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NON-WOOD FOREST PRODUCTS

10

Tropical palms

Food and Agriculture Organization of the United Nations

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by

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FAO Regional Office for Asia and the Pacific
FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
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Foreword

Palms are among the most common plants in tropical countries, where they often dominate the rural landscape. All palms belong to the *Arecaceae* family (previously called the *Palmae* family), which comprises some 2.200 species, distributed mainly throughout the tropics and sub-tropics. The palm family is highly variable and exhibits a tremendous morphological diversity. Palms are found in a wide range of tropical and sub-tropical ecological zones, but they are most common in the understory of tropical humid forests.

Since ancient times, mankind has derived an impressive assortment of products from palm-trees for food, construction, fiber and fuel. In terms of utility of the products derived from them, the palm family ranks third in the world (after the *Gramineae* and *Leguminosae* families), and its role is even more obvious when focusing on the tropical regions.

However, despite their frequent occurrence in tropical forests and the vast array of products derived from them, foresters have so far, dedicated little attention to palms when designing and implementing forest management plans. Usually, wild palm trees in a forest are considered more of a nuisance than an asset.

The purpose of this study is to remedy this situation by providing basic information on palms as an important forest resource and to present a comprehensive coverage of the variety of non-wood forest products which can be obtained from them. The prospective audience includes foresters, rural development workers and policy makers, and international conservation and development agencies. Through the use of this document, it will be possible to better assess the contribution of palm products to sustain the livelihood of rural people and to evaluate the contribution of palms to sustainable forestry and agroforestry development.

The present study was developed jointly by the Regional Office for Asia and the Pacific and the Forest Products Division of the Forestry Department at FAO Headquarters. The draft of this document was prepared by Dennis V. Johnson, under the guidance of Patrick B. Durst and Paul Vantomme.

It gives us great pleasure to release this document, in the hope that it will provide essential information so that palms can be afforded their rightful place in tropical forestry development.

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This document was prepared, based on a draft made by Dennis V. Johnson, previously of the United States Department of Agriculture (USDA) Forest Service, Washington, DC., and who is an authority on palm utilization, conservation and development. The document benefited from the detailed comments of John Dransfield, Royal Botanical Gardens Kew, UK; and from the following individuals who contributed information and ideas to this report: Michael Balick, Henrik Balslev, Charles Clement, Neela De Zoysa, John Dowe, Patrick Durst, Andrew Henderson, Don Hodel, Francis Kahn, Jane MacKnight, Mónica Moraes, Jean-Christophe Pintaud, C. Renuka, Natalie Uhl, Jane Villa-Lobos and Scott Zona.

This report derives its basic information on the conservation status of palms from the plants database of the World Conservation Monitoring Centre (WCMC), Cambridge, U.K. The assistance of Harriet Gillett of WCMC is gratefully acknowledged. The preparation of this report also draws upon data collected by the World Conservation Union/Species Survival Commission (IUCN/SSC) Palm Specialist Group in the course of preparing an action plan on palm conservation and sustained utilization.

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Introduction

Palms are monocots, included in the section of Angiosperms characterized by bearing a single seed leaf. Scientifically, palms are classified as belonging to the family Palmae (the alternative name is Arecaceae), are perennial and distinguished by having woody stems.

According to Uhl and Dransfield[1] (1987), the palm family consists of six subfamilies, each representing a major line of evolution. The Coryphoideae is the subfamily with the most unspecialized characters. It is followed by the Calamoideae, Nypoideae, Ceroxyloideae, Arecoideae and Phytelephantoideae subfamilies; the last exhibiting the greatest number of specialized characters. The foregoing names are based on the genus originally thought to be most characteristic of each subfamily, all of which have species of economic importance. These are: the talipot palm (*Corypha*), rattan palm (*Calamus*), nipa palm (*Nypa*), Andean wax palm (*Ceroxylon*), betel nut palm (*Areca*) and South American vegetable ivory palm (*Phytelephas*).

About 200 palm genera are currently recognized. The number of palm species is much less precise because of conflicting concepts by palm taxonomists as to what constitutes a distinct species, and the need to revise a number of large genera. In the literature, the number of palm species is often given as approximately 2,500, a figure that can be used to give an idea of the taxonomic complexity of the palm family.

Natural history information on the palm family can be found in Corner (1966). Palm anatomy and structural biology have been the subjects of studies by Tomlinson (1961; 1990). Illustrated books which provide general information on the more common palms of the world include McCurrach (1960), Langlois (1976), Blombery and Rodd (1982), Lötschert (1985), Del Cañizo, 1991, Stewart (1994) and Jones (1995).

Growth Habit

The stem or trunk is a principal means of describing and identifying palms. There are five basic stem types: solitary, clustering, aerial branching, subterranean branching and climbing. The first two types are not mutually exclusive; in some instances the same species may exhibit either a solitary or clustering habit.

Solitary palms. (Fig. 1-1,C). The single-stemmed growth habit is very common and is characteristic of many of the palms cultivated for ornamental and economic purposes. Great variability exists in both the height and diameter of solitary palms. At one extreme is the ornamental potato-chip palm (*Chamaedorea tuerckheimii*) which has a stem no larger than the shaft of a pencil and may reach a height of only 30 cm. At the other extreme are the Chilean wine palm (*Jubaea chilensis*) with a stem diameter up to 2 m and the Andean wax palm (*Ceroxylon alpinum*) which may reach a height of 60 m. The economic disadvantage of solitary palms is that they must be propagated by seed and are vulnerable to fatal damage to the single growing tip.

[1] *Genera Palmarum,* is the best source of general information about the palm family to the generic level. It also defines technical terms associated with describing palms and provides illustrative line drawings and photographs. However, it contains little in the way of detailed information about individual palm species.

Clustering palms. (Fig. 1-1,B). Multiple-stemmed palms are also quite common. From a common root system, the palm produces suckers (basal offshoots) at or below ground level; the suckers growing to maturity and replacing the oldest stems as they die. Clustering palms may be sparse or dense; in the latter they may form thickets. Numerous examples of clustering palms are found among the popular ornamental species of the genus *Chamaedorea*; another is the date palm (*Phoenix dactylifera*). However, the date palm, in formal cultivation, typically has its suckers removed giving it the appearance of a solitary palm. Many clustering palms can be propagated by separating and transplanting young suckers, making them easier to cultivate.

Aerial branching palms. (Fig. 1-1,A). Aerial branching in palms is unusual and only found naturally in species of the genera *Hyphaene* and *Dypsis,* as well as in the rattan genera *Korthalsia* and *Laccosperma.* Branching occurs by equal forking (dichotomous branching) at the growth point and, in *Hyphaene compressa*, may occur as many as five times. Because of sublethal damage to the growing point by insects or a physical force such as lightning, aerial branching can occur abnormally in solitary palms. Examples of this are found in the coconut (*Cocos nucifera*) and palmyra (*Borassus flabellifer*). No technique has yet been devised to induce abnormal aerial branching for economic purposes.

Subterranean branching palms. (Fig. 1-1,D). Subterranean branching occurs by at least two processes. Nipa palm (*Nypa fruticans*) is an example of dichotomous branching; the salak palm (*Salacca zalacca*) is representative of lateral branching and is similar to the type of branching which takes place in dicots with branches developing from the growth of lateral meristems. Palms producing subterranean branches by either process can be vegetatively propagated by separating and transplanting individual branches.

Climbing palms. (Fig. 1-2). About 600 species of palms in 15 genera have a climbing growth habit. Most noteworthy is the genus *Calamus*--the largest genus in the palm family with approximately 350 described species--source of nearly all commercial rattan. The majority of climbing palms are also clumping palms, sending out new shoots from the root system.

Initially erect, the slender stems seek out trees for support and climb up into the forest canopy by means of recurved hooks and spines growing on the stem, leaves and inflorescences. In all climbing palms the leaves are pinnate and grow along the stem instead of forming a dense crown. The stems of climbing palms, more often referred to as canes, are solid in contrast to bamboo poles which are almost always hollow.

Leaves

Palm leaves are as variable as palm growth habits. In a forest setting, the leaves of palms are generally large and in many instances spectacular, making them a key aspect of identification. Palms typically bear their leaves, frequently referred to as fronds, in a crown at the top of the stem. Some exceptions to this leaf arrangement occur, such as in the ornamentally-popular lady palms (*Rhapis* spp.) which have leaves distributed along the upper stem. Among the acaulescent (stemless) palms, leaves may appear to be emerging from the root system but are in fact growing from the subterranean stem.

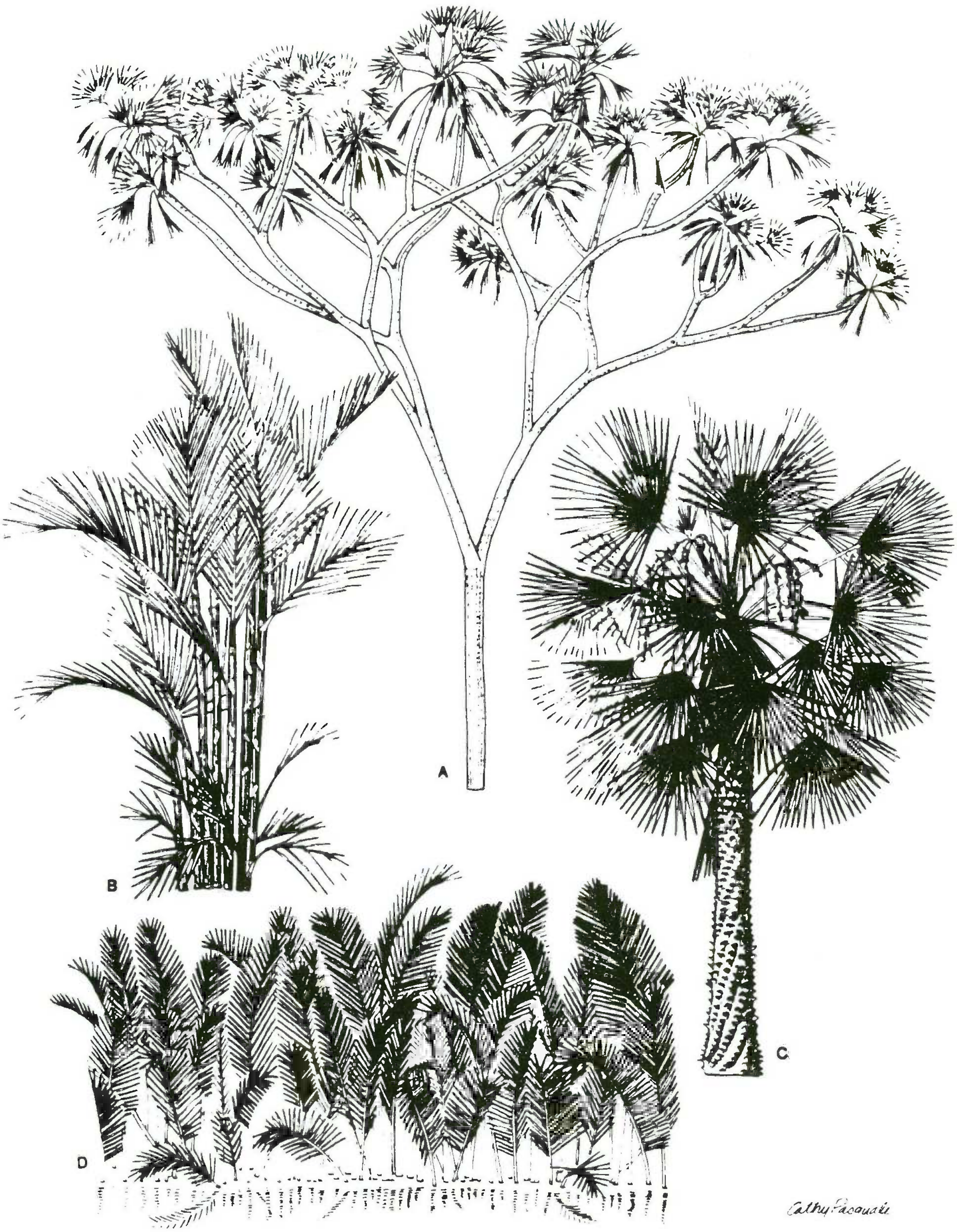

Figure 1-1. **Palm Growth Habits I. A. An aerial branching palm, the doum palm (*Hyphaene thebaica*). B. A clustering palm, the sealing wax palm (*Cyrtostachys renda*). C. A solitary palm, the carnaúba wax palm (*Copernicia prunifera*). D. A subterranean branching palm, the nipa palm (*Nypa fruticans*).**

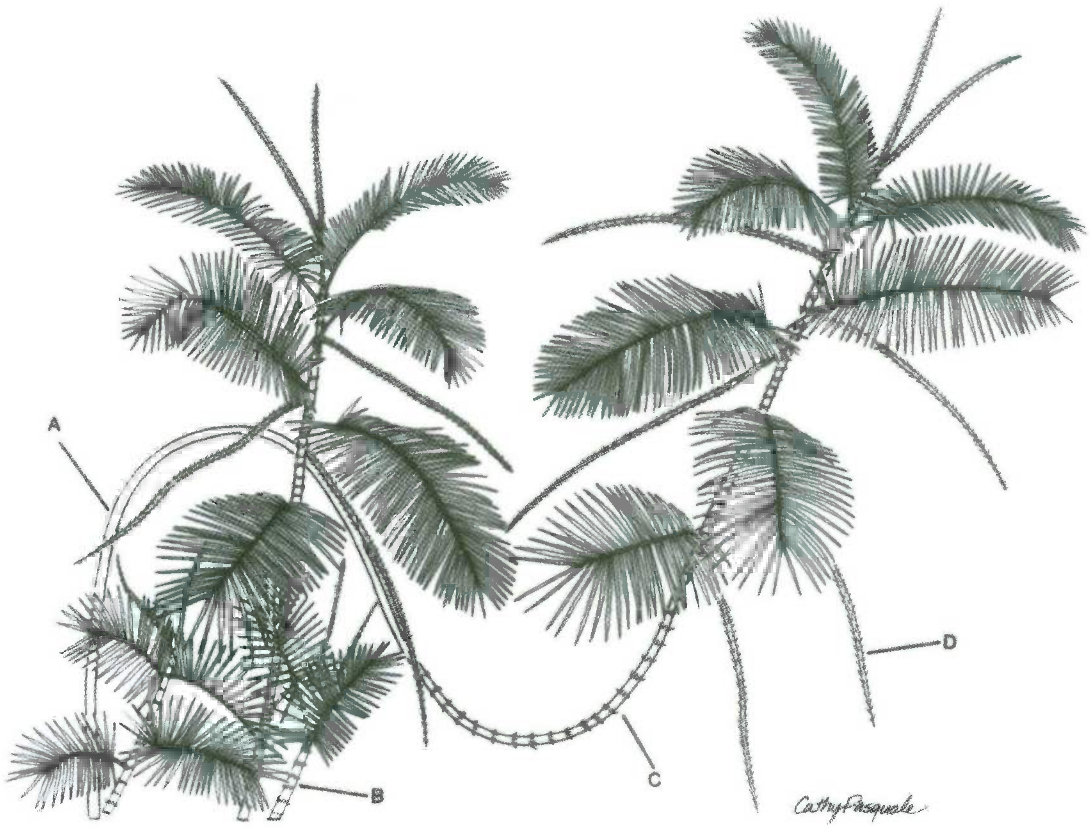

Figure 1-2. **Palm Growth Habits II. A climbing palm, the rattan palm (*Calamus* sp.). A. Bare section of old stem. B. Young shoot. C. Spiny leaf sheath. D. Flagellum. Redrawn from Jones, 1995.**

Four basic forms are characteristic of palm leaves: pinnate, palmate, bipinnate and entire

Pinnate leaves. (Fig. 1-3,D) Pinnate leaves are the most common type found in the palm family. They are divided into leaflets attached to a central leaf axis (the rachis) and often resemble a feather, hence palms bearing such foliage are often referred to as being feather-leaved or simply feather palms. Pinnate leaves exhibit an extreme size-range in the Palmae, varying from (including the petiole) well under 1 m in length in species of *Chamaedorea* to 25 m long in *Raphia regalis*. The latter is reputed to be a world record for the plant kingdom. All five major economic palms have pinnate leaves: coconut (*Cocos nucifera*), African oil palm (*Elaeis guineensis*), date (*Phoenix dactylifera*), betel nut palm (*Areca catechu*) and pejibaye (*Bactris gasipaes*).

Palmate leaves. (Fig. 1-3,A) These are also known as fan-leaved or fan palms. Palmate leaves have extended leaf parts (lamina) which are circular or semi-circular, divided into segments and radiate out from the point where they are attached to the petiole. Laminae may be slightly divided to being divided nearly to the leaf base. In size, leaves may be not much larger than a human hand in the lady palms (*Rhapis* spp.), to a maximum of 5 m across such as in the talipot palm (*Corypha umbraculifera*). The most important economic palm with palmate leaves is the palmyra palm (*Borassus flabellifer*).

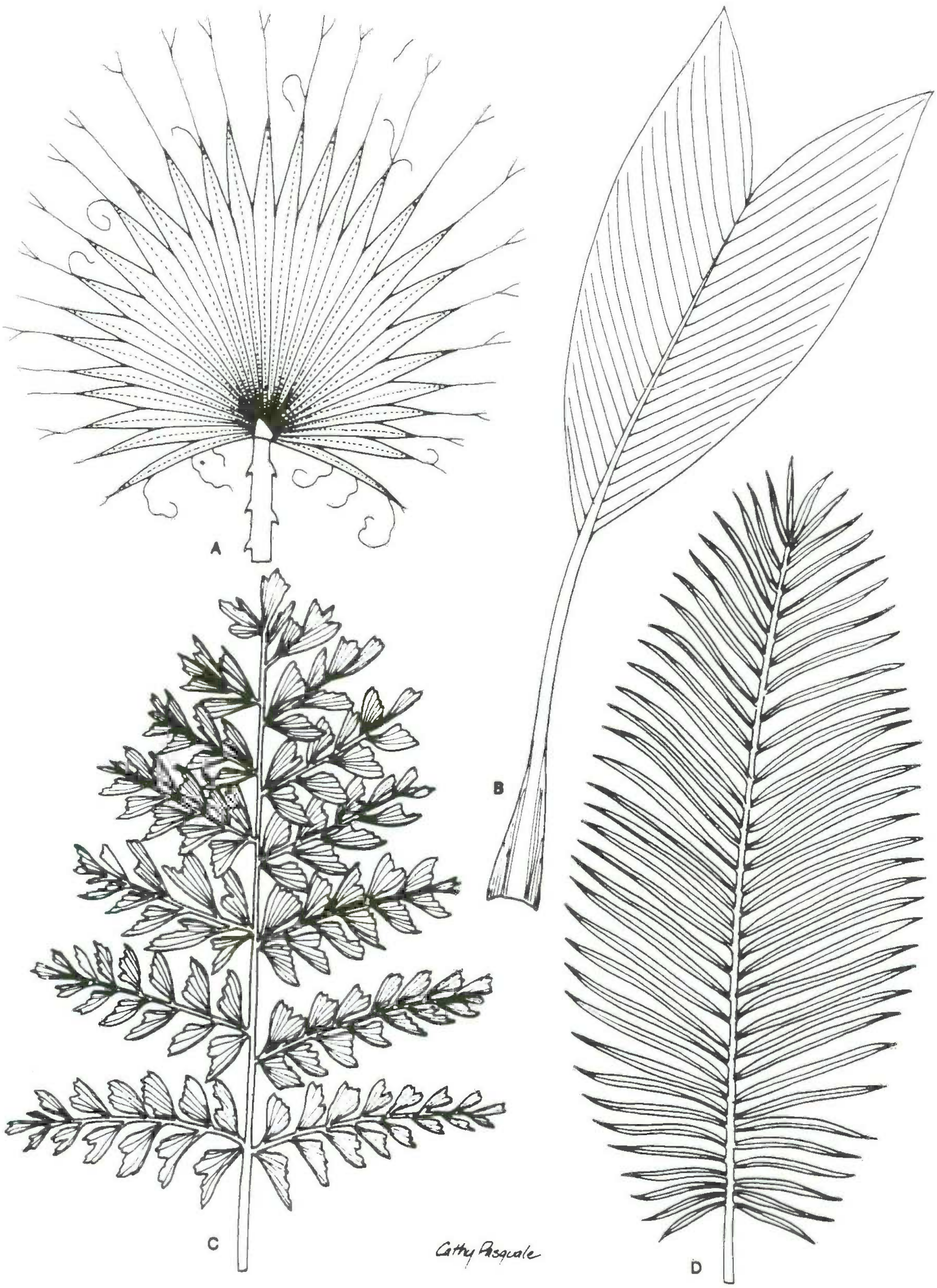

Figure 1-3. **Palm Leaf Types. A. A palmate leaf, as in the Mexican fan palm (*Washingtonia robusta*). B. An entire leaf, as in the necklace palm (*Chamaedorea geonomiformis*). C. A bipinnate leaf, as in the fishtail palms (*Caryota* spp.). D. A pinnate leaf, as in the nipa palm (*Nypa fruticans*).**

Bipinnate leaves. (Fig. 1-3,C) Bipinnate means twice-divided and gives leaflets (pinnules) a resemblance to a fishtail. This leaf type is rare in the Palmae, apparently restricted to *Caryota* spp., the fishtail palms. Individual fronds are as much as 4 m long and 3 m wide, depending upon the species.

Entire leaves. (Fig. 1-3,B) Entire leaves have a basic structure that is similar to pinnate leaves except that they are simple and undivided. Only about five palm genera have species with entire leaves; the largest and most beautiful is the diamond-shaped leaf of *Johannesteijsmannia magnifica.*

Fruits

In the palm family as a whole, from as little as three years to 40 years or more are required before individual palm species reach maturity and begin to flower and produce fruit.

Examples of rapid sexual maturity are found among *Chamaedorea* spp., whereas the buri palm (*Corypha utan*) is one of the slowest to mature.

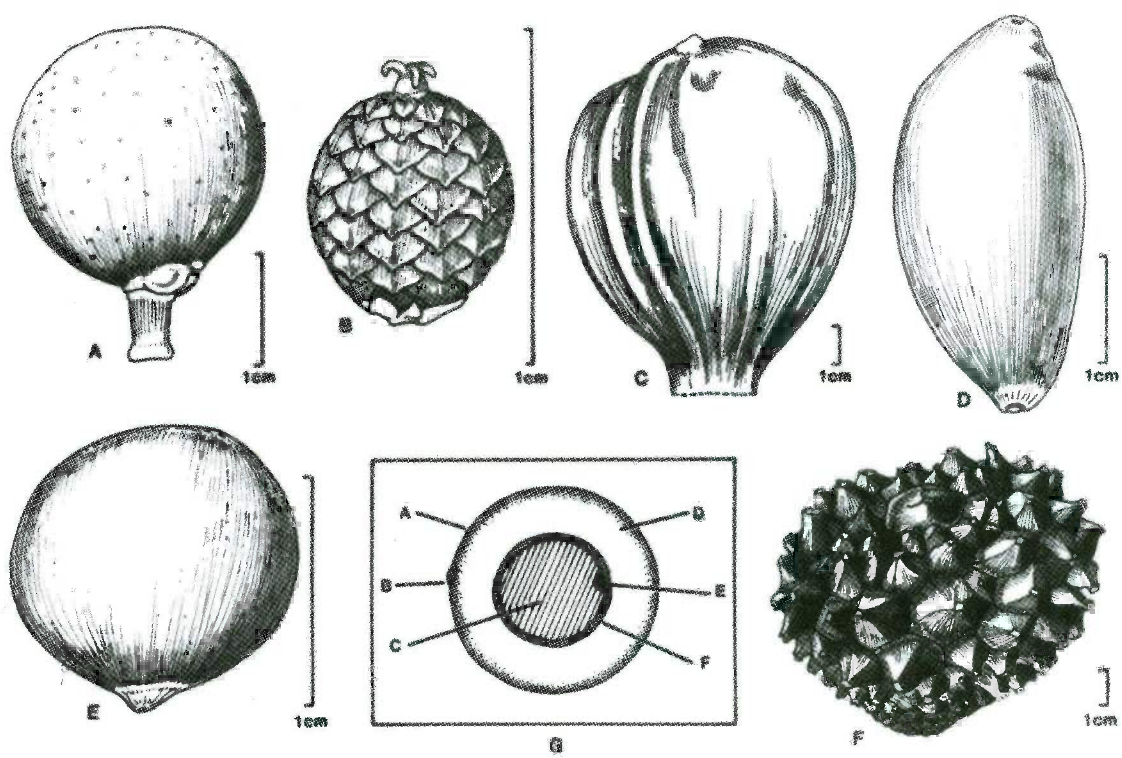

Figure 1-4. Palm Fruit Types. A. *Corypha,* Coryphoideae subfamily. B. *Calamus,* Calamoideae subfamily. C. *Nypa*, Nypoideae subfamily. D. *Ceroxylon*, Ceroxyloideae subfamily. E. *Areca*, Arecoideae subfamily. F. *Phytelephas*, Phytelephantoideae subfamily. G. A Palm Fruit in Cross-section. A. Epicarp. B. Hilum. C. Endosperm. D. Mesocarp. E. Embryo. F. Endocarp.

Figure 1-4 demonstrates the variability of fruits in the palm family. Illustrations A through F depict a representative fruit from each genus which gives its name to a palm subfamily. In terms of weight and size, palm seeds exhibit extreme differences. An individual seed of the popular ornamental parlor palm (*Chamaedorea elegans*) weighs only 0.23 g, as compared to the massive seed of the double coconut (*Lodoicea maldivica*) which weighs as much as 20 kg. The double coconut has the distinction of bearing the largest seed in the plant kingdom.

A cross-section of a palm fruit is provided in Figure 1-4,G. It serves to introduce the terminology associated with the different parts of the palm fruit to be employed in subsequent discussions.

Habitats

Geographically, palms can be found in habitats ranging from southern France where the European fan palm (*Chamaerops humilis*) naturally occurs at 44° north latitude, to Chatham Island, New Zealand, at 44° south latitude, where the shaving brush palm (*Rhopalostylis sapida*) is native. However, despite this impressive spread of latitude, the overwhelming majority of palm species are native to the tropical regions of the earth. Dowe (1992) estimated that only about 130 palm species occur naturally beyond the tropical latitudes (23.5° N. & S.).

Detailed data do not yet exist on a global basis as to the precise habitat of each palm species, and therefore it is somewhat difficult to discuss palms in terms of common habitat types. Nevertheless, on the basis of what we do know, palm habitats can be generalized into five types: forest habitats; montane habitats; grassland and scrubland habitats; desert habitats; and unusual soil-type habitats.

Forest habitats. Included here are both closed forest and open forest. Palms are predominantly forest species, as evidenced by two recent studies in South America. According to a habitat characterization of native Peruvian palms, 90 percent of the species occur in forests (Kahn and Moussa, 1994); across the continent in the Brazilian state of Espírito Santo, part of the Atlantic Forest, Fernandes (1993) did a similar study and found that 27 of the 30 native palms (90 percent) also were forest species.

Within tropical forests, individual palm species may be tall enough to be emergent and to form a part of the canopy or they may be understory species of short stature adapted to shady conditions. From the standpoint of forest degradation or destruction, it is the understory species which seldom survive, whereas some emergent species may appear actually to thrive as a result of disturbance.

The tropical forest habitat is not homogenous. Apart from the lands of adequate drainage, there are some areas subject to poor drainage or periodic flooding. Such areas are characterized by distinct vegetation associations with palms often playing a principal role. In South America, for example, the moriche palm (*Mauritia flexuosa*) forms extensive almost pure stands where conditions are swampy. To cite an example from Africa, the wine palm of West Africa, *Raphia hookeri*, is abundant in coastal freshwater swamps. And in Southeast Asia, the nipa palm (*Nypa fruticans*) forms dense stands in estuaries of brackish water.

Well-drained coastal areas forming a part of the tropical forest habitat likewise have some distinctive palm communities. The best example of this is the coconut palm (*Cocos nucifera*).

Montane habitats. Tropical montane habitats are generally defined as being above 1,000 m. Any combination of lower temperatures caused by altitude, extremely wet conditions due to clouds and complex topography creates unique ecological niches to which certain palm species have become adapted. The Andean wax palms (*Ceroxylon* spp.), for example, are found only in montane forests. In Africa, the Senegal date palm *(Phoenix reclinata)* occurs both in lowland and montane forests. The montane forests in Asia do not appear to have any palm genera unique to the habitat but do have numerous species of genera common in the lowlands, such as the rattans (*Calamus* spp.)

Grassland and scrubland habitats. There is less palm species diversity in grasslands and scrublands, but the palms that do occur may be present in fairly large populations. Examples are the carnaúba wax palm (*Copernicia prunifera*) of northeastern Brazil, the vegetable ivory palm of Africa (*Hyphaene petersiana*) and the palmyra palm (*Borassus flabellifer*) of Asia. In apparently all instances, palms in these habitats are found in association with some water source, e.g. stream valleys, perched water tables or the like.

Desert habitats. These dry habitats are generally defined as areas receiving less than 254 mm of annual rainfall and represent true desert. Palms in a desert habitat are often referred to as oasis palms. The occurrence of palms in such dry habitats appears, in most cases, to represent relict distributions from previous geologic periods of more favorable rainfall conditions. Examples of oasis palms are the date palm (*Phoenix dactylifera*), California fan palm (*Washingtonia filifera*) and the Central Australian cabbage palm (*Livistona mariae*).

Unusual soil-type habitats. Soils derived primarily from limestone can produce extremely basic soils which support a distinctive flora. The same is true of very acidic soils rich in heavy metals (chromium, iron, copper or manganese), which are often referred to as being ultrabasic or serpentinic soils. Certain palm species tolerate such extreme soil conditions. A number of palms in the Caribbean region are adapted to limey soils, such as the thatch palms (*Thrinax* spp.). In the Pacific island of New Caledonia, to cite another example, ten of the native palm species are found only on serpentinic soils.

False Palms

The term "palm," correctly-applied, refers to plants which are members of the Palmae, but by popular usage has also been applied to plants which resemble palms in some ways. At least seven plants have a common name which includes the word "palm," but which are not palms in the scientific sense. It is useful to clear up this confusion and dispense with the false palms as being beyond the scope of this study.

Traveller's palm. (Fig. 1-5,A) *Ravenala madagascariensis*, Strelitziaceae family, is a woody tree with a palm-like stem. It is native to Madagascar and widely cultivated as an ornamental throughout the tropics. Individual leaves bear greater resemblance to a banana plant (to which it is related) than a palm; they are arranged in two distinct ranks in the same plane forms a fan-shaped head. Flowers of the traveller's palm are similar to those of the bird-of-paradise plant. The vernacular name of the traveller's palm is said to derive from the fact that the cup-like leaf bases hold water which travellers could drink.

Sago palm. (Fig. 1-5,B) Major confusion is associated with this common name because it refers to the true palm *Metroxylon sagu* as well as to the palm-like Asian cycad *Cycas revoluta,* in the family Cycadaceae. Both the stem (which is sometimes branching) and the terminal crown of pinnate leaves of *Cycas revoluta* are similar to those of a true palm. However, *Cycas revoluta* leaves are stiff and borne as a rosette not singly as in palms; the male inflorescence resembles a cone, a key identifying character. *Cycas revoluta* is the most widely cultivated cycad. Edible starch, "sago," can be extracted from the stem of both *Metroxylon* sago and *Cycas revoluta,* which explains the shared common name.

Palm lily or ti palm. (Fig. 1-5,C) The popular ornamental plants *Cordyline australis* and *C. terminalis* of the agave family (Agavaceae) bear these common names. They are native to, respectively, New Zealand and East Asia. The branching habit gives the palm lily a resemblance to the branching palm *Hyphaene,* but has sword-like leaves crowded together at the end of the branches. These two species of *Cordyline* resemble plants in the genus *Dracaena,* with which they are often confused.

Screw palm. (Fig. 1-5,D) This common name is applied to *Pandanus spiralis* and other species in the genus of the Pandanaceae family. Native to Australia and tropical Asia, its morphology somewhat resembles the branching *Hyphaene* palm. The screw palm's sword-like leaves form tufted crowns and the tree bears large pineapple-like fruits. Where *Pandanus* spp. occur, leaves are widely used for weaving mats, baskets and so on.

Palm fern. This plant is indeed a fern and not a palm. Its scientific name is *Cyathea cunninghamii,* originating from New Zealand and Australia, and it is a member of the tree-fern family, Cyatheaceae. This tall, slender plant has a single stem and pinnate leaves somewhat resembling those of a true palm.

Palm grass. The scientific name for this perennial Asian grass, *Setaria palmifolia,* is an indication that the entire leaves resemble those of certain palms. It is classified as belonging to the grass family, Gramineae/Poaceae.

Panama hat palm. This plant is a monocot like a palm but is a member of the Cyclanthaceae family and bears the binomial *Carludovica palmata.* With its palmate leaf, this stemless understory plant of the lowland forests of Central and South America, is often mistaken for a true palm. The common name comes from the use of the fiber of young leaves to weave high quality hats.

Objectives, Coverage and Format

The purpose of this report is to provide basic information about palms as non-timber forest products. The prospective audience includes forestry technicians, international development workers, policy makers and international conservation and development agencies. Guiding principles of this report are: 1) to identify and describe palm products; 2) to link the product to the palm species being exploited as well as to the conservation status of that species; 3) to give citations within the technical literature to more detailed sources of information if needed. Strictly ornamental use of palms is not considered in this report, except for a very few relevant references. Through the use of this report, it will be possible to assess the role palms and their products can play within integrated forestry, agriculture, conservation and natural resource management activities.

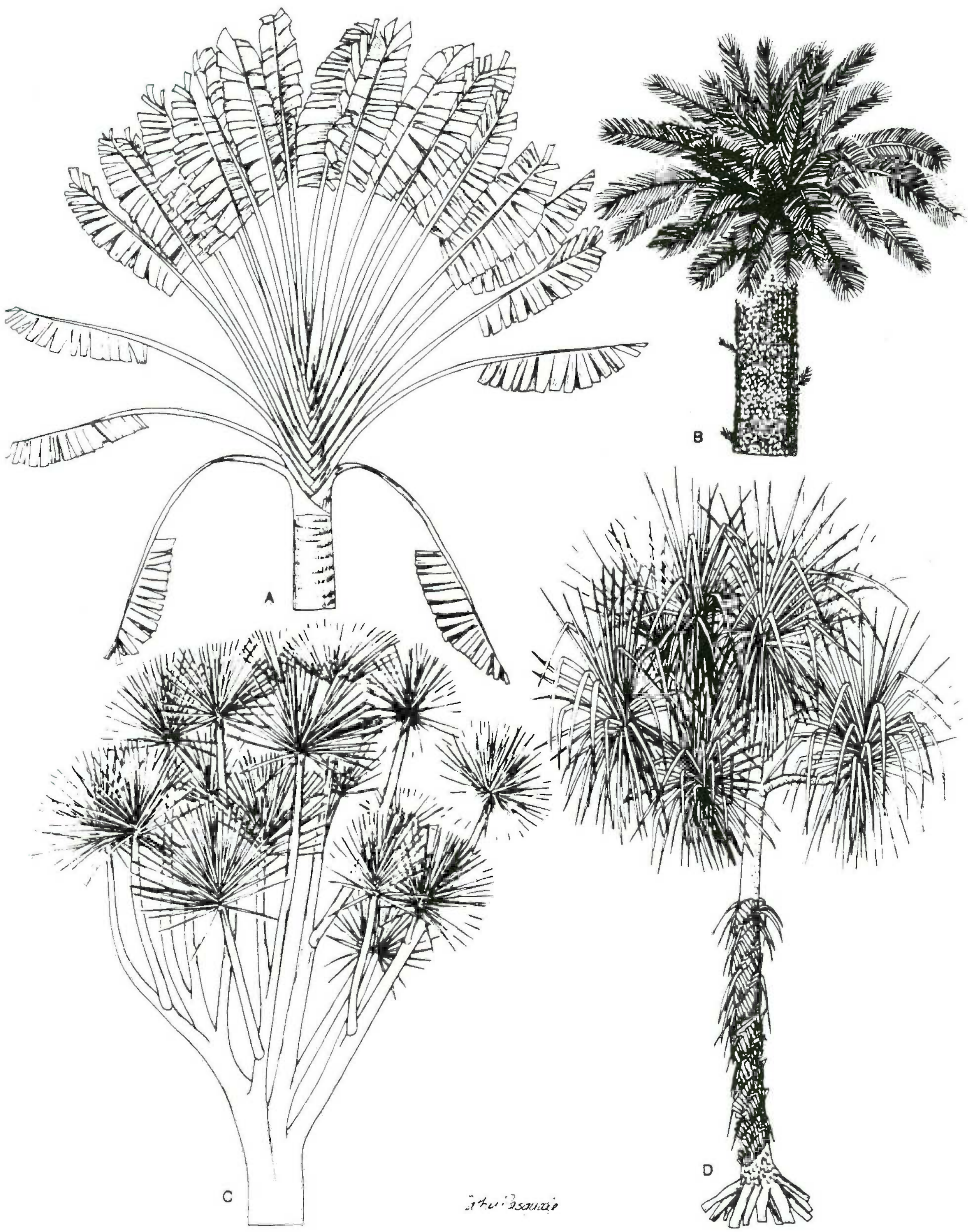

Figure 1-5. False Palms. A. The traveller's palm (*Ravenala madagascariensis*). B. The sago palm (*Cycas revoluta*). C. The palm lily or ti palm (*Cordyline* spp.). D. The screw palm (*Pandanus spiralis*).

This report concentrates on the tropics where the great majority of palm species are to be found. In a few instances, where it seems practical, information is included on native palms which occur beyond the tropics. Inasmuch as this report deals with forest products and the impacts of their exploitation, the focus is on native palms as they occur in the wild. Exotic palm species are of course present throughout the tropics, being grown casually as ornamental species or on plantations as in the case of major economic species. In a few instances, exotic palms have become naturalized and are able to grow on their own in their new habitat. Domesticated palms are discussed because of the examples they represent in terms of the ways in which their products have been used and developed. To achieve full coverage of palm products, palm stem wood is included in this report, despite the "non-wood" designation.

Three distinct parts constitute this report. Part one consists of the first three chapters. This first chapter provides a general introduction to palms as the diverse group of plants they represent. It is followed by an examination of the ways in which historically human societies have made use of palm products. Case studies of indigenous palm use and short summaries of the characteristics of the major domesticated palms are included. Chapter 3 focuses on contemporary palm products and provides a means to classify products and their processing requirements.

Part two provides regional examinations of utilized native palms in Asia, the Pacific, Latin America and Africa. The same general approach is used in Chapters 4-7: to consider native utilized species on the basis of their conservation status in the wild, either "threatened" or "non-threatened." Selected local palm names are included in the tables. Chapter 8 attempts a pantropical review of palm products and addresses the issue of which species have the most development potential and how a coordinated effort could be beneficial for sustainable palm utilization and development.

The final third of the report includes a section devoted to an assemblage of tables on the technical properties of palm products. Other sections consists of a lengthy list of cited references, a compilation of other palm information sources and finally a directory of palm specialists.

Historical role of palms in human culture

Pre-industrial indigenous people of the past as well as of the present have an intimate and direct relationship with the renewable natural resources of their environment. Prior to the Industrial Age, wild and cultivated plants and wild and domesticated animals provided all of the food and most of the material needs of particular groups of people. Looking back to those past times it is apparent that a few plant families played a prominent role as a source of edible and nonedible raw materials. For the entire world, three plant families stand out in terms of their past and present utility to humankind: the grass family (Gramineae), the legume family (Leguminosae) and the palm family (Palmae). If the geographic focus is narrowed to the tropical regions, the importance of the palm family is obvious.

The following discussion sets out to provide an overview of the economic importance of palms in earlier times. No single comprehensive study has yet been made of the historical role of palms in human culture, making this effort more difficult. A considerable amount of information on the subject is scattered in the anthropological and sociological literature as part of ethnographic treatments of culture groups throughout the tropics. Moreover, historical uses of products from individual palm species can be found in studies of major economic species such as the coconut or date palms. It should also be noted that in addition to being highly utilitarian, palms have a pivotal role in myth and ritual in certain cultures.

Three different but complementary approaches are taken to elucidate the historical role of palms in human culture. An initial approach is to look at ancient and traditional palm products, which deals mostly but not exclusively with subsistence palm uses. Next, case studies of indigenous groups and their particular array of palm uses are presented. Finally, the subject of palm domestication is addressed.

Ancient and Traditional Palm Products

The assortment of products that have been derived from palms at some time or another is indeed impressive. Although now somewhat dated, one of the best and concise summaries of palm usage can be found in Dahlgren (1944). Balick and Beck[2] (1990), in their excellent bibliography, compiled a list of 388 keywords to describe palm products. The bibliography editors broke down these many products into a dozen major classes, as follows: beverages; building materials; chemicals and industrial products; cosmetics and hygiene; feeds; fertilizers; food; fuel; handicrafts; medicines and rituals; ornamental plants; and structure and shelter. Handicrafts represent the largest class with 162 products and is divided into nine subclasses.

As a means of demonstrating some of the oldest human palm uses, the foregoing product classes are followed and one or more individual examples cited within each class, except in the instance of handicrafts where subclasses are included. It is not the intention here to describe in detail the processing of particular palm products, but instead to give a historical perspective through examples that will aid in better understanding the current situation and the potential for

[2] *Useful Palms of the World: A Synoptic Bibliography*, represents the most comprehensive single source of information on palm utilization. It contains abstracts of 1,039 publications.

palm product development, subjects to be dealt with in future chapters of this report. In choosing the examples presented below, preference was given, whenever possible, to traditional products directly used by local populations. Selected bibliographic references are provided.

Beverages. Palm wine or toddy is an ancient beverage derived from the sap of a number of different palm species, and serves as an appropriate example of a beverage. The sap is obtained by tapping and collecting the liquid in a receptacle from the inflorescence of the tree employing sophisticated techniques that must have required considerable trial-and-error experimentation. Tapping the stem or felling the tree are also means of obtaining sap that are much simpler. There is no difference in the quality of the sap obtained from the different methods. Because of the presence of naturally-occurring yeast, the sweet palm sap ferments within hours into a mild alcoholic beverage.

Palm tapping for beverage purposes is a pantropical practice, but has its greatest historical depth in Asia and Africa. In Asia, several palm species are traditional sources of palm wine; among them are the coconut (*Cocos nucifera*), the palmyra (*Borassus flabellifer*), the wild date (*Phoenix sylvestris*) and nipa (*Nypa fruticans*). Hamilton and Murphy (1988) describe tapping of nipa palm in Southeast Asia. The African continent has a long tradition of palm wine production, for example from the African oil palm (*Elaeis guineensis*), the doum palms (*Hyphaene* spp), the raffia palms (*Raphia* spp.), as well as the Senegal date palm (*Phoenix reclinata*). Essiamah (1992) provides a description of palm wine production in West Africa from the African oil palm; Cunningham (1990a,b) reports on the tapping of *Hyphaene coriacea* and *Phoenix reclinata* in southeastern Africa. Tapping palms for the production of palm wine in Latin America and the Caribbean also has a long history, but the practice is uncommon today. The best example of a wine palm in South America is the moriche palm (*Mauritia flexuosa*) (Gumilla, 1963).

Building Materials. Within this class of products is one of the oldest and most ubiquitous palm product of all: thatch. Palm thatch is widely used for temporary and more permanent structures. The leaves of virtually all palms can be used for thatch, whether they are pinnate, palmate or entire in shape. This palm use is so widespread that there is almost no need to give examples of particular geographic areas or palm species. Bomhard (1964) provides a good summary of the various ways palms are utilized in building houses. An annotated bibliography of palm leaf and stem use was compiled by Killmann *et al.*(1989). Leaf sheath fiber may also be used for thatch. *Arenga pinnata*, for example, is a source of very durable thatch of this type, lasting 50 years or more (J. Dransfield, pers. com.)

Utilizing palm thatch is simple. Leaves are cut from the palm, generally selecting leaves that are younger and more flexible. Transported to the construction site, the leaves are attached individually to a roof frame in an overlapping fashion beginning at the lowest point. When a palm is exploited that has small leaves, the leaves may be attached to a stick in the form of a panel before being affixed to the roof. The small understory Amazonian palm *Lepidocaryum tenue* is used in this manner. A palm-thatched roof is light-weight and, if tightly made, remarkably waterproof. But at the same time it is porous, allowing air movement and the escape of cooking-fire smoke. A roof will last for a few years, the length of time depending upon the local climate and the type of palm leaf used.

Chemicals and Industrial Products. Clearly this class of products is modern. Nevertheless an original traditional palm product can be mentioned. Dragon's blood is the common name for the red resinous exudation which occurs on the scales of fruits of the Southeast Asian rattans *Daemonorops didymophylla*, *D. draco* and related species. (The original source of dragon's blood was *Dracaena* spp. in the Agave family). This resinous substance was a dye source for coloring cloth, woven mats and the like among indigenous peoples and in the 19th Century was adopted for industrial use in Europe as both a varnish and dye. In the traditional medicine of Southeast Asia, dragon's blood was used to treat stomach ailments, a use carried over into European medicine for a time (Burkill, 1966). Apparently dragon's blood continues to be of industrial use as a resin and is commercially available (Merlini and Nasini, 1976).

Cosmetics and Hygiene. Palm oils in general have a wide variety of household and industrial uses (see Hodge, 1975). An example within this product class can be cited from Madagascar where mesocarp oil of the raffia palm (*Raphia farinifera*) has been employed as a traditional hairdressing (Sadebeck, 1899).

Feeds. Cattle can be fed fresh young palm leaves if there is a shortage of better forage, as occurs in tropical areas subject to a protracted dry season. Leaves are cut and brought to the cattle and may or may not be chopped into smaller pieces to make them easier to consume. If the palms are of low enough stature, cattle and other livestock may forage on them directly. In Paraguay, leaves of the mbocaya palm (*Acrocomia totai*) provide forage (Markley, 1953). Palm fruits in general are eaten by pigs.

Fertilizer. Traditional palm exploitation indirectly produces quantities of organic matter such as waste fruit parts, leaves and stalks suitable for incorporation into garden soil as fertilizer.

Food. This class of palm products represents the most important in economic terms since it includes the vegetable oils. Best known are the coconut (*Cocos nucifera*) and the African oil palm (*Elaeis guineensis*), both now commercially cultivated as sources of oil throughout the tropical realm. In addition, there are a number of Neotropical oil palms of lesser importance (see Balick, 1979a).

There are two types of oil derived from the palm fruit: mesocarp oil and endosperm (kernel) oil. Both types have a long history of pre-industrial utilization for culinary and other purposes throughout the tropics. The African oil palm is a good example because it is a source of both oil types; the mesocarp and the kernel each containing about 50 percent oil. In this palm, oil can be extracted from the fleshy mesocarp most easily. Fruits are fermented for a few days, pounded to remove the pulp which is boiled in water and the oil skimmed off. Mesocarp oil remains liquid at ambient temperatures in the tropics. Extraction of kernel oil requires crushing the kernels and mechanically pressing the resultant cake to express the oil.

