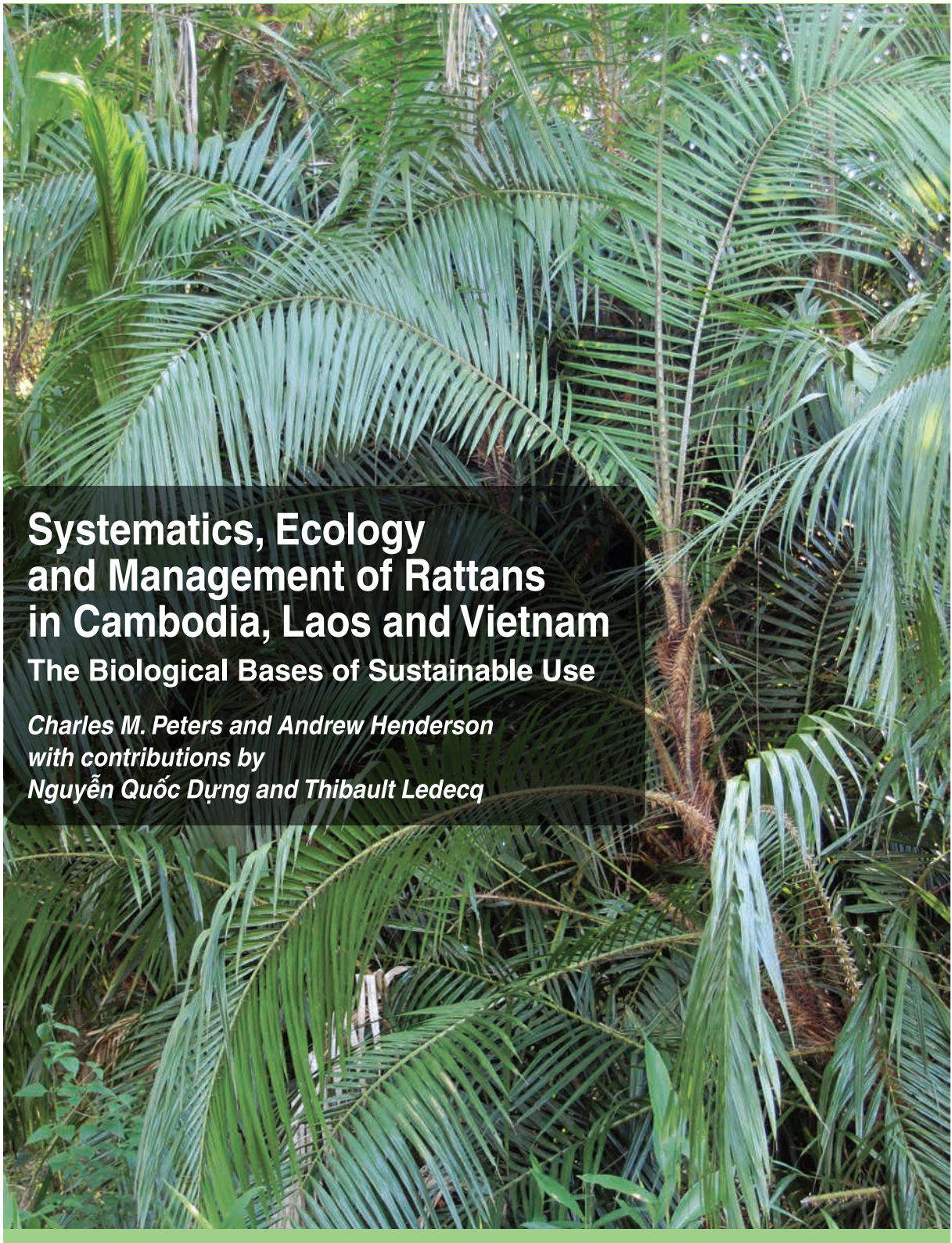

Systematics, Ecology and Management of Rattans in Cambodia, Laos and Vietnam

The Biological Bases of Sustainable Use

Charles M. Peters and Andrew Henderson
with contributions by
Nguyễn Quốc Dựng and Thibault Ledecq

Agricultural Publishing House

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Foreword

The Greater Mekong region is one of the most biologically diverse places on the planet. Home to the world's largest freshwater fish species and extensive tiger habitat, its forests, rivers, grasslands and wetlands pulse with life. About 80 per cent of the region's 300 million people depend directly on the goods and services its ecosystems provide, such as food, fibre and clean water. Recent decades of accelerated economic development in the Greater Mekong have put great pressure on its environment and natural resources, especially its forest resources. Yet, despite this impressive economic growth, the Greater Mekong remains relatively poor. In this context the sustainable use of natural resources and equitable sharing of the gains are crucial for maintaining and furthering development.

WWF-Greater Mekong works with government, industry and civil society partners to ensure that, as the region develops, it doesn't squander the natural riches that so many depend on and that underwrite its economic future. Since 2006, WWF and its partners have supported the development of a sustainable rattan industry in Vietnam, Laos and Cambodia. Rattan is one of the most important non-timber forest products in the region in terms of export value and its contribution to household income and food security.

Many of the 65 species of rattan from Cambodia, Laos and Vietnam listed in this book support local livelihoods, as food or material for shelters and handicraft products. Yet forest conversion and unsustainable harvesting are leading to serious declines in rattan stocks, threatening the potential growth and sustainability of the region's rattan industry. With support from the European Commission's SWITCH-Asia Programme, DEG-Germany's Entrepreneurial Development Cooperation and IKEA, WWF and its partners, including The New York Botanical Garden, SNV, Oxfam, GIZ and national governments, have been piloting and scaling up models for sustainable rattan harvest and production of value-added goods such as furniture. Among other achievements, this work has yielded the world's first FSC-certified rattan products and has facilitated the creation of the

Rattan Association of Cambodia and the Vietnam Rattan Programme - both important mechanisms for ensuring that producers share in the benefits of a growing demand for sustainable rattan products.

This book speaks to several distinct audiences:

- For the professional or simply curious naturalist, this book represents the best field guide available for identifying the region's diverse and fascinating rattan species;
- For those engaged in cultivating, managing and harvesting rattan, this guide provides value in terms of maximizing yields and achieving sustained productivity of rattan resources; and
- For those engaged in supporting the sustainable management and development of the region's important rattan sector, the insights and lessons learned over the past eight years of work - from research on rattan growth to sustainable management planning to processing and export policies - will provide guidance and inspiration.

I would like to thank all of the stakeholders involved in the Greater Mekong region's rattan industry - from communities to NGOs, from policy-makers to national and international retailers - for their efforts to ensure that future generations will be able to appreciate rattan in both its diverse natural settings and as part of beautiful, useful products that enrich our lives. I would also like to thank the authors of this book, in particular Dr. Charles Peters and Dr. Andrew Henderson of The New York Botanical Garden, and Mr. Nguyễn Quốc Dựng of the Forest Inventory and Planning Institute, Vietnam, for providing their valuable time and inputs. Their unique experience and knowledge form the backbone of this book.

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Stuart Chapman
Representative, WWF-Greater Mekong
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Introduction

Rattans are spiny, climbing palms in the subfamily Calamoideae. There are over 550 different species of rattan belonging to 12 genera distributed throughout the Old World tropics (Dransfield et al. 2008). Rattan palms are used for a variety of subsistence purposes, e.g. cordages, basketry, food, medicine, and thatch, and the flexible stem, or canes, form the basis of a multi-billion dollar a year furniture industry. The great majority of this material is harvested from wild populations. It is estimated that several million people use, collect, and sell rattan or are involved in some way in the international rattan trade (Dransfield and Manokaran, 1994). Rattan is, without question, one of the most important and widely used non-timber forest products in the world.

For the past 15 years, we have studied rattan in a variety of different countries and contexts. We have looked at rattan growth and exploitation in Indonesia (Peters and Giesen, 2000), inventoried wild rattans in northern Myanmar (Peters et al, 2007), surveyed selected rattan taxa in China (Guo and Henderson, 2007), and collected and described numerous new species of rattan throughout Southeast Asia (e.g. Henderson, Ban, and Dung, 2008; Henderson, 2005; Henderson and Henderson, 2007). In each case, we have been confronted with the same set of unfortunate conditions.

First, there is confusion about the naming of different rattan species. Local names are highly variable, and the exact taxonomic identity of many commercial species is still questionable. Second, there is a total lack of information about the density and conservation status of wild rattan populations. Beyond the general warning that "rattan stocks are declining", we know virtually nothing about the population densities of wild rattans, or whether these populations are regenerating, or which species appear most resilient to the impacts of repeated harvesting. Finally, most, if not all, of the rattan is harvested in an uncontrolled manner. Harvest quotas are based more on the existing demand for the resource than on the actual supply of cane, and the idea of consciously managing wild rattan populations, although occasionally discussed, is rarely implemented (Hirschberger, 2011).

As a response to this situation, in 2009 we started a project in the Central Truong Son Mountains of Vietnam on the conservation and management of local rattan species. We trained forestry staff from six protected areas in rattan identification, standardized inventory methodologies, and management planning, and made extensive collecting trips to document the local rattan flora. Growth studies of important commercial canes were also initiated in each reserve. By the end of the project, field crews had identified, counted, and measured all of the rattan plants in 960 inventory transects, the annual extension growth of 4,500 rattan canes had been quantified, and six new rattan species had been described. This research represented an unprecedented step forward in understanding the supply side of the rattan sector in Vietnam.

During this same period, we started collaborating with the WWF Sustainable Rattan Production and Harvesting Project that had been working in Cambodia and Laos since 2006 and had recently started operations in Vietnam. The information that we were collecting about the density and productivity of wild rattans was a useful complement to the work that they were doing on rattan processing and market development. As our collaboration deepened, we started to integrate the demand side and the supply side of the regional rattan market and began to develop a system that communities could use to manage the resource base.

Working together with the WWF team, the management concepts and field procedures developed in the protected areas of Vietnam were modified and slowly implemented in the community forests of Laos and Cambodia, and later in Vietnam. We made several trips to collect local rattan species, and held workshops in Vientiane and Phnom Penh to train staff in simple field methods that could be used by communities to collect baseline data about their rattans. Site visits were made to collaborating villages in Laos and Cambodia to review field operations, answer questions, and correct any problems. As the inventory and growth data started coming in from the villages, additional workshops were held to review data analysis and work through the mechanics of calculating a sustainable harvest of rattan from a given area of forest.

During the workshops and site visits with WWF Rattan Program staff, we talked extensively about rattan taxonomy, forest inventories, yield studies, community management planning, and the biological bases of sustainable resource use. We discovered new species and made changes in the collection of field data. We simplified the growth measurements and standardized the methods for analyzing and using the data. Perhaps most importantly, we made sure that everyone understood that: 1) you can't sustainably harvest from a forest in one year more rattan than was produced in that same time period, and 2) a useful estimate of annual rattan production can be obtained by combining inventory and growth data collected at the community-level.

After five years of collaborative work in Cambodia, Laos, and Vietnam, what we came up with was a relatively simple and inexpensive way to manage wild rattan populations on a sustainable[1] basis. The management protocols can be implemented by villagers within a community forest or by forest rangers within the buffer zone of a national protected area. This book explains how to do this.

[1]Sustainable resource use involves a variety of different economic, social, and ecological factors. Within the present context, sustainability will be defined in a restricted, ecological sense. From an operational or management perspective, a sustainable system for exploiting rattan is one in which rattan canes can be harvested indefinitely from a limited area of forest with negligible impact on the structure and dynamics of the populations being harvested.

Method of Presentation

There are five chapters and a Literature Cited section with references to supporting material. A brief description of the study region is presented in Chapter I and the major biophysical factors that control the distribution and abundance of local rattans are outlined. A typology of the important rattan habitats in the region is included, together with a discussion of the regional rattan trade. Chapter II, which represents the botanical foundation of the volume, is a field guide to the rattans of Cambodia, Laos, and Vietnam. A dichotomous key is provided to allow the reader to identify each of the 65 different species of rattan found in the region. Detailed descriptions, distribution maps, and diagnostic photos are provided for each species. Chapter III focuses on the ecology of local rattans and presents data on the density, size-class distribution, and annual growth of selected species. An assessment of the conservation status of different commercial species based on extent of occurrence (IUCN, 2001), population density, habitat specificity, and harvest intensity is also provided. The data collection protocols and analyses required to define a sustainable harvest of wild rattan are described in Chapter IV, together with a discussion of impact monitoring and periodic harvest adjustments. The final chapter, Chapter V, examines the future of the rattan trade in Cambodia, Laos, and Vietnam, and underscores the critical importance of market incentives, local governance, and policy to promote the sustainable use and management of wild rattan.

How To Use This Book

This book was written to answer questions and to solve problems encountered by practitioners, policy makers, and project managers. Feel free to go directly to the chapter that best addresses your query. The sequence of chapters, however, follows the logical flow of how the management of a wild resource usually proceeds, i.e. identify the species, understand its basic ecology, collect density and yield data, apply these data within a management context, and it can, as a result, be helpful to initially read the whole text from front to back. It is, perhaps, most useful to consult the book as a reference during the development of an actual management plan for the sustainable exploitation of rattan.

It is important to point out that this book is unique. There are field guides for identifying plants, books that provide an overview of tropical ecology, and silvicultural texts that describe the management components of sustainable resource use. Rarely, if ever, have the systematics, ecology, and management of a valuable tropical forest resource ever been addressed in a single volume. By putting all the necessary tools together in one place, we hope that wild rattan resources of Cambodia, Laos, and Vietnam - together with the forests within which they grow - will finally get the stewardship that they desperately need.

CHAPTER I
The Setting

Charles Peters and Thibault Ledecq

The geographic focus of this book is the roughly 75 million hectares of tropical landscape contained in the countries of Cambodia, Laos, and Vietnam (Figure 1.1). Frequently referred to as the "Lower Mekong Ecoregion Complex" (Baltzer et al., 2001), the area exhibits a diverse topography including mountains, canyons, valleys, limestone karsts, lowlands, alluvial plains, river deltas, and harbors some of the most species-rich and severely threatened tropical forests in the world. Complex combinations of geology, soils, climate and land-use history have produced an incomparable variety of plant habitats and forest types, and each of three countries embodies a unique flora and fauna.

In spite of the biophysical differences between countries, the region holds together as a relevant unit of study because of two main features. First, the Mekong River flows through and plays an important ecological role in each of the three countries (refer to Figure 1.1). Most of the western border of Laos is demarcated by the Mekong, and more than a third of the water in the river comes from the vast watersheds of this country (ADB, 2012). After flowing over the Khone Phapheng waterfall in southwestern Laos, the Mekong River enters Cambodia and meanders through the low, rolling hills of the Tonlé Sap Basin. When levels in the Mekong are low, the Tonlé Sap acts as a tributary and drainage waters flow into the Mekong. The flow reverses when the Mekong floods each year, the floodwaters pushing back up the Tonlé Sap River into the lake and inundating over 1.5 million hectares of lowlands (MRC, 2010). The delta of the Mekong River starts to form south of Phnom Penh, and continues to expand in an alluvial fan as it moves through Vietnam toward the East Sea. The Mekong delta extends over 3.9 million hectares in Vietnam and is home to 17 million people who depend on it for their livelihood (ADB, 2011). It's not surprising that the entire region is named after the river.

Figure 1.1. Map of Cambodia, Laos, and Vietnam showing Mekong River, Tonlé Sap basin and other prominent geographic features. Spatial data from ESRI, NASA, and the U.S. Geological Survey.

The second feature of importance shared by Cambodia, Laos, and Vietnam is the rattan resource. Although many species are found in only one or two of the countries, or are endemic to selected habitats within a single country, almost a third of the rattans covered in this book are found throughout the region. Additionally, it has become increasingly common in recent years for rattans collected in one country to be sold in another (Evans, 2002), with the result that the three countries, in many ways, have started to function as a single market chain (Hirschberger, 2011).

For these reasons, it seems useful to provide some general background information about the geology, soils, and climate that have interacted to produce the different rattan habitats in the region[1], and to briefly describe the ethnic diversity of each country and the current pattern and intensity of rattan use. This chapter, in a sense, sets the stage for all of the chapters that follow. What types of forest habitat exist in the region? How do they differ, and which ones provide appropriate conditions for the growth and reproduction of rattan? How much of the rattan is sold and how have trade patterns changed in recent years?

1.1. Geological History

The Lower Mekong region rests on an ancient block of continental crust, called Indosinia by geologists. This crust was relatively stable, and a wide inland sea covered a large part of the region during the Upper Mesozoic. During the late Cretaceous period, uplifting in northern Vietnam raised the Fansipan range (see Figure 1.1) and warped the Indosinia block creating a series of broad domes and basins. Large parts of central Laos were turned into a low-lying basin that filled with salt deposits, some over 250 meters thick, from the drained inland sea. Much of Cambodia was pushed up into a massive dome of sandstone that gradually eroded leaving exposed granite outcrops from the crust in many areas.

About 40 million years ago during the Cenozoic period, the precursor of the Mekong River emptied out into the East Sea where the delta of the Red River is currently located (Figure 1.1). When the Indian and Eurasion plates collided, pushing up the Himalayas and forming the Tibetan Plateau, much of the Mekong drainage turned southward and started cutting deep gorges though the bedrock of northern Laos. The present course of this segment of the river was formed approximately 8 million years ago.

The tectonic and volcanic events of the Quaternary Period created many of the prominent landforms in the central part of the Lower Mekong. The basaltic areas of the Truong Son or Annamite Mountains were formed about 600,000 years ago, and the uplift of this range moved the long, middle segment of the Mekong River into its current position on the border between Laos and Thailand and created the Khone Falls (Figure 1.1).

[1]Much of the material in this section has been adapted from ADB (2012) and MRC (2010).

The subsidence of the Tonlé Sap Basin around 12,000 years drew the lower section of the river eastward from its former connection with the Chao Phraya River in Thailand.

The last glacial period came to abrupt end 19,000 years ago and sea levels rose rapidly, reaching a maximum of about 4.5 meters above present levels in the early Holocene. The shoreline of the East Sea was almost to Phnom Penh at this time. Sediments deposited in the Tonlé Sap 7,500 years ago show indications of a marine influence and suggest a connection to the East Sea (Penny, 2006). The current configuration of the Mekong Delta developed over the last 6,000 years, the floodplain advancing southward across a broad embayment formed by the higher ground along the Cambodian border and the uplands North of Ho Chi Minh city at a rate of about 20 meters per year (Nguyen et al., 2000).

1.2. Soils

The edaphic characteristics of the Lower Mekong are a result of geological substrates coupled with the action of volcanism, sea level change, and local sediment deposition over millennia. The soils of Cambodia can be divided into three main groups based on the age and general origins of the parent material. There are regions like the Cardamom and Truong Son Mountains where the original parent material is retained, areas that are covered by ancient alluvial plains, and regions such as the Tonlé Sap floodplain that receive annual depositions of alluvial sediments. Sandy surface soils are common throughout the country except for around the Tonlé Sap, along the floodplains of the major rivers, and in areas developed on basalt.

The soils of Lao can be broadly grouped into floodplain and upland soils. Floodplain soils, formed from alluvium deposited by rivers, present sandy or sandy clay textures and are neutral to slightly acidic in pH. Upland soils may be derived from crystalline, granitic, schistose, or sandstone parent materal, and are generally more acidic and less fertile than floodplain soils. There are also areas of leached and iron-bearing laterite soils in parts of southern Laos, and finely-textured, basaltic soils throughout much of the Bolaven Plateau (see Figure 1.1).

Much of Northern Vietnam is characterized by reddish, iron-rich soils; some are fertile and suitable for agriculture, others are deficient in soluble bases. Sandy soils are common in the central part of the country, while the soils of the Mekong delta are typically alluvial clays.

1.3. Climate

The characteristic climate of the region is tropical monsoon, i.e. almost always hot, and moist to varying degrees depending on the season. Rainfall patterns are caused by the annual, alternating cycle of high and low pressure airflows over the Central Asian landmass (Clift and Plumb, 2008). Warm, moisture-laden air from the Indian Ocean is drawn landward during the summer months causing the southwest monsoon. This produces a wet season that typically extends from May to late September, with brief hot and dry spells at both the beginning (April) and the end (October) of the southwest monsoon. In winter, a high-pressure system developing over the Asian continent brings lower temperatures and little rainfall from November to March as part of the Northeast monsoon. The Truong Son Mountains generate a notable rain shadow effect over the Mekong Basin during the northeast monsoon.

Annual rainfall is substantial in all areas of the lower Mekong, ranging from 1,200 to over 3,000 mm; rainfall averages for Cambodia are generally less than those recorded in Laos and Vietnam. The wettest places in the region are the Cardamom Mountains in Cambodia, the northern mountains and the Bolaven Plateau in Laos, and Bach Ma National Park in central Vietnam. The range in mean temperature between the coldest and hottest months in Cambodia, Laos, and Vietnam is only five degrees, while the diurnal range in temperature may be 8 - 10° in summer and even higher in winter.

1.4. Forest Types[2]

Different combinations of geology, soils, climatic conditions and land-use history have produced a variety of different forest communities in the

[2]Descriptions of forest types are based on Gressitt (1970), Rollet (1972), Schmid (1989), Rundel (2001), and personal observations.

Lower Mekong region. Although species composition and forest structure can vary significantly between neighboring tracts of forests, there are a few consistent similarities that allow a useful classification of local forest vegetation based on elevation, phenology, i.e. deciduous or evergreen, seasonality of precipitation and the presence or absence of conifers.

Lowland Evergreen Forests

This category contains forests growing at elevations below 800 - 1,000 m (or even lower in some areas) that keep most of their leaves throughout the year. Four types of lowland evergreen forest occur in the region: wet evergreen forest, semi-evergreen forest, seasonal swamp forests, and mangrove forests.

Wet evergreen forests are classic, multi-storied, tropical rain forests. Canopies reach heights of 40 m or more and the crowns of dominant trees contain abundant lianas, e.g. rattan. Annual rainfall usually exceeds 2,000 mm. Examples of this forest type are found in the Cardamom Mountains of southwestern Cambodia, small areas of Laos, and in the Truong Son Mountains of central Vietnam. Conifers, e.g. Podocarpaceae, may occasionally play an important role as dominants in these forests.

Semi-evergreen forests occur in areas where the mean annual rainfall is between 1,200 and 2,000 mm, and there is a significant (3 to 6 months) dry period each year. A significant number of canopy trees lose their leaves during the dry season, and some forms of this forest type may display a brief, seasonal dominance of deciduous species. Relative to wetter forest formations, semi-evergreen forests exhibit a lower diversity of trees, palms, and lianas, a less developed understory, and a lower (30 to 40 m) and more open canopy.

Seasonal Swamp Forests develop along coastal deltas and inland wetlands subject to seasonal inundation by freshwater. The floristic composition of these forests is usually distinct and less diverse in response to the periodic flooding and more restrictive habitat conditions. The forest canopy contains a number of species that lose their leaves during the flooding. Extensive areas of seasonal swamp forest occur in the Tonlé Sap floodplain of Cambodia.

Mangrove forests form in coastal areas subjected to regular flooding by tidal or brackish salt water. The most diverse mangrove communities form in areas that flood at high tide and are influenced by flows of freshwater at other times. Mangrove forests in the Red River delta are typically less diverse than those found along the southern coast of the Lower Mekong Region. Mangrove forests are limited in parts of Cambodia and Central Vietnam because of the rocky shoreline and lack of major river deltas.

Lowland Deciduous Forests

This forest type occurs over large areas of the Lower Mekong region with climates that exhibit a marked dry season and seasonal water deficits. Most of the tree species in lowland deciduous forests lose their leaves during the dry season, although the leaf fall is not synchronous. Two types of lowland deciduous forest are distinguished: mixed deciduous forest and deciduous Dipterocarp forest; there is also a derived savanna community.

Mixed deciduous forest covers extensive areas of northern Laos and there are also scattered tracts in northern Vietnam. The canopy of mixed deciduous forest is typically closed, reaching up to 30 m. The understory is open, yet contains a rich assemblage of small trees, shrubs, and bamboos; lianas and plant epiphytes are rare, but there are rattan. Leaf fall usually starts about a month or two after the onset of the dry season in November and continues until the majority of the canopy trees have lost all of their leaves. The leafless period usually lasts about four to five months. Fire is a regular source of disturbance in these forests.

Deciduous Dipterocarp forest is a low, open forest community that typically occurs in areas with 1,000 - 1,500 mm of rainfall per year and a severe five to seven month dry season. The canopy is scattered and relatively open, 5 to 8 m high, and the understory is well illuminated and dominated by grasses. Deciduous species of the Dipterocarpaceae eg. *Shorea siamensis*, *S. obtuse*, and *Dipterocarpus obtusifolius* are the dominant trees in this forest type; *Pinus merkusii* is occasionally a codominant species. Fire is a frequent occurrence in deciduous Dipteropcarp forest, and many tree species have thick corky bark and possess the ability to re-sprout after burning.

Savannah woodland may be produced from deciduous Dipterocarp forest after repeated fires. The formation of this derived woodland appears to be most common on the sandy or lateritic soils of northern Cambodia and southern Vietnam. The dominant woodland species are fire resistant trees, e.g. *Shorea siamensis* and *Pinus merkusii*, while the grassland component is dominated by *Imperata*, *Vetiveria*, *Panicum*, and other grasses. Thorny shrubs may increase in abundance when these communities are used for grazing.

Montane Forests

At elevations greater than 800 to 1,000 m (and sometimes lower, i.e. 600 to 700 m in northern Laos and Vietnam), montane forests start to develop. The structure of these forests is open, with numerous twisted tree forms and abundant epiphytes. The Dipterocarpaceae and other lowland tropical plant families are replaced in these forests by a variety of temperate trees. The height of the canopy decreases with increasing elevation, and at elevations greater than 1,800 to 2,000 m, true cloud forest may develop. Although rattans are common in montane forests at elevations up to about 1,500 m, many of the species encountered in this forest type are non-climbing.

Conifers are a dominant component of montane forests in many parts of the Lower Mekong Region, especially throughout the mountains of Laos and Vietnam. Pines may become dominant on drier montane sites with less than 2,000 mm of annual rainfall and on well-drained or shallow soils. Repeated fires can also increase the abundance of conifers in montane forests. *Pinus kesiya* and *Keeteleria evelyniana* are frequently encountered conifers in montane forests.

Based on recent estimates (FAO, 2011), about 50% of the land in Cambodia, Laos, and Vietnam is still covered by forest in varying condition. The proportion of forest varies from country to country, with Cambodia exhibiting a forested landscape of 57.2%, followed by Laos (49.9%) and Vietnam (44.5%). More than 25% of the forests in Vietnam are single-species plantations of fast-growing trees, e.g. *Eucalyptus*, *Acacia*, and *Pinus*. Taken together, the three countries have about 36 million hectares of forest remaining.

Forests throughout the region are under pressure from population growth, agriculture, infrastructure development, and mining, and the overall rate of forest decline ranged from 1.2% in Cambodia to 0.5% in Laos during the period form 2005 to 2010. Vietnam, which has invested heavily in reforestation projects in recent years, showed a 1.6% increase in forest area during the same period.

1.5. Plant Diversity and Eco-Regions

The forests of the Lower Mekong Region are some of the most species-rich habitats in the world. A reliable estimate of the total number of plant species found in the region, however, is complicated by a lack of botanical collections and an incomplete understanding of the taxonomy and distribution of local species. The combined floras of Cambodia, Laos, and Vietnam are thought to contain from 12,000 - 15,000 species (Schmid, 1989) or up to 20,000 species (Thompson, 2008). Vietnam alone is reported to have more than 8,000 species of vascular plants and to exhibit a level of endemism equal to about 10% of the national flora (Davis et al., 1994). Endemism seems to be highest in lowland wet evergreen and montane forests, while semi-evergreen and seasonal swamp forests exhibit a smaller percentage of local endemics (Rundel, 2001). There is great need for floristic inventories and systematics work that extends beyond the boundaries of a single country.

Habitats and species can be grouped together into ecoregions that contain a geographically unique collection of local communities. Ecoregions share similar species, environmental conditions, and ecological dynamics and, as a result, can provide a useful analytical tool for purposes of conservation or resource management. In 1998, a list 200 ecoregions of special importance to the conservation of global biodiversity was developed by the WWF (Olsen and Dinerstein, 1998). As is shown in Figure 1.2, the Lower Mekong Region contains sixteen of the WWF Global 200 ecoregions. This is the largest concentration of critical ecoregions in all of mainland Asia (MRC, 2010).

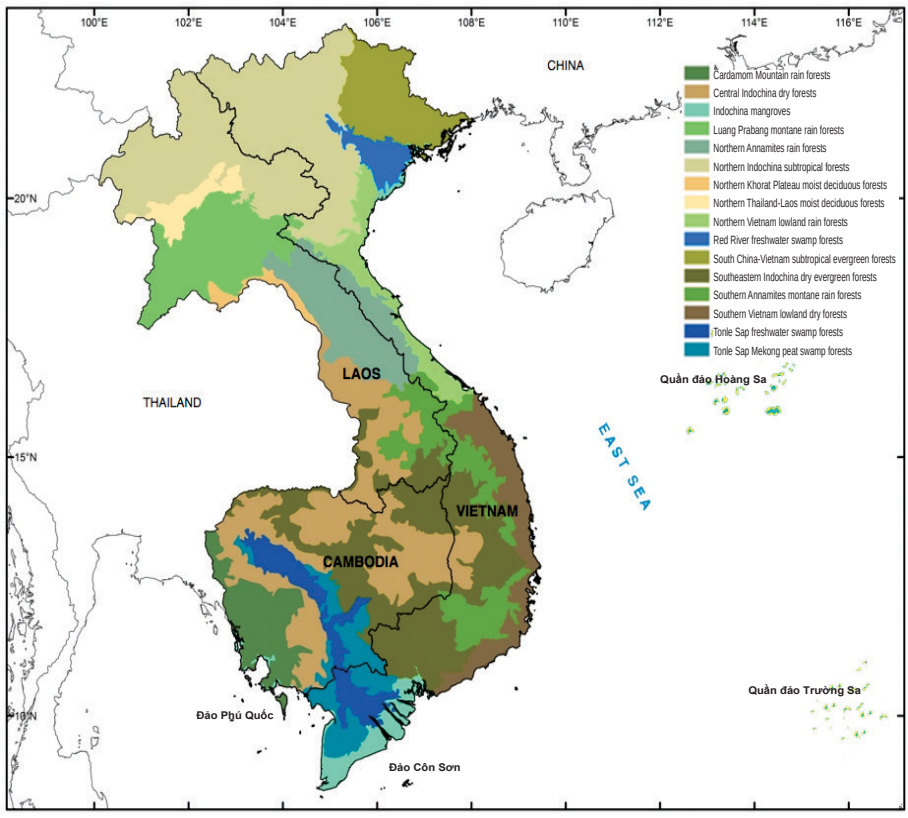


Figure 1.2. Map of WWF Global 200 Ecoregions (Olsen and Dinerstein, 1998) that occur in Laos, Cambodia, and Vietnam. Data from WWF-US, *Terrestrial Ecoregions of the World*, Version 2.0.

