

Rattan: a report of a workshop held in Singapore, 4~6 June 1979

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Postal Address: Box 8500, Ottawa, Canada K1G 3H9
Head Office: 60 Queen Street, Ottawa, Canada

IDRC, Ottawa CA

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Foreword

Rattans are climbing palms that have been utilized for centuries in several Asian countries. In recent years the demand for rattan products, and for rattan furniture in particular, has increased considerably mainly because of a growing export market for these products. At present the demand for good quality rattan exceeds the supply and the opportunities for increasing the economic benefits of this renewable resource are excellent in several countries of Southeast Asia.

Although a few species of rattan have been cultivated in Indonesia for more than 100 years, the greatest proportion of the production comes from plants growing in the natural forests. In several areas the supply of rattan is diminishing at a fast rate and there is no reliable information available about the growing stock because rattan is not included in the forest surveys carried out to estimate the volume of standing commercial timber.

To help the rattan industry a few producing countries have started in recent years to give some attention to research on the silviculture and utilization of rattan. It is as a result of an inquiry from Malaysia about the possibility of supporting a research project on rattan that IDRC was first made aware of the problems of the industry and of the need to do research to develop silvicultural techniques to establish rattan plantations. A search of the literature revealed that little information was readily available about the existing knowledge on rattan in Asia.

Because rattan was obviously an important forest product in several Asian countries, IDRC invited Mr K.D. Menon, former Director General of Forestry for Malaysia, to prepare a state-of-the-art review of the production and utilization of rattan in South and Southeast Asia. More specifically he was asked to assemble the information available on the collection, processing, and trade of rattan, to review the research being undertaken on the cultivation of commercially important species, and to propose priority research areas after consultation with government, industry, and research people of the region. After traveling to most countries of the region, Mr Menon submitted his report to IDRC toward the end of 1978. He suggested that IDRC sponsor a workshop of rattan specialists so that they could review his report and give their opinion on research priorities and other activities that should be undertaken in the region to focus attention on this important natural resource.

A workshop attended by specialists of seven Asian countries concerned with the production and utilization of rattan was convened in Singapore in June 1979. The study undertaken by Mr Menon was presented as a background paper and, as a result of the workshop discussions, the paper was revised in the form presented in this report. The proposals for priority research areas reflect the consensus of those who attended the workshop.

IDRC wishes to express its gratitude to Mr Menon and to all the people who

helped him carry out his assignment successfully. We are also indebted to the workshop participants for the valuable contributions they made. Hopefully the information contained in this report will give rise to several projects that will contribute to the development of the rattan industry in Asia.

Gilles Lessard

Associate Director (Forestry)

Agriculture, Food and Nutrition Sciences Division

International Development Research Centre

Participants

Casin, R.F. Chief, Wood Preservation Division, Forest Products Research and Industries Development Commission, National Science Development Board, College, Laguna 3720, Philippines

Dransfield, J. Senior Scientific Officer (Palms), Royal Botanic Gardens, Kew, Richmond, Surrey TW9 3AB, England

Generalao, M.L. Coordinator, Agroforestry Research Center, Forest Research Institute, Ministry of Natural Resources, College, Laguna 3720, Philippines

Graham, Michael Head, Technical Editing Unit, Communications Division, IDRC, P.O. Box 8500, Ottawa, Canada K1G 3H9

Hallam, Robin Liaison Officer (Asia), Agriculture, Food and Nutrition Sciences Division, IDRC, Tanglin P.O. Box 101, Singapore 9214

Harun Alrasjid Chief, Silviculture Department, Lembaga Penelitian Hutan, Jalan Gunung Batu, P.O. Box 66, Bogor, Indonesia

Hepburn, John Supernumerary Forestry Research Officer, The Forest Department, P.O. Box 1407, Sandakan, Sabah, East Malaysia

Johari Baharudin Assistant Director (Plantations), Forest Research Institute, Kepong, Selangor, West Malaysia

Leong Hing Nin State Director of Forestry, Johore, Johore Baru, Malaysia

Menon, K.D. Forestry Consultant, 36 Lorong Permai, Robson Heights, Kuala Lumpur 08-06, Selangor, Malaysia

Nambiar, V.P. Krishnan Plant Taxonomist, Kerala Forest Research Institute, Peechi 680653, Trichur District, Kerala State, India