Fuel. The simplest fuel usages of palms are exemplified by the burning of dry palm leaves, petioles, stem wood and fruit husks of some species such as the coconut. Often such fuels represent using by-products of the extraction of some other palm product. This palm use is ubiquitous.

Handicrafts. This class of palm products is exceedingly large and for that reason has been subdivided into nine subclasses.

Agricultural Implements. Climbing loops are traditional devices often made from palm leaf fiber, midribs or petioles. They are employed as an aid in climbing palms to harvest fruit, leaves or to tap the tree for sap; loops are, of course, used to climb trees other than palms for similar purposes. There are a number of different styles of climbing loops across the tropics. A type employed in West Africa is made from the petiole and leaf fiber of the African oil palm. It encircles both the tree trunk and the climber, permitting him to have his hands free to tap, in many cases, the same palm species which has provided materials for the climbing loop.

Clothing. The classic example of this palm use is a hat made from palm leaf material, a use found throughout the tropics. Young pinnate and palmate leaves of virtually any palm species serves for hat making. The weave may be coarse or fine depending upon how thin the leaflets are stripped and the amount of time invested by the artisan. Leaf fiber can also be woven into cloth and made into clothing. *Raphia* fiber is used extensively for this purpose in Madagascar even today (J. Dransfield, pers. com).

Furniture. Hammocks represent an article of furniture often made from fiber extracted from young palm leaves. In South America, the pinnate-leaf chambira palm (*Astrocaryum chambira*) is the preferred palm fiber source (Wheeler, 1970). The fiber is made into string and then woven into an open mesh hammock. The word hammock is Amerindian in origin and the weaving and use of hammocks appears to be restricted to the Neotropics as an ancient and modern practice.

Games and Toys. A variety of simple objects for children to play with in the tropics are fashioned from palm leaves and petioles. Certain games involve palm products. In Southeast Asia, for example, hollow balls made of wound rattan strips are kicked in a game played by children and adults. Historically, in Sri Lanka, a variety of coconut was cultivated with an exceptionally thick shell (endocarp) for a game called "fighting coconuts." The game involves two competitors each clutching one of these special coconuts. The contest entails striking the coconuts together until one breaks, the holder of the intact nut being the winner.

Household Items. Sieves represent examples of ubiquitous household items made from palm fiber throughout the tropical regions. Thin strips of leaflets are woven in a square or diagonal pattern to produce a rectangular or round sieve. Wood sticks are often incorporated into the edge to prevent fraying and make the sieve easier to handle.

Jewelry. Among many cultural groups in the tropics necklaces traditionally are made by stringing small palm seeds. The hard endosperm of the Caroline ivory nut palm (*Metroxylon amicarum*), native to the Caroline Islands in the Pacific Ocean, is carved into beads and buttons.

Musical Instruments. In addition to the use of palm fiber to make strings for musical instruments, drums can be made from hollowed-out palm stems. The palmyra palm (*Borassus flabellifer*) has reportedly been used for this latter purpose in parts of Asia.

Stationery and Books. Palm leaves were an ancient writing material in India, perhaps as old as written language itself. Segments of the palmate leaves of the talipot palm (*Corypha umbraculifera*), as well as some other palms, were written upon with a metal stylus. Examples of these palm leaf manuscripts are preserved in museums.

Weapons and Hunting Tools. Palm wood is widely used for this purpose. For example, indigenous people in the Philippines utilize the hard outer wood of the palms in the genus *Livistona* to make bows and spear shafts (Brown and Merrill, 1919).

Medicines and Ritual. Throughout their range palms are sources of folk medicines and are a part of rituals. Dragon's blood resin (see Item 3 above) is burned as incense in witchcraft rituals in the United States and is sold in shops specializing in products associated with magic.

An example combining medicinal and ritual use is found in the betel nut palm (*Areca catechu*). Large numbers of people in Asia and Polynesia have for millennia chewed betel seeds mixed with fresh betel pepper leaf and a bit of slaked lime; it is the classic Asian masticatory. The betel nut contains an alkaloid that is mildly narcotic (see Table 9-1).

Ornamental Use. Flowers are universally used as decorations for many types of rites and ceremonies. In the tropics, branches of palm inflorescences are often employed. Sprigs of coconut flowers, for example, are used in India and Sri Lanka for wedding decorations.

Structure and Shelter. This is another huge class of palm products. A couple of the less common uses are the rigging of sailing vessels with thin rattans rather than rope in Indonesia, and the use of entire stems of the caranday palm (*Copernicia alba*) as utility poles in Paraguay.

The product classes employed in this section portray the great variety of palm products, past and present, and cover every aspect of material culture. But that does not explain everything about palms and human culture. Apart from their value as a source of useful products, palms are also of general interest simply because of their beauty and symmetry, which may help to explain the role of palms in religion and folklore.

Case Studies: Indigenous Groups and Their Use of Palms

Shifting away from a product approach to a focus on specific indigenous groups and their utilization of palms provides another dimension to this discussion. For this purpose, accounts of palm use have been taken from studies in Asia, the Pacific, Africa and Latin America. Criteria for selection of the case studies were as follows: focus on a particular indigenous group, local as well as scientific names of the utilized palms were known and palm use was described in some detail. Moreover, an attempt was made to have the case studies represent widely separated geographic regions and a diversity of local palm species diversity. The four case studies chosen describe the Iban of Sarawak, the Shipibo of Amazonian Peru, the Kwanyama Ovambo of Namibia and the Trukese of the Caroline Islands of Micronesia in the Pacific. The grammatical present tense is used in this section to refer to both past and present palm uses.

The Iban

This first case study focuses on the Iban, an indigenous group in southwestern Sarawak, East Malaysia. The Iban inhabit an area of largely undisturbed natural forest, with heavy rainfall, varied terrain and an attitudinal range of sea level to 760 m. Kubah National Park occupies about 2,230 ha in the area. Pearce (1994) studied the palms of the park and its immediate environs and gathered excellent data on the identify of the palms as well as their utilization by the Iban people. Pearce relied on earlier systematic studies by J. Dransfield, when she did field work in 1990. Southwestern Sarawak is considered to have one of the richest palm floras in the world, as evidenced by the cataloging of 99 palms in and around the park.

The 47 native palms used by the Iban are listed in Table 2-1. The predominance of the rattan palm genera (*Calamus*, *Daemonorops*, *Korthalsia*, *Plectocomia*, *Plectocomiopsis*) is striking as they together account for 31 of the 47 palms.

Table 2-1: Iban Utilization of Native Palms

Scientific Name/Iban Name	Uses
Arenga hastata, mudor	down on stem as tinder
Calamus blumei, wi kijang	baskets
Calamus caesius, sega	many uses, the best split rattan
Calamus conirostris, rotan	basket spars and weaving; general uses
Calamus corrugatus, wijanggut	many uses, as good as Calamus caesius; smallest diameter of local cane
Calamus crassifolius, witakong	binding basket edges and parangs (bush knives); sewing atap (thatch)
Calamus flabellatus, wi takung	baskets; various other uses
Calamus gonospermus, sega ai	baskets, split or whole
Calamus hispidulus, rotan	cane can be used
Calamus javensis, wi anak	baskets, split or whole
Calamus laevigatus var. laevigatus, rotan lio	baskets, mats, tying
Calamus laevigatus var. mucronatus, rotan	good cane
Calamus marginatus, wi matahari	sold as Calamus caesius
Calamus mattanensis, rotan lemba	baskets; many other uses
Calamus muricatus, rotan putch	baskets, rough temporary; tying; good split or whole
Calamus nematospadix, rotan tunggal	baskets; various other uses; sewing atap (split)
Calamus paspalanthus, rotan tingkas	edible palm heart, sour fruit; cane
Calamus pilosellus, rotan anak	binding
Caryota mitis, mudor	edible palm heart; stem down for tinder
Ceratolobus discolor, danan	basket spars, weaving
Ceratolobus subangulatus, rotan janggut	baskets, tying, etc.
Daemonorops acamptostachys, rotan duduk	fishing baskets from petiole skin
Daemonorops cristata, wi getah	fruit exudate as gum; fruit eaten by children
Daemonorops didymophylla wi getah, rotan jernang	baskets, especially earth baskets; sarcotesta sweet and juicy
Daemonorops fissa (none)	basket spars, weaving; fruit slightly sweet, edible; palm heart edible, sold locally
Daemonorops periacantha, wi empunok	basket edges, mats, chairs; palm heart and fruit edible
Daemonorops sabut, wi lepoh	basket spars, weaving
Eugeissona insignis pantu kejatau	petiole pith for dart plugs, petiole skin for baskets; palm heart and young fruit edible

Scientific Name/Iban Name	Uses
Korthalsia cheb, danan semut	furniture and general utility
Korthalsia echinometra, wi seru	cane used
Korthalsia ferox, danan kuning	baskets, furniture, many other uses.
Korthalsia flagellaris, danan	baskets, weaving, many other uses
Korthalsia rigida, danan tai manok	baskets, chairs, various other uses
Korthalsia rostrata, danan wi batu	baskets, chicken coops; sewing (split); tying logs
Licuala bintuluensis, biru	leaflets for hats, wrapping; petiole skin for weaving winnowing baskets
Licuala orbicularis, biru bulat	leaves for wrapping, making hats, umbrellas and atap
Licuala petiolulata, gerenis	petiole skin for making baskets
Licuala valida, pala	petiole skin for winnowing baskets; leaflets for wrapping; palm heart edible
Oncosperma horridum, nibong	bark for floors and walls; palm heart edible
Pinanga cf. *ligulata*, pinang	stem for lance shaft
Pinanga mooreana, pinang murind	walking sticks; fruit eaten
Plectocomia mulleri, rotan tibu	baskets, chairs, etc; good split
Plectocomiopsis nov. sp., belibih	many uses; very useful because nodes are flat
Salacca affinis var. *borneensis* ridan	petiole for fishing rods; petiole skin for baskets; leaves for camp shelters; fruit edible
Salacca nov. sp., lekam	fruit (sweet-sour) edible
Salacca vermicularis, lamayung	petiole skin for weaving baskets; fruit edible

Source: Pearce, 1994.

The Shipibo

The Shipibo of Peru serve as a second case study. These Amerindian people occupy tropical lowland forest land on the central Ucayali river, a tributary of the Amazon, near the Peruvian city of Pucallpa. Bodley and Benson (1979) made a detailed study of the Shipibo which focused on the utilization of palms in everyday life. Field research was carried out in 1976-1977. In vegetation surveys, the authors found within the Shipibo reserve and adjoining areas a rich palm flora of at least 24 species. Data were collected on the contemporary utilization of palms and products identified to their species of origin. Table 2-2 lists 19 different local palms utilized by the Shipibo.

As Table 2-2 shows, considerable use is made of palms for building materials, food and handicrafts. It is interesting to note that the Shipibo have taken their tradition of making bows and arrows from palm wood and turned it into crafting souvenirs to sell to tourists visiting the area.

Table 2-2: Shipibo Utilization of Native Palms

Scientific* and Shipibo Common Names	Uses
Astrocaryum huicungo (=A. murumuru var. *huicungo),* páni	new pinnate leaves to make women's spinning basket; stems as house posts
Astrocaryum jauari, yahuarhuanqui	stems as house posts; petioles to make burden baskets; ripe fruit as fish bait
Attalea tessmannii, conta	leaf pinnae to make brooms
Bactris concinna, shiní	edible fruit
Bactris gasipaes, juani	cultivated for edible fruit; stem wood made into bows, arrow points, lances, awls, clubs, spindles, loom parts
Bactris maraja, taná	edible fruit; stems as house floor supports, rafters
Chelyocarpus ulei, bonká	palmate leaves as sitting mats, umbrellas, bush meat wrapper
Euterpe precatoria, paná	stems as house posts; stem slats as house walls; edible palm heart; fruit mesocarp oil as women's hair dressing
Geonoma deversa, quebón juani	stems to support mosquito nets
Iriartea ventricosa (=I. deltoidea), tao	stem wood for house flooring, shelving, rafters, support beams, harpoon staves, arrow points, roof ridge pins; swollen stem for temporary canoe
Jessenia bataua (=Oenocarpus bataua), isá	edible fruit; leaf pinnae made into brooms
Mauritia flexuosa, vinon	edible fruit; petioles for loom parts; split petioles woven into sitting mats
Maximiliana venatorum (uncertain name), canis	split petioles woven into sleeping mats; spathe made into hanging storage basket
Oenocarpus multicaulis (=O. mapora), jephue isá	stem wood for bows and arrows sold to tourists; edible fruits; stems as house posts
Phytelephas microcarpa (=P. macrocarpa), jephue	pinnate leaves for roof thatch; petiole made into tray-like storage basket; edible immature fruit endosperm
Scheelea bassleriana (=Attalea butyracea), shebón	pinnate leaves for thatch; new leaves to make sitting mats, small baskets; leaf pinnae to make brooms; edible fruit
Scheelea brachyclada (=Attalea butyracea), cansín	pinnate leaves for thatch, basketry, brooms
Socratea exorrhiza, sino	stem wood for flooring, bows and arrow for tourists; spiny roots as graters
Syagrus sancona, shuhui	stem wood for loom parts

Note: * Synonyms indicated are in accord with Henderson *et al.*, 1995.
Source: Bodley and Benson, 1979.

The Kwanyama Ovambo

Case study three is from Africa where palm species diversity is low; nevertheless palm utilization is high and focused on relatively few species.

The Kwanyama live in Ovamboland which lies in north-central Namibia bordering Angola to the north. The latitude is approximately 17.5° south, elevations average about 1,000 m and annual rainfall is 520 mm. Namibia has only two native palms. The most prevalent is the African ivory nut palm, common name omulunga, *Hyphaene petersiana* (synonym: *Hyphaene ventricosa*); this species of *Hyphaene* is single-stemmed and does not branch. The second palm is the Senegal date palm, vernacular name omulunga wangolo, *Phoenix reclinata.*

Rodin (1985) published a detailed ethnobotanical study of the Kwanyama based upon field work in 1947 and 1973. More recently, Konstant *et al.* (1995) and Sullivan *et al.* (1995) studied exploitation of *Hyphaene petersiana* in the same general area. Table 2-3 summarizes palm utilization based on these references.

Table 2-3: Kwanyama Ovambo Utilization of Native Palms

Palm Product Classes*	Uses of African ivory nut palm, *Hyphaene petersiana*, except as noted
beverages	palm wine by fermenting mesocarp pulp and from sap by tapping flower bud; palm wine distilled into spirits
building materials	leaves for thatch; leaf fiber made into rope; petioles for hut construction, fencing
chemicals and industrial products	vegetable ivory (hard endosperm) carved into buttons, ornamental objects
cosmetics and hygiene	shredded leaves dyed for wigs
feeds	cattle, goats and donkeys rely on palms for fodder
fertilizer	likely, but not specifically stated in references cited
food	edible palm heart, raw fibrous fruit mesocarp; fruits of Phoenix reclinata eaten fresh or preserved by drying
fuel	petioles, flower stalks for cooking fires
handicrafts (all types)	leaves used to weave baskets, mats, hats; petioles made into hunting bows, carrying poles, stirring spoons; leaflets woven into special beer strainer; fused twin seeds as childrens' dolls
medicines and ritual	leaves used to shape headdresses and bridal hats; skirts, necklaces and bracelets braided from leaf blades during female puberty rites
ornamental use	shade tree, but not specifically stated in references cited
structure and shelter	stems hollowed out for cattle water troughs

Note: * After Balick and Beck, 1990.
Sources: Rodin, 1985; Konstant *et al.*, 1995; Sullivan *et al.*, 1995.

Palm use is recorded within each of 12 product classes developed by Balick and Beck (1990), and all originate from the African ivory nut palm, except for limited food use of the fruits of the Senegal date palm, a rare tree in the area. No medicinal use of this palm is reported despite its intensive exploitation and the fact that other species of *Hyphaene* play a role in medicine. Rodin (1985) asserts that the ivory nut palm is the most useful of all the native plants in Ovamboland; he further states that it is illegal to cut down the palm because of its exceptional value to the local people.

The Trukese

The final case study is from the Pacific Ocean region. Geographically Truk designates a group of islands which form a part of the Caroline Islands and are located about 680 miles southeast of Guam. The inhabitants, the Trukese, are Micronesians.

Despite its equatorial latitude, Truk has very poor palm species diversity. According to Moore and Fosberg (1956), only three species of palms occur naturally in the Truk Islands; namely *Clinostigma carolinensis*, an endemic palm under threat of extinction, the Caroline ivory nut palm, "os" in the local language, (*Metroxylon amicarum*) and the nipa palm (*Nypa fruticans*). The coconut palm, locally-called "ny," (*Cocos nucifera*) is naturalized and widely cultivated on Truk. Other reported introduced species in the islands are the betel nut palm (*Areca catechu*) and the African oil palm (*Elaeis guineensis*).

LeBar (1964) conducted a study of the material culture of Truk which revealed the extent to which the local people make use of floral resources to provide their needs. Field research was done in 1947-1948. Using the categories in LeBar's study, information on palm use was excerpted and is presented in Table 2-4.

Table 2-4 documents the utilization of only the coconut and ivory nut palms, but the diversity of coconut palm use, with examples in every material culture category, is impressive. The significance of the coconut palm among the Trukese may have been enhanced during the years of Japanese control of the islands (1914-1945) when coconut growing for copra production was encouraged. The absence of hat making from palm leaves is because of the presence and use of pandanus for that purpose.

The four preceding case studies demonstrate how very important palms are, for subsistence and commercial purposes, to indigenous peoples throughout the tropics. Most revealing about the case studies is that palm utilization is equally intense in areas of high and low palm species diversity. A major difference appears to be that local people have a choice of different palms to exploit for the same end use where high palm species diversity occurs; for example, leaves for thatching or weaving.

Table 2-4: Trukese Utilization of Palms

Material Culture Category	Uses of coconut *(Cocos nucifera)*, except as noted
tools and utensils	fiber cord as polisher; leaflet midrib made into needle; shell flask made with coconut fiber handle; dry husks or old palm leaf basket as cushion; leaf sheath fiber to hold grated coconut meat to be pressed; fiber cord made into tree climbing loops
cordage	coir fiber for cordage
plaiting	leaflet plaited into mats: single wall mat, double wall mat, canoe mat; leaflet baskets: temporary field basket, semipermanent field basket, woman's fish basket, woman's weaving basket; leaflet fans; cord baskets
weaving	ivory nut palm midrib to make loom parts; coconut fiber sling for loom
chemical industries	coconut shell molds used for dye cake; netted fiber bag to store shell molds; coconut water base used to rinse fabrics before dyeing; grated coconut meat rubbed on dyed fabric to produce sheen; coconut oil base for perfume; spathe ash added to lime in making cement
agriculture	coconut a major crop, many varieties recognized; copra provides cash income
hunting and fishing	half coconut shell containing bait used in bird snare; leaflet midrib used in making crab snares; coconut cloth used to wrap fish poison; coconut leaf sweeps used to drive fish into weirs and nets; dried leaf torches used in night spear fishing and harpooning sea turtles; leaflet used to tie knots as part of divination in turtle fishing; coconut water drunk as part of ritual before bonito fishing; leaflet midribs used to make fishing kite; dried midrib leaflet made into netting needle; ivory nut palm leaf midrib used as net mesh gauge; coconut fiber lines to catch sea turtles; dry coconut meat gratings tossed in water to attract fish
food and stimulants	coconut cream used extensively in cooking; coconut meat gratings burned in smudge fire to repel mosquitoes; dry husk or shredded leaf base fiber used a tinder; half coconut shells used in food preparation and as drinking cups; fresh coconut water as beverage; sweet and fermented toddy from palm sap
housing	leaf matting and fronts used for walls on temporary shelters; ivory nut palm leaves made into thatch sheets for roofing; coconut frond midrib strips are used to tie ivory nut palm leaves to binding rods; fiber cord used to tie thatch sheets to rafters; fiber ropes used in pole-and-sling operation to carry large house timbers; palm fronds used to cover earthen house floors; coconut shell flask of perfume kept in storage box to impart sweet scent to clothing
canoes	fiber cord used to attach and decorate end pieces and attach outrigger booms; young leaflets are strung on coconut fiber cord around outside of gunwales of large paddling canoes for decoration; shell halves used for bailing
clothing	plaited coconut fiber used to make reef shoes
ornaments	coconut shell made into small beads to decorate belts, bands and to make necklaces and pendants; burning spathe applied to sea turtle shell to loosen shell; turtle shell softened by boiling in mixture of coconut milk and sea water; coconut shell pieces used for ear piercing and made into ear rings; shell used in making comb handles; palm leaf midrib used to apply pigment in tattooing; glowing end of coconut leaflet midrib used in scarification
weapons	coconut wood used to make spears; fiber cord to make slings
recreation objects	coconut meat used to close end of nose flute

Source: LeBar, 1964.

Palm Domestication

A final perspective on the historical palm use can be realized through examination of the subject of palm domestication. Domestication of a particular palm species represents the end-point of a continuum that begins with utilization of wild palms (Clement, 1992). Over time, utilization leads to some level of management of wild populations; in turn this can result in the palm being brought into cultivation. At the point where cultivation begins, true selection also is assumed to begin for the cultivator will gather for propagation fruit or suckers from plants which have certain desirable qualities such as rapid growth, large fruit size or the like. Over many plant generations cultivated palms will come to exhibit morphological and genetic characters markedly different from their wild relatives; they are then deemed to be domesticated.

Five palm species are clearly domesticated and all are currently major economic species: betel nut palm (*Areca catechu*), coconut palm (*Cocos nucifera*), date palm (*Phoenix dactylifera*), African oil palm (*Elaeis guineensis*) and pejibaye or peach palm (*Bactris gasipaes*).

The palm domestication process is driven by an economic interest in one key product, as is generally the case in plant domestication. The principal product is in some instances mutually exclusive to another palm use; in other instances the predominance of the key economic product may overshadow other useful products of the same palm and preclude development of the palm in a more integrated fashion. This situation can be remedied by promoting greater understanding of the inherent multipurpose character of already-domesticated palms as well as those with domestication potential. For present purposes, it is useful to review the domestication of the five major palms and their multipurpose character.

Betel Nut Palm *(Areca catechu)*

This palm appears to have been domesticated for its hard dried endosperm which contains the alkaloid arecoline and is chewed as a narcotic. Betel nut has a number of reported medicinal uses. The origin of the betel nut palm is unclear because of its long history of use, the fact that a definitely wild population has never been found and that it is but one of about 60 species distributed in South and Southeast Asia and the Pacific. In India it has been in cultivation for as many as 3,000 years, but is considered to have been introduced from Southeast Asia at an earlier time (Bavappa *et al.*, 1982).

India is the leading world producer of betel nut; in 1980-1981 there were 184,500 ha under cultivation on plantations and small farms. Bavappa *et al.* (1982) devoted a chapter to alternative uses of betel nut. The endosperm contains tannin obtained as a by-product of preparing immature nuts for chewing and also fat comparable to coconut oil (see Table 9-1). Currently in India the husk is used as fuel or mulch although it is a source of fiber material suitable for hard board, paper board and pulp for paper. Leaf sheaths have traditional uses to make containers and represent a raw material with industrial applications to manufacture plyboard as well as disposable cups and plates. Betel nut palm leaves are used for thatch and organic manure and the stem wood made into a variety of articles such as waste paper baskets. The palm heart is the only food product from this palm.

Additional technical information on the betel nut palm can be found in a 1982 symposium proceedings (Shama Bhat and Radhakrishnan Nair, 1985). An extensive bibliography on the subject has also been published (Joshi and Ramachandra Reddy, 1982).

Coconut Palm *(Cocos nucifera)*

This is the most ubiquitous palm of tropical coastal areas and a species with which nearly everyone is familiar. Origin of the coconut has long been a matter of debate, but recent evidence (Schuiling and Harries, 1994) strongly suggests that the coconut originated in Malesia (the region between southeast Asia and Australasia), where wild types have been found.

From its origins, the coconut was dispersed by humans and apparently by ocean currents, for the nut will float and remain viable for three months or more. The chief criterion used in selecting coconuts for cultivation appears to have been larger nuts with a greater quantity of useable endosperm (coconut meat). A secondary factor may have been more rapid germination. When the coconut was domesticated is an equally difficult question to answer. Child (1964) cites evidence that coconuts were in India some 3,000 years ago but may, like the betel nut palm, have been introduced.

The coconut is often referred to as the "tree of life" because of its multitude of subsistence and commercial uses (Persley, 1992; Ohler, 1984). Figure 2-1 attempts to capture the remarkable utility of the coconut palm.[3] Tables 9-8 through 9-12 provide technical information on the major coconut products.

Production data for 1994 show that Indonesia, Philippines and India are the world's leading producers of coconuts (FAO, 1994). The coconut's primary commercial product is edible oil, derived from the endosperm, which is one of the world's most important vegetable oils. The Philippines is the largest producer of copra and coconut oil. In 1994 the Philippines exported 852,300 mt of coconut oil, which represented 56 percent of world exports of that commodity (Cocoinfo, 1995). Coconut is grown under plantation conditions but remains an important tree crop of the small farmer who often cultivates the palm in combination with other annual and perennial crops, and with livestock raising.

Numerous other studies on coconut not mentioned above have been published. A selection of technical information sources includes the proceedings of two international symposia (Nayar, 1983; Nair *et al.*, 1993); a lengthy monograph (Menon and Pandalai, 1958); a technical guide written for small landholders (Bourgoing, 1991); and a study of the combining of cattle raising and coconut growing (Reynolds, 1988).

Date Palm *(Phoenix dactylifera)*

This may represent the oldest domesticated palm, having originated most likely in Mesopotamia (modern Iraq) 5,000 to 10,000 years ago. The earlier time period would place the date palm among the most ancient of domesticated plants. Its history is obscured by the fact that species of *Phoenix* freely cross to produce hybrids thereby making it highly unlikely that wild populations of *Phoenix dactylifera* will ever be located.

In cultivation there exist numerous date varieties named for the fruit characteristics. Nutritional data on one of the date varieties is provided in Table 9-23. The date palm is also a multipurpose species, greatly relied upon for an array of products in its desert environments of

[3] A number of other palms could similarly be represented as "trees of life," among them are the date palm, African oil palm, palmyra palm, babassu palm and pejibaye palm.

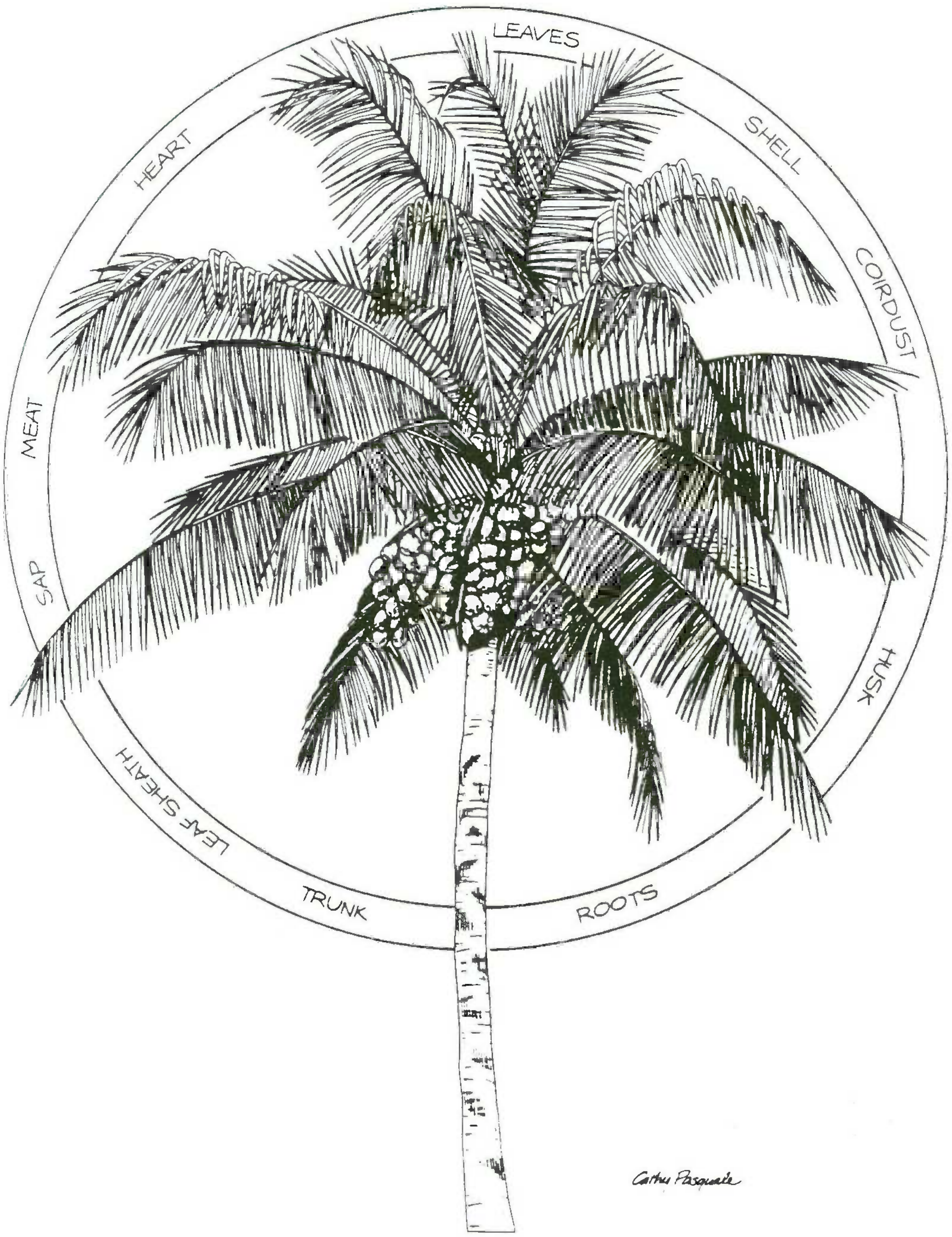

Figure 2-1. The coconut palm (*Cocos nucifera*); the tree of life. Examples of end-products, clockwise. Trunk - construction, wood, timber, plywood, furniture, picture frames, charcoal. Leaf Sheath - bags, hats, caps, slippers. Sap - toddy, arrak, vinegar, yeast. Meat -oil, desiccated coconut, copra cake, candy, coconut water, coconut cheese, coconut milk, jam. Heart - fresh and pickled palm heart, animal feed. Leaves - mats, hats, slippers, midrib brooms, draperies, bags, toothpicks, roof thatch, midrib furniture, fencing, fans, fuel, fodder. Shell - trays, buttons, jewelry, trinkets, charcoal, activated charcoal, wood preservative, bowls, fuel. Coirdust - coirdust coke, plasterboard, blocks, insulation, potting mix. Husk - rope, yarn, coir mat, coir fiber, brushes, cushion and mattress stuffing, compost, fuel. Roots - dye stuff, medicine, fuel.

limited vegetation resources (Dowson, 1982; Barreveld, 1993). In 1994, the three leading date-producing countries were Iran, Egypt and Iraq (FAO, 1994).

Other sources of technical information on the date palm include the following. Munier (1973) wrote a general study of the palm; there have been two international conferences on date palm (PFSODP, 1983; PSSODP, 1989); a lengthy bibliography of date palm has been compiled (Asif and Al-Ghamdi, 1986); and Dowson and Aten, 1962) describe date processing in detail.

African Oil Palm *(Elaeis guineensis)*

The African oil palm represents the most recently domesticated major palm. Within the past century this palm was brought into formal cultivation and developed to increase its mesocarp oil productivity through breeding of high-yielding hybrids. The oil palm is unsurpassed in yield of oil per unit area (Hartley, 1988). Unlike the three preceding examples, this palm exists in wild, semi-wild and cultivated states in West Africa where it originates, and also in Madagascar and East Africa. It is likewise cultivated extensively in Southeast Asia and to some degree in the New World tropics. Malaysia is the leading nation in production of this vegetable oil, followed by Indonesia and Nigeria (FAO, 1994).

More studies have been published on the African oil palm than any other palm. A sampling of titles includes: an economic study (Moll, 1987); a volume on research (Corley *et al.*, 1976); a general book on the palm (Surre and Ziller, 1963); and an example of one of several conference proceedings from Malaysia (Pusparajah and Chew Poh Soon, 1982).

Apart from being an outstanding plantation crop, the oil palm remains a multipurpose tree among local populations in Africa. It is a traditional source of cooking oil, palm wine and other useful products. Nutritional data on the fruit and oil are given in Tables 9-15 and 9-16. The African oil palm has potential for multipurpose utilization in those areas where it is grown on plantations.

Pejibaye *(Bactris gasipaes)*

The only example of a major domesticated palm from the American tropics is the pejibaye. (*Guilielma gasipaes* is a synonym). Pejibaye may have originated from wild relatives, possibly as a hybrid, in the southwestern portion of the Amazon Basin and has been widely dispersed by humans in South and Central America (Clement, 1988; Mora-Urpí, 1996). The palm was domesticated for either its mesocarp starch or oil; both mesocarp and endosperm are edible after being boiled. Tables 9-2 and 9-3 provide nutritional information on the fruit. The palm produces basal suckers that can be separated for propagation, or it can be grown from seed. Pejibaye has been under cultivation since ancient times in humid tropical areas at elevations from sea level to about 1,200 m.

Pre-Columbian uses of pejibaye were documented by Patiño (1963). In addition to the food uses already mentioned, the palm heart is eaten; the mesocarp pulp is fermented into an alcoholic beverage (chicha); male flowers are used as an ingredient in flavorings; leaves are employed for thatching and basketry; spines are made into needles; stem wood is cut to fashion bows, arrows, fishing poles, harpoons as well as flooring and paneling for houses; the roots have medicinal use as a vermicide.

Pejibaye has been the object of considerable development in Central and South America focused on improving fruit quality for human and animal consumption; it is also under cultivation as a commercial source of palm hearts. An international conference on the biology, agronomy and industrialization of pejibaye was held in 1991 in Peru (Mora-Urpí *et al.* 1993). Costa Rica is said to be the leading country in pejibaye cultivation, but data on area and production levels were not found. To date, pejibaye has not been commercially cultivated in Asia or Africa.

An unusual example of a domesticated palm is the coco cumbé palm (*Parajubaea cocoides*) of South America. It is known only as an ornamental tree in Andean cities and towns of Ecuador and Colombia. Moraes and Henderson (1990) postulate that coco cumbé probably originated from the wild *P. torallyi* which occurs in Bolivia.

Current palm products

The emphasis in this and subsequent chapters will be on products currently known to be derived from palms. (Examples of the array of artisanal palm products are shown in Figures 3-1, 3-2 and 3.3.)

With respect to more important economic species, some production statistics are available; however, as regards most of the minor palms no data are obtainable and anecdotal information must suffice. Focusing on present-day usage screens out exotic and outdated utilizations and permits a closer look at those palm products which have stood the test of time and remain of either subsistence or commercial value and hence have the greatest economic development potential. It needs to be stated that keeping a focus on palm products promotes re-examination of the current species as product sources as well as encourage assessment of new potential species not currently being exploited.

At this point, some observations regarding contemporary palm products are appropriate and some terminology needs to be introduced to give clarity to the discussions in this and future chapters. Obviously, not all of the possible products can be derived from a particular palm all of the time because one product typically precludes another in practical terms, or some products are mutually exclusive. All of the major domesticated palms, for example, are chiefly cultivated for products derived from their fruits; also, fruits are the most important product of a number of wild palms. Therefore, if fruit production is the prime objective, any other product extraction from the same tree that would retard or reduce fruit production should be avoided.

A clear example of a practice that will directly and adversely affect fruit production is tapping the inflorescence for sap; also, cutting leaves for basketry can impair the normal growth of the tree and reduce its resistance to pests and disease.

Palm Product Categories

In assessing and evaluating palms for the many products they can and do provide, it is instructive to consider the individual products as falling into three different general categories: primary products, secondary or by-products and salvage products.[4]

Primary Products. These are the chief commercial, or in some cases subsistence, products derived from a palm. Generally, primary product processing occurs at a point removed from actual harvesting. Vegetable oil obtained from a palm fruit, for example; or palm stem starch. An entire plant can represent the primary product when a palm is dug up in the wild and sold as a live ornamental plant.

Secondary and By-products. As defined and used here, by-products refer to useful items directly generated by processing of the primary product. Secondary products are those which require one step of processing from the primary product to reach the desired end product.

[4] An alternative more detailed classification method has been devised by Chandrasekharan (1995) to cover forest products other than wood in general.

Examples of by-products are coir fiber from the coconut mesocarp and press cake remaining after extracting seed oil, which can be fed to livestock. Some by-products, however, are of little if any economic value and even pose disposal problems if unsuitable for use as fertilizer or fuel. Arrak is an example of a secondary product; palm wine, the primary product, must first be produced before it can be distilled to produce arrak.

Salvage Products. This terminology characterizes those palm products that are indirectly generated as a result of harvesting the primary product. Products in this category are typically discarded at the harvesting site and are not transported to another location as part of primary processing. Extracting a palm heart from a wild tree kills it; any products subsequently used such as stem wood or leaves, are by this definition salvage palm products.

Salvage palm products may also derive from other activities such as the cutting of palms for some land-use related reason, replacement of senescent palms in plantations or palm damage or destruction due to natural causes such as a tropical cyclone. Living ornamental palms removed from a site to be cleared to save them from being destroyed would, under such circumstances, be considered salvage products.

As revealed in the foregoing discussion, either a primary product or a by-product may be considered to be a salvage product if it was indirectly generated. Distinctions of this type are worth making because of the information they provide about the origin of the raw material and the stability of their supply.

A second group of palm product terms is proposed to characterize the extent of processing a newly-harvested raw material requires to transform it into a commercial item. From the simple to the most complex, four stages of raw material processing were chosen for use in this study: immediate use, cottage-level processing, small-scale industrial processing and large-scale industrial processing.

Immediate Use. Products in this category require little if any processing before being utilized. Examples include palm fronds cut for use in thatching, coconut water drunk from the nut, palm heart consumed fresh and entire palm stems used in construction. The only tools needed to generate immediate-use products is an ax and machete.

Cottage-level Processing. Those products requiring a modest amount of processing fall into this category, so named because the activities typically are carried out in or near the residence of the individuals involved. The physical locations where palm processing activities are carried out also function as living space or for other purposes when the processing is not actively being carried on; there is no designated processing area exclusively devoted to cottage-level processing. Traditional extraction of palm mesocarp oil, weaving of mats and other leaf products, drying of date fruits and carving of vegetable ivory into toys are examples. Very few tools are required for this level of processing.

Small-scale Industrial Processing. The use of the term "industrial" in designating this category connotes some specialized equipment, a dedicated locality or structure where processing takes place and a number of skilled or trained workers. Actual processing activities may be manual, semi-mechanized or mechanized depending upon their requirements and the level of investment. Canning of palm hearts, distillation of palm wine to produce arrak and extraction of coconut oil from copra exemplify this category.

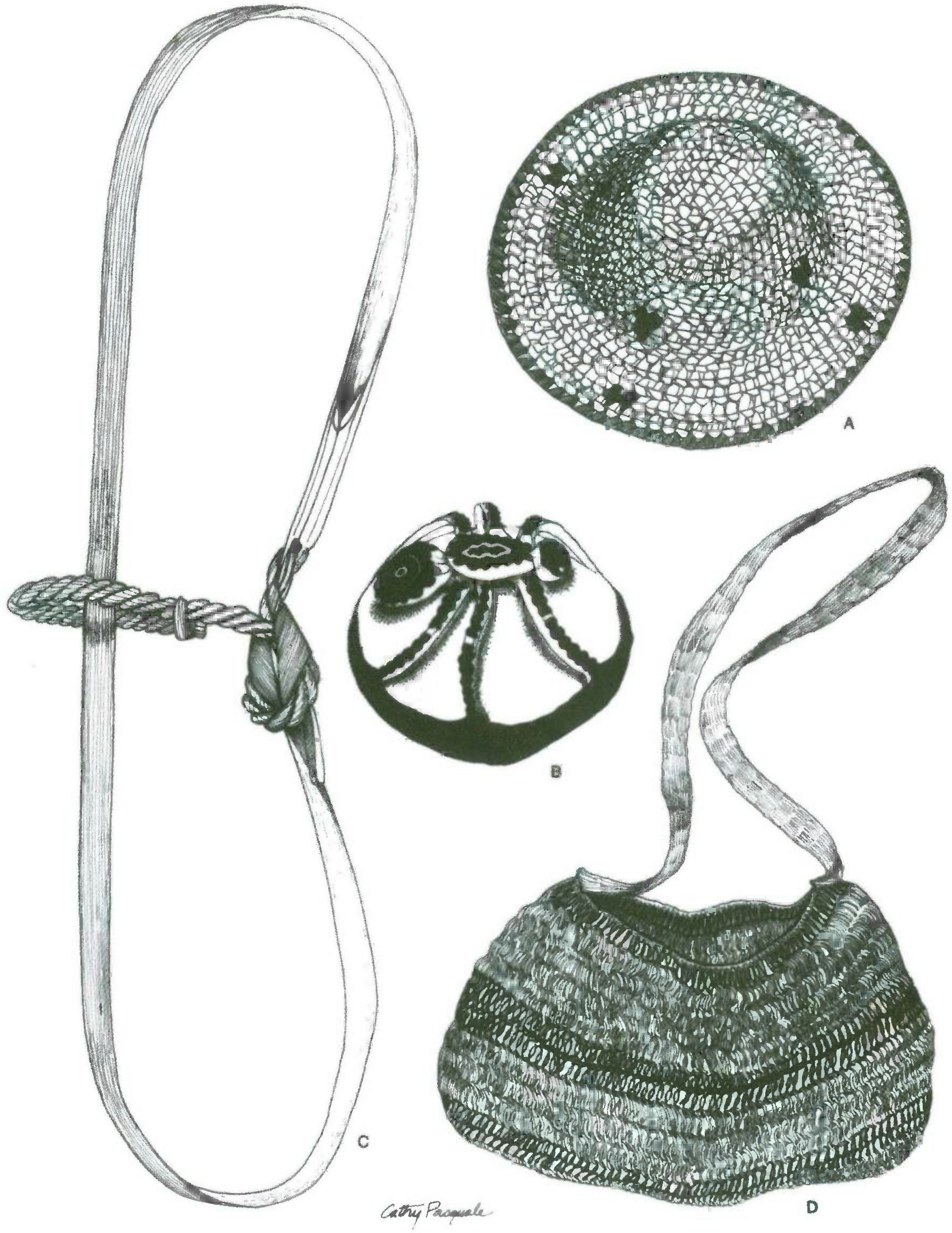

Figure 3-1. Artisanal Palm Products I. A. Hat woven from palmyra palm (*Borassus flabellifer*) leaf fiber, Tamil Nadu, India. B. Spider figure carved from seed of South American vegetable ivory palm (*Phytelephas macrocarpa*), Ecuador; 7.5 cm in diameter. C. Palm climbing belt made from African oil palm (*Elaeis guineensis*) petiole and leaf fiber, Guinea-Bissau; 108 cm long, 30 cm wide as illustrated. D. Shoulder bag with strap woven from chambira palm (*Astrocaryum chambira*) leaf fiber, Ecuador; 38 cm wide, 25 cm high.

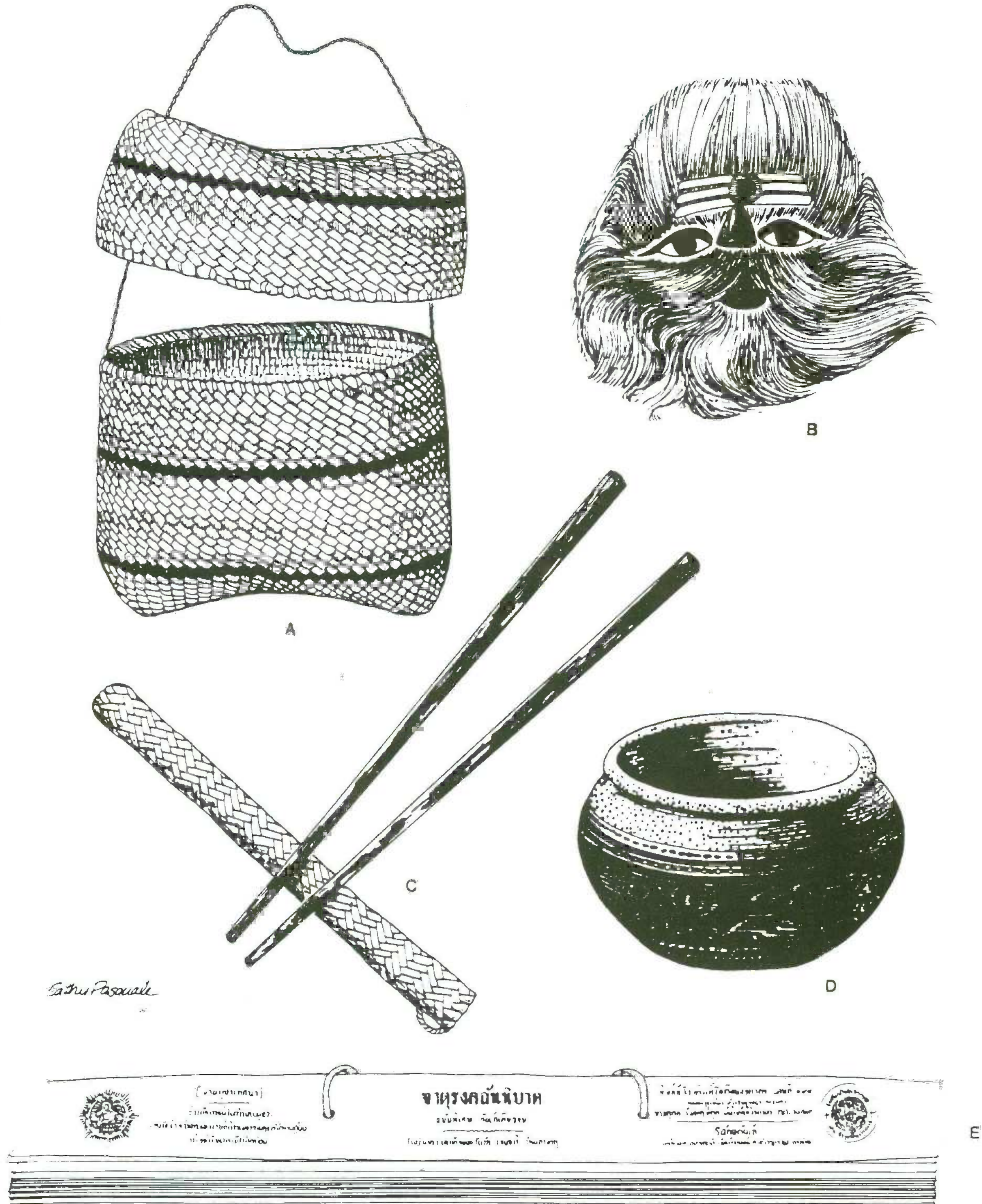

Figure 3-2. **Artisanal Palm Products II. A. Woven basket with attached overlapping lid, made of palmyra palm (*Borassus flabellifer*) leaf fiber, Casamance, Senegal; 20 cm high (closed), 24 cm wide. B. Head figure (a sadhu, a devotee who has renounced the world and gone to live in a remote area) made of the carved seed and mesocarp fiber of palmyra palm (*Borassus flabellifer*), Tamil Nadu, India; 10 x 10 cm. C. Chopsticks and case, chopsticks made of palmyra palm (*Borassus flabellifer*) stem wood, case raw material undetermined, Thailand; chopsticks 23 cm long. D. Turned bowl made of coconut palm (*Cocos nucifera*) stem wood, Philippines; 7.5 cm in diameter. E. Palm leaf writing (Buddhist Bible), made of talipot palm (*Corypha umbraculifera*) leaflets, Thailand; 51 cm long, 4.5 cm wide.**

Large-scale Industrial Processing. This category is distinguished from the preceding in terms of the greater physical size of the processing facility, a higher level of sophistication in the processing itself through more complicated mechanical devices and certain highly skilled workers to operate and maintain equipment. Examples which can be cited are African palm oil factories, the processing of export quality sago starch and integrated processing of fresh coconuts.

