PREFACE

This book

There is no complete description of the total anatomy of a palm and yet we claim to present information about all 183 genera which are included in the palm family (Arecaceae). This paradox arises because palms are large organisms of considerable structural complexity that changes with age so that a full description of anatomical variation within a single individual has never been attempted. Nevertheless, our seemingly reductionist approach, which deals with small samples from relatively standard regions, must serve to generate the overview we present in this book. So immediately we make apologies for the evident deficiencies of our work. Furthermore, we deal only with vegetative anatomy: inflorescence, flower, fruit, and seed represent different topics.

The palms are such a distinctive group of plants that it is appropriate to describe their unique anatomical features in detail. They are unusual monocotyledons because they have developed the tree habit in the absence of secondary growth, a feature shared by a few other groups of monocotyledons (e.g. Pandanaceae, bamboos). Because palms cannot increase stem thickness by secondary growth they are developmentally constrained in terms of habit (aerial stems normally unbranched and with a terminal cluster of large leaves), giving them their distinctive physiognomy. They are, with few exceptions, entirely tropical in their distribution and they have become tropical icons, most familiar in the economically important coconut palm.

The present book provides an overview of the vegetative anatomy of palms in a systematic context, using a recent classification based on molecular evidence (Dransfield et al. 2005, 2008b). This allows some development of ideas about the distribution of structural features in the relation to the putative phylogeny of palms. The book is an amplification of the first extensive account in English of the anatomy of palms as Volume II (Palmae) in the series 'Anatomy of Monocotyledons' originating under the editorship of C.R. Metcalfe (Tomlinson 1961).

Justification for this newer treatment is determined by several factors. First, is the availability of much living palm material in cultivation in the tropical and subtropical United States, notably at Fairchild Tropical Botanic Garden and the Montgomery Botanical Center in Coral Gables, Florida together with the National Tropical Botanical Garden, Kalaheo, Kauai, Hawaii. Second, the much greater understanding of the structure and development of palms achieved during the five decades since 1961. Much of this work has been summarized in *The Structural Biology of Palms* (Tomlinson 1990). Third, there has been the availability of a detailed overview of palms in *Genera Palmarum* (Uhl and Dransfield 1987), now replaced by its second edition *Genera Palmarum—The Evolution and Classification of Palms* (Dransfield et al. 2008b); these books are a prime source of information on the morphology, geography, phylogeny, and classification of palms.

It should be emphasized that information is presented in a concise format, but its documentation is supported by extensive photographic illustration, in an attempt to minimize textural description. The intent is to present a broad overview that illustrates the distinctive structural features of palms in the context not only of systematics but also ecology and possible evolution.

Information will have use in several other disciplines and applied fields. Comparison with other monocotyledons emphasizes the many unique features of palms and the peculiar difficulties of carrying out structural and developmental research on a group of plants that have been described as 'unruly monsters'. The special methods we have used and which are outlined here could be applied to many categories of plants.

Palms are important in the understanding of plant biomechanics because they illustrate how tall trees can be made structurally sound in the absence of secondary thickening. Palms as fossils, notably petrifactions, can only be interpreted on the basis of information derived from extant plants but the peculiar difficulties of doing this with palms needs constant emphasis. Structural features are the basis for functional processes so that anatomical information is essential for knowledge of how the palm 'works'. Abnormal or pathological growth processes can only be recognized when a normal condition has been described. A natural extension for this approach is in the field of agronomy and horticulture because palms constitute a major economic resource. A somewhat more esoteric application is in forensic science because small fragments of palms may need to be identified and can provide evidence in criminal cases. Knowledge about the use of palms in ancient cultures can be much improved if small fragments can be identified. Palms have multiple uses in the local economy of those modern countries in which they grow; this is the field of ethnobotany, and this enormously diverse use of palm materials must have an important anatomical base from which to assess its value depending on its source.