The sixteen ecoregions mapped in Figure 1.2 represent the ecological context within which the use and potential management of rattans occurs in Cambodia, Laos, and Vietnam. Some ecoregions contain an abundance of rattan, e.g. Northern Vietnam lowland rain forests[3] and Luang Prabang montane rain forests, while others, e.g. Indochina mangroves, have no rattan resources at all. Several of the ecoregions are largely intact and contain protected areas, e.g. Cardamom Mountain rain forests and Northern Annamites rain forests. Unfortunately, an even larger number of the ecoregions found in Cambodia, Laos, and Vietnam, e.g. Northern Khorat Plateau moist deciduous forests, Northern Vietnam lowland rain

[3]The ecoregion terminology is somewhat different than that used in Section 1.4 to describe local forest types. For example, "rain forests" refer to "evergreen forests", "dry forests" are "semi-evergreen forests" or "deciduous forests", "montane rain forests" are "montane forests", and "peat swamp forests" are "seasonal swamp forests".

forests, South China-Vietnam subtropical evergreen forests, Southeastern Indochina dry evergreen forests, and Southern Vietnam lowland dry forests, have their conservation status listed as "critical/endangered" (WWF, 2013).

1.6. Population[4]

According to recent population statistics, about 107 million people live in the Lower Mekong Region; over 80% of these people live in Vietnam. Although most of the population is found in rural areas, population densities vary greatly from country to country. Owing to the rugged topography and lack of arable land, population densities in Laos (26 people/km^2) are the lowest in the region, followed by Cambodia (80 people/km^2) and Vietnam (263 people/km^2). Much of this population is young, especially in Laos and Cambodia where 37% and 39% of the population, respectively, is under the age of 15. A quarter of the villages in Laos and over half of the land are affected by unexploded ordinance.

More than 70 different ethnic groups live in the Lower Mekong Region, most of them practicing subsistence agriculture in the uplands and collecting non-timber forest products, e.g. rattan, bamboo, resins, medicinal plants, to supplement their livelihood. Kinh (86%), Tay, Thai, Muong, Hoa, Khmer, and Nung (around 1 million each) are the most common ethnic groups in Vietnam, Lao-Tai (66%), Mon-Khmer, and Hmong are most common in Laos, and Khmer (95%), Cham, Lao, and assorted hill tribes are the major groups in Cambodia.

1.7. Rattan Trade[5]

The rural villages of the Lower Mekong Region have harvested rattan from local forests on a subsistence basis for centuries. The cane is used to make baskets, mats, and assorted household utensils, for cordage and construction, and the fruits of several species are eaten or used as medicine (Dransfield

[4]The demographic data cited in this section are taken from ADB (2012), World Bank (2013), and MRC (2010).

[5]The discussion of rattan trade is based largely on the work of Hirschberger (2011), the experiences of the WWF Sustainable Rattan Program in Cambodia, Laos, and Vietnam, and personal observations of the authors.

and Manokaran, 1994). It is hard to imagine village life without rattan. As the prevalence of roads into more remote areas increased, villagers began to sell their products in local and national markets to supplement their livelihood and obtain the cash needed to buy rice and other necessities. The collection and sale of forest products was especially important activity during the dry season.

As the local demand for rattan began to increase in response to the global market, the commercial exploitation of this resource by villagers intensified dramatically. The harvested cane was either used to support a young, burgeoning rattan industry such as was developing in Vietnam, or sold as raw material to neighboring countries, e.g. Thailand, China, Vietnam, as was done in Laos and Cambodia. Although the rattan trade has developed along different trajectories in each of the three countries, the harvest of wild rattan continues to provide an important source of income for rural communities throughout the Lower Mekong.

During the early 2000s, Vietnam was the second largest exporter of rattan canes in the world after Indonesia. The great majority of this material was sold to China. As the local rattan industry continued to grow, however, the sale of rattan cane declined and larger quantities of processed rattan were exported. By 2008, global imports of rattan products from Vietnam were valued at US$68.6 million, about two-thirds of this from furniture and the remaining third from basketry. The rattan harvested in Cambodia and Laos, in contrast, is sold primarily as unprocessed cane, although a small quantity of rattan basketwork is also produced in Laos.

A graphic representation of the rattan trade in Cambodia, Laos, and Vietnam from 2001 to 2008 is shown in Figure 1.3. The combined trade from all three countries during this period is also presented together with the rattan export data for Indonesia, the largest producer of rattan for the global market. Several caveats are necessary concerning the data used to construct this histogram. The existing import and export data for rattan are incomplete and notoriously incorrect. Laos does not report any trade data at all, and Vietnam reports the value, but not the quantity of rattan traded. The export data reported by Indonesia (used in Figure 1.3) are drastically different than the totals reported by the countries that import their rattan.

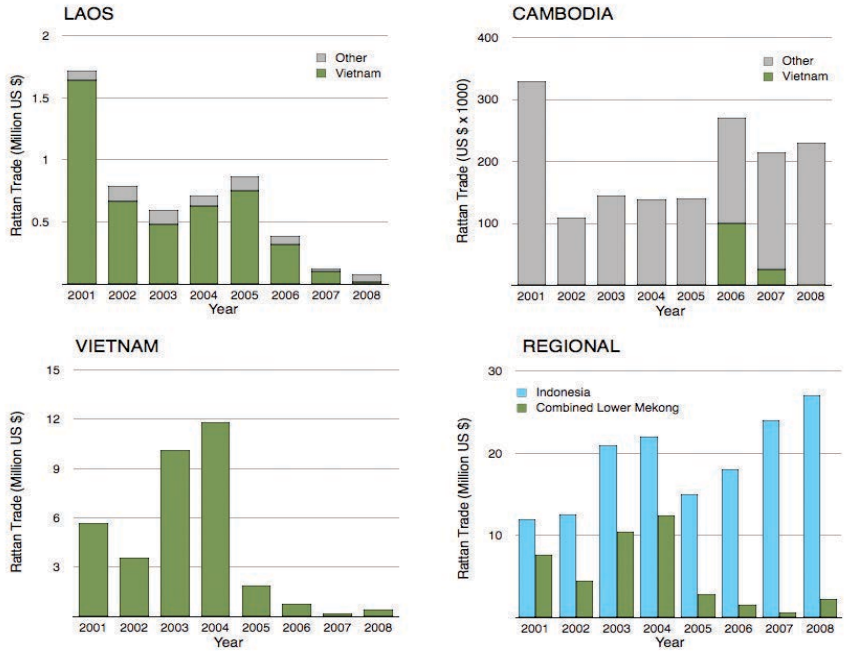


Figure 1.3. Value of rattan trade in Laos, Cambodia, and Vietnam from 2001 to 2008, together with combined data for the entire Lower Mekong Region and Indonesia during the same period. Green portions of the histograms for Laos and Cambodia show the value of rattan sold to Vietnam; note scale change in y-axis for Cambodia. Adapted from Hirschberger (2011).

With these limitations in mind, several points of interest should be noted in Figure 1.3. First, a significant portion of the rattan harvested in Cambodia and Laos is sold to Vietnam. It is estimated that Vietnam imports about 33,000 tons of rattan a year to satisfy the demand from its rattan industry. Although the amount of material sold to Vietnam by Laos and Cambodia has declined in recent years, the market chains between these countries are clearly related.

Second, the entire rattan trade in the Lower Mekong Region, has dropped considerably since 2005, especially in Laos and Vietnam. Although market factors certainly play a role here, this trend may also reflect a continual decline in the rattan resources found in each country. In most cases, the dwindling rattan supplies are the result of forest loss and over-exploitation (De Beer et al., 2000; Evans, 2002; Binh, 2009). In the absence of good inventory and growth data, the actual volume and yield of rattans in the Lower Mekong is largely unknown, harvest quotas are based more on

market demand than a consideration of existing supplies - and the resource appears to be running out.

Finally, and on a more hopeful note, the combined Lower Mekong Region market chain was trading a significant amount of rattan from 2001 to 2004. In some years, this trade was more than half of that reported by Indonesia, the country that produces about 80% of all the rattan on the global market and has a rattan industry involving more than 5 to 6 million people (ITTO, 2007). Cambodia, Laos, and Vietnam have the infrastructure and the manpower to harvest, process, and sell considerably more rattan than is currently traded. All that is needed is a larger supply of rattan cane. One way to achieve this objective is to start managing the wild rattan populations found in the Lower Mekong Region. The first step is to identify the rattan species.

CHAPTER II
A Field Guide to the Rattans of Cambodia, Laos and Vietnam

Andrew Henderson and Nguyễn Quốc Dựng

This guide serves several purposes. It acts as the taxonomic foundation of all the other work reported in this book, it allows for the identification of any rattan from the three countries, and it contains information on the morphology, range, habitat, phenology, and uses of all the rattans. Perhaps most importantly, it contains the correct names for the species. This, the correct scientific name, is essential for communication on species, and if the rattan sector is to develop a common system of names is essential.

Up until quite recently, the scientific names of even common species were in doubt, and scientists from different countries would use different names for the same species. Fortunately, we have two recent field guides, one for Laos (Evans et al., 2001) and one for Cambodia (Khou Eang Hourt, 2008), and these have done much to resolve nomenclatural problems. However, even since the publication of these guides, there have been some nomenclatural changes and new species have been discovered in Cambodia. By including all three countries, Cambodia, Laos, and Vietnam in a single guide, we get a much better overview of the species.

Local names are confusing, and great care must be taken in their use. Local people sometimes give different names to male and female plants, and local people from different places give different names to the same species. Conversely, several species can have the same local name. Local names from one country are completely unintelligible in other countries. Some times, a local name is given to a plant, and a different name to the cane. There is no standard list of accepted local names.

2.1. The Layout of This Guide

The guide begins with an illustrated glossary. Many of the features of rattans used in the key and descriptions are shown here. The glossary is followed by a key. This enables the user to find the correct scientific name of any rattan species in Cambodia, Laos, or Vietnam. The key is structured by couplets. Each numbered couplet, starting with 1a. and 1b., gives the user two choices. For example, 1a. asks if the leaflets are rhomboidal with jagged apices. If the rattan under consideration has these characteristics, then the user goes to the next indicated couplet, in this case 2. If not, the user goes to 1b. - leaflets linear, lanceolate, or ellipsoid with pointed apices - and is directed to couplet 3. The process is repeated until the final name is reached. Each couplet usually includes more than one morphological character. It may take a bit of practice to get used to the key.

Each species has a separate page. First, the Latin name is given, and this is followed by the abbreviated name of the botanist(s) who named the species for the first time. Nomenclature generally follows Henderson (2009). The Latin name is followed by the local names. Many local names, and other information are taken from Evans et al. (2001) and Khou Eang Hourt (2008).

Next is a short description of the palm. These descriptions are designed to give the most important, easily visible characters of each species, starting with stems and proceeding with leaves, inflorescences, and finally fruits. The most important parts of the rattan - the first parts to look at when attempting to identify a plant - are bold-faced (**stems**, **leaf sheaths**, **ocreas**, **knees**, **flagella**, **rachis**, **cirri**, **inflorescences**, **fruits**). Note that the stem diameters given include leaf sheaths. The rattan cane itself will have a narrower diameter. Also note that the characteristics of the leaf sheaths are best observed on youngest leaves; on older leaves the coloring and hair patterns may be obscured. Not all species of *Calamus* and *Daemonorops* have climbing stems - a few have non-climbing stems. However, all species, climbing or non-climbing, are included in this guide.

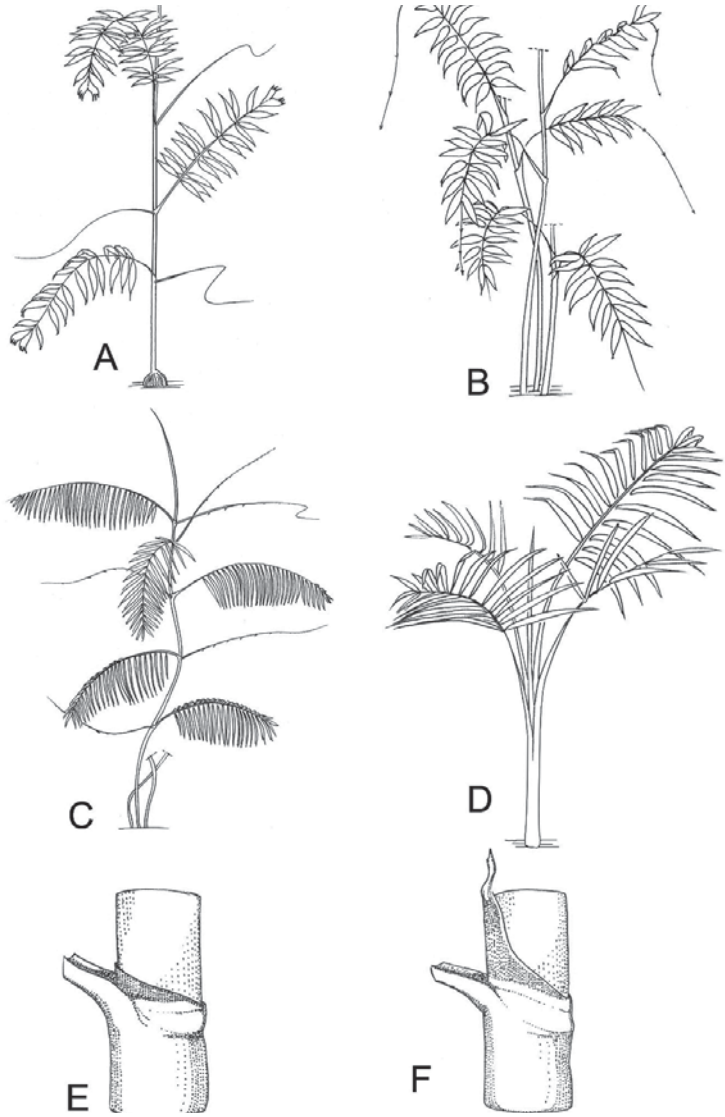
The description is followed by notes on distribution and habitat. Distribution is given first for Cambodia, Laos, and Vietnam (and if endemic to a country it is noted as such), and then other countries in parentheses. The abbreviations N. R. and N. P. refer to Nature Reserve and National Park. Habitat is given as well as elevation range based on data taken from herbarium specimens.

A short section on uses gives the most common uses of each species. As with many other palms, there are usually many uses for any particular species, but only the most important are given here.

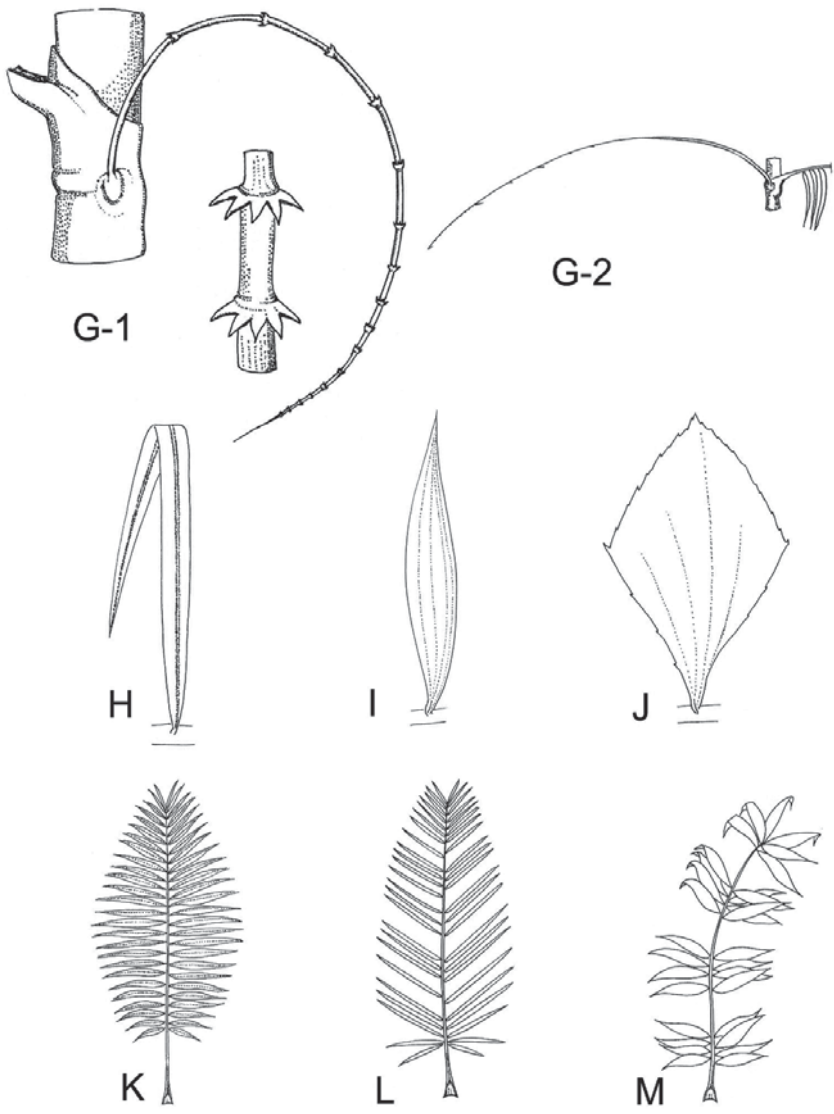
Flowering and fruiting months are given. These are taken mostly from herbarium specimens, and so may give an incomplete account. Also note that the same species growing in different parts of the region may have different flowering and fruiting times.

On the facing page to the description, illustrations are given. A range map for each species is based on herbarium specimens, and each dot on the map represents the locality of a herbarium specimen. Many species occur in a wider area than that indicated on the maps. For each species we have tried to illustrate the leaf sheath, the leaf, and either flowers or fruits.

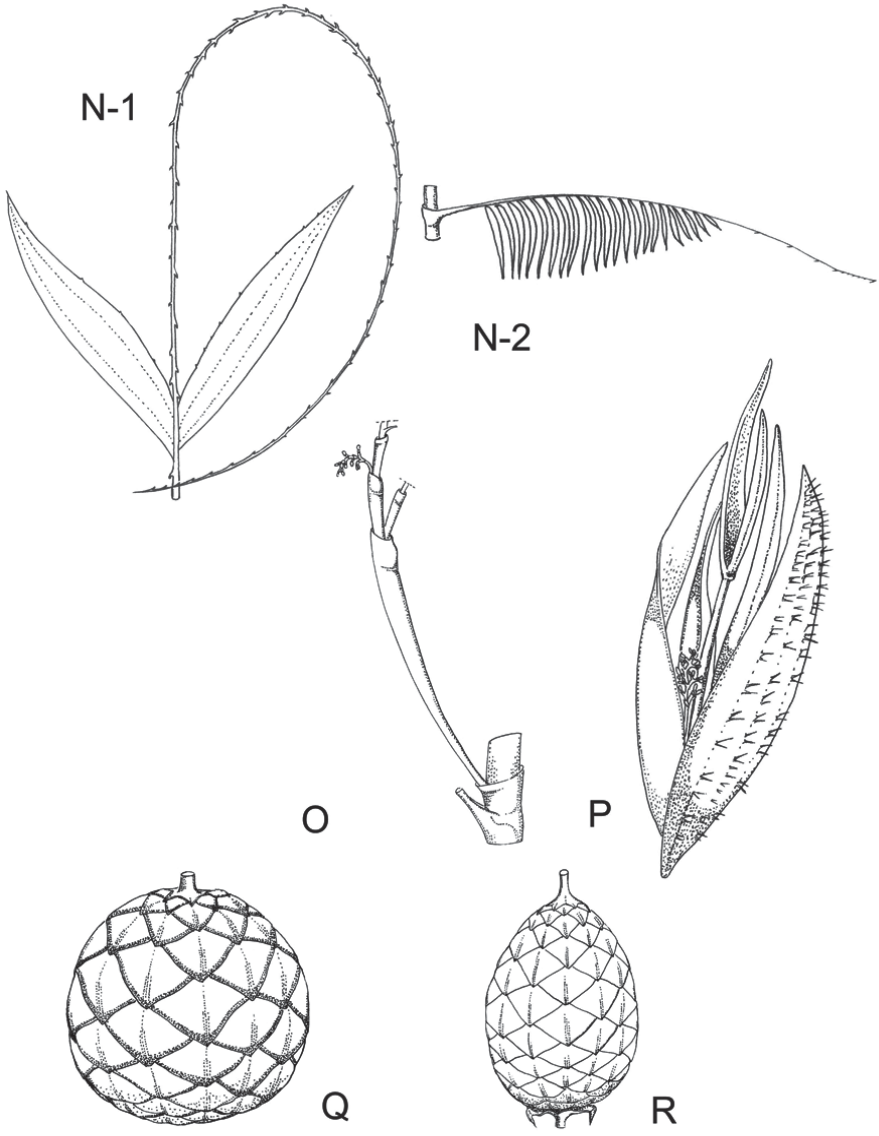
2.2. Illustrated Glossary



A. Solitary stem. B. Clustered stem. C. Climbing stem. D. Non-climbing stem. E. Scarcely developed ocrea. F. Well-developed ocrea.



G-1. Flagella. G-2. Flagella. H. Linear leaflet. I. Lanceolate leaflet. J. Rhomboid leaflet. K. Leaf with regularly arranged leaflets. L. Leaf with regularly arranged leaflets but with gaps. M. Leaf with clustered leaflets.



N-1. Cirrus. N-2. Cirrus. O. Tubular inflorescence bract. P. Inflorescence with boat-shaped bracts splitting their entire length and remaining attached and enclosed by the prophyll. Q. Globose fruit. R. Ovoid fruit.

2.3. Key to the Rattans of Cambodia, Laos and Vietnam

1a. Leaflets rhomboidal, stalked, with jagged apices, silvery-gray on the lower surfaces; climbing stems branching above ground level 2

1b. Leaflets linear, lanceolate, or ellipsoid, not stalked, with pointed apices, rarely rhomboidal, green on the lower surfaces, rarely silvery-gray; climbing stems branching only at ground level, rarely above ground level 3

2a. Leaflets 24-33 cm long, 11-18 cm wide; fruits to 2 cm long and 1.5 cm diameter; endosperm ruminate . . . . . *Korthalsia laciniosa*

2b. Leaflets 17-20 cm long, 6-11 cm wide; fruits to 0.8 cm long and 0.7 cm diameter; endosperm homogeneous . . . . . *Korthalsia minor*

3a. Knees on leaf sheaths absent; inflorescences borne simultaneously at apex of stem, their production ending life of stem; climbers 4

3b. Knees on leaf sheaths usually present; inflorescences borne sequentially along the stem, their production not ending life of stem; climbers or non-climbers 9

4a. Leaflets usually silvery-gray on the lower surfaces; inflorescence branches covered with prominent, overlapping bracts, these obscuring the flowers 5

4b. Leaflets usually green on the lower surfaces; inflorescence branches without prominent, overlapping bracts, the flowers visible 7

5a. Leaflets green on the lower surfaces, minutely spiny along the margins, with elongate, thread-like apices, without prominent, sub-marginal veins . . . . . *Plectocomia himalayana*

5b. Leaflets silvery-gray on the lower surfaces, not or rarely spiny along the margins, without thread-like apices, with prominent, sub-marginal veins 6

6a. Youngest, unopened leaves and sheaths gray; leaf sheath spines few, in short rows below the petioles . . . . . *Plectocomia elongata*

6b. Youngest, unopened leaves and sheaths reddish; leaf sheath spines dense, covering the entire sheath . . . . . *Plectocomia pierreana*

7a. Leaf sheath spines in complete rings around the sheaths; ocreas absent; fruits covered with minute scales . . . . . *Myrialepis paradoxa*

7b. Leaf sheath spines scattered, sometimes absent; ocreas present; fruits covered with normal-sized scales 8

8a. Leaflets with conspicuous, yellow bristles on the upper surfaces . . . . . *Plectocomiopsis geminiflora*

8b. Leaflets without bristles on the upper surfaces . . . . . *Plectocomiopsis songthanhensis*

9a. Inflorescences not flagellate, usually shorter than the leaves, with boat-shaped bracts splitting their entire length and then either falling off or remaining attached and enclosed by the prophyll, without grapnel-like spines; cirri usually present 10

9b. Inflorescences flagellate or non-flagellate, usually longer than the leaves, with sheathing, tubular bracts not or only briefly splitting and remaining attached, not enclosed by the prophyll, usually with grapnel-like spines; cirri present or absent 16

10a. Stems non-climbing, free-standing; knees absent; cirri absent or vestigial 11

10b. Stems climbing; knees and cirri usually present 12

11a. Stems to 5 m long; fruits globose, to 2 cm diameter; Vietnam (Ninh Thuan) . . . . . *Daemonorops nuichuaensis*

11b. Stems to 0.5 m long (rarely to 4 m long); fruits ellipsoid, to 3.5 cm long and 2.5 cm diameter; Vietnam (Khanh Hoa) . . . . . *Daemonorops brevicaulis*

12a. Stems to 1 cm diameter; rachis to 0.3 m long with 9-11 leaflets per side; Vietnam (Thua Thien-Hue) . . . . . *Daemonorops fissilis*

12b. Stems to 5 cm diameter; rachis to 3 m long with 26-89 leaflets per side; widespread 13

13a. Inflorescence bracts persistent, swollen, splitting lengthwise to reveal the flowering branches; Cambodia, Laos, and Vietnam . . . . . *Daemonorpos jenkinsiana*

13b. Inflorescence bracts falling from the elongating inflorescences, only the basal bract persistent; Vietnam 14

14a. Leaf sheath spines to 18 cm long, densely covered with gray or brown hairs; southern Vietnam (Khanh Hoa) . . . . . *Daemonorops mollispina*

14b. Leaf sheath spines to 6.5 cm long, not densely hairy 15

15a. Ocreas prominent; leaflets not bristly on the veins; fruits to 1.7 cm diameter; southern Vietnam (Khanh Hoa) . . . . . *Daemonorops ocreata*

15b. Ocreas obscure; leaflets bristly on the veins; fruits to 2.5 cm diameter; central and southern Vietnam (Ha Tinh to Khanh Hoa) . . . . . *Daemonorops poilanei*

16a. Stems non-climbing, free-standing, scrambling, or short and subterranean; knees, flagella, and cirri usually absent; inflorescence bracts without clawed spines 17

16b. Stems climbing; knees, flagella, and/or cirri usually present; inflorescence bracts with clawed spines 27

17a. Stems to 0.8 cm diameter, scrambling; leaflets to 12 per side of rachis, light gray-green on the lower surfaces; Cambodia and southern Vietnam . . . . . *Calamus salicifolius*

17b. Stems to 7 cm diameter, free-standing or short and subterranean; leaflets 14-49 per side of rachis, green on the lower surfaces; widespread 18

18a. Leaflets clustered and spreading in different planes 19

18b. Leaflets regularly arranged, sometimes with gaps, spreading in the same plane 21

19a. Stems to 5 m tall; Vietnam (Thanh Hoa) . . . . . *Calamus thysanolepis*

19b. Stems short and subterranean, sometimes to 1 m tall 20

20a. Stems clustered; Cambodia and Laos . . . . . *Calamus acanthophyllus*

20b. Stems solitary; Vietnam (Phu Yen) . . . . . *Calamus acaulis*

21a. Stems short and subterranean; Vietnam (Dong Nai, Lam Dong) . . . . . *Calamus dongnaiensis*

21b. Stems 1-10 m tall and 4-7 cm diameter; widespread 22

22a. Petioles with groups or whorls of long, yellow or brown spines 23

22b. Petioles without groups or whorls of long yellow spines 25

23a. Partial inflorescences spicate; western Cambodia . . . . . *Calamus kampucheaensis*

23b. Partial inflorescences branched 24

24a. Stems to 1.8 m tall; southern Laos . . . . . *Calamus harmandii*

24b. Stems to 6 m tall; northern Laos . . . . . *Calamus erectus*

25a. Stems to 10 m tall and 7 cm diameter; Vietnam (Bac Giang, Cao Bang) . . . . . *Calamus dianbaiensis*

25b. Stems to 1.5 m tall and 3 cm diameter 26

26a. Inflorescences to 3 m long, flagellate, arching; bracts tubular; Vietnam (Quang Ninh) . . . . . *Calamus yentuensis*

26b. Inflorescences to 0.5 m long, not flagellate, erect; bracts splitting and tattering; Vietnam (Kon Tum, near Da Nang City) . . . . . *Calamus modestus*

27a. Flagella and cirri present (but often reduced or absent) 28

27b. Flagella or cirri present 29

28a. Central Laos . . . . . *Calamus bimaniferus*

28b. Central Vietnam . . . . . *Calamus spiralis*

29a. Flagella absent; cirri present 30

29b. Flagella present; cirri absent 33

30a. Stems to 1 cm diameter; leaflets 3-13 per side of rachis; Vietnam (Nghe An, Ninh Binh, Phu Tho) . . . . . *Calamus centralis*

30b. Stems to 6 cm diameter; leaflets 12-40 per side of rachis 31

31a. Leaflets about 65 per side of rachis, linear, pendulous, regularly arranged; Cambodia . . . . . *Calamus erinaceus*

31b. Leaflets 15-40 per side of rachis, lanceolate, spreading, usually irregularly arranged; widespread 32

32a. Stems clustered; sheath spines reddish-brown; leaflets usually arranged in distant clusters; fruits not borne on short stalks, to 1.2 cm long, with a pronounced nipple at the tip, the scales not channeled . . . . . *Calamus palustris*

32b. Stems solitary or clustered; sheath spines yellowish or reddish-brown; leaflets usually regularly or irregularly arranged; fruits borne on short stalks, to 2.4 cm long, without a pronounced nipple at the tip, the scales channeled . . . . . *Calamus nambariensis*