Poh Kok Kian Executive Director, Sabah Rotan Corp. Sdn. Bhd., WDT No. 56, Kota Kinabalu, Sabah, East Malaysia

Prasert Bhodthipuks Silvicultural Research Sub-division Chief, Royal Forest Department, Bangkok, Bangkok, Thailand

Salleh Mohd. Nor Director, Forest Research Institute, Kepong, Selangor, West Malaysia

Soenarjo Hardjodarsono, Moh. Director, Lembaga Penelitian Hasil Hutan, Jalan Gunung Batu, P.O. Box 84, Bogor, Indonesia

Soerjono, R. Director, Lembaga Penelitian Hutan, Jalan Gunung Batu, P.O. Box 66, Bogor, Indonesia

Tyebally, Abdullah Executive Director, Rattan Industries Pte. Ltd, 396-A Pasir Panjang Road, Singapore 5

Verma, V.P.S. Officer in Charge, Minor Forest Products Branch, Forest Research Institute, P.O. New Forest, Dehra Dun, India

Vivekanandan, K. Research Officer, Forestry Department, No. 9 Kew Road, Colombo 2, Sri Lanka



Proposals for Priority Research Areas

If one considers the fact that research on rattan has been largely neglected for several years and that planned rattan research programs were formulated, formalized, and initiated only in the midseventies, and even then in only two of the countries visited by Mr Menon, almost any or every aspect from the resource base itself to final utilization can be identified as requiring research. Noting the role that the rattan industry and trade can play in socioeconomic development and the impact and impetus that research can give that industry and trade, particularly when rattan and rattan products are in increasing demand, one can detect the urgency for meaningful research.

A meaningful research program at this stage and status of the industry and trade in rattan can best be formulated if it is directed toward solving problems faced or expected to be faced in the foreseeable future. In this regard, a newsletter to keep researchers informed would be valuable.

In the allocation of priorities, the urgency of the problem must receive first consideration. However, the availability of manpower, facilities, or equipment to execute the program is no less important. Other criteria like status of available information should also be considered but should not be allowed to overshadow the issue.

Three broad areas requiring immediate attention are: conservation of existing stocks; standardization of research procedures; and extension and training.

Urgent attention should be given to the complete reappraisal of the legislation governing the exploitation of rattans. Up to now rattans have not been included in forest management plans, and until they are, the chances of controlling exploitation are minimal. With the rapid disappearance of forests throughout the region and excessive exploitation, rattans, especially those of economic importance, are a severely threatened plant group. Serious consideration must be given to strict protection of rattans in nature reserves and the establishment of gene pools in arboreta and botanic gardens. At the same time rational control of exports of raw rattan would help to control excessive exploitation and would have the additional benefit of promoting local rattan industries.

Immediate gains can be accrued to these local industries with the introduction of standardization of rattan grades and specification, and dissemination of existing information on better means of processing as practiced by the trade in some of the other countries of the region.

The introduction of improved processing techniques and training of the rattan workers will not only benefit rural communities but will have a positive effect on the trade as a whole. Examples of local improvements include transportation methods that will avoid the bending of canes, and their subsequent downgrading in value, and refinement of cleaning and scraping techniques.

It was felt that it was important that research results be comparable throughout the region. For this to occur, it is necessary that research procedures be standardized. After considerable discussion of research priorities, three main areas for investigation were identified: large-diameter rattans, especially those greater than 25 mm in diameter; small-diameter rattans, particularly *C. caesius* and *C. trachycoleus*; and utilization.

Large-Diameter Rattans (> 18 mm)

High Priority

(1) There is a need for an extensive regional survey involving the collection of botanical specimens together with cane samples for commercial testing and ecological and ethnobotanical data.

(2) A complete reassessment of the qualities and potential of large-diameter rattans should be carried out by the commercial testing of cane samples. This testing should include not only those species presently used but others of similar diameter as well.

(3) The information gained in the regional survey and from the results of the commercial testing should be used to identify large-diameter rattans of silvicultural potential.

(4) Silvicultural trials should be carried out with these species to gauge their plantation potential.

(5) Successfully tested species must be used to establish pilot plantations and consideration should be given to the inclusion of rattans in agroforestry systems.

Where it is already known that certain species, such as "rotan manau" (*C. manan*) and "palasan" (*C. maximus*) are of silvicultural potential, then silvicultural research as outlined for small-diameter rattans can be implemented immediately. But, it is very important that the presence of a species already identified as having silvicultural potential does not preclude the implementation of survey work. It may well be that species of greater potential also occur.