A number of palm products are associated with more than one of these four categories, depending upon local traditions and economic conditions. Salak fruits (*Salacca* spp.) are sold as fresh fruit (category 1) and preserved in tins or jars (category 3); rattan furniture making can be done on a small scale in the home (category 2) or in a small industrial facility (category 3); palm oil extraction can take place in the home (category 2) as well as in small- or large-scale factories (categories 3 and 4).

At this juncture, it is worthwhile to return to the major classes of palm products developed by Balick and Beck (1990) and discussed in Chapter 2. The authors presented a list of 388 palm products, which they broke down into 12 major classes. Selecting the leading palm products from the longer list permitted a reduction of the number to 84 principal products. Adhering to the organization into 12 major classes, they are presented in Table 3-1.

Table 3-1: Principal Palm Products

Beverages arrak (distilled spirits) milk substitute palm wine (toddy) soft drink flavorings sweet sap **Building Materials** fiber parquet flooring rattan thatch timber weaving material wood **Chemicals/Industrial Products** activated charcoal dye/resin fiber (coir) industrial oils paper pulp particle board polishes textile finishes upholstery stuffing vegetable ivory wax **Cosmetics/Hygiene** hairdressing soap	**Feeds** fodder forage press cake **Fertilizer** biofertilizer **Food** candy edible oil fruit ice cream/sherbet inflorescence (pacaya) kernels palm hearts preserves starch/sago sugar/jaggery syrup vinegar **Fuel** charcoal fuel oil fuel wood **Handicrafts** **Agricultural Implements** nets ropes	**Clothing** clothes hats **Furniture** hammock lamp shades mats rattan wickerware **Games/Toys** balls (rattan) chess pieces palm leaflet balls **Household Items** bags baskets brooms brushes cigarette papers coat hangers cups fans ladles purses twine walking sticks **Weapons/Hunting Tools** bows spears	**Jewelry** beads miniature carvings bracelets, rings and ear rings **Medicines/Rituals** masticatory **Ornamental Use** cut foliage houseplants ornamental tree seeds shade tree **Structure/Shelter** bridges fences floors nursery shade pilings posts rafters roofs utility poles walls

Source: after Balick and Beck, 1990.

Table 3-1 lists palm products which are not far removed industrially from the original raw material and are most likely to be encountered in natural resource management and development activities. A linkage exists between the product and the palm. Many manufactured products are omitted which have in their makeup some palm raw material, but the raw material has ceased to be recognizably from a palm. Palm oils, for example, are ingredients in the manufacture of hundreds of food and industrial products. To include such a wide spectrum of products in the current discussion would diverge from the intended focus on palms themselves as providers of useful commodity, in the original sense of the latter term.

Palm Product Matrix

A matrix of principal palm products is presented in Table 3-2. The contents of Table 3-1 were evaluated in terms of the general product categories and the processing categories to construct the matrix. Products were entered into the matrix in the same order as they appear in Table 3-1. Roman numerals across the top and letters along the left side permit shorthand reference to the products. The decision as to where within the matrix to place each product was made by taking into account the most common type of processing currently in practice; in a number of cases a product is placed in more than one box. For example, fiber is included in I-A, I-B, III-A and III-B, depending upon its source and end use; palm timber is placed in III-C and III-D since it is typically a salvage product requiring a small or large mill; edible oil appears in I-B, I-C, and I-D because it can be processed by various means depending upon the end use.

This matrix is provided with the hope it can serve to highlight the respective products in a way which conveys the relationship between product and processing levels.

Recent Related Development Trends

Beginning in the 1980s three new international development approaches arose which have fortuitously directed more attention to palm products. The three subjects are: agroforestry, non-wood (or non-timber) forest products and integrated product development. Because the future development of palm products needs to be linked to such broader issues, a brief discussion of each is appropriate.

Agroforestry

The emergence of agroforestry as a new international development approach is to help small farmers. It involves working to improve the overall productivity of mixed production systems which include various combinations of annual crops, perennial crops and livestock. Palms are common tree species in mixed small farming systems and agroforestry tends to favor such multipurpose trees; agroforestry's multidisciplinary approach has also been effective in emphasizing the broadest possible product use of palms (as with all plants and animals within the particular systems) for subsistence and commercial end uses.

Palms and their potential within agroforestry have been the focus of a number of research studies. Among them, Johnson (1983) did a general assessment of 52 multipurpose palms suitable for agroforestry systems; Liyanage (1983) studied the agroforestry role of the coconut palm in Sri Lanka; May *et al.* (1985) examined the babassu palm's (*Attalea speciosa*, syn. *Orbignya phalerata*) potential in Brazil; Clement (1989) produced a study of the pejibaye palm (*Bactris gasipaes*) in agroforestry systems; and Flach and Schuiling (1989) reviewed the cultivation of the sago palm (*Metroxylon sagu*) as an agroforestry tree.

Table 3-2: Matrix of Principal Palm Products

General Categories / Processing Categories	I. Primary Product	II. Secondary Product/ By-Product	III. Salvage Product
A. Immediate Use	palm wine; sweet sap; fiber; thatch; fruit; kernels; bridges; nursery shade; pilings; posts; rafters; roofs; utility poles	fodder; forage; press cake; biofertilizer; fuelwood; fences	fiber, thatch; fuelwood; house plants; shade trees; bridges; fences; pilings; posts; rafters; roofs; utility poles
B. Cottage-level Processing	milk substitute; fiber; rattan; weaving material; wood; upholstery stuffing; edible oil; fruit; kernels/copra; edible oil; nets; ropes; hats; hammocks; lamp shade; mats & rugs; rattan balls; chess pieces; bags; baskets; brooms; cups; fans; ladles; purses; twine; walking sticks; beads; miniature carvings; bows; spears; masticatory; cut foliage; seeds (ornamental); floors; walls	sugar/jaggery; syrup; charcoal	fiber; weaving material; wood; floors; walls
C. Small-scale Industrial Processing	soft drink flavor; industrial oils; upholstery stuffing; vegetable ivory; wax; hairdressings; soap; edible oil; inflorescence (pacaya); palm hearts; preserves; starch/sago; sugar/jaggery; syrup; hammocks; lamp shades; rattan wickerware; brushes; cigarette papers; coat hangers; bracelets, rings & ear rings	arrak; parquet flooring; activated charcoal; sugar/jaggary; syrup; charcoal; fiber (coir); candy; ice cream & sherbet; vinegar	parquet flooring; timber; palm hearts
D. Large-scale Industrial Processing	dye/resin; industrial oils; paper pulp; particle board; polishes; textile finishes; wax; soap; edible oil; starch/ sago; fuel oil	fiber (coir)	parquet flooring; timber

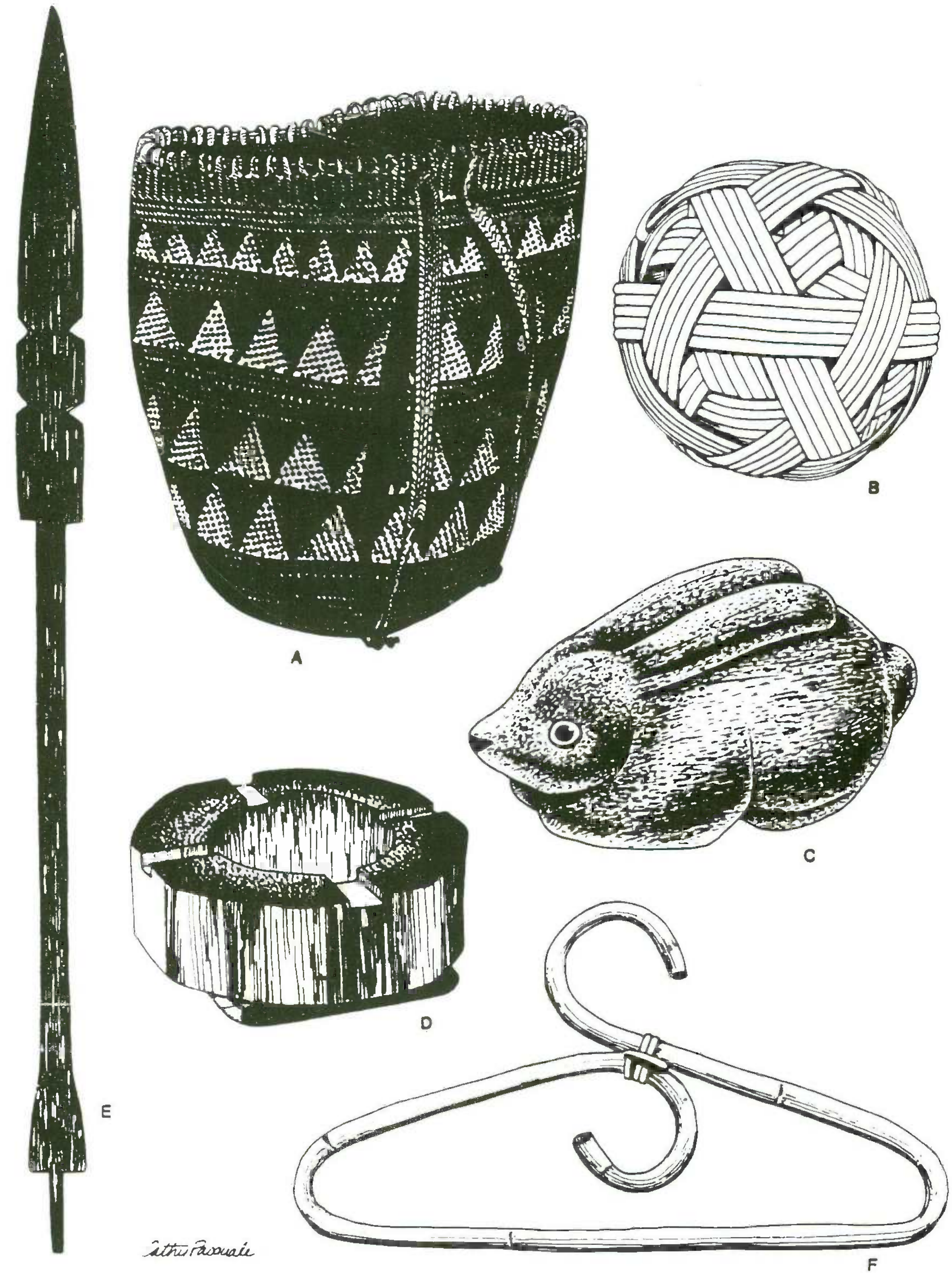

Figure 3-3. Artisanal Palm Products III. A. Rattan palm (likely *Calamus* sp.) shoulder bag, Sarawak, Malaysia; 36 cm high, 21 cm in diameter. B. Rattan palm (likely *Calamus* sp.) ball, Peninsular Malaysia; 12 cm in diameter. C. Coco bunny, made of coconut palm (*Cocos nucifera*) husk, Guyana; 17 cm long. D. Ashtray, made of peach palm (*Bactris gasipaes*) stem wood, Ecuador; 12 cm in diameter. E. Spear made of peach palm (*Bactris gasipaes*) stem wood, Peru; 102 cm long. F. Rattan palm (likely *Calamus* sp.) coat hanger, country of origin unknown; 41 cm wide, 23 cm high.

Non-Wood Forest Products

The emergence of non-wood forest products as an international development issue derives from attempts to transform traditional high grading of tropical timber into sustainable forest management. Sustainable forest management is only feasible if wood and non-wood products are given full consideration and local needs are acknowledged to be as important as timber or lumber exports. Although the designation "non-wood" appears to exclude them, palm wood, rattans, and bamboo are typically included among non-wood forest products because they are not considered by foresters to be either traditional wood or timber.

Pantropically, non-wood forest products are of local importance as food and raw material sources. An excellent overview of the subject can be found in Nepstad and Schwartzman (1992). Palms represent one of the most important plant families of non-wood forest products. Two examples of studies containing good information on palms as forest products are by Beer and McDermott (1989), who point out the importance of rattans and edible palm products in southeast Asia; and Falconer and Koppell (1990) who document the significance of palms among the forests products in West Africa.

Integrated Product Development

Integrated product development, as used here, refers to an industrial approach which views primary products, by-products (including waste products) together in seeking ways to achieve greater overall productivity and profit.

As demonstrated in this chapter, individual palm parts are sources of one or more raw materials which can be used in various ways for commercial purposes; therefore, an integrated approach to product development and processing should follow a whole fruit processing approach and include the valorization of by-products to the greatest extent possible. To a major degree, attention has been drawn to integrated product development for practical reasons, with the agroindustries associated with the major domesticated palms taking the lead.

Processing the whole fruit of any of the cocoid palms[5], the oil palms, is an excellent case in point because oil extraction has the potential of generating several useful end products. Depending upon the individual species of oil palm, products include: edible oil, edible starch, mesocarp pulp, edible kernels, industrial oil, dry distillation of husks to obtain acetates, press cake for livestock and shells for conversion to activated charcoal or directly for fuel.

A model of potential applicability to certain of the other oil palms is represented by modern coconut processing technology. This technology takes a whole fruit approach and adopts a wet processing procedure for coconut endosperm which eliminates the traditional intermediary step of making copra prior to producing coconut oil (Hagenmaier, 1980).

In Malaysia, the African oil palm industry is going a step farther and considering the entire palm. Estimates are that in the late 1990s Malaysia will be replanting over 80,000 ha of oil palm per year (Jamil *et al.*, 1987). The industry must deal with huge quantities of oil palm stems

[5] Cocoid palms are those which, according to Uhl and Dransfield (1987), belong to the Cocoeae tribe within the Arecoideae subfamily. All of the oil-bearing palms are included, among them the coconut *(Cocos nucifera)*, African oil palm *(Elaeis guineensis)* and pejibaye *(Bactris gasipaes)*.

and fronds resulting from replanting, replacement of dead palms and pruning of leaves. Husin *et al.* (1986) estimate that in the late 1990s about 26 million metric tons of oil palm stem and leaf dry matter will be generated per annum. Under study are conversion into lumber, fuel, pulp and paper, reconstituted board and animal feed (Shaari *et al.*, 1991; Khoo *et al.*, 1991). Technologies developed to solve this problem of the African oil palm will have implications throughout the palm family.

Major date growing countries are also considering date palm cultivation in a broader product context. The recent book by Barreveld (1993) on the date palm devotes a major chapter to traditional palm products other than dates.

To conclude this discussion of recent development trends relative to palm products, it can be restated that numerous palm tree species already provide, or have the potential to provide, more than one subsistence or commercial product; such trees are appropriately referred to as multipurpose palms. Within the framework of natural resource management, sustainable forest management or regional development efforts, it is imperative that the full spectrum of useful palm products from any one palm tree species be taken into account. In that way commercially-valuable and subsistence products can be generated for industrial enterprises and for the benefit of local peoples.

Asian region

The Asian region is an immense area containing the greatest palm species diversity in the world along with the oldest and most assorted types of palm utilization. For the purpose of this chapter, Asia is defined geographically as stretching from Pakistan on the west to Indonesia on the east and north to include China.

Across the region, the level of knowledge about palm systematics and documented examples of particular palm products ranges from excellent to fragmentary. Malaysia represents a country in the former category, Vietnam one of the latter. A World Wide Fund for Nature Asian palm project which focused on India, Indonesia, Malaysia and the Philippines summarized old and generated much new information on conservation and utilization (Johnson, 1991b).

Chapter 4 has been broken down into three separate but interrelated parts to simplify dealing with such a large number of palms. The first part is concerned with the palms of South Asia, i.e. India, Bangladesh, and Sri Lanka; and to a minor degree with Pakistan, Nepal, Bhutan and Sikkim. Part two covers Southeast Asian palms and includes the countries from Myanmar eastward to Indonesia and the Philippines, and southern China. These two regional treatments exclude rattans which are dealt with as a group in a separate third section of this chapter.

The approach in this and the following regional chapters links together utilization and conservation because without such a linkage sustainable resource use can never be achieved. The conservation status of a utilized wild palm is a vital piece of information in any consideration of continued or expanded exploitation. For convenience, palm species are considered to be in one of three categories: threatened, non-threatened or unknown. Except for rattans in this chapter, utilized palms with an unknown conservation status are not discussed.

South Asia

The utilized native palms of this region, excluding rattans, were divided into two groups based on their conservation status.

Threatened South Asian Palms

Thirteen species of native South Asian palms were found to be both under threat in the wild and utilized by local people. Information on these palms is presented in Table 4-1. The strong relationship between sensitive island habitats and threatened palms is in evidence in Table 4-1 where half the species included occur on islands. One island endemic is also monotypic (i.e. a genus with a single species): *Loxococcus rupicola* in Sri Lanka.

Discussion

Perusal of the palm products in Table 4-1 shows that leaves, petioles and stems are exploited for a variety of end-uses; and fruits, sap and starch provide edible products. All these existing patterns of utilization are for subsistence purposes alone. Were the rattans included, that would not be the case.

Table 4-1: Threatened South Asian Palms with Reported Uses (excluding rattans)

Scientific Names	Selected Local Names[1]	Distribution[2]	Products/Uses
Areca concinna	len-teri	Sri Lanka (endemic)	nuts as betel substitute
Arenga wightii	dhudasal, alam panei	India: Kerala, Karnataka, Tamil Nadu (endemic to India)	peduncle tapped for sap
Bentinckia nicobarica	Nicobar bentinckia palm ?	India: Great Nicobar Island (endemic)	leaves for thatching and stems as hut pillars
Corypha umbraculifera	condapana; tala	India: Kerala; Sri Lanka	leaves used as umbrellas; edible starch from stem; seeds to make beads; formerly, leaf blades as writing material
Hyphaene dichotoma (syn. H. indica)	oka mundel (Indian doum palm)	India: Gujarat, Maharashtra (endemic to India)	fibrous fruit mesocarp (see Table 9-20 for composition) & unripe kernel eaten; leaves for thatching; stem wood for posts, roof beams & fuel
Licuala peltata	selai pathi, mota pathi	India: Northeast & Andaman Islands; Bangaldesh; Sikkim	leaves for thatching & as rain hats; split leaf blades woven into baskets, mats, etc.; stems as pillars
Livistona jenkinsiana	toko pat, takau-araung	India: Northeast; Sikkim	fresh nuts used as masticatory; leaves for thatching & rain hats; stems for hut construction
Loxococcus rupicola (monotypic)	dotalu	Sri Lanka (endemic)	edible palm heart
Oncosperma fasciculatum	katu-kitul	Sri Lanka (endemic)	stem wood for construction ?
Phoenix rupicola	cliff date palm ?	India: Arunachal Pradesh, Meghalaya; Sikkim	starch extracted from stem as famine food
1) Pinanga dicksonii; 2) P. manii		1) India: Kerala, Tamil Nadu (endemic to India); 2) India: Andaman & Nicobar Islands (endemic)	1 & 2) stems used for fencing & posts; leaves for thatching; nuts used as betel substitute
Wallichia disticha	tashe	India: Arunachal Pradesh, West Bengal; Bangladesh, Bhutan, Sikkim	edible stem starch

Notes: 1. Other local names are given in some of the sources cited.
2. Distribution is within the South Asian region as defined; some species also occur elsewhere.

Sources: Basu, 1991; Basu and Chakraverty, 1994; Blatter, 1926; De Zoysa, 1996; Mahabale, 1982; Malik, 1984; Mathew and Abraham, 1994; Rolla and Joseph, 1962.

From a utilization standpoint, it should be possible to reduce the exploitation of these threatened palms inasmuch as there exist inexpensive alternative sources of the palm products.

A combination of utilization and habitat destruction appears to have led to the extinction in the wild of the tara palm (*Corypha taliera*) endemic to West Bengal, India. Leaves were formerly used for tying rafters of houses and leaf blades employed as writing material. Although no longer found in its natural habitat, the tara palm is under cultivation in botanic gardens, affording an opportunity for a reintroduction effort.

On a more positive note, recognition in Thailand of the overexploitation of the naturalized talipot palm (*Corphya umbraculifera*) has led to its inclusion in a list of the protected non-wood forest products. Under forest regulations, small amounts of protected NWFPs can be harvested for subsistence needs, but any commercial exploitation requires a permit (Subansenee, 1995).

Non-threatened South Asian Palms

About the same number of economic palms are not under threat in South Asia. *Nypa fruticans* is included as one of the dozen species in Table 4-2 despite the fact that it is threatened in Sri Lanka and should be protected there. Sri Lanka represents the western limit of the palm's natural range, where it occurs only in a small estuarine area of the island.

Discussion

The small number of species in Table 4-2 should not be construed as an indication that palms are of minor significance in the region. To the contrary, palms are quite important and provide a great range of different products for subsistence and commercial purposes.

Arenga pinnata, Borassus flabellifer and *Phoenix sylvestris* are all multipurpose species that individually approach the coconut palm in terms of overall utility. One product common to the three palms is sap which is consumed in the form of soft or hard beverages, fermented into vinegar or boiled down to yield palm sugar which is comparable to cane or beet sugar. Over many centuries, tapping techniques have been developed which enhance sap flow while minimizing the negative impact on the individual tree. The monotypic *Nypa fruticans* is also a source of sweet sap but it is not as important in South Asia as it is Southeast Asia.

With the exception of *Areca triandra*, all the palms in Table 4-2 are exploited for leaf products of one kind or another. Cottage industries producing hats, bags, mats and other products woven from young palm leaves are common in South Asia and the products are of the highest quality.

The importance of non-wood forest products is officially recognized in Bangladesh where *Nypa fruticans* and *Phoenix paludosa* harvest requires permits from the Forest Department (Basit, 1995).

It is obvious that many if not most of these non-threatened palms could be brought under better management and the production of palm products increased on a sustainable basis. Research along these lines is being carried out in South India at the Kerala Forest Research Institute where a project entitled "Palm resources of Kerala, their conservation and utilization," is in progress under the direction of C. Renuka.

Table 4-2: Non-threatened South Asian Palms with Reported Uses (excluding rattans)

Scientific Names	Selected Local Names[1]	Distribution[2]	Products/Uses
Areca triandra var. triandra	bon gua	India: Northeast, Andaman Islands	nuts used as betel substitute
Arenga pinnata	gomuti (sugar palm)	India: Eastern, Andaman Islands; Bangladesh; Sri Lanka	multipurpose palm: sap for sugar & other products; edible immature seed (fresh mesocarp of ripe fruit is filled with irritant needle crystals); edible starch from stem; edible palm heart; leaf base fiber for fish nets, etc.; leaflets for weaving baskets, etc.; stem wood for various uses
Borassus flabellifer	tal, palmyra	India, Bangladesh, Sri Lanka	multipurpose palm: sap for toddy & sugar; edible mesocarp pulp; edible unripe endosperm; edible palm heart; leaves for thatching; leaflets for weaving; stem wood for construction & fuel; see Tables 9-4 and 9-5 for composition of sap & sugar
1) *Caryota mitis;* 2) *C. urens*	2) bherli mad, kittul	1) India: Andaman Islands; 2) India, Bangladesh, Nepal, Sri Lanka	1) edible starch from stem; leaves for thatching, weaving & decoration; ripe fruits contain irritant poison; 2) leaf-sheath fiber to make rope, etc.; edible starch from stem; sap for toddy & sugar; edible palm heart; seeds as masticatory & to make beads
Licuala spinosa	jungli selai	India: Andaman Islands	leaves for thatching & clothing
Nypa fruticans (monotypic)	golpata	India: Orissa, West Bengal, Andaman Islands; Bangladesh; Sri Lanka	leaves for thatching, sap from inflorescence for beverage or sugar; mature seeds suitable for vegetable ivory
1) *Phoenix acaulis;* 2) *P. farinifera;* 3) *P. loureirii;* 4) *P. paludosa;* 5) *P. sylvestris;* 6) *P. zeylanica*	1) khajur; 3) khajoor; 4) hantal; 5) thakil (sugar date palm); 6) indi	1) India: Meghalaya, Uttar Pradesh; Nepal; Sikkim; 2) India: Tamil Nadu; Sri Lanka; 3) India: Uttar Pradesh, Kerala; Nepal; Pakistan; 4) India: Bengal, Orissa, Andaman Islands; Bangladesh; 5) India (common); Nepal; 6) Sri Lanka	1) edible fruit, heart & stem starch; leaf fiber for ropes; leaves for thatching; 2) edible fruit; leaflets woven into sleeping mats; split petiole to make baskets; edible starch from stem; 3) leaves woven into mats & to make brooms; edible fruit; starch from stem; medicinal use of palm heart; 4) stem wood for construction; leaves for thatching & to make brooms; leaf fiber to make rope; edible fruit?; 5) multipurpose palm: sap from stem as beverage & to make sugar; edible fruit; leaves made into brooms or woven into baskets & mats; stem wood for fuel; 6) edible fruit; leaves woven into mats and baskets

Notes:
1. Other local names are given in some of the sources cited.
2. Distribution is within the South Asian region as defined; some species also occur elsewhere.

Sources: References for Table 4-1 and in addition: Basit, 1995; Davis, 1972, 1988; Davis and Joel, 1989; Davis and Johnson, 1987; De Zoysa, 1992; Dissanayake, 1986; Francis, 1984; Ghosh and Ghose, 1995; Kovoor, 1983; Miller, 1964; Padmanabhan and Sudhersan, 1988.

If information were available on its conservation status, the useful mazari palm (*Nannorrhops ritchiana*) would probably be included in Table 4-2. This monotypic palm is native to arid portions of northwestern India, Pakistan and westward to the Arabian Peninsula, and has a variety of uses. For example: leaves are woven into mats and baskets, made into fans and brushes, and have medicinal use; stems, leaves and petioles serve as fuel; young leaves and inflorescences, as well as the heart and fruit are eaten; and seeds are made into beads.

Southeast Asia

Native palms currently reported to be exploited in Southeast Asia also have been broken down into threatened and non-threatened species lists. Considerable knowledge gaps exist about palms in this very diverse area, especially in Myanmar, Thailand, the countries of former Indochina and the Indonesian province of Irian Jaya on the island of New Guinea.

Threatened Southeast Asian Palms

A total of 24 palm species, belonging to 13 genera, are listed in Table 4-3. More than one-half of these species are endemic palms and most countries in the region are represented. They are, therefore, fairly representative of the situation.

Three genera are among the largest non-rattan palm genera in Asia: *Pinanga* has around 120; *Licuala* about 105 and *Areca* approximately 55 species. Each genus has numerous species for which conservation data are lacking and there is justifiable concern that when data are available the results will be alarming and show that most are also threatened. The reason for this concern is that the habitat of all three genera is the undergrowth of tropical forests, and Southeast Asian forests are under intense pressure from logging and shifting cultivation, resulting in deforestation and degradation on a massive scale.

Another aspect of the genera in Table 4-3 is that several (e.g. *Areca, Arenga, Caryota, Eugeissona, Licuala, Livistona, Phoenix* and *Pinanga*) also appear in Table 4-4 among the listing of non-threatened palms. Inasmuch as palm genera have distinctive individual habitat requirements, the linkage between threatened and non-threatened congeneric species needs to be kept in mind in promoting palm products. In other words, it is not sufficient to know that an individual species is not threatened; taking into account other species (which often yield similar products) is the safest approach to take.

Discussion

Food and non-food products are about equally represented in Table 4-3 and appear to be solely for subsistence purposes. Some palm utilizations are relatively benign, such as collecting the fruits of *Pinanga* spp. and other *Areca* spp. as a substitute for the cultivated betel nut (*Areca catechu*). Leaf harvest for thatching and other end uses may or may not be of concern, depending upon the intensity of the practices.

Table 4-3: Threatened Southeast Asian Palms with Reported Uses (excluding rattans)

Scientific Names	Selected Local Names[1]	Distribution[2]	Products/Uses
1) *Areca hutchinsoniana;* 2) *A. ipot;* 3) *A. macrocarpa;* 4) *A. parens*	1) bunga; 2) bungang-ipot; 3) bungang-lakihan; 4) takobtob	1) Philippines: Mindanao; 2) Luzon; 3) Zamboanga; 4) Luzon (each species is endemic)	nuts as occasional betel substitute; edible palm heart
Arenga hastata	mudor	Borneo, Peninsular Malaysia	leaf sheath as knife sheath
Borassodendron borneense	bidang	Borneo (endemic)	edible palm heart & immature fruit endosperm; stem sawn into boards for house construction
1) *Caryota no;* 2) *C. rumphiana*	1) entibap mudol; 2) takipan	1) Borneo (endemic); 2) Philippines: Luzon; Indonesia: Moluccas, Irian Jaya	1) edible stem starch & palm heart; leaf-sheath fiber for tinder & to make fishing line, etc.; 2) edible palm heart
Eugeissona brachystachys	tahan bertam	Peninsular Malaysia (endemic)	edible stem starch; leaves for thatching; edible immature endosperm; petioles to make darts, etc.
Heterospathe elmeri		Philippines: Camiguin (endemic)	nuts as betel substitute; edible palm heart
1) *Johannesteijsmannia altifrons;* 2) *J. lanceolata, J. magnifica, J. perakensis*	1) sal	1) Sarawak, Peninsular Malaysia, Sumatra, Thailand; 2) Peninsular Malaysia (all endemic)	1) leaves for thatching roofs & walls; fruits in medicine; 2) seed collected for ornamental planting
1) *Licuala fatua;* 2) *L. orbicularis*	1) cây trui; 2) biru balat	1) Vietnam: Ha Nam Ninh, Tua Thien (endemic); 2) Sarawak (endemic ?)	1) stems to make tool handles; 2) leaves for wrapping, making hats, umbrellas & thatching
Livistona robinsoniana		Philippines: Polillo (endemic)	leaves for thatching; stems as posts
Orania sylvicola	iwul	Indonesia: Java, Sumatra; Malaysia: Peninsular, Sarawak; Thailand	stem wood for construction; poisonous heart & fruit (said to apply to all *Orania* species)
Phoenix hanceana var. philippinensis	voyavoy	Philippines: Batanes Islands (endemic)	leaves to make thatched raincoat; leaflets woven into mats
1) *Pholidocarpus kingianus;* 2) *P. macrocarpus*	2) serdang	1) Peninsular Malaysia (endemic); 2) Peninsular Malaysia, Thailand	1 & 2) stems for pilings & timber; leaves for thatching
1) *Pinanga cochinchinensis;* 2) *P. duperreana;* 3) *P. punicea var. punicea*	1) cao cuóc chuóc; 2) sla condor	1) Vietnam (endemic); 2) Kampuchea, Laos, Vietnam; 3) Indonesia: Moluccas, Irian Jaya	1) fruit used as fish bait; leaves to make mats & sails; 2) edible palm heart; nuts as betel substitute; 3) leaves to make mats & sails

Notes: 1. Other local names are given in some of the sources cited.
2. Distribution is within the Southeast Asian region as defined; some species also occur elsewhere.

Sources: Brown and Merrill, 1919; Burkill, 1966; Davis, 1988; Fernando, 1990; Gagnepain, 1937; Guzman and Fernando, 1986; Kiew, 1991; Madulid, 1991a,b; Mogea, 1991; Pearce, 1991, 1994; Uhl and Dransfield, 1987; Whitmore, 1973.

The spectacular umbrella leaf palm (*Johannesteijsmannia altifrons*) is a case in point. Referred to as nature's answer to corrugated iron, the enormous undivided leaves are up to 3 m long and 1 m wide. Highly prized for thatching roofs and walls (which last 3-4 years) the leaves are cut and sold for this purpose in Peninsular Malaysia. Providing 2-3 leaves are left on each plant, the practice may be sustainable (Kiew, 1991). However, almost nothing is known about the flowering and fruiting characteristics of palms in this genus; periodic leaf harvest could, over time, adversely affect fruit production and lead to a decline in natural regeneration. This biological factor is apart from habitat destruction; these palms require an understory forest habitat. In addition, illegal seed collection and export of these highly-desirable ornamental palms is having detrimental effects on the wild populations in Peninsular Malaysia.

The most destructive exploitation occurs in extracting edible palm hearts and edible stem starch for the trees are killed in the process. In some instances it appears that palm heart extraction is associated with felling a tree for some other purposes such as to obtain stem wood or starch; it is therefore sometimes a "salvage" product, to use the term introduced in Chapter 3.

By and large, the products derived from palms in Table 4-3 are for subsistence needs and alternative sources should be suggested where the current exploitation is having a serious negative impact on wild palm populations.

Non-threatened Southeast Asian Palms

The full range of palm utilization in Southeast Asia is represented in Table 4-4 which lists 41 species in 18 genera. Geographic coverage is complete as every country in the region is included, although with varying completeness. The table is a clear indication of the fact that Southeast Asia has both the highest palm species diversity and the greatest variety of palm utilization of anywhere in the world.

Arenga, Phoenix, Pinanga and *Salacca* species account for around one-half of the entries in the table. The genera *Eleiodoxa* and *Eugeissona* occur only in Southeast Asia.

Discussion

Table 4-4 includes six major economic palm species each worthy of individual attention. They are: *Arenga pinnata, Borassus flabellifer, Corypha utan, Metroxylon sagu, Nypa fruticans* and *Salacca zalacca*.

Arenga pinnata. The aren or sugar palm is a multipurpose species which finds its greatest utility in Southeast Asia. Miller (1964) provides an excellent summary of the economic uses of the palm. Known chiefly as a source of sap derived from tapping the inflorescence to make sugar and a provider of edible starch from the trunk, the sugar palm grows in humid forest areas and under drier conditions. The fruit of the sugar palm fruit merits special attention because although the immature endosperm is edible, the mesocarp pulp of ripe fruits contains irritating needle crystals which make them inedible.

The growth habit of the sugar palm is notable with respect to its products. The palm is hapazanthic, i.e. it flowers at about 10 years of age and dies. The harvestable quantities of sap and starch represent the tree's stored nutrients for the protracted flowering and fruiting which extends over a period of around two years.

Table 4-4: Non-threatened Southeast Asian Palms with Reported Uses (excluding rattans)

Scientific Names	Selected Local Names[1]	Distribution[2]	Products/Uses
1) *Areca macrocalyx;* 2) *Areca triandra var. triandra*	2) câu rúng (Viet)	1) Indonesia: Irian Jaya; 2) Indonesia, Peninsular Malaysia, Vietnam, Laos, Kampuchea, Thailand, Myanmar, Philippines	1) (inferred) nut as betel substitute; edible heart; leaves for thatch; 2) nut as betel substitute
1) *Arenga microcarpa;* 2) *A. obtusifolia;* 3) *A. pinnata;* 4) *A. tremula var. tremula;* 5) *A. undulatifolia*	2) langkap (Pen Mal); 3) aren; 4) dumayaka (Phil); 5) aping	1) Irian Jaya; 2) Peninsular Malaysia; Indonesia: Sumatra, Java; 3) widespread; 4) Philippines: Luzon; 5) Borneo; Philippines: Sulu; Indonesia: Sulawesi	1) edible palm heart; 2) edible palm heart & endosperm; 3) multipurpose palm: sap for sugar & other products; edible immature seed (fresh mesocarp of ripe fruit is filled with irritant needle crystals); edible stem starch; palm heart; leaf-base fiber for fish nets, etc.; leaflets for weaving baskets, etc.; stem wood for various uses; 4) petiole split to make baskets; 5) edible stem starch (Sarawak) & other products
Borassus flabellifer (syn. B. sundaicus)	lontar	widespread as native & cultivated species	multipurpose palm: sap for toddy & sugar; edible mesocarp pulp; edible unripe endosperm; edible palm heart; leaves for thatching; leaflets for weaving; stem wood for construction & fuel
1) *Caryota mitis;* 2) *C. rumphiana var. rumphiana*	1) mudor (Sar); 2) sagu moro (Irian)	1) Brunei; Malaysia: Peninsular, Sarawak; Myanmar; Indonesia: Java, Sulawesi; Thailand; Vietnam; China: Hainan Island (where it is threatened); 2) Indonesia: Irian Jaya, Moluccas	1 & 2) edible palm heart & stem starch
1) *Corypha lecomtei;* 2) *C. utan (syn. C. elata)*	1) la buong (Viet); 2) gebang, buri	1) Vietnam; Thailand; 2) Indonesia: Java, Kalimantan, Sulawesi, Sumatra; Malaysia: Peninsular, Sabah; Philippines	1) leaves for thatching & weaving mats, sails and bags; petiole to make arrows & walking sticks; edible stem starch; fruits as fish poison; 2) stem starch as food & medicine; sap from inflorescence for wine & sugar; edible palm heart; edible fruit (see Table 9-14 for nutritional composition); leaves for thatching & weaving mats, baskets & fans.
Eleiodoxa conferta	kelubi	Malaysia: Peninsular, Sarawak, Sabah; Brunei; Singapore; Indonesia: Kalimantan, Sumatra; Thailand	fruit used to make pickles & relishes; edible palm heart; leaves for thatching & to make mats

Scientific Names	Selected Local Names[1]	Distribution[2]	Products/Uses
1) *Eugeissona tristis;* 2) *E. utilis*	1) bertam; 2) nanga	1) Peninsular Malaysia; Thailand; 2) Borneo	1) leaves for thatching & to make fish traps; edible immature fruit; 2) stem starch; edible palm heart; purple flower pollen used as condiment; leaves for thatching; split petiole to make darts
Gulubia costata	limbun	Indonesia: Irian Jaya, Moluccas	stems for floor and wall boards; inflorescence used as brush; leaf sheath of crown shaft folded to make buckets & baskets and to wrap food
1) *Licuala peltata;* 2) *L. spinosa*	1 & 2) palas (Indon)	1) Thailand; Myanmar; 2) Malaysia: Peninsular, Sarawak, Sabah; Brunei; Indonesia: Java, Sumatra; Philippines; China; Thailand	1 & 2) leaves for thatching & to wrap food
Livistona rotundifolia var. rotundifolia	serdang	Indonesia: Moluccas, Sulawesi; Borneo; Philippines	leaves for thatching and to wrap food
Metroxylon sagu f. longispinum	sagu	Indonesia: Irian Jaya, Moluccas; Philippines: Mindanao	stem starch; leaves for thatching; petioles & stem wood for construction, etc.
Nypa fruticans (monotypic)	nipah, atap	widespread in coastal areas	leaves for thatching & weaving; sap from inflorescence for beverage, sugar or alcohol; immature seeds edible, mature seeds suitable for vegetable ivory; leaflet epidermis to make cigarette wrapper
1) *Oncosperma horridum;* 2) *O. tigillarium*	1) bayas (Malay), bayeh (Indon); 2) nibong (Malay)	1) Malaysia: Peninsular, Sarawak, Sabah; Brunei; Indonesia: Kalimantan, Sumatra; Philippines; Thailand; 2) Malaysia: Peninsular, Sarawak, Sabah; Brunei; Indonesia: Java, Kalimantan, Sumatra; Philippines; Indochina?	1 & 2) whole stems resistant to sea water used in construction; stems split into strips to make fish traps, floor & wall coverings, etc.; leaves to weave baskets; nuts as betel substitute; edible palm heart

Scientific Names	Selected Local Names[1]	Distribution[2]	Products/Uses
1) *Phoenix acaulis;* 2) *P. loureirii;* 3) *P. paludosa;* 4) *P. sylvestris*	2) bua cha la (Viet); 3) cây cut chuôt (Viet)	1) Myanmar; Thailand; 2) China; Thailand; Vietnam; 3) Peninsular Malaysia; Indonesia: Sumatra; Thailand; Vietnam; 4) Myanmar	1) edible fruit; leaf fiber for ropes; leaves for thatching; 2) edible fruit; other uses likely; 3) edible fruit and palm heart; leaves for temporary fencing; 4) (inferred) multipurpose palm: sap from stem as beverage & to make sugar; edible fruit; leaves made into brooms or woven into baskets & mats; stem wood for fuel
Pigafetta filaris	wanga	Indonesia: Irian Jaya, Moluccas, Sulawesi	whole stems used in construction, split or sawn into flooring & hollowed for water pipe
1) *Pinanga caesia;* 2) *P. coronata;* 3) *P. crassipes;* 4) *P. mooreana;* 5) *P. schortechinii;* 6) *P. simplicifrons*	pinang in general	1) Indonesia: Sulawesi (endemic); 2) Indonesia: Java, Sumatra; 3) Malaysia: Sarawak, Sabah; 4) Malaysia: Sarawak; Brunei; 5) Malaysia: Peninsular; Thailand; 6) Malaysia: Peninsular, Sarawak; Brunei; Indonesia: Sumatra	(in general) leaves for thatching; stems as laths; nuts sometimes chewed as betel substitute
1) *Salacca affinis;* 2) *S. glabrescens;* 3) *S. vermicularis;* 4) *S. wallichiana;* 5) *S. zalacca*	1) salak, ridan (Sar); 2) salak; 3) kepla; 5) salak	1) Malaysia: Peninsular, Sarawak, Sabah; Brunei; Indonesia: Kalimantan, Sumatra; 2) Peninsular Malaysia; Thailand; 3) Borneo; 4) Peninsular Malaysia; Thailand; Vietnam; Laos; Kampuchea; China; Myanmar; 5) Indonesia: Java, Sumatra	1) edible fruit & palm heart; flexible end of rachis as fishing rod; 2) edible fruit; 3) edible fruit and palm heart; 4) fruit used in curry; petioles for fishing rods; 5) edible fruit (see Table 9-25 for nutritional composition); leaves for fencing & decoration
Trachycarpus fortunei	chusan	China (endemic)	leaf-base fiber to make rope, mats, brushes; leaves for thatching & to weave fans, hats, chairs; fruit wax to make polishes, etc.; seed source of hemostatic drug; roots, leaves & flowers contain medicinal compounds; stems as house pillars; edible flowers; seeds as animal fodder

Notes: 1. Other local names are given in some of the sources cited.
2. Distribution is within the Southeast Asian region as defined; some species also occur elsewhere.

Sources: References for Table 4.3 and in addition: Davis, 1988; Davis and Kuswara, 1987; Davis *et al.*, 1990; Dransfield, 1977; Dransfield and Johnson, 1991; Essig, 1982; Essig and Dong, 1987; Fong, 1989, 1992; Fox, 1977; Hay, 1984; House, 1983; Kovoor, 1983; Lubeigt, 1977; Miller, 1964; Mogea *et al.*, 1991; O'Brien and Kinnaird, 1996; Ruddle *et al.*, 1978; Sastrapradja *et al.*, 1978; Yaacob and Subhadrabandhu, 1995.

Borassus flabellifer. The lontar palm is a multipurpose species in Southeast Asia just as it is in South Asia. However, its uses do not quite reach the diversity found in South Asia. This is documented by Fox (1977) who studied two different culture groups which make considerable use of the palm on the Indonesian islands of Roti and Madura. As a sugar source, lontar has been studied in great detail by Lubeigt (1979) in central Myanmar. The lontar is a palm of dry environments and is tolerant of poor soils. Its major drawback as an economic palm is that it is a single-stemmed species.

Corypha utan. This palm has a very wide distribution in Asia, most often in drier more open areas. It typically is found in association with settlements, suggesting that humans may have contributed to its current geographic range. A large single-stemmed tree, the gebang palm shares with the sugar palm a terminal-flowering habit and also its main economic products of sweet sap and stem starch. The gebang has very large fan-shaped leaves with numerous uses.

Metroxylon sagu. The sago palm is most notable in the region as a subsistence source of stem starch in areas of its occurrence in Indonesia and the Philippines. A tropical peat swamp palm, sago occupies a largely undesirable habitat as far as competing land uses are concerned. Centuries ago, sago was introduced from farther east to Borneo and Malaya, apparently by migrating peoples. Today it can be found in a semi-wild or cultivated state where suitable habitat exists. Anyone seeing the extensive sago areas in Sarawak, and the dependence of local people on it for starch and various other projects, would find it difficult to believe that the palm is not native. This hapazanthic suckering palm is discussed in more detail in Chapter 5.

Nypa fruticans. Nipa is solely a mangrove palm and its distribution is centered in Southeast Asia. Although sago and nipa occupy somewhat similar habitats, the former grows in fresh water swamps, the latter brackish water environments along the coast. Major economic products are sap for sugar or alcohol and leaves for thatching. Panels of nipa thatch are in common use wherever the palm occurs. Hamilton and Murphy (1988) studied the general use and management of nipa over its broad range and Fong (1992) has done field studies on nipa management in Peninsular Malaysia and tapping in Sarawak (Fong, 1989).

Salacca zalacca. The salak palm is a forest undergrowth species primarily important for its edible fruit, which is obtained from wild and cultivated plants. As indicated in Table 4-4, several other species also have edible fruits, but fruit from *S. zalacca* is the largest and sweetest. Salak fruit is very popular in Indonesia where it is consumed fresh and is canned for domestic and export markets. According to Mogea (1991) 15 local trade names exist for salak fruits based on quality and fruit characteristics. In Thailand, clones of what is believed to be *S. wallichiana* are under cultivation (Yaacob and Subhadrabandu, 1995). The preceding reference provides detailed information on cultivating salak which is recommended for home gardens.

As for the remaining palms in Table 4-4 the use pattern is similar to that of Table 4-3 in that food and non-food items have about equal weight. *Eugeissona utilis* is what might be termed a minor multipurpose palm as indicated by the variety of uses listed in Table 4-4. However, they represent predominantly subsistence uses by indigenous peoples who sometimes (in Sarawak) plant the palm near their houses.

In addition to being used for thatching and to weave a variety of products, certain fan palm leaves provide cheap food-wrapping material. *Licuala peltata*, one form of which has undivided leaves, and *Livistona rotundifolia*, with shallowly-divided leaves, are good examples. Almost everywhere that palm leaves are cut from wild plants, for whatever end use, there is a tendency to harvest an excessive number of leaves per plant, in large part to minimize walking distances.

The effect of leaf harvest of *Livistona rotundifolia* was the subject of a recent study in North Sulawesi, Indonesia. The study confirms assumptions about the adverse impact of over-harvesting of leaves. Research results showed that leaves on harvested plants grew faster but reached a smaller final leaf size than on unharvested plants. A census of harvested and unharvested palm populations showed that palm density was twice as high and there were ten times as many reproductive-sized palms in unharvested areas (O'Brien and Kinnaird, 1996).

Together the four members of the genus *Phoenix* in Table 4-4 occur widely in Southeast Asia and are common sources of food and non-food subsistence items. These palms persist in many areas because they are adapted to disturbed habitats, can grow on drier sites with poor soils and produce basal suckers which are a major factor in their natural regeneration.