33a. Leaflets rhomboidal . . . . . *Calamus bousigonii*

33b. Leaflets linear, lanceolate, linear-lanceolate, broadly lanceolate, or elliptic 34

34a. Leaflets 4-15 per side of rachis, usually broadly lanceolate or elliptic and irregularly arranged, the apical ones often inserted close together in a fan shape, the apical pair free or often joined at their bases 35

34b. Leaflets 15-90 per side of rachis, usually linear or linear lanceolate and regularly arranged, the apical ones not inserted close together in a fan shape, nor joined at their bases 46

35a. Stems to 5 cm diameter, solitary; leaf sheath spines with sinuous margins, densely hairy initially; leaflets broadly lanceolate; northern Laos, Vietnam (Phu Tho) . . . . . *Calamus acanthospathus*

35b. Stems less than 2 cm diameter, usually clustered; leaf sheath spines not with sinuous margins and densely hairy initially; leaflets linear or lanceolate; widespread 36

36a. Ocreas densely bristly; central Laos . . . . . *Calamus evansii*

36b. Ocreas not densely bristly; widespread 37

37a. Leaf sheath spines conspicuously longer at sheath apices; leaflets regularly arranged but in in two or three distant groups; Vietnam (Khanh Hoa) . . . . . *Calamus seriatus*

37b. Leaf sheath spines not longer at sheath apices; leaflets not arranged in distant groups; widespread 38

38a. Leaflets silvery-gray on the lower surfaces; inflorescence bracts split; central Laos . . . . . *Calamus minor*

38b. Leaflets green on the lower surfaces; inflorescence bracts not split; widespread 39

39a. Stems 0.3 m diameter; leaflets 2-3 per side of the rachis; Vietnam (Khanh Hoa) . . . . . *Calamus parvulus*

39b. Stems 0.4-1.8 cm diameter; leaflets 4-13 per side of the rachis; widespread 40

40a. Apical pair of leaflets split to their bases . . . . . *Calamus dioicus*

40b. Apical pair of leaflets joined at their bases 41

41a. Leaf sheaths densely covered with reddish-brown spines; ocreas densely spiny as the sheath but with longer spines; Vietnam (Thua Thien-Hue) . . . . . *Calamus bachmaensis*

41b. Leaf sheath spines not reddish-brown; ocreas not densely spiny; widespread 42

42a. Inflorescence bracts splitting to the base, tattering; Vietnam (Kon Tum) . . . . . *Calamus kontumensis*

42b. Inflorescence bracts tubular, not splitting; widespread 43

43a. Basal pair of leaflets swept back across the sheaths; petioles absent; leaflets conspicuously bristly on the margins, curled over at the apices; Vietnam (Quang Tri, Thua Thien-Hue, near Da Nang City, Quang Nam) . . . . . *Calamus crispus*

43b. Basal pair of leaflets not swept back across the sheaths; petioles present; leaflets not conspicuously bristly on the margins, not curled over at the apices; widespread 44

44a. Stems solitary; central Laos . . . . . *Calamus solitarius*

44b. Stems clustered; widespread 45

45a. First partial inflorescence well branched; Cambodia, Laos, Vietnam . . . . . *Calamus tetradactylus*

45b. First partial inflorescence not or scarcely branched; central Laos . . . . . *Calamus oligostachys*

46a. Fruits borne on conspicuous, slender stalks; Vietnam (Khanh Hoa) . . . . .*Calamus ceratophorus*

46b. Fruits not borne on conspicuous, slender stalks; widespread 47

47a. Stems solitary 48

47b. Stems clustered 49

48a. Leaf sheaths with to 3.5 cm long spines, sometimes without spines; leaf rachis to 3.4 m long; endosperm homogeneous; central and Northern Laos, central and southern Vietnam . . . . . *Calamus poilanei*

48b. Leaf sheaths without spines, or with a few spines to 0.7 cm long; leaf rachis to 1.4 m long; endosperm ruminate; Cambodia, Vietnam (Dong Nai) . . . . . *Calamus lateralis*

49a. Leaflets clustered and spreading in different planes 50

49b. Leaflets regularly arranged, or regularly arranged but with gaps, spreading in the same plane 53

50a. Leaflets whitish on the lower surfaces; central Laos . . . . . *Calamus laoensis*

50b. Leaflets green on the lower surfaces 51

51a. Upper surfaces of petioles with rings of spines; central and Northern Laos, throughout Vietnam . . . . . *Calamus rhabdocladus*

51b. Upper surfaces of petioles without spines 52

52a. Leaflets more or less regularly arranged, but with gaps . . . . . *Calamus siamensis*

52b. Leaflets irregularly arranged and spreading in different planes . . . . . *Calamus viminalis*

53a. Leaf sheath spines conspicuously longer at sheath apices 54

53b. Leaf sheath spines not longer at sheath apices (sometimes only a few spines longer) 56

54a. Leaf sheath spines scattered, not in rows . . . . . *Calamus flagellum*

54b. Leaf sheath spines in rows 55

55a. Leaf sheaths split open, not tubular; upper surface of petioles without spines; southern Laos, Cambodia, southern Vietnam (Vung Tau, Dong Nai, Binh Thuan, Quang Nam, Phu Yen) . . . . . *Calamus rudentum*

55b. Leaf sheaths closed for their entire length; upper surface of petioles with rings of spines; central and northern Laos, throughout Vietnam . . . . . *Calamus rhabdocladus*

56a. Ocreas densely bristly with black bristles . . . . . *Calamus walkeri*

56b. Ocreas not bristly 57

57a. Petioles short or absent; basal leaflet swept back across the sheath; central Laos, Cambodia . . . . . *Calamus godefroyi*

57b. Petioles well-developed; basal leaflet not swept back across the sheath; widespread 58

58a. Leaf sheaths with upward pointing spines; ocreas long, prominent but soon splitting; inflorescences bracts splitting lengthways; southern Laos, Cambodia . . . . . *Calamus guruba*

58b. Leaf sheath spines horizontally pointing; ocreas short; inflorescence bracts tubular, not splitting lengthways 59

59a. Leaf sheaths mottled with dark and whitish-brown hairs 60

59b. Leaf sheaths not mottled 61

60a. Leaf sheath spines conical-based, to 0.5 cm long; leaflets curled over at the tips; northern and central Laos, central Vietnam (Thua Thien-Hue, Quang Nam, Kon Tum) . . . . . *Calamus gracilis*

60b. Leaf sheath spines not conical-based, more than 0.5 cm long; leaflets not curled over at the tips; western Cambodia . . . . . *Calamus mellitus*

61a. Leaf sheath spines with oblique, crescent-shaped bases; central Laos . . . . . *Calamus tenuis*

61b. Leaf sheath spines not with oblique, crescent-shaped bases; northern and central Laos, northern and central Vietnam . . . . . *Calamus henryanus*

Calamus acanthophyllus Becc.

Local names. *Phdao sbath, phadao ankuy (Cam); Wai tia, wai kok, wai foom, wai nang (Lao).*

Description. Stems clustered, non-climbing, short and subterranean. **Leaf sheaths** open, greenish-brown with brown hairs, with scattered, yellowish, flattened, to 1 cm long spines; **ocreas** present, ear-like; **knees** absent; **flagella** absent; petioles to 30 cm long; **rachis** to 1.5 m long with 15-20, linear-lanceolate leaflets per side, these clustered and spreading in different planes, prominently bristly along margins and veins; **cirri** absent. **Inflorescences** to 1.1 m long, erect, not flagellate; bracts tubular, swollen; **fruits** globose-ellipsoid, to 1.2 cm long and 0.9 cm diameter, whitish.

Distribution and habitat. Central and Southern Laos and also reported from Northern Cambodia (Khou Eang Hourt, pers. comm.; also in Thailand); in deciduous Dipterocarp forest to 250 m elevation.

Flowering and fruiting. Flowers March; fruits November.

Uses. Only minor, such as the leaves made into brooms and edible fruits. The roots are said to have anti-malarial properties.


QUẦN ĐẢO HOÀNG SA
Đảo Phú Quốc
Đảo Côn Sơn
QUẦN ĐẢO TRƯỜNG SA
0 50 100 200 Km

Calamus acanthospathus Griff.

Local names. *Wai hom, blong eur (Lao); trèo đối (Vie).*

Description. Stems solitary, climbing, to 50 m long and 5 cm diameter. **Leaf sheaths** green or pinkish-brown, with sparsely to densely arranged, sometimes in short rows, brown, flattened, to 1 cm long spines, these with sinuous, hairy margins initially; **ocreas** short, densely bristly; **knees** present; **flagella** present, to 5.6 m long; petioles short or absent; **rachis** to 1.4 m long with 8-15, broadly lanceolate leaflets per side, these regularly arranged, sometimes irregularly, especially near base of leaves, minutely bristly on the margins; **cirri** absent. **Inflorescences** to 3 m long, flagellate; bracts tubular; **fruits** ovoid to ellipsoid, to 2.5 cm long and 1.5 cm diameter, yellowish-brown.

Distribution and habitat. Northern Laos and northern Vietnam in lowland evergreen or montane forest at medium elevations often on limestone soils (also in Bhutan, China, northeastern India, Myanmar, Nepal, and Thailand).

Flowering and fruiting. Flowers March.

Uses. Provides a good quality cane used in basket making and furniture making.


Đảo Phú Quốc
Đảo Côn Sơn
0 50 100 200 Km

Calamus acaulis Henderson, N. K. Ban & N. Q. Dung

Local names. *Mật cật, mây cật (Vie).*

Description. Stems solitary, non-climbing, short and subterranean or to 1 m long and 3.5 cm diameter. **Leaf sheaths** green, with scattered, yellowish, to 6 cm long spines; **ocreas** brown, to 10 cm long, bristly; **knees** absent; **flagella** absent; petioles to 60 cm long; **rachis** to 0.7 m long with 10-25, lanceolate leaflets per side, these irregularly arranged in distant clusters of 2-6, spreading in different planes, yellowish at their bases, the apical pair joined at their bases, bristly at apices only; **cirri** absent. **Inflorescences** to 1 m long, not flagellate, erect; bracts tubular; **fruits** globose, 1 cm diameter, whitish-brown.

Distribution and habitat. South-central Vietnam in Phu Yen (Krong Trai N. R.) and near border with Khanh Hoa (Ca Pass) in lowland deciduous forest or disturbed forest at 100 m elevation.

Flowering and fruiting. Flowers July; fruits October.

Uses. The stems are used in joinery.


Đảo Phú Quốc
Đảo Côn Sơn
0 50 100 200 Km

Calamus bachmaensis Henderson, N. K. Ban & N. Q. Dung

Local names. *Mây tre, mây cám tre (Vie).*

Description. Stems clustered, climbing, to 10 m long and 1.3 cm diameter. **Leaf sheaths** green with whitish-brown hairs, densely covered with reddish-brown, flattened, to 1 cm long spines, these denser and finer at sheath apices; **ocreas** short, densely spiny as the sheath but with longer spines; **knees** present; **flagella** present, to 1 m long; petioles to 15 cm long; **rachis** to 0.4 m long with 4-6, elliptic leaflets per side, these clustered, the apical pair joined at their bases; **cirri** absent. **Inflorescences** to 1 m long, flagellate; bracts tubular; **fruits** globose, to 1 cm diameter, brown.

Distribution and habitat. Central Vietnam in Thua Thien-Hue (Bach Ma N. P.) in lowland evergreen forest at 100-500 m elevation.

Flowering and fruiting. Flowers January; fruits April.

Uses. Provides a good quality, thin cane used for tying and basket making.


Đảo Phú Quốc
Đảo Côn Sơn
0 50 100 200 Km

Calamus batoensis Henderson & N. Q. Dung

Local names. *Mây rắc, mây ba tơ (Vie).*

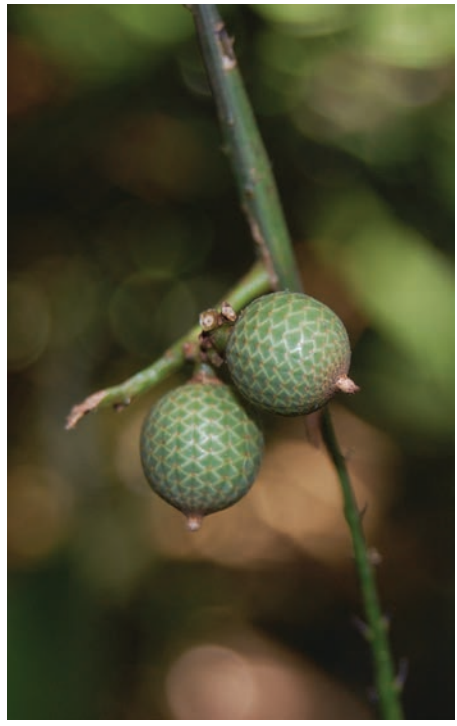
Description. Stems clustered, climbing, to 10 m long and 0.8 cm diameter. **Leaf sheaths** greenish-white with scattered, brown-tipped, to 0.2 cm long spines; **ocreas** present; **knees** present; **flagella** present, to 0.7 m long; petioles to 11 cm long; **rachis** to 0.3 m long with 3-4, elliptic leaflets per side, these clustered, the apical ones close together in a fan shape, the apical pair joined at their bases; **cirri** absent. **Inflorescences** to 0.8 m long, flagellate; bracts tubular but swollen near the apices; **fruits** globose, to 0.9 cm diameter, greenish.

Distribution and habitat. Central Vietnam in secondary, evergreen forest at 600 m elevation.

Flowering and fruiting. Flowers September; fruits May.

Uses. Not recorded.


Đảo Phú Quốc
Đảo Côn Sơn
0 50 100 200 Km



Calamus bimaniferus Evans, K. Sengdala, O. Viengkham, B. Thammavong & J. Dransf.

Local names. *Wai hangnou, wai hangnou noi, wai keekai, re itch (Lao).*

Description. Stems clustered, climbing, to 3 m long and 1 cm diameter. **Leaf sheaths** green with brown hairs, without spines or with scattered, black-tipped, flattened, to 0.7 cm long spines; **ocreas** present; **knees** present; **flagella** present, to 0.5 m long; petioles to 15 cm long; **rachis** to 0.4 m long with 4-8, elliptic leaflets per side, these irregularly arranged, often in pairs; **cirri** present, vestigial, to 0.2 m long, sometimes absent especially on younger leaves. **Inflorescences** to 1.0 m long, not flagellate; bracts tubular; **fruits** globose, 0.8 cm diameter, yellowish-brown.

Distribution and habitat. Central and southern Laos (possibly in Thailand) in lowland evergreen or deciduous forest at 200-530 m elevation.

Flowering and fruiting. Flowers January.

Uses. Provides a good quality cane used for tying.


Đảo Phú Quốc
Đảo Côn Sơn
0 50 100 200 Km

Calamus bousigonii Becc.

Local names. *Phdao arech (Cam); chà phun, mây cun, mây phun, mây lá rộng (Vie).*

Description. Stems clustered or solitary, climbing, to 20 m long and 2 cm diameter. **Leaf sheaths** green, mottled with whitish-brown hairs, with sparsely to densely arranged, yellowish-brown, swollen-based, to 1.3 cm long spines; **ocreas** short, not spiny; **knees** present; **flagella** present, to 1.5 m long; petioles to 35 cm long; **rachis** to 1 m long with 5-10, rhomboidal leaflets per side, these regularly arranged, with bristly margins; **cirri** absent. **Inflorescences** to 1.1 m long, flagellate; bracts tubular; **fruits** globose to ellipsoid, to 1.4 cm long diameter, yellowish.

Distribution and habitat. Cambodia and central and southern Vietnam (also in Thailand) in lowland evergreen or montane forest at 100-1,600 m elevation.

Flowering and fruiting. Flowers July; fruits April.

Uses. Produces a medium quality cane used in tying and basket making.

Notes. Two subspecies are recognized: *C. bousigonii subsp. bousigonii* in Vietnam and Cambodia, and *subsp. smitinandii* J. Dransf., with more deeply split inflorescence bracts, in Peninsular Thailand.


QUẦN ĐẢO HOÀNG SA
Đảo Phú Quốc
Đảo Côn Sơn
50 100 200 Km

Calamus centralis Henderson, N. K. Ban & N. Q. Dung

Local names. *Mây, mây gà, mây mật (Vie).*

Description. Stems clustered, climbing, to 20 m long and 1 cm diameter. **Leaf sheaths** green, mottled with reddish-brown hairs, with scattered, yellowish-green or brown, flattened, to 2 cm long spines; **ocreas** short, not spiny; **knees** prominent; **flagella** absent; petioles short or absent; **rachis** to 0.8 m long with 3-7, linear-lanceolate leaflets per side, these distantly and irregularly arranged, the basal ones swept back across the sheaths, minutely bristly on the margins; **cirri** to 0.8 m long. **Inflorescences** to 0.4 m long, not flagellate, erect or arching; bracts tubular; **fruits** ellipsoid, to 2 cm long and 1 cm diameter, whitish-green.

Distribution and habitat. Central Vietnam in Nghe An (Pu Huong N. R., Pu Mat N. R.), Ninh Binh (Cuc Phuong N. P.), and Phu Tho (Xuan Son N. P.) in lowland evergreen forest or disturbed places, on karst limestone hills, at 100-450 m elevation.

Flowering and fruiting. Flowers May; fruits July.

Uses. Provides a medium quality cane used in domestic furniture making.


Đảo Phú Quốc
Đảo Côn Sơn
50 100 200 Km

Calamus ceratophorus Conrard

Local names. *Mây sung, úi song, mây roi (Vie).*

Description. Stems solitary, climbing, to 30 m long and 3 cm diameter. **Leaf sheaths** green and yellow, mottled with reddish-brown hairs, with scattered to densely arranged (sometimes in short rows), yellowish, flattened, downward-pointing, to 2 cm long spines; **ocreas** short, not spiny; **knees** prominent; **flagella** present; petioles to 80 cm long, yellowish on lower surfaces; **rachis** to 1.5 m long with 21-30, linear-lanceolate leaflets per side, these regularly arranged, with few bristles at apices only; **cirri** absent. **Inflorescences** to 5 m long, flagellate; bracts tubular; **fruits** borne on conspicuous, slender stalks, ellipsoid, to 1.9 cm long and 0.8 cm diameter, yellowish.

Distribution and habitat. South-central Vietnam in Khanh Hoa (Hon Ba N. R. and along new road from Nha Trang to Da Lat) in lowland evergreen or montane forest at 900-1,488 m elevation.

Flowering and fruiting. Fruits April, July.

Uses. Produces a good quality cane used in furniture making.


QUẦN ĐẢO HOÀNG SA
Đảo Phú Quốc
Đảo Côn Sơn
50 100 200 Km

Calamus crispus Henderson, N. K. Ban & N. Q. Dung

Local names. *Mây tắt, mây tôm (Vie).*

Description. Stems clustered, climbing, to 15 m long and 1.8 cm diameter. **Leaf sheaths** green with reddish-brown hairs, with scattered, yellowish-green, downward-pointing, flattened, to 1 cm long spines; **ocreas** short, not spiny; **knees** prominent; **flagella** present; petioles short or absent; **rachis** to 0.4 m long with 7-10, elliptic leaflets per side, these clustered in alternate groups of 2-3, leathery, curled over at the apices, the basal pair swept back across the sheaths, the apical pair joined for about half their length, conspicuously spiny along the margins; **cirri** absent. **Inflorescences** to 1.3 m long, flagellate; bracts tubular; **fruits** borne on short stalks, globose, to 0.9 cm diameter, yellowish.

Distribution and habitat. Central Vietnam in Quang Tri (Bac Huong Hoa N. R., Da Krong N. R.), Thua Thien-Hue (Bach Ma N. P., Phong Dien N. R., Sao La N. R.), near Da Nang City (Ba Na-Nui Chua N. R.), and Quang Nam (Song Thanh N. R.) in lowland evergreen forest at 400-1,000 m elevation.

Flowering and fruiting. Flowers April.

Uses. Provides a medium quality cane used for tying.


Đảo Phú Quốc
Đảo Côn Sơn
50 100 200 Km

Calamus dianbaiensis C. F. Wei

Local names. *Hèo ông (Vie).*

Description. Stems clustered, non-climbing, free-standing or creeping, to 10 m long and 7 cm diameter. **Leaf sheaths** green with brown hairs, with short, oblique combs of greenish-brown, flattened, to 3 cm long spines; **ocreas** to 20 cm long, fibrous, tattering; **knees** absent; **flagella** absent; petioles to 60 cm long; **rachis** to 3 m long with 30-40, linear-lanceolate leaflets per side, these regularly arranged, bristly on upper surface veins and margins; **cirri** absent. Inflorescences to 1 m long, not flagellate; bracts split open and tattering at the apices; fruits globose to ellipsoid, to 2 cm long and 1.5 cm diameter, whitish-brown.

Distribution and habitat. Northeastern Vietnam in Bac Giang (Suoi Mo Landscape Protection Area) and Cao Bang (Pia Oac N. R.) in lowland evergreen forest at 450-600 m elevation (also in Guangxi and Guangdong, China).

Flowering and fruiting. Flowers March; fruits October-November.

Uses. The shoots are edible.

Notes. In Vietnam it is known as *heo ong*, which means 'grandfather of heo' (*heo* is a climbing species, *Calamus rhabdocladus*). This non-climbing species has an interesting growth habit which does not appear to have been recorded before in *Calamus*. Stems form clumps, and one or more stems from the clump grow up vertically until they are up to 10 m tall, and then bend over so that the top of the stem comes into contact with the ground. Here the stems root into the ground and form a new clump.


Đảo Phú Quốc
Đảo Côn Sơn
50 100 200 Km

Calamus dioicus Lour.

Local names. *Mây chỉ, mây răm, mây sắp (Vie).*

Description. **Stems** clustered, climbing, to 10 m long and 0.4 cm diameter. **Leaf sheaths** green with patches of brown hairs, sparsely to moderately covered with yellowish, black-tipped, flattened, to 0.6 cm long spines; **ocreas** to 4 cm long, brown, membranous and soon falling, with needle-like spines at the bases; **knees** prominent; **flagella present**, to 1 m long; petioles short or absent; **rachis** to 0.2 m long with 5, lanceolate leaflets per side, these irregularly and distantly arranged in three groups, the basal pair swept back across the sheaths, the apical pair split to their bases, minutely bristly along the margins; **cirri** absent. **Inflorescences** to 1.5 m long, not flagellate; bracts tubular; **fruits** globose, to 0.8 cm diameter, yellowish-white.

Distribution and habitat. Central and southern Vietnam in Quang Nam (Song Thanh N. R.), Bien Hoa, and Dong Nai (Cat Tien N. P.) in lowland rain forest at 150-412 m elevation.

Flowering and fruiting. Fruits May.

Uses. Produces a good quality cane used for tying.


QUẦN ĐẢO HOÀNG SA
Đảo Phú Quốc
Đảo Côn Sơn
50 100 200 Km

Calamus dongnaiensis Pierre ex Becc.

Local names. *Mây đồng nai (Vie).*

Description. Stems clustered, non-climbing, short and subterranean, to 12 cm diameter. **Leaf sheaths** open, greenish-brown with brown hairs, with oblique rows of brownish, flattened, to 5 cm long spines; **ocreas** not known; **knees** absent; **flagella** absent; petioles to 120 cm long**; rachis** to 3.6 m long with 14-26, broadly lanceolate, leathery leaflets per side, these regularly arranged, bristly along the margins; cirri absent. **Inflorescences** to 4 m long, not flagellate; bracts split open and tattering at the apices; **fruits** ovoid, to 6 cm long and 3 cm diameter, yellowish-green.

Distribution and habitat. Southern Vietnam in Dong Nai and Lam Dong (Bao Loc District, Deo Bao Loc) in lowland evergreen or montane forest at 544-1,500 m elevation.

Flowering and fruiting. Flowers July; fruits July.

Uses. The mesocarp of the fruits is eaten.

Notes. This species is incompletely understood; some specimens have irregularly arranged leaflets.


Đảo Phú Quốc
Đảo Côn Sơn
50 100 200 Km

Calamus erectus Roxb.

Local names. *Wai namsay, blong chintra, kak tamarr (Lao).*

Description. Stems clustered, non-climbing, free-standing or sometimes leaning, to 6 m long and 5 cm diameter. **Leaf sheaths** dark green with dark brown hairs, with short rows of brown, flattened, to 3.5 cm long spines; **ocreas** present, with rows of short spines, split into two, soon falling; **knees** absent; **flagella** absent; petioles to 190 cm long, with whorls of yellow spines; **rachis** to 3 m long with to 40, lanceolate leaflets per side, these regularly arranged, bristly along the margins; **cirri** absent. **Inflorescences** to 2 m long, not flagellate; bracts tubular, tattering at the apices; **fruits** ellipsoid, to 5 cm long and 2.5 cm diameter, greenish- or reddish-brown.

Distribution and habitat. Northern and central Laos (also in Bangladesh, Bhutan, China, Northeastern India, Myanmar, Nepal, and Thailand) in lowland evergreen, montane forest, or deciduous forest, usually on steep slopes, to 1,400 m elevation.

Flowering and fruiting. Flowers February; fruits March, April.

Uses. Provides a short, thick, non-flexible cane used in construction and furniture making.


QUẦN ĐẢO HOÀNG SA
Đảo Phú Quốc
Đảo Côn Sơn
50 100 200 Km

Calamus erinaceus (Becc.) J. Dransf.

Local names. *Phdao toek prai (Cam).*

Description. Stems clustered, climbing, to 20 m long and 6 cm diameter. **Leaf sheaths** yellowish-green with gray hairs, with densely arranged, oblique rows of brown, needle-like or flattened, to 3.5 (-10 at sheath apices) cm long spines; **ocreas** very short or absent; **knees** present, orange-yellow, without spines on upper part; flagella absent; petioles to 30 cm long; **rachis** to 2.5 m long with 65-70, linear leaflets per side, these regularly arranged and pendulous; **cirri** present, to 2 m long. **Inflorescences** to 1.5 m long, not flagellate; bracts tubular; **fruits** globose, to 1 cm diameter, yellowish.

Distribution and habitat. Cambodia (also in Borneo, the Philippines, Singapore, Sumatra, Peninsular Malaysia, and Thailand) in mangrove forest and other places near the sea at low elevations.

Flowering and fruiting. Not recorded.

Uses. The cane is reported to be of low quality and seldom used.


Đảo Phú Quốc
Đảo Côn Sơn
50 100 200 Km

Calamus evansii Henderson

Local names. *Leum, wai leum (Lao).*

Description. Stems clustered, climbing, to 7 m long and 1.3 cm diameter. **Leaf sheaths** green with white hairs, with sparsely to densely arranged brown, black-tipped, flattened, horizontally spreading spines to 1 cm long, sometimes with many short spines interspersed; **knees** present; **ocreas** present, densely bristly; **flagella** present; petioles to 20 cm long; rachis to 0.5 m long with 3-6, lanceolate leaflets per side, these arranged in distant groups or solitary, the apical pair free or only briefly joined at their bases; **cirri** absent. **Inflorescences** to 3 m long, flagellate; bracts tubular; **fruits** not seen.

Distribution and habitat. Central Laos in lowland evergreen forest at 520-530 m elevation. Known from a few localities; one locality is now flooded by a hydro-electric dam.

Flowering and fruiting. Flowers March.

Uses. The canes are used for handicrafts.

Notes. This species was referred to as *Calamus kingianus* Becc. in Evans et al. (2001).


Đảo Phú Quốc
Đảo Côn Sơn
50 100 200 Km

Calamus flagellum Griff.

Local names. *Wai lao, wai mon, wai namleuang, wai thoon, blong poul (Lao); mây gai, mây nước, mây nước đá, mây roi, mây trâu (Vie).*

Description. **Stems** clustered, climbing, to 30 m long and 5 cm diameter. **Leaf sheaths** greenish-yellow with dense, dark brown hairs, with densely arranged, black, brownish, or yellowish, flattened, to 5.5 cm long (sometimes to 10 cm long at sheath apices) spines, interspersed with shorter spines; **ocreas** to 10 cm long, fibrous, early tattering and falling; **knees** present, inconspicuous; **flagella** present, to 7 m long; petioles to 70 cm long; **rachis** to 3 m long with 24-36, linear-lanceolate leaflets per side, these regularly arranged, conspicuously bristly along the margins; cirri absent. **Inflorescences** to 7 m long, flagellate; bracts tubular, tattering at the apices; **fruits** ovoid to ellipsoid, to 3.5 cm long and 2.5 cm diameter, yellowish or brownish.

Distribution and habitat. Northern Laos and Northern and central Vietnam (also in Bangladesh, Bhutan, China, Myanmar, Nepal, Northeastern India, and Thailand) in lowland evergreen or montane forest at 100-1,350 m elevation.

Flowering and fruiting. Flowers March, April, October; fruits April-May.

Uses. Provides a medium quality cane used in furniture making.


Đảo Phú Quốc
Đảo Côn Sơn
50 100 200 Km

Calamus flavinervis Henderson & N. Q. Dung

Local names. *Mây rắc, mây vằn (Vie).*

Description. Stems clustered, climbing, to 8 m long and 1.3 cm diameter. **Leaf sheaths** densely brown tomentose with dense, greenish-yellow, to 1.1 cm long spines; **ocreas** present; **knees** present; **flagella** present, to 1.9 m long; petioles to 22 cm long; **rachis** to 0.6 m long with 7-10, elliptic leaflets per side, these clustered, the apical ones close together in a fan shape, the apical pair joined at their bases, leathery, with prominent yellow cross veins; **cirri** absent. **Inflorescences** to 3 m long, flagellate; bracts tubular; **fruits** globose, to 0.7 cm diameter, greenish.

Distribution and habitat. Southern Vietnam in montane rain forest on steep slopes at 900-1,000 m elevation.

Flowering and fruiting. Flowers July; fruits August.

Uses. Not recorded.


QUẦN ĐẢO HOÀNG SA
Đảo Phú Quốc
Đảo Côn Sơn
0 50 100 200 Km

Calamus godefroyi Becc.

Local names. *Phdao toek (Cam); wai nong (Lao).*

Description. **Stems** clustered, climbing, to 30 m long and 1.5 cm diameter. **Leaf sheaths** green with brown hairs, with scattered to densely arranged, black-tipped, flattened, triangular, to 2 cm long spines; **ocreas** present; **knees** present; **flagella** present, elongate; petioles short or absent; **rachis** to 1 m long with 15-20, linear-lanceolate leaflets per side, these regularly arranged and grayish-green on the lower surface, with the basal few leaflets often swept back across the sheath; **cirri** absent. **Inflorescence**s to 1.3 m long, flagellate; bracts tubular; **fruits** globose to ellipsoid, to 1.6 cm long and 1.2 cm diameter, yellowish or whitish.