While workers are collecting information during regional surveys for large-diameter rattans, little additional effort is required to obtain specimens and data on small-diameter rattans, other than the commonly utilized *C. caesius* and *C. trachycoleus*. This is particularly important in areas with a climate more seasonal than that found in the range of *C. caesius*.

Small-Diameter Rattans (< 18 mm)

High Priority

(1) A socioeconomic and management study of the existing small-holder rattan plantations in the Barito Selatan area of Central Kalimantan, Indonesia, is

required as a basis for the immediate implementation of plantations of these species elsewhere.

(2) An analysis of the growth of these rattan species is required to be able to predict levels of production.

(3) It is necessary to establish reliable seed sources of *C. caesius* and *C. trachycoleus*.

Medium Priority

(1) Phenological studies are required to determine where and when seeds of required species can be collected for trials and possible establishment of plantations.

(2) It is necessary to conduct seed technology studies to investigate treatment and storage, and transportation and quarantine of seeds of chosen species to improve seed supply and facilitate the exchange of seed within the region.

(3) Silvicultural studies are needed to investigate transplanting and spacing techniques; survival and growth; soil, moisture and light requirements; induction and acceleration of growth of seedlings; suckering habits, including induction of suckering and multiple suckering; the ecology of mature species under natural growing conditions; and protection from pests and diseases.

(4) An inventory and selection of varieties of *C. caesius* to determine the best variety for silviculture is also required.

Low Priority

(1) Population-dynamics studies of naturally occurring populations of small-diameter rattans, including the development of seeds and seedlings in the forest, should be undertaken to augment data obtained from silvicultural trials.

(2) Germination studies may be required in certain situations. Standard forest nursery practices appear to give good results under normal conditions and no immediate research is needed.

(3) Studies on vegetative propagation to reduce the time required for plantation establishment would be valuable.

(4) Also of interest would be a study to determine the most suitable fast growing trees for support and the provision of the correct amount of shade.

C. trachycoleus, in its natural distribution is confined to a small area of Borneo. But there is much to suggest that it could grow in all areas of the natural range of *C. caesius*. Outside the perihumid area of Southeast Asia, it will probably be necessary to find other small-diameter rattan species with similar cane characteristics of silvicultural potential. But, silvicultural practices established for *C. caesius* and *C. trachycoleus* could well be applicable to other small-diameter rattans.

Utilization

High Priority

(1) Studies are required to improve harvesting techniques to reduce wastage and the effort involved in collection.

(2) It is necessary to investigate the scientific basis for the current processing techniques of washing, fumigation, dipping, drying, and boiling, so that these techniques may be better understood and perhaps improved and standardized.



Studies are required of the scientific basis for the procedures used in small processing plants such as this one in Jambi, Sumatra where stems of "rotan sega" (Calamus caesius) and sticks of "rotan manau" (Calamus manan) can be seen drying on the ground.

(3) Improved methods of harvesting and processing, including correct techniques of scraping of nodes and methods for the prevention of bent canes during transport, should be extended to rural communities. This would increase the economic benefits to the primary producers in the rural areas, while improving the quality of the cane.

Medium Priority

(1) Anatomical, physical, and mechanical properties should be related to the improvement of methods of seasoning and treatment of rattan.

(2) It is also necessary to relate anatomical, physical, and mechanical properties to the uses of rattan so that the large number of presently unused species can be investigated and possibly brought into use.

The investigations suggested above for processing techniques are aimed at arresting deterioration and stabilizing the raw material. Utilization research can only be carried out successfully by close cooperation with the rattan trade. Product improvement is normally beyond the scope of research institutes, and the trade itself must bring about these changes. With regard to anatomical studies many aspects could provide excellent projects for short-term research in the universities of the region.

Emphasis on increasing personal contacts and the exchange of information will lead to a better understanding of regional problems, help foster regional cooperation, and ultimately aid in the development of this important rural-based industry.

Background Paper

Rattan: A State-of-the-Art Review

K.D. Menon



Introduction

Rattan may be rated as the most important forest product after timber. Yet it is relegated to the status of a “minor forest product,” an appellation by which a host of other common forest products are known. Until very recently rattan has been one of the most neglected natural resources in Southeast Asia. Although rattans have been exploited and utilized for centuries, comparatively sparse scientific attention has been paid to them. Corner (53) in his study of the natural history of palms states that long before the Portuguese brought rattan commerce to Europe with the opening of the Orient, “rattans were so invaluable to village-life that one can speak of the rattan civilization of Southeast Asia as one can speak of the tree-palm civilization of India and the bamboo civilization of Indo-China, China, and Japan.”

