beccari, *A. Westerhoutii* Griffith, *A. Wightii* Griffith, *?Didymosperma humile* Lauterbach & K. Schumann, *Saguerus australasicus* H. Wendland & Drude.

ARENGA section DIDYMOSPERMA (H. Wendland & Drude ex J. D. Hooker) H. E. Moore *stat. nov.*

Didymosperma H. Wendland & Drude ex J. D. Hooker in Bentham & Hooker, *Genera Plantarum* 3: 917. 1883.

Lectotype: *Arenga porphyrocarpa* (Blume) H. E. Moore. Additional species transferred with confidence follow. Others have been described in *Didymosperma* but are not transferred here because some or all may be no more than forms of the three species listed below. Those not transferred are *Didymosperma borneense* Beccari, *D. hastatum* Beccari, *D. Hookerianum* Beccari and *D. tonkinense* (Beccari) Beccari ex Gagnepain, all perhaps no more than forms of *Arenga caudata, D. Horsfieldii* (Blume) H. Wendland ex Salomon, a dubious species, and *D. humile* Lauterbach & K. Schumann. The last appears to be a species of section *Arenga* related to or identical with *A. microcarpa* or *A. gracilicaulis. Didymosperma gracile* J. D. Hooker appears distinct on the basis of the description but no material has been studied.

ARENGA PORPHYROCARPA (Blume) H. E. Moore *tr. nov.*

Orania regalis Blume, *Rumphia* 2: *pl. 95.* 1837. not O. *regalis* Zippelius (1829).

Orania porphyrocarpa Blume in Martius, *Historia Naturalis Palmarum* 3: 187. 1838-39 [ed. 1] and 190. 1849 [ed. 2].

Wallichia orania Blume, *Rumphia* 2: 113. 1843.

Didymosperma porphyrocarpum (Blume) H. Wendland & Drude ex J. D. Hooker, *Report on the Progress and Condition of the Royal Gardens at Kew* 1882: 61. 1884.

Blancoa porphyrocarpa (Blume) O. Kuntze, *Revisio Generum Plantarum* 2: 727. 1891.

Wallichia Reinwardtiana Miquel, *Plantae Junghuhnianae* 1: 157. 1852. *Blancoa Reinwardtiana* (Miquel) O. Kuntze, *Revisio Generum Plantarum* 2: 727. 1891.

Didymosperma Reinwardtianum (Miquel) H. Wendland & Drude ex Jackson, *Index Kewensis* 1: 756. 1895.

ARENGA CAUDATA (Loureiro) H. E. Moore *tr. nov.*

Borassus caudata Loureiro, *Flora Cochinchinensis* 2: 619. 1790.

Wallichia caudata (Loureiro) Martius, *Historia Naturalis Palmarum* 3: 315. 1850.

Didymosperma caudatum (Loureiro) H. Wendland ex Salomon, *Die Palmen* 130. 1887.

Blancoa caudata (Loureiro) O. Kuntze, *Revisio Generum Plantarum* 2: 727. 1891.

ARENGA NANA (Griffith) H. E. Moore *tr. nov.*

Harina nana Griffith, *Palms of British East India* 176, 1850.

53. *Wallichia densiflora* reproduced from Curtis's Botanical Magazine 77: pl. 4584, 1851. Flowering plant much reduced; 1, staminate inflorescence before expansion; 2, staminate flower and bud enlarged; 3, rachilla of pistillate inflorescence with young fruit about 3/4 natural size; 4, immature fruit enlarged; 5, cross section of immature fruit.

Wallichia nana Griffith in Martius, *Historia Naturalis Palmarum* 3: 315. 1850.

Didymosperma nanum (Griffith) H. Wendland & Drude ex J. D. Hooker, *Report on the Progress and Condition of the Royal Garden at Kew 1882:* 61. 1884.

Blancoa nana (Griffith) O. Kuntze, *Revisio Generum Plantarum* 2: 727. 1891.