Distribution and habitat. Cambodia and central Laos, and just reaching Southwestern Vietnam (also in Thailand) in marshy areas in seasonal swamp forest at low elevations.

Flowering and fruiting. Fruits August.

Uses. The canes are used locally in basket making and handicrafts.


Đảo Phú Quốc
Đảo Côn Sơn
50 100 200 Km

Calamus gracilis Roxb.

Local names. *Wai hom, wai soum, wai tairtair (Lao); mây tắt, mây nước (Vie).*

Description. Stems clustered, climbing, to 30 m long and 2 cm diameter. **Leaf sheaths** green, mottled with dark and whitish-brown hairs, without spines or with scattered, black-tipped, conical-based, to 0.5 cm long spines; **ocreas** small, not spiny; **knees** present; **flagella** present; petioles short; **rachis** to 0.7 m long with 8-15, linear or lanceolate leaflets per side, these regularly arranged but with wide gaps, shiny green, curled over at the tips, the apical ones inserted close together in a fan shape, the apical pair not joined at their bases, bristly on upper surface and lateral veins; **cirri** absent. **Inflorescences** to 0.7 m long, flagellate; bracts tubular; **fruits** borne on short stalks, ovoid to ellipsoid, to 2.5 cm long and 1.7 cm diameter, yellowish or orange.

Distribution and habitat. Central Laos and central Vietnam in Thua Thien-Hue (Sao La N. R.), Quang Nam (Song Thanh N. R.), and Kon Tum (Ngoc Linh N. R.) (also in Bangladesh, China, northeastern India, and Myanmar) in lowland evergreen or montane forest at 850-1,500 m elevation.

Flowering and fruiting. Fruits March, December.

Uses. Provides a medium (Vietnam) to good (Laos) quality cane used for tying.


QUẦN ĐẢO HOÀNG SA
Đảo Phú Quốc
Đảo Côn Sơn
50 100 200 Km

Calamus guruba Buch.-Ham.

Local names. *Phdao achmoan, phdao traes, traes anchmoan (Cam); wai deng (Lao).*

Description. Stems clustered, climbing or forming thickets, to 20 m long and 3 cm diameter. **Leaf sheaths** dull green with rusty brown or light brown hairs, with scattered to densely arranged, brown, flattened, upward-pointing, to 3.5 (sometimes -10 at sheath apices) cm long spines; **ocreas** present, conspicuous, tattering and soon falling; knees present; **flagella** present, to 3 m long; petioles to 35 cm long; **rachis** to 1.3 m long with 30-65, linear-lanceolate leaflets per side, these regularly arranged, the apical ones smaller than the others; **cirri** absent. **Inflorescences** to 3 m long, flagellate, bracts not sheathing, split open and flat, brown; **fruits** globose, to 0.8 cm diameter, yellowish or brown.

Distribution and habitat. Cambodia and southern Laos (also in Bangladesh, Bhutan, China, India, Myanmar, Thailand, Peninsular Malaysia) in lowland evergreen and montane forest, savannah woodland, mixed deciduous forest, and in disturbed places, especially roadsides, to 1,200 m elevation, rarely more.

Flowering and fruiting. Flowers December.

Uses. Provides a good quality cane used in basket making and furniture making.


Đảo Phú Quốc
Đảo Côn Sơn
50 100 200 Km

Calamus harmandii Pierre

Local names. *Nya seui, yeu mo (Lao).*

Description. Stems solitary, non-climbing, free-standing, to 1.8 m long and 4 cm diameter. **Leaf sheaths** open, green with rings of yellowish, flattened, to 3 cm long spines; **ocreas** present, prominent, spiny; **knees** absent; **flagella** absent; petioles to 85 cm long, with groups of yellow spines; **rachis** to 1 m long with 27-37, linear leaflets per side, these regularly arranged; **cirri** absent. **Inflorescences** to 1.8 m long, erect, not flagellate; bracts split, open and tattering at the apices; partial inflorescences branched (the females appearing unbranched); **fruits** globose-ellipsoid, to 1.2 cm long and 0.9 cm diameter, brown.

Distribution and habitat. Southern Laos (Phou Lefkay Conservation Forest) in lowland deciduous forest at 200-300 m elevation.

Flowering and fruiting. Flowers May; fruits February, May, June.

Uses. The fruits are eaten, the stems used as tool handles, and the leaves for thatching.


Đảo Phú Quốc
Đảo Côn Sơn
50 100 200 Km

Calamus henryanus Becc.

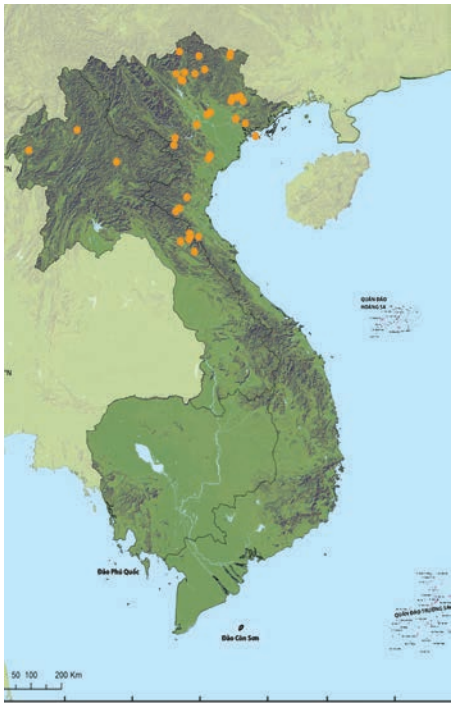
Local names. *Wai namlee, wai hangnou, wai khairp, bong knair (Lao); mây hồng, mây mật, mây nếp, mây tắt (Vie).*

Description. Stems clustered, climbing, to 20 m long and 1.8 cm diameter. **Leaf sheaths** green, mottled with reddish brown hairs, with scattered to densely arranged, yellowish, flattened, triangular, to 2.5 cm long spines; **ocreas** very small, sometimes spiny; **knees** prominent; **flagella** present, to 4 m long; petioles to 55 cm long; **rachis** to 1.3 m long with 29-45, linear leaflets per side, these regularly arranged, or often regularly arranged but with gaps, not bristly or bristly on upper surface veins; **cirri** absent. **Inflorescences** to 4.5 m long, flagellate; bracts splitting and tattering at apices; **fruits** globose to ellipsoid, to 1.5 cm long and 1 cm diameter, yellowish-brown.

Distribution and habitat. Northern Laos and Northern and central Vietnam (also in China, Myanmar and Thailand) in lowland evergreen or montane forest, savannah wooldand, or secondary forest at 100-800 m elevation.

Flowering and fruiting. Flowers February, April-May, July, October, December; fruits October.

Uses. Provides a medium quality cane used in furniture making.


Đảo Phú Quốc
Đảo Côn Sơn
50 100 200 Km

Calamus kampucheaensis Henderson & Khou Eang Hourt

Local names. *Phdao banla dang penh (Cam).*

Description. Stems clustered, non-climbing, free-standing or leaning over and rooting, to 2 m long and 2.5 cm diameter. **Leaf sheaths** open, green with rings of flat, brown, to 6 cm long spines, interspersed with shorter spines; **ocreas** present, prominent, to 20 cm long; **knees** absent; **flagella** absent; petioles to 70 cm long, with groups of brown spines; **rachis** to 0.4 m long with 77-98, linear leaflets per side, these regularly arranged; **cirri** absent. **Inflorescences** to 1.0 m long, erect, not flagellate; bracts split, open and tattering at the apices; partial inflorescences unbranched (sometimes young plants forming at inflorescence apices); **fruits** not known at maturity.

Distribution and habitat. Cambodia in Cardamon mountains (Pursat, Kampong Speu, Koh Kong provinces) in montane forest on mountain tops at 1,200 m or more elevation.

Flowering and fruiting. Flowering February.

Uses. Not recorded.


Đảo Phú Quốc
Đảo Côn Sơn
50 100 200 Km

Calamus kontumensis Henderson, N. K. Ban & N. Q. Dung

Local names. *Mây rắt, măng la (Vie).*

Description. Stems clustered, climbing, to 3 m long and 0.9 cm diameter. **Leaf sheaths** green or brown, with scattered, yellowish, black-tipped, flattened, to 1 cm long spines, sometimes spines absent; **ocreas** short, not spiny; **knees** present; **flagella** to 0.2 m long; petioles to 15 cm long; **rachis** to 0.3 m long with 5-6, lanceolate leaflets per side, these in distinct clusters, the apical pair briefly joined at their bases, not bristly; **cirri** absent. **Inflorescences** to 0.5 m long, briefly flagellate; bracts splitting to the base, tattering; **fruits** globose, to 0.7 cm diameter, brown.

Distribution and habitat. Central Vietnam in Kon Tum (Kon Plong District) in montane forest at 1,100-1,200 m elevation.

Flowering and fruiting. Fruits April.

Uses. Not recorded.


Đảo Phú Quốc
Đảo Côn Sơn
50 100 200 Km

Calamus laoensis T. Evans, K. Sengdala, O. Viengkham, B.Thammavong & J.Dransf.

Local names. *Wai leum, wai katok, wai wa, wai keyomee (Lao).*

Description. Stems clustered, climbing, to 40 m long and 5 cm diameter. **Leaf sheaths** dark green with brown hairs, with densely arranged, brown, black-tipped, flattened, triangular, to 6 cm long spines, interspersed with many small spines; **ocreas** present, spiny; **knees** present; **flagella** present, elongate; petioles to 35 cm long, with whorls of pale spines; **rachis** to 2 m long with to 50, lanceolate leaflets per side, these clustered in groups of 2-5 and spreading in different planes, whitish on lower surfaces; **cirri** absent. **Inflorescences** to 10 m long, flagellate; bracts tubular, split, open and spreading at the apices; **fruits** ellipsoid, to 2 cm long and 1.2 cm diameter, brown.

Distribution and habitat. Central Laos in lowland evergreen forest at low elevations.

Flowering and fruiting. Flowers June; fruits January, June (said to produce fruits twice a year, in January and August).

Uses. Provides a cane used in furniture making and basket making; locally considered third in quality after *C. poilanei* and *C. rudentum.*


Đảo Phú Quốc
Đảo Côn Sơn
50 100 200 Km

Calamus lateralis Henderson, N. K. Ban & N. Q. Dung

Local names. *Mây tù, mây xanh (Vie).*

Description. Stems solitary, climbing, to 70 m long and 5.5 cm diameter. **Leaf sheaths** green, with early deciduous, dark-brown hairs, without spines or with a few, hooked, to 1 cm long spines; **ocreas** absent; **knees** prominent; flagella present, to 5 m long; petioles to 25 cm long; **rachis** to 1.4 m long with 39-51, lanceolate leaflets per side, these regularly arranged, conspicuously bristly on upper surface lateral veins; **cirri** absent. **Inflorescences** to 2.8 m long, flagellate (male ones not flagellate); bracts tubular; **fruits** ellipsoid, to 3.5 cm long and 2 cm diameter, orange to red.

Distribution and habitat. Cambodia in Mondulkiri (Seima Biodiversity Conservation Area) and Southern Vietnam in Dong Nai (Cat Tien N. P.) in lowland evergreen or semi-evergreen forest at 150-250 m elevation.

Flowering and fruiting. Fruits May.

Uses. Provides a high quality cane used in furniture making in Vietnam, but reported not to be useful in Cambodia (Khou Eang Hourt, 2008).


Đảo Phú Quốc
Đảo Côn Sơn
50 100 200 Km

Calamus mellitus Henderson & Khou Eang Hourt

Local names. *Toek khmum, phdao toekkhmun (Cam).*

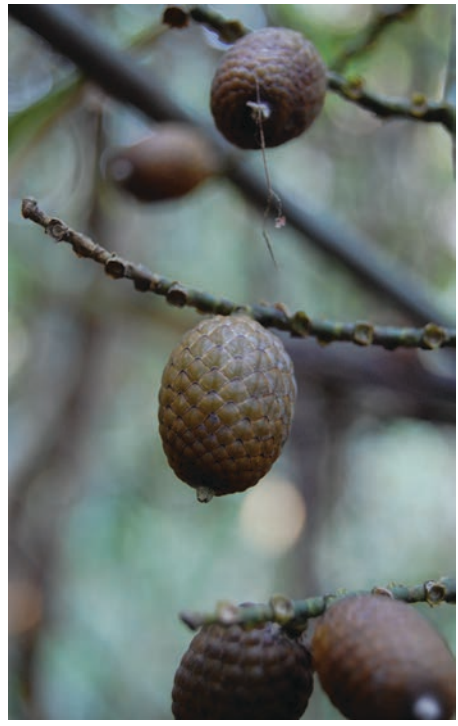
Description. Stems clustered, forming dense clumps on exposed root masses, climbing, to 100 m long and 2.5 cm diameter. **Leaf sheaths** green, mottled with dark and whitish-brown hairs, sparsely covered with short, swollen-based spines to 0.5 cm long; **ocreas** present, scarcely developed; **knees** present; **flagella** present; petioles to 10 cm long; **rachis** to 34 cm long with 25-27, linear leaflets per side, these regularly arranged; **cirri** absent. **Inflorescences** to 2 m long, flagellate; inflorescences bracts tubular; **fruits** ellipsoid, to 2 cm long and 1.5 cm diameter, orange-brown.

Distribution and habitat. Cambodia (Cardamom mountains in Battambang and Pursat) in lowland evergreen and montane forest at 200-927 m elevation.

Flowering and fruiting. Fruits February.

Uses. Provides a high quality cane used in furniture making.


Đảo Phú Quốc
Đảo Côn Sơn
50 100 200 Km



Calamus minor Henderson

Local names. *Wai deng, wai kamlao (Lao).*

Description. Stems clustered, climbing, to 3 m long and 1 cm diameter. **Leaf sheaths** greenish-yellow, sparsely covered with brown, black-tipped, flattened, horizontally or upward spreading spines to 1.4 cm (sometimes to 2.5 cm at sheath apices) long; **ocreas** present, fibrous, disintegrating; knees present; **flagella** absent or rarely present; petioles to 10 cm long; **rachis** to 0.7 m long with 5-6, lanceolate leaflets per side, these regularly but distantly arranged, gray on the lower surfaces, the apical pair briefly joined at their bases; **cirri** absent. **Inflorescences** to 0.4 m long, briefly or not flagellate; inflorescences bracts open and not sheathing; **fruits** not known.

Distribution and habitat. Northern Laos in savannah woodland or bamboo forest at 140-160 m elevation.

Flowering and fruiting. Flowers January.

Uses. The shoots are edible and the canes used for handicrafts.

Notes. This species was referred to as *Calamus hypoleucus* (Kurz) Kurz by Evans et al. (2001).


Đảo Phú Quốc
Đảo Côn Sơn
50 100 200 Km

Calamus modestus T. Evans & T. P. Anh

Local names. *Hèo đá, mây, song đá (Vie).*

Description. Stems clustered, non-climbing, free-standing, to 4 m long and 2.5 cm diameter. **Leaf sheaths** green or brown, with rows of black, flattened, to 2.5 cm long spines borne on ridges, interspersed with shorter spines; **ocreas** prominent, spiny; **knees** absent; **flagella** absent; petioles to 40 cm long; **rachis** to 0.8 m long with 23-34, linear leaflets per side, these regularly arranged but sometimes with gaps, bristly on margins and upper surface veins; **cirri** absent. **Inflorescences** to 0 .5 m long, not flagellate, erect; bracts splitting and tattering; **fruits** ovoid, to 1.5 cm long and 0.6 cm diameter, orange-brown.

Distribution and habitat. Central Vietnam near Da Nang City (Ba Na-Nui Chua N. R.) and Kon Tum (Ngoc Linh N. R., Dak Gley District), and probably adjacent Laos, in montane forest at 1,100-1,300 m elevation.

Flowering and fruiting. Flowers March-July, November; fruits January.

Uses. Not recorded.


Đảo Phú Quốc
Đảo Côn Sơn
50 100 200 Km

Calamus nambariensis Becc.

Local names. *Wai nwn, wai niuw, wai nokkhor, wai namleuang, kateng blor (Lao); song mật, mây song, song (Vie).*

Description. Stems solitary or clustered, climbing, to 35 m long and 5 cm diameter. **Leaf sheaths** green, yellowish, or reddish-brown, with densely arranged, yellowish-brown, triangular, flattened, downward-pointing, to 5 cm long spines, often interspersed amongst many shorter spines; **ocreas** small, non-spiny; **knees** prominent; **flagella** absent; petioles short or absent; **rachis** to 3.3 m long with 13-36, lanceolate leaflets per side, these irregularly or regularly arranged, sometimes in distant clusters, bristly along the margins; **cirri** present, to 1.6 m long. **Inflorescences** to 2 m long, not flagellate; bracts tubular; **fruits** borne on short stalks, globose to ovoid or ellipsoid, to 2.4 cm long and 2.5 cm diameter, whitish, with channeled scales.

Distribution and habitat. Northern and central Laos and central and Northern Vietnam (also in Bangladesh, Bhutan, China, Northeastern India, Myanmar, Nepal, and Thailand) in lowland evergreen or montane forest at 100-1,500 m elevation.

Flowering and fruiting. Flowers in March-May; fruits in July, September-November.

Uses. Provides a high quality cane used in furniture making and binding; sometimes planted.

Notes. A very variable species, particularly in leaflet size and arrangement, and not easy, without fruits, to distinguish from *Calamus palustris*.


Đảo Phú Quốc
Đảo Côn Sơn
50 100 200 Km

Calamus oligostachys T. Evans, K. Sengdala, O. Viengkham, B. Thammavong & J. Dransf.

Local names. *Wai kating (Lao).*

Description. Stems clustered, climbing, to 7 m long and 1 cm diameter. **Leaf sheaths** green with scattered, brown, needle-like, to 0.7 cm long spines; **ocreas** present; **knees** present; **flagella** present, to 1.8 m long; petioles to 10 cm long; **rachis** to 0.6 m long with 5-9, elliptic leaflets per side, these clustered, the apical ones close together in a fan shape, the apical pair joined at their bases; **cirri** absent. **Inflorescences** to 2.2 m long, flagellate, the first partial inflorescence not or scarcely branched; bracts tubular; **fruits** globose, to 0.7 cm diameter, yellowish.

Distribution and habitat. Central Laos (also in Thailand) in lowland evergreen forest at low elevations.

Flowering and fruiting. Not recorded.

Uses. Provides a cane used in making handicrafts.


Đảo Phú Quốc
Đảo Côn Sơn
50 100 200 Km

Calamus palustris Griff.

Local names. *Phdao chhveang, kbang, kantrong, ta-uonh (Cam); wai hangnou, wai namleuang, wai khairt, wai kiyow, wai hom, wai namhang, wai tiukeng, wai savang, wai sard, wai kanebouang, re tair (Laos); mây tầu, song, song cật, song mây (Vie).*

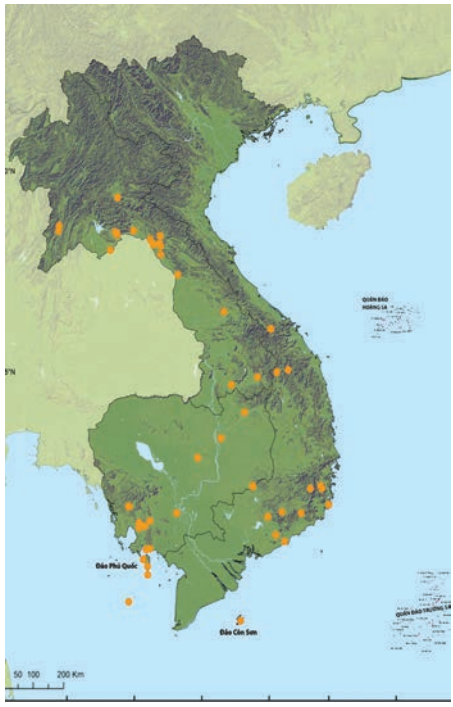
Description. Stems clustered, climbing, to 30 m long and 3 cm diameter. **Leaf sheaths** green, mottled with whitish or brownish hairs, with scattered, reddish-brown, to 5 cm long spines, these often curving downwards, interspersed amongst many smaller spines; **ocreas** small, not spiny; **knees** prominent; **flagella** absent; petioles short or to 30 cm long, flat and spiny on upper surfaces; **rachis** to 1.7 m long with 16-20, broadly lanceolate leaflets per side, these irregularly arranged (rarely regularly), usually in distant, alternate clusters of 2-4 leaflets, minutely bristly along the margins; **cirri** present, to 2 m long. **Inflorescences** to 1.3 m long, not flagellate, erect; bracts tubular; **fruits** not borne on short stalks, ellipsoid to ovoid, to 1.2 cm long and 1 cm diameter, yellowish, with a pronounced nipple at the tip and flattened perianth at the base, the scales not channeled.

Distribution and habitat. Cambodia, Laos, and Southern and central Vietnam (also in Andaman Islands, Myanmar, Thailand, and Peninsular Malaysia) in lowland evergreen or montane forest, disturbed areas, and sometimes by villages, at 150-1,900 m elevation.

Flowering and fruiting. Flowers October-December; fruits May.

Uses. Provides a good quality cane used in furniture making, and the palm hearts are eaten.

Notes. A very variable species, particularly in leaflet size and arrangement, and not easy, without fruits, to distinguish from *Calamus nambariensis.*


Đảo Phú Quốc
Đảo Côn Sơn
50 100 200 Km

Calamus parvulus Henderson & N. Q. Dung

Local names. *Mây chỉ, mây rắt chỉ (Vie).*

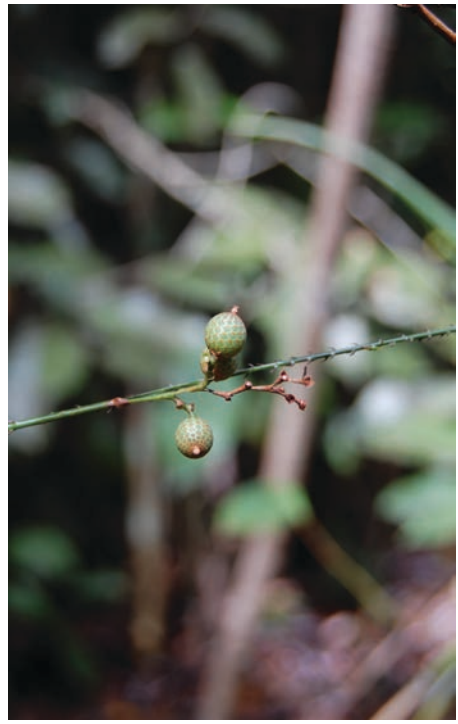
Description. Stems clustered, climbing, to 10 m long and 0.4 cm diameter. **Leaf sheaths** green with scattered brown hairs, with few, recurved, to 0.2 cm long spines; **ocreas** small, not spiny; **knees** present; **flagella** present, to 60 cm long; petioles to 3 cm long; **rachis** to 19 cm long with 2-3, linear-lanceolate leaflets per side, the apical ones joined for ca. one third their length, not bristly; **cirri** absent. **Inflorescences** to 0.4 m long, arching, flagellate; bracts tubular; **fruits** globose, to 1 cm diameter, greenish.

Distribution and habitat. South-central Vietnam in Khanh Hoa (Khanh Vinh District) in primary, evergreen forest at 300-400 m elevation.

Flowering and fruiting. Flowers April-May; fruits April-May.

Uses. Provides a high quality cane used in basket making and tying.


Đảo Phú Quốc
Đảo Côn Sơn
50 100 200 Km



Calamus phuocbinhensis Henderson & N. Q. Dung

Local names. *Mây, mây cát (Vie).*

Description. Stems clustered, climbing, to 15 m long and 2.1 cm diameter. **Leaf sheaths** green with scattered, brown, to 1.5 cm long spines; **ocreas** present; **knees** present; **flagella** present, to 1.7 m long; petioles to 24 cm long; rachis to 1.3 m long with 44-45, linear leaflets per side, these irregularly arranged in clusters and spreading in different planes; **cirri** absent. **Inflorescences** and **fruits** not recorded.

Distribution and habitat. Southern Vietnam in mixed deciduous forest at 300 m elevation.

Flowering and fruiting. Not recorded.

Uses. Not recorded.


Đảo Phú Quốc
Đảo Côn Sơn
0 50 100 200 Km

Calamus poilanei Conrard

Local names. *Wai thoon, blong thoon, gapari (Lao); song, song bột (Vie).*

Description. Stems solitary, climbing, to 150 m long and 7.5 cm diameter. **Leaf sheaths** green or yellowish with patches or stripes of brown hairs, with scattered, greenish, flattened, triangular, to 3.5 cm long spines (sometimes spines absent); **ocreas** small, not spiny; **knees** prominent; **flagella** present, to 6 m long; petioles to 60 cm long; **rachis** to 3.4 m long with 40-50, linear leaflets per side, these regularly arranged, conspicuously bristly on veins of upper and lower surfaces; cirri absent. **Inflorescences** to 6 m long, flagellate; bracts tubular; **fruits** ellipsoid, to 2 cm long and 1.4 cm diameter, orange-brown.

Distribution and habitat. Northern and central Laos and central and Southern Vietnam (also in Thailand) in lowland evergreen or montane forest at 100-1,200 m elevation.

Flowering and fruiting. Fruits August-November.

Uses. Provides a high quality, large diameter cane used in furniture making.


Đảo Phú Quốc
Đảo Côn Sơn
50 100 200 Km

Calamus quangngaiensis Henderson & N. Q. Dung

Local names. *Mây rắt quảng ngãi (Vie).*

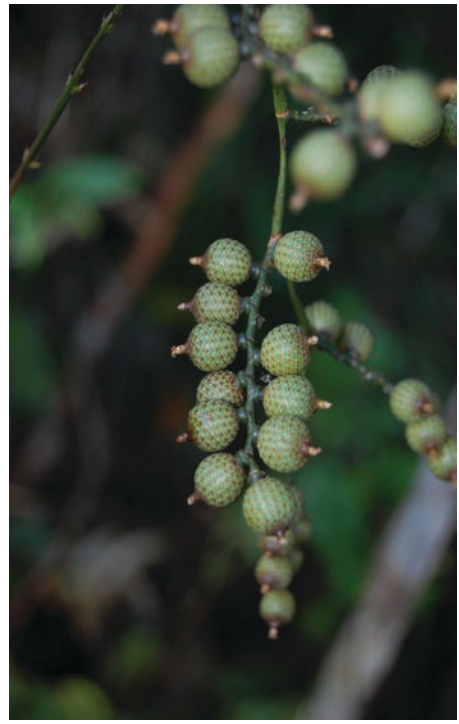
Description. **Stems** clustered, climbing, to 4 m long and 1.5 cm diameter. **Leaf sheaths** densely brown tomentose with dense, greenish-yellow, flat, to 1.2 cm long spines; **ocreas** present; **knees** present; **flagella** present; petioles to 44 cm long; **rachis** to 0.5 m long with 11-13, lanceolate leaflets per side, these regularly arranged and spreading in the same plane; **cirri** absent. **Inflorescences** to 1.5 m long, flagellate; bracts tubular; **fruits** globose to ellipsoid, to 0.8 cm diameter, greenish.

Distribution and habitat. Central Vietnam in secondary, lowland evergreen forest at 600 m elevation.

Flowering and fruiting. Flowers July, September; fruits April.

Uses. Provides a medium quality cane.


Đảo Phú Quốc
Đảo Côn Sơn
0 50 100 200 Km



Calamus rhabdocladus Burret

Local names. *Wai wan, boun wan, wai bounwan, wai bounyong, blong salay (Lao); hèo, mây, mây cuống, mây đắng, mây gồ, song đen, mây thuấn, r'sui (Vie).*

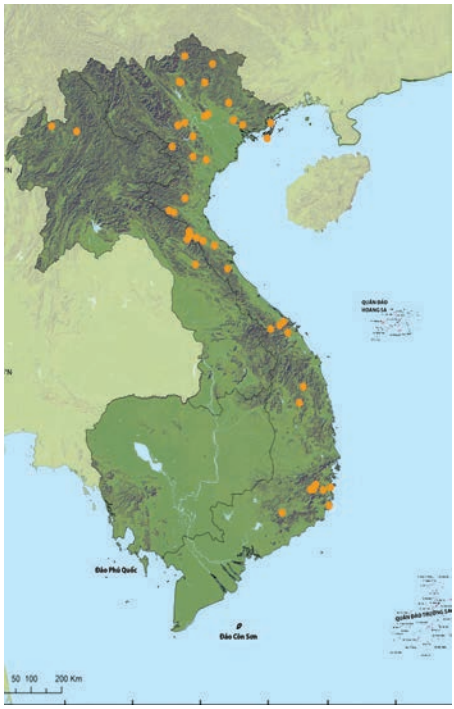
Description. **Stems** clustered, climbing (sometimes only shortly climbing or free-standing), to 40 m long and 10 cm diameter. **Leaf sheaths** green, yellowish-green, or reddish-brown, with densely arranged, oblique rows of glossy, black or brown, flattened, to 4 cm long (to 10 cm long at sheath apices) spines; **ocreas** elongate, with rows of spines, bristly at the apices; **knees** inconspicuous or absent; **flagella** present, to 5 m long; petioles to 80 cm long; with rings of spines on upper surfaces; **rachis** to 2.7 m long with 27-74, linear leaflets per side, these regularly arranged and spreading in the same plane (young plants regularly arranged but with gaps, rarely plants with irregularly arranged leaflets spreading in different planes), bristly on veins of upper and lower surfaces; cirri absent. **Inflorescences** to 10 m long, flagellate; bracts tubular; **fruits** globose, ellipsoid, or ovoid, to 1.4 cm long and 0.8 cm diameter, reddish or yellowish.

Distribution and habitat. Northern and central Laos and Vietnam (also in China) in lowland evergreen or montane forest at 20-1,850 m elevation.

Flowering and fruiting. Flowers April-May; fruits April-May, July, October-November.

Uses. Provides a medium quality cane used for furniture making, and the palm hearts and fruits are eaten.

Notes. A widespread and extremely variable species; some forms have irregularly arranged leaflets and some flower when still erect and non-climbing (e.g., in Tam Dao N. P.).