Today the rattan industry remains very much a part of the village or rural life, and rightly so. Though no accurate data are available on employment generated by the rattan industry in the rural areas of Southeast Asia, a conservative estimate puts the figure at half a million directly employed in cultivation, extraction, processing, and cottage-scale manufacturing.

The rattan industry is labour intensive, with a per-worker investment far below that of most of the other industries that seem to find favour with entrepreneurs and governments. In the processing and manufacturing aspects of the industry it is estimated (139) that investment per worker is about U.S.\$1750 compared with U.S.\$26 250 in petrochemicals. Collection and extraction of rattan involves far less investment.

Trade in rattan in recent years has become a multimillion dollar business. Trade in raw rattan amounts to U.S.\$50 million, and by the time the manufactured product reaches the consumer its value is increased to about U.S.\$1.2 billion. Rattan products are said to be “fashion proof,” and they have stalwartly withstood competition from substitute materials. In fact, they have recently gained greater popularity, for they seem to blend with or complement many other modern construction materials.

In the last 5 years there has been an increasing surge of interest in rattan and rattan products. There is a healthy trend toward more organized research into

some of the more important aspects of rattan cultivation and utilization, notably in the Philippines and in Malaysia. Several other countries, like India, Indonesia, and Thailand have indicated their firm intention or desire to initiate planned research. Village cooperatives are being established among collectors, processors, and manufacturers, as for example in India. A leading importer of rattans in Hong Kong has recently established joint venture companies in the rattan cultivation areas of Kalimantan in Indonesia to ensure steady supplies of better quality rattan. In Malaysia, a firm of consultants has confidently chosen to involve itself directly in the rattan industry and has not only established its own processing and exporting centre in Peninsular Malaysia but also established a similar centre in Sabah in a joint venture with a corporate body of the Sabah Government; further, it has plans to extend its operations into rattan cultivation. Attempts are also being made in some countries to promote rattan as an agroforestry product.

In the Philippines, export of raw rattan has been banned. In March 1978, Thailand followed suit. In India some of the rattan-growing states have imposed a ban on interstate trade of rattan to ensure more employment for their own rural people. And Sabah and Sarawak have recently imposed a fee on the export of raw rattan.

There is an awareness of the importance of rattan in socioeconomic development, but such awareness is yet to forcibly penetrate the topmost echelons of national decision-makers. The fast disappearance for agricultural development of large tracts of the more easily accessible forest areas, which contain rich resources of rattan, the uncontrolled collection of rattan, incorrect handling and treatment of rattan leading to a high rate of deterioration, the increasing demand for better quality rattan, and several other contributory factors have alerted researchers, entrepreneurs, and trades to the need for greater research inputs and for better organization and management of the rattan industry and trade.

Opportunities for promoting the rattan industry as a labour-intensive, comparatively low capital investment, rural-based industry with an increasing prospect for earning greater foreign exchange not only are evident but are beginning to compel serious attention. Many researchers and research establishments have indicated their willingness to initiate, augment, or widen the scope of their research efforts, whether on their own or in cooperation with researchers or research establishments in Southeast Asia. However, there are difficulties or impediments, not only in the field of research but also in other areas, that can and must be overcome if the rattan industry is to be dynamic and is to contribute its fair share to the socioeconomic development of the countries of the region.



The Rattan Plant

The Malay word “rotan,” which is the collective name for the climbing members of a big group of palms called *Lepidocaryoideae* (meaning scaly fruited in Greek), is suggested (49) to be derived from “raut,” which in Malay means to pare, smoothen, or whittle. The paring or smoothing operation takes place when a rattan collector drags down a cane, twists it around a convenient rough-barked tree trunk, and rubs off the prickly leaf sheath; later, the siliceous surface is also rubbed off. The word “rattan” is an anglicized version of “rotan.”