The wanga palm (*Pigafetta filaris*) is a somewhat unusual palm in that it is a pioneer species which colonizes disturbed habitats where it is native in Indonesia and Papua New Guinea. Although its chief economic value is a source of stem wood for construction, *P. filaris* is also esteemed as an elegant ornamental palm. Davis and Kuswara (1987) studied the biology of this palm in Indonesia.

Trachycarpus fortunei is well known as an ornamental palm grown in the middle latitudes because of its cold tolerance. The palm also turns out to be a drug source in China as well as the origin of several other products.

As more becomes known in general about the use of palms in China (and Indochina), other examples can be expected to be added to any future list of economic palms.

Asian Rattans

Rattans are first and foremost important as commercial and subsistence sources of cane, the rattan stem. The stem, after stripping off its leaf sheaths, provides the raw material for the cane furniture industry. Depending on the species, the diameter of canes is from about 3 mm to 60 mm or more. In the rattan industry, canes are graded on the basis of seven basic factors: diameter, length of cane, color, hardness, defects and blemishes, length of nodes and uniformity of thickness (UNIDO, 1983).

Another way to characterize rattans is based solely on their diameter: canes are referred to as "large" if they have a diameter above 18 mm; "small" canes are those below that diameter. Large canes are used whole to make the frames of cane furniture. Whole small canes are also used as struts in some furniture, but more often they are split and used to weave the chair back (Dransfield, 1988).

Three desirable properties characterize rattan canes. One, they are solid (unlike bamboo which are typically hollow) and hence very strong. Two, by the application of heat, most rattans can be bent into and will hold various shapes without deformation. Three, canes can be lacquered to preserve their natural light color or can also be painted.

In addition to its use in furniture making, split cane furnishes material for handicraft and cottage industries to make baskets, mats, bags, hats, fish traps and a host of other products. Rattans are also employed as cordage for tying and binding. The case study (Chapter 2) of the

Iban in Sarawak, Malaysia demonstrates how very useful rattans are to indigenous people.

The rattans of Asia belong to the following ten genera: *Calamus, Calospatha, Ceratolobus, Daemonorops, Korthalsia, Myrialepis, Plectocomia, Plectocomiopsis, Pogonotium* and *Retispatha*. More than 500 rattan species have been described, with the two genera *Calamus* and *Daemonorops* representing the bulk of the species.

Nearly all rattan canes continue to come from wild plants. However, in the coming years rattan cultivation, along with some form of rattan management, will play an increasing role in providing sources of raw canes and in turn relieve some of the pressures on threatened wild populations.

Rattan canes represent the palm family's most valuable non-wood forest product. At the same time rattans, as a group, are exceedingly difficult to generalize about because of incomplete data on distribution patterns and conservation status as well as the confusion which exists between local or trade names on the one hand and scientific names on the other.

Following the general approach used for South and Southeast Asia palms, rattans were divided into two groups on the basis of whether they are known to be threatened or not threatened in the wild. An attempt was made to ascertain if canes from the two groups of candidate rattans were utilized, but it was not possible to do so with an acceptable degree of reliability. The only practical solution was to include all rattans with a known conservation status and assume that, where utilization information was absent, there was at least the possibility that the individual species had some present or future utility as a cane source. This approach seemed to be a better alternative than omitting many rattan species altogether.

A rough count shows that three out of four rattans lack information about their conservation status. Dozens of these species are known to have utility as cane sources. In order to include and consider all such rattans, a third group was formed consisting of rattans known to be utilized but with an unknown conservation status.

Information on secondary uses of the rattans dealt with here was collected and is presented separately.

Threatened Asian Rattans

As climbing palms, rattans need trees for support and hence deforestation leads to their destruction. But most rattans can and do survive in areas of timber harvesting or partial land clearing where some tree cover remains. Secondary forest supports rattan growth, but the rattans do not reach their maximum length and diameter, as they do in primary forest.

Cutting wild rattans is a destructive exploitation comparable to felling palms for stem starch, construction wood or palm heart. Exploitation of rattans for commercial and subsistence purposes appears to be a major factor which has placed so many species at risk.

At least 121 rattan species are known to be threatened in the wild and these are presented in Table 4-5.

Table 4-5: Threatened Asian Rattans

Scientific Names	Selected Local Names[1]	Distribution[2]
Calamus adspersus	?	Indonesia: Java, Sumatra
Calamus andamanicus[*]	mofabet	India: Andaman Islands (endemic)
Calamus asperrimus	rotan leulues	Indonesia: Java
Calamus bacularis[*]	wi tulang	Malaysia: Sarawak (endemic)
Calamus balanseanus	than-moï	Vietnam: Ha Bac, Lang Son
Calamus bicolor	lasi, rasi	Philippines: Mindanao
Calamus brandisii	vanthai	India: Kerala, Karnataka, Tamil Nadu (endemic)
Calamus ceratophorus	ui sông	Vietnam: Phu Khanh
Calamus ciliaris[*]	hoe cacing	Indonesia: Java, Sumatra
Calamus cockburnii	?	Malaysia: Peninsular, Pahang (endemic)
Calamus conjugatus	wi janggut	Malaysia: Sarawak (endemic)
Calamus corneri	rotan perut ayam	Malaysia: Peninsular (endemic)
Calamus crassifolius	wi takong	Malaysia: Sarawak (endemic)
Calamus cumingianaus[*]	douung-douung	Philippines: Luzon
Calamus delicatulus	nara wel	Sri Lanka (endemic)
Calamus densiflorus[*]	rotan kerai	Peninsular Malaysia; Singapore; Thailand
Calamus digitatus	kukulu wel	Sri Lanka (endemic)
Calamus dilaceratus	?	India: Andaman Islands (endemic)
Calamus dimorphacanthus[*]	lambutan, tandulang-montalban	Philippines: Luzon
Calamus dioicus	rani	Vietnam
Calamus discolor[*]	halls, kumaboy	Philippines: Luzon
Calamus dongnaiensis	long-tchéou	Vietnam: south
Calamus endauensis	?	Malaysia: Peninsular (endemic)
Calamus filipendulus	rotan batu	Malaysia: Peninsular (endemic)
Calamus foxworthyi	?	Philippines: Palawan
Calamus godefroyi	phdau tuk	Vietnam
Calamus grandifolius[*]	saba-ong	Philippines: Luzon
Calamus harmandii	?	Laos
Calamus hepburnii	?	Malaysia: Sabah (endemic)
Calamus holttumii	rotan perut ayam	Malaysia: Peninsular (endemic)
Calamus huegelianus	soojibetha	India: Tamil Nadu (endemic)

Scientific Names	Selected Local Names[1]	Distribution[2]
Calamus hypertrichosus	?	Malaysia: Sarawak. Indonesia: Kalimantan
Calamus inermis	rong	India: West Bengal; Bhutan; Sikkim
Calamus inops[*]	rotan tohiti	Indonesia: Sulawesi
Calamus jenningsianus	lagipi	Philippines: Mindoro
Calamus karuensis	rotan penjalin rawa	Indonesia: Sumatra
Calamus kjellbergii	?	Indonesia: Sulawesi
Calamus koordersianus[*]	rotan boga	Indonesia: Sulawesi
Calamus laevigatus var. serpentinus[*]	rotan tunggal	Malaysia: Sabah (endemic)
Calamus laxissimus	?	Malaysia: Peninsular (endemic)
Calamus longispathus[*]	rotan kunyung	Malaysia: Peninsular (endemic)
Calamus manan[#]	rotan manau	Malaysia: Peninsular; Indonesia: Sumatra; Borneo; Thailand ?
Calamus megaphyllus[*]	banakbo	Philippines: Leyte
Calamus melanoloma	rotan gelengdage	Indonesia: Java
Calamus melanorhynchus[*]	dalimban	Philippines: Mindanao
Calamus merrillii[#]	palasan	Philippines: Luzon
Calamus meyenianus	?	Philippines: Pangasi, Nueva Vizcaya
Calamus minahassae[*]	datu	Indonesia: Sulawesi
Calamus minutus	?	Malaysia: Peninsular (endemic)
Calamus mitis[*]	matkong	Philippines: Batanes, Babuyan
Calamus moorhousei	?	Malaysia: Peninsular (endemic)
Calamus moseleyanus[*]	sarani	Philippines: Basilan, Malanipa
Calamus multinervis[*]	balala	Philippines: Mindanao
Calamus multirameus	?	Malaysia: Peninsular (endemic)
Calamus nagbettai	nag betta	India: Karnataka, Coorg & South Kanara Dist. (endemic)
Calamus nicobaricus	tchye	India: Great Nicobar Island (endemic)
Calamus nielsenii	?	Malaysia: Sarawak (endemic)
Calamus ovoideus[#]	thudarena	Sri Lanka (endemic)
Calamus pachystemonus	kukulu wel	Sri Lanka (endemic)
Calamus padangensis	?	Malaysia: Peninsular (endemic)
Calamus penicillatus	rotan batu	Malaysia: Peninsular (endemic)
Calamus platyacanthus	song mat	Vietnam

Scientific Names	Selected Local Names[1]	Distribution[2]
Calamus poensis	?	Malaysia: Sarawak (endemic)
Calamus poilanei	u pôn	Vietnam: Lam Dong, Phu Khanh
Calamus pseudoscutellaris	r'sui	Vietnam: Lam Dong, Phu Khanh, Dong Nai
Calamus pycnocarpus	rotan kong	Malaysia: Peninsular (endemic)
Calamus radiatus	kukulu wel	Sri Lanka (endemic)
Calamus radulosus	?	Malaysia: Peninsular (endemic)
Calamus ridleyanus	rotan kerai	Malaysia: Peninsular; Singapore (endemic to Malay Peninsula)
Calamus rivalis	ela wewel	Sri Lanka (endemic)
Calamus robinsonianus	?	Indonesia: Moluccas
Calamus scutellaris	cây mai	Vietnam: Thanh Hoa
*Calamus sedens**	rotan dudok	Malaysia: Peninsular (endemic)
*Calamus semoi**	wi tut	Malaysia: Sarawak (endemic)
Calamus senalingensis	?	Malaysia: Peninsular (endemic)
Calamus setulosus	rotan kerai	Malaysia: Peninsular (endemic)
*Calamus simplex**	rotan kerai gunung	Malaysia: Peninsular (endemic)
Calamus spectabilis	ombol	Indonesia: Java, Sumatra
Calamus spectatissimus	rotan semut	Malaysia: Peninsular; Indonesia: Kalimantan, Sumatra; Thailand
*Calamus symphysipus**	rotan umbol	Philippines: Catanduanes, Bucas Grande; Indonesia, Sulawesi
Calamus tanakadatei	rotan tekok	Malaysia: Peninsular (endemic)
Calamus tonkinensis	may dang	Vietnam
*Calamus trispermus**	?	Philippines: Luzon
*Calamus vidalianus**	yantok	Philippines: Luzon
Calamus vinosus	yaming	Philippines: Mindanao
*Calamus warburgii**	?	Indonesia: Irian aya
Calamus whitmorei	?	Malaysia: Peninsular (endemic)
Calamus zeylanicus	thambotu wel	Sri Lanka (endemic)
*Calospatha scortechinii**	rotan demuk	Malaysia: Peninsular (endemic)
Ceratolobus glaucescens	rotan beula	Indonesia: Java
Ceratolobus kingianus	rotan jere landak	Malaysia: Peninsular (endemic)
Ceratolobus pseudoconcolor	rotan omas	Indonesia: Java, Sumatra
Daemonorops acamptostachys	daun wi, rotan dudok	Malaysia: Sarawak, Sabah; Indonesia: Kalimantan

Scientific Names	Selected Local Names[1]	Distribution[2]
Daemonorops affinis	bag-bag	Philippines: Mindanao
*Daemonorops clemensiana**	?	Philippines: Mindanao
*Daemonorops curranii**	pitpit	Philippines: Palawan
*Daemonorops leptopus**	rotan bacap	Malaysia: Peninsular; Singapore (endemic to Malay Peninsula)
Daemonorops loheriana	?	Philippines: Luzon
*Daemonorops longispatha**	wi tibu	Borneo
Daemonorops macrophylla	rotan cincin	Malaysia: Peninsular (endemic)
Daemonorops manii	chang bet	India: Andaman Islands (endemic)
Daemonorops margaritae var. palawanicus	ka-api	Philippines: Palawan
Daemonorops oligophylla	?	Malaysia: Peninsular (endemic)
Daemonorops pannosa	sabilog	Philippines: Leyte
Daemonorops sepal	rotan getah gunung	Malaysia: Peninsular (endemic)
Daemonorops unijuga	?	Malaysia: Sarawak (endemic)
Daemonorops urdanetana	sahaan	Philippines: Mindanao
Korthalsia junghuhnii	rotan bulu	Indonesia: Java
Korthalsia lanceolata	rotan dahan	Malaysia: Peninsular (endemic)
Korthalsia merrillii	?	Philippines: Palawan (endemic)
Korthalsia rogersii	?	India: Andaman Islands (endemic)
Korthalsia tenuissima	rotan daha tikus	Malaysia: Peninsular (endemic)
Plectocomia billitonensis	?	Indonesia: Sumatra, Belitung Island
Plectocomia dransfieldiana	rotan mantang ilang	Malaysia: Peninsular (endemic)
Plectocomia elmeri	binting dalaga	Philippines: Mindanao, Mt. Apo
Plectocomia longistigma	?	Indonesia: Java, east
Plectocomia lorzingii	?	Indonesia: Sumatra, Sibolangit
Plectocomia pygmaea	?	Indonesia: Kalimantan, Sei Poetat, Pontianak
Plectocomiopsis wrayi	rotan pepe	Malaysia: Peninsular (endemic)
Pogonotium moorei	?	Malaysia: Sarawak, Gunung Gaharu (endemic)
Pogonotium ursinum	rotan bulu	Malaysia: Peninsular, Sarawak; Brunei

Notes: 1. Other local names are given in some of the sources cited.
2. Distribution is within the Asian region as defined; some species also occur elsewhere.
Major commercial species, as defined by Dransfield and Manokaran, 1993.
* Minor commercial species, as defined by Dransfield and Manokaran, 1993.

Sources: Alam, 1990; Avé, 1988; Basu, 1992; De Zoysa and Vivekanandan, 1994; Dransfield, 1979, 1982, 1984, 1992; Dransfield and Manokaran, 1993; Gagnepain, 1937; Guzman and Fernando, 1986; Johnson, 1991b; Kurz, 1874; Lakshmana, 1993; Liao, 1994; Madulid, 1981; Pearce, 1994; Rattan Information Centre Bulletin, various issues; Renuka, 1992, 1995; Siebert, 1989.

Non-threatened Asian Rattans

On the basis of current knowledge, only 25 Asian rattans are not under threat from exploitation and deforestation. Table 4-6 identifies these species. Why these rattans are not threatened is unclear. The answer probably lies in some combination of factors such as their greater natural populations, in some cases broader geographic ranges, adaptability to forest disturbance and the clustering grown form which characterizes about three-fourths of the species listed.

Table 4-6: Non-threatened Asian Rattans

Scientific Names	Selected Local Names[1]	Distribution[2]
*Calamus burckianus**	howe belukbuk	Indonesia: Java
Calamus exilis#	rotang gunung	Peninsular Malaysia; Indonesia: Sumatra
Calamus formosanus	(Formosan cane)	Taiwan
Calamus gregisectus	?	Myanmar
*Calamus heteroideus**	howe cacing	Indonesia: Java, Sumatra
Calamus javensis#	rotan opot	Malaysia: Peninsular, Sarawak, Sabah; Brunei; Singapore; Indonesia: Kalimantan, Java, Sumatra; Philippines: Palawan; Thailand
Calamus pseudotenuis	perumperambu	India: Deccan Peninsula, Western Ghats. Sri Lanka
Calamus reinwardtii	rotan dedek	Indonesia: Java (endemic)
Calamus trachycoleus#	rotan itit	Indonesia: Kalimantan
*Daemonorops calicarpa**	lumpit	Peninsular Malaysia; Indonesia: Sumatra
*Daemonorops crinita**	?	Indonesia: Sumatra, Kalimantan
*Daemonorops didymophylla**	rotan tunggal	Malaysia: Peninsular, Sarawak, Sabah; Brunei; Singapore; Indonesia: Kalimantan, Sumatra; Thailand
*Daemonorops fissa**	rotan kotok	Malaysia: Sarawak, Sabah; Brunei; Indonesia: Kalimantan
*Daemonorops grandis**	rotan sendang	Peninsular Malaysia; Singapore; Thailand
Daemonorops hallieriana	?	Indonesia: Kalimantan
Daemonorops macroptera	?	Indonesia: Sulawesi
*Daemonorops oblonga**	rotan pitik	Indonesia: Java
*Daemonorops rubra**	teretes	Indonesia: Java
Korthalsia echinometra#	uwi hurang	Malaysia: Peninsular, Sarawak, Sabah; Brunei; Singapore; Indonesia: Kalimantan, Sumatra
Korthalsia laciniosa#	rotan dahan	Peninsular Malaysia; Singapore; Indonesia: Java, Sumatra; Philippines; Vietnam; Thailand, Myanmar; India: Andaman & Nicobar Islands
Korthalsia zippelii	inuwai	Indonesia: Irian Jaya

Scientific Names	Selected Local Names[1]	Distribution[2]
*Myrialepis paradoxa** (*syn. M. scorthechinii*)	rotan kertong	Malaysia: Peninsular; Singapore; Indonesia: Sumatra; Thailand; Kampuchea; Myanmar; Vietnam
Plectocomia elongata var. elongata	wi	Malaysia: Peninsular, Sarawak, Sabah; Indonesia: Java, Sumatra; Brunei; Vietnam
Plectocomia mulleri	rotan tibu	Malaysia: Peninsular, Sarawak, Sabah; Indonesia: Kalimantan; Brunei
*Plectocomiopsis geminiflora**	ialis, rotan pa	Malaysia: Peninsular, Sarawak, Sabah; Indonesia: Kalimantan, Sumatra; Brunei; Thailand

Notes: 1. Other local names are given in some of the sources cited.
2. Distribution is within the Asian region as defined; some species also occur elsewhere.
Major commercial species, as defined by Dransfield and Manokaran, 1993.
* Minor commercial species, as defined by Dransfield and Manokaran, 1993.
Sources: Same as Table 4-5.

Asian Rattans with Unknown Conservation Status

Documented utilization information of rattan species which also lack conservation-status information prompted the compilation of Table 4-7. Dransfield and Manokaran (1993) summarized information on 30 major and 105 minor rattan species. The 86 rattan species the authors described which were not included in either Tables 4-5 or 4-6 are listed in Table 4-7. That we know nothing about the status in the wild of such a large number of useful rattan species is indeed alarming.

Table 4-7: Asian Rattans with Unknown Conservation Status and Reported Uses

Scientific Names	Selected Local Names[1]	Distribution[2]
*Calamus albus**	rotan putih	Indonesia: Moluccas (endemic ?)
*Calamus aruensis**	?	Indonesia: Moluccas
*Calamus arugda**	arugda	Philippines: Cagayan, Luzon
*Calamus axillaris**	rotan sega air	Malaysia: Peninsular, Sarawak; Brunei; Indonesia: Sumatra
*Calamus blumei**	rotan tukas	Malaysia: Peninsular, Sarawak, Sabah; Brunei; Indonesia: Kalimantan, Sumatra; Thailand
*Calamus boniensis**	tomani	Indonesia: Sulawesi (endemic ?)
Calamus caesius#	rotan sega	Malaysia: Peninsular, Sarawak, Sabah; Indonesia: Kalimantan, Sumatra; Philippines: Palawan
*Calamus castaneus**	rotan cucor	Peninsular Malaysia; Indonesia: Sumatra; Thailand
*Calamus conirostris**	rotan dago kancil	Malaysia: Peninsular, Sarawak, Sabah; Brunei; Indonesia: Kalimantan, Sumatra
*Calamus didymocarpus**	nue waatang	Malaysia: Sulawesi (endemic ?)

Scientific Names	Selected Local Names[1]	Distribution[2]
*Calamus diepenhorstii**	rotan batu	Malaysia: Peninsular, Sarawak, Sabah; Brunei; Singapore; Indonesia: Sumatra; Philippines: Palawan; Thailand
Calamus egregius#	duanye shengteng	China: Hainan Island (endemic)
*Calamus elmerianus**	sababai	Philippines: Tayabas, Dinagat, Agusan, Davao
*Calamus erioacanthus**	wi buluh	Malaysia: Sarawak (endemic)
*Calamus flabellatus**	rotan lilin	Malaysia: Peninsular, Sarawak, Sabah; Brunei; Indonesia: Kalimantan, Sumatra
*Calamus gibbsianus**	silau-silau	Malaysia: Sarawak, Sabah
*Calamus halconensis var. dimorphacanthus**	lambutan	Philippines: Laguna, Mindoro
*Calamus hispidulus**	rotan bulu	Malaysia: Sarawak; Indonesia: Kalimantan
*Calamus hollrungii**	uawa jawa	Indonesia: Irian Jaya
*Calamus insignis**	rotan batu	Peninsular Malaysia; Singapore; Indonesia: Sumatra; Thailand
*Calamus laevigatus** *var. laevigatus and var. mucronatus*	rotan tunggal	Malaysia: Peninsular, Sarawak, Sabah; Brunei; Singapore; Indonesia: Kalimantan, Sumatra
*Calamus leiocaulis**	rotan jermasi	Indonesia: Sulawesi (endemic ?)
*Calamus leptostachys**	ronti	Indonesia: Sulawesi (endemic ?)
*Calamus longisetus**	leme	Myanmar; Thailand; Peninsular Malaysia
*Calamus luridus**	huwi pantis	Peninsular Malaysia; Indonesia: Sumatra; Thailand
*Calamus manillensis**	bayabong	Philippines: Nueva Viscaya, Tayabas, Sorsogon, Dinagat, Agusan, Davao, Surigao
*Calamus marginatus**	rotan besi	Malaysia: Sarawak, Sabah; Brunei; Indonesia: Kalimantan, Sumatra; Philippines: Palawan
*Calamus mattanensis**	rotan maran	Malaysia: Sarawak; Indonesia: Kalimantan
*Calamus microcarpus**	kalapit	Philippines: Rizal, Laguna, Tayabas, Camarines, Sorsogon, Davao, Agusan, Lanao
*Calamus microsphaerion**	kulakling	Philippines: Palawan, Bataan, Culion; Malaysia: Sabah
Calamus mindorensis#	tumalim	Philippines: Luzon, Mindanao
*Calamus muricatus**	rotan melukut	Malaysia: Sarawak, Sabah; Brunei; Indonesia: Kalimantan, Sumatra
*Calamus myriacanthus**	wi dudok	Malaysia: Sarawak; Indonesia: Kalimantan; Brunei
Calamus optimus#	rotan taman	Malaysia: Sarawak, Sabah; Indonesia: Kalimantan; Brunei
Calamus ornatus#	rotan kesup	Malaysia: Peninsular, Sarawak, Sabah; Singapore; Brunei; Indonesia: Java, Sumatra, Sulawesi; Philippines; Thailand
*Calamus oxleyanus**	manau riang	Malaysia: Peninsular, Sarawak, Sabah; Brunei; Singapore; Indonesia: Sumatra; Thailand

Scientific Names	Selected Local Names[1]	Distribution[2]
Calamus palustris#	rotan buku hitam	Peninsular Malaysia; Myanmar; Thailand; Vietnam; China; India: Nicobar and Andaman Islands
*Calamus paspalanthus**	rotan sirikis	Malaysia: Peninsular, Sarawak, Sabah; Indonesia: Kalimantan; Brunei
*Calamus pedicellatus**	samole	Indonesia: Sulawesi (endemic)
*Calamus perakensis**	rotan dudok	Peninsular Malaysia; Indonesia: Sumatra
*Calamus peregrinus**	nguay	Thailand; Peninsular Malaysia
*Calamus pilosellus**	rotan lintang	Malaysia: Sarawak, Sabah; Indonesia: Kalimantan; Brunei (endemic to Borneo)
Calamus pogonacanthus#	wi tut	Malaysia: Sarawak, Sabah; Indonesia: Kalimantan; Brunei (endemic to Borneo)
*Calamus polystachys**	wai lau cincin	Peninsular Malaysia; Indonesia: Java, Sumatra
*Calamus ramulosus**	panlis	Philippines: Luzon (endemic)
*Calamus reyesianus**	apas	Philippines: Laguna, Tayabas, Quezon
*Calamus rhomboideus**	rotan dawuh	Indonesia: Sumatra, Java
*Calamus rhytidomus**	?	Indonesia: Kalimantan
*Calamus ruvidus**	wee lumbak	Malaysia: Sarawak (endemic)
*Calamus scabridulus**	dara panda	Peninsular Malaysia; Indonesia: Sumatra
Calamus scipionum#	rotan semambu	Malaysia: Peninsular, Sarawak, Sabah; Brunei; Singapore; Indonesia: Kalimantan, Sumatra; Philippines: Palawan; Thailand
Calamus simplicifolius#	danye shengteng	China: Hainan Island
*Calamus siphonospathus**	talola	Philippines: Luzon, Mindanao; Indonesia: Sulawesi
*Calamus spinifolius**	kurakling	Philippines: Luzon
Calamus subinermis#	rotan batu	Malaysia: Sabah; Philippines: Palawan; Indonesia: Sulawesi
Calamus tetradactylus#	baiteng (white rattan)	China: South, Hainan Island
*Calamus tomentosus**	rotan tukas	Peninsular Malaysia; Borneo
Calamus tumidus#	rotan manau tikus	Peninsular Malaysia; Indonesia: Sumatra
*Calamus ulur**	?	Peninsular Malaysia; Indonesia: Sumatra
*Calamus unifarius**	wai sidekeni	Indonesia: Java, Sumatra; India: Nicobar Islands
*Calamus usitatus**	babuyan	Philippines; Malaysia: Sabah
*Calamus viminalis**	penjalin cacing	Indonesia: Java, Bali, Sumatra; Peninsular Malaysia; Kampuchea; Thailand; Myanmar; Bangladesh; Sikkim; India: Andaman Islands, West Bengal, Bihar, Orissa, Pradesh, Maharastra
Calamus wailong#	wailong	China: Yunnan (endemic)
Calamus zollingeri#	rotan batang	Indonesia: Sulawesi, Moluccas

Scientific Names	Selected Local Names[1]	Distribution[2]
*Daemonorops angustifolia**	rotan getah	Peninsular Malaysia; Thailand
*Daemonorops draco**	rotan jernang	Indonesia: Sumatra, Kalimantan, Riau Archipelago; Malaysia: Sarawak
*Daemonorops elongata**	lempinin pahetan	Indonesia: Kalimantan; Malaysia: Sabah (endemic to Borneo)
*Daemonorops hystrix**	rotan sepet	Indonesia: Sumatra; Malaysia: Peninsular, Sarawak; Singapore
*Daemonorops ingens**	keplar	Malaysia: Sarawak, Sabah; Brunei; Indonesia: Kalimantan (endemic to Borneo)
*Daemonorops lamprolepis**	lapa	Indonesia: Sulawesi (endemic ?)
Daemonorops margaritae var. margaritae#	huangteng	China: South, Hainan Island
*Daemonorops melanochaetes**	sekei udang	Indonesia: Java, Sumatra; Peninsular Malaysia
*Daemonorops micracantha**	rotan jernang	Malaysia: Peninsular, Sarawak, Sabah; Indonesia: Kalimantan
*Daemonorops ochrolepis**	ditaan	Philippines: Leyte
*Daemonorops periacantha**	wi empunoh	Malaysia: Peninsular, Sarawak, Sabah; Brunei; Singapore; Indonesia: Kalimantan
*Daemonorops propinqua**	rotan jernang	Peninsular Malaysia (endemic)
Daemonorops robusta#	rotan susu	Indonesia: Sulawesi, Moluccas
*Daemonorops ruptilis**	widudok	Malaysia: Sarawak, Sabah; Brunei
Daemonorops sabut#	jungan	Malaysia: Peninsular, Sarawak, Sabah; Singapore; Brunei; Indonesia: Kalimantan; Thailand
*Daemonorops scapigera**	wi empunok ruai	Malaysia: Peninsular, Sarawak, Sabah; Brunei; Indonesia: Kalimantan
*Daemonorops sparsiflora**	wi ruah air	Malaysia: Sarawak, Sabah; Brunei; Indonesia: Kalimantan (endemic to Borneo)
Korthalsia cheb#	keb	Malaysia: Sarawak; Sabah; Indonesia: Kalimantan
Korthalsia flagellaris#	rotan dahan	Malaysia: Peninsular, Sarawak, Sabah; Singapore; Brunei; Indonesia: Sumatra
Korthalsia rigida#	rotan dahan	Malaysia: Peninsular, Sarawak, Sabah; Brunei; Indonesia: Kalimantan, Sumatra; Philippines: Palawan; Thailand
Korthalsia robusta#	rotan asas	Malaysia: Peninsular, Sarawak, Sabah; Brunei; Indonesia: Kalimantan, Sumatra; Philippines: Palawan
Korthalsia rostrata#	rotan semut	Malaysia: Peninsular, Sarawak, Sabah; Brunei; Singapore; Indonesia: Kalimantan, Sumatra; Thailand

Notes: 1. Other local names are given in some of the sources cited.
2. Distribution is within the Asian region as defined; some species also occur elsewhere.
Major commercial species, as defined by Dransfield and Manokaran, 1993.
* Minor commercial species, as defined by Dransfield and Manokaran, 1993.

Sources: Same as Table 4-5.

Discussion

A detailed discussion of rattan canes and their commercial and subsistence uses is beyond the scope of the present study. However, two objectives may be undertaken. First, to draw attention to the major sources of technical information on rattans and their products. Second, to examine other selected issues related to the exploitation of wild rattans.

Technical Information on Rattans

There has been an impressive outpouring of technical studies on rattans over the past decade and a half. Rattans have easily received more attention than all other wild palm products combined, a clear indication of their economic value.

Modern rattan development was initiated in 1975 with a rattan project in Peninsular Malaysia. Four years later, the first rattan workshop was held in Singapore (IDRC, 1980) sponsored by the International Development Research Centre (IDRC) of Canada. Also the first regional rattan study, of Peninsular Malaysia, was published (Dransfield, 1979). Since then, more than 20 major publications have appeared (Table 4.8). Workshop proceedings, regional rattan studies and studies of specific topics have generated much-needed information in three major subject areas: taxonomy, distribution and ecology of wild rattans; domestication and plantation growth of promising species; and industrial processing of canes. Two rattan bibliographies are included among the publications in Table 4.8.

Rattan research is actively being carried on in several Asian countries, most prominently in Malaysia, Indonesia, the Philippines and India. A library of technical information on all aspects of rattans is housed at the Rattan Information Centre, Forest Research Institute Malaysia, Kepong. The Centre published a bulletin from 1982 to 1993 (see Chapter 11).

In an effort to promote collaborative rattan research, the International Network for Bamboo and Rattan (INBAR) was established in 1993. It is located in New Delhi. INBAR is directing its activities toward five subject areas: socio-economic research; information, training and technology transfer; production research; post-harvest technology and utilization; and biodiversity and genetic conservation. INBAR publishes a quarterly newsletter (see Chapter 11) as well as a series of working papers and technical reports. The two initial working papers dealt with socio-economics (Duraiaippah, 1994; Nasendi, 1994). Technical reports issued have dealt with priority species for rattan cultivation (Williams and Ramanatha Rao, 1994) and rattan nursery techniques (Wan Razali *et al.*, 1994).

Rattan-Related Issues

Four topics are relevant to the future of rattan as a non-wood forest product and should be touched upon here. The topics are: 1) increased wild sources of raw cane; 2) management of wild stands in a sustainable fashion; 3) conservation of threatened rattans and their habitat; and 4) socio-economic and cultural issues related to rattan collecting. Each of these topics should be reviewed as part of any forestry activity which includes rattan collecting.

Table 4-8: Major Publications on Rattan Since 1979

Abbreviated Title and Reference	Geographic Coverage	Contents/Comments
Rattans. PROSEA 6 (Dransfield & Manokaran, 1993); Bibliography (Wulijarni-Soitjipto & Danimihardja, 1995).	China, Vietnam, Laos, Kampuchea, Thailand, Myanmar, Malaysia, Singapore, Brunei, Philippines, Indonesia, Papua New Guinea & Australia	Introduction to rattans of region; 30 major spp. covered in detail; brief descriptions of 105 minor spp. Best single general information source. Bibliography provides localized references on rattans in Southeast Asia.
Rattan Bibliography (Kong-Ong & Manokaran, 1986)	World	All aspects of rattan from 1790 to June 1986.
Guide Cultivation Rattan. (Wan *Razali et al.*, 1992)	Southeast Asia but with strong focus on Peninsular Malaysia & Borneo	Field guide for growing rattan as commercial crop, includes discussions of economics & processing. Primary source.
Manual Production Rattan Furniture. (UNIDO, 1983)	Asia	Manual of processing, marketing, design, manufacturing, etc. Well illustrated guide to the industry.
Rattan Workshop. (IDRC, 1980)	Asia. Meeting site: Singapore	Proceedings lst regional rattan meeting (1979). Mostly consists of state-of-the-art review of rattan at the time.
Rattan Seminar. (Wong & Manokaran, 1985)	Asia; country reports on China, India, Indonesia, Malaysia, Philippines & Thailand. Meeting site: Kuala Lumpur, Malaysia	Proceedings 2nd regional rattan meeting (1984). Technical papers (23) on following topics: propagation practices; ecology & silviculture; properties, pests & diseases; processing & utilization; extension & information dissemination. Broad coverage of key issues.
Recent Research on Rattans. (Rao & Vongkaluang, 1989)	Asia. Meeting site: Chiangmai, Thailand	Proceedings 3rd regional rattan meeting (1987). Technical papers (36) on following topics: research; growth & silviculture; biology; processing & utilization; properties & multipurpose uses; economics & production. Benchmark on research.
Rattan Management & Utilization. (Chand Basha & Bhat, 1993)	Primarily India; also Malaysia and Sri Lanka. Meeting site: Trichur, Kerala, India	Proceedings of Indian rattan meeting (1992). Technical papers (50) on following topics: area status reports; resource assessment & conservation; production & management; structure, properties & processing; socio-economics & trade. Good mix of research and technology.
Third National Rattan Conference (ATI, 1995)	Philippines. Meeting site: Manila.	National rattan meeting (1995). Theme: Strengthening Community Resource Management Through NTFP Enterprise Development. Papers on rattan and NTFP in general.
Rattan Workshop. (PCARRD, 1990)	Philippines. Meeting site: Cebu City, Philippines	National rattan meeting (1988). Technical papers (10) on various aspects of production, processing & marketing.

Abbreviated Title and Reference	Geographic Coverage	Contents/Comments
Rattans - Philippines. (PCARRD, 1985)	Philippines	Summary of information & recommended practices for plantation establishment, management, cane processing & marketing.
Rattans - Malay Peninsula. (Dransfield, 1979)	West Malaysia & Singapore	Taxonomy of native rattans with good line drawings of 104 spp; natural history; utilization & cultivation; common names.
Rattans - Sabah. (Dransfield, 1984)	Sabah, East Malaysia	Taxonomy of 79 native rattan spp. with line drawings of each.
Rattans - Sarawak. (Dransfield, 1992)	Sarawak, East Malaysia	Same format as Sabah book of 105 native rattan spp.
Rattans - India. (Basu, 1992)	India, including Andaman & Nicobar Islands	Taxonomic study of 48 native rattan spp., with line drawings & information on propagation & utilization.
Rattans - Western Ghats. (Renuka, 1992)	Andhra Pradesh, Karnataka, Kerala Tamil Nadu states, India	Taxonomic study of 19 native rattan spp. of South India, with line drawings & distribution maps. Flowering & fruiting seasons given.
Rattans - South India. (Lakshmana, 1993)	Same as above	General study including taxonomy; silviculture; regeneration; pests & diseases; utilization.
South Indian Rattans (Bhat, 1992)	Same as above	Structure & properties of 15 native *Calamus spp.*
Kerala Rattans (Renuka *et al.*, 1987)	Kerala State, India	Morphology, anatomy & physical properties of 10 native *Calamus spp.*
Rattans - Andaman & Nicobar Islands. (Renuka, 1995)	Andaman & Nicobar Islands, India	Taxonomic study of 18 native rattan spp., with line drawings & distribution maps; utilization; good color photos.
Rattans - Sri Lanka. (De Zoysa & Vivekanandah, 1994)	Sri Lanka	Field guide to 10 native rattan spp., with line drawings & color photos. Full information on biology & utilization.
Bamboo & Rattan - Sri Lanka. (De Zoysa & Vivekanandah, 1991)	Sri Lanka	Detailed study of 8 rattan and 4 bamboo spp. native to & utilized in Sri Lanka. Illustrated.
Rattans - Bangladesh. (Alam, 1990)	Bangladesh	Taxonomic study of 11 spp. of native rattans.

Increased wild cane sources. Quantities of useable raw cane can be increased in two major ways. One is to improve harvesting techniques to minimize waste. Rattan gatherers sometimes are unable to reach the full length of commercial cane they have cut and it goes to waste. Immature rattans are cut rather than being allowed to grow to more worthwhile cane lengths. Gatherers may leave harvested small-diameter canes in the forest to rot because they derive more income from carrying out a large-diameter cane. The foregoing problems are inherent to the gathering of non-wood forest products everywhere in the tropics and are discussed as a socio-economic issue.

A second means of increasing wild cane production is to harvest a wider range of different species. At present, only about 20 percent of the rattan species have commercial use (Dransfield and Manokaran, 1993). Clearly there is potential to begin to utilize some of the remaining 80 percent of the species. To introduce new commercial species to the industry requires involvement at every level of the product chain from the rattan gatherer to the rattan product consumer. Central to finding new commercial rattan species is field research on the plants themselves, study of their technical properties and educating collectors and end users about the new raw material. A good example of an attempt to increase wild cane production is to be found in South India where research efforts are focusing on 15 native *Calamus* spp. as sources of raw material for cane furniture and other products (Renuka, 1992; Bhat, 1992). Lesser known-canes can contribute to wild rattan supplies; some also can be selected for silvicultural trials (Dransfield, 1985).

Rattan management. To insure stable rattan supplies in the future, management is a reasonable compromise between continuing to rely exclusively on wild rattans and outright rattan cultivation. Rattans pose unique management difficulties because of their growth habit since they may climb from tree to tree in the forest canopy. This creates problems in the inventory of standing stock as well as in monitoring of the conditions of rattan populations and their natural regeneration.

Three basic types of management are applicable to rattans:

A) Natural regeneration within the forest. This level of management requires no specific technical inputs but does require that a sustainable harvest plan be developed and adopted. Protected areas such as national parks, nature preserves or watersheds any of which permit gathering of wild resources are highly suitable to this management approach. Siebert (1995) has shown that sustained-yield rattan harvest is achievable within two Indonesian national parks. Designating extractive reserves for rattan harvest, as suggested by Peluso (1992) for Kalimantan, Indonesia, would fit within this management approach.

B) Enhanced natural regeneration and or cultivation within natural forest. In this instance, forest cover is still largely intact (the area may have been selectively logged) and an area may be set aside for rattan and other non-wood forest products. Management inputs may include clearing of competing undergrowth vegetation in naturally-occurring forest canopy gaps to promote young rattan growth. Selective felling to create artificial canopy gaps is also an option. It is well known that canopy gaps are highly favorable for rattan growth (Chandrashekara, 1993). Priasukmana (1989) reports on planting rattan within the natural forest of East Kalimantan, Indonesia, to increase rattan stock.

C) Rattan cultivation as part of shifting cultivation or agroforestry. Incorporation of rattan into shifting cultivation is an indigenous system in Kalimantan. Weinstock (1983) describes how the Luangan Dayaks clear a forest plot to plant food crops for 1-2 years, but before leaving the land fallow they plant rattan. When the rotation is repeated in 7-15 years, the farmer first harvests the rattan then clears the plot again for food crops. Godoy (1990) suggests that traditional rattan cultivation be incorporated into new agroforestry systems to raise small landholder income. In Malaysia, trials to interplant rattans with rubber trees are being studied (Aminuddin *et al.*, 1985). All of these approaches merit further attention since rattan cannot be grown as a monocultural crop.

Rattan conservation. Conservation is a matter of expediency for rattans because of the raw material shortages being experienced by rattan industries in Southeast Asia and because of the potential loss of essential gene pools for rattan domestication and plantation establishment.

It is somewhat encouraging that the need for rattan conservation is beginning to be recognized seriously. A CIRAD-Foret collaborative program in Malaysia is focused on seed collection, establishment of conservation plots and genetic diversity (Durand, 1995). Five of the major rattan species listed in Tables 4-5, 4-6 and 4-7 are under study: *Calamas manan* (threatened); *C. trachycoleus* (non-threatened) and *C. caesius, C. optimus* and *C. subinermus* (all of unknown status).

Rattan conservation cannot be separated from general forest conservation. The combination of decreasing forest cover and over-exploitation of wild canes threatens the very survival of a commercial rattan industry in many parts of Southeast Asia (Dransfield, 1989). As shown in Table 4-7, the sad fact is that we do not know enough about the conservation status of wild rattans to identify which areas should be the focus of priority conservation actions.

Socio-economic and cultural issues. The impact on local rattan collectors of the decline in wild rattan resources is often overshadowed by the more publicized concerns for the rattan product industry. Affected groups may be indigenous people living a relatively traditional life in or near the forest or small landholders eking out a living with shifting cultivation. There are a number of instances of local groups which are dependent upon gathering wild rattan and other non-wood forest products for a cash income to purchase necessary modern industrial goods.

Examples from the Philippines include the following: Antolin (1995) writes of rattan collecting as an important source of employment in the uplands of northeastern Luzon; Conelly (1985) describes how rattan and copal collecting represents a significant source of cash income for the Tagbanua of Palawan Island; and Siebert and Belsky (1985) relate how a lowland village depends upon collecting rattan and harvesting timber for a key source of livelihood. Peluso (1992) and Weinstock (1983), already referred to above with respect to Kalimantan, Indonesia, also stress the socio-economic importance of rattan. In Malaysia, Kiew (1991) and Lim and Noor (1995) emphasize how the Orang Asli communities have a stake in the future of rattan collecting.

Two interrelated socio-economic elements play a vital role in the future of rattans as non-wood forest products. One is land tenure. Rattan management, of whatever kind, will only be a success if those involved have clear title to the land, or have long and easily renewable lease rights, so that the future benefits of sustainable practices can be guaranteed. The second element involves the rattan collectors' stake in the rattan resources they exploit. Currently, a rattan collector rationally maximizes his or her income by harvesting the best and most accessible canes, because they are paid by the piece for their labors. Larger canes bring the best price and minimizing walking time is an efficiency for the collector. This same situation applies to most non-wood forest product collecting. What is needed is a means to provide the rattan collector with a stake in wild resource management and a method of payment which rewards sustainable practices over excessive or wasteful exploitation.

Other Uses of Rattan Palms

A discussion of rattan utilization would be incomplete without mention of useful products other than canes. Examples of secondary products uses are summarized in Table 4-9. It should be pointed out that Table 4-9 contains data on only the 232 rattans in Tables 4-5, 4-6 and 4-7, or roughly 35-40 percent of Asian rattans. Secondary uses are documented for other rattan species as well; uses given in Table 4-9 are representative of rattan palms in general. Not included in Table 4-9 but worth mentioning because it is unusual is the apparent exploitation of a rattan in Thailand for palm heart. A company in Chiangmai is canning and exporting a product they call "Rattan Shoot." But it is in fact palm heart and is derived possibly from *Daemonorops schmidtiana* (John Dransfield, pers. com.). No information is available about whether this endemic species has value for its cane; its conservation status is unknown.

Table 4-9: Secondary Uses and Products of Rattan Species Listed in Tables 4-5, 4-6 and 4-7

Product/Use	Genus and Species
fruit eaten	*Calamus conirostris; C. dongnaiensis; C. longisetus; C. manillensis; C. merrillii; C. ornatus*[1]*; C. paspalanthus; C. pseudoscutellaris; C. subinermis; C. viminalis* *Calospatha scortechinii* *Daemonorops hystrix; D. ingens; D. periacantha; D. ruptilis*
palm heart eaten	*Calamus egregius; C. javensis; C. muricatus; C. paspalanthus; C. pseudoscutellaris; C. simplicifolius; C. subinermis* *Daemonorops fissa; D. longispatha; D. margaritae; D. melanochaetes; D. periacantha; D. scapigera; D. schmidtiana; D. sparsiflora* *Plectocomiopsis geminiflora*
seeds chewed	*Calamus tonkinensis*
fruit in traditional medicine	*Calamus castaneus; C. longispathus* *Daemonorops didymophylla*
palm heart in traditional medicine	*Calamus exilis; C. javensis; C. ornatus* *Daemonorops grandis* *Korthalsia rigida*
fruit as red dye source	*Daemonorops didymophylla; D. draco; D. maculata; D. micracantha; D. propinqua; D. rubra*
leaves for thatching	*Calamus andamanicus; C. castaneus; C. dilaceratus; C. longisetus* *Daemonorops calicarpa; D. elongata; D. grandis; D. ingens; D. manii*
leaflet as cigarette wrapper	*Calamus longispathus* *Daemonorops leptopus*
leaf sheath/petiole for grater	*Calamus burckianus; C. insignis*
rachis for fishing pole	*Daemonorops grandis*

Note: 1. See Table 9-6 for nutritional composition of fruit.
Sources: Same as Table 4-5.

Figure 4-1. Cultivated sago palm (*Metroxylon sagu*) in Sarawak, East Malaysia. Photograph by Dennis Johnson.

Figure 4-2. Sago palm starch *(Metroxylon sagu)* for sale in West Kalimantan, Indonesia. The starch is wrapped in leaves from the same palm. Photograph by Johanis Mogea.

Figure 4-3. Rattan canes (*Calamus* spp.) drying in the sun in South Sulawesi, Indonesia. Photograph by Johanis Mogea.

Figure 4-4. Rattan factory. Java, Indonesia. Photograph by Dennis Johnson.

Figure 4-5. Nipa palm (*Nypa fruticans*) in habitat in Sarawak, East Malaysia. Photograph by Dennis Johnson.

Figure 4-6. Salak palm fruits (*Salacca zalacca*) for sale. Java, Indonesia. Photograph by Dennis Johnson.

Figure 4-7. House wall panels made from buri leaves (*Corypha utan*). Mindanao, Philippines. Photograph by Dennis Johnson.

Figure 4-8. Boiling down sap of buri palm (*Corypha utan*) to make sugar. Mindanao, Philippines. Photograph by Domingo Madulid.

Figure 4-9. *Calamus merrillii* fruits (center) being sold in the Baguio Market, Philippines. Photograph by Domingo Madulid.

Figure 4-10. Wild date palm (*Phoenix sylvestris*) along a roadside. West Bengal, India. Photograph by Dennis Johnson.

Figure 4-11. Brushes made from palmyra palm (*Borassus flabellifer*) leaf-base fiber. Tamil Nadu, India. Photograph by Dennis Johnson.