CARYOTA Linnaeus, *Species Plantarum* 2: 1189. 1753.

Dwarf to large solitary or caespitose monoecious palms with bipinnate or rarely tripinnate leaves (pinnate in the juvenile state), the pinnules obliquely cuneate with veins divergent from the base and the truncate oblique apex toothed. Inflorescences solitary at each node, the flowers in protandrous triads of two staminate and a central pistillate at least basally on the rachillae. Staminate flowers with 3 imbricate sepals exceeded by 3 distinct valvate navicular petals, stamens 6 to usually 9-100 or more with filaments basally connate and adnate to the petals, short and distinct above, the anthers basally sagittate, apically bifid or acute, the connective sometimes apiculate; pistillate flowers with 3 imbricate sepals, 3 petals united to about 1/3 their length or less and valvate above; staminodes 6-0; ovary trilocular with generally 1-2-locules fertile, stigma conical, 3-lobed. Fruit red to blackish, small, 1-2-seeded, the seeds with ruminate endosperm.

Type: *C. urens* Linnaeus

Distribution: about 13 species of Australasia including *C. aequatorialis* Ridley, *C. bacsonensis* Magalon, *C. Cumingii* Loddiges ex Martius, *C. macrantha* Burret, *C. majestica* Linden, *C. Merrillii* Beccari, *C. mitis* Loureiro, *C. monostachya* Beccari, *C. obtusa* Griffith, *C. ochlandra* Hance, *C. Rumphiana* Martius, *C. sympetala* Gagnepain and *C. urens* Linnaeus.

WALLICHIA Roxburgh, *Plants of the Coast of Coromandel* 3: 91. 1820. ('1819'). *Harina* F. Hamilton, *Memoirs of the Wernerian Natural History Society* 5(2): 317. 1826.

Small to moderate solitary or caespitose monoecious palms with imparipinnate leaves, the pinnae exauriculate at the base, nearly linear to cuneate or deltoid with margins and apex variously sinuately to panduriformly lobed and toothed, the nerves divergent from the base and from the midnerve. Inflorescences solitary, often dimorphic: the staminate usually lateral with numerous bracts, these nearly or quite hiding the peduncle and bases of the few to numerous slender often pendulous rachillae, flowers paired with sometimes intermediate rudimentary pistillate flowers or solitary; the pistillate usually terminal with prominent peduncle and fewer stouter generally stiffish and spreading branches, these often becoming more or less pendulous in fruit, the flowers solitary and spirally disposed. Staminate flowers with cylindric truncate 3-lobed or -toothed calyx much exceeded by the corolla, the petals united basally in a short or long, often solid cylindric tube, the lobes valvate; stamens 6 or more rarely 9-15 *(W. chinensis* 6-9, *W. siamensis* 12-15), with filaments united basally in a short to long column adnate in part or in entirety to the corolla tube, distinct and sometimes (when 6) partly adnate to corolla lobes above, the linear anthers basally sagittate, apically acute or obtuse; pistillode lacking; pistillate flowers with 3 thick imbricated sepals or the sepals united in a 3-lobed ring (?), petals 3, united basally to about the middle, valvate

54. *Wallichia disticha* in the botanical garden at Rio de Janeiro, Brazil, 1924, showing terminal inflorescence. Photograph by L. H. Bailey.

above; staminodes 3-0; pistil 2-3-locular, 2-3-ovulate with conical stigma. Fruit red or purple, small, 1-2-rarely 3-seeded, the seeds with homogeneous endosperm.

Type: *Wallichia caryotoides* Roxburgh.

Distribution: Six species of tropical Himalaya in India and Upper Burma, southern China (Kwangsi), Indochina: *W. caryotoides* Roxburgh, *W. chinensis* Burret, *W. densiflora* (Martius) Martius, *W. disticha* T. Anderson, *W. gracilis* Beccari, *W. siamensis* Beccari.