Đảo Phú Quốc
Đảo Côn Sơn
50 100 200 Km

Calamus rudentum Lour.

Local names. *Phdao dambang (Cam); boun, wai boun, boun khao, wai tabong wai tabong, boun waan (Lao); song đá, mây ngọt (Vie).*

Description. Stems clustered, climbing (sometimes non-climbing), to 75 m long and 7 cm diameter. **Leaf sheaths** split open, not tubular, yellowish-green or brown, with densely arranged rows of yellowish to black, flattened, to 6 cm long (to 15 cm long at sheath apices) spines, the rows borne on ridges interspersed amongst many, shorter, needle-like spines; **ocreas** short, spiny; **knees** inconspicuous or absent; **flagella** present, to 10 m long; petioles to 60 cm long, the upper surfaces without spines, deeply channeled; **rachis** to 3 m long with 45-50, lanceolate leaflets per side, these regularly or irregularly arranged, conspicuously bristly along the margins; **cirri** absent. **Inflorescences** to 10 m long, flagellate; bracts tubular; **fruits** globose-ellipsoid, to 2 cm long and 1.5 cm diameter, yellowish.

Distribution and habitat. Cambodia, Southern Laos, and Southern Vietnam in Vung Tau (Con Dao), Dong Nai (Cat Tien N. P.), Binh Thuan (Ta Kou N. R.), Quang Nam (Song Thanh N. R.), and Phu Yen (Krong Trai N. R.) (also in Myanmar and Thailand) in lowland evergreen and secondary forest at 150-412 m elevation.

Flowering and fruiting. Flowers March; fruits May-July.

Uses. Provides a high quality cane used in furniture making.


Đảo Phú Quốc
Đảo Côn Sơn
50 100 200 Km

Calamus salicifolius Becc.

Local names. *Lpeak ropeak (Cam); mây lá liễu (Vie).*

Description. Stems clustered, non-climbing, free-standing or scrambling, to 6 m long (usually less) and 0.8 cm diameter. **Leaf sheaths** green, with scattered, bulbous-based, black spines to 1 cm long, occasionally without spines; **ocreas** small, minutely spiny; **knees** present; **flagella** sometimes present but very short; petioles short or absent; **rachis** to 0.4 m long with to 15, very small, lanceolate leaflets per side, these strongly clustered and spreading in different planes, the apical ones smaller still, light gray-green on the lower surfaces, bristly on veins; **cirri** absent. **Inflorescences** to 0.3 m long, not flagellate; bracts split open and briefly spreading at the apices; **fruits** globose, to 1 cm diameter, yellowish-brown.

Distribution and habitat. Cambodia and Southern Vietnam often along margins of rice fields and open areas, especially in Tonle Sap floodplain and margins of the Mekong and its tributaries at low elevations.

Flowering and fruiting. Flowers February; fruits February-March.

Uses. Provides a good quality cane used in handicrafts and basket making.


Đảo Phú Quốc
Đảo Côn Sơn
50 100 200 Km

Calamus seriatus Henderson & N. Q. Dung

Local names. *Mây cám , mây rắc (Vie).*

Description. Stems clustered, climbing, to 10 m long and 1.8 cm diameter. **Leaf sheaths** green with reddish-brown hairs, densely covered with yellowish-green, to 1.5 cm long (to 4 cm long at the sheath apices) spines, forming rows on either side of sheath apices and petiole bases; **ocreas** scarcely developed; knees absent; **flagella** present, to 60 cm long; petioles to 30 cm long; **rachis** to 70 cm long with 8-14, linear-lanceolate leaflets per side, these arranged in two or three distant groups, the apical pair joined for one third to one half their length, not bristly; **cirri** absent. **Inflorescences** to 0.7 m long, arching, flagellate; bracts tubular; **fruits** globose, to 1 cm diameter.

Distribution and habitat. South-central Vietnam in Khanh Hoa (Hon Ba N. R. and Khanh Vinh District) in primary, lowland evergreen or montane forest at 500-910 m elevation.

Flowering and fruiting. Fruits May, July.

Uses. Provides a medium quality cane used in basket making.


Đảo Phú Quốc
Đảo Côn Sơn
50 100 200 Km

Calamus siamensis Becc.

Local names. *Phdao toek (Cam); wai khom, wai nam, wai deng, yo, re dark (Lao).*

Description. Stems clustered, often forming thickets, climbing, to 25 m long and 2 cm diameter. **Leaf sheaths** green, with brown hairs, with scattered, brown, flattened, to 4.5 (sometimes a few spines -7 at sheath apices) cm long spines, interspersed among shorter spines; **ocreas** present, inconspicuous; **knees** present; **flagella** present, to 3 m long; petioles to 20 cm long; **rachis** to 1.5 m long with 30-50, linear leaflets per side, these regularly arranged, sometimes with gaps; **cirri** absent. **Inflorescences** to 2.5 m long, flagellate; bracts tubular; **fruits** globose, 0.8 cm diameter, whitish or yellowish, sometimes borne in pairs.

Distribution and habitat. Cambodia and Southern Laos, and probably just reaching Vietnam (also in Thailand, Peninsular Malaysia, and probably Myanmar) in lowland evergreen forest, savannah woodland, or disturbed areas, at low elevations.

Flowering and fruiting. Flowers May; fruits July.

Uses. Provides a cane for use in furniture making; planted in Laos for its palm heart.


Đảo Phú Quốc
Đảo Côn Sơn
50 100 200 Km

Calamus solitarius T. Evans, K. Sengdala, O. Viengkham, B. Thammavong & J. Dransf.

Local names. *Wai thork, wai yong, wai hakyong, wai savang (Lao).*

Description. Stems solitary, climbing, to 50 m long and 1.5 cm diameter. **Leaf sheaths** green with gray hairs, with scattered to densely arranged, green, needle-like, to 2 cm long spines; **ocreas** present; **knees** present; **flagella** present, to 1 m long; petioles short or absent; **rachis** to 0.9 m long with 9-14, elliptic leaflets per side, these distinctly clustered, the apical ones close together in a fan shape, the apical pair joined at their bases; **cirri** absent. **Inflorescences** to 5 m long, flagellate; bracts tubular; **fruits** globose, to 0.8 cm diameter, yellowish.

Distribution and habitat. Central Laos (and also in Thailand) in lowland evergreen forest at low elevations.

Flowering and fruiting. Not recorded.

Uses. Provides a high quality cane used in furniture making and basket making.


Đảo Phú Quốc
Đảo Côn Sơn
50 100 200 Km

Calamus spiralis Henderson, N. K. Ban & N. Q. Dung

Local names. *Mây cám mỡ (Vie).*

Description. Stems clustered, climbing, to 15 m long and 0.7 cm diameter. **Leaf sheaths** green or gray, sparsely covered with bulbous-based groups of 3, black spines to 0.3 cm long, these longer at sheath apices; **ocreas** present, bristly; **knees** present; **flagella** present; petioles short or absent; **rachis** to 0.2 m long with 3, linear-lanceolate leaflets per side, the basal pair swept back across the sheaths, not bristly; **cirri** present, to 0.6 m long. **Inflorescences** to 0.4 m long, not flagellate; bracts tubular; **fruits** ellipsoid, 2.3 cm long and 1.4 cm diameter, reddish-brown.

Distribution and habitat. Central Vietnam in Thua Thien-Hue (Bach Ma N. P. and adjacent areas) in lowland evergreen forest at 400 m elevation.

Flowering and fruiting. Flowers April; fruits April-May.

Uses. Provides a good quality cane used for tying.


Đảo Phú Quốc
Đảo Côn Sơn
50 100 200 Km

Calamus tenuis Roxb.

Local names. *Wai nyair, nyair (Lao), mái, mây nước (Vie).*

Description. **Stems** clustered, often forming thickets, climbing, to 20 m long and 2.5 cm diameter. **Leaf sheaths** green with brownish-white hairs, often with ridges, with scattered or rows of greenish-brown or black, flattened, to 2 cm long spines, with oblique, crescent-shaped bases and hairy margins; **ocreas** present, very small and papery; **knees** present; **flagella** present, to 2.5 m long; petioles to 25 cm long; **rachis** to 1 m long with 31-42, linear or linear-lanceolate leaflets per side, these regularly and closely arranged; **cirri** absent. **Inflorescences** to 2.5 m long, flagellate; bracts tubular; **fruits** globose to ellipsoid, to 1.6 cm long and 1.2 cm diameter, whitish or yellowish-brown.

Distribution and habitat. Central Laos and possibly Northern Vietnam (also in Bangladesh, Bhutan, India, Nepal, Myanmar, Thailand, Java, and Sumatra) in lowland evergreen forest, in swampy or flooded areas, often cultivated or persisting near villages, to 300 m elevation.

Flowering and fruiting. Fruits April, May.

Uses. Provides a medium quality cane used in basket making and weaving; planted in Laos for its palm heart.


Đảo Phú Quốc
Đảo Côn Sơn
50 100 200 Km

Calamus tetradactylus Hance

Local names. *Sae soeng, phdao changret, phdao lpeak, hapeak (Cam); wai hangnou, wai hangnou nyai, wai savang, kacek doikanair, re peu (Lao); mây nếp, mây tắt, mây ruột gà (Vie).*

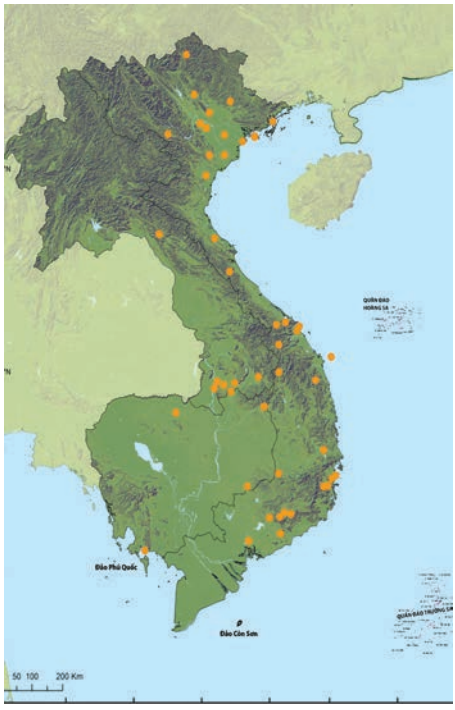
Description. Stems clustered, climbing, to 6 m long and 1.8 cm diameter. **Leaf sheaths** green with light brown or gray hairs, with scattered, ellowish-brown, triangular, to 1.5 cm long spines, or spines absent; **ocreas** prominent, brown, membranous, not spiny; **knees** present; **flagella** present, to 1 m long; petioles to 50 cm long, usually short; **rachis** to 0.7 m long with 8-22, elliptic leaflets per side, arranged in distant clusters, the apical ones close together in a fan shape, the apical pair joined at their bases, sometimes grayish on the lower surfaces, minutely bristly along the margins; **cirri** absent. **Inflorescences** to 1.8 m long, usually flagellate; bracts tubular; **fruits** borne on short stalks, globose, to 0.9 cm diameter, yellowish.

Distribution and habitat. Cambodia, Laos, and Vietnam (also in China and Thailand) in lowland evergreen forest, savannah woodland, disturbed places, and often planted in hedges, at 20-544 m elevation.

Flowering and fruiting. Flowers March-July, October-November; fruits March, May-July.

Uses. Provides a high quality cane used in weaving and basket making.

Notes. A variable species; plants from the southern part of Vietnam in Binh Thuan, Dong Nai, and Lam Dong have leaflets which are grayish on the lower surfaces; a plant from Kon Tum has long, narrow spines at the sheath apices.


Đảo Phú Quốc
Đảo Côn Sơn
50 100 200 Km

Calamus thysanolepis Hance

Local names. *Mây tua (Vie).*

Description. Stems clustered, non-climbing, short and subterranean or free-standing, to 5 m long and 5 cm diameter. **Leaf sheaths** greenish-brown, with densely arranged, black, needle-like, to 2 cm long spines; **ocreas** to 40 cm long, spiny, fibrous and soon tattering; **knees** absent; **flagella** absent; petioles to 80 cm long; **rachis** to 1.5 m long with 28-49, lanceolate leaflets per side, these strongly clustered and spreading in different planes; **cirri** absent. **Inflorescences** to 1 m long, erect, not flagellate; bracts split open and tattering; **fruits** ovoid or ellipsoid, to 1.5 cm long and 1 cm diameter, reddish-brown.

Distribution and habitat. Northern Vietnam in Thanh Hoa (also in China).

Flowering and fruiting. Not recorded.

Uses. The fruits are eaten.

Notes. The only record for Vietnam is a historical one and the species has not been recorded there for many years.


Đảo Phú Quốc
Đảo Côn Sơn
50 100 200 Km

Calamus viminalis Willd.

Local names. *Phdao krek, phdao kok, phdao lving, traes sor, phdao kantel (Cam); wai ton, wai nyair, wai na, wai khom (Lao); mây cát, song cát (Vie).*

Description. Stems clustered, climbing or often forming thickets, to 35 m long and 4 cm diameter. **Leaf sheaths** green, with grayish or brownish hairs, with scattered, greenish or brownish, triangular, flattened, to 4.5 cm long spines, rarely spines absent; **ocreas** short, membranous, not spiny; **knees** present; **flagella** present, to 5 m long; petioles to 30 cm long; **rachis** to 1.3 m long with 32-55, lanceolate leaflets per side, these gray-green, distinctly clustered and spreading in different planes, the apical ones usually smaller than the others, bristly along the margins; **cirri** absent. **Inflorescences** to 3 m long, flagellate, bracts tubular; **fruits** globose, to 1 cm diameter, whitish or yellowish.

Distribution and habitat. Cambodia, Laos, and Vietnam (also in Andaman Islands, Bangladesh, China, India, Myanmar, Thailand, Bali, Java, and Peninsular Malaysia) in lowland evergreen or deciduous forest, persisting in cleared areas, at 20-500 m elevation.

Flowering and fruiting. Flowers May, August-October; fruits March, April, June.

Uses. Provides a good quality cane used in basket making and furniture making; palm hearts eaten in Laos; fruits edible. Often planted.

Notes. A very common and widespread species.


Đảo Phú Quốc
Đảo Côn Sơn
50 100 200 Km

Calamus walkeri Hance

Local names. *Mây đắng, mây đót (Vie).*

Description. Stems clustered, climbing, to 15 m long and 4 cm diameter. **Leaf sheaths** green with gray-brown hairs, with scattered, yellowish, black-tipped, flattened, to 2.5 cm long spines; **ocreas** short, densely black bristly; knees prominent; **flagella** present, to 5 m long; petioles to 60 cm long; **rachis** to 1.5 m long with 25-40, linear-lanceolate leaflets per side, these regularly arranged, upper surfaces of central and lateral veins bristly, three veins prominent on upper surfaces; **cirri** absent. **Inflorescences** to 5.5 m long, flagellate; bracts tubular; **fruits** ovoid, to 1.2 cm long and 1 cm diameter, yellowish.

Distribution and habitat. Vietnam (also in China) in lowland evergreen forest and often in disturbed places, at 200-900 m elevation.

Flowering and fruiting. Flowers March-April, July; fruits April-June.

Uses. Provides a medium quality cane.


Đảo Phú Quốc
Đảo Côn Sơn
50 100 200 Km

Calamus yentuensis Henderson & N. Q. Dung

Local names. *Mây đen, hèo đen (Vie).*

Description. Stems clustered, non-climbing, free-standing, to 1.5 m long and 1.2 cm diameter. **Leaf sheaths** green or brown, with rings of black, to 4.5 cm long spines, interspersed amongst many smaller spines; **ocreas** to 15 cm long, covered with rings of spines as the sheaths, with a tuft of brownish hairs at the apices, becoming split into two 'ears'; **knees** absent; **flagella** absent; petioles to 50 cm long; rachis to 70 cm long with about 43, linear leaflets per side, regularly arranged but with gaps, bristly on upper and lower veins; **cirri** absent. **Inflorescences** to 3 m long, flagellate, arching; bracts tubular; **fruits** globose, to 1 cm diameter, brown.

Distribution and habitat. Northern Vietnam in Quang Ninh (Yen Tu N. R.) in secondary forest at the base of Yen Tu mountain at 100 m elevation.

Flowering and fruiting. Flowers and fruits June.

Uses. Provides stems which are used in furniture making.


Đảo Phú Quốc
Đảo Côn Sơn
50 100 200 Km

Daemonorops brevicaulis Henderson & N. Q. Dung

Local names. *Mây đất (Vie).*

Description. Stems solitary, non-climbing, short and subterranean or to 4 m long and 3 cm diameter. **Leaf sheaths** brownish, with scattered, yellowish, to 11 cm long spines; **ocreas** to 4 cm long; **knees** absent; **flagella** absent; petioles to 60 cm long with rings of yellowish spines; **rachis** to 3.1 m long with to 34 linear-lanceolate leaflets per side, these regularly or slightly irregularly arranged, without bristles; **cirri** absent or very short on taller plants. **Inflorescences** to 1.2 m long, erect or curved downwards, not flagellate; bracts splitting laterally and falling; **fruits** ellipsoid, to 3.5 cm long and 2.5 cm diameter, brown.

Distribution and habitat. South-central Vietnam in Khanh Hoa (Hon Ba N. R., Khanh Vinh and Khanh Son Districts) in primary lowland evergreen and montane forest at 203-1,445 m elevation.

Flowering and fruiting. Flowers April-May; fruits May.

Uses. Not recorded.


Đảo Phú Quốc
Đảo Côn Sơn
50 100 200 Km

Daemonorops fissilis
(Henderson, N. K. Ban & N. Q. Dung) Henderson

Local names. *Mây cám (Vie).*

Description. Stems clustered, climbing, to 10 m long and 1 cm diameter. **Leaf sheaths** green with reddish-brown hairs, with reddish-brown, flattened, to 1 cm long spines, these arranged in small, horizontally spreading groups; **ocreas** short, not spiny; knees obscure; **flagella** absent; petioles short or absent; **rachis** to 0.3 m long with 9-12 linear-lanceolate leaflets per side, these regularly arranged, minutely bristly along the margins; **cirri** present, to 0.5 m long. **Inflorescences** to 0.4 m long, erect or arching, not flagellate; bracts splitting almost to their bases; **fruits** globose, 1 cm diameter, greenish-brown.

Distribution and habitat. Central Vietnam in Thua Thien-Hue (Bach Ma N. P.) and near Da Nang City (Ba Na-Nui Chua N. R.) in lowland evergreen forest at 100-800 m elevation.

Flowering and fruiting. Flowers April-May; fruits June.

Uses. Provides a medium quality cane used for tying.


Đảo Phú Quốc
Đảo Côn Sơn
50 100 200 Km

Daemonorops jenkinsiana (Griff.) Mart.

Local names. *Phdao soam (Cam); boun, boun faat, wai boun, wai boun faat, wai faat, wai keedeng, wai kwa, wai seui, blong ckik, re ya, kateng parua, khamay (Lao); mây nước, mây rừng, mây trâu, mây nước gai đen, mây nước nghé, song trâu (Vie).*

Description. Stems clustered, climbing or often forming thickets, to 15 m long and 5 cm diameter. **Leaf sheaths** yellowish-green, with gray, brown, or reddish-black hairs, with scattered or rows of black, flattened, triangular, to 4 cm long spines, interspersed amongst smaller, needle-like spines; **ocreas** obscure; **knees** present, conspicuous; **flagella** absent; petioles to 35 cm long; **rachis** to 2.3 m long with 26-89, linear leaflets per side, these regularly and closely arranged, minutely spiny on the margins and sometimes with long, yellow bristles on upper surfaces on the veins; **cirri** present, to 0.8 m long. **Inflorescences** to 0.8 m long, erect; bracts persistent, swollen, splitting lengthwise to reveal the flowering branches, eventually falling as fruits develop; **fruits** globose to ellipsoid, to 2 cm long and 2 cm diameter, yellowish-brown or orange-brown.

Distribution and habitat. Cambodia, Laos, and Vietnam (also in Bangladesh, Bhutan, China, India, Myanmar, Nepal, and Thailand) in lowland evergreen or montane forest, often persisting in disturbed areas, at 20-1,200 m elevation.

Flowering and fruiting. Flowers March-June; fruits March-May, July, September-December.

Uses. Provides a medium quality cane used in furniture making.


Đảo Phú Quốc
Đảo Côn Sơn
50 100 200 Km

Daemonorops mollispina J. Dransf.

Local names. *Mây hèo (Vie).*

Description. Stems clustered, climbing, to 8 m long and 5 cm diameter. **Leaf sheaths** brownish with densely arranged, brown, triangular, to 4.5 cm long (to 18 cm long at sheath apices) spines, these densely covered with gray or brown hairs; **ocreas** obscure; **knees** absent; **flagella** absent; petioles to 70 cm long, yellowish; **rachis** to 2.1 m long with 60-68, lanceolate leaflets per side, these regularly arranged, with few bristles along the margins; **cirri** present, to 1.5 m long. **Inflorescences** to 1 m long, arching; bracts falling from the elongating infructescence, only the basal bract persistent; **fruits** globose, to 1.5 cm diameter, brown.

Distribution and habitat. South-central Vietnam in Khanh Hoa (Hon Heo mountain) in lowland deciduous forest at 334 m elevation.

Flowering and fruiting. Fruits April, July.

Uses. Provides a medium quality cane used in furniture making.


Đảo Phú Quốc
Đảo Côn Sơn
50 100 200 Km

Daemonorops nuichuaensis
(Henderson, N. K. Ban & N. Q. Dung) Henderson

Local names. *Mây sui (Vie).*

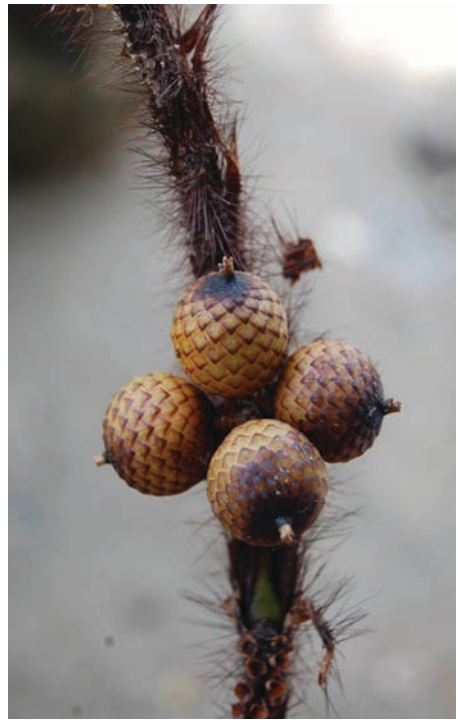
Description. Stems solitary, non-climbing, to 5 m long and 3 cm diameter. **Leaf sheaths** open, green with brown or yellowish hairs, with sparsely to densely arranged, yellowish-brown, flat, to 6 cm long spines; **ocreas** elongate, split into two 'ears'; **knees** absent; **flagella** absent; petioles to 60 cm long, yellowish; **rachis** to 1 m long with 33-36, lanceolate leaflets per side, these regularly arranged and spreading in the same plane, not bristly; **cirri** absent. **Inflorescences** 0.6-1.5 m long, arching below the leaves, not flagellate; bracts open to their bases; **fruits** globose, to 2 cm diameter, reddish-brown.

Distribution and habitat. southern Vietnam in Ninh Thuan (Nui Chua N. P.) in lowland deciduous forest on rocky, granite slopes at 650-1,000 m elevation.

Flowering and fruiting. Flowers October; fruits July, October.

Uses. Not recorded.


QUẦN ĐẢO HOÀNG SA
Đảo Phú Quốc
Đảo Côn Sơn
50 100 200 Km



Daemonorops ocreata Henderson & N. Q. Dung

Local names. *Mây giá (Vie).*

Description. Stems clustered, climbing, to 40 m long and 3.2 cm diameter. **Leaf sheaths** brown, with early deciduous whitish hairs, with densely arranged, yellowish-brown, to 6.5 cm long spines, interspersed among many smaller spines; **ocreas** to 10 cm long, brown, with fewer spines than sheaths; **knees** obscure; **flagella** absent; petioles to 60 cm long; **rachis** to 1.9 m long with about 34, linear leaflets per side of rachis, these regularly arranged, bristly along the margins; **cirri** present, to 70 cm long. **Inflorescences** to 55 cm long, erect; bracts falling from the elongating inflorescence, only the basal bract persistent; **fruits** globose, to 1.7 cm diameter, yellowish.

Distribution and habitat. South-central Vietnam in Khanh Hoa (Khanh Vinh District) in primary lowland evergreen forest at 400-500 m elevation.

Flowering and fruiting. Fruits May.

Uses. Provides a cane said to be of the same quality as *Daemonorops poilanei.*


Đảo Phú Quốc
Đảo Côn Sơn
50 100 200 Km

Daemonorops poilanei J. Dransf.

Local names. *Mây nước mỡ, mây nước gai vàng (Vie).*

Description. Stems clustered, climbing, to 20 m long and 4 cm diameter. **Leaf sheaths** yellowish-green or brown with reddish-brown hairs, with densely arranged, brown, triangular, flattened, to 4.5 cm long spines, interspersed amongst many, short, black spines; **ocreas** short, not spiny; **knees** present; **flagella** absent; petioles to 35 cm long; **rachis** to 3 m long with 35-45, linear-lanceolate leaflets per side, these regularly arranged or sometimes irregularly arranged in groups, bristly on margins and lateral veins on upper surfaces and main veins on lower surfaces; **cirri** present, to 1.5 m long. **Inflorescences** to 0.7 m long, arching; bracts falling from the elongating infructescence, only the basal bract persistent; **fruits** globose, to 2.5 cm diameter, yellowish-brown.

Distribution and habitat. Central and southern Vietnam from Ha Tinh to Khanh Hoa in lowland evergreen forest and persisting in disturbed areas at 20-579 m elevation.

Flowering and fruiting. Flowers April-May; fruits July, October-November.

Uses. Provides a good quality cane used in furniture making. Often planted.

Notes. Younger plants have more irregularly arranged leaflets, and have whorls of yellow spines on the backs of the petioles. Newly opened leaves are often reddish-brown.


Đảo Phú Quốc
Đảo Côn Sơn
50 100 200 Km

Korthalsia lacinosa (Griff.) Mart.

Local names. *Preah phdao, phdao krahorm (Cam); wai taleuk (Lao); mây rã phướn, mây tầm vông (Vie).*

Description. Stems clustered (and also branching above ground level), climbing, to 75 m long and 7 cm diameter. **Leaf sheaths** green with brown hairs, with scattered, black, triangular, to 1.9 cm long spines; **ocreas** to 20 cm long, sheathing, becoming loose and net-like in older leaves; **knees** absent; **flagella** absent; petioles to 10 cm long; **rachis** to 2 m long with 7-11, rhomboidal leaflets per side, these regularly arranged, 24-33 cm long, 11-18 cm wide, with jagged apices, silvery-gray on the lower surfaces; cirri present, to 1.2 m long. **Inflorescences** to 0.8 m long; **fruits** globose to ellipsoid, to 2 cm long and 1.5 cm diameter, brown.

Distribution and habitat. Cambodia, Laos, and Vietnam (also in Andaman and Nicobar Islands, Myanmar, Thailand, Java, Peninsular Malaysia, the Philippines, Singapore, and Sumatra) in lowland evergreen, semi-evergreen, or montane forest at 224-1,000 m elevation.

Flowering and fruiting. Fruits December.

Uses. Provides a medium quality cane used in furniture making and basket making.


Đảo Phú Quốc
Đảo Côn Sơn
0 50 100 200 Km

Korthalsia minor Henderson & N. Q. Dung

Local names. *Wai nga, wai nyeng, wai neng, detlhe (Lao); mây đùng đình, mây rã nhỏ, phướn nhỏ (Vie).*

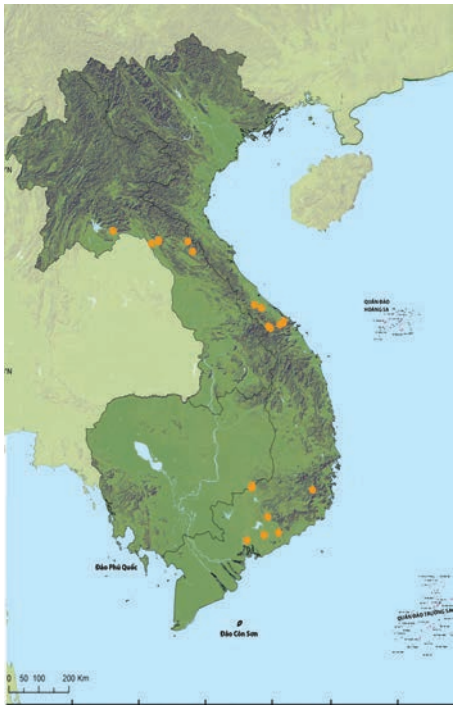
Description. Stems clustered (and also branching above ground level), climbing, to 50 m long and 2 cm diameter. **Leaf sheaths** green with brown hairs, with scattered, black, triangular, to 1 cm long spines; **ocreas** to 13 cm long, sheathing, becoming loose and net-like in older leaves; **knees** absent; **flagella** absent; petioles to 15 cm long; **rachis** to 0.5 m long with 4-8, rhomboidal leaflets per side, these regularly arranged, 17-20 cm long, 6-11 cm wide, with jagged apices, silvery-gray on the lower surfaces; **cirri** present, to 0.3 m long. **Inflorescences** to 0.4 m long; **fruits** obovoid, to 0.8 cm long and 0.7 cm diameter, yellow-brown.

Distribution and habitat. Laos and central and southern Vietnam in lowland evergreen, semi-evergreen, or montane forest at 100-892 m elevation.

Flowering and fruiting. Fruits May.

Uses. Produces a medium quality cane used in furniture making and basket making.

Notes. This species was referred to as *Korthalsia* sp. A. by Evans et al. (2001).


QUẦN ĐẢO HOÀNG SA
Đảo Phú Quốc
Đảo Côn Sơn
0 50 100 200 Km

Myrialepis paradoxa (Kurz) J. Dransf.