Figure 4-12. Assorted products made from palmyra palm (*Borassus flabellifer*) leaf fiber. Tamil Nadu, India. Photograph by Dennis Johnson.

Figure 4-13. Sawing boards of coconut wood (*Cocos nucifera*) in Mindanao, Philippines. Photograph by Dennis Johnson.

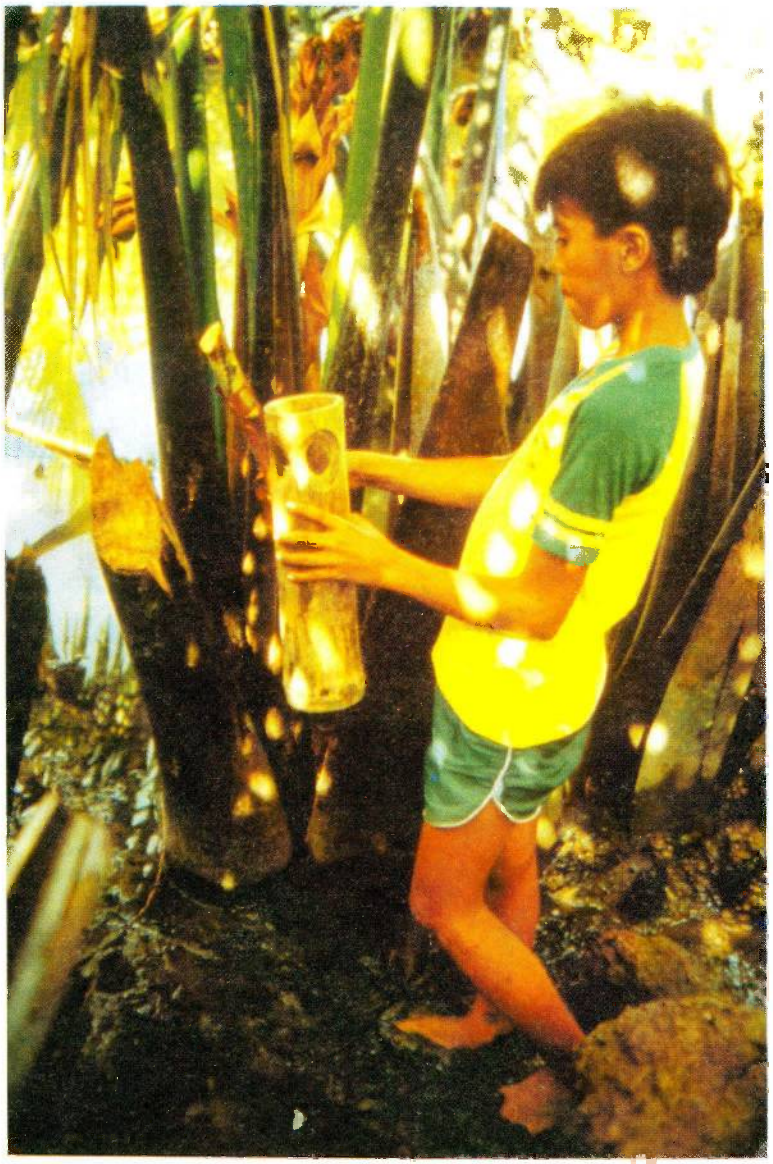

Figure 4-14. Tapping nipa palm (*Nypa fruticans*) using a bamboo container to collect the sap. Mindanao, Philippines. Photograph by Domingo Madulid.

Pacific Ocean region

This chapter considers the islands of the Pacific Ocean which are geographically divided into Micronesia, Melanesia and Polynesia. Micronesia delimits islands in the western Pacific and consists of the Mariana, Palau, Caroline, Marshall and Gilbert island groups. Melanesia lies to the northeast of Australia and includes New Caledonia, Vanuatu (formerly known as the New Hebrides), Solomon Islands and Fiji. Polynesia designates the islands of the central Pacific, including Samoa (Western and American), French Polynesia (Marquesas, Society Islands, etc.) and Tonga. Papua New Guinea is also included within the scope of this chapter; politically the nation of Papua New Guinea consists of the eastern portion of the island of New Guinea and the Bismarck Archipelago (e.g. New Britain and New Ireland) as well as Bougainville.

The following geographic areas where palms occur are excluded from discussion in this chapter and this report. The Hawaiian Islands; New Zealand, including the Kermadec Islands; Australia and its island territories (e.g. Lord Howe, Norfolk, Christmas and Cocos); and the Bonin and Ryukyu Islands belonging to Japan.

The Pacific Ocean Region presents some very unusual patterns of native palms diversity. In the entire area of Micronesia there are only about ten species of native palms (Moore and Fosberg, 1956). The situation in Polynesia is comparable. In marked contrast Melanesia has much greater native palm diversity. For example, New Caledonia alone has 32 indigenous palm species, all endemic (Moore and Uhl, 1984) and Vanuatu has 21 native palms (Dowe and Cabalion, 1996). Papua New Guinea and its islands hold a very rich diversity of palms; about 190 native species in all (Essig, 1995; Hay, 1984).

Coconut, considered as a cultivated tree, is the most widespread palm of the Pacific, found on virtually every island, inhabited or uninhabited, that is of sufficient size and high enough above sea level to support the growth of trees. A dozen or more palms from outside the region have been introduced to these islands and in some cases become naturalized, giving individual islands the appearance of a richer palm flora than they naturally possess. The betel nut palm (*Areca catechu*) and the African oil palm (*Elaeis guineensis*) as well as several strictly ornamental species serve as examples. Palms native to the region have also been introduced to islands where they are not native. Examples are the useful sago palms, *Metroxylon* spp., and two ornamental species, the Fiji fan palm, *Pritchardia pacifica* and the Marquesas palm, *Pelagodoxa henryana*.

Native palms of the Pacific Ocean Region, as defined above, were assessed for information on their utilization patterns and conservation status. The results of the assessment are evaluation presented below; however, they can be understood better if placed within a broader context. Two major factors stand out.

First of all, native palms of the region are not utilized to the magnitude that might be expected. This circumstance can be explained by the existence of excellent alternative sources of plant raw materials which are readily accessible. In the Pacific Islands, the chief alternative plants are coconuts and the screw pines (*Pandanus* spp.). The case study on the multiple utility of the coconut palm on the Truk Islands of Micronesia (Chapter 2) documents the very limited exploitation of native palms. As for the other alternative plant source, screw pines are widely distributed in the Pacific and provide edible fruits as well as leaves for thatching and weaving.

The second factor is that information is lacking that would allow assigning a threatened or non-threatened status to many native palms in the region. This applies in particular to Papua New Guinea where 90 percent of the palm species carry an "unknown" conservation status. Some uses for these "unknown" palms are reported in the literature. However, without conservation status information, a reasonable appraisal cannot be made as to whether a particular utilization is acceptable and apparently sustainable, or should be discouraged because it represents a threat to the survival of wild populations.

Threatened Pacific Ocean Region Palms

A review of the technical literature on palms revealed a total of 28 species of threatened palms, representing 12 genera, currently being exploited in the region (Table 5-1). It is acknowledged that this compilation is probably incomplete as regards palm utilization because it was not possible to peruse the numerous ethnographic studies of this culturally and linguistically diverse area. Coverage for Papua New Guinea is insubstantial because both conservation status and detailed ethnographic data are lacking.

Habitat destruction or degradation caused by logging and clearing of land for agriculture and urban development are the major threats to palms in the region. Palms occurring on islands are particularly at risk because they often occupy habitats that are relatively small in area. Moreover, island palms often represent distinctive species which have evolved due to isolation. New Caledonia is a remarkable example of this circumstance for it possesses 32 native described species, all endemic to the island and in certain instances individual species occur only in small areas of the island.[6] All 32 of New Caledonia's palms are threatened, but only one, *Alloschmidia glabrata*, is reportedly exploited, for palm hearts. In New Caledonia, as elsewhere in the region, coconuts and screw pines furnish plant materials for a wide variety of uses.

Discussion

An examination of the palm products listed in Table 5-1 indicates that in most cases the threatened palms are being exploited for subsistence-level production. Thatching and stem wood for construction purposes are most prominent with some food products as well. If the destructive impact of exploiting these palms is publicized it should be possible to promote alternative raw material sources.

Commercial-level exploitation appears to be confined to the rattan palms (*Calamus* spp.), popular sources of canes for furniture making, and palm heart exploitation.

Of the six threatened rattan species, only *Calamus hollrungii* and *C. warburgii* are of sufficient importance to be even considered "minor rattans" in a recent study of this plant resource (Dransfield and Manokaran, 1993). *Calamus hollrungii*, according to the source just cited, is a source of excellent furniture canes and has potential for cultivation. Rattans represent a potential sustainable resource, especially in Papua New Guinea where about 34 species of *Calamus* occur, but except for the two species mentioned above, there is no information on either conservation status or utilization.

[6] A book on the palms of New Caledonia is in process by Jean-Christophe Pintaud and Donald R. Hodel and is expected to be published in 1997.

Table 5-1: Threatened Pacific Ocean Region Palms with Reported Uses

Scientific Names	Selected Local Names[1]	Distribution[2]	Products/Uses
Actinorhytis calapparia	vekaveke (New Ireland); boluru (Sol)	PNG, Solomons	nuts as betel substitute, edible palm heart
Alloschmidia glabrata (monotypic)	?	New Caledonia (endemic)	edible palm heart
Areca guppyana	bua lau	Solomons (endemic)	nuts as betel substitute
1) *Balaka longirostris;* 2) *B. pauciflora;* 3) *B. seemannii*	1) mbalaka, niuniu; 2) black bamboo; 3) mbalaka, niuniu	1, 2 & 3) Fiji (all endemic)	1) stems to make ceremonial spears; edible kernel; 2) stems to make spears; 3) stems for walking sticks & to make spears
1) *Calamus hollrungii;* 2) *C. stipitatus;* 3) *C. vanuatuensis;* 4) *C. vestitus;* 5) *C. vitiensis;* 6) *C. warburgii*	1) Papuan white rattan (PNG), kuanua (New Ireland); 2) ?; 3) loya ken; 4) ?; 5) ngganuya; 6) ?	1) PNG, Solomons; 2) Solomons (endemic); 3) Vanuatu (endemic); 4) PNG, Solomons; 5) Fiji (endemic); 6) PNG, Solomons	1,2,4 & 6) traditional house building & furniture making; 3) minor use for furniture making, stem sap drunk & used as ointment; 5) baskets, walking sticks
Carpoxylon macrospermum (monotypic)	bungool	Vanuatu (endemic)	fruit eaten, brooms from leaves, carrying & storage vessels from first inflorescence bract and leaf sheath
1) *Clinostigma harlandii;* 2) *C. onchorhynchum;* 3) *C. samoense*	1) ngami igh; 2 & 3) niu vao	1) Vanuatu (endemic); 2 & 3) Western Samoa (both endemic)	1) fruit mesocarp & palm heart eaten; 2 & 3) stem wood split into rods for attaching thatch, leaves for thatch
Cyphosperma tanga	tangga	Fiji (endemic)	seed & palm heart edible
Licuala grandis	tabataba	Vanuatu	leaves used for wrapping and as an umbrella, also in medicine
1) *Metroxylon amicarum;* 2) *M. salomonense;* 3) *M. vitiense;* 4) *M. warburgii*	1) rypwyng; 2) heavy nut, ivory nut (Sol), bia (Van); 3) songo; 4) tenebee (Sol), uluwar (Van), ota (Rot)	1) Carolines (endemic); 2) Solomons, Vanuatu; 3) Fiji (endemic); 4) Solomons, Vanuatu Rotuma	1) leaves for thatching, seed is source of vegetable ivory; 2) seed is source of vegetable ivory, leaves for thatching & other uses; 3) leaves for thatching; 4) leaves for thatching, stem starch (Van, Rot)
Pelagodoxa henryana (monotypic)	énu	Marquesas Islands (endemic)	young endosperm eaten
1) *Veitchia filifera;* 2) *V. joannis;* 3) *V. pedionoma;* 4) *V. vitiensis;* 5) *V. montgomeryana*	1) thangithake; 2) niusawa; 3) niuniu; 4) kaivatu; 5) palmtri	1-4) Fiji (all endemic); 5) Vanuatu (endemic)	1) stems previously (?) used as rafters; 2) leaves for thatching, stem for spars & construction, seed & palm heart edible; 3) leaves for thatching, stem wood to make canoe ribs, ceremonial spears, immature fruit edible; 4) stems for house rafters, palm heart, seed & inflorescence all edible; 5) palm heart harvested for tourist restaurants;

Notes: 1. Many other local names are given in most of the sources cited.
2. Distribution is within the region as defined; some species also occur elsewhere.

Sources: Cribb, 1992; Dowe, 1989a,b, 1996; Dowe, Benzie and Ballment, in press; Essig, 1978, 1995; Gillett, 1971; Hay, 1984; Horrocks, 1990; LeBar, 1964; Moore, 1979; Moore and Uhl, 1984; Rauwerdink, 1986; Uhl and Dransfield, 1987; Whistler, 1992.

The native rattans of the Pacific Ocean region are in general of lower quality and have less value than the primary commercial species in Southeast Asia. As a substitute for exploiting native rattan resources, the South Pacific Forestry Development Programme has launched a program to introduce three commercial rattan species from Malaysia into the South Pacific (Tan, 1992). Trial plantings have been carried out using sega (*Calamus caesius*), manau (C. *manau*) and batu (*C. subinermis*).

Seven palms in Table 5-1 are indicated to have edible palm hearts and *Veitchia montgomeryana* in Vanuatu is exploited to furnish exotic salad ingredients to restaurants operated primarily for tourists. All seven of these palms are solitary species and therefore the exploitation is unsustainable and should be strongly discouraged.

The sago palms (*Metroxylon* spp.) are multipurpose species. Products currently being derived from the four threatened species in Table 5-1 could all be derived from the main cultivated species, *Metroxylon sagu*, as an alternative.

Non-threatened Pacific Ocean Region Palms

In the Region, only ten non-threatened palm species, in eight genera, have reported uses (Table 5-2). This number will certainly increase as more becomes known about the palms of Papua New Guinea. *Arenga microcarpa, Caryota rumphiana* and *Metroxylon sagu* share the characteristics of producing suckers and of terminal flowering; palms having these growth habitats are readily managed on a sustainable basis.

Discussion

Subsistence-level uses for construction materials and food products characterize the palms in Table 5-2. Three of the palms merit further discussion. *Korthalsia zippelii* in Papua New Guinea apparently supports a cottage industry for furniture making.

Metroxylon sagu in Papua New Guinea is exploited for stem starch which is both a subsistence and commercial product. Sago is produced manually and some surplus is produced and sold in markets. Shimoda and Power (1986) and Power (1986) discuss the status of sago in Papua New Guinea. Inasmuch as *M. sagu* is native to New Guinea it represents a natural resource with substantial development potential. Over the past 20 years the sago palm has received considerable attention because it is a high producer of starch per unit area and sago starch has certain unique qualities for food and industrial uses. Table 5-3 lists the nine books on sago which have been published.

Nypa fruticans is found in pure stands in Papua New Guinea, but has been under utilized. A major drawback is the lack of local knowledge of tapping techniques to obtain nipa sap and convert it to sugar or alcohol. According to Päivöke (1983, 1984) nipa has development potential in Papua New Guinea.

Table 5-2: Non-threatened Pacific Ocean Region Palms with Reported Uses

Scientific Names	Selected Local Names[1]	Distribution[2]	Products/Uses
Areca macrocalyx	kumul (New Ireland), e'ésu (Sol)	PNG, Solomons	nuts as betel substitute
Arenga microcarpa	?	PNG	edible palm heart
Caryota rumphiana	gelep (New Ireland)	PNG, New Ireland	stem wood for construction planks
Clinostigma savaiiense	níu vao	Western Samoa (endemic)	stem wood split into rods for attaching thatch, leaves for thatch
1) Gulubia costata; 3) G. cylindrocarpa; 2) G. macrospadix	1) ?; 2) niulip; 3) niniu (Boug)	1) PNG; 2) Vanuatu, Solomons (endemic to the two island groups); 2) PNG, Bougainville, Solomons	1) stem wood for floor boards & siding; 2) palm heart & fruit eaten; 3) stem wood for floor boards & siding
Korthalsia zippelii	? (rattan)	PNG	furniture making, walking sticks, etc.
Metroxylon sagu	ambutrum (PNG)	PNG, Solomons	stem starch (see Table 9-22 for nutritional composition), leaves for thatching, petioles for construction, etc.
Nypa fruticans (monotypic)	ak-sak (Boug); towe'el (Palau)	PNG, Bougainville; Marianas	leaves for thatching, tapped for sap, heart & immature endosperm eaten; leaves for thatching (Mar)

Notes: 1. See Table 5-1.
2. See Table 5-1.

Sources: References for Table 5-1 and in addition: Essig, 1982; McClatchey and Cox 1992; Päivöke, 1983, 1984; Ruddle *et al.*, 1978; Whistler, 1987.

Table 5-3: Books Published on the Sago Palm (*Metroxylon sagu*) Since 1977

Abbreviated Title and Reference	Contents/Comments
First Sago Symposium (Tan, 1977)	Proceedings represent a benchmark on sago & consist of 32 papers under the general headings: prehistory & ethnobotany; agronomy & economics; technology & industry.
Palm Sago (Ruddle, *et al.*, 1978)	A global study of sago starch with chapters on: traditional extraction; sago as subsistence food; sago in myth and ritual; modern commercial sago production; international trade; future outlook.
Second Sago Symposium (Stanton & Flach, 1980)	Proceedings consist of 17 papers divided between sago palm growth & starch production, & actual & potential food & industrial uses.
Sago West Malaysia (Tan, 1983)	A detailed study of the sago industry in Batu Pahat District, southwestern Peninsular Malaysia.
Sago Palm (Flach, 1983)	A development paper prepared especially for the expert consultation meeting in January 1984, see next item. A solid state-of-the art summary.
Sago Palm Products (FAO, 1986)	A collection of 25 papers for an expert consultation meeting, January 1984, covering the general topics: management of natural stands; agronomy & farming systems; sago processing & utilization; socio-economics.
Third Sago Symposium (Yamada & Kainuma, 1986)	Proceedings consist of 28 papers covering three general areas: case studies of sago production in specific areas of Southeast Asia & Papua New Guinea; sago palm growth; technical & industrial aspects of starch production.
Fourth Sago Symposium (Ng *et al.*, 1991)	Proceedings consist of 33 papers given in the following seven broad areas: status & prospects; ecology, distribution & germplasm; in vitro culture; growth & nutrition; environment & production; processing & quality; utilization & product development
Fifth Sago Symposium[1] (Subhadrabandhu & Sdodee, 1995)	Proceedings comprised of 19 papers covering three general areas: technical & industrial aspects of sago starch; sago palm cultivation; economics

Note: 1. A Sixth International Sago Symposium is scheduled for December 9-12, 1996, in Pekanbaru, Indonesia; the theme of the symposium is "The Future Source of Food and Feed." The proceedings will be published.

Latin American region

New World palms and their products are the subject of this chapter. The region is defined as extending north-south from Mexico to Chile and Argentina, and including the islands of the Caribbean.

Palm species diversity in this region is second only to Asia. Glassman (1972) recognized over 1,100 palm species in the Americas (including the United States). However, in a recent field guide to New World palms, Henderson *et al.* (1995) consider there to be only 550 palm species native to the Americas. This significant difference in species totals is attributable to the many synonymous names included in the higher figure and the fact that Henderson *et al.* follow a broad species concept resulting in the lower number.

Over the last two decades, research in the biological and social sciences has helped to generate a reliable body of knowledge about the utilization patterns and scientific names of Latin American palms. This knowledge has come from several different approaches, and can be illustrated by the following examples grouped into five categories.

General palm studies. The survey of the major underutilized palms of tropical America (FAO/CATIE, 1984) is an excellent source of information. Papers in the palm symposium proceedings (Balick, 1988b) primarily deal with the Latin American region. Balick (1984, 1989) also has provided surveys of palm ethnobotany and diversity of use in the region. A natural resource approach was used by Kahn (1991) in a study of palms in swamp forests of the Amazon. Kahn and de Granville (1992), in their study of palm forest ecosystems of Amazonia, provide data on leaf and fruit productivity which have direct relevance to exploiting palm products. A literature survey of South American palms as sources of medicine was carried out by Plotkin and Balick (1984). Schultes (1974) examined the relationship between palms and religious beliefs among indigenous people in the northwest Amazon.

Indigenous palm use. South America has been the focus of a number of such recent studies. The palm use of the Shipibo in Peru was studied by Bodley and Benson (1979), as previously shown in the case study in Chapter 2. Anderson (1978) investigated indigenous palm names and uses by the Yanomama in Brazil. An ethnobotanical study of the Chácobo Indians in Bolivia by Boom (1986) documented palm use. Gragson (1992) studied palm use by the Pume Indians and Beckerman (1977) by the Bari Indians, both in Venezuela. Palm utilization in coastal Ecuador among the Cayapas and Coaiqueres was investigated by Barfod and Balslev (1988). Balick (1979b) documented palm use by the Guahibo in Colombia and the Apinayé and Guajajar Indians in Brazil (1988c).

Geographic area studies. Apart from floras themselves, palm use in specific geographic areas has been studied by Read (1988) in the Caribbean, Quero (1992) in Mexico and Bernal (1992) in Colombia. Borchsenius *et al.* (1996) did a study of Ecuadorean palm use; and Kahn (1988), Mejía (1988, 1992) and López Parodi (1988) all researched the subject in parts of eastern Peru. Pinheiro and Balick (1987) edited and translated material on Brazilian palm use.

Oil palm studies. The American oil palms have been the subject of several investigations relative to their economic potential. Lleras and Coradin (1988) provide an overview of the oil-bearing palms of the region and Balick (1979a) examined the subject in the Amazon. Balick (1986, 1988a) also looked in detail at oil palms in the genus *Oenocarpus* (including *Jessenia*). Anderson *et al.* (1991) studied in depth the potential of the babaçu palm (*Attalea speciosa,* syn. *Orbignya phalerata*) in Brazil. Pesce (1985) is a source of information on the characteristics of Amazonian palm oils.

Management and domestication studies. Apart from American oil palms, management of other wild palm stands has been the subject of research. Anderson (1988) in the Lower Amazon in Brazil, and Urdaneta (1981) in the Orinoco Delta in Venezuela, each studied management of the açaí or manaca palm *(Euterpe oleracea*). Voeks (1988) examined management of the piassava palm (*Attalea funifera*) in Bahia, Brazil. Pinard and Putz (1992) researched palm demographics and management which included a dozen New World palms. Ecuadorian palms with agroforestry production potential were the subject of a book by Borgtoft Pedersen and Balslev (1990). Coradin and Lleras (1988) provided an overview of New World palms with domestication potential. The only fully domesticated native palm of the region, pejibaye (*Bactris gasipaes*) has been the object of a number of studies (Clement, 1988; Mora-Urpí, 1996), the results of which may be applicable to other species in the region.

Threatened Latin American Palms

The foregoing discussion provides background for an assessment of natural native palm populations which have reported uses and are also under threat in the wild. Table 6-1 lists 27 genera and their species which are known to be utilized as well as threatened by a combination of factors. Criteria for inclusion in the table on the basis of utilization were that uses are contemporary or historical with the possibility of renewal; some examples of very minor and occasional use are omitted.

It should be noted that there exist a number of threatened species which do not appear in Table 6-1 because they have no current utility. Also, information on the conservation status of some forest palms in remote areas is unknown. Within the Latin American region, the two chief threats to native palms populations are deforestation and shifting cultivation. Exploitation also plays a role depending upon the product and varying from species to species.

Discussion

The main purpose of Table 6-1 is to draw attention to those products derived from threatened palms, products which should not be promoted for commercial production if they rely upon wild palm stands. It is well to distinguish in general between subsistence uses and commercial uses. Subsistence-level exploitation, especially by indigenous groups of forest-dwellers, in most cases poses no significant threat to wild palm populations. But commercialization of the products of threatened palms which inevitably must lead to an increase of pressure on wild palms can bring about adverse effects. Over exploitation of leaves and fruits impairs natural regeneration of populations of standing trees. Digging of palm seedlings for ornamental use has the same effect if insufficient numbers of young plants are not left in place. Felling trees themselves for products such as palm heart can result in the most serious impact of extractive activities on native palms.

Predominant uses in Table 6-1 are leaves for thatching as well as for weaving in basketry; food and feed products derived from fruits, palm heart and palm sap; and construction material from palm stems. Certain of the palms listed warrant discussion.

Table 6-1: Threatened Latin American Palms with Reported Uses

Scientific Names[1]	Selected Local Names[2]	Distribution	Products/Uses and Selected References
Aiphanes linearis	chirca (Col)	Colombia	edible fruit
1) *Allagoptera arenaria;* 2) *A. brevicalyx*	1) cacandó (Bra); 2) buri da praia (Bra)	1 & 2) Brazil	1 & 2) edible fruit
1) *Astrocaryum aculeatissimum;* 2) *A. malybo;* 3) *A. triandrum*	1) brejaúva (Bra); 2) anchamba (Col); 3) cabecenegro (Col)	1) Brazil; 2 & 3) Colombia	1) leaves for brooms & hats, stems for construction; liquid endosperm used medicinally; 2) veins of young leaflets used to make mats, baskets; 3) stems used for fencing & construction
1) *Attalea*[3] *amygdalina (incl. A. victoriana)* 2) *A. crassispatha;* 3) *A. oleifera (incl. A. burretiana, A. concentrista);* 4) *A. tessmannii*	1) táparo (Col); 2) carossier (Hai); 3) catolé (Bra); 4) coco (Bra), conta (Per)	1) Colombia; 2) Haiti; 3) Brazil; 4) Brazil, Peru	1) edible & oil-bearing seed; 2) seeds eaten by children; 3) leaves for thatching, oil-bearing seed; 4) endocarp burned to smoke rubber
1) *Brahea aculeata;* 2) *B. dulcis*	1) palmilla (Mex); 2) palma de sombrero (ElS), suyate (Hon), capulín (Mex)	1) Mexico; 2) Mexico to El Salvador & Nicaragua	1) leaves for thatching; 2) stems for construction, leaves for thatch, leaf fibers for rope, edible fruit
Butia eriospatha	butiá (Bra)	Brazil	fruits used to flavor alcoholic drink
Calyptronoma rivalis	coquito (DR); palma (Hai); palma manaca (PR)	Dominican Republic, Haiti, Puerto Rico	young leaves for weaving, mature leaves for thatching (Zona, 1995)
Ceroxylon spp.	palma de cera (Col); palma de ramo (Ecu); ramo benedito (Ven)	Bolivia, Colombia, Ecuador, Peru, Venezuela	leaves cut for Palm Sunday, stems for fences & construction, fruits fed to pigs
Chamaedorea spp. (all except C. tepejilote)	canelilla, guaya, guaita, molinillo, pacaya, pacayita, palmilla, sangapilla, tepejilote, xaté[4]	Mexico to Brazil & Bolivia	cut foliage, whole plants & seed for ornamental use
1) *Coccothrinax borhidiana;* 2) *C. crinita;* 3) *C. ekmanii*	1) guano (Cub); 2) guano barbudo (Cub); 3) gwenn (Hai)	1 & 2) Cuba; 3) Haiti	1,2 & 3) leaves for thatching
Colpothrinax wrightii	palma barrigona (Cub)	Cuba	leaves for thatching, stem for canoes, water barrels, etc., fruits fed to livestock

Scientific Names[1]	Selected Local Names[2]	Distribution	Products/Uses and Selected References
1) *Copernicia brittonorum;* 2) *C. gigas;* 3) *C. ekmanii*	1) jata de costa (Cub); 2) barrigón (Cub); 3) om de pay (Hai)	1 & 2) Cuba; 3) Haiti	1, 2 & 3) leaves for thatching
1) *Cryosophila guagara;* 2) *C. williamsii*	1) guágara (CR); 2) mojarilla (Hon)	1) Costa Rica; 2) Honduras	1) leaves for thatching; 2) edible palm heart (Evans, 1996)
1) *Euterpe catinga;* 2) *E. edulis;* 3) *E. luminosa*	1) açaí da catinga (Bra), asaí de sabana (Col), manaca (Col, Ven); 2) yayih (Arg) juçara, (Bra); 3) guayaquil (Per)	1) Colombia, Venezuela, Peru, Brazil; 2) Brazil, Argentina, Paraguay; 3) Peru	1) stems for construction, leaves for thatching, fruits to make drink; 2) edible palm heart (see Table 9-17 for nutritional composition); 3) stems for poles
Gaussia maya	palmasito (Bel), cambo, (Mex)	Belize, Mexico	stems used for construction
Geonoma congesta	cortadera (Col), caña de danta (CR), suita (Hon)	Honduras, Nicaragua, Costa Rica, Panama, Colombia	leaves for thatching
Itaya amicorum (monotypic)	xila (Bra), marimiipa (Col)	Colombia, Peru, Brazil	leaves for thatching
Jubaea chilensis (monotypic)	palma de coquitos (Chi)	Chile	nuts sold as snack food, tapped for sap
Mauritia carana	caraná (Bra, Col, Ven), canangucha de sabana (Col), aguaje (Per)	Colombia, Venezuela, Peru, Brazil	leaf sheath fibers to make brooms, leaves for thatching
Oenocarpus[5] *distichus*	bacaba (Bra)	Brazil, Bolivia	fruits used to make a beverage & extract oil
1) *Parajubaea sunkha;* 2) *P. torallyi*	1) palma sunkha (Bol); 2) janchicoco (Bol)	1 & 2) Bolivia	1 & 2) leaf sheath & petiole fiber woven into rope (Moraes, 1996; Vargas, 1994)
Phytelephas seemannii; P. tumacana	tagua (Col, Pan)	Panama, Colombia	seeds for vegetable ivory, leaves for thatching (Dalling et al., 1996)
1) *Pseudophoenix ekmanii;* 2) *P. lediniana*	1) cacheo (DR); 2) pal (Hai)	1) Dominican Republic; 2) Haiti	1) former source of palm wine by felling tree; 2) fruits collected for livestock feed
1) *Sabal pumos;* 2) *S. uresana*	1) palma real (Mex); 2) palma blanca (Mex)	1 & 2) Mexico	1) fruit mesocarp edible, leaves for thatching; 2) leaves for thatching

Scientific Names[1]	**Selected Local Names**[2]	**Distribution**	**Products/Uses and Selected References**
1) *Syagrus botryophora;* 2) *S. harleyi;* 3) *S. pleioclada;* 4) *S. smithii;* 5) *S. werdermannii*	1) pati (Bra); 2) côco de raposa (Bra); 3) coqueirinho (Bra), 4) catolé (Bra); 5) côco de vassoura (Bra)	1,2,3 & 5) Brazil; 4) Colombia, Peru, Brazil	1) stems in construction, seeds for oil; 2) waxy leaves as fuel; 3) leaves to make brooms; 4) leaves for thatching, seeds eaten; 5) leaves to make brooms & strainers
Trithrinax brasiliensis	carandaí (Bra)	Brazil	leaflets used to weave hats
1) *Wettinia fascicularis;* 2) *W. hirsuta;* 3) *W. longipetala*	1) macana (Col); 2) palma mazorca (Col); 3) no common name	1) Colombia, Ecuador; 2) Colombia; 3) Peru	1,2 & 3) stems used for construction (Bernal, 1995)

Notes: 1. Scientific names follow Henderson *et. al.* (1995); synonyms are given where notable changes have occurred.
2. An index of common names appears in Henderson *et al.* (1995).
3. The genus *Attalea* includes the genera *Maximiliana, Orbignya* and *Scheelea.*
4. There are numerous common names for *Chamaedorea* palms and they vary from place to place; for more detail see Hodel (1992).
5. Including the genus *Jessenia.*

Source: Henderson *et al.*, 1995.

Table 6-1 groups species of *Ceroxylon* and *Chamaedorea*. Eleven species of *Ceroxylon* are recognized by Henderson *et al.* (1995). *Ceroxylon* palms are unique because they represent, for the palm family, some of the tallest palms in the world (up to 60 m in height) and those occurring at the highest elevations (to 3,150 m). These palms occur in montane rain forests, areas under intense pressure as a result of logging and land clearing for agriculture and livestock raising. As indicated, the palm stems are a source of construction material. Formerly, palms were felled to extract the wax covering the stems of *Ceroxylon*. Remaining stands of these palms should be protected and exploitation for any of their products discouraged.

Chamaedorea palms are also grouped in a single entry, with the exception of *C. tepejilote* as noted. This represents one of the largest New World palm genera, with 77-100 species, depending on which systematic source is followed. The habitat of *Chamaedorea* palms is the understory of tropical rain forests ranging from sea level to 2,600 m. About ten species of *Chamaedorea* are important in ornamental horticulture and for cut foliage, particularly in the United States and Europe. *Chamaedorea seifrizii* (xate or bamboo palm) and *C. elegans* (parlor palm, neanthe bella) are the two most important commercial species. This is not the place to go into a detailed discussion of commercial species of *Chamaedorea,* a subject covered in detail by Hodel (1992). It will suffice here to point out the key issues related to wild populations.

Without question, the chief threat to chamaedoreas is the destruction of their natural forest habitat, for the palms cannot survive without it. Both the gathering of wild *Chamaedorea* seed and the cutting of leaves for the florist trade have adverse effects on wild populations. Seed collection results in reduced natural regeneration and removal of more than a few leaves per stem can diminish plant vigor and diminish fruit production.

Fortunately, increasing cultivation of chamaedoreas for seed is reducing the pressure on wild palms, except in the case of certain species (e.g. *Chamadorea elegans*) which are difficult to grow without artificial pollination. The main sources of wild collected seed are Mexico and Guatemala. Cut leaf exports originate from Mexico, Guatemala and Costa Rica. In northern Guatemala, there is a project to try to manage sustainably the harvest of leaves of wild *C. elegans*, with some hopeful initial results (Reining and Heinzman, 1992). Most promising in the long run is to encourage local farmers to cultivate the desirable palm species to satisfy the demand for seed and cut foliage (Vovides and Garcia Bielma, 1994).

Euterpe edulis is a single-stemmed palm native to the Atlantic Forest in South America. To a major degree, its inclusion in Table 6-1 is because of exploitation for commercial palm heart production in Brazil, Argentina and Paraguay. In Brazil, wild stands were reduced to uneconomic levels, forcing many palm heart companies to shift operations to the Lower Amazon and the exploitation of *E. oleracea*. Nevertheless, naturally-occurring *E. edulis* is still being cut in southern Brazil; industries continue to operate as well in the two neighboring countries. In none of the three countries is the practice sustainable. If replacement plantings were done in the forest to replace harvested trees, sustainable production of palm heart from *E. edulis* could be achieved. Efforts are being made in Brazil to grow the palm on plantations and to produce a hybrid between *Euterpe edulis* and *E. oleracea* with a clustering stem that could make cultivation production price competitive with the harvest of wild *E. edulis* (EMBRAPA, 1987).

Two threatened South American palms, *Itaya amicorum* and *Jubaea chilensis*, are represented by monotypic genera, that is there is but a single species within the genus. From a conservation standpoint, monotypic species merit special attention because of the unique biodiversity they represent.

Non-threatened Latin American Palms

A slightly longer list of palms is presented in Table 6-2. Represented are 34 genera, 19 of which are not included in Table 6-2. The 15 genera common to both tables demonstrate that exploited palm species within the same genus may be either threatened or non-threatened in the wild. Palms in Table 6-2 were selected on the same basis as those in Table 6-1, that is there is current or past use documented. Uses in the latter category are included if there is a possible resumption of the exploitation. Again, a small number of palms are not included because the level of utilization is very minor or only occurs occasionally.

Discussion

At current levels of exploitation, the palms listed in Table 6-2 do not appear to be negatively impacted in a serious manner by their utilization. Major commercial products derived from palms in the region fall into four product groups: edible palm heart; vegetable oil from palm seeds; leaf and leaf base fiber; and wax from palm leaves. The following discussion is comprised of general comments about some of the respective products and palms, and is intended to highlight those utilizations which may lead to problems of sustainability in the near future.

Species in the five genera *Acrocomia, Astrocaryum, Attalea* (including *Maximiliana, Orbignya* and *Scheelea*), *Elaeis* and *Oenocarpus* (including *Jessenia*) comprise the most important oil-bearing palms of the region. Indigenous peoples depended upon these palms as a source of vegetable oil and subsistence utilization continues to this day. These palms produce high quality oil; *Oenocarpus* oil has been compared to olive oil. But the quantity of oil-bearing fruit in these wild palms is low.

Two major problems hinder large-scale industrialization of oil production from these New World palms. One, the palms are wild or semi-wild and hence fruit collection is inefficient and productivity per unit area is low. Two, national and international markets are dominated by other palm oils, e.g. African oil palm and coconut, as well as oils from annual crops such as soybeans. The first problem could be overcome by domestication and breeding of superior American oil palm species; but the second problem currently is insurmountable because of high productivity per unit area of the competing vegetable oil crops. The best potential for expanded utilization may rest with the management of natural palm stands to increase population densities and promote growth along with development of village-level vegetable oil industries to serve local markets.

Internationally, the most significant contribution of the American oil palms thus far concerns *Elaeis oleifera*, which is being used as a source of germplasm for a breeding program to improve disease resistance in *E. guineensis*.

Leaf and leaf base fibers constitute both subsistence and commercial activities in the region. As indicated in Table 6-2, many palm leaves are used for thatching. Providing leaf harvest from individual trees is not excessive, this palm use is sustainable. Where the palm-like Panama hat plant (*Carludovica palmata*) occurs in Central America and northern South America, it represents an often preferred source of leaf material for weaving. In Brazil, palm leaf base fibers are collected from *Attalea funifera* (Bahia piassava) and *Leopoldinia piassaba* (Pará piassava) and primarily used to manufacture brushes and brooms. Collection of these fibers is a benign and sustainable form of exploitation providing that the trees themselves are not damaged in the process.

Table 6-2: Non-threatened Latin American Palms with Reported Uses

Scientific Names[1]	Local Names[2]	Distribution	Products/Uses and Selected References
Acrocomia aculeata (incl. all other spp. except A. hassleri)	mbocayá (Arg), totaí (Bol), macaúba (Bra), corozo (Col, Ven), tamaco (Col), coyol (CR, ElS, Hon, Mex), carosse (Hai)	Mexico, Honduras, El Salvador, Costa Rica to Argentina, Bolivia & Paraguay; Haiti	multipurpose palm including oil-bearing seed & sap for palm wine (Balick, 1990)
1) *Allagoptera campestris*; 2) *A. leucocalyx*	1) buri (Bra); 2) motacuchí (Bol), côco da chapada (Bra)	1) Brazil, Paraguay, Argentina; 2) Brazil, Bolivia, Paraguay, Argentina	1) edible immature fruits; 2) mesocarp & seeds edible
Aphandra natalia	piassaba (Bra, Ecu); tagua (Ecu)	Ecuador, Peru, Brazil	leaf sheath fiber for making brooms, leaves for thatching, edible immature fruit, male inflorescences fed to cattle (Borgtoft Pedersen, 1992; 1996)
Asterogyne martiana	cortadera (Col), pico (Ecu), capoca (Gua), pacuquilla (Hon), pata de gallo (Nic)	Guatemala, Honduras, Nicaragua, Colombia & Ecuador	leaves for thatching
1) *Astrocaryum aculeatum* 2) *A. campestre* 3) *A. chambira* 4) *A. jauari* 5) *A. mexicanum* 6) *A. murumuru* 7) *A. standleyanum* 8) *A. vulgare*	1) chonta (Bol), tucum (Bra), awara (Guy), cemau (Sur), tucuma (Ven); 2) jarivá (Bra); 3) tucuma (Bra), chambira (Col, Ecu, Per), cumare (Col, Ven), coco (Col, Ecu); 4) jauri (Bra), güiridima, (Col, Ven), yavarí (Col), chambirilla, (Ecu, Per), sauarai (Guy), liba awara (Sur) 5) lancetilla (Hon), chocho (Mex); 6) chonta (Bol), murumuru (Bra), chuchana (Col, Ecu), huicungo (Per); 7) güérregue (Col), mocora (Ecu); tucum (Bra), awarra (Sur)	1) Colombia, Venezuela, Trinidad, Guyana, Suriname, Brazil, Bolivia; 2) Brazil, Bolivia; 3) Colombia, Venezuela, Ecuador, Brazil; 4) Colombia, Venezuela, Guyana, Suriname, Peru, Brazil; 5) Mexico, Belize, El Salvador, Nicaragua, Honduras; 6) Colombia, Venezuela, Guianas, Ecuador, Peru, Brazil, Bolivia; 7) Costa Rica, Panama, Colombia, Ecuador; 8) Suriname, French Guiana, Brazil	1) fruit mesocarp edible, oil-bearing seed (Moussa & Kahn, 1996); 2) young leaf fiber to make fishing nets, fruits edible; 3) young leaf fiber to make hammocks, fishing nets, bags (Holm Jensen & Balslev, 1995); 4) leaf rachis used for weaving, endocarps for necklaces, fruits as fish bait, edible palm heart; 5) young inflorescence & endosperm eaten, leaves for thatching & stems for tool handles (Ibarra-Manriquez, 1988); 6) mesocarp eaten, leaves for thatching, stems for construction; 7) stems for construction, fruit fed to pigs, young leaves for weaving (Borgtoft Pedersen, 1994); 8) fruit mesocarp to make mash, flavor ice cream & a beverage (Moussa & Kahn, 1996)

Scientific Names[1]	Local Names[2]	Distribution	Products/Uses and Selected References
1) *Attalea*[3] *allenii;* 2) *A. butyracea;* 3) *A. cohune (syn. Orbignya cohune);* 4) *A. colenda;* 5) *A. exigua;* 6) *A. funifera;* 7) *A. maripa (syn. Maximiliana maripa);* 8) *A. phalerata (syn. Scheelea phalerata);* 9) *A. speciosa (syn. Orbignya speciosa)*	1) taparín (Col), igua (Pan); 2) palla (Bol), jací (Bra), palma de vino (Col), palma real (CR, Pan), corozo (CR, Gua, Mex, Ven), canambo (Ecu), coquito (Gua), coyol real (Mex), shebon (Per), palma de agua (Ven); 3) cohune (Bel, Gua, Hon, Mex), corozo (ElS, Gua, Hon), manaca (Hon); 4) palma real (Col, Ecu); 5) babaçu (Bra); 6) piaçava (Bra); 7) cusi (Bol), anajá (Bra), güichire (Col), inayo (Ecu), maripa (FrG, Sur), kukarit (Guy), inayuga (Per), cucurito (Ven); 8) motacú (Bol) urucuri (Bra), shapaja (Per); 9) cusi (Bol), babaçu (Bra)	1) Panama, Colombia; 2) Mexico, Guatemala, Costa Rica, Panama, Bolivia, Brazil, Colombia, Venezuela, Ecuador, Peru; 3) Mexico, Guatemala, Belize, Honduras, El Salvador; 4) Colombia, Ecuador; 5) Brazil; 6) Brazil; 7) Colombia, Venezuela, Trinidad, Guyana, Suriname, French Guiana, Ecuador, Brazil, Bolivia; 8) Peru, Brazil, Bolivia, Paraguay; 9) Guyana, Suriname, Brazil, Bolivia	1) leaves cut for Palm Sunday, fruit edible; 2) leaves for thatching (Standley & Steyermark, 1958); 3) oil from seeds, leaves for thatching (McSweeney, 1995); 4) seeds collected for commercial oil extraction (Blicher-Mathiesen & Balslev, 1990; Feil, 1996); 5) endosperm used to make candles & sweeten food; 6) leaf base fiber is commercially exploited (Voeks, 1988); 7) leaves for thatching; 8) leaves for thatching, endocarps burned to smoke rubber; 9) seeds collected for commercial oil extraction (Anderson et al., 1991; Balick, 1987)
1) *Bactris*[4] *barronis;* 2) *B. brongniartii;* 3) *B. concinna;* 4) *B. ferruginea;* 5) *B. guineensis;* 6) *B. macana;* 7) *B. major;* 8) *B. maraja;* 9) *B. plumeriana*	1) lata (Col), alar (Pan); 2) marajá (Bra), chacarrá (Col), bango palm (Guy), ñejilla (Per), caña negra (Ven); 3) marajaú (Bol), marajá (Bra), chontilla (Ecu), ñejilla (Per); 4) mané véio (Bra); 5) corozo (Col), biscoyol (CR), coyolito (Nic), uvita de monte (Pan), piritu (Ven); 6) chontilla (Bol), pupunha brava (Bra), chinamato (Col), pijuayo del monte (Per), macanilla (Ven); 7) hones (Bel), marayáu (Bol) marajá (Bra), lata (Col), huiscoyol (ElS, Gua, Hon, Nic), jahuacté (Mex), caña brava (Pan), cubarro (Ven); 8) chontilla (Bol, Col, Per), marajá (Bra), chacarrá (Col), uvita (Pan), ñeja (Per), piritu (Sur, Ven), uva de montaña (Ven); 9) coco macaco (Cub), coco macaque (Hai), prickly pole (Jam)	1) Panama, Colombia; 2) Colombia, Venezuela, Guianas, Peru, Brazil, Bolivia; 3) Colombia, Ecuador, Peru, Brazil, Bolivia; 4) Brazil; 5) Nicaragua, Costa Rica, Panama, Colombia, Venezuela; 6) Colombia, Venezuela, Peru, Brazil, Bolivia; 7) Mexico, Guatemala, Belize, Honduras, El Salvador, Nicaragua, Panama, Colombia, Venezuela, Bolivia; 8) Costa Rica, Panama, Colombia, Venezuela, Suriname, Peru, Bolivia; 9) Cuba, Dominican Republic, Haiti, Jamaica	1) split stems as flooring; 2) fruits eaten; 3) fruits eaten by humans & livestock; 4) leaf fiber woven into fishing line; 5) stems formerly once used to make walking sticks for export, fruit to make a drink; 6, 7 & 8) fruits eaten; 9) fruits eaten by humans & livestock