Palm anatomy in context

Three major factors contribute to the anatomical diversity of palms. Distribution of histological features can be correlated with systematic (i.e. phylogenetic) position, reflecting the ancestral origin of characters. This is a somewhat speculative field, but one most easily observed when histological features coincide in their distribution with the morphological and molecular evidence used in classification. However, the situation in which the palm grows can lead to adaptive structural responses, as in the contrast between palms of wet or dry habitats, of shaded and sunlight environments, or from low versus high altitudes. Finally, the size of palm structures, related to their biomechanical properties, influences structural variation. Such differences can be seen where a genus includes species of different overall size or habit, as in the distinction between caulescent (trunk-forming) versus acaulescent palms without a visible above-ground trunk, as in a few rhizomatous palms. This variation is best appreciated in palms with the climbing habit (notably the economically important rattans), in which distinctive features unique to them can be seen and relate directly to their growth form. Comparative study is possible here because the climbing habit has evolved independently in several groups of palms that are not closely related. This invokes the concept of parallelism (homoplasy) in the evolution of structural features.

However, we cannot claim to provide answers to all the intriguing problems of palm structure and function. The objective is to create a new foundation for the study of this fascinating and distinctive family.

The sources of information and their limitations

We have examined some material of the lamina of all 183 currently accepted genera of palms in Dransfield et al. (2008b) together with a fairly comprehensive study of leaf axis, stem, and root sufficient to provide an overview of structural features that can be useful taxonomically. In addition to much material assembled since we started the project in 2006 we have had access to a large collection of microscope slides retained at Harvard Forest, the residuium of material processed during extended periods of palm study in the 1960s to 2000. Much of this included an extensive collection of slides of leaf axis, stem, and root material. In turn, much of this was based on fluid-preserved samples made by Professor H.E. Moore as adjuncts to herbarium material now housed at the Bailey Hortorium of Cornell University. This puts the time frame of our recent activity into an extended prior period and emphasizes the extensive early collaborative nature of the effort that has resulted in this book. Without this existing resource we could not have completed the project in the four years during which we had direct support from the National Science Foundation or met the terms of the grant by means of which we were financed. It is important to make clear the history leading up to our project completion because it illustrates the lengthy time it takes scientific effort to come to fruition.

Documentation

All recently collected material both original fluid-preserved specimens and the temporary mounted sections derived from it are preserved at Fairchild Tropical Botanic Garden (FTBG) and should become the source for continuing research on palm anatomy. The Harvard Forest collections are also still useful although many sections have deteriorated with age and would require remounting.

An apologia

Having said this we must offer an explanation as to why our results are obviously very incomplete and can easily be criticized. But we must constantly emphasize the fact that palms are bulky organisms with structures well beyond the range of practising anatomists. How can one represent the anatomy of a palm of the gigantic proportions of a *Corypha*, with stems easily 1 m in basal diameter and leaves so large that at least two people are necessary to support one when detached? To reduce this monster (Fig. 45C) to six small images (Fig. 60A–E) derived from sections of a size that can be examined microscopically is a travesty of reductionism and can be repeated throughout our presentations. This is a prime demonstration of the difficulty of transposing the traditional approaches of plant anatomy to the exuberance of tropical plant form. The little bits we examine would seem to bear little reference to the whole, were it not for the results we present, which speak for themselves because they do allow us to make perceptive statements about anatomical variation throughout the palm family in relation to its phylogeny and hence classification. The results should be of significance to evolutionary biologists seeking to account for changes in a large tropical plant family that must have occurred in evolutionary time.

The immediate constraint has been the impossibility of presenting all the information we have about palm anatomy in a single monographic study. We have examined some material of about 300 species and taken of the order of 2500 photographs of which we present about 800 but do not attempt a description of every genus. Our presentation has thus been quite arbitrary and its incompleteness should be recognized. From the start we have used the term 'big picture' to account for our approach. Consequently our work must be seen as a beginning. It should provide a base-line for the very necessary and more comprehensive studies, taxa by taxa, of palm anatomy that awaits the enthusiastic (and brave!) botanists of the future.

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