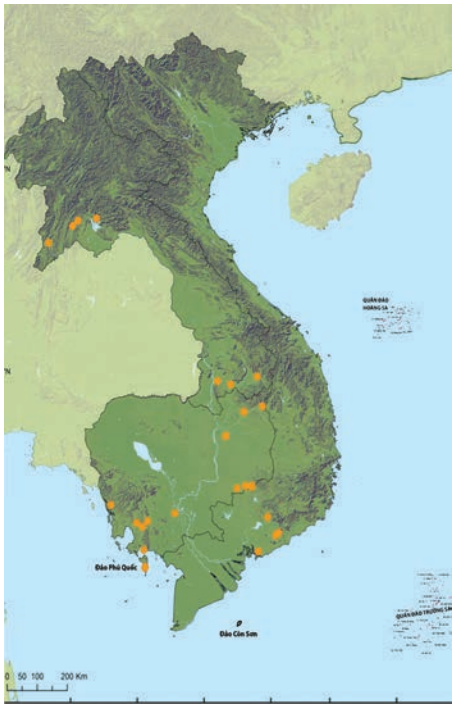
Local names. *Phdao reussey, traes chheu (Cam); wai namsay, wai deng, wai keekay, wai lao, reduln (Lao); song rúp, mây rúp (Vie).*

Description. **Stems** clustered, climbing, to 25 m long and 3.5 cm diameter. **Leaf sheaths** green with reddish-brown hairs, with short or long, oblique rows of needle-like, yellowish-brown, to 5 cm long spines; **ocreas** absent; **knees** absent; **flagella** absent; petioles to 30 cm long; **rachis** to 2.1 m long with 15-26, lanceolate leaflets per side, these irregularly arranged in clusters and spreading in different planes, sometimes with small spines on the margins; cirri present, to 1.5 m long. **Inflorescences** to 0.75 m long; fruits depressed globose, to 2.5 cm long and 3 cm diameter, greenish; **fruit** scales minute.

Distribution and habitat. Cambodia, central Laos, and Southern Vietnam in Binh Thuan (Nui Ong N. R.) and Dong Nai (Cat Tien N. P.) (also in Myanmar, Thailand, Peninsular Malaysia, Singapore, Sumatra) in lowland evergreen forest, usually at forest margins or in disturbed places at 150-224 m elevation.

Flowering and fruiting. flowers May; fruits May.

Uses. Provides a low quality cane sometimes used in basket making and furniture making.


Đảo Phú Quốc
Đảo Côn Sơn
0 50 100 200 Km

Plectocomia elongata Mart. & Blume

Local names. *Phdao reussey yeak, phdao dambang (Cam); mây tượng, song voi, song lá bạc (Vie).*

Description. Stems solitary or with basal shoots, climbing, to 50 m long and 17 cm diameter. **Leaf sheaths** green with gray hairs, with short rows of brown, needle-like, to 4 cm long spines borne in rows below the petioles and along sheath margins; **ocreas** absent; **knees** absent; **flagella** absent; petioles to 60 cm long (much shorter on older plants); **rachis** to 6.1 m long with 20-64, lanceolate leaflets per side, these clustered and spreading in different planes, grayish on the lower surfaces, with prominent sub-marginal veins and non-spiny margins; **cirri** present, to 2.5 m long. **Inflorescences** to 1 m long; flowering branch bracts to 7 cm long, with few felt-like hairs on outer surfaces; **fruits** globose, to 3 cm diameter; fruit scales reddish-brown with woolly, lacerate, erect apices.

Distribution and habitat. Cambodia and Vietnam (also in Myanmar, Thailand, Borneo, Java, Peninsular Malaysia, the Philippines, Singapore, and Sumatra) in lowland evergreen, semi-evergreen, or montane forest, often in disturbed places at 300-1,700 m elevation.

Flowering and fruiting. Fruits April.

Uses. The canes are of low quality and rarely used.


Đảo Phú Quốc
Đảo Côn Sơn
0 50 100 200 Km

Plectocomia himalayana Griff.

Local names. *Wai katheui (Lao).*

Description. Stems clustered or sometimes solitary, climbing, to 20 m long and 10 cm diameter. **Leaf sheaths** brown with brownish hairs, with rows of brown, needle-like, to 2.5 cm long spines encircling the sheath; **ocreas** absent; **knees** absent; **flagella** absent; petioles to 15 cm long; **rachis** to 1.5 m long with 25-30 lanceolate leaflets per side, these clustered and spreading in different planes, green on the lower surfaces, usually attached by short stalks, with elongate, thread-like apices, without prominent submarginal veins and minutely spiny on the margins; **cirri** present, to 1 m long. **Inflorescences** to 0.8 m long; flowering branch bracts densely hairy on outer surfaces; **fruits** globose, to 1.5 cm diameter; fruit scales yellowish-brown, fringed, without bristly, erect apices.

Distribution and habitat. Northern Laos (also in Bhutan, China, India, Nepal, and Thailand) in montane forest at 1,500-2,500 m elevation.

Flowering and fruiting. Not recorded.

Uses. The canes are too soft to be of much use, but the pith is occasionally eaten.


Đảo Phú Quốc
Đảo Côn Sơn
0 50 100 200 Km

Plectocomia pierreana Becc.

Local names. *Chang o, traes amboh (Cam); wai katheui, wai lao, wai namkhao, wai tang, wai nyipoon (Lao); mây nhánh, mây tượng, song hầu, song voi gai đỏ, mây xương móc (Vie).*

Description. Stems clustered or solitary, sometimes branching above ground level, climbing, to 50 m long and 10 cm diameter. **Leaf sheaths** green with reddish-brown hairs, densely covered with stout, yellowish-brown, to 2 cm long spines, these usually borne in short rows; **ocreas** absent; **knees** absent; **flagella** absent; petioles absent or to 10 cm long; **rachis** to 2.1 m long with 18-40 broadly lanceolate leaflets per side, these clustered and spreading in different planes, sometimes almost regularly arranged, pendulous, grayish on the lower surfaces, with prominent sub-marginal veins; cirri present, to 1.2 m long. **Inflorescences** to 1.1 m long; flowering branch bracts to 5 cm long, not or scarcely hairy on outer surfaces; **fruits** globose to ellipsoid, to 2.3 cm diameter; fruit scales yellowish-brown, fringed only, without bristly, erect apices.

Distribution and habitat. Cambodia, Laos, and Vietnam (also in China and Thailand) in lowland evergreen or montane forest at 100-1,700 m elevation.

Uses. Provides a poor quality cane used in handicrafts.

Flowering and fruiting. Fruits April, May.

Notes. Usually occurs at higher elevations than *Plectocomia elongata*, but often they occur together. Plants from the Cardamom mountains of Cambodia, with leaflets green on the lower surfaces, may represent an undescribed species.


Đảo Phú Quốc
Đảo Côn Sơn
0 50 100 200 Km

Plectocomiopsis geminiflora (Griff.) Becc.

Local names. *Phdao taing oa, phdao krahorm, thngae (Cam); wai deng, wai dengnoy, wai nou, wai nyang, wai kamlao, nyang (Lao); mây rút, mây đỏ, mây đọt đắng (Vie).*

Description. Stems clustered, climbing and forming thickets, to 15 m long and 2.5 cm diameter. **Leaf sheaths** green or grayish, with scattered, yellow, needle-like, to 2 cm long (longer at sheath apices) spines; **ocreas** to 3 cm long, becoming tattered; **knees** absent; **flagella** absent; petioles short or absent; **rachis** to 1.3 m long with 12-20, lanceolate leaflets per side, these irregularly arranged, pendulous, with conspicuous, yellow bristles on the upper surfaces; **cirri** present, to 0.5 m long. **Inflorescences** to 0.4 m long; **fruits** depressed-globose, to 3 cm long and 3.5 cm diameter, yellowish-green.

Distribution and habitat. Cambodia, Laos, and South-central Vietnam in Binh Thuan, Dong Nai, and Khanh Hoa)(also in Myanmar, Thailand, Borneo, Peninsular Malaysia, and Sumatra) in lowland evergreen forest, usually in disturbed places or forest margins, at 20-158 m elevation.

Flowering and fruiting. Fruits May.

Uses. Produces a poor quality cane that is seldom used.


QUẦN ĐẢO HOÀNG SA
Đảo Phú Quốc
Đảo Côn Sơn
QUẦN ĐẢO TRƯỜNG SA
0 50 100 200 Km

Plectocomiopsis songthanhensis
Henderson & N. Q. Dung

Local names. *Mây phun, mây rút (Vie).*

Description. **Stems** clustered, climbing, forming large thickets, to 30 m long and 1.7 cm diameter. **Leaf sheaths** green or gray-green, with few, scattered, yellowish, to 0.5 cm long spines; **ocreas** to 1 cm long, membranous, becoming brown and splitting irregularly; **knees** absent; **flagella** absent; petioles absent or to 2 cm long; **rachis** to 87 cm long with 11-13, lanceolate leaflets per side, these more or less regularly and distantly arranged, without bristles on the upper surfaces; **cirri** present, to 0.8 m long. **Inflorescences** to 0.8 m long; **fruits** depressed-globose, to 1.8 cm diameter, brownish-green.

Distribution and habitat. Central Vietnam in Quang Nam (Song Thanh N. R.) and Thua Thien-Hue (Bach Ma N. P.) in disturbed places by roads or in disturbed areas of lowland evergreen forest at 100-412 m elevation.

Flowering and fruiting. Flowers and fruits March, April.

Uses. Provides a poor quality cane which is only used locally.


Đảo Phú Quốc
Đảo Côn Sơn
0 50 100 200 Km

2.5. Synonyms

Synonyms are listed under each species name (**bold face**). These are superfluous names that have sometimes been applied to the species under which they are listed. This list includes all synonyms for each species even if they were described from other countries, not just Cambodia, Laos, and Vietnam.

***Calamus acanthospathus* Griff.**

Calamus feanus Becc., *Calamus feanus* var. *medogensis* S. J. Pei & S. Y. Chen, *Calamus montanus* T. Anderson, *Calamus yunnanensis* Govaerts, *Calamus yunnanensis* var. *densiflorus* S. J. Pei & S. Y. Chen, *Calamus yunnanensis* var. *intermedius* S. J. Pei & S. Y. Chen, *Palmijuncus acanthospathus* (Griff.) Kuntze, *Palmijuncus montanus* (T. Anderson) Kuntze

***Calamus dianbaiensis* C. F. Wei**

Calamus guangxiensis C. F. Wei, *Calamus yuangchunensis* C. F. Wei

***Calamus dioicus* Lour.**

Palmijuncus dioicus (Lour.) Kuntze

***Calamus erectus* Roxb.**

Calamus collinus Griff., *Calamus erectus* var. *birmanicus* Becc., *Calamus erectus* var. *collinus* (Griff.) Becc., *Calamus erectus* var. *macrocarpus* (Griff.) Becc., *Calamus erectus* var. *schizospathus* (Griff.) Becc., *Calamus macrocarpus* Griff., *Calamus schizospathus* Griff., *Palmijuncus collinus* (Griff.) Kuntze, *Palmijuncus erectus* (Roxb.) Kuntze, *Palmijuncus macrocarpus* (Griff.) Kuntze, *Palmijuncus schizospathus* (Griff.) Kuntze

***Calamus erinaceus* (Becc.) J. Dransf.**

Calamus aquatilis Ridl., *Daemonorops erinacea* Becc.

***Calamus flagellum* Griff.**

Calamus flagellum var. *furvifuraceus* S. J. Pei & S. Y. Chen, *Calamus flagellum* var. *karinensis* Becc., *Calamus jenkinsianus* Griff., *Calamus karinensis* (Becc.) S. J. Pei & S. Y. Chen, *Calamus polygamus* Roxb., *Palmijuncus flagellum* (Griff.) Kuntze, *Palmijuncus jenkinsianus* (Griff.) Kuntze, *Palmijuncus polygamus* (Roxb.) Kuntze

***Calamus gracilis* Roxb.**

Palmijuncus gracilis (Roxb.) Kuntze

***Calamus guruba* Buch.-Ham.**

Calamus guruba var. *ellipsoideus* S. Y. Chen & K. L. Wang, *Calamus mastersianus* Griff., *Calamus multirameus* Ridl., *Calamus nitidus* Mart., *Daemonorops guruba* (Buch.-Ham.) Mart., *Daemonorops guruba* var. *hamiltonianus* Mart., *Daemonorops guruba* var. *mastersianus* (Griff.) Mart., *Palmijuncus guruba* (Buch.-Ham.) Kuntze, *Palmijuncus nitidus* (Mart.) Kuntze

***Calamus harmandii* Pierre**

Zalacella harmandii (Pierre) Becc.

***Calamus henryanus* Becc.**

Calamus balansaeanus Becc., *Calamus balansaeanus* var. *castanolepis* (C.F. Wei) S. J. Pei & S. Y. Chen, *Calamus henryanus* var. *castanolepis* C.F. Wei

***Calamus nambariensis* Becc.**

Calamus doriaei Becc., *Calamus giganteus* var. *robustus* S. J. Pei & S. Y. Chen, *Calamus inermis* T. Anderson, *Calamus inermis* var. *menghaiensis* S. Y. Chen, S. J. Pei & K. L. Wang, *Calamus khasianus* Becc., *Calamus multinervis* var. *menglaensis* S. Y. Chen, S. J. Pei & K. L. Wang, *Calamus nambariensis* var. *alpinus* S. J. Pei & S. Y. Chen, *Calamus nambariensis* var. *furfuraceus* S. J. Pei & S. Y. Chen, *Calamus nambariensis* var. *menglongensis* S. J. Pei & S. Y. Chen, *Calamus nambariensis* var. *xishuangbannaensis* S. J. Pei & S. Y. Chen, *Calamus nambariensis* var. *yingjiangensis* S. J. Pei & S. Y. Chen, *Calamus obovoideus* S. J. Pei & S. Y. Chen, *Calamus palustris* var. *longistachys* S. J. Pei & S. Y. Chen, *Calamus platyacanthoides* Merr., *Calamus platyacanthus* Warb., *Calamus platyacanthus* var. *longicarpus* S. Y. Chen & K. L. Wang, *Calamus platyacanthus* var. *mediostachys* S. J. Pei & S. Y. Chen, *Calamus polydesmus* Becc., *Calamus wailong* S. J. Pei & S. Y. Chen, *Palmijuncus inermis* (T. Anderson) Kuntze

***Calamus oligostachys* T. Evans, K. Sengdala, O. Viengkham, B. Thammavong & J. Dransf.**

Calamus pauciflorus T. Evans, K. Sengdala, O. Viengkham, B. Thammavong & J. Dransf.

***Calamus palustris* Griff.**

Calamus dumetorum Ridl., *Calamus extensus* Roxb., *Calamus gregisectus* Burret, *Calamus humilis* Roxb., *Calamus kerrianus* Becc., *Calamus latifolius* Kurz, *Calamus latifolius* Roxb., *Calamus latifolius* var. *marmoratus* Becc., *Calamus loiensis* Hodel, *Calamus macracanthus* T. Anderson, *Calamus palustris* var. *amplissimus* Becc., *Calamus palustris* var. *cochinchinensis* Becc., *Calamus palustris* var. *malaccensis* Becc., *Calamus quinquenervius* Roxb., *Palmijuncus extensus* (Roxb.) Kuntze, *Palmijuncus humilis* (Roxb.) Kuntze, *Palmijuncus latifolius* (Roxb.) Kuntze, *Palmijuncus macracanthus* (T. Anderson) Kuntze, *Palmijuncus palustris* (Griff.) Kuntze, *Palmijuncus quinquenervius* (Roxb.) Kuntze

***Calamus rhabdocladus* Burret**

Calamus pseudoscutellaris Conrard, *Calamus pseudoscutellaris* var. *cylindrocarpus* Conrard**,** *Calamus rhabdocladus* var. *globulosus* S. J. Pei & S. Y. Chen

***Calamus rudentum* Lour.**

Palmijuncus rudentum (Lour.) Kuntze, *Rotang rudentum* (Lour.) Baill.

***Calamus salicifolius* Becc.**

Calamus salicifolius var. *leiophyllus* Becc.

***Calamus siamensis* Becc.**

Calamus siamensis var. *malaianus* Furtado

***Calamus tenuis* Roxb.**

Calamus amarus Lour., *Calamus royleanus* Griff., *Calamus heliotropium* Buch.-Ham., *Calamus horrens* Blume, *Calamus stoloniferus* Teijsm. & Binn., *Palmijuncus amarus* (Lour.) Kuntze, *Palmijuncus heliotropium* (Buch.-Ham.) Kuntze, *Palmijuncus horrens* (Blume) Kuntze, *Palmijuncus royleanus* (Griff.) Kuntze, *Palmijuncus tenuis (Roxb.)* Kuntze, *Rotang royleanus* (Griff.) Baill.

***Calamus tetradactylus* Hance**

Calamus bonianus Becc., *Calamus cambojensis* Becc., *Calamus tetradactylus* var. *bonianus* (Becc.) Conrard, *Palmijuncus tetradactylus* (Hance) Kuntze

***Calamus thysanolepis* Hance**

Calamus hoplites Dunn, *Calamus sculletaris* Becc., *Calamus thysanolepis* var. *polylepis* C.F. Wei, *Palmijuncus thysanolepis* (Hance) Kuntze

***Calamus viminalis* Willd.**

Calamus extensus Mart., *Calamus fasciculatus* Roxb., *Calamus litoralis* Blume, *Calamus pseudorotang* Mart., *Calamus viminalis* var. *fasciculatus* (Roxb.) Becc., *Calamus viminalis* var. *fasciculatus subvar. andamanicus* Becc., *Calamus viminalis* var. *fasciculatus subvar. bengalensis* Becc., *Calamus viminalis* var. *fasciculatus subvar. cochinchinensis* Becc., *Calamus viminalis* var. *fasciculatus subvar. pinangianus* Becc., *Palmijuncus fasciculatus* (Roxb.) Kuntze, *Palmijuncus litoralis* (Blume) Kuntze, *Palmijuncus pseudorotang* (Mart.) Kuntze, *Palmijuncus viminalis* (Willd.) Kuntze, *Rotang viminalis* (Willd.) Baill.

***Calamus walkeri* Hance**

Calamus faberi Becc., *Calamus faberi* var. *brevispicatus* (*Calamus* F. Wei) S. J. Pei & S. Y. Chen, *Calamus tonkinensis* Becc., *Calamus tonkinensis* var. *brevispicatus Calamus* F. Wei, *Palmijuncus walkeri* (Hance) Kuntze

***Daemonorops jenkinsiana* (Griff.) Mart.**

Calamus jenkinsianus Griff., *Calamus margaritae* Hance, *Calamus nutantiflorus* Griff., *Daemonorops jenkinsiana* var. *tenasserimica* Becc., *Daemonorops margaritae* (Hance) Becc., *Daemonorops margaritae* var. *palawanica* Becc., *Daemonorops nutantiflora* (Griff.) Mart., *Daemonorops pierreana* Becc., *Daemonorops schmidtiana* Becc., *Palmijuncus jenkinsianus* (Griff.) Kuntze, *Palmijuncus margaritae* (Hance) Kuntze, *Palmijuncus nutantiflorus* (Griff.) Kuntze

***Daemonorops fissilis* (Henderson, N. K. Ban & N. Q. Dung) Henderson**

Calamus fissilis Henderson, N. K. Ban & N. Q. Dung

***Daemonorops nuichuaensis* (Henderson, N. K. Ban & N. Q. Dung) Henderson**

Calamus nuichuaensis Henderson, N. K. Ban & N. Q. Dung

***Korthalsia laciniosa* (Griff.) Mart.**

Calamosagus harinifolius Griff., *Calamosagus laciniosus* Griff., *Calamosagus wallichiifolius* Griff., *Korthalsia andamanensis* Becc.,

Korthalsia bejaudii Gagnepain, *Korthalsia grandis* Ridl., *Korthalsia scaphigera* Kurz, *Korthalsia teysmannii* Miq., *Korthalsia wallichiifolia* (Griff.) H. Wendl.

Myrialepis paradoxa* (Kurz) *J. Dransf.

Bejaudia cambodiensis Gagnep., *Calamus paradoxus* Kurz, *Myrialepis floribunda* (Becc.) Gagnep., *Myrialepis scortechinii* Becc., *Palmijuncus paradoxus* (Kurz) Kuntze, *Plectocomiopsis annulata* Ridl., *Plectocomiopsis floribunda* Becc., *Plectocomiopsis paradoxa* (Kurz) Becc., *Plectocomiopsis scortechinii* (Becc.) Ridl.

***Plectocomia elongata* Mart. & Blume**

Calamus maximus Reinw., *Plectocomia crinita* Gentil, *Plectocomia elongata* var. *bangkana* Becc., *Plectocomia elongata* var. *philippinensis* Madulid, *Plectocomia griffithii* Becc., *Plectocomia hystrix* Linden, *Plectocomia ichythospinus auct., Plectocomia macrostachya* Kurz, *Plectocomia sumatrana* Miq., *Rotang maximus* Baill.

***Plectocomia himalayana* Griff.**

Plectocomia montana Griff.

***Plectocomia pierreana* Becc.**

Plectocomia barthiana Hodel, *Plectocomia cambodiana* Gagnep., *Plectocomia kerriana* Becc.

***Plectocomiopsis geminiflora* (Griff.) Becc.**

Calamus geminiflorus Griff., *Calamus turbinatus* Ridl., *Plectocomia geminiflora* (Griff.) H. Wendl., *Plectocomiopsis geminiflora* var. *billitonensis* Becc., *Plectocomiopsis geminiflora* var. *borneensis* Becc.

CHAPTER III
Ecological Factors Relevant to the Conservation and Management of Local Rattans

Charles Peters

Every rattan species exhibits a specific set of ecological characteristics that facilitates its growth, reproduction, and continued survival in the forest. Different species do different things. Some species grow fast, form high-density populations, are widely distributed, and maintain a continual level of seedling establishment from year to year. Other species occur as slow growing, scattered individuals on a restricted range of sites. The rattans in the first group will have a greater ability to withstand the rigors of commercial harvesting and will also be considerably easier to manage. Uncontrolled, intensive harvesting of the rattans in the second group can rapidly lead to resource depletion.

It is important to understand the ecological mechanisms that different rattan species have evolved to insure survival from seedling in the understory to fruiting adult. Building on the taxonomic information presented in Chapter II, therefore, a selective overview of rattan ecology is offered here. What are the different life forms and reproductive strategies exhibited by rattans and what effect do these parameters have on the management potential of a species? How abundant are different rattan species in the Lower Mekong Region? Do these populations appear to be regenerating themselves and are there different patterns to the periodicity of seedling recruitment? How fast do the local rattan species grow? What are the main factors that influence the annual growth rate of wild rattan? The answers to these questions go a long way in explaining the current situation with rattan in Cambodia, Laos, and Vietnam. The ecological data presented also provide a first glimpse at the types of diagnostic information that are needed to develop sustainable systems for managing rattan.

3.1. Life Form

Rattan stems exhibit a variety of different forms. Many species creep along the forest floor until they encounter a host tree to climb, some are non-climbing (e.g. *Calamus acanthophyllus*, *C. erectus*), some grow upright and then bend over under their own weight, root at the stem apex, and form a new stem (e.g. *C. dianbaiensis*), some species produce a solitary stem (e.g. *C. poilanei*, *C. solitarius*, *Daemonorops nuichuaensis*), and others form a clump containing numerous stems (e.g. *C. tenuis*, *D. jenkinsiana*, *Plectocomiopsis songthanhensis*). A few species have individuals with both solitary and clustered stems (e.g. *C. bousigonii*, *Plectocomia himalayana*, *Plectocomia pierreana*). Of the 65 species of rattan described in Chapter II, 54 species are climbers, 11 species are non-climbers[1], 56 species have clustered stems, and 9 species have a solitary stem. Four of the solitary species, i.e. *C. acanthospathus*, *C. lateralis*, *C. poilanei*, and *C. solitarius*, produce export-quality rattan cane and are heavily exploited throughout the region.

The inherent problem with the harvest of solitary rattans is that these species have only a single apical meristem or growing point at the tip of the stem. Cutting the stem to harvest the cane kills the plant. Rattan species with clustered stems, on the other hand, can produce new shoots after harvesting from accessory vegetative buds located at the base of the stem (Dransfield, 1978). Rattan species with clustered stems can be harvested repeatedly; those with solitary stems can be harvested only once.

3.2. Reproductive Dynamics

The majority of the rattans in the Lower Mekong Region, i.e. all species of *Calamus* and *Daemonorops*, produce flowers and fruits every year based on growing conditions and the health of the plant. In species of *Korthalsia*, *Myrialepis*, *Plectocomia,* and *Plectocomiopsis*, however, the production of flowers is followed by the death of the stem, i.e. semelparous (Henderson, 2002). In species with solitary stems, e.g. some individuals of *Plectocomia elongata* and *P. himalyana*, the entire plant dies after flowering. In clustering

[1]With the exception of *C. salicifolius*, the non-climbing species are usually not important sources of rattan cane.

species, the individual continues to produce new basal shoots and it is only the flowering stem that dies. With the exception of *Korthalsia*, which produces bisexual flowers, all of the rattans in the region are dioecious, i.e. with separate male and female plants (Henderson, 2009).

Rattans rely on a variety of different insect vectors to pollinate their flowers. Although few studies have been conducted and the exact pollinators of most species are not known, wasps, flies and small beetles appear to be common pollinators for *Calamus* and *Daemonorops*, and bees and weevils have been reported as pollinators for *Plectocomia* (Dransfield, 1979).

A final parameter of importance, of which we know very little, concerns the age at first reproduction. After germination, how long does it take a wild rattan stem to grow up into the canopy and garner sufficient resources to flower and fruit? The length of this period depends on many factors, including climate, light levels, soil moisture, and species. It is estimated to take less than a decade for a small cane rattan growing under adequate light conditions to flower, while larger, clustering species may take several decades to reproduce (Henderson, 2002; Siebert, 2012).

The management importance of flowering and fruiting is straightforward. If no seeds are produced, there will be no new rattan seedlings. Without new recruits, there will no smaller canes to replace the larger adult canes that are harvested. This is how rattan gets depleted. Delaying the harvest of solitary canes until after reproduction can greatly increase the input of rattan seeds and potentially enhance levels of seedling establishment on the site. Maximizing rattan growth through management would not only increase yields, it would also reduce the pre-reproductive phase of young canes and result in a further increase in the seed rain.

3.3. Population Density

A clear indication of the reproductive success of a species is the density and abundance of the populations it forms. Yet, in spite of the importance of this parameter, detailed surveys of wild rattan populations in the Lower Mekong were virtually non-existent until recently. Extensive inventories

of rattan were initiated in 2009 in six protected areas in the Central Truong Son Mountains of Vietnam, and similar surveys of community forests in Laos and Cambodia were conducted shortly thereafter. We now know quite a bit about the wild rattan populations growing in the Lower Mekong.

There is neither the need nor the space to present quantitative data on the population density of each of the 65 species included in this book. There are, however, several patterns that have emerged from the inventory work that can be usefully illustrated using the results from Vietnam[2]. Basic data from these inventories are shown in Table 3.1

The number of rattan species recorded in the inventories at each nature reserve was surprisingly uniform, ranging from 12 - 15 species. Each reserve, however, had a different complement of species, and only five of the rattans, e.g. *D. poilanei*, *D. jenkinsiana*, *C. nambariensis*, *C. tetradactylus*, and *P. pierreana*, occurred in all six reserves. *Calamus modestus* and *C. dioicus*, on the other hand, were only recorded in two reserves.

Based on the density of canes ≥ 4.0 meters long[3], *D. poilanei*, *K. laciniosa, D. jenkinsiana*, and *C. bousigonii* are the most abundant rattans growing in the Central Truong Son Mountains of Vietnam. Each of these species exhibits an average population density greater than 10 canes/hectare, and the densities recorded in specific reserves were frequently much higher than this. The abundance of *D. poilanei* at Da Krong, for example, was 45.7 canes/hectare and almost 48 canes/hectare were recorded for *K. laciniosa* at Sao La. While these densities suggest that the clustering stems and climbing habit of the four species have been quite successful ecologically in maintaining their populations in the forest, it is important to point out that none of these species produce cane of great value.

[2]The quantitative inventories conducted in the Bac Huong Hoa, Da Krong, Phong Dien, Sao La, Song Thanh, and Ngoc Linh Nature Reserves in Vietnam generated an unprecedented amount of information about local rattan species. The rattan flora was sampled using 10 X 200 meter transects located in a stratified random fashion; each reserve sampled 160 transects. In total, the local field crews laid out 960 transects, sampled 192 hectares of lowland and montane forest, and identified, counted, and measured over 175,000 rattan plants. As far as we know, this is the largest rattan inventory ever conducted.

[3]Within the present context, a rattan cane ≥ 4.0 m long is considered to be "harvestable" or "merchantable".

Table 3.1. Number of merchantable rattan canes (≥ 4.0 meters long) of different species recorded in 32 hectares of inventory transects in six nature reserves in the Central Truong Son Mountains of Vietnam. Nature Reserve codes: I = Bac Huong Hoa, II = Da Krong, III=Phong Dien, IV = Sao La, V = Song Thanh, and VI = Ngoc Linh.

	Nature Reserve						Average Density
Species	**I**	**II**	**III**	**IV**	**V**	**VI**	**(Canes/ha)**
Daemonorops poilanei	398	1464	685	448	1036	176	21.9
Korthalsia lacinosa	153	208	506	1535	599		18.7
Daemonorops jenkinsiana	290	1080	469	390	292	623	16.4
Calamus bousigonii			131	402	636	284	11.5
Calamus walkeri	206		324	15	683	10	7.7
Calamus rhabdocladus		116	280	392	82		6.8
Calamus nambariensis	152	143	131	275	207	184	5.7
Calamus gracilis	66	115		310			5.1
Plectocomiopsis songthanhensis		39	110	269	49	1	2.9
Calamus crispus	170	18		86			2.8
Calamus palustris	31	53	126	80	122		2.6
Calamus poilanei	7		180			62	2.6
Calamus flagellum		71		8	118		2.0
Calamus tetradactylus	61	92	28	18	139	31	1.9
Plectocomia elongata	18			62	40	5	1.0
Plectocomia pierreana	39	84	1	3	11	6	0.7
Calamus modestus	1					40	0.6
Calamus dioicus					39	1	0.6

The most valuable rattan species recorded in the Vietnam inventories are *C. poilanei*, *C. tetradactylus*, *C. walkeri*, *C. nambariensis*, *C. gracilis*, and *C. dioicus*, and the population densities of these species are, not surprisingly, considerably lower. The occurrence of even a few canes/hectare of *C. poilanei* at Phong Dien and Ngoc Linh, however, is encouraging, given the value of this export-quality cane and its solitary growth form.