Scientific Names[1]	Local Names[2]	Distribution	Products/Uses and Selected References
Chamaedorea tepejilote	palmito dulce (CR), pacaya (ElS, Gua, Mex), caña verde (Pan)	Mexico, Guatemala, El Salvador, Costa Rica, Panama, Colombia	immature male inflorescence as food from cultivated & wild plants (Castillo Mont et al., 1994); see Table 9-7 for nutritional composition of this product
Chelyocarpus chuco	hoja redonda (Bol), caranaí (Bra)	Brazil, Bolivia	leaves for thatching & to weave hats
1) *Coccothrinax argentata;* 2) *C. argentea;* 3) *C. barbadensis;* 4) *C. miraguama*	1) silvertop (Bah), thatch palm (Cay), yuruguana de costa (Cub), silver thatch (Jam), knacás (Mex); 2) guano (DR), latanye maron (Hai); 3) latanier balai (Gud, Mar), palma de abanico (PR); 4) miraguano (Cub)	1) Mexico, Honduras, Bahamas, Cayman Is., Cuba, Jamaica 2) Dominican Republic, Haiti; 3) Guadeloupe, Martinique, Puerto Rico; 4) Cuba, Dominican Republic, Haiti	1) stems for construction, leaves for thatching; 2 & 3) leaves for thatching; 4) leaves for weaving & thatching
1) *Copernicia alba;* 2) *C. prunifera;* 3) *C. tectorum;* 4), *C. macroglossa, C. baileyana, C. cowellii, C. hospita. C. rigida*	1) caranday (Arg, Bol, Par), carandá (Bra); 2) carnaúba (Bra); 3) sará (Col), cobija (Ven); 4) yarey, jata, guano cano (Cub)	1) Brazil, Bolivia, Argentina, Paraguay; 2) Brazil; 3) Colombia, Venezuela; 4) Cuba	1) stems for construction & utility poles, leaves for weaving (Markley, 1955; Moraes, 1991); 2) leaves source commercial wax (see Table 9-13 for wax composition & properties) & to weave hats & mats (Johnson, 1972); 3) leaves for weaving & thatching, stems for construction; 4) leaves to weave hats & baskets, thatching, stems for fence posts
1) *Desmoncus cirrhiferus;* 2) *D. giganteus;* 3) *D. mitis;* 4) *D. orthacanthos;* 5) *D. polyacanthos*	1) matamba (Col), bora negra (Ecu); 2) jacitara (Bra), vara casha (Per); 3) jacitara (Bra), bejuco alcalde (Col), barahuasca (Per); 4) basket tie (Bel), bayal (Bel, Gua, Hon, Mex), urubamba (Bol), matamba (Col, CR, Pan), jacitara (Bra), karwari (Guy), bambamaka (Sur), camuari (Ven); 5) jacitara (Bra), bejuco alcalde (Col), vara casha (Per), voladora (Ven)	1) Colombia, Ecuador; 2) Colombia, Ecuador, Peru, Brazil; 3) Colombia, Venezuela, Ecuador, Brazil, Bolivia; 4) Mexico, Guatemala, Belize, Honduras, Costa Rica, Panama, Colombia, Venezuela, Guyana, Suriname, Brazil, Bolivia 5) Brazil, Colombia, Peru, Venezuela, Bolivia	1) stems used to weave baskets & fish traps, fruit edible; 2) stems used to weave various products (Henderson & Chávez, 1993); 3) stems use for basketry & to tie beams in construction (Galeano, 1991); 4) stems for basketry; 5) stems for basketry & sieves
1) *Dictyocaryum fuscum;* 2) *D. lamarckianum;* 3) *D. ptarianum*	1) palma araque (Ven); 2) barrigona (Col), palma real (Ecu), basanco (Per); 3) bombona paso (Col), pona colorada (Per)	1) Venezuela; 2) Colombia, Ecuador, Peru, Bolivia; 3) Venezuela, Colombia, Peru, Brazil	1) wood used in cabinetry; 2) stems used for construction; 3) stems used in construction, leaves for thatching

Scientific Names[1]	Local Names[2]	Distribution	Products/Uses and Selected References
Elaeis oleifera	caiaué (Bra), nolí (Col)	Central America, Northern South America, Colombia, Brazil	mesocarp oil extracted for cooking & other uses (Schultes, 1990)
1) *Euterpe oleracea*; 2) *E. precatoria*	1) açaí (Bra), naidí (Col); manaca (Ven); 2) açaí (Bra), asaí (Bol, Col), huasi (Per), manaca (Ven)	1) Colombia, Ecuador, Venezuela, Brazil; 2) Central America, Colombia, Venezuela, Guianas, Ecuador, Peru, Brazil, Bolivia	1) stems cut for commercial palm heart (see Table 9-17 for nutritional composition), fruits made into drink (Anderson, 1988; Pollak et al., 1995, Strudwick & Sobel, 1988; Tabora et al., 1993; Urdaneta, 1981); 2) stems cut for commercial palm heart, stems used for construction, fruits made into drink
Geonoma spp.	(selected) ubim, assai-rana, jatata, palmiche, cortadera, ubimaçu, huasipanga, daru	wide tropical distribution	leaves of many species used for thatching, most important is G. deversa (jatata) in Bol & Per (Rioja, 1992), stems of some species used in construction
Iriartea deltoidea (monotypic)	copa (Bol), paxiúba barriguda (Bra), barrigona (Col), maquenque (CR), bomba (Ecu), huacrapona (Per), barriguda (Ven)	Nicaragua, Costa Rica, Panama, Colombia, Venezuela, Ecuador, Peru, Brazil, Bolivia, Brazil	stems split for construction & other wood uses (Pinard, 1993)
Leopoldinia piassaba	piassaba (Bra), chiquichique (Col, Ven)	Colombia, Venezuela, Brazil	stem fiber gathered & traded locally, fruits used to make a drink (Putz, 1979)
Lepidocaryum tenue	caraná (Bra, Col), caraña (Per), morichito (Ven)	Colombia, Venezuela, Peru, Brazil	leaves for thatching, esp. in Peru (Kahn & Mejía, 1987)
Manicaria saccifera	temiche (Ven), bussú (Bra), jiquera (Col), troolie (Guy), guágara (Pan)	Panama, Colombia, Venezuela, Guyana, Ecuador, Peru, Brazil	leaves for thatching (Wilbert, 1976)
Mauritia flexuosa	caranday-guazú (Bol), buriti (Bra), aguaje (Per), moriche (Col, Ven)	Northern South America, Colombia, Venezuela, Peru, Bolivia, Brazil	multipurpose palm: edible fruit mesocarp (see Table 9-21 for composition), oil from fruit, leaf fibers for rope, baskets, wine & starch from stem (Padoch, 1988; Ruddle & Heinen, 1974)
1) *Oenocarpus bacaba*; 2) *O. bataua*; 3) *O. mapora*	1) bacaba (Bra), manoco (Col), unguraui (Per), seje pequeño (Ven); 2) bataua (Bra), seje (Col), chapil (Ecu), unguraui (Per), aricaguá (Ven); 3) bacaba (Bol), bacabai (Bra), pusuy (Col), ciamba (Per), mapora (Ven)	1 & 2) Northern South America, Colombia, Venezuela, Peru, Brazil; 3) Costa Rica, Panama, Colombia, Venezuela, Peru, Bolivia, Brazil	1) fruits used to make beverage; 2) fruits contain edible oil, also used to make beverage, leaves woven into baskets, stems in construction (Balick & Gershoff, 1981); 3) fruits used to make beverage, leaflet midveins used for basketry

Scientific Names[1]	Local Names[2]	Distribution	Products/Uses and Selected References
1) *Phytelephas aequatorialis;* 2) *P. macrocarpa;* 3) *P. schottii*	1) tagua (Ecu); 2) yarina (Col, Ecu, Per); 3) cabecinegro (Col)	1) Ecuador, Colombia; 2) Peru, Brazil, Bolivia; 3) Colombia	1, 2 & 3) seeds for vegetable ivory (Barfod, 1989; Barfod et al., 1990; Calera Hidalgo, 1992; Koziol & Borgtoft Pedersen, 1993; Ziffer, 1992)
Polyandrococos caudescens	buri (Bra)	Brazil	stems in construction, leaves for thatching, edible fruit
Pseudophoenix vinifera	cacheo (DR), katié (Hai)	Dominican Republic, Haiti	leaves for thatching, fruits fed to livestock, former source of palm wine obtained by felling tree
Raphia taedigera	jupatí (Bra), pángana (Col), yolillo (CR), matomba (Pan)	Nicaragua, Costa Rica, Panama, Colombia, Brazil	petioles used as poles, petiole strips used to make shrimp traps & bird cages
1) *Roystonea borinquena;* 2) *R. regia*	1) palma caruta (DR), palmis (Hai), palma real (PR); 2) yagua (Hon, Mex), palma criolla (Cub), palma real (Cub, Hon, Mex)	1) Puerto Rico, Dominican Republic, Haiti; 2) Mexico, Honduras, Cuba, Caribbean	1) fruits fed to livestock (Zanoni, 1991); 2) stems cut into planks for construction, fruits fed to livestock, leaves for thatching (Zona, 1991)
1) *Sabal causiarum;* 2) *S. domingensis;* 3) *S. maritima;* 4) *S. mauritiiformis;* 5) *S. mexicana;* 6) *S. palmetto;* 7) *S. pumos;* 8) *S. yapa*	1) palma cana (DR), palma de sombrero (PR); 2) palma cana (DR), latanier-chapeau (Hai); 3) guana cana (Cub), bull thatch (Jam); 4) botán (Bel, Gua), palma amarga (Col), palma de guagara (Pan), carata (Ven); 5) palma de sombrero (ElS), palma de micharo (Mex); 6) guana cana (Cub); 7) palma real (Mex); 8) thatch palm (Bel), botán (Bel, Gua), palma guano (Cub), cana (Mex)	1) Haiti, Dominican Republic; 2) Haiti, Dominican Republic, Cuba; 3) Cuba, Jamaica; 4) Mexico, Belize, Guatemala, Panama, Colombia, Venezuela; 5) Mexico, El Salvador, Central America; 6) Bahamas, Cuba; 7) Mex; 8) Mexico, Belize, Guatemala, Cuba	leaves for thatch & weaving hats, mats, etc; mesocarp of S. pumos edible (Zona, 1990)
1) *Socratea exorrhiza;* 2) *S. montana*	1) pachuba (Bol), paxiúba (Bra), zancona (Col), bombón (Ecu), jira (Pan), cashapona (Per), macanilla (Ven); 2) gualte (Ecu)	1) Central America, Panama, Colombia, Venezuela, Ecuador, Peru, Bolivia, Brazil; 2) Colombia, Ecuador	1 & 2) outer part of lower stem split to make house floors and walls

Scientific Names[1]	Local Names[2]	Distribution	Products/Uses and Selected References
1) *Syagrus cardenasii*; 2) *S. comosa*; 3) *S. coronata*; 4) *S. flexuosa*; 5) *S. inajai*; 6) *S. oleracea*; 7) *S. petraea*; 8) *S. romanzoffiana*; 9) *S. sancona*; 10) *S. schizophylla*; 11) *S. vagans*	1) corocito (Bol); 2) babo (Bra); 3) ouricuri (Bra); 4) acum; 5) curua rana (Bra); 6) catolé (Bra); 7) cocorito (Bol), côco de vassoura, (Par); 8) pindó (Arg, Par), jeribá (Bra); 9) sumuqué (Bol), sarare (Col, Ven); 10) aricuriroba (Bra); 11) pindoba (Bra)	1) Bolivia; 2) Brazil; 3) Brazil; 4) Brazil; 5) Gui, Brazil; 6) Brazil, Paraguay; 7) Brazil, Bolivia; 8) Brazil, Paraguay, Argentina, Uruguay, Bolivia; 9) Venezuela, Peru, Bolivia; 10) Brazil; 11) Brazil	1, 2) edible fruit; 3) edible fruit, oil from seed, edible palm heart, leaves fed to livestock, wax from leaves; 4) edible fruit; 5) leaves for thatching, edible fruit; 6) edible fruit, edible palm heart; 7) leaves for brooms & basketry; 8) edible fruit, edible palm heart, stems in construction; 9) stems for fencing and to conduct water; 10) edible fruit; 11) leaves & inflorescences fed to livestock, fruit fed to livestock, leaves for thatching & weaving hats
1) *Thrinax morrisii*; 2) *T. radiata*	1) miraguano (Cub), palma de escoba (PR); 2) guano de costa (Cub), guanillo (DR), latanier-la-mer (Hai) chit (Mex)	1) Cuba, Puerto Rico, Caribbean; 2) Mexico, Belize, Honduras, Haiti, Dominican Republic, Caribbean, Belize, Honduras	1 & 2) leaves for thatching, stems as poles
1) *Trithrinax campestris*; 2) *T. schizophylla*	1) sago (Arg), caranday (Uru); 2) carandillo (Arg, Bol), burití (Bra)	1) Argentina, Uruguay; 2) Brazil, Paraguay, Argentina	1) leaves for thatching; 2) stems in construction, leaves for thatching & making hats & baskets
Welfia regia	amargo (Col, Pan), palma conga (CR) camara (Per)	Costa Rica, Panama, Northern South America, Colombia, Peru	leaves for thatching, stems in construction
1) *Wettinia aequalis*; 2) *W. kalbreyeri*; 3) *W. maynensis*; 4) *W. praemorsa*; 5) *W. quinaria*	1) ratonera (Col), gualte (Ecu); 2) gualte (Col, Ecu); 3) corunta (Col), gualte (Ecu), camonilla (Per); 4) mapora (Col); prapa (Ven); 5) memé (Col), gualte (Col, Ecu)	1) Panama, Colombia, Ecuador; 2) Colombia, Ecuador; 3) Colombia, Ecuador, Peru; 4) Venezuela, Colombia; 5) Colombia. Ecuador	1-5) stems used in construction

Notes: 1. Scientific names follow Henderson *et. al.* (1995); synonyms are given where notable changes have occurred.
2. See Note 2, Table 6-1.
3. The genus *Attalea* includes the genera *Maximiliana, Orbignya* and *Scheelea.*
4. Pejibaye (*Bactris gasipaes*) is not included in this list because it is a domesticated palm not known in the wild.

Sources: Henderson, *et al.*, 1995; and in addition: Quero, 1992; Read, 1988.

Over its natural range in Mexico, Central America and Colombia, the pacaya palm (*Chamaedorea tepejilote*) occurs in considerable numbers. It is also an exception within the genus in that it tolerates disturbance and the more open habitats disturbance creates. This palm is also widely cultivated for its edible, immature male inflorescence which resembles an ear of maize. Pacaya (the palm and the food product share the common name) is a traditional food of local people and is eaten fresh as well as preserved in jars or tins. A small industry exists in Guatemala to preserve pacaya for markets in the region; a quantity is exported to supply emigrant populations in the United States and Canada. Little known outside the region or the ethnic groups in other countries, pacaya has the potential of being promoted as an exotic food item.

The carnaúba palm (*Copernicia prunifera*) represents the region's chief commercial source of hard vegetable wax. Carnaúba palms constitute almost pure stands in seasonally-flooded river valleys in northeastern Brazil. Leaves of this fan palm have a coating of hard wax which is obtained by cutting and drying the leaves and then mechanically chopping them into small pieces to dislodge the wax particles. Although in recent decades carnaúba wax has been replaced in many of its former applications by synthetics, it still retains a market for high quality floor and automobile polishes, and is used in the food, pharmaceutical and cosmetic industries because of its high melting point and because it is edible. Current levels of exploitation could be expanded with more efficient harvest techniques and new markets for the wax.

The genus *Desmoncus* represents the New World counterpart to the true rattans of the Old World. The stems of several species of this climbing palm are used in Latin America to weave baskets and other objects. In recent years, as part of a search for new wild rattan supplies, importers in the United States have investigated the possibility of exploiting *Demoncus* populations. However, the small diameter and general physical characteristics of *Desmoncus* are not well suited for making quality rattan furniture. No species of *Desmoncus* is currently classified as threatened, but that could be because the conservation status of these palms is so poorly known. Moreover, the taxonomy of the genus needs revision to determine valid species names. Any proposed exploitation of wild populations should be preceded by taxonomic and conservation studies.

South America is the source of most of the world's commercial palm heart. Industries based on the exploitation of natural stands of *Euterpe oleracea* and *E. precatoria* operate in Brazil, Guyana, Venezuela, Colombia, Ecuador, Peru and Bolivia. Both palm species are widely distributed in South America and occur as major tree species. In addition, both have high quality palm heart. Exploitation is destructive because the individual tree is killed to extract the tender apical meristem.

The basic difference between the two species is that *Euterpe oleracea* is a clustering palm with ten or more stems per cluster, whereas *E. precatoria* is a single-stemmed species. As to the question of sustainability of this wild plant resource, the clustering species has potential providing annual harvest involves taking only large stems and the protection of one mature stem per cluster to serve as a seed source for natural regeneration. On the other hand, *E. precatoria* has little or no economic potential for sustained management based on natural regeneration; it is similar to the situation discussed previously with regard to *E. edulis*. Felling *E. precatoria* for palm heart production precludes natural regeneration by eliminating a source of seed. Natural populations of *E. precatoria* will likely, in the next decade or two, follow the pattern of *E. edulis* with populations reduced to uneconomic levels. In terms of palm heart production, economic development efforts should be directed toward practical management systems for *E. oleracea*.

Palm heart is the major palm product included in a new study of non-timber forest products in northern South America (Broekhoven, 1996).

Mauritia flexuosa is Latin America's most abundant palm, occurring as dense stands in permanently swampy areas, particularly in the Amazon Basin. From an economic development standpoint the moriche palm has considerable potential because it is the source of so many different products. Management of natural stands could enhance fruit and leaf production to provide food items and fiber. Stem starch and sap production for palm wine could also be promoted as a means of diversifying economic output from a management unit,

Vegetable ivory is the hardened endosperm of palms in the genus *Phytelephas*. Two species of this palm are included in Table 6-1 because they are threatened, whereas three species appear in Table 6-2 because at present they are not. Vegetable ivory was used in the 19th and early 20th century for making buttons, until plastics replaced it. In 1990, Conservation International, Washington, D.C., established the Tagua Initiative, to revive vegetable ivory products including buttons, jewelry and carvings. Promotion focused on the items being natural products and an alternative to animal ivory. Raw materials come from *P. aequatorialis* stands Ecuadorian coast, where the industries are also located. The Tagua Initiative has achieved modest success.

About one-half the genera in Table 6-2 indicate stem wood as a product. Palm stems are cut and used whole for poles and in construction. Split stems may also be used as floor and wall coverings, as well as fashioned into spears, bows and other objects. Palm wood can be sawn into parquet pieces and used on the floors and walls of public buildings and in modern homes. Palm wood from the genera *Bactris, Iriartea, Socratea* and *Wettinia* is reported to be the highest quality. There are many abundant palms species in these four genera which could be exploited for specialized wood products.

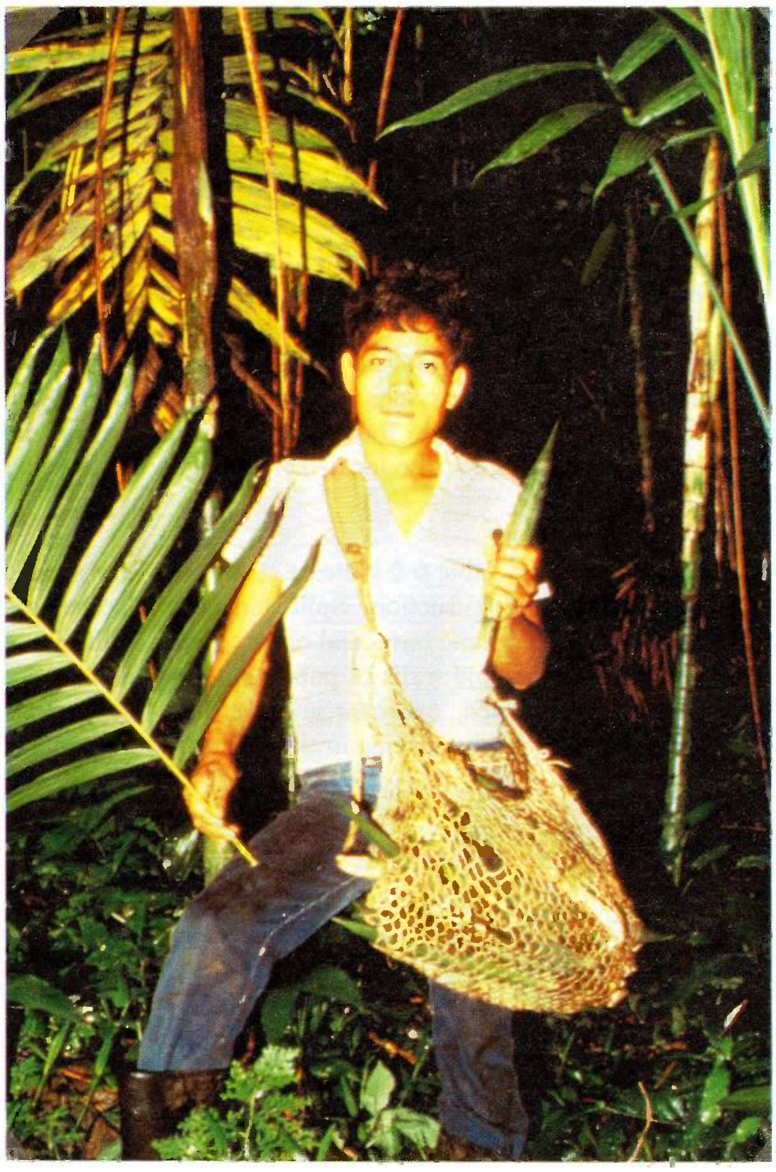

Figure 6-1. Collecting pacaya inflorescences (*Chamaedorea tepejilote*) in Guatemala. Photograph by Don Hodel.

Figure 6-2. **Babaçu fruits (*Attalea speciosa* syn. *Orbignya phalerata*) being sun-dried in Northeast Brazil. Photograph by Dennis Johnson.**

Figure 6-3. **Tucum fruits (*Astrocaryum aculeatum*) for sale in Manaus, Brazil. Photograph by Dennis Johnson.**

Figure 6-4. The huasaí palm (*Euterpe precatoria*) in habitat near Iquitos, Peru. Photograph by Dennis Johnson.

Figure 6-5. **Spear and bow carved from buri palm wood (*Polyandrococos caudescens*) in Bahia, Brazil. Pataxos Amerindians living near Monte Pascoal National Park make these objects to sell to tourists. Photograph by Dennis Johnson.**

Figure 6-6. Palm leaf products (from *Euterpe oleracea* and other palms) for sale in Belém, Brazil. Photograph by Dennis Johnson.

Figure 6-7. Bundles of recently-harvested piassava leaf base fiber (*Attalea funifera*). Bahia, Brazil. Photograph by Dennis Johnson.

Figure 6-8. Pejibaye palm (*Bactris gasipaes*) cultivated in a germplasm collection near Manaus, Brazil. Photograph by Dennis Johnson.

African and the western Indian Ocean region

This chapter provides an overview of palm products of the African Mainland, as well as the major island groups of the western Indian Ocean.

Africa

The continent of Africa is defined geographically to include, because of close mainland ties, the equatorial Atlantic islands (Malabo, Sao Tomé and Príncipe) as well as Zanzibar and Pemba, part of Tanzania, in the Indian Ocean. Excluded are the northern Atlantic island groups of the Canaries and Cape Verde.

Compared to Asia or Latin America, the palm flora of Africa is relatively poor in species diversity. Only about 50 palm species are native to the continent as defined here. However, from a utilization point of view, the low species diversity is compensated for by extensive populations of several species and a range of palm products that approaches that of Asia or Latin America.

Tuley (1995), in his book on African palms, includes a major section on utilization; it serves as a primary source for the following discussion and to a large extent makes it possible. Other botanical sources are the floras of West Africa (Russell, 1968) and East Africa (Dransfield, 1986).

African palms providing subsistence and commercial products have been separated into two groups on the basis of whether they are under threat or not in the wild (Tables 7-1 and 7-2).

Threatened African Palms

The palms in Table 7-1 are under threat as a result of destructive exploitation by humans and animals for leaves, fruit, wood or rattan; as well as because of deforestation. With the exception of *Dypsis pembanus*, there is scant field information about the conservation status of these palms. Until its rediscovery in 1995 in Sudan, *Medemia argun* was feared to be extinct (Gibbons and Spanner, 1996). The genera *Oncocalamus* and *Sclerosperma* are both in need of study to clarify the number of valid species and their distributions.

Table 7-1: Threatened African Palms with Reported Uses

Scientific Name	Selected Local Names[1]	Distribution[2]	Products/Uses
Calamus deeratus[3]	? (rattan)	Across Africa from Senegal to Tanzania	canes used for furniture, etc.
Dypsis[4] *pembanus*	mpapindi	Pemba Island, Zanzibar (endemic)	seed for ornamental plantings
Hyphaene reptans	doum	Somalia	multiple products
Jubaeopsis caffra (monotypic)	inkomba, Pondoland palm	Cape Province, South Africa (endemic)	seed for ornamental plantings, edible fruit ?
Livistona carinensis	carin	Somalia, Djibouti	leaves & stems
Medemia abiadensis, M. argun	argoon	Sudan, Egypt	leaves to weave mats, edible fruit, stem wood ?
Oncocalamus mannii	? (rattan)	equatorial west Africa, Congo Basin	canes used for furniture, etc.
Podococcus barteri	?	Nigeria to Gabon	canes used for furniture, etc.
Sclerosperma mannii	?	Ghana to Angola	canes used for furniture, etc.

Notes: 1. Dozens of common names exist in the many African languages, but no adequate compilation could be found.
2. Distribution is within the Africa region as defined; some species also occur elsewhere.
3. The ecology and uses of *Calamus deeratus, Phoenix reclinata* and *Raphia farinifera* around Lake Victoria is the subject of a doctoral dissertation by Willy Kakuru, Makerere University, Kampala, Uganda.
4. Formerly *Chrysalidocarpus*.

Sources: Tuley, 1995; and in addition: Johnson, 1991a; Morakinyo, 1995; Täckholm and Drar, 1973; Wicht, 1969.

Non-threatened African Palms

Although the palms in Table 7-2 generally are not known to be under threat in the wild, that is not necessarily so for all species of the genera *Eremospatha, Hyphaene, Laccosperma* and *Raphia*. This factor is elaborated on below. *Borassus aethiopum, Elaeis guineensis* and *Phoenix reclinata*, on the other hand, occur in large numbers over wide areas and are the source of many different palm products.

Eremospatha and *Laccosperma* are both climbing palms and sources of rattan. Morakinyo (1995), in a study of rattans occurring in Nigeria, provides useful information on both palm genera in Nigeria and over their range in Africa. Seven species of *Eremospatha* have been described, but further study, which is needed, may reduce the number. According to Morakinyo, *E. hookeri, E. laurentii, E. macrocarpa* and *E. wendlandiana* are harvested for canes. However, the conservation status of the first two named species is unknown and hence harvest should not be encouraged until such time as it can be determined that it is sustainable. The third and fourth species occur in sufficient numbers such that they are currently not threatened. There are as many as eight, but probably fewer, species of *Laccosperma*; this genus needs further study. The main rattan species used is *L. secundiflorum*, which is not threatened; another species *L. opacum* is also exploited to a limited degree; its conservation status is not known.

The statement is made by Morakinyo (1995) that the taxonomy and ecology of African rattans are poorly known and merit further study.

Table 7-2: Non-threatened African Palms with Reported Uses

Scientific Name	Selected Local Names[1]	Distribution[2]	Products/Uses
Borassus aethiopum	ron, palmyra	African savannas	multiple products
Elaeis guineensis	African oil palm	humid parts of Africa	multiple products
Eremospatha spp.	unknown (rattan)	Sierra Leone to Gabon; Zaire, Tanzania, Uganda	cane split to make rope; chewing stick
Hyphaene spp.	doum palm, lala, mokola	arid parts of Africa	multiple products
Laccosperma spp.	? (rattan)	Senegal east to Sudan and south to Angola	canes used for furniture & basket frames, etc.
Phoenix reclinata	Senegal date, wild date	African savannas	multiple products (see Table 9-24 for nutritional composition of palm wine)
Raphia spp.	raffia	humid parts of Africa	multiple products

Notes: 1. Dozens of common names exist in the many African languages, but no adequate compilation could be found.
2. Distribution is within the Africa region as defined; some species also occur elsewhere.
Sources: Tuley, 1995; Morakinyo, 1995.

The doum palm genus *Hyphaene* is poorly known in Africa where it chiefly occurs. Its habitat includes arid and semiarid areas and river valleys. Although as many as 26 species have been named in Africa, Dransfield (1986) and Tuley (1995) propose the recognition of six species. The most pragmatic approach to take with respect to doum palms and their products is to promote utilization of local palm populations on a sustainable basis. Doum palms are multipurpose in nature; products include the edible mesocarp of the fruit in most species, leaves for thatch and fiber, wood and palm wine derived from tapping the trunk. This latter practice is the most destructive as the individual trees are killed. The case study presented in Chapter 2 on the use of *H. petersiana* by local people in Namibia represents a good example of the potential breadth of uses.

Hyphaene products and patterns of utilization are fairly well documented. Täckholm and Drar (1973) provide information from ancient and modern Egypt; Hoebeke (1989) studied the palm and its uses in Kenya (see Table 9-18); Cunningham (1990a,b) investigated palm wine production in southern Africa; Konstant *et al.* (1995) and Sullivan *et al.* (1995) looked at *Hyphaene* utilization and the impact on palm populations in Namibia; and Cunningham and Milton (1987) did a study of basket making from the mokola palm (*H. petersiana*) in Botswana.

The genus *Raphia* is better known than *Hyphaene*, thanks to the research of Otedoh (1982), who recognized 18 African species of this mostly swamp-dwelling palm. Although the taxonomy of the genus has been studied, information about the conservation status of the palms in the wild is very limited. Like *Hyphaene*, the *Raphia* palms provide many products. *Raphia hookeri* and *R. palma-pinus* are sources of a leaf base fiber used commercially to make stiff brushes. In commerce it is known as African bass or African piassava (Tuley, 1994). Common names in Nigeria for *R. hookeri* are ovie-ogoro and afiaku. *Raphia* palms are also excellent sources of leaf stalks for construction purposes, the very large leaves make good roofing material, the fruit mesocarp yields an edible oil and in many of the species the inflorescence is tapped for palm wine.

The ron palm (*Borassus aethiopum*) and the Senegal date palm (*Phoenix reclinata*) both occur in large numbers in the African savannas and represent important local sources of subsistence products. The ron palm produces a single stem whereas the Senegal date is a suckering species and forms thickets of many stems. A study by Sambou *et al.* (1992) on Borassus in Senegal gave the uses listed in Table 7.3.

Table 7.3: *Borassus aethiopum* Uses in Senegal

1. Uses based on structural properties
stem: timber, boards
leaves: roofs, baskets, mats, rugs, furniture
petiole: fences, fiber
2. Uses based on nutritional and medicinal properties
food: endosperm, tuber (cotyledonary haustorium), palm heart, mesocarp sap (wine) tapped from stem
medicinal: roots, male rachillae, stamens, mesocarp, seedling (hypocotyl) sap (wine tapped from stem

Source: Sambou *et al.* (1992)

Sambou *et al.* (1992) point out that in countries such as Senegal, Borassus aethiopum is "a victim of its own high utilitarian value;" overexploitation is a serious threat and natural populations are being reduced by drought and agriculture. They argue that strict management practices be adopted and enforced to sustain the palm populations for the benefit of local people.

Phoenix reclinata has similar but slightly more limited uses than the ron palm. The fruit is edible but smaller and inferior to the domesticated date. Both the inflorescence and stem are tapped for palm wine, and the leaves, petioles and trunk have various uses. Because of its suckering growth habit, the Senegal date palm is under little threat due to exploitation for its products.

The African oil palm (*Elaeis guineensis*), as both its common name and specific epithet imply, is native to West Africa and the Congo Basin. Although it has been the object in the 20th century of one of the most successful crop improvement efforts of any cultivated palm, extensive stands of wild or semiwild African oil palms continue to exist throughout its native range. Mesocarp and endosperm oil are major subsistence products, but the palm inflorescences are tapped for palm wine[7], leaves are employed in thatching and to make baskets and mats and the petioles and wood serve as construction materials. Under these conditions, the African oil palm is a classic multipurpose species, unlike the plantation counterpart which is focused only on palm oil and palm kernel oil. In recent years, interest has broadened to more efficient use of *Elaeis guineensis* as a multipurpose subsistence tree in its native area. Beye and Eychenne (1991) published an excellent study of the African oil palm which exemplifies its "tree of life" status in the Casamance of Senegal, an approach worthy of consideration elsewhere in Africa.

[7] See Okereke (1982) for a description of traditional palm wine practices.

Palm utilization is detailed in the humid forest zone of West Africa by Falconer and Koppell (1990). Three references abstracted in the foregoing source merit mention here. Blanc-Pamard (1980) studied utilization patterns of, *Borassus aethiopum, Elaeis guineensis* and *Phoenix reclinata* among the Baoulé people in Ivory Coast; Coleman (1983) did a sociological study of the rattan enterprises in the Bassam area of Ivory Coast; and Shiembo (1986) researched minor forest products in Cameroon, which included *Raphia* spp. and three species of rattan.

A few introduced, naturalized or domesticated economic palms figure in the forest products of Africa. Coconuts are grown commercially from Senegal to Equatorial Guinea in West Africa, and from Somalia to Mozambique in East Africa (Kullaya, 1994). The nipa palm (*Nypa fruticans*) was introduced early in this century and has become naturalized in coastal Nigeria and Cameroon. It represents an underutilized palm resource, compared to the numerous uses it has in its native areas in Asia. Finally, mention needs to be made of the date palm (*Phoenix dactylifera*), which is an important oasis species and fruit crop in the countries of North Africa.

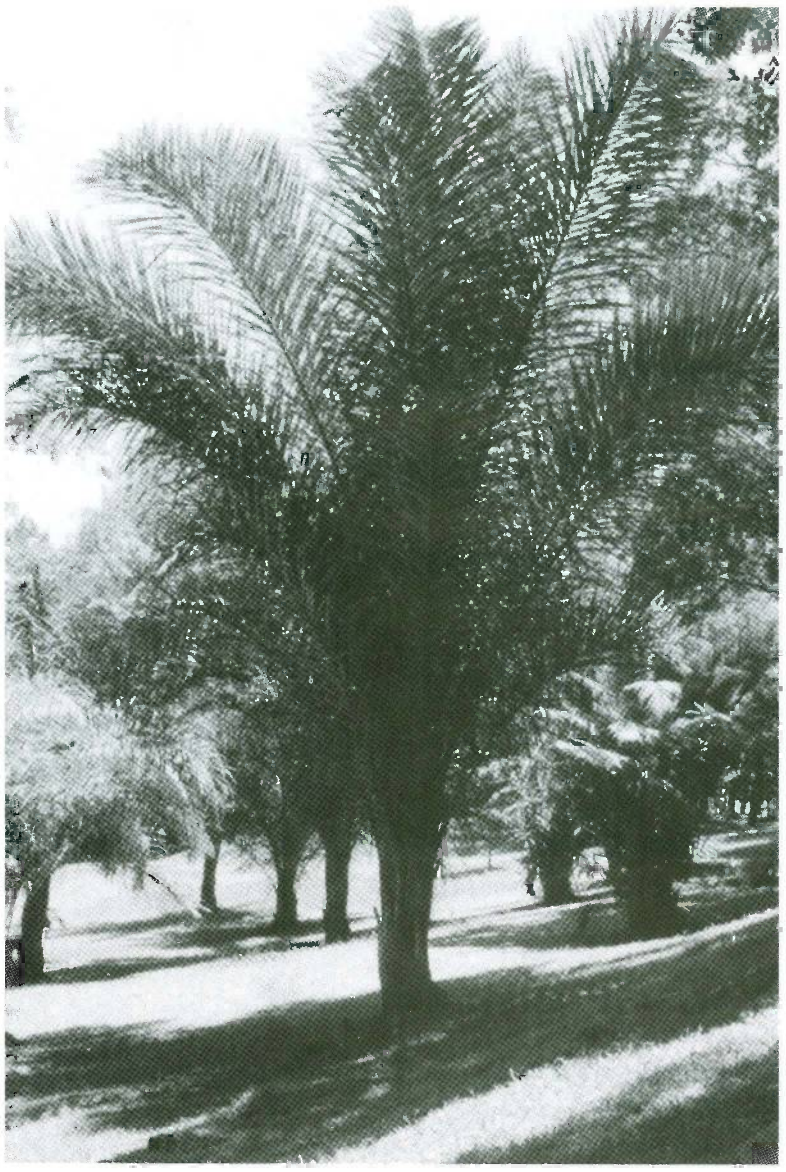

Figure 7-1. **Raffia palm *(Raphia farinifera)* cultivated in a botanic garden. Photograph by Dennis Johnson.**

Figure 7-2. **Doum palm (*Hyphaene* sp.) as an ornamental tree in Burkina Faso. Photograph by Dennis Johnson**

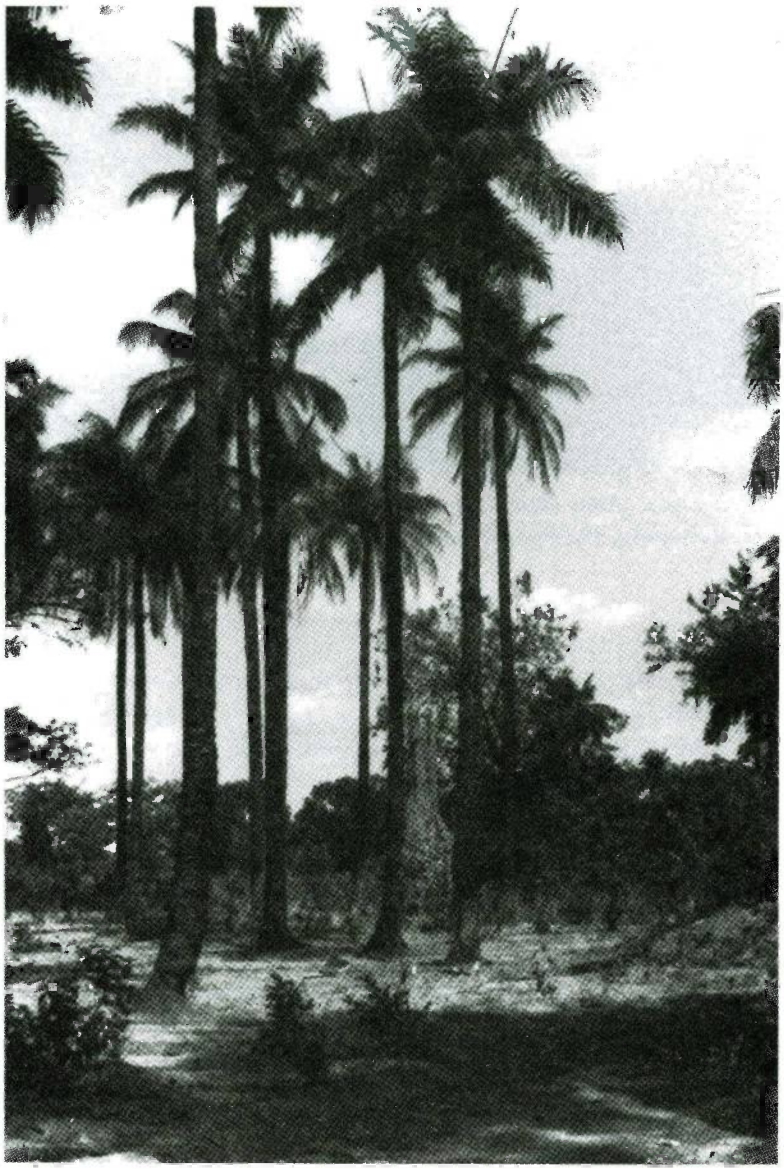

Figure 7-3. Subspontaneous African oil palm stand (*Elaeis guineensis*). Guinea-Bissau, West Africa. Photograph by Dennis Johnson.

Figure 7-4. **African fan palms (*Borassus aethiopum*) in a village in Guinea-Bissau, West Africa. Photograph by Dennis Johnson.**

Madagascar

This large island off the east coast of Africa has the most remarkable palm flora of anywhere in the world. Dransfield and Beentje (1995) describe as native 167 species in 13 genera; only two of these species are also found in mainland Africa, giving Madagascar a palm species endemism rate of 99 percent.

In addition to its prominence as the homeland of so many endemic palm species, Madagascar has the dubious distinction of being an area of extremely high deforestation and environmental degradation. Because of their uniqueness, certain Madagascar palms also are overexploited for seed and small plants are dug from the wild for the nursery trade. As a result of the combination of these factors, nearly all of the native palms are threatened with extinction or severe reductions in wild populations.

Information about the full array and magnitude of products derived from native palms is incomplete. Reported uses of palms are included in Dransfield and Beentje (1995), if this information is available, but in many instances it is unknown. In Madagascar, promoting the development of forest products derived from wild palm populations must be approached with great caution. On the basis of incomplete ethnobotanical data, about 60 palm species are used in some way by local people.

Threatened Madagascar Palms

Table 7-4 gives the names of 48 utilized palms which are known to be under threat. Local palm names given in Tables 7-4 and 7-5 must be used carefully because they are often misleading. The same name may be applied to more than one described species or the same described species may have several common names over its geographic range. Making a link between a local name and a scientific name should always be verified with additional information.

Table 7-4: Threatened Madagascar Palms with Reported Uses

Scientific Name	Selected Local Names	Distribution[1]	Products/Uses
Beccariophoenix madagascariensis (monotypic)	manarano, manara, maroala, sikomba	Mantady & SW Madagascar	stem wood for house construction
Borassus madagascariensis	dimaka, marandravina, befelatanana	Western Madagascar	edible palm heart
Dypsis[2] *ampasindavae*	lavaboka	Nosy Be and Manongarivo Mts.	edible palm heart
Dypsis andrianatonga	tsiriki andrianatonga	Manongarivo & Marojejy Massif	stem wood for house walls; leaf decoction as medicine
Dypsis ankaizinensis	laboka, hovatra, lavaboka	Mt. Tsaratanana	edible palm heart
Dypsis basilonga	madiovozona	Vatovavy	edible palm heart
Dypsis canaliculata	lopaka, monimony	Manonogarivo area & Ampasimanolotra	edible palm heart ?
Dypsis ceracea	lafaza	Marojejy & Betampona areas	leaves for thatching & brooms
Dypsis confusa	tsikara, tsimikara	Masoala, Mananara & Betampona	stems to make blow-pipes
Dypsis crinita	vonitra	NW & NE Madagascar	leaves for thatching; leaf base fiber to make oil filter; heartwood used in medicine
Dypsis decaryi	laafa	S Madagascar	leaves for thatching; edible fruit
Dypsis decipiens	betefaka, manambe, sihara leibe	Central Madagascar, between Ankazobe & Fianarantsoa	edible palm heart; leaves used in erosion control
Dypsis hiarakae	sinkiara, tsirika	Manongarivo, Masoala & Mananara Avaratra	stems to make blow-pipes
Dypsis hovomantsina	hovomantsina	Maroantsetra & Mananara	edible palm heart
Dypsis ligulata		NW Madagascar	edible palm heart
Dypsis madagascariensis	hirihiry, kizohazo, farihazo, madiovozona, kindro	NW & W Madagascar	stem wood for floor boards; edible palm heart; edible fruit

Scientific Name	Selected Local Names	Distribution[1]	Products/Uses
Dypsis mahia		Manombo	stems used to make blow-pipes
Dypsis malcomberi	rahosy, vakaka	Andohahela	stem wood for house walls; edible palm heart
Dypsis mananjarensis	laafa, lakatra, ovodaafa	East coast between Vatomandry & Tolanaro	stem wood for house planks; edible palm heart; leaf fiber
Dypsis nauseosa	rahoma, mangidibe, laafa	Fianarantsoa	stem wood for roofing beams & floor planks
Dypsis nossibensis		NW Madagascar, Lokobe forest	stem wood for construction
Dypsis oreophila	kindro, lafaza, fitsiriky	Tsaratanana, Marojejy, near Maroantsetra & Mandritsara	edible palm heart; stem to make blow-pipes
Dypsis perrieri	besofina, menamosona, kase	Marojejy, Masoala & Mananara Avaratra	edible palm heart
Dypsis pilulifera	ovomamy, lavaboko, hozatanana	Sambirano region, Marojejy & Mantady	edible palm heart
Dypsis prestoniana	tavilo, babovavy, tavilo	Midongy area, SE coast	edible palm heart
Dypsis scandens	olokoloka	Ifanadian area in NE	stems split to make fish traps, bird cages, hats
Dypsis schatzii	tsinkiara	E Madagascar: Betampona	stems to make blow-pipes
Dypsis thermarum	fanikara	Ranomafana National Park	stems split to make crayfish traps
Dypsis thiryana	tsinkiara, sinkarambolavo maroampototra, taokonampotatra	Marojejy & Masoala to Anosibe-an-Ala	leaves for thaching ?
Dypsis tsaratananensis	kindro	Mt. Tsaratanana	edible palm heart
Dypsis tsaravoasira	tsaravoasira, hovotravavy, lavaboko	Marojejy, Maroantsetra & Mananara	edible palm heart
Dypsis utilis	vonitra, vonitrandrano	E Madagascar	edible palm heart; edible fruit
Marojejya insignis	menamoso, beondroka, maroalavehivavy, betefoka, besofina, hovotralanana, mandanzezika, fohitanana	E Coast, Marojejy to Andohahela	edible palm heart
Masoala kona	kona, kogne	Ifanadiana area	leaf has magical properties

Scientific Name	Selected Local Names	Distribution[1]	Products/Uses
Masoala madagascariensis	kase, hovotralanana, mandanozezika	Morojejy, Masoala & Mananara	leaves for thatching
Orania longisquama	sindro, anivona, ovobolafotsy, vakapasy	NW & E Madagascar	stem wood for house wall planks
Orania trispatha	sindro, sindroa, anivo	E Madagascar	stem wood for house construction
Ravenea albicans	hozatsiketra	NE Madagascar	edible palm heart
Ravenea dransfieldii	anivo, ovotsarorona, lakatra, lakabolavo	Eastern Madagascar; between Marojejy Mts. & Ifanadiana	edible palm heart ?; leaves for hat-making
Ravenea glauca	anivo, sihara	Central-S Madagascar; W side Andringitra Mts. & Isalo	edible palm heart ?
Ravenea julietiae	sindro madiniky, saroroira, vakapasy, anive, anivona	E Madagascar, between Mananara Avaratra & Vangaindrano	stem wood for construction; hollowed out stems as irrigation pipes
Ravenea lakatra	lakatra, tsilanitafika, manarana	E Madagascar, between Andasibe & Vangaindrano	leaf fiber for hat making
Ravenea madagascariensis	anivo, anivokely, anivona, tovovoka	Central & E Madagascar	stem wood for house wall & floor planks
Ravenea rivularis	gora, bakaly, vakaka, malio	S Central Madagascar, Mangoky & Onilahy rivers	seed collected for export
Ravenea robustior	hovotravavy, manara, tanave, retanan, monimony, loharanga, anivona, laafa, anivo, lakabolavo, bobokaomby, vakabe, vakaboloka	NW, E & SE Madagascar	stem wood for construction & furniture; leaves for thatching; edible palm heart; stem pith eaten
Ravenea sambiranensis	anivo, anivona, mafabely, soindro, ramangaisina	NW, W & E Madagascar	stem wood for floor planks; edible palm heart; edible fruit
Ravenea xerophila	ahaza, anivo, anivona	S Madagascar, between Ampanihy & Ampingaratra Mts.	leaf fiber for hats & baskets
Voanioala gerardii (monotypic)	voanioala	Masoala Peninsula	edible palm heart

Notes: 1. All are endemic to Madagascar
2. Numerous species of *Dypsis* were formerly in the genera *Chrysalidocarpus, Neodypsis, Neophloga* and *Phloga*.
Source: Dransfield and Beentje, 1995.