Many of the rattans have additional qualifying epithets in Malay or aboriginal tongues. In Malay, many of these qualifying names have obvious significance and indicate specific characteristics of the plants. These names may refer to the surface of the cane, its thickness or hardness, its want of length, its use, its branching in order to flower, the bitterness of its apical buds, the shape of the sheaths or leaves, the arrangement of prickles, the type of resin or sap exuded — all these seem to have influenced the naming of different species in the Malay language. In several cases, though, the qualifying words have no obvious meanings in Malay, “as if they had their origin in the languages of the Pagan races.” (49).

Nevertheless, there is an enormous confusion in local names even within countries. For instance, in Sabah “rotan batu” is a cane 2–4 cm in diameter, but in the Malay Peninsula it is a cane 0.5 cm in diameter. In fact, they are totally different species. In Nabawan (Sabah), all uneconomic though botanically different species are called “rotan pipit.” Some names are rather consistently applied, e.g., “rotan sega” (*Calamus caesius*) in Malaysia and “rotan tamam” (the cultivated *C. caesius*) in South Borneo. The confusion in local names makes it impossible to rely on them. Even within the same country, a botanically similar species may be known by different local names in different states or provinces. There has been much confusion stemming from early works incorporating uncritical lists of local names and their botanical equivalents. This, unfortunately, has been perpetuated from publication to publication. There is an obvious need for a critical reappraisal.



A group of Daemonorops mirabilis in selectively logged forest in Balikpapan, Kalimantan, Indonesia.

Dransfield (59) gives a concise and simple account of the stems, roots, leaf sheaths, leaves, climbing organs, inflorescences, flowers, and fruits of the rattan plant, noting important variations in their character.

The stem system of rattans is very variable; it affects the general appearance of the plant and hence is of considerable taxonomic value. Some species of *Calamus* are even "stemless" (49). Unfortunately, there is little information on the different systems.

One of the most important stem variations, and one that has economic significance, is solitary versus clustered stems. Solitary stemmed rattans like *Calamus manan* and *C. laevigatus* are one-harvest rattans. Clustering species

such as *C. caesius*, *C. trachycoleus*, and all species of *Korthalsia* are reharvestable. Another important parameter of the stem system is aerially branched versus aerially unbranched. Nearly all rattans, if they branch at all, do so at ground level. *Korthalsia*, peculiar in many respects, branches aerially and profusely. Suckering and aerial branching are thought to be sympodial from axillary buds. Suckering at the base of the stem normally occurs one sucker from each node, growing directly into aerial stems or passing through an intermediate stolon stage that metamorphoses into an aerial stem.

In the case of two important cultivated rattans, *C. caesius* and *C. trachycoleus*, an elaboration of the stolon metamorphosis is noted. In *C. caesius* when the very short stolon undergoes metamorphosis into an aerial stem, it produces two branches that develop into short stolons, many of which remain dormant as bulb-like shoots. The "bulbs" metamorphose into aerial stems only if the clump is cleared. In *C. trachycoleus*, the branching system is exactly the same except that the stolons are long, above ground, and there is no dormancy of shoots. The diameter of the stems varies from broad stolons with short internodes to slender aerial stems with long internodes. In both these species, the first produced stem is erect and becomes an aerial stem of small diameter. The first one to three suckers also become aerial stems, but subsequent suckers become stolons. In the case of *C. trachycoleus*, a vast area of ground and canopy may be covered by the plant (62).

Stem diameter varies considerably. Some montane *Calamus* spp. may be a mere 3 mm in diameter, whereas the species *Plectocomia elongata* may reach a massive 20 cm in diameter. Stem diameters hardly increase at all with age. Stem lengths vary from the very short ones of species such as *C. castaneus* to the immense 200 m stems of *C. manan* and *C. caesius*. Internodal lengths tend to vary considerably within species, among stems from the same clump or even on the same stem (49). Surface features, such as colour, gloss, and texture, vary considerably among different species of rattan. These features contribute to the economic value of the species.

Little is known of root systems. In one species (*C. caesius*) examined by Dransfield (59), at least four systems were distinguishable in swamp soils — horizontal spreading roots, vertical geotropic roots, vertical apogeotropic roots, and fine lateral roots.

Leaf-form variation is enormous. The degree of apical growth of the leaf and the length of the petiole are two major parameters of leaf form. The most important single vegetative feature for purposes of identification is the armature of the leaf sheath, which is very varied and specifically distinct. The spine arrangement of the leaf sheath is highly characteristic. Very few species have virtually unarmed leaf sheaths. It is these spiny leaf sheaths and the climbing organs, which anchor the rattan in the canopy, that are the two major hindrances to rattan collection.