The density of harvestable canes recorded in an inventory tells only one part of the story about the ecological status of a species. Given that all of the rattans encountered in the Truong Son inventories were recorded, a closer look at the population densities of the six commercial species is presented in Table 3.2. These data, taken from the Phong Dien, Da Krong, and Song Thanh results, show the number of seedlings, pre-commercial individuals, and commercial canes per hectare exhibited by each species. For most of the species, low densities of merchantable canes are accompanied by larger number of seedlings and pre-commercial canes.

Table 3.2. Density of seedlings, pre-commercial canes (≤ 4.0 meters tall), and commercial canes (≥ 4.0 meters tall) canes of six rattan species from three Nature Reserves in Vietnam.

		Pre-commercial Canes	**Commercial Canes**
	Seedlings	**(≤ 4.0 meters tall)**	**(≥ 4.0 meters tall)**
Phong Dien N.R.			
Calamus poilanei	13.1	9.7	5.6
Calamus tetradactylus	3.4	1.5	0.8
Calamus walkeri	49.2	23.7	10.1
Calamus nambariensis	28.4	11.9	4.1
Dakong N.R.			
Calamus gracilis	37.5	8.6	3.6
Song Thanh N.R.			
Calamus dioicus	0.5	1.1	1.2

Even populations of the highly valued *C. poilanei* contain an average of about 13 seedlings/hectare. What is suggested here is that these populations are continuing to regenerate in spite of the periodic harvest of adult canes. This, however, does not appear to be the case for *C. dioicus*. This species was recorded in only two of the nature reserves, densities of commercial canes are low, and there doesn't seem to be a sufficient level of recruitment to replace the inevitable mortality of large canes. There are a lot of different things that could be going here, e.g. over-harvesting, but the inventory

data shown in Table 3.2 suggest that *C. dioicus* may be in for some hard times in Central Vietnam. It is worth noting that Evans (2002) included *C. dioicus* in his list of globally threatened rattans.

3.4 Size-Class Distribution

An even more detailed assessment of the regeneration dynamics of a plant population can be obtained by grouping the data from a forest inventory into size-classes. Plotting the results in a histogram can provide a wealth of information about the ecological behavior of a species. Such an analysis, for example, can reveal whether a species is regenerating or not, whether recruitment occurs periodically or continually, and the degree to which a species depends on disturbance or canopy openings for seedling establishment. Long used by foresters to investigate the regeneration characteristics of trees, size-class histograms have also recently become an important analytical tool in the study of rattans (e.g. Siebert, 2004; Binh, 2009).

In spite of the variety of different reproductive and growth strategies used by plants, plant populations reflect only a limited number of different size-class distributions. Three of the most common distributions exhibited by rattan populations are shown in Figure 3.1. All of the data presented were collected from the Song Thanh Nature Reserve; histograms depict the proportion of the number of individuals found in each size class. After the initial seedling class that contains small, stemless individuals, size classes reflect stem height in meters, i.e. class 2 contains rattans from 1.1 to 2.0 meters tall.

The type I size-class distribution, illustrated by *D. jenkinsiana* in Figure 3.1, displays a greater number of small individuals than large, commercial canes, and there is a consistent reduction in the number of stems from one class to the next. This type of population structure is characteristic of rattan species that maintain a more or less constant rate of recruitment from year to year. There is a high probability that the harvest of commercial canes will be ultimately be replaced by the growth of individuals in the smaller sized classes.

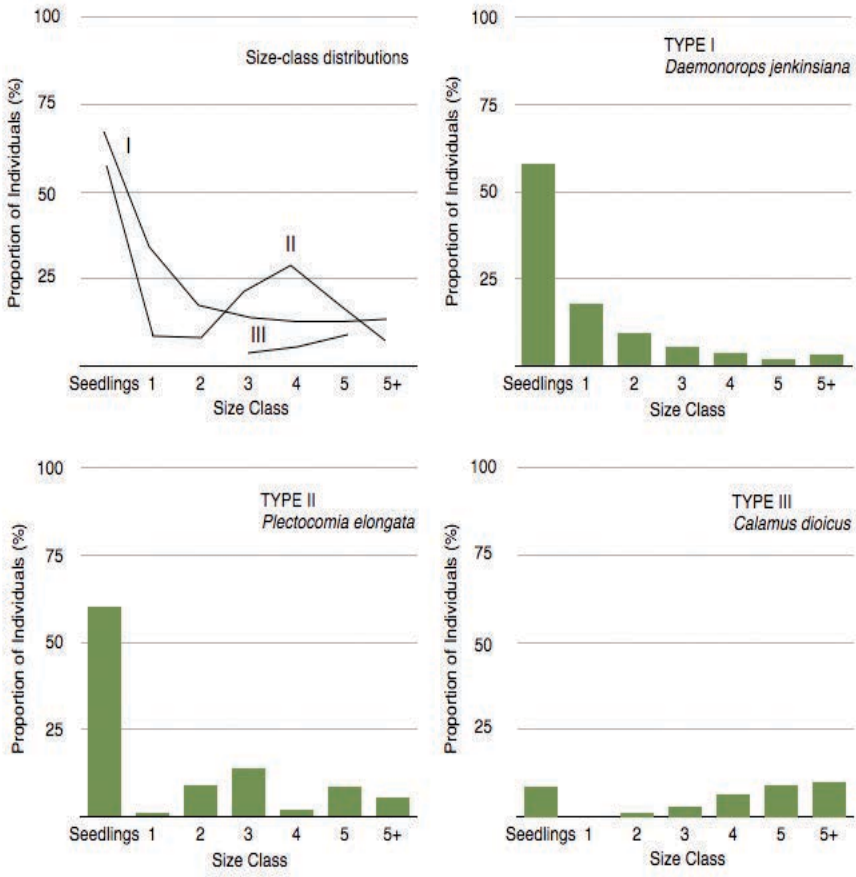


Figure 3.1. Generalized size-class distributions exhibited by rattan populations with specific examples from *D.jenkinsiana, P. elongata, and C. dioicus.*

A type II size distribution, such as displayed by *Plectocomia elongata*, is characteristic of species that show discontinuous or periodic seedling recruitment. The actual level of seedling establishment may be sufficient to maintain the population, but its infrequency causes notable discontinuities or gaps and peaks in the size-distribution. It is unclear what might have caused this pattern in the *P. elongata* populations at Song Thanh, but the solitary growth form and the semelparous reproductive strategy of this species undoubtedly play an important role in the fluctuations in seedling establishment recorded in its size-distribution.

The final size distribution, type III, reflects a species, in this case *C. dioicus*, whose regeneration is severely limited for some reason. Population density is low (Table 3.2), seedling numbers are greatly reduced, and there are very few individuals in the intermediate size classes. Unless conditions change to increase the level of recruitment, e.g. increased seed production by adult canes or higher rates of seedling survival, this species could disappear from the forests at Song Thanh.

The size-class distribution of a rattan population is extremely sensitive to environmental conditions. A type I distribution can easily change into a type II if existing levels of seedling recruitment are diminished or mortality rates, i.e. harvesting levels, go up. Further constraints on regeneration may drive the population to a type III size-class distribution. It is, perhaps, most useful to view these three distributions as a single sequence through which a rattan population passes as it is being over-exploited. The analysis of size-class distributions is a simple and reliable method to monitor the vigor of a population of forest resources, and the occurrence of a type III curve is a strong signal that the rate of harvest needs to be adjusted.

3.5 Growth

While the population density or number of harvestable rattan canes is clearly the parameter of greatest interest to a rattan collector, the annual growth rate of different species may actually be a more important number in terms of management. Growth rates determine the length of the pre-reproductive period, and growth rates determine the amount of time required to produce a merchantable cane, and growth rates are what ultimately define a sustainable harvest of rattan from the forest. Unfortunately, reliable estimates of the annual extension growth of different species of wild rattan have, until quite recently, been very hard to come by. This started to change in 2009, when growth studies of selected rattan species were initiated in protected areas of Central Vietnam, as well as in community forests in Cambodia and Laos. To date, growth studies have been conducted on six rattan species in Vietnam, five species in Cambodia, and one species in Laos. These data are summarized in

Table 3.3. Growth estimates represent the average of all measurements from canes ranging in size from 40 centimeters to almost 20 meters. The Vietnam studies were continued for one year; the work in Cambodia and Laos is on-going.

Based on over 5,000 measurements, the growth of rattan plants in the Lower Mekong Region ranges from 0.4 to 1.69 meters/year. There are distinct differences between species, *C. nambariensis* exhibiting a growth rate that is about a quarter of that presented by *Plectocomia pierreana*.

Table 3.3. Average rates of annual extension growth (meters/year) for six species of rattan in Vietnam, five species in Cambodia, and one species in Laos; all growth measurements from wild plants.

Species	No. Measurements	Years	Average Growth (meters/year)
Vietnam			
Daemonorops poilanei	1,415	1	1.15±0.04
Daemonorops jenkinsiana	1,398	1	1.12±0.04
Calamus walkeri	571	1	1.09±0.03
Calamus tetradactylus	286	1	1.23±0.04
Calamus nambariensis	285	1	0.44±0.021
Calamus gracilis	260	1	1.12±0.03
Cambodia			
Calamus palustris	122	4	0.78±0.05
Calamus tetradactylus	443	4	0.65±0.01
Calamus viminalis	173	4	1.39±0.06
Myrialepis paradoxa	60	4	1.29±0.14
Plectocomia pierreana	62	4	1.69±0.12
Laos			
Calamus solitarius	352	4	0.80±0.02

The data shown in Table 3.3, however, do not tell the whole story, because the annual growth rate of rattan is significantly influenced by site and the size of the plant. The effect of location on rattan growth is shown in Figure 3.2, which groups the growth estimates for three species of rattan in Vietnam by nature reserve. There are pronounced differences between the growth measurements collected in different reserves, and there is a

suggestion that growth rates are somewhat higher in the more southern reserves, i.e. Sao La and Song Thanh, relative to those recorded in reserves located in the northern part of the Central Truong Son Mountains, i.e. Bac Huong Hoa and Da Krong.

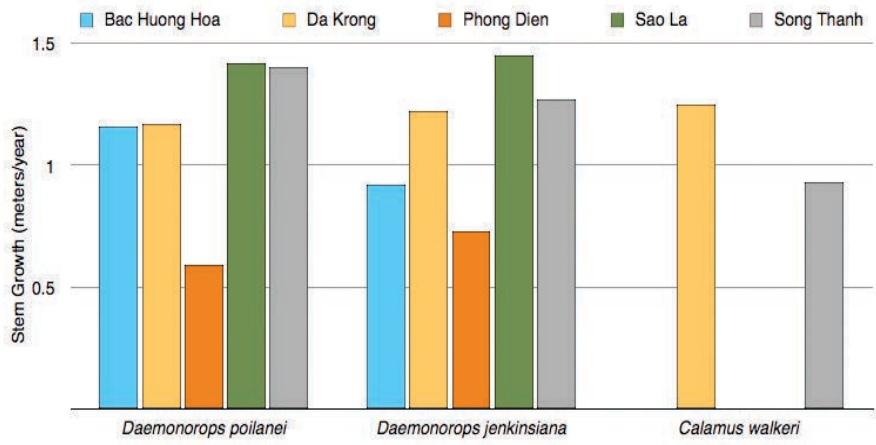


Figure 3.2. Annual growth rate of *D. poilanei*, *D. jenkinsiana*, and *C. walkeri* in five nature reserves in the Central Truong Son Mountains of Vietnam.

The effect of plant size on growth is in shown in Figure 3.3 using data from the Cambodia and Laos growth studies. The number above each histogram bar indicates the number of sample plants; the dotted horizontal line in each represents the growth rate calculated when only merchantable canes ≥ 4.0 meters long are included. Several points of importance should be noted in this figure. First, each of the species exhibits increased growth with increasing size. For *C. solitarius* and *C. viminalis*, this growth increase is quite pronounced, merchantable canes growing two to three times faster than canes that are only 1.0 meters tall. Taller plants are exposed to more light, experience less competition, and are less susceptible to damage because they are hooked to a host tree. It is not surprising that these plants grow faster. The notable growth difference between small and larger plants is further reinforced by the growth estimate calculated using only commercial canes.

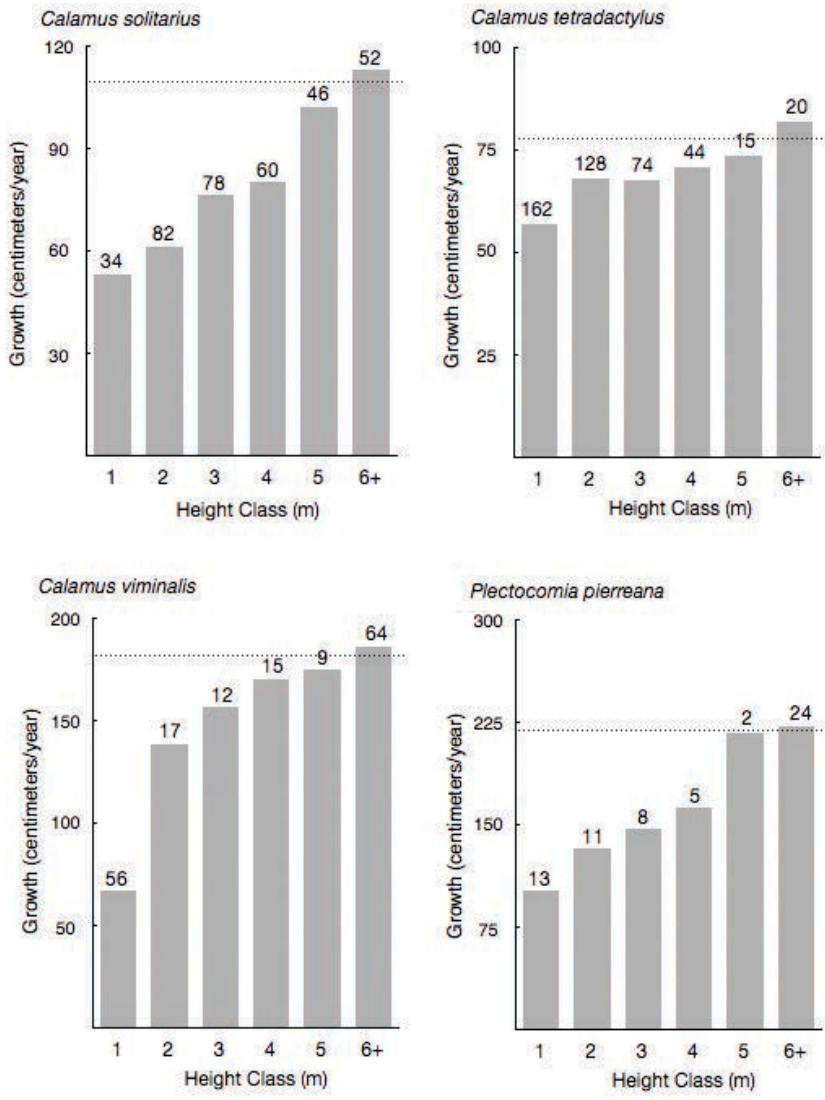


Figure 3.3. Average annual size-specific growth (centimeters/year) for *C. solitarius*, *C. tetradactylus*, *C. viminalis*, and *P. pierreana*. Number of measurements are shown above the bars in each histogram; dotted horizotal line indicates the mean growth of commercial canes (≥ 4.0 meters long).

It is tempting to use the faster growth rates of larger plants to estimate the time required to produce a merchantable cane or to calculate the annual harvest of rattan from a forest. The biological reality, however, is that large canes spend several years growing up through the smaller size classes before

they reach the canopy. The time spent in the shade of the forest understory must necessarily be taken into account. The average growth rate of a rattan includes periods of both fast and slow growth, and to be truly useful, the growth estimates that guide the management of these resources should also include both life stages.

3.6. Conservation Assessment

There have been numerous reports that the rattan supplies in many parts of the Lower Mekong Region are dwindling, e.g. Evans, 2002; Binh, 2009; Hirschberger, 2011, yet little formal analysis has been conducted of the species that may be threatened by over-exploitation or vulnerable to the impacts of forest loss. Given information on the distribution, use, and life form for all 65 species in the region (Chapter II), as well as quantitative data on the density and regeneration status of certain canes from forest inventories, we conducted a conservation assessment of local rattans.

The analysis was done in several steps. The Extent of Occurrence (IUCN, 2001) was first determined from the distribution maps for species with at least three unique localities by creating a minimum convex polygon in ArcGIS (Miller et al., 2012). The data points were then plotted on the WWF Global 200 Ecoregions map (Figure 1.2), and the number of habitats within which each species occurred was recorded as a measure of habitat specificity[4]. Finally, the average density of commercial canes and seedlings were calculated for those species with inventory data (n = 18), and, together with the use and life form designations, the values were relativized, and then summed to provide an additional index for ranking the taxa.

The results from the conservation assessment are shown in Table 3.4 for 41 rattan species. The data are arranged into four groups. The first group, from *C. bachmaensis* to *C. harmandii*, contains species that exhibit

[4]Rattan species may grow in a large number of different habitats or they may be restricted to only a few sites. Species with high habitat specificities, i.e. those that are found in only a few sites, are usually more vulnerable to the impacts of habitat loss and over-harvesting than species with wider tolerances.

an Extent of Occurrence of less than 100 square kilometers. According to IUCN (2010) thresholds, these four rattans fall into the "Critically Endangered" category. It should be noted that none of the species are represented by very many collections and none produce a cane of great value.

The second group contains five species with an Extent of Occurrence greater than 100 square kilometers and less than 5,000 square kilometers; IUCN criteria classify these rattans as "Endangered". Two of the species, i.e. *D. brevicaulis* and *C. ceratophorus* have a solitary stem and are found in only two ecoregions. *Calamus erinaceus*, although reported from only a few areas of southwestern Cambodia in the Lower Mekong, is a relatively common rattan in other parts of Southeast Asia.

The third group contains six species that occur in an area of less than 20,000 square kilometers; this category is classified as "Vulnerable". Of special interest in this group is *C. solitarius*. The species is a preferred commercial rattan, it is solitary-stemmed, and it is know to be heavily exploited in Laos (Evans, 2001). It was recorded in only three ecoregions.

The final group of rattans contains 26 species that occur over large areas in the Lower Mekong Region. There are inventory data for many of these species, and the rankings in this group are, as a result, based on more than Extent of Occurrence alone. *Calamus poilanei*, for example, is ranked higher, i.e. more vulnerable, than would be indicated by its Extent of Occurrence because of its solitary life form, its relatively low population density (Table 3.1) and lack of regeneration, and its value as a large-diameter commercial cane. Similarly, *C. dioicus* has been moved up in the list because of its low density and type III size-class distribution (Figure 3.1).

At the bottom of this group are rattan species that seem to be able to grow almost anywhere. Of the 16 ecoregions found in the Lower Mekong, *C. tetradactylus*, *C. palustris*, and *D. jenkinsiana* have been collected in 14 of them; *C. viminalis* occurs everywhere except in salt water. Many of the species in this group also produce a high-quality cane, have large populations, and appear to be regenerating in the forest. Although all of the rattans in Cambodia, Laos, and Vietnam would benefit from a concerted management effort, the rattans in the last group would undoubtedly be

the easiest to manage - and would provide that largest and most immediate return on the investment.

Table 3.4. Assessment of the conservation status of 41 rattan species from the Lower Mekong Region based on Extent of Occurrence, habitat specificity, life form, and intensity of use. Population density and level of seedling recruitment were used as additional ranking measures for those species with inventory data. Following IUCN (2010) criteria, the first group (4 species) is Critically Endangered, the second group (5 species) is Endangered, the third group (6 species) is Vulnerable, and the final group of 26 species appears to be in good condition.

Species	N[1]	Extent of Occurrence (Km^2 x 1000)	No. Ecoregions	Life Form[2]	Use[3]
Calamus bachmaensis	4	0.02	1	C	2
Calamus minor	6	0.02	1	C	2
Calamus dongnaiensis	3	0.03	2	C	3
Calamus harmandii	6	0.08	1	S	3
Calamus seriatus	3	0.26	2	C	2
Daemonorops brevicaulis	5	0.46	2	S	3
Calamus ceratophorus	5	0.48	2	S	2
Plectocomiopsis songthanhensis	11	0.92	2	C	3
Calamus erinaceus	4	2.2	1	C	3
Calamus crispus	11	6.4	4	C	2
Calamus modestus	8	6.7	1	C	3
Calamus solitarius	14	8.7	3	S	1
Calamus bimaniferus	7	13.3	3	C	2
Calamus centralis	8	14.2	3	C	2
Calamus laoensis	6	14.6	3	C	1
Calamus dioicus	6	46.1	3	C	1
Calamus poilanei	21	366.8	6	S	1
Calamus siamensis	16	29.7	2	C	2
Calamus acanthospathus	5	31.4	1	S	1
Calamus salicifolius	11	41.6	5	C	2
Calamus tenuis	9	42.6	9	C	1
Calamus gracilis	11	64.0	4	C	1

Table 3.4. (Con't)

Calamus nambariensis	6	53.1	6	C	1
Calamus guruba	8	60.7	8	C	1
Daemonorops poilanei	25	73.5	4	C	1
Calamus godefroyi	8	81.2	3	C	2
Plectocomiopsis geminiflora	10	154.3	4	C	3
Calamus flagellum	16	168.2	6	C	2
Calamus walkeri	37	170.2	12	C	1
Calamus henryanus	27	186.3	7	C	2
Calamus bousigonii	21	205.9	6	C	2
Korthalsia lacinosa	18	291.4	8	C	2
Calamus rudentum	18	308.9	6	C	1
Plectocomia elongata	21	331.3	5	S	3
Myrialepis paradoxa	30	386.5	5	C	2
Calamus rhabdocladus	32	409.1	8	C	2
Calamus tetradactylus	46	451.7	14	C	1
Calamus viminalis	62	530.3	15	C	1
Calamus palustris	49	542.7	14	C	1
Plectocomia pierreana	43	629.8	11	S	3
Daemonorops jenkinsiana	76	702.9	14	C	2

[1]Number of specimens included in analysis.
[2]C = clumped or clustering; S = solitary stem.
[3]1 = high quality cane; 2 = occasionally used; 3 = poor quality, rarely used.

CHAPTER IV
Steps Toward the Sustainable Use of Wild Rattans

Charles Peters

The sustainable use of rattan resources in the Lower Mekong Region will require three things: data, decisions, and responsive action. We need data on how much rattan there is in the forest, data on the density of different species, and data on the size-class distributions of the populations we want to exploit. We also need data on how fast different rattans grow. In terms of decisions, we need to decide which rattan species to exploit, and where, and how much to harvest. Responsive action, the final and perhaps most important component, implies that we actually do what we have decided to do. If we decide that we need a 5% inventory of rattan in all of the harvest areas, we go the field and count the canes. If we calculate the number of rattan canes that can be harvested each year on a sustainable basis, we stick to this harvest quota, regardless of market opportunities, selling prices, or other extenuating circumstances. Taken together, data, decisions, and responsive action comprise a management plan.

The present chapter focuses on what needs to be done to facilitate the sustainable management of wild rattans and provides detailed instructions on how to do this. The basic concepts of "resource stock" and "yield" are presented, and the way that sustainable resource use - or over-exploitation - results from the interplay of these two parameters is explained. The discussion then moves to more applied, operational concerns and address the collection of baseline data needed to make management decisions. What is the best way to inventory wild rattans? What is an appropriate sample percentage? How do you conduct a yield study? The next section of the chapter focuses on management planning and defining a sustainable yield of rattan from a given piece of forest. How much rattan can be harvested without seriously disrupting the regeneration and growth dynamics of the harvest population? The final

section addresses impact monitoring and successive harvest adjustments. How do we know if things are working and what do we do if things go wrong? This chapter, in sum, provides the nuts and bolts of sustainable resource use.

4.1. Relationship Between Stock and Yield

From a management perspective, a forest resource is most usefully described in terms of two parameters. The *stock* is the number of stems or individual plants of the resource-producing species that is found in the forest at one point in time. Stock is the parameter that a forest inventory quantifies. The population density data presented in Section 3.1 and in Tables 3.1 and 3.2, for example, describe the stock of different rattan species. The *yield* represents the rate at which a particular resource grows, or multiplies, or increases in quantity each year. The yield from resources like timber and rattan that are harvested by cutting the entire stem is quantified through a growth study[1]. The results from growth studies of rattan are shown in Section 3.5, Table 3.3, and Figures 3.2 and 3.3.

There is a close relationship between the current stock and the yield of a forest resource. Abundant species with dense populations have a large stock and produce a large amount of harvestable resource each year, while sparse, low-density populations exhibit a much lower yield. As the stock of a resource goes up within a given area of forest, so does the annual yield. Unfortunately, the converse of this is also true. As the stock of a resource decreases, so does the annual yield of that resource.

The relationship between stock and yield can have profound consequences for the sustainable exploitation of a forest resource. If we want to exploit the same species year after year from the same area, it is important that we harvest no more than its annual growth each year. If we harvest more than the annual growth in a single year, we diminish the current stock of the resource and, over time, the resource can be depleted from the forest.

[1]Different types of yield studies are required for other resources, e.g. studies to estimate fruit production, latex yield, or bark growth (see Peters, 1996).

A graphic example of this process is presented in Figure 4.1. The initial stock of rattan is assumed to be 1000 commercial canes with each of these canes exhibiting the phenomenal growth rate of 2.0 m/yr. Based on the initial stock of rattan and the growth rate, the annual yield from the population is 500 canes, i.e. 1000 canes x 2.0 m/yr ÷ 4.0 m/commercial cane.

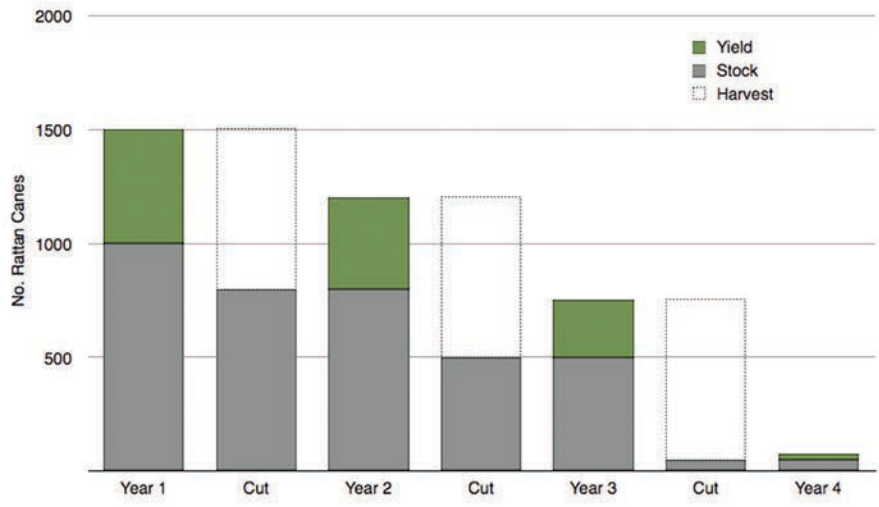


Figure 4.1. Relationship between the stock (green) and yield (gray) of a resource as illustrated by rattan harvesting. Rattan growth is assumed to be 2.0 m/yr; harvest rates are held constant at 700 canes (≥4.0 meters long) per year.

By the end of Year 1, the initial stock of 1000 canes has produced 500 new canes. During the first harvest, 700 canes are removed from the forest, reducing the stock to 800 canes. In Year 2, the reduced stock yields less new material, i.e. 400 canes, but harvest rates are held constant at 700 canes. The resultant Year 3 population exhibits a stock of only 500 canes and grows enough to produce only 250 new canes. The final harvest of 700 canes reduces the population to 50 individuals, which will only produce 25 new canes, and which will certainly not support another commercial harvest. It is important to note that this resource depletion scenario has played out in only three years.

4.2. Collection of Baseline Data

Given the inviolate relationship between the stock and yield of rattan, the first step in the management process is to find out how much rattan there is in the forest and to quantify how fast it grows. These data will be used to calculate the total production of rattan, to define harvest volumes, and, if necessary, to divide up the forest into management areas. The data also provide a baseline for assessing change in the rattan populations under exploitation, i.e. to see if the commercial canes harvested each year are being replaced by the growth of smaller rattans. The quantitative inventories and yield studies needed to collect these data are described below.

Species Selection

The species descriptions and dichotomous key presented in Chapter II should first be used to identify all of the rattan species found in local forests. The objective here is to make a list of local rattan species and to decide which species are to be included in the data collection activities. Although it takes only marginally longer to survey fifteen, rather than five, species of rattan in a forest inventory, the exclusion of non-commercial and unused species may be appropriate in some conditions. Rattans collected and used on a subsistence basis, but for which a market currently does not exist, should definitely be included.

In some cases, it may be desirable to include other non-timber forest resources, e.g. forest fruits, medicinal plants, plant exudates, in the data collection. This decision, ideally, should be made before the rattan inventories start to avoid having to repeat the surveys to include additional species.

Forest Inventories

A variety of different plot sizes and shapes have been used to inventory rattan (e.g. Stockdale, 1994; Evans and Viengkham, 2001), and there is a trade-off of time, cost, and statistical precision inherent in each

one. Inventories to be conducted at the village level have the additional requirement that the sampling methodology be easy to understand, easy to apply, and not involve the use of specialized or expensive field equipment. Based on these considerations, and after many years of experimenting with different inventory methods in a village context, a systematic sample composed of parallel, 10 m wide transects is recommended for estimating local stocks of rattan. This sample design has been shown to provide a high level of precision for wild rattans with a minimal investment of time (Siswanto and Soemarna, 1988; Stockdale and Wright, 1996), and it is relatively easy to teach people how to use. The transect method has been used to count rattans in dozens of community forests in Cambodia, Laos, and Vietnam, and, as a result, it has the additional benefit of producing inventory data that can be compared to other sites.

The transects are run straight along a pre-determined bearing using a compass. The bearing should be selected so that the transects run across topographical features, e.g. up or down slopes and across rivers, rather than parallel to them. Orienting the transects in this way will maximize the number of different habitats encountered in the inventory and provide a more representative sample of the forest.