Discussion

Palm hearts and stem wood represent the most prevalent palm usages involving threatened palms, and the two frequently go hand-in-hand. When a palm is felled for its stem wood, the heart, if edible, is also extracted and eaten. The reported cutting of palms for stem wood or palm heart is particularly alarming since about three-fourths of the involved species are single-stemmed.

Very little empirical data exist on how individual threatened palm species could be sustainably managed. One welcome exception is a new study on conservation and *in situ* management of *Dypsis decaryi*. It recommends that annual leaf harvesting be no more than about 25 percent of the leaves per tree per year and that seed collection be limited to well under 95 percent of the annual crop to assure natural regeneration (Ratsirarson *et al.*, 1996).

Non-threatened Madagascar Palms

A small number of native palms currently occur in sufficient populations to consider promotion of greater use of their products. Nine such species are listed in Table 7-5. Madagascar's two non-endemic palms, *Hyphaene coriacea* and *Phoenix reclinata*, are included in the table.

Table 7-5: Non-threatened Madagascar Palms with Reported Uses

Scientific Name	Local Names	Distribution	Products/Uses
Bismarckia nobilis	satra, strabe, satrana, satranabe, satrapotsy	N & W Madagascar (endemic)	flattened trunk for construction; leaves for thatch & basketry; pith for bitter sago; ornamental tree
Dypsis[1] *baronii*	farihazo, tongalo	N, Central & E Madagascar (endemic)	edible palm heart; edible fruit; ornamental tree
Dypsis fibrosa	vonitra, vonitrambohitra, ravimbontro	MW & E Madagascar (endemic)	leaves for thatching; inflorescence as brushes
Dypsis lastelliana	menavozona, sira, ravintsira	NW, NE & E Madagascar (endemic)	pith formerly used to make salt; edible palm heart said to be poisonous
Dypsis lutescens	rehazo, lafahazo, lafaza	E coast (endemic)	ornamental tree; other uses ?
Dypsis nodifera	ovana, bedoda, sincaré, tsirika, tsingovatra	NW, E & SE Madagascar (endemic)	hollowed out stems as blowpipes
Dypsis pinnatifrons	tsingovatra, tsingovatrovatra, ovatsiketry, ambolo, hova, tsobolo	Widespread in humid forest (endemic)	hollowed out stems as blowpipes; house beams
Hyphaene coriacea	satrana, sata	W Madagascar (non-endemic)	leaf fiber for basketry, hats, rope; edible palm heart; palm wine (see Table 9-19 for composition)
Phoenix reclinata	dara, taratra, taratsy	NW & NE Madagascar; isolated stands in SW (non-endemic)	leaflets for basketry; fruit edible

Notes: 1. Numerous species of *Dypsis* were formerly in the genera *Chrysalidocarpus, Neodypsis, Neophloga* and *Phloga*.

Source: Dransfield and Beentje, 1995.

Discussion

Although the palms in Table 7-5 have development potential for forest products, there are certain factors with respect to individual products which must be taken into account. Products requiring the felling of a palm for sago, palm heart, construction wood or other stem uses, results in killing the individual tree. If the involved palm species is single-stemmed, this destroys seed sources and makes regeneration difficult and uncertain; such practices are inherently unsustainable. Clustering palms, on the other hand, can be harvested for such products and possess the potential to be managed on a sustainable basis.

There are three species of palms in Madagascar which were introduced to the island and are either under cultivation or have become naturalized. These are the coconut, *Cocos nucifera*; tsingilo (local name) or African oil palm, *Elaeis guineensis*; and raffia palm, *Raphia farinifera* The raffia and coconut palms are sources of numerous food and nonfood items for local people. In sharp contrast to its wide utility on the African Mainland, the African oil palm is of limited importance in Madagascar.

Seychelles, Mascarene Islands and Comoro Islands

These three small island groups of the western Indian Ocean are comparable to Madagascar in terms of native palm populations. The palm flora of each island group is unique with exceedingly high rates of palm endemism; in the Seychelles all six of the native palms are endemic. Threats to the palm populations are as great as in Madagascar, owing to human population pressures, animal introductions and agriculture which has led to significant habitat destruction and to animal introductions. All the native palms in these islands are classified as threatened. There should be no promotion of non-wood forest products from natural palm populations. Fortunately, coconut palms are naturalized in the islands and serve as a source of products for local people.

Palms with development potential

To assess the potential for development of economic palm species it is worthwhile to consider whether individual species currently have either greater domestication potential or management potential. These two categories are established for analytical purposes; they are not mutually exclusive. In fact, in some cases palm management is a useful initial step toward palm domestication.

Domestication potential implies that the products of a palm have enough promise to becoming commercialized at a scale sufficient to justify the costly and lengthy effort involved. Certainly that was and is the case of the five fully domesticated palms (arecanut, coconut, date, African oil palm and pejibaye) discussed in Chapter 2.

The chief obstacle to palm domestication is that many years are required to select and breed a superior palm for a particular product or set of products. The age of sexual maturity among the palms varies considerably from species to species, ranging from about 3-40 years. An essential part of any new palm domestication effort would include detailed studies of the reproductive biology of the candidate species, because so little is known about this aspect of wild palms. A domestication program would also need to have a clear definition of its objectives in terms of the chief commodities to be produced. If the candidate palm for domestication is a multipurpose species, there must be consideration of primary as well as secondary products. Secondary products can play an important role in providing employment and income to local people.

Coradin and Lleras (1988) reviewed research directed at domestication of New World palms with economic potential. The authors also presented a model of how to characterize native populations in order to design successful domestication or management strategies. The model is applicable to palms in Asia and Africa.

Breeding and domesticating a palm is one thing, propagating an improved palm quite another because of the time necessary to the initiation of flowering and fruiting. Any palm which can be vegetatively propagated, such as most species in the genus *Phoenix*, has a major natural advantage over palms which can only be grown from seed. However, three of the five domesticated palms mentioned in the previous paragraph are seed propagated, i.e. arecanut, coconut and African oil palm. Tissue culture is a technological alternative to seed propagation but research on palms has not yet solved all of the problems that would permit large-scale reproduction by this means at a reasonable cost.

Management potential is possessed by many more palm species because costs are significantly lower, the time required is much shorter and production continues as management practices are adopted. In addition to wild species, also included in this category are palms which are often referred to as being "semi-domesticated." This term implies that selection of wild seed or suckers for informal cultivation has taken place, but no actual breeding program undertaken. Semi-domesticated species in most cases are very promising candidates for a formal domestication effort.

Promising Palms

Reviewing the material presented within this report, a global list of palms with development potential was compiled. Table 8-1 presents information on 18 palms; the list is not exhustive. As can be seen, most often a palm is represented by a single species, but in some instances it is represented by two species, or all or most species in a genus. This is simply a reflection of the differing circumstances from one palm to another. The palms in Table 8-1 were selected without regard for their native areas. Nevertheless, the palms included do reflect the Asian region as being foremost in economic species, with Latin America a strong second and Africa a distant third.

Discussion

The candidate palms in Table 8-1 are annotated as to whether they have more management or domestication potential. The approach taken with respect to realizing the development potential of individual palms will be determined to a significant degree by the magnitude of the economic potential of the product or products to be realized. Whether the option chosen is domestication or management, these palms should be developed within a broad context to benefit local people as well as financial investors.

Palm domestication highlights the importance of wild genetic resources in selecting genetic material for an initial breeding and improvement effort. Conservation of wild germplasm has equal value in maintaining and further improving domesticated palms. The African oil palm is a perfect example.

Comparing the palms in Table 8-1 reveals that sap and seed oil are major products common to several species. From a practical standpoint, an expensive and lengthy domestication program cannot be mounted for each palm. Instead, it will be necessary to evaluate the sap-producing palms and select one of them for domestication; the species not selected should be considered for management improvement. A similar approach could be used for seed oil and other major products.

The ideal mechanism for deciding which palms should be given priority for domestication or management development would be to convene a technical panel of palm specialists to make recommendations.

A key factor in palm development is that it should be done so that management and domestication efforts are not narrowly focused on individual species. There is much to be gained from a palm development program which consists of management and domestication efforts involving several palms in different countries. Major benefits would include an integrated research strategy, sharing of results from several locations on different palm species, as well as the advantage of sharing of general costs.

Table 8-1: Candidate Palms for Domestication or Management

Scientific Names Common Names	Native Distribution and Habitat	Major Products	Minor Products	Comments and Selected References
Arenga pinnata sugar palm	S. & SE. Asia tropical rain forest into dry forest, to 1,200 m.	sap to make sugar, wine, alcohol, vinegar, sap yield 3-6 liters/ tree/day; starch from stem, yield 75 kg/tree	leaf sheath fiber; edible heart; etc.	solitary, terminal flowering feather palm; traditional multipurpose palm with a history of cultivation; strong candidate for domestication; agroforestry potential; Mogea *et al.*, 1991
Attalea funifera piassava	S. America: Atlantic Forest, Brazil tropical rain forest, coastal areas	leaf base fiber	leaves for thatching	solitary feather palm; narrow range of products; over-exploitation of natural stands, experimental planting; management could stabilize fiber supplies & sustain markets; Voeks, 1988
Attalea speciosa *(syn. Orbignya phalerata)* babaçu	S. America tropical rain forest, upland sites	edible oil, yield 40 kg/tree/yr	edible mesocarp pulp; leaves for thatching; shells to make charcoal; press cake for livestock feed	solitary feather palm; multipurpose palm with wide array of commercial & subsistence products; some management already being done, could be improved upon & domesticated if integrated processing of fruits is adopted; good agroforestry potential; Anderson *et al.*, 1991
Borassus flabellifer, *B. aethiopum* palmyra, ron	S. & SE. Asia; Africa tropical dry forest into savanna, to 750 m.	sap to make sugar, wine, alcohol, vinegar, sap yield 11-20 liters/ tree/day	leaf stalk fiber; leaves for thatching & basketry; edible immature fruit endosperm; edible; mesocarp; stem wood for construction & fuelwood; etc.	solitary fan palms; multipurpose species of major utility to local peoples; incipient management already in practice in S. & SE. Asia; candidate for domestication, agroforestry potential; Davis & Johnson, 1987
Calamus spp. rattan	S. & SE. Asia tropical rain forest to 1,000 m.	canes for furniture making, yield to 6 t/ha	edible fruit & heart in some spp.	climbing solitary or suckering feather palms; several spp. under study for cultivation; cane industry-driven research & development as well as coordination by INBAR; Dransfield & Manokaran, 1993
Caryota urens toddy palm	S. & SE. Asia tropical rain forest to 1,500 m.	sap to make sugar, wine, alcohol, vinegar, sap yield 20-27 liters/ tree/day; starch from stem, yield 100-150 kg/tree	leaf sheath fiber; edible heart; etc.	solitary, terminal flowering feather palm; numerous products; informal cultivation practiced; domestication potential in agroforestry systems; De Zoysa, 1992

Scientific Names Common Names	Native Distribution and Habitat	Major Products	Minor Products	Comments and Selected References
Chamaedorea spp. (ornamental spp.)	Mexico, C. America, N. South America understory of tropical rain forest to 3,000 m.	seed for commercial growing of ornamental plants & foliage for cut flower arrangements	none known	solitary or suckering feather palms; a few major ornamental spp. under cultivation for seed in Belize; management potential of wild palms for cut foliage; Hodel, 1992
Chamaedorea tepejilote pacaya	Mexico, C. America, N. South America tropical rain forest to 1,600 m.	edible immature male inflorescence	edible palm heart; leaves fed to livestock	solitary (sometimes suckering) feather palm; already under informal cultivation, could be managed for pacaya & palm heart; agroforestry potential; Castillo Mont *et al.*, 1994
Corypha umbraculifera *C. utan* talipot, buri	S. & SE. Asia tropical rain forest to 600 m.	sap to make sugar, wine, alcohol, vinegar, sap yield 20 liters/ tree/day for 3-4 months, for C. utan; starch from stem, yield 90 kg/tree; buntal fiber from petiole to make hats; leaf midrib used to make furniture	leaves for thatching & weaving various products; edible heart; etc.	solitary, terminal flowering fan palm; multipurpose palm with good mix of commercial & subsistence products; strong candidate for management or domestication, also agroforestry potential; Madulid, 1991a
Euterpe oleracea; *E. edulis* açaí, juçara	S. America tropical rain forest. açaí in seasonally flooded lowland sites; juçara in upland sites to 1,000 m.	commercial palm heart production, yield up to 1 kg/tree	edible fruit mesocarp; leaves for weaving & thatching	suckering *(E. oleracea)*, solitary *(E. edulis)* feather palms; açaí has excellent management potential as palm heart source, juçara of use for future breeding program for domestication; Anderson, 1988
Hyphaene spp. doum	Africa semi-deserts & deserts, to 600 m.	edible fruit; sap for wine, alcohol	leaves for thatching & weaving	solitary branched fan palm; management of wild stands would provide sustainable sources of commercial & subsistence products in dry areas; Tuley, 1995
Mauritia flexuosa moriche	S. America tropical rain forest, seasonally flooded lowland sites	edible fruit mesocarp; edible oil; starch from trunk, yield to 60 kg/tree	leaf fiber for making rope; trunk for wood; petiole for "cork"	solitary feather palm; extensive dense stands have management potential for multiple products; Padoch, 1988
Metroxylon sagu sago	SE. Asia tropical rain forest, fresh water swamps	starch from stem, yield 300 kg/tree	leaves for thatching	suckering feather palm; palm is cultivated & managed successfully; research by industry & FAO progressing well; Flach & Schuiling, 1989

Scientific Names Common Names	Native Distribution and Habitat	Major Products	Minor Products	Comments and Selected References
Nypa fruticans nipa	S. & SE Asia tropical rain forest, brackish water swamps of tidal rivers	sap for sugar, alcohol, sugar yield 3,000 kg/ha/year; leaves for thatching (atap)	edible fruit; etc.	suckering feather palm; incipient management in practice, could benefit from improved practices & broader utilization of products, especially in Papua New Guinea; Hamilton & Murphy, 1988
Oenocarpus bataua *(syn. Jessenia bataua)* batauá	S. America tropical rain forest, upland sites to 1,000 m.	edible oil, fruit	stem wood, leaves for thatching & weaving	suckering feather palm; high quality seed oil gives this palm potential for domestication, also good agroforestry species; Balick, 1988
Phoenix sylvestris wild date	S. Asia tropical rain forest to dry forest, to 1,500 m.	sap for sugar, wine, sugar yield 40 kg/tree/year; edible fruit	leaves for weaving & to make brooms; stem wood for fuel; etc.	solitary feather palm; already under management & informal cultivation; good multipurpose palm with domestication potential within agroforestry systems; Davis, 1972
Raphia spp. raffia	West Africa tropical rain forest, seasonally flooded lowland sites	commercial leaf base fiber (African bass fiber) for brushes & brooms; sap for wine, alcohol	petioles as poles, leaves for thatching & weaving; etc.	suckering (most spp.) terminal flowering feather palm; *R. hookeri* & *R. palma-pinus* are main brush fiber sources, also tapped for sap; one or more spp. could be managed for multiple products; Tuley, 1995
Salacca zalacca salak	SE. Asia understory of tropical rain forest, to 300 m.	edible fruit (fresh, canned, pickled)	leaves for thatching & weaving	suckering feather palm; fruit production from wild, semi-wild & cultivated plants; more than a dozen local variety names; strong candidate for domestication using germplasm of other promising sp. such as *S. wallichiana*; Yaacob & Subhadrabandhu, 1995

Source: In addition to selected references cited, compiled from information provided elsewhere in this report.

Coordination of Activities

Informal and formal information networks exist for research and development of the five domesticated palms (African oil palm, arecanut, coconut, date and pejibaye); as well as for the sago palm and rattans. In some cases formal organizations exist such as the International Network for Bamboo and Rattan; in other instances information networking is achieved through technical conferences and journals, as with the African oil palm.

Another important source of information on specific palm products comes from looking at a particular product from an industrial point of view. An excellent example is the palm sugar workshop organized by the Asia Regional Cookstove Program and held in Indonesia in 1994 (ARECOP, 1994). Participants from six Asian countries shared experiences and discussed ways in which small scale industries could be promoted. These types of industrial activities need to be linked to enhancing production through management and domestication.

An information networking mechanism is needed for all of the economic palms not yet covered in some way. This would serve to coordinate and bolster efforts to realize their full development potential. There is considerable benefit to be derived from an exchange of ideas and examples from region to region (Johnson, 1992).

The IUCN, Species Survival Commission, Palm Specialist Group represents a means to fulfill this networking need. The Palm Specialist Group has just published its Action Plan (Johnson, 1996) which is aimed at both palm conservation and utilization. The Group is in the process of establishing a Secretariat at the Fairchild Tropical Garden, Miami, Florida. An outside source of funding for the Palm Specialist Group to take on such a role would be necessary, but it would be very efficient and cost effective. Alternatively, a research institution or university could assume such a role.

Whichever organization assumes a central networking role to coordinate palm development, there should also be a sub-network of institutions located in the respective regions (Asia, Pacific, Latin America and Africa) to serve as local points of contact. Botanical gardens or research institutions could fulfill this role.

Composition and characteristics of selected palm products

This compilation of 25 tables has been assembled to provide technical information on the array of food and industrial products derived from palms. Included is information on domesticated and wild palms; palm products are somewhat similar so that in the absence of any data for a wild palm product some inferences can be made from closely-related domesticated species. The tables are arranged in alphabetical order by scientific name.

Table 9-1: Chemical Constituents of Arecanut, *Areca catechu*

Constituents[1]	Green Nut (range)	Ripe Nut (range)
Moisture content (%)	69.4-74.1	38.9-56.7
Total water extractives (%)	32.9-56.5	23.3-29.9
Polyphenols (%)	17.2-29.8	11.1-17.8
Arecoline (extraction method) (%)	0.11-0.14	0.12-0.24
Fat (%)	8.1-12.0	0.12-0.24
Crude fiber (%)	8.2-9.8	11.4-15.4
Total polysaccharides (%)	17.3-23.0	17.8-25.7
Crude protein (%)	6.7-9.4	6.2-7.5
Ash (%)	1.2-2.5	1.1-1.5

Note: 1. Constituents expressed as percentage values calculated as dry basis (except moisture).
Source: Bavappa *et al.*, 1982.

Table 9-2: Nutritional Composition of Pejibaye Fruit Mesocarp Pulp, *Bactris gasipaes* (per 100 g)

Water (%)	56	Iron (mg)	2.76
Calories	194	Sodium (mg)	-
Protein (%)	3.01	Ascorbic Potassium (mg)	-
Fat (%)	6.14	Carotene (mg)	1.28
Carbohydrate (%)	33.05	Thiamine (mg)	0.030
Fiber (%)	1.02	Acid (mg)	-
Ash (%)	0.88	Niacin (mg)	0.455
Calcium (mg)	44.6	Riboflavin (mg)	0.068
Phosphorus (mg)	101.84		

Source: Pérez Vela, 1985.

Table 9-3: Nutritional Composition of Pejibaye Flour[1], *Bactris gasipaes* (fresh basis per 100 g)

Calories	413.5	Vitamin B_2 (mg)	0.3
Humidity (g)	12.0	Vitamin C (mg)	62.2
Protein (g)	3.8	Niacin (mg)	2.5
Fat (g)	8.9	Iron (mg)	6.1
Ash (g)	1.3	Calcium (mg)	10.9
Crude fiber (g)	2.1	Sodium (mg)	2.7
Carbohydrates (g)[2]	72.1	Potassium (mg)	162.8
Vitamin A (*u*g eq)	1.2	Magnesium (mg)	11.7
Vitamin B_1 (g)	0.1	Zinc (mg)	2.1

Notes: 1. Values calculated from fresh pejibaye fruit mesocarp. 2. Carbohydrates by difference.
Source: Blanco Metzler *et al.* 1992.

Table 9-4: Nutritional Composition of Palmyra Sweet Sap, *Borassus flabellifer*

Specific gravity	1.07	Calcium	Trace
pH	6.7-6.9	Phosphorus (g/100 cc)	0.14
Nitrogen (g/100 cc)	0.056	Iron (g/100 cc)	0.4
Protein (g/100 cc)	0.35	Vitamin C (mg/100 cc)	13.25
Total sugar (g/100 cc)	10.93	Vitamin B_1 (IU)	3.9
Reduced sugar (g/100 cc)	0.96	Vitamin B complex	Negli-gible
Minerals as ash (g/100 cc)	0.54		

Source: Davis and Johnson, 1987.

Table 9-5: Nutritional Composition of Palmyra Sugar (Jaggery), *Borassus flabellifer*

Moisture	Nil	Phosphorus (%)	0.064
Protein (%)	0.24	Iron (mg/100 g)	30.0
Fat (%, ether extract)	0.37	Nicotinic acid (*u*mg/100 g)	4.02
Mineral matter (%)	0.50	Vitamin B_1 (*u*mg/100 g)	Nil
Carbohydrate (% by difference)	98.89	Riboflavin (*u*mg/100 g)	229
Carbohydrate (%, direct polarimetry)	98.4	Caloric value (/100 g)	398
Calcium (%)	0.08		

Source: Davis and Johnson, 1987.

Table 9-6: Nutritional Composition of Limuran Fruit,*Calamus ornatus* var. *philippinensis* (per 100 g)

Water (%)	0	Iron (mg)	8.1
Calories	376	Sodium (mg)	-
Protein (%)	2.9	Ascorbic Potassium (mg)	-
Fat (%)	5.7	Carotene (*u*g)	-
Carbohydrate (%)	88.6	Thiamine (mg)	0.29
Fiber (%)	2.4	Acid (mg)	23.8
Ash (%	2.9	Niacin (mg)	4.29
Calcium (mg)	90.5	Riboflavin (mg)	0.05
Phosphorus (mg)	47.6		

Source: Atchley, 1984.

Table 9-7: Nutritional Composition of Palm Inflorescence, Pacaya, *Chamaedorea tepejilote* (10 g edible portion)

Energy value (cal)	45	Phosphorus (mg)	106.0
Water (%)	85	Iron (mg)	1.4
Protein (g)	4.0	Vitamin A (mcg)	5.0
Carbohydrates (g)	8.3	Thiamine (mg)	0.08
Fiber (g)	1.2	Riboflavin (mg)	O.10
Ash (g)	2.0	Niacin (mg)	0.9
Calcium (mg)	3.69	Ascorbic acid (mg)	14.0

Source: Castillo Mont *et al.*, 1994.

Table 9-8: Components of Whole Coconut, *Cocos nucifera* (wet basis)

Husk	35%	Meat (endosperm)	28%
Shell	12%	Water	25%

Source: Phil. Coco. Auth., 1979.

Table 9-9: Characteristics of Coconut Oil from Copra, *Cocos nucifera* (usual range)

Fat, % of part, dry basis	65-72
Characteristics of fat	
Acid value	1-10
Saponification value	251-264
Iodine value	7-10
Thiocyanogen value	6.1-7.0
R-M value	6-8
Polenske value	12-18
Unsaponifiable (%)	0.15-0.6
Refr. index, n_D, 40° C	1.448-1.450
Sp. gr., 40°/25°	0.908-0.913
Melting point (° C)	23-26
Titer (° C)	20-24
Composition of fatty acids, wt. % of total fatty acids	
Saturated acids Capric	 0-0.8
Caprylic	5.5-9.5
Capric	4.5-9.5
Lauric	44-52
Myristic	13-19
Palmitic	7.5-10.5
Stearic	1-3
Arachidic	0-0.4
Unsaturated acids Hexadecenoic	 0-1.3
Oleic	5-8
Linoleic	1.5-2.5

Source: Eckey, 1954.

Table 9-10: Composition of Coconut Shell, *Cocos nucifera* (dry basis)

Lignin	36%	Ash	0.6%
Cellulose	53%		

Source: Ohler, 1984.

Table 9-11: Nutritional Composition of Coconut Water, *Cocos nucifera*

Water (%)	95.5	Carbohydrates (%)	4.0
Protein (%)	0.1	Calcium (%)	0.02
Fat (%)	0.1	Phosphorous (%)	0.001
Mineral matter (%)	0.4	Iron (mg/100 g)	0.5

Source: Thampan, 1975.

Table 9-12: Mechanical Properties of Coconut Wood, *Cocos nucifera*

Basic density	Av. MC	M o E	M o R	Stress at limit of proportio n-ality	Impact bending	Compres-sion parallel grain	Compres-sion perpendi-cular grain[1]	Shear radial[2]	Cleavage maximum[3]
kg/m^3	%	MPa	MPa	MPa	mN	MPa	MPa	MPa	N/mm^2
600 +	57	10857	86	52	20	49	8	10	12
	12	11414	104	62	20	57	9	13	11
400-599	107	6880	53	30	18	31	3	6	9
	12	7116	63	38	10	38	3	8	8
250-399	240	3100	26	13	8	15	1	4	4
	12	3633	33	15	9	19	2	n.a.	4

Notes: 1. Compressive stress at limit of proportionality.
2. Radial and tangential values differ insignificantly.
3. Combined maximum values of radial and tangential cleavage.

Source: Killmann, 1988.

Table 9-13: Composition and Properties of Carnaúba Wax, *Copernicia prunifera*

	Types[1] 1,2,2A	Types 3,4	Type 5
Melting point - minimum (°C)	83	82.5	82.5
Flash point - minimum (°C)	310	299	299
Volatile matter (including moisture) maximum %	2	1.5	6
Insoluble impurities - maximum %	1	2	1.5

Note: 1. Carnaúba wax is graded in terms of quality on a scale from 1-5; Type 1 is the highest quality.

Source: Johnson, 1970.

Table 9-14: Nutritional Composition of Buri Palm Fruit, *Corypha utan* (per 100 g)

Water (%)	0	Iron (mg)	1.1
Calories	326	Sodium (mg)	-
Protein (%)	3.7	Ascorbic Potassium (mg)	-
Fat (%)	0.5	Carotene (ug)	-
Carbohydrate (%)	93.7	Thiamine (mg)	0.05
Fiber (%)	6.8	Acid (mg)	57.9
Ash (%	2.1	Niacin (mg)	3.16
Calcium (mg)	73.7	Riboflavin (mg)	0.11
Phosphorus (mg)	89.5		

Source: Atchley, 1984.

Table 9-15: Nutritional Composition of African Oil Palm Fruit, *Elaeis guineensis* (per 100 g)

Water (%)	0	Iron (mg)	5.6
Calories	746	Sodium (mg)	-
Protein (%)	2.2	Ascorbic Potassium (mg)	-
Fat (%)	81.9	Carotene (ug)	50,680.6
Carbohydrate (%)	14.6	Thiamine (mg)	0.35
Fiber (%)	3.8	Acid (mg)	12.5
Ash (%	1.3	Niacin (mg)	1.81
Calcium (mg)	136.1	Riboflavin (mg)	0.17
Phosphorus (mg)	61.1		

Source: Atchley, 1984.

Table 9-16: Nutritional Composition of African Oil Palm Oil[1], *Elaeis guineensis* (per 100 g)

Water (%)	0	Iron (mg)	5.5
Calories	882	Sodium (mg)	-
Protein (%)	0.0	Ascorbic Potassium (mg)	-
Fat (%)	99.6	Carotene (ug)	27,417.1
Carbohydrate (%)	0.4	Thiamine (mg)	0.00
Fiber (%)	0.0	Acid (mg)	-
Ash (%	0.0	Niacin (mg)	0.00
Calcium (mg)	7.0	Riboflavin (mg)	0.03
Phosphorus (mg)	8.0		

Note: 1. Source does not indicate whether mesocarp oil or kernel oil.
Source: Atchley, 1984.

Table 9-17: Nutritional Composition of Palm Heart, *Euterpe* spp.

Component	*Euterpe edulis*	*Euterpe oleracea*
Protein (%)	2.42	1.72
Ash (%)	1.43	0.83
Crude fiber (%)	0.89	0.27
Fat (%)	0.33	0.08
Total sugars (%)	0.86	0.70
Reducing sugars (%)	0.49	0.30
Tannins (%)	0.06	0.06
Vitamin C (mg/100 g)	1.8	1.4

Source: Quast and Bernhardt, 1978.

Table 9-18: Nutritional Composition of African Doum Palm Fruit Mesocarp, *Hyphaene compressa*

Moisture (%)	4	Calcium (mg)	34
Energy (Kcal)	390	Phosphorus (mg)	110
Protein (g)	3.8	Thiamin (mg)	0.05
Fat (g)	0.8	Riboflavin (mg)	0.10
Carbohydrate (g)	84.1	Niacin (mg)	3.4
Ash (g)	7.3		

Source: Hoebeke, 1989.

Table 9-19: Nutritional Composition of Palm Wine from Sap of *Hyphaene coriacea* (per 100 g)

Moisture (%)	98.8	Potassium (mg)	152
Ash (g)	0.4	Copper (mg)	0.04
Protein (g)	0.1	Zinc (mg)	0.01
Fat (g)	-	Manganese (mg)	trace
Fiber (g)	-	Phosphorus (mg)	1.37
Carbohydrate (g)	0.7	Thiamin (mg)	0.01
Energy value	13 + 109	Riboflavin (mg)	0.01
Calcium (mg)	0.13	Niacin (mg)	0.22
Magnesium (mg)	4.18	Vitamin C (mg)	6.8
Iron (mg)	0.07	Alcohol (% v/v)	3.6
Sodium (mg)	9.88		

Source: Cunningham and Wehmeyer, 1988.

Table 9-20: Nutritional Composition of Indian Doum Palm Mesocarp, *Hyphaene dichotoma* (young fruit)

Energy Cal/100 g	406	Fiber (%)	50.07
Water (%)	0	Ash (%)	7.69
Protein (%)	9.26	Calcium (mg/100g)	268
Fat (%)	7.21	Phosphorus (mg/100g)	224
Carbohydrate (%)	75.81	Iron (mg/100g)	38.24[1]

Note: 1. High iron value probably due to soil type.
Source: Bonde *et al.* 1990

Table 9-21: Nutritional Composition of Moriche Palm Fruit[1], *Mauritia flexuosa*. (per 100 g)

Water (%)	0	Iron (mg)	12.9
Calories	526	Sodium (mg)	-
Protein (%)	11.0	Ascorbic Potassium (mg)	-
Fat (%)	38.6	Carotene (ug)	90,992.6
Carbohydrate (%)	46.0	Thiamine (mg)	0.11
Fiber (%)	41.9	Acid (mg)	95.6
Ash (%	4.4	Niacin (mg)	2.57
Calcium (mg)	415.4	Riboflavin (mg)	0.85
Phosphorus (mg)	69.9		

Note: 1. Source does not indicate but assumed to be mesocarp pulp.
Source: Atchley, 1984.

Table 9-22: Nutritional Composition of Sago Starch, *Metroxylon sagu* (per 100 g of raw sago)

Calories	285.0	Calcium (mg)	30.0
Water (g)	27.0	Carbohydrate (g)	71.0
Protein (g)	0.2	Iron (mg)	0.7
Fat, carotene, thiamine, ascorbic acid	negligible	Fiber (g)	0.3

Source: Ruddle *et al.*, 1978.

Table 9-23: Nutritional Composition of Date[1] Fruit, *Phoenix dactylifera* (100 g, edible portion)

Water (%)	22.5	Iron (mg)	3.0
Food energy (cal)	274	Sodium (mg)	1
Protein (g)	2.2	Potassium (mg)	648
Fat (g)	0.5	Vitamin A (IU)	50
Carbohydrate (g, total)	72.9	Thiamine (mg)	0.9
Carbohydrate (g, fiber)	2.3	Riboflavin (mg)	0.10
Ash (g)	1.9	Niacin (mg)	2.2
Calcium (mg)	59	Ascorbic acid (mg)	0
Phosphorus (mg)	63		

Note: 1. Natural, domestic date; not stated but very likely the Deglet Noor variety.
Source: Watt and Merrill, 1963.

Table 9-24: Nutritional Composition of Palm Wine from Sap of *Phoenix reclinata* (per 100 g)

Moisture (%)	98.3	Potassium (mg)	157
Ash (g)	0.4	Copper (mg)	0.05
Protein (g)	0.2	Zinc (mg)	0.02
Fat (g)	-	Manganese (mg)	trace
Fiber (g)	-	Phosphorus (mg)	1.74
Carbohydrate (g)	1.1	Thiamin (mg)	0.01
Energy value	22 + 109	Riboflavin (mg)	0.01
Calcium (mg)	0.45	Niacin (mg)	0.5
Magnesium (mg)	5.12	Vitamin C (mg)	6.5
Iron (mg)	0.07	Alcohol (% v/v)	3.6
Sodium (mg)	5.85		

Source: Cunningham and Wehmeyer, 1988.

Table 9-25: Nutritional Composition of Salak Palm Fruit, *Salacca zalacca* (per 100 g)

Water (%)	0	Iron (mg)	19.1
Calories	345	Sodium (mg)	-
Protein (%)	1.8	Ascorbic Potassium (mg)	-
Fat (%)	0.0	Carotene (*u*g)	0.00
Carbohydrate (%)	95.0	Thiamine (mg)	0.18
Fiber (%)	-	Acid (mg)	9.1
Ash (%	3.2	Niacin (mg)	-
Calcium (mg)	127.3	Riboflavin (mg)	-
Phosphorus (mg)	81.8		

Source: Atchley, 1984.

References

Alam, M.K. 1990. *Rattans of Bangladesh.* Chittagong: Bangladesh Forest Research Institute.

Aminuddin, M., Rahim, S. and Lee, H.S. 1985. Country Report: Malaysia. *In*: Wong and Manokaran. *Op. cit.*, pp. 221-229.

Anderson, A.B. 1978. The names and uses of palms among a tribe of Yanomama Indians. *Principes* 22(1):30-41.

Anderson, A.B. 1988. Use and management of native forests dominated by açaí palm (*Euterpe oleracea* Mart.) in the Amazon Estuary. *Advances in Economic Botany* 6:144-154.

Anderson, A.B., May, P.H. and Balick, M.J. 1991. *The subsidy from nature: palm forests, peasantry, and development on an Amazon frontier.* New York: Columbia University Press.

Antolin, A.T. 1995. Rattan: a source of employment for upland communities of northeastern Luzon. *In*: Durst and Bishop. *Op. cit.*, pp. 55-60.

ARECOP. 1994. *Proceedings of the workshop on small scale palm sugar industries.* Yogyakarta, Indonesia: Asia Regional Cookstove Program.

Asif, M.I.A. and Al-Ghamdi, A.S. (eds.). 1986. *Bibliography of date palm* (Phoenix dactylifera). Al Hassa, Saudi Arabia: Date Palm Research Center.

Atchley, A.A. 1984. Nutritional value of palms. *Principes* 28(3):138-143.

ATI, 1995. *Proceedings of the third national rattan conference: 24-25 August 1995.* Manila, Philippines: Appropriate Technology International.

Avé, W. 1988. Small-scale utilization of rattan by a Semai community in West Malaysia. *Economic Botany* 42(1):105-119.

Balick, M.J. 1979a. Amazonian oil palms of promise: a survey. *Economic Botany* 33(1):11-28.

Balick, M.J. 1979b. Economic botany of the Guahibo. I. Palmae. *Economic Botany* 33(4):361-376.

Balick, M.J. 1984. Ethnobotany of palms in the neotropics. *Advances in Economic Botany* 1:9-23.

Balick, M.J. 1986. Systematics and economic botany of the *Oenocarpus-Jessenia* (Palmae) complex. *Advances in Economic Botany* 3:1-140.

Balick, M.J. 1987. The economic utilization of the babassu palm: a conservation strategy for sustaining tropical forest resources. *Journal of the Washington Academy of Sciences* 77(4):215-223.

Balick, M.J. 1988a. Jessenia *and* Oenocarpus: *neotropical oil palms worthy of domestication.* FAO Plant Production and Protection Paper 88. Rome: FAO.

Balick, M.J. (ed.) 1988b. The palm -- tree of life: biology, utilization and conservation. *Advances in Economic Botany* 6:1-282.

Balick, M.J. 1988c. The use of palms by the Apinayé and Guajajara Indians of northeastern Brazil. *Advances in Economic Botany* 6:65-90.

Balick, M.J. 1989. The diversity of use of neotropical palms. *Ceiba* 30(1):21-46.

Balick, M.J. 1990. Production of coyol wine from *Acrocomia mexicana* (Arecaceae) in Honduras. *Economic Botany* 44(1):84-93.

Balick, M.J. and Beck, H.T. (eds.) 1990. *Useful palms of the world: a synoptic bibliography*. New York: Columbia University Press.

Balick, M.J. and Gershoff, S.N. 1981. Nutritional evaluation of the *Jessenia bataua* palm: source of high quality protein and oil from tropical America. *Economic Botany* 35(3):261-271.

Barfod, A. 1989. The rise and fall of vegetable ivory. *Principes* 33(4):181-190.

Barfod, A. and Balslev, H. 1988. The use of palms by the Cayapas and Coaiqueres on the coastal plain of Ecuador. *Principes* 32(1):29-42.

Barfod, A.S., Bergmann, B. and Borgtoft Pedersen, H. 1990. The vegetable ivory industry: surviving and doing well in Ecuador. *Economic Botany* 44(3):293-300.

Barreveld, W.H. 1993. *Date palm products*. Agricultural Services Bulletin 101. Rome: FAO.

Basit, M.A. 1995. Non-wood forest products from the mangrove forests of Bangladesh. *In*: Durst and Bishop. *Op. cit.*, pp. 193-200.

Basu, S.K. 1991. India: palm utilization and conservation. *In*: Johnson 1991b. *Op. cit.*, pp. 13-35.

Basu, S.K. 1992. *Rattans (canes) in India: a monographic revision.* Kuala Lumpur: Rattan Information Centre.

Basu, S.K. and Chakraverty, R.K. 1994. *A manual of cultivated palms in India.* Calcutta: Botanical Survey of India.

Bavappa, K.V.A., Nair, M.K. and Kumar, T.P. (eds.) 1982. *The arecanut palm* (Areca cathecu *Linn.*). Kasaragod, Kerala: Central Plantation Crops Research Institute.

Beckerman, S. 1977. The uses of palms by the Bari Indians of the Maracaibo basin. *Principes* 21(4):143-154.

Beer, J.H. de and McDermott, M.J. 1989. *The economic value of non-timber forest products in Southeast Asia.* Amsterdam: Netherlands Committee for IUCN.

Bernal, R. 1992. Colombian palm products. *In:* Plotkin and Famolare. *Op. cit.*, pp. 158-172.

Bernal, R. 1995. Nuevas especies y combinaciones en la subtribu Wettiniinae (Palmae). *Caldasia* 17(82-85):367-378.

Beye, M. and Eychenne, D. 1991. *La palmeraie de Casamance.* Série Études et Recherches 105. Dakar, Senegal: ENDA.

Bhat, K.M. 1992. *Structure and properties of South Indian rattans.* Peechi, India: Kerala Forest Research Institute.

Blanc-Pamard, C. 1980. De l'utilisation de trois éspèces de palmiers dans le sud du "V Boualé" (Côte d'Ivoire). *Série Sciences Humaine, Cahiers d'ORSTOM* 17(3/4):247-257.

Blanco Metzler, A., Monteiro Campos, M., Fernández Piedra, M. and Mora-Urpí, J. 1992. Pejibaye palm fruit contribution to human nutrition. *Principes* 36(2):66-69.

Blatter, E. 1926. *The palms of British India and Ceylon.* London: Oxford University Press.

Blicher-Mathiesen, U. and Balslev, H. 1990. *Attalea colenda* (Arecaceae), a potential lauric oil resource. *Economic Botany* 44(3):360-368.

Blombery, A. and Rodd, T. 1982. *Palms.* Sydney, Australia: Angus & Robertson.

Bodley, J.H. and Benson, F.C. 1979. *Cultural ecology of Amazonian palms.* Report 56, Laboratory of Anthropology. Pullman, WS: Washington State University.

Bomhard, M.L. 1964. *Palms--their use in building.* Leaflet No. 2. Washington, DC: Housing and Home Finance Agency, Office of International Housing.

Bonde, S.D., Agate, V.V. and Kulkarni, D.K. 1990. Nutritional composition of the fruits of doum palms (*Hyphaene*) from the west coast of India. *Principes* 34(1):21-23.

Boom, B.M. 1986. The Chacobo Indians and their palms. *Principes* 30(2):63-70.

Borchsenius, F., Borgtoft Pedersen, H. and Balslev, H. 1996. *Manual of the palms of Ecuador.* Denmark: University of Aarhus. Manuscript.

Borgtoft Pedersen, H. 1992. Use and management of *Aphandra natalia* (Palmae) in Ecuador. *Bulletin de l'Institut Français d'Études Andines* 21(2):741-753.

Borgtoft Pedersen, H. 1994. Mocora palm-fibers: use and management of *Astrocaryum standleyanum* (Arecaceae) in Ecuador. *Economic Botany* 48(3):310-325.

Borgtoft Pedersen, H. 1996. Production and harvest of fibers from *Aphandra natalia* (Palmae) in Ecuador. *Forest Ecology and Management* 80:155-161.

Borgtoft Pedersen, H. and Balslev, H. 1990. *Ecuadorean palms for agroforestry.* AAU Report 23:1-122.

Bourgoing, R. 1991. *Coconut: a pictorial technical guide for smallholders.* Paris: IRHO.

Broekhoven, G. 1996. *Non-timber forest products: ecological and economic aspects of exploitation in Colombia, Ecuador and Bolivia.* Gland, Switzerland: IUCN.

Brown, W.H. and Merrill, E.D. 1919. *Philippine palms and palm products.* Bulletin No. 18, Bureau of Forestry, Department of Agriculture and Natural Resources. Manila: Bureau of Printing.

Burkill, I.H. 1966. *A dictionary of the economic products of the Malay peninsula.* Kuala Lumpur: Ministry of Agriculture and Cooperatives.

Calera Hidalgo, R. 1992. The tagua initiative in Ecuador: a community approach to tropical rain forest conservation and development. *In:* Plotkin and Famolare. *Op. cit.*, pp. 263-273.

Castillo Mont, J.J., Gallardo, N.R. and Johnson, D.V. 1994. The pacaya palm (*Chamaedorea tepejilote;* Arecaceae) and its food use in Guatemala. *Economic Botany* 48(1):68-75.

Chand Basha, S. and Bhat, K.M. (eds.) 1993. *Rattan management and utilisation.* Peechi, Kerala, India: Kerala Forest Research Institute.

Chandrasekharan, C. 1995. Terminology, definition and classification of forest products other than wood. *In: Report of the international expert consultation on non-wood forest products.* Non-Wood Forest Products 3. FAO: Rome. pp. 345-380.

Chandrashekara, U.M. 1993. Forest canopy gaps and cane distribution in a humid tropical forest of Kerala, India. *In:* Chanda Basha and Bhat. *Op. cit.*, pp. 123-132.

Child, R. 1964. *Coconuts.* 2nd ed. London: Longman.

Clement, C.R. 1988. Domestication of the pejibaye palm (*Bactris gasipaes*): past and present. *Advances in Economic Botany* 6:155-174.

Clement, C.R. 1989. The potential use of the pejibaye palm in agroforestry systems. *Agroforestry Systems* 7(3):201-212.

Clement, C.R. 1992. Domesticated palms. *Principes* 36(2):70-78.

Cocoinfo. 1995. *Cocoinfo International* 2(2):39-41.

Coleman, A. 1983. La production artisanale dans le développement de la Côte d'Ivoire: le cas des travailleurs de rotin sur la route de Bassam. Thesis, Institut d'ethno-sociologie, Université de Côte d'Ivoire, Abidjan.

Conelly, W.T. 1985. Copal and rattan collecting in the Philippines. *Economic Botany* 39(1):39-46.

Coradin, L. and Lleras, E. 1988. Overview of palm domestication in Latin America. *Advances in Economic Botany* 6:175-189.

Corley, R.H.V., Hardon, J.J., Wood, B.J. (eds.). 1976. *Oil palm research.* Amsterdam: Elsevier.

Corner, E.J.H. 1966. *The natural history of palms.* Berkeley, CA: University of California Press.

Cribb, P. 1992. *Licuala grandis* in its native habitat in Espiritu Santo, Vanuatu. *Principes* 36(1):36-38.

Cunningham, A.B. 1990a. Income, sap yield and effects of sap tapping on palms in south-eastern Africa. *South African Journal of Botany* 56(2):137-144.

Cunningham, A.B. 1990b. The regional distribution, marketing and economic value of the palm wine trade in the Ingwavuma District, Natal, South Africa. *South African Journal of Botany* 56(2):191-198.

Cunningham, A.B. and Milton, S.J. 1987. Effects of basket-weaving industry on mokola palm and dye plants in northwestern Botswana. *Economic Botany* 41(3):386-402.

Cunningham, A.B. and Wehmeyer, A.S. 1988. Nutritional value of palm wine from *Hyphaene coriacea* and *Phoenix reclinata* (Arecaceae). *Economic Botany* 42(3):301-306.

Dahlgren, B.E. 1944. Economic products of palms. *Tropical Woods* 78:10-35.

Dalling, J.W., Harms, K.E., Eberhard, J.R. and Candanedo, I. 1996. Natural history and uses of tagua (*Phytelephas seemannii*) in Panamá. *Principes* 40(1):16-23.

Davis, T.A. 1972. Tapping the wild date. *Principes* 16(1):12-15.

Davis, T.A. 1988. Use of semi-wild palms in Indonesia and elsewhere in South and Southeast Asia. *Advances in Economic Botany* 6:98-118.

Davis, T.A., Jamadon, B. and Noh, A.J.M. 1990. Nipah leaflets as wrappers for cigarettes. *Principes* 34(1):24-27.

Davis, T.A. and Joel, A.J. 1989. *Phoenix acaulis* Buch. ex. Roxb. (Arecaceae) in South India. *Palms & Cycads* 23:2-10.

Davis, T.A. and Johnson, D.V. 1987. Current utilization and further development of the palmyra palm (*Borassus flabellifer* L., Arecaceae) in Tamil Nadu State, India. *Economic Botany* 41(2):247-266.

Davis, T.A. and Kuswara, T. 1987. Observations on *Pigafetta filaris*. *Principes* 31(3):127-137.

De Zoysa, N. 1992. Tapping patterns of the kitul palm (*Caryota urens*) in the Sinharaja area, Sri Lanka. *Principes* 36(1):28-33.

De Zoysa, N. 1996. Sri Lanka. *In*: Johnson. *Op. cit.*, pp. 53-57.

De Zoysa, N. and Vivekanandan, K. 1991. *The bamboo and rattan cottage industry in Sri Lanka.* Battaramulla, Sri Lanka: Sri Lanka Forest Department.

De Zoysa, N. and Vivekanandan, K. 1994. *Rattans of Sri Lanka.* Battaramulla: Sri Lanka Forest Department.

Del Cañizo, J.A. 1991. *Palmeras*. Madrid: Ediciones Mundi-Prensa.

Dissanayake B.W. 1986. Techno-economic aspects of production and utilization of two related palms - kitul (*Caryota urens*) and palmyra. *In*: Yamada and Kainuma. *Op. cit.*, pp. 75-85.

Dowe, J.L. (ed.) 1989a. *Palms of the Solomon Islands*. Milton, Queensland: The Palm and Cycad Societies of Australia.