The distance between transects determines the percentage of the total area that will be sampled. The closer the transects are together, the higher the sample percentage, and the greater the number of sample strips that must be inventoried to cover a given area. For example, separating the 10 m wide transects by 100 m would give a sample intensity of 10%, i.e. (10÷100) x 100 = 10, while separating the transects by 200 m would yield a sample percentage of 5%, i.e. (10÷200) x 100 = 5.

So, what is an appropriate sample percentage for rattan? This is an important question, because the higher the sample percentage, the higher the cost and the longer the inventory takes to conduct. We need a reasonable estimate of the density of wild rattans, but we also need a sampling strategy that is not so expensive or time-consuming that it would never be implemented by local communities. The basic problem is that the number of transects needed to adequately describe rattan density is a function of the variability encountered from plot to plot. If there is a lot

of variability, i.e. plots with lots of rattan next to plots with none, a lot of transects are needed. Conversely, populations that are more evenly spread out over the landscape can be described with fewer transects.

The extensive inventory results from communities in Cambodia and Laos were analyzed to assess the variability in the data and to estimate, given this variability, how many transects would need to be sampled to obtain a useful and statistically significant estimate of the mean density of rattan[2]. Although the recommended sample intensity varied from community to community, the rattan populations in most of the sites could be adequately described by sampling from 1.0 - 2.0% of the forest, i.e. about 2.0 hectares should be sampled for every 100 hectares of forest. Based on this finding, it is recommended that the inventory transects be spaced 400 m apart to provide a sample intensity of 2.5%.

Each 10 m wide transect is composed of a series of contiguous 10 x 20 m plots; the data from each plot should be recorded separately. Each 20 m segment of the transect should be carefully laid out using a compass and a nylon transect rope (described below). Stakes (approximately 2.0 m tall) should be cut, marked with bright flagging, and set at the beginning of each plot. The stakes help keep the transect straight and provide a point of reference to sight back on when laying out the next plot.

It is very important that a slope reading be taken using a clinometer[3] at the beginning of each plot, and that the length of the plot be adjusted as necessary to correct for slope. Failure to adjust for slope can lead to significant measurement errors. Assume, for example, that a 10 m wide transect is run for 1000 m along a 30% slope. If no correction is made for the topography, every 20 m measured along the transect will be 0.80 m too short and each 10 x 20 meter plot will contain 192 m^2, rather than 200 m^2. By the end of the transect, the sample will be 40 m too short and will contain 400 m^2, i.e. two plots, less than it should.

[2]Group means and coefficients of variation from hundreds of inventory transects were used to determine the number of sample units needed to obtain a mean value of rattan density with a standard error of less than 10% of the mean (Philip, 1994; Husch et al., 2003).

[3]A simple clinometer is found on many newer models of compass, and an angle gauge can also be used. With practice, percent slope can be estimated visually with reasonable precision.

A table of corrections for different percent slopes is shown in Table 4.1, and a slope-correcting transect rope should be made using the values in this table. Using a 30 m length of nylon rope of about 1.0 cm diameter, a double knot is tied at "zero" at one end of the rope and a second double knot is tied at 20 m. Single knots are then tied at each distance indicated in the table, e.g. the first knot at 20.10 m for a 10% slope, the second knot at 20.40 m, and so forth.

Table 4.1. Corrections to obtain a horizontal distance of 20 m along different percent slopes.

Slope (%)	Distance (m)
10	20.10
20	20.40
30	20.88
40	21.54
50	22.36
60	23.32
70	24.41
80	25.61
90	26.91
100	28.28

In laying out the plot, one crew member stretches out the rope 20 m along the correct bearing, guided by the compass person who stays behind at the start of the plot to take the slope reading. If, for example, the slope reading is 50%, the transect rope would be stretched tightly out to 22.36 m, or the fifth knot, before setting the plot stake. The rope should be left on the ground after setting the stake to provide a clear centerline for the plot. The transect rope is used in a similar manner in measuring out the distance between transects; slope corrections are made as needed.

Within each 20 m segment, two crewmembers move slowly from one end of the transect rope to the other, carefully searching for rattans within 5 m to the left of the centerline and 5 m to the right of the centerline. A meter tape or a 5 m piece of nylon rope can be used to

check whether rattan plants near the border are "in" or "out" of the plot. Rattans that fall right on the line are recorded alternatively, i.e. the first plant is "in" and the second plant is "out". The compass person, or another crew member assigned to record the data, will slowly walk the centerline and keep pace with the crew members working each side of the transect.

The rattan plants encountered in the plot are identified and then assigned to one of six height classes: 0 - 1.0 m, 1.1 - 2.0 m, 2.1 - 3.0 m, 3.1 - 4.0 m, 4.1 - 5.0 m, and 5.1+ m. On locating a rattan, or clump of rattans, the crew member should first call out the species, then the size class, and then the number of individuals. Reporting the data in this order will help reduce the number of recording errors. For clumped species that exhibit an excessive number stems, the number of stems/clump can be counted on a subsample of plants, e.g. one individual every other plot (Stockdale, 1994; Peters and Geisen, 2000).

To help document the relationship between habitat and the abundance of different species, as well as to provide details for mapping the management area, obvious changes in forest type, forest structure, or changes in land-use should be recorded for the plot in which the change occurs. Geographic features such as rivers, roads, fences, or field boundaries should also be noted.

A sample tally sheet for recording the data from each plot is shown in Table 4.2. Separate sheets should be used for each transect. The date, the GPS coordinate of the starting point (in Location column), the compass bearing, and the members of the field team should be recorded on the first sheet of every transect.

Yield Studies

The objective of a rattan yield study is to quantify the size-specific annual extension growth of different species growing in different habitats. This is an important number, because it will ultimately determine how much rattan can be harvested from the forest. In the same way that the sample percentage in a forest inventory should change in response to

the heterogeneity of the habitat, the number of individuals that need to be measured to obtain a reasonable estimate of annual stem growth depends on the species, the habitat, and the variability in the growth measurements between individuals. To sort out these patterns, the growth data presented in Table 3.3 were used to calculate the number of pre-commercial and commercial sample plants that need to be measured to obtain a meaningful estimate[4] of the annual growth of different rattans.

Table 4.2. Sample tally sheet for use in rattan inventories. Several lines can be used for each plot depending on the number of species encountered.

Date:								Team:	
Location:								Bearing:	
			Height Class						
Transect	Plot	Species	1	2	3	4	5	5+	Notes

The results from this analysis showed that the recommended sample sizes of combined pre-commercial and commercial plants ranged from 72 (for *C. viminalis*) to 26 (for *C. tetradactylus*). Within the present context, a reasonable estimate of the annual growth of wild rattan can be obtained by marking 50 - 60 sample plants, over half of which are of pre-commercial size (Peters et al., 2013).

The transect plot data can be used to locate sample plants for the growth study, although it is not necessary that all of the plants be growing within a transect. To sample as much environmental variability as possible, it is best

[4]Standard error/mean = 0.1; analysis followed Philip (1994) and Hutsch et al. (2003).

if the sample plants are located in clusters throughout the management area, rather than all grouped together in one place. The location of these clumps should be marked on a base map of the area and referenced with GPS coordinates.

Once a sample plant is located, its total height is measured[5], it is assigned to one of the six size classes, and it is given a unique number and labeled with a plastic tag. A GPS reading should be taken for each individual. In addition, each plant should be assigned to one of three canopy classes: 1) open - canopy more than 50% open with direct sunlight entering the understory, 2) patchy - clear patches of sky visible overhead with canopy cover ranging from 50 - 90%, and 3) closed - canopy more than 90% closed with most irradiance entering the understory as sunflecks, and evidence of rattan harvesting, logging, or other forms of disturbance noted. Field crews should keep a running tally of how many commercial and pre-commercial individuals of each species have been marked to better orient the search and selection of individuals.

Information about the sample individual and the site are recorded together on a tally sheet; an example is shown in Table 4.3. The plant is then marked for growth measurement by painting the apical portion of the stem (bud and last leaf) with bright yellow or orange paint. Spray paint usually works best for this. Field crews will have to climb or construct a simple ladder to paint the apical portion of the stem of plants in the taller size classes.

As the plant grows, all new tissue produced after the stem was painted will be green and there will be a clear line between the new and the old stem section. The sample plants will be left to grow undisturbed for 12 months following the stem marking before re-measurement. At this time, the total length of the green, unmarked apical portion of the stem will be carefully measured and recorded. Given that different groups of sample plants will undoubtedly have been marked on different dates, the exact date of re-measurement will vary. Re-measurement times

[5]This can be done with a ladder, by climbing a neighboring tree, or by means of a long pole with a meter tape attached. The objective here is to assign the plant to a 1.0 m height class.

should be programmed in advance to insure that the growth data from each sample plant is collected as close as possible to 12 months after the initial stem painting. If at all possible, the growth studies should be continued for more than one year. New plants can be marked to replace the loss of individuals due to mortality, e.g. harvest, or to increase the sample size.

Table 4.3. Sample tally sheet for use in the rattan growth studies. CC is Canopy Cover, i.e. 1=open, 2=patchy, and 3=closed; GPS column is for recording the coordinates of each sample plant.

No.	Species	Date I	Height (m)	CC	GPS	Date II	Growth (m)	Notes
1								
2								
3								
4								
5								

4.3. Estimating the Annual Yield of Rattan

Given data on the density and size-class distribution of a rattan species and growth estimates of reasonable precision, it is possible to calculate the total quantity of new rattan cane (m) produced by a species in a single year. This result will define the sustainable harvest level for the species. If the inventory or yield studies were stratified by habitat or forest type, the annual yield estimate will pertain solely to that particular environment.

The first step in this process is to insure that each habitat or forest type is a realistic, reasonably homogenous unit for grouping the data. Are there pockets of atypically high rattan density, or, alternatively, areas that contain very little rattan? Mapping the commercial densities of different species on a base map is the quickest way to look for these patterns. If there are obvious discontinuities, and these match up with environmental changes noted during the transect sampling, the

management area can be usefully divided into two or more stands. A hypothetical example of using inventory data to stratify an area like this is shown in Figure 4.2. The example is based on a forest type map from a village in Bolikhamxay Province in Laos; inventory transects are shown as horizontally strips running through the dark green forest type that was originally considered to be a homogenous unit. Assume, however, that the plots to the east of the temporary road (colored gray) showed a notably different grouping of rattan species and higher densities of commercial cane. These plots could be split off, grouped together, and the whole sample area separated out as a different forest type. Because of the consistent 400 m spacing between transects, the sample area in the new forest type is still 2.5%. The best tool for reducing the variability in either inventory or growth data is frequently a finer scale of stratification, i.e. grouping things together better.

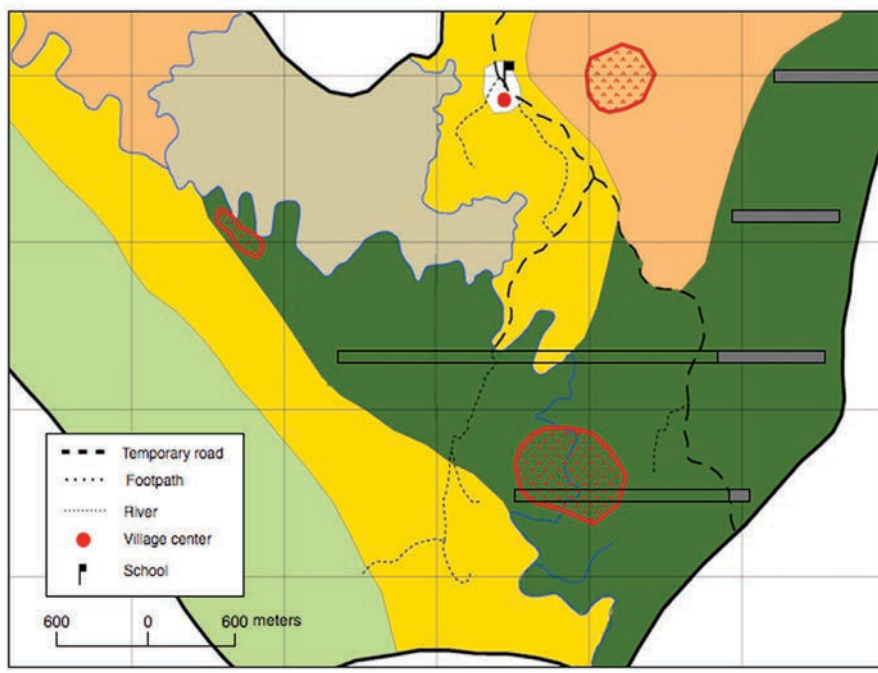


Figure 4.2. Hypothetical forest type map showing arrangement of transects and grouping of plots (shown in gray) with similar characteristics to create an additional habitat or forest type. Note that transects have been oriented to run perpendicular to the topography and to cross rivers rather than to run parallel to them; stippled red patches are high-density rattan stands. Based on actual land-use map from a village in Bolikhamxay Province in Laos.

Size-Class Structure

Once the habitat or forest types have been defined, the inventory data from each unit should be compiled into a size-class histogram showing the number of individuals/hectare in each of the six size classes (see Section 3.4 and Figure 3.1). Careful examination of the size-class distributions of different rattan species is a quick way to assess which populations can be exploited and which ones are best left alone for a few years. Populations with Type III curves, i.e. those that exhibit a pronounced lack of regeneration, should definitely be given a rest and periodically monitored.

Growth of Commercial and Pre-Commercial Canes

The growth measurements should be grouped into two classes: pre-commercial canes and commercial canes. Although a 4.0 m cut-off is used here, the actual merchantability criteria of a given region should be used to sort the growth data. Means and standard errors should then be calculated for the pre-commercial and commercial classes of every species included in the yield study.

Defining a Sustainable Harvest

Multiplying the growth rate of commercial and pre-commercial canes by the number of individuals in the size classes comprising each group provides an estimate of how many meters of new rattan cane/hectare was produced in a year. An example of this calculation, using inventory and growth data for *C. solitarius* collected in community forests at the village of Ban Sopphuane in Laos is shown in Table 4.4.

Based on the baseline data collected, the *C. solitarius* populations at Ban Sopphuane contain over 6,000 individuals that grow about 4,500 m each year. Most of this growth occurs in the pre-commercial size classes because of the large number of stems[6]. In terms of cane that can actually

[6] Another good example of the relationship between stock and yield.

be harvested, the commercial size classes are growing almost 175 m/year, or 44 merchantable (≥4.0 m long) canes/ha/yr. This is the amount of material that can be harvested from the forest without causing a decrease in the overall stock of cane on the site, i.e. the sustainable rate of harvest. Assuming that the species continues to establish new seedlings on the site, and that the growth rates and natural rates of mortality stay more or less the same, 44 *C. solitarius* canes can be harvested from every hectare of forest at Ban Sopphuane on an annual basis. Interestingly, the sustainable off-take of cane from this site is about 20% of the total stock of commercial canes[7].

Table 4.4. Calculation of total cane production from a wild rattan population using size-specific desnity data and growth estimates for pre-commercial and commercial size classes. Data from *C. solitarius* populations growing in community forests at the village Ban Sopphuane in Laos.

Size Class	N (canes/ha)	Growth (m/year)	Class Total (m/year)	No. Canes (≥4.0 m long)
1	5735	0.73`	4186.55	
2	155	0.73	113.15	
3	75	0.73	54.75	
4	75	1.09	81.75	20.45
5	30	1.09	32.7	8.17
6	55	1.09	59.9	14.97
TOTALS:	6125		4528.8	43.59

4.4. Monitoring

The collection of commercial-length rattan canes can cause changes in the harvest population. Shifts in biophysical parameters, e.g. rainfall, temperature, presence or absence of predators or pollinators, can also cause a population to recruit fewer or more seedlings each year or to exhibit a lower or higher rate of mortality. As the structure or dynamics of a rattan population changes, so does the number of canes that can

[7]In the absence of quantitative growth data for commercial rattan species in Cambodia and Laos, the WWF Sustainable Rattan Project initially based community management prescriptions on a generic 20% harvest limit.

be harvested from it on a sustainable basis. Harvest levels may need to go down if the number of smaller canes growing into the commercial size classes drops or growth rates decline, and harvest increases may be warranted if the population density goes up. A stand table projection[8] using the inventory and growth data from Ban Sopphuane, for example, found that with harvest controls the *C. solitarius* population increased 130% in five years, sustainable harvest volumes increasing from 44 to 57 canes/hectare.

The important point is that population changes, in either direction, do not go undetected. The best way to avoid this is to set up a series of permanent plots in the forest and re-inventory them every five years or so (Peters, 1994). The monitoring system could contain a subset of the original transect plots, together with any sample plants in the vicinity included in growth studies. The data from the initial inventory is the baseline against which change is assessed. Is the size-distribution of individuals changing in a predictable way? Are levels of regeneration being maintained? Is the total number of harvestable canes going up or down? How is the canopy cover above the plants marked for growth measurements changing?

As with everything else that has been discussed in this chapter, the total number of permanent plots needed for a monitoring system will ultimately depend on the variability encountered in the habitat. Scattering the plots throughout the management area, rather than clumping them together, will help account for this. As an initial approximation, 1 out of every 20 transect plots could be used for monitoring. Spacing the sample units 200 m apart would provide 25 monitoring plots for a 400 hectare management area. Running means of pre-commercial, commercial and total rattan density should be graphed as each successive monitoring plot is added to see whether the mean value for the subsample has stabilized, and, even more importantly, has stabilized at a level that approximates the mean

[8]Stand table projection uses size-specific growth rates, inferred rates of mortality, and inventory data on the initial structure of a forest populations to estimate population structure at some point in the future (Husch et al., 2003).

value obtained from all inventory plots. The plots should be marked to facilitate location, but not marked in such a prominent way that rattan collectors would avoid them.

The periodic re-sampling of the monitoring plots will reveal one of three patterns: 1) the density of rattans is going down, 2) the density of rattans is going up, or 3) the density of rattans is staying about the same. Each of these findings is a useful piece of diagnostic information, because now we know something about the actual impact of rattan harvesting. And this is where the responsive action come in. To reduce this impact, or to refine our definition of a sustainable harvest, or to congratulate ourselves for documenting an example of sustainable resource use, something will need to happen once the results from the monitoring plots are available. If the appropriate actions are taken, the back and forth between annual rattan harvesting and periodic glimpses of rattan population structure and growth will ultimately produce a sustainable system for exploiting the rattan resources of Cambodia, Laos, and Vietnam.

4.5. Recommendations/Caveats

The sustainable management of wild rattan is both a science and an art, and, in most cases, the actual sustainability of the enterprise hinges more on the willingness of a community to follow the prescribed harvest limits than on the statistical rigor of the data used to estimate them. The important point is to count plants and measure growth as best as possible, and to make sure that everyone understands how and why these data were collected. And to continually affirm that things will get better and better if the harvest controls are respected.

A few final thoughts:

- Always make back-up copies of the data from forest inventories and growth studies and store them in a different place from where the originals are kept.

- Always measure out to check whether borderline canes are "in" or "out" when running transects and always correct for slope.
- Annual harvest rates should always be based on the density and growth rates of the species being exploited.
- Freely share what you learn about rattan with colleagues, local authorities, and community members.
- Both the harvested and the harvester ultimately benefit from sustainable resource management. Do the best you can.

CHAPTER V
The Importance of Markets, Communities and Policies

Charles Peters and Thibault Ledecq

The sustainable exploitation of wild populations of rattan in Cambodia, Laos, and Vietnam has great potential for promoting forest conservation, conserving biodiversity, and enhancing the livelihoods of local communities. There is, however, a complicated and continually changing context within which this land-use practice is embedded. Market demand, consumer preferences, raw material supply, community organization, local enforcement, and policies relevant to rattan at both national and international levels all exert an influence of the way that rattan cane is produced and exploited in the Lower Mekong Region[1]. Some of these factors may greatly increase the probability that a community initiates a program of sustainable resource management; others may inhibit management efforts and promote existing patterns of resource use.

It would seem useful, therefore, to briefly look at the major drivers that will ultimately determine the fate of the wild rattan resource. Knowing the scientific name of a rattan species or defining a sustainable harvest level is only a small part of a much larger issue. Who will buy the rattan cane that is produced? And how much are they willing to pay for this material? Will local collectors and market chains respect the harvest limits imposed? What effect might forest certification have on markets, communities, and rattan supplies? What is the role of central governments in incentivizing the rational use of non-timber forest resources? How are the major importing countries responding to diminishing supplies and over-exploitation of the rattan resource? The present chapter will address these questions and

[1]The WWF rattan program did comprehensive reviews of the factors that need to be addresses to establish a sustainable rattan supply chain in Cambodia (Vahl, 2011), Laos (Campbell and Knowles, 2011), and Vietnam (Cuong Kim Vien, 2011), and also did gap analyses of rattan-related legislation in each country (Ros, 2010; Phanvilay, 2010; and Nguyen Van San, 2010).

examine alternative scenarios involving the systematics, ecology, and management of local rattans. Although the discussion is structured around market demand, community involvement, and government policies, these categories are very much interrelated and changes in one sector will usually engender a response in the others.

5.1. Market Demand

In spite of threats of diminishing supplies, there is still a strong demand for rattan in European and US markets (Foppes, 2012). On one hand, this is a good sign for community producers who are thinking of starting a program to manage rattan as there are a lot of buyers. In the absence of local management efforts, however, the continuing demand for rattan will do little more than put additional pressure on the resource base. Market demand can provide a management opportunity or an incentive for resource depletion.

Indonesia's decision in 2011 to ban the export of raw rattan is another source of demand that is having an impact on the rattan resources of the Lower Mekong Region. Prior to the ban, Indonesia was the number one supplier of rattan cane in the world and the rattan industries in several countries, e.g. China, Singapore, Thailand, depended on this raw material (Hirschberger, 2011). Now that these supplies are no longer available, increasing quantities of rattan cane are being sourced from Cambodia and Laos. Much of this material is undocumented, harvested in an uncontrolled fashion, and trucked across the border into China and Vietnam (see Section 1.7 and Figure 1.3).

In spite of the increasing demand for rattan cane, selling prices have fluctuated in different countries, and increasing transaction costs, e.g. transportation fees, taxes, and documentation requirements, have generally kept community profits low even when the price of the raw material has gone up. This would seem to be largely the result of a lack of information to producers about the actual value of the cane and the costs involved to

get it to market. Without management systems in place, however, a more realistic price would undoubtedly create more harvesting.

5.2 .Community Involvement

An additional trend that was noted in the international rattan trade was an increase in the demand for certified rattan. There is a growing number of consumers who appreciate the conservation benefits of good forest management and are willing to pay a price premium for sustainably-sourced rattan products. Combining community management of rattan with forest certification is a promising way to take advantage of this increasing market share. In 2011, the rattan forests[2] of four villages in the Bolikhamxay Province, Laos were certified sustainable by the Forest Stewardship Council (FSC). In each village, baseline data were collected and detailed management plans with harvest quotas were developed. These communities, in essence, have actualized the basic management tenets outlined in this book. If the market is able to compensate them for their efforts by offering a higher selling process for sustainably-produced cane[3], certification and sustainable rattan production could quickly become a viable land-use strategy.

Communities are the interface between the market and the forest. If the demand for a resource goes up, the community can: a) harvest more from the forest regardless of what is stipulated in the management plan, or b) address the demand increase through a discussion of price with the buyer, i.e. same supply, higher price. The first scenario has consistently been the most common one for rattan. There is a great need to increase capacity at the community-level about the value chain in which it participates, and to put in place better mechanisms of enforcement to deal with over-harvesting and inequities and/or misunderstandings between buyers and sellers. By

[2]A total of 1,142 hectares of forest were certified. The project was a joint effort between WWF, the National Agriculture and Forestry Research Institute, and the Department of Forestry.

[3]It is reported that the communities are receiving a 20- 30% price increase for the canes (http://wwf.panda.org/?201497/World-Premiere-First-FSC-certified-rattan-forest-in-Laos), and that the overall revenues flows from the project have been positive (Campbell and Knowles, 2011).

banding together to consolidate their rattan resources, communities could enhance their market position and strengthen their ability to negotiate a price with buyers.

5.3. Government Policies

The governments of both producer and importing countries have enacted policies that have an impact on the management and trade of rattan. The amendments added to the U.S. Lacey Act (16 U.S.C. 3371 et seq.)[4] in 2008, for example, have significant implications for the rattan industry in the way that they prohibit both the import of illegally harvested raw materials and the finished products made from them. The same import declaration forms needed for rattan cane harvested in Cambodia is required for a chair made from this material in China. Neither product would be allowed in the U.S. if the raw material was harvested or transported illegally. Additionally, not only do importers have to know the details of the chain of custody of the material, they are also required to know the scientific name, i.e. genus and species, of the plant. Given that the U.S. is the largest single importer of rattan furniture, basketwork, and mats in the world, the Lacey Act amendments add a new relevance - and an urgency - to the rattan field guide presented in Chapter II.

To reduce dependency on the import of rattan cane, the government of Vietnam is currently implementing a five year program through the Ministry of Agriculture and Rural Development (MARD) to expand the amount of land under rattan cultivation. The Ministry will provide rattan seedlings and a small subsidy to villagers that agree to plant rattan. While this initiative will increase the amount of locally-produced rattan cane in a few years, it is unclear what effect the program will have on efforts directed toward the management of wild rattan populations.

The proposed formation of a single ASEAN Economic Community (AEC)[5] in 2015 will undoubtedly have a major impact on the rattan

[4]The U.S. Lacey Act of 1900 prohibits trade in wildlife, fish, and plants that have been illegally harvested, transported, or sold. The law was amended in 2008 to expand protection to a wider range of plants and plant products, including rattan (http://www.aphis.usda.gov/plant_health/lacey_act/).

[5] In 2007, the leaders of the ten ASEAN countries, i.e. Singapore, Philippines, Malaysia,

industry. The net effect of this consolidation on different countries in the Lower Mekong Region will largely depend on how the AEC concept is implemented and accepted. The elimination of existing tariffs and trade restrictions could mean more exports of raw cane and faster liquidation of local rattan resources in countries like Cambodia and Laos, where rattan processing capabilities are still undeveloped. The enlarged market provided by the AEC will probably benefit large investor countries, e.g. Vietnam, Thailand, Indonesia, and Singapore, and be a disadvantage for member countries with a lower level of industrial development, e.g. Cambodia and Laos.

One forum within the ASEAN context that can play an important role in promoting sustainable resource management is the ASEAN Social Forestry Network (ASFN). The ASFN is a government-driven social forestry network that links policy makers directly with members of civil society, research organizations, academia, and the private sector, all sharing the common vision of enhancing social forestry initiatives in ASEAN member countries as a means of alleviating poverty and improving the management and use of local forest.

Recommendations from the ASFN concerning the production, commercialization, and trade of rattan could produce a host of relevant policy changes in the Lower Mekon Region. The creation of a sustainable rattan industry within the AEC, with FSC-certified production systems and creative links to green markets in Europe and the US, would provide innumerable economic, social, and conservation benefits to villages in Cambodia, Laos, and Vietnam. It would also set a standard for forest conservation and the sustainable use of non-timber forest products unparalleled by any other tropical region in the world.

Finally, rattan is the foundation of a small but growing furniture and basketry industry in Cambodia, Laos, and Vietnam. Based on more than

Thailand, Indonesia, Vietnam, Laos, Cambodia, Brunei, and Myanmar, agreed to the formation of a unified regional economic community representing a single market and production base (http://www.thaifta.com/ThaiFTA/Portals/0/ASEAN_AECFactBook.pdf).

eight years of work on rattan in these countries, from taxonomy and ecology to community manangement, certification and export, we offer the following policy recommendations for developing the local rattan industry and sustaining the rattan resource:

- Local and international organizations should work together to assist national and provincial governments in developing a landscape approach for existing Green Economy strategies (Kingdom of Cambodia, 2009) and to stimulate small and medium enterprises (SME) and community initiatives based on rattan and other NTFPs.
- Given that the demand for sustainable and legally harvested rattan products from international retailers exceeds the current supply in the Lower Mekong, it is crucial to continue supporting: i) capacity building for all stakeholders, i.e producers, processors, and traders, ii) strengthening linkages in the rattan value chain,and iii) promoting the development of mutually-beneficial business partneships.
- Vietnam has recently developed a national rattan program[6] in response to the decreasing supplies of rattan cane. Support is needed to extend and strengthen the legal documentation required by this program at all levels. The policy initiatives on rattan in Vietnam could be usefully emulated by Cambodia and Laos.
- An effective market information system needs to be established to provide producers, processors, and traders with basic information, e.g. market prices for rattan, contact information of buyers, processors, and manufacturers, procession techniques, legal documents required for rattan harvesting and transport, and updates on important market developments.

[6]Decision No. 11/2011/QD-TTg of the Prime Minister, dated February 18, 200, on incentive policies for rattan and bamboo industry development.

- An appropriate incentive system for the private sector is needed to stimulate investment in rattan. For example, the tax laws relevant to the rattan sector need to be simplified and made more transparent and specific to different parts of the value chain, i.e. rattan traders, middlemen, small and medium enterprises.
- Cross-border gate regulations between Cambodia, Laos, and Vietnam should be developed and strictly enforced to control the flow of rattan between countries.
- The FSC certification efforts in Lao provide a useful example for Cambodia and Vietnam. Within ASFN, the forest certification initiatives should be supported as they promote sustainable resource use, produce rattan to supply a growing market sector, and could result in larger revenue flows to communities.

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Rattans, spiny climbing palms in the subfamily Calamoideae, are some of the most valuable and widely-used non-timber forest products in the Asian tropics. Although the collection and sale of rattan cane generates large revenues each year for Cambodia, Laos, and Vietnam, the taxonomy of most wild species - even the most important commercial ones - is unclear, and there is a total lack of information about the density, abundance, and conservation status of wild rattan populations. Rattan stocks are dwindling, yet we still don't know the names of all the species, or which ones are most threatened, or what can be done to harvest the resource on a sustainable basis.

The present book addresses these questions. It provides a field guide to the 65 different species of rattan that occur in the three countries together with distribution maps, diagnostic photos, and a dichotomous key for identifying the species, summarizes the ecology and conservation of local taxa, and outlines a simple protocol for collecting the inventory and growth data needed to define a sustainable harvest of wild rattan. By putting all the necessary tools together in one place, it is hoped that the wild rattan resources of Cambodia, Laos, and Vietnam - together with the forests within which they grow - will finally get the stewardship that they desperately need.

Cover image: *Calamus rudentum* Lour. growing in Cat Tien National Park in southern Vietnam. Photo by A. Henderson

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