Dowe, J.L. (ed,) 1989b. *Palms of the south-west Pacific*. Milton, Queensland: The Palm and Cycad Societies of Australia.

Dowe, J.L. 1992. Extra-tropical palms: a statistical overview. *The Palm Enthusiast* 9(3):4-8.

Dowe, J.L. 1996. Uses of some indigenous Vanuatu palms. *Principes* 40(2):93-102.

Dowe, J.L., Benzie, J. and Ballment, E. in press. Distribution, ecology and population genetics of *Carpoxylon macrospermum* H. Wendl. & Drude (Arecaceae), an endangered palm from Vanuatu. *Biological Conservation.*

Dowe, J.L. and Cabalion, P. 1996. A taxonomic account of Arecaceae in Vanuatu, with descriptions of three new species. *Australian Systematic Botany* 9(1):1-60.

Dowson, V.H.W. 1982. *Date production and protection*. FAO Plant Production and Protection Paper 35. Rome: FAO.

Dowson, V.H.W. and Aten, A. 1962. *Dates: handling, processing and packing*. FAO Agricultural Development Paper 72. Rome: FAO.

Dransfield, J. 1977. Dryland sago palms. *In:* Tan, K. *Op. cit*, pp. 76-83.

Dransfield, J. 1979. *A manual of the rattans of the Malay Peninsula*. Kuala Lumpur: Forest Department.

Dransfield, J. 1982. A reassessment of the genera *Plectocomiopsis, Myrialepis* and *Bejaudia* (Palmae: Lepidocaryoideae). *Kew Bulletin* 37(2):237-254.

Dransfield, J. 1984. *The rattans of Sabah*. Sabah Forest Record No. 13. Sabah, Malayasia: Forest Department.

Dransfield, J. 1985. Prospects for lesser known canes. *In*: Wong and Manokaran. *Op. cit.*, pp. 107-114.

Dransfield, J. 1986. Palmae. *Flora of tropical East Africa*. Rotterdam: A.A. Balkema.

Dransfield, J. 1988. Prospects for rattan cultivation. *Advances in Economic Botany* 6:190-200.

Dransfield, J. 1989. The conservation status of rattan in 1987 a cause for great concern. *In*: Rao and Vongkaluang. *Op. cit.*, pp. 6-10.

Dransfield, J. 1992. *The rattans of Sarawak*. Richmond, U.K.: Royal Botanic Gardens, Kew.

Dransfield, J. and Beentje, H. 1995. *The palms of Madagascar*. Richmond, U.K.: Royal Botanic Gardens, Kew.

Dransfield, J. and Johnson, D. 1991. The conservation status of palms in Sabah (Malaysia). *In*: Johnson 1991b. *Op. cit*., pp. 175-179.

Dransfield, J. and Manokaran, N. (eds.) 1993. *Plant resources of south-east Asia*. 6. Rattans. Wageningen, Netherlands: Pudoc.

Duraiaippah, A. K. 1994. *A state of the art review on the socio-economics of the bamboo and rattan sector in southeast Asia*. INBAR Working Paper No. 1. New Delhi: INBAR.

Durand, P. 1995. Collaborative development-oriented research on conservation of rattan biodiversity in Malaysia. *In:* Durst and Bishop. *Op. cit*., pp. 321-325.

Durst, P.B. and Bishop, A. (eds.) 1995. *Beyond timber: social, economic and cultural dimensions of non-wood forest products in Asia and the Pacific*. Bangkok: FAO Regional Office for Asia and the Pacific.

Eckey, E.W. 1954. *Vegetable fats and oils*. New York: Reinhold.

EMBRAPA. 1987. *Palmito 1º encontro nacional de pesquisadores*. Curitiba, Brazil: Empresa Brasileira de Pesquisa Agropecuaria.

Essiamah, S.K. 1992. Sapping of oil palm (*Elaeis guineensis*, Jacq.) in the rain forest region of West Africa. *Der Tropenlandwirt* 93:123-135.

Essig, F.B. 1978. A revision of the genus *Ptychosperma* Labill. (Arecaceae) *Allertonia* 1(7):415-478.

Essig, F.B. 1982. A synopsis of the genus *Gulubia*. *Principes* 26(4):159-173.

Essig, F.B. 1995. A checklist and analysis of the palms of the Bismarck Archipelago. *Principes* 39(3):123-129.

Essig, F.B. and Yun-Fa Dong. 1987. The many uses of *Trachycarpus fortunei* (Arecaceae) in China. *Economic Botany* 41(3):411-417.

Evans, R.J. 1996. Conservation status of *Cryosophila* with special reference to the critically endangered *Cryosophila cookii* and *Cryosophila williamsii*. *Principes* 40(3):129-147.

Falconer, J. and Koppell, C.R.S. 1990. *The major significance of "minor" forest products: the local use and value of forests in the West African humid forest zone*. Community Forest Note 6. Rome: FAO.

FAO, 1986. *The development of the sago palm and its products*. Report of the FAO/BPPT Consultation, Jakarta, Indonesia, 16-21 January 1984. Rome: FAO.

FAO, 1994. *FAO production yearbook*. Vol. 48. Rome: FAO.

FAO/CATIE, 1984. *Palmeras poco utilizadas de América tropical*. San José, Costa Rica: CATIE.

Feil, J.P. 1996. Fruit production of *Attalea colenda* (Arecaceae) in coastal Ecuador - an alternative oil resource? *Economic Botany* 50(3):300-309.

Fernandes, H.Q.B. 1993. Native palms of Espirito Santo State, Brazil. *In*: Dematte, M.E.S.P. (ed.) *First international symposium on ornamental palms. Acta Horticulturae* 360., pp. 95-111.

Fernando, E.S. 1990. A preliminary analysis of the palm flora of the Philippine Islands. *Principes* 34(1):28-45.

Flach, M. 1983. *The sago palm.* FAO Plant Production and Protection Paper 47. Rome: FAO.

Flach, M. and Schuiling, D.L. 1989. Revival of an ancient starch crop: a review of the agronomy of the sago palm. *Agroforestry Systems* 7(3):259-281.

Fong, F.W. 1989. The apung palm: traditional techniques of sugar tapping and alcohol extraction in Sarawak. *Principes* 33(1):21-26.

Fong, F.W. 1992. Perspectives for sustainable resource utilization and management of nipa vegetation. *Economic Botany* 46(1):45-54.

Fox, J.J. 1977. *Harvest of the palm.* Cambridge MA: Harvard University Press.

Francis, P. Jr. 1984. Plants as human adornment in India. *Economic Botany* 38(2):194-209.

Gagnepain, F. 1937. Palmiers. *Flore générale de L'Indo-Chine.* 6(7,8):946-1056.

Galeano, G. 1991. *Las palmas de la región de Araracuara.* Estudios en la Amazonia Colombiana. Vol. 1. Bogotá: Tropenbos.

Ghosh, S.S. and Ghose, M. 1995. *Phoenix sylvestris* (L.) Roxb., a promising sugar-yielding wild date palm. *Mooreana* 5(2):47-54.

Gibbons, M. and Spanner, T.W. 1996. *Medemia argun* lives! *Principes* 40(2):65-74.

Gillett, G.W. 1971. *Pelagodoxa* in the Marquesas Islands. *Principes* 15(2):45-48.

Glassman, S.F. 1972. *A revision of B.E. Dahlgren's Index of American palms.* Tomus VI. Cramer, Germany: Phanerogamarum Monographiae.

Godoy, R. 1990. The economics of traditional rattan cultivation. *Agroforestry Systems* 12:163-172.

Gragson, T.L. 1992. The use of palms by the Pume Indians of southwestern Venezuela. *Principes* 36(3):133-142.

Gumilla, J.S.I. 1963. *El Orinoco ilustrado.* Caracas: Ed. Academia de la Historia. Quoted in Kahn, F., León, B. and Young, K.R. 1993. *Las plantas vasculares en las aguas continentales del Perú.* Lima: Instituto Francés de Estudios Andinos.

Guzman, E.D. de and Fernando, E.S. 1986. Philippine palms. *In*: *Guide to Philippine flora and fauna.* Vol. 4. Philippines: Natural Resources Management Center. pp. 145-233.

Hagenmaier, R. 1980. *Coconut aqueous processing.* 2nd ed. Cebu City, Philippines: San Carlos Publications.

Hamilton, L.S. and Murphy, D.H. 1988. Use and management of nipa palm (*Nypa fruticans*, Arecaceae): a review. *Economic Botany* 42(2):206-213.

Hartley, C.W.S. 1988. *The oil palm.* 3rd ed. London: Longman.

Hay, A.J.M. 1984. Palmae. *A guide to the monocotyledons of Papua New Guinea.* Part 3. Lae: Papua New Guinea University of Technology. pp. 195-318.

Henderson, A. and Chávez, F. 1993. *Desmoncus* as a useful palm in the western Amazon Basin. *Principes* 37(4):184-186.

Henderson, A., Galeano, G. and Bernal, R. 1995. *Field guide to the palms of the Americas.* Princeton NJ: Princeton University Press.

Hodel, D. 1992. *The Chamaedorea palms.* Lawrence, Kansas. International Palm Society, Allen Press.

Hodge, W.H. 1975. Oil-producing palms of the world--a review. *Principes* 19(4):119-136.

Hoebeke, P. 1989. The doumpalm (*Hyphaene compressa*) as biological resource in Turkana District, Kenya. M.Sc. thesis, University of Trondheim, Norway.

Holm Jensen, O. and Balslev, H. 1995. Ethnobotany of the fiber palm *Astrocaryum chambira* (Arecaceae) in Amazonian Ecuador. *Economic Botany* 49(3):309-319.

Horrocks, M. 1990. Fabrication of *Metroxylon* thatch. *Palms & Cycads* 29:6-7.

House, A.P.N. 1983. The use of palms by man on Siberut Island, Indonesia. *Principes* 27(1):12-17.

Husin, M., Hassan, A.H.H. and Mohammed, A.T. 1986. *Availability and potential utilisation of oil palm trunks and fronds up to the year 2000.* PORIM Occasional Paper 20. Kuala Lumpur: Palm Oil Research Institute of Malaysia.

Ibarra-Manriquez, G. 1988. The palms of a tropical rain forest in Veracruz, Mexico. *Principes* 32(4):147-155.

IDRC. 1980. *Rattan: a report of a workshop held in Singapore, 4-6 June 1979.* Ottawa, Canada: International Development Research Centre.

Jamil, H.M., Hassan, H.A.H., Sulaiman, A.S. and Mokhtar, A.S. 1987. *The oil palm industry in Malaysia: a guidebook.* Kuala Lumpur: Palm Oil Research Institute of Malaysia.

Johnson, D.V. 1970. The carnaúba wax palm (*Copernicia prunifera*) and its role as an economic plant. Master's thesis, University of California, Los Angeles.

Johnson, D.V. 1972. The carnaúba wax palm (*Copernicia prunifera*). Principes 16(1):16-19, (2):42-48, (3): 111-114, (4): 128-131.

Johnson, D.V. 1983. Multipurpose palms in agroforestry: a classification and assessment. *The International Tree Crops Journal* 2(3/4): 217-244.

Johnson, D.V. 1991a. The mpapindi palm (*Chrysalidocarpus pembanus*) of Pemba Island, Tanzania. *Principes* 35(2):83-85.

Johnson, D.(V.) (ed.) 1991b. *Palms for human needs in Asia*. Rotterdam: A.A. Balkema.

Johnson, D.V. 1992. Palm utilization and management in Asia: examples for the neotropics. *Bulletin de l'Institut Français d'Études Andines* 21(2):727-740.

Johnson, D.(V.) (ed.) 1996. *Palms: their conservation and sustained utilization*. Status survey and conservation action plan. Gland, Switzerland: IUCN The World Conservation Union.

Jones, D.L. 1995. *Palms throughout the world*. Washington, DC: Smithsonian Institution Press.

Joshi, Y. and Ramachandra Reddy, N. 1982. *Arecanut palm* (Areca catechu *Linn.) an annotated bibliography up to 1981*. Kasaragod, India: Central Plantation Crops Research Institute.

Kahn, F. 1988. Ecology of economically important palms in Peruvian Amazonia. *Advances in Economic Botany* 6:42-49.

Kahn, F. 1991. Palms as key swamp forest resources in Amazonia. *Forest Ecology and Management* 38:133-142.

Kahn, F. and de Granville, J-J. 1992. *Palms in forest ecosystems of Amazonia*. Berlin: Springer-Verlag.

Kahn, F. and Mejía, K. 1987. Notes on the biology, ecology and use of a small Amazonian palm: *Lepidocaryum tessmannii*. *Principes* 31(1):14-19.

Kahn F. and Moussa, F. 1994. Diversity and conservation status of Peruvian palm. *Biodiversity and Conservation* 3:227-242.

Khoo, K.C., et al. (eds.) 1991. *Seminar proceedings: oil palm trunk and other palmwood utilization*. Oil Palm Tree Utilization Committee of Malaysia. Kuala Lumpur: Ministry of Primary Industries.

Kiew, R. 1991. Palm utilization and conservation in Peninsular Malaysia. *In*: Johnson 1991b. *Op. cit.*, pp. 75-130.

Killmann, W. 1988. *How to process coconut palm wood*. Wiesbaden: Vieweg.

Killmann, W., Wong, W.C. and Shaari, K. 1989. *Utilisation of palm stems and leaves: an annotated bibliography*. Kuala Lumpur: Forest Research Institute Malaysia.

Kong-Ong, H.K. and Manokaran, N. 1986. *Rattan: a bibliography*. Rattan Information Centre, Selangor, Malaysia.

Konstant, T.L., Sullivan, S. and Cunningham, A.B. 1995. The effects of utilization by people and livestock on *Hyphaene petersiana* (Arecaceae) basketry resources in the palm savanna of north-central Namibia. *Economic Botany* 49(4):345-356.

Kovoor, A. 1983. *The palmyrah palm: potential and perspectives.* FAO Plant Production and Protection Paper 52. Rome: FAO.

Koziol, M.J. and Borgtoft Pederson, H. 1993. *Phytelephas aequatorialis* (Arecaceae) in human and animal nutrition. *Economic Botany* 47(4):401-407.

Kullaya, A. 1994. *State of coconut production in Africa.* Paris: BuroTrop.

Kurz, S. 1874. Enumeration of Burmese palms. *Journal Asiatic Society of Bengal* 43(2):191-218.

Lakshmana, A.C. 1993. *Rattans of South India.* Bangalore, India: Evergreen Publishers.

Langlois, A.C. 1976. *Supplement to Palms of the World.* Gainesville, FL: University of Florida.

LeBar, F.M. 1964. *The material culture of Truk.* Publications in Anthropology 68. New Haven CT: Yale University.

Liao, Jih-Ching. 1994. *Illustrations of the family Palmae in Taiwan.* Taipei: National Taiwan University.

Lim H.F and Noor, N.S.M. 1995. Social, economic and cultural aspects of rattan in Malaysia. *In:* Durst and Bishop. *Op. cit.,* pp. 165-180.

Liyanage, M. de S. 1983. Agroforestry systems associated with coconuts. *The Sri Lanka Forester* 15(1/2):25-27.

Lleras, E. and Coradin, L. 1988. Native neotropical oil palms: state of the art and perspectives for Latin America. *Advances in Economic Botany* 6:201-213.

López Parodi, J. 1988. The use of palms and other native plants in non-conventional, low cost rural housing in the Peruvian Amazon. *Advances in Economic Botany* 6:119-129.

Lötschert, W. 1985. *Palmen.* Stuttgart: Ulmer.

Lubeigt, G. 1979. *Le palmier à sucre (*Borassus flabellifer*) en Birmanie* Central. Paris: Université de Paris-Sorbonne.

Madulid, D.A. 1981. A monograph of *Plectocomia* (Palmae: Lepidocaryoideae). *Kalikasan The Philippine Journal of Biology* 10(1):1-94.

Madulid, D.A. 1991a. The Philippines: palm utilization and conservation. *In:* Johnson 1991b. *Op. cit.,* pp. 181-225.

Madulid, D.A. 1991b. Utilization of Philippine palms. *In:* Johnson 1991b. *Op. cit.,* pp. 245-253.

Mahabale, T.S. 1982. *Palms of India.* Pune, India: Maharashtra Association for the Cultivation of Science.

Malik, K.A. 1984. Palmae. *Flora of Pakistan* 153:1-33.

Markley, K.S. 1953. *La palma mbocaya.* Servicio Tecnico Interamericano de Cooperación Agricola. Asunción: Ministerio de Agricultura y Ganadeira.

Markley, K.S. 1955. Caranday - a source of palm wax. *Economic Botany* 9(1):39-52.

Mathew, S.P. and Abraham, S. 1994. The vanishing palms of the Andaman and Nicobar islands, India. *Principes* 38(2):100-104.

May, P.H., Anderson, A.B., Frazao, J.M.F. and Balick, M.J. 1985. Babassu palm in the agroforestry systems in Brazil's mid-north region. *Agroforestry Systems* 3(3):275-295.

McClatchey, W. and Cox, P.A. 1992. Use of the sago palm *Metroxylon warburgii* in the Polynesian island, Rotuma. *Economic Botany* 46(3):305-309.

McCurrach, J.C. 1960. *Palms of the world.* New York: Harper & Brothers.

McSweeney, K. 1995. The cohune palm (*Orbignya cohune*, Arecaceae) in Belize: a survey of uses. *Economic Botany* 162-171.

Mejía C., K. 1988. Utilization of palms in eleven mestizo villages of the Peruvian Amazon (Ucayali River, Department of Loreto). *Advances in Economic Botany* 6:130-136.

Mejía C., K. 1992. Las palmeras en los mercados de Iquitos. *Bulletin de l'Institut Français d'Études Andines* 21(2):755-769.

Menon, K.P.V. and Pandalai, K.M. 1958. *The coconut palm: a monograph.* Ernakulam, India: Indian Central Coconut Committee.

Merlini L. and Nasini, G. 1976. Constituents of dragon's blood. Part II. Structure and oxidative conversion of a novel secobiflavonoid. *Journal of the Chemical Society* 14:1570-1576.

Miller, R.H. 1964. The versatile sugar palm. *Principes* 8(4):115-147.

Mogea, J.P. 1991. Indonesia: palm utilization and conservation. *In*: Johnson 1991b. *Op. cit.*, pp. 37-73.

Mogea, J., Seibert, B. and Smits, W. 1991. Multipurpose palms: the sugar palm (*Arenga pinnata* (Wurmb) Merr.). *Agroforestry Systems* 13:111-129.

Moll, H.A.J. 1987. *The economics of oil palm.* Wageningen, Netherlands: Pudoc.

Moore, Jr., H.E. 1979. Arecaceae. *In:* Smith, A.C. *Flora vitiensis nova.* Lawai, Kauai, Hawaii: Pacific Tropical Botanical Garden. pp. 392-438.

Moore, Jr., H.E. and Fosberg F.R. 1956. The palms of Micronesia and the Bonin Islands. *Gentes Herbarum* 8(6):421-478.

Moore, Jr., H.E. and Uhl, N.W. 1984. The indigenous palms of New Caledonia. *Allertonia* 3(5):313-402.

Moraes, M. 1991. Contribución al estudio del ciclo biológico de la palma *Copernicia alba* en un area ganadera (Espíritu, Beni, Bolivia). *Ecologia en Bolivia* 18:1-20.

Moraes, M. 1996. Novelties of the genera *Parajubaea* and *Syagrus* (Palmae) from interandean valleys of Bolivia. *Novon* 6:85-92.

Moraes, M. and Henderson, A. 1990. The genus *Parajubaea* (Palmae). *Brittonia* 42(2):92-99.

Mora-Urpí, J. 1996. Peach palm (*Bactris gasipaes* K.). School of Biology, University of Costa Rica. Manuscript.

Mora-Urpí, J., Szott, L.T., Murillo, M. and Patiño, V.M. (eds.) 1993. *IV Congresso international sobre biología, agronomía e industrialización del pijuayo.* San José, Costa Rica: Editorial de la Universidad de Costa Rica.

Morakinyo, A.B. 1995. Profiles and Pan-African distributions of the rattan species (Calamoideae) recorded in Nigeria. *Principes* 39(4):197-209.

Moussa, F. and Kahn, F. 1996. (in press) Utilizaciones y potencial económico de dos palmas, *Astrocaryum aculeatum* Meyer y *A. vulgare* Martius, en la Amazonia. *In*: Rios, M. and Borgtoft Pedersen, H. (eds.) *Memorias del II simposio ecuatoriano de ethnobotánica y botánica económica.* Quito.

Munier, P. 1973. *Le palmier-dattier.* Paris: Maisonneuve & Larose.

Nair, M.K., Khan, H.H., Gopalasundrama, P. and Bhaskara Rao, E.V.V. (eds.) 1993. *Advances in coconut research and development.* New York, NY: International Science Publisher.

Nasendi, B.D. 1994. *Socio-economic information on rattan in Indonesia.* INBAR Working Paper No. 2. New Delhi: INBAR.

Nayar, N.M. (ed.) 1983. *Coconut research & development.* New Delhi: Wiley Eastern Ltd.

Nepstad, D.C. and Schwartzman, S. (eds.) 1992. Non-timber products from tropical forests. *Advances in Economic Botany* 9:1-164.

Ng Thai-Tsiung, Tie Yiu-Liong and Keuh Hong-Sion (eds.) 1991. *Towards greater advancement of the sago industry in the '90s.* Proceedings of the fourth international sago symposium held August 6-9, 1990, Kuching, Sarawak, Malaysia. Kuching: Ministry of Agriculture & Community Development.

O'Brien, T.G. and Kinnaird, M.F. 1996. Effect of harvest on leaf development of the Asian palm *Livistona rotundifolia. Conservation Biology* 10(1):53-58.

Ohler, J.G. 1984. *Coconut, tree of life.* FAO Plant Production and Protection Paper 57. Rome: FAO.

Okereke, O. 1982. The traditional system of oil palm wine production in Igbo Eze local government area of Anambra State of Nigeria. *Agricultural Systems* 9:239-253.

Otedoh, M.O. 1982. A revision of the genus *Raphia* Beauv. (Palmae). *Journal of the Nigerian Institute for Oil Palm Research* 6(22):145-189.

Padmanabhan, D. and Sudhersan, C. 1988. Mass destruction of *Phoenix loureirii* in South India. *Principes* 32(3):118-123.

Padoch, C. 1988. Aguaje (*Mauritia flexuosa* L.f.) in the economy of Iquitos, Peru. *Advances in Economic Botany* 6:214-224.

Päivöke, A.E.A. 1983. Nipa palm (*Nypa fruticans*) as a raw material. *Abstracts on Tropical Agriculture* 9(9):11-19.

Päivöke, A.E.A. 1984. Tapping patterns in the nipa palm (*Nypa fruticans* Wurmb.). *Principes* 28(3):132-137.

Patiño, V.M. 1963. *Plantas cultivadas y animales domesticos en América equinoccial.* Cali, Colombia: Imprenta Departamental.

PCARRD. 1985. *The Philippines recommends for rattan.* Technical Bulletin Series No. 55, Philippine Council for Agriculture and Resources Research and Development. Los Baños: Philippine Council for Agriculture, Forestry and Natural Resources Research and Development.

PCARRD. 1990. *Rattan: proceedings of the national symposium/workshop on rattan.* Los Baños: Philippine Council for Agriculture, Forestry and Natural Resources Research and Development.

Pearce, K.G. 1991. Palm utilization and conservation in Sarawak (Malaysia). *In*: Johnson 1991b. *Op. cit.*, pp. 131-173.

Pearce, K.G. 1994. The palms of Kubah National Park, Kuching Division, Sarawak. *Malayan Nature Journal* 48:1-36.

Peluso, N.L. 1992. The rattan trade in East Kalimantan, Indonesia. *Advances in Economic Botany* 9:115-127.

Pérez Vela, J.M. 1985. *El pijuayo en el Peru: manejo y usos.* Manuscript. Yurimaguas, Peru.

Persley, G.B. 1992. *Replanting the tree of life: towards an international agenda for coconut palm research.* Wallingford, Oxon, UK: CAB International.

Pesce, C. 1985. *Oil palms and other oilseeds of the Amazon.* Algonac, MI: Reference Publications.

PFSODP. 1983. *Proceedings of the first symposium on the date palm.* March 23-25, 1982. Al Hassa, Saudi Arabia: King Faisal University.

Phil. Coco. Auth., 1979. *Technical data handbook on the coconut.* Quezon City: Philippine Coconut Authority.

Pinard, M. 1993. Impacts of stem harvesting on populations of *Iriartea deltoidea* (Palmae) in an extractive reserve in Acre, Brazil. *Biotropica* 25:2-14.

Pinard, M.A. and Putz, F.E. 1992. Population matrix models and palm resource management. *Bulletin de l'Institut Français d'Etudes Andines* 21(2):637-649.

Pinheiro, C.U.B. and Balick, M.J. (eds.) 1987. *Brazilian palms.* Contributions from The New York Botanical Garden Vol. 17.

Plotkin, M.J. and Balick, M.J. 1984. Medicinal uses of South American palms. *Journal of Ethnopharmacology* 10:157-179.

Plotkin, M. and Famolare, L. (eds.) 1992. *The sustainable harvest and marketing of rainforest products*. Covelo, CA: Island Press.

Pollak, H., Mattos, M. and Uhl, C. 1995. A profile of palm heart extraction in the Amazon Estuary. *Human Ecology* 23(3):357-385.

Power, A.P. 1986. Strategy for sago development in the East Sepik Province, Papua New Guinea. *In*: Yamada and Kainuma. *Op. cit*., pp. 105-108.

Priasukmana, S. 1989. Rattan for economic development in East Kalimantan. *In*: Rao and Vongkaluang. *Op. cit*., pp. 248-257.

PSSODP. 1989. *Proceedings of the second symposium on the date palm*. March 3-6, 1986. 2 vols. Riyadh, Saudi Arabia: Mars Publishing House.

Pushparajah, E. and Chew Poh Soon (eds.). 1982. *The oil palm in agriculture in the eighties*. 2 vols. Kuala Lumpur: Incorporated Society of Planters.

Putz, F.E. 1979. Biology and human use of *Leopoldinia piassaba. Principes* 23(4):149-156.

Quast, D.G. and Bernhardt, L.W. 1978. Progress in palmito (heart-of-palm) processing research. *Journal of Food Protection* 41(8):667-674.

Quero, H.J. 1992. Current status of Mexican palms. *Principes* 36(4):203-216.

Rao, A.N. and Vongkaluang, I. (eds.) 1989. *Recent research on rattans*. Bangkok: Faculty of Forestry, Kasetsart University.

Ratsirarson, J., Silander, J.A., Jr. and Richard, A.F. 1996. Conservation and management of a threatened Madagascar palm species, *Neodypsis decaryi*, Jumelle. *Conservation Biology* 10(1):40-52.

Rattan Information Centre (RIC) Bulletin. 1982-1993. Rattan Information Centre, Kepong, Malaysia.

Rauwerdink, J.B. 1986. An essay on *Metroxylon,* the sago palm. *Principes* 30(4):165-180.

Read, R.W. 1988. Utilization of indigenous palms in the Caribbean (in relation to their abundance). *Advances in Economic Botany* 6:137-143.

Reining, C. and Heinzman, R. 1992. Nontimber forest products in the Petén, Guatemala: why extractive reserves are critical for both conservation and development. *In*: Plotkin and Famolare. *Op. cit.*, pp. 110-117.

Renuka, C. 1992. *Rattans of the Western Ghats: a taxonomic manual.* Peechi, Kerala, India: Kerala Forest Research Institute.

Renuka, C. 1995. *A manual of the rattans of Andaman and Nicobar islands.* Peechi, Kerala, India: Kerala Forest Research Institute.

Renuka, C., Bhat, K.M. and Nambiar, V.P.K. 1987. *Morphological, anatomical and physical properties of* Calamus *species of Kerala forests.* Kerala Forest Research Institute No. 46, Peechi, Kerala, India.

Reynolds, S.G. 1988. *Pastures and cattle under coconuts.* FAO Plant Production and Protection Paper 91. Rome: FAO.

Rioja, G. 1992. The jatata project: the pilot experience of Chimane empowerment. *In*: Plotkin and Famolare. *Op. cit.*, pp. 192-196.

Rodin, R.J. 1985. *The ethnobotany of the Kwanyama Ovambos.* Monographs in Systematic Botany from the Missouri Botanical Garden 9:1-163.

Rolla, S.R. and Joseph, J. 1962. *Livistona Jenkinsiana. Principes* 6(3):103-106.

Ruddle, K. and Heinen, H.D. 1974. Ecology, ritual and economic organization in the distribution of palm starch among the Warao of the Orinoco Delta. *Journal of Anthropological Research* 50(2):116-138.

Ruddle, K., Johnson, D., Townsend, P.K. and Rees, J.D. 1978. *Palm sago: a tropical starch from marginal lands.* Honolulu: University Press of Hawaii.

Russell, T.A. 1968. Palmae. *Flora of west tropical Africa* 3(1):159-169. London: Crown Agents.

Sadebeck, R. 1899. *Die kulturgewachse der deutschen kolonien und ihre Erzeugnisse.* Jena, Germany: Gustav Fischer.

Sambou, B., Lawesson, J.E. and Barfod, A.S. 1992. *Borassus aethiopum*, a threatened multiple purpose palm in Senegal. *Principes* 36(3):148-155.

Sastrapradja, S., Mogea, J.P., Sangat, H.M. and Afriastini, J.J. 1978. *Palem Indonesia.* Bogor: Lembaga Biologi Nasional.

Schuiling, M. and Harries, H.C. 1994. The coconut palm in East Africa. 1. East African tall. *Principes* 38(1):4-11.

Schultes, R.E. 1974. Palms and religion in the northwest Amazon. *Principes* 18(1):3-21.

Schultes, R.E. 1990. Taxonomic, nomenclatural and ethnobotanic notes on *Elaeis. Elaeis* 2:172-187.

Shaari, K., Khoo, K.C. and Ali, A.R.M. 1991. *Oil palm stem utilisation: review of research.* Kuala Lumpur: Forest Research Institute Malaysia.

Shama Bhat, K. and Radhakrishnan Nair, C.P. (eds). 1985. *Arecanut research & development.* Kasaragod, India: Central Plantation Crops Research Institute.

Shiembo, P. 1986. Development and utilization of minor forest products in Cameroon with particular reference to raphia and cane (rattan) palms. Thesis, Department of Forest Resource Management, Ibadan University, Ibadan, Nigeria.

Shimoda, H. and Power, A.P. 1986. Investigation into development and utilization of sago palm forest in the East Sepik Region, Papua New Guinea. *In*: Yamada and Kainuma. *Op. cit.*, pp. 94-104.

Siebert, S.F. 1989. The dilemma of a dwindling resource: rattan in Kerinci, Sumatra. *Principes* 33(2):79-87.

Siebert, S.F. 1995. Prospects for sustained-yield harvesting of rattan (*Calamus* spp.) in two Indonesian national parks. *Society and Natural Resources* 8:209-218.

Siebert, S.F. and Belsky, J.M. 1985. Forest-product trade in a lowland Filipino village. *Economic Botany* 39(4):522-533.

Standley, P. and Steyermark, J. 1958. Palmae. Flora of Guatemala. *Fieldiana Botany* 24:196-299.

Stanton, W.R. and Flach, M. (eds.) 1980. *Sago: the equatorial swamp as a natural resource.* Proceedings of the second international sago symposium, held in Kuala Lumpur, Malaysia, September 15-17, 1979. The Hague: Martinus Nijhoff.

Stewart, L. 1994. *A guide to palms & cycads of the world.* Sydney, Australia: Angus & Robertson.

Strudwick, J. and Sobel, G.L. 1988. Uses of *Euterpe oleracea* Mart. in the Amazon Estuary, Brazil. *Advances in Economic Botany* 6:225-253.

Subansenee, W. 1995. Major non-wood forest products of Thailand. *In*: Durst and Bishop. *Op. cit.*, pp. 201-214.

Subhadrabandhu, S. and Sdodee, S. (eds.) 1995. *Fifth international sago symposium.* Hat Yai, Songkhla, Thailand, 27-29 January 1994. *Acta Horticulturae* 389.

Sullivan, S., Konstant, T.L. and Cunningham, A.B. 1995. The impact of utilization of palm products on the population structure of the vegetable ivory palm (*Hyphaene petersiana*, Arecaceae) in north-central Namibia. *Economic Botany* 49(4):357-370.

Surre, C. and Ziller, R. 1963. *Le palmier à huile.* Paris: Maisonneuve & Larose.

Tabora, Jr., P.C., Balick, M.J., Bovi, M.L.A. and Guerra, M.P. 1993. Hearts of palm (*Bactris, Euterpe* and others). In: Williams, J.T. (ed.) *Underutilized crops.* London: Chapman & Hall. pp. 193-218.

- *Palms & Cycads*. Magazine of the Palm & Cycad Societies of Australia. Four times per year, 1984-. PACSOA, P.O. Box 1134, Milton, Qld 4064 Australia.

- *Palmwood News*. Occasional, 1995-. Protrade/GTZ, P.O. Box 5180, D-65726 Eschborn, Germany.

- *The Philippine Journal of Coconut Studies*. Two times per year, 1976-. Philippine Coconut Research & Development Foundation, Inc., PCRDF Bldg., Pearl Drive cor. Lourdes St., Ortigas Complex, 1600 Pasig, Metro Manila, Philippines.

- *Principes*. Journal of the International Palm Society. Four times per year, 1956-. The International Palm Society, P.O. Box 1897, Lawrence KS 66044-8897 USA.

- *Ric Bulletin*. Four times per year, 1982-1993. Rattan Information Centre, Forest Research Institute, Kepong, Selangor, Malaysia.

- *Sago Communication*. Three times per year, 1990-. In Japanese and English. Tsukuba Sago Fund, 791-27 Inaoka, Tsukuba, Ibaraki 305 Japan. (sago palm)

Palm Videos

- Coconut. The Asian and Pacific Coconut Community, P.O. Box 1343, Jakarta 10013, Indonesia. Series of six videos (VHS-PAL format) with the following titles:

  ⇒ *Wealth Under the Tree of Life*. Promotes advantages of mixed farming systems including coconut. 25 minutes. 1991.

  ⇒ *Cash in Shell*. Overview of coconut shell products. 25 minutes. 1992.

  ⇒ *Coir the Versatile Fibre*. Coir fiber and its products. 25 minutes. 1992.

  ⇒ *Copra Making and Coconut Oil Manufacture*. Descriptions of copra making and small-scale oil milling. 25 minutes. 1992.

  ⇒ *Coconut Culture*. General information on coconut growing. 20 minutes. 1994.

  ⇒ *Coconut Pests*. Coconut pests and methods of control. 25 minutes. 1995.

- Date. Coachella Valley Historical Society, 82-616 Miles Avenue, Indio CA 92202 USA.

  ⇒ *Date Palm: The Tree of Life*. Story of date cultivation in Southern California. 13 minutes. 1990. NTSC format.

- Malaysia. PACSOA, P.O. Box 1134, Milton, Qld 4064, Australia.

  ⇒ *Rare Palms in Malaysia*. Major Malaysian palms in habitat, especially *Johannesteijsmannia* spp. 26 minutes. 1990? VHS-PAL or NTSC formats available.

Täckholm, V. and Drar, M. 1973. *Flora of Egpyt.* Vol. 2. Koenigstein, Germany: Otto Koeltz.

Tan, C.F. 1992. *Prospects for rattan planting and a field manual for rattan cultivation in the South Pacific.* Port Vila, Vanuatu: South Pacific Forestry Development Programme.

Tan, K. (ed.) 1977. *Sago-76: papers of the first international sago symposium.* The equatorial swamp as a natural resource 5-7 July 1976. Kuala Lumpur: Kemajuan Kanji Sdn. Bhd.

Tan, K. 1983. *The swamp-sago industry in West Malaysia.* Singapore: Institute of Southeast Asian Studies.

Thampan, P.K. 1975. *The coconut palm and its products.* Cochin, India: Green Villa Publishing.

Tomlinson, P.B. 1961. *Anatomy of the monocotyledons: II. Palmae.* London: Oxford University Press.

Tomlinson, P.B. 1990. *The structural biology of palms.* New York: Oxford University Press.

Tuley, P. 1994. African bass/piassava - a historical perspective. *Principes* 38(1):36-46.

Tuley, P. 1995. *The palms of Africa.* Cornwall, UK: Trendrine Press.

Uhl, N.W. and Dransfield, J. 1987. *Genera palmarum.* Lawrence, KS: International Palm Society, Allen Press.

UNIDO. 1983. *Manual on the production of rattan furniture.* New York: United Nations Industrial Development Organization.

Urdaneta, H. 1981. *Planificación silvicultural de los bosques ricos en palma manaca* (Euterpe oleracea) *en el delta del Río Orinoco.* Mérida, Venezuela: Universidad de los Andes.

Vargas C., I. 1994. Ecology and uses of *Parajubaea torallyi* in Bolivia. Principes 38(3):146-152.

Voeks, R.A. 1988. The Brazilian fiber belt: harvest and management of piassava palm (*Attalea funifera* Mart.). *Advances in Economic Botany* 6:254-267.

Vovides, A.P. and Garcia Bielma, M.A. 1994. A study of the in situ situation of four species of threatened understory palms of the genus *Chamaedorea* in the wild in the State of Veracruz, Mexico. *Principes* 38(2):109-113.

Wan Razali, W.M., Dransfield, J. and Manokaran, N. (eds.) 1992. *A guide to the cultivation of rattan.* Kuala Lumpur: Forest Research Institute Malaysia.

Wan Razali, W.M., Dransfield, J. and Manokaran, N. (eds.) 1994. *Nursery techniques for rattan.* Technical Report No. 2. New Delhi: INBAR.

Watt, B.K. and Merrill, A.L. 1963. *Composition of foods.* Agricultural Handbook No. 8. Washington, DC: U.S. Department of Agriculture.

Weinstock, J.A. 1983. Rattan: ecological balance in a Borneo rainforest swidden. *Economic Botany* 37(1):58-68.

Wheeler, M.A. 1970. Siona use of chambira palm fiber. *Economic Botany* 24(2):180-181.

Whistler, W.A. 1987. Ethnobotany of Tokelau: the plants, their Tokelau names, and their uses. *Economic Botany* 42(2):155-176.

Whistler, W.A. 1992. The palms of Samoa. *Mooreana* 2(3):24-29.

Whitmore, T.C. 1973. *Palms of Malaya*. Kuala Lumpur: Oxford University Press.

Wicht, H. 1969. *The indigenous palms of southern Africa*. Cape Town: Howard Timmins.

Wilbert, J. 1976. *Manicaria saccifera* and its cultural significance among the Warao Indians of Venezuela. *Botanical Museum Leaflets* 24:275-335.

Williams, J.T. and Ramanatha Rao, V. (eds.) 1994. *Priority species of bamboo and rattan*. Technical Report No. 1. New Delhi: INBAR

Wong, K.M. and Manokaran, N. 1985. *Proceedings of the rattan seminar, 2nd-4th October 1984 Kuala Lumpur, Malaysia*. Kepong, Malaysia: The Rattan Information Centre.

Wulijarni-Soitjipto, N. and Danimihardja, S. (eds.) 1995. *Plant resources of south-east Asia. Bibliography 6. Rattans*. Bogor, Indonesia: Prosea.

Yaacob, O. and Subhadrabandhu, S. 1995. *The production of economic fruits in South-East Asia*. Kuala Lumpur: Oxford University Press.

Yamada, N. and Kainuma, K. (eds.) 1986. *The third international sago symposium: sago-'85, Tokyo, Japan, May 20-23*. Yatabe, Japan: Tropical Agriculture Research Center.

Zanoni, T.A. 1991. The royal palm on the island of Hispaniola. *Principes* 35(1):49-54.

Ziffer, K. 1992. The tagua initiative: building the market for a rain forest product. *In*: Plotkin and Famolare. *Op. cit.*, pp. 274-279.

Zona, S. 1990. A monograph of the genus *Sabal* (Arecaceae: Coryphoideae). *Aliso* 12:583-666.

Zona, S. 1991. Notes on *Roystonea* in Cuba. *Principes* 35(4):225-233.

Zona, S. 1995. A revision of *Calyptronoma* (Arecaceae). *Principes* 39(3):140-151.

Additional information sources

Palm Journals And Newsletters

- *Boletin Pejibaye.* Two times per year, 1989-. Universidad de Costa Rica, Ciudad Universitaria Rodrigo Facio, San José, Costa Rica. (peach palm)
- *Burotrop Bulletin.* Three times per year, 1991-. French and English editions. BuroTrop, 17, rue de la Tour, 75016 Paris, France. (coconut and African oil palm)
- *Cocoinfo International.* Two times per year, 1994-. Asian and Pacific Coconut Community, P.O. Box 1343, Jakarta, Indonesia.
- *Cocomunity Newsletter.* Two times per month, 1971-. Asian and Pacific Coconut Community, P.O. Box 1343, Jakarta, Indonesia.
- *Cocos.* Journal of the Coconut Research Institute of Sri Lanka. One time per year, 1983-. Coconut Research Institute of Sri Lanka, Lunuwila, Sri Lanka.
- *Cord.* Coconut Research and Development. Two times per year, 1985-. Asian and Pacific Coconut Community, P.O. Box 1343, Jakarta, Indonesia.
- *The Date Palm Journal.* Two times per year, 1981-1987. FAO Regional Project for Palm & Dates Research Centre, P.O. Box 10085, Karradah Al-Sharkiyah, Baghdad, Iraq.
- *Elaeis.* The International Journal of Oil Palm Research and Development. Two times per year, 1989-. Palm Oil Research Institute of Malaysia (PORIM), P.O. Box 10620, 50720 Kuala Lumpur, Malaysia. (African oil palm)
- *Inbar Newsletter.* Four times per year, 1993-. International Network for Bamboo and Rattan, 17 Jor Bagh, New Delhi 110003 India.
- *Mooreana.* Journal of the Palmetum. Three times per year, 1991-. Townsville City Council, P.O. Box 1268, Townsville Qld 4810 Australia.
- *Nigerian Journal of Palms and Oil Seeds.* Irregular, 1953-. Nigerian Institute of Oil Palm Research, P.M.B. 1030, Benin City, Nigeria. (African oil palm and coconut)
- *The Palm Enthusiast.* Three times per year, 1984-. The South African Palm Society, 30 Charbury Road, Lynnwood Manor 0081 South Africa.
- *The Palm Journal.* Six times per year, 1993-. The Southern California Chapter, International Palm Society, 1601 Via Sage, San Clemente CA 92673 USA.
- *Palmas.* Four times per year, 1980-. Federación Nacional de Cultivadores de Palma Africana, A.A. 13772, Bogotá, Colombia. (African oil palm)

- Rattan. IDRC, P.O. Box 8500, Ottawa, Ontario K1G 3H9, Canada.

  ⇒ *Rattan in Asia.* Rattan use, processing and research. 18 minutes. 1989. VHS-PAL or NTSC formats available.

Organization Computer Home Pages And E-Mail Addresses

- Asian and Pacific Coconut Community
  Home page: <HTTP:WWW.IDRC.ORG.SG/PAN/APCC>
  E-mail: <APCC@INDO.NED.ID>

  Objectives, services and publications of this intergovernmental commodity organization.

- Growing Hardy Palms
  Home page: <HTTP://WWW.GEOCITIES.COM/THETROPICS/1811>
  E-mail (Leonard Holmes): <LGHOLL@FACSTAFF.WM.EDU>

  Information on growth of cold-hardy palms including sources of planting material.

- The Hardiest Palm
  Home page: <HTTP://WWW.LIBERTYNET.ORG/~BGMAP/HARDIPLM.HTML>
  E-mail: <71231.3252@COMPUSERVE.COM>

  Cultivation information on frost-hardy palm species.

- The International Palm Society
  Home page: <HTTP://WWW.PALMS.ORG>
  E-mail (Jim Cain, President): <PALM.DUDE@GENIE.COM>

  General information on the society, which has as its objective the study of palms and the dissemination of information about them.

- International Network for Bamboo and Rattan
  Home page: <HTTP//WWW.IDRC.ORG.SG/INBAR/GENDESC.HTML>
  E-mail: <INBAR@IDRC.CA>

  Objectives, services and staff of this research and development organization.

- Palm & Cycad Societies of Australia
  E-mail: <PACSOA1@OZEMAIL.COM.AU>

  General information on the societies, which have as their objectives to promote propagation and cultivation of palms and cycads, education and dissemination of knowledge, scientific study and conservation of endangered species in the wild.

- Palmeiras
  Home page: <HTTP://WWW.CIAGRI.USP.BR/TRILHAS/PALMEIRAS.HTML>

  Information on native and exotic palms grown in Brazil (in Portuguese)

- Palms
  Home page: <HTTP://HAMMOCK.IFAS.UFL.EDU/TXT/FAIRS/MG/19949.HTML>

  Information on growing palms from the Florida Agricultural Information Retrieval System

- Palms for the Sunshine Coast
  Home page: <HTTP://PEG.APC.ORG/~FUTURECOM/AASUNZINE/PALMS.HTM>
  E-mail: <LIVINGONLINE@PEG.APC.ORG>

  Cultivation information on palms suitable for the Queensland Coast, Australia.

- Palms of the World
  Home page: <HTTP://WWW.PE.NET/~MAXSON>
  E-mail (Mike Maxson): <M.MAXSON3@GENIE.COM>

  Information on selected palms, sources of planting material and publications.

- PORIM (Palm Oil Research Institute of Malaysia)
  Home page: <HTTP://PORIM.GOV.MY/HOMEPAGE96>

Information on all aspects of the African oil palm industry in Malaysia and other countries.

Directory of palm specialists

The following list of palm specialists includes individuals who are actively carrying out research and writing about palms; it is not exhaustive. An attempt has been made to provide a breadth of geographic coverage and specialties among the various palm-related research and development subjects. Thesis research in progress by graduate students is also included. Information provided, if known, is in the following order: (1) mailing address, (2) telephone number, (3) fax number, (4) e-mail address, (5) key palm research and publication areas.

BAKER, William J. (1) Department of Botany, Plant Sciences Laboratories, Whiteknights, PO Box 221, Reading, Berkshire RG6 6AS, UNITED KINGDOM (2) 44-1734-318-160 (3) 44-1734-753-676 (4) W.J.BAKER@READING.AC.UK (5) Phylogenetics and biogeography of calamoid palms.

BALICK, Michael J. (1) Institute of Economic Botany, The New York Botanical Garden, Bronx NY 10458 USA (2) 1-718-817-8763 (3) 1-718-220-1029 (4) MBALICK@NYBG.ORG (5) Systematics; economic botany; oil-producing species; conservation; New World.

BALSLEV, Henrik (1) Sarmiento de Gamboa 383 y Darwin, Quito, Ecuador (2) 593-2-434-884 (3) 593-2-434-884 (4) HBALSLEV@PI.PRO.EC (5) Systematics; ethnobotany; Ecuador; Bolivia.

BARFOD, Anders S. (1) Botanical Institute, Nordlandsvej 68, Risskov, DK-8240, DENMARK (2) 45-89-423-188 (3) 45-89-424-747 (4) BIOBASB@AAU.DK (5) Systematics; economic species; *Phytelephas;* New World.

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