The two major climbing organs are the cirrus and the flagellum; although both appear as long whips barbed with reflexed thorns, they are of different origin. The cirrus and the flagellum are responsible for much of the unpleasantness in surprise encounters with rattan in the jungle. The cirrus is an elongation of the apex of the leaf that bears reflexed thorns in whorls or singly. The flagellum originates from the leaf sheath and bears tightly sheathed tubular bracts with a dense covering of reflexed thorns.

There are two major types of inflorescence: terminal, which die after fruiting; and lateral, from which the stems continue to grow and flower until they are damaged, killed, or die of old age.

Little is known of the phenology of flowering in rattans. Generally, undergrowth species appear to flower and fruit throughout the year, whereas some high climbing species show evidence of seasonality. In seasonal areas, e.g. North Celebes, there is evidence of seasonality in flowering. All Southeast Asian rattans, apart from *Korthalsia* have unisexual flowers. They are relatively small, rarely exceeding 1 cm in length, and are brownish, greenish, or cream in colour.

Rattan fruits are similar throughout all species and genera in that they have reflexed scales on the pericarp. The scaly fruits are often a rich brown colour and have a high lustre. One fruit has one seed, or occasionally two or three seeds. Apparently, rattan seeds cannot withstand drying; "yet they still take one to six months to germinate" (59).



Phytogeography

Dransfield (59) observed that relatively little is known about rattan distribution and that “the main problem is that, as the taxonomy is still in a rudimentary stage, so is their phytogeography.” However, it is noted that “some species are very widespread and others have extremely disjunct and various distribution patterns that are not easy to explain.”

The most widespread taxon is the genus *Calamus*, which is “distributed from West Africa to Fiji and from South China to Queensland.” It is the largest genus of rattans and, indeed, of palms. The centre of diversity is said to lie in the Malay Peninsula, in the stable centre of the ever wet areas of the Sunda Shelf.

Eleven genera are found in Southeast Asia: *Calamus*; *Daemonorops*; *Korthalsia*; *Plectocomia*; *Ceratolobus*; *Plectocomiopsis*; *Myrialepis*; *Calospatha*; *Beaudia*; and two as yet unpublished genera. Two more genera, *Cornera* and *Schizospatha*, are described by Furtado (73), but Dransfield (61) believes these are extreme forms within the genus *Calamus*. In West Africa, three small genera, *Eremospatha*, *Ancistrophyllum*, and *Oncocalamus*, are found along with the widespread genus *Calamus*. Moore (106) regards the three West African genera as showing the greatest number of primitive features within the rattans and argues an African origin for Lepidocaryoideae.

Nine of the eleven genera of Southeast Asian rattans are found in the Malay Peninsula. Of these, one genus (*Calospatha*) is found nowhere else. Away from the centre of diversity, the Malay Peninsula, the number of genera, according to Dransfield (personal communication), decreases: Sumatra 7; Java 5; the island of New Guinea 3; Fiji 1; Thailand 6; N.E. India 3; Borneo 8; and the Philippines 4. The distribution of the eleven Southeast Asian genera is as follows:

Korthalsia centre of diversity in Sunda Shelf, few species found outside this area;

Plectocomia Bali, Java, Sumatra, Borneo, the Philippines, the Malay Peninsula, mainland Southeast Asia, north to the foothills of the Himalayas and South China;

Plectocomiopsis Sumatra, Borneo, the Malay Peninsula, Thailand, and Indo-China;

Myrialepis Sumatra and the Malay Peninsula;
Bejaudia Indo-China;
Calospatha the Malay Peninsula;
Daemonorops found from South China and South India to the island of New Guinea (centre of diversity is in Sumatra and Borneo);
Calamus from West Africa to Fiji and from South China to Queensland;
Ceratolobus confined to Sumatra, the Malay Peninsula, Borneo, and Java;
New Genus 1 ("Pogonotium" Dransfield) the Malay Peninsula, Borneo;
New Genus 2 ("Retispatha" Dransfield) Borneo.

Commenting on the distribution of rattan species, Dransfield (59) states that "the rattan flora east of Wallace's line has generally little in common with the rattan flora west of the line, whereas within the two areas thus separated there are generally similarities between the different Island floras. Thus only one rattan species *Calamus ornatus* is known to occur in both Celebes and the Sunda Shelf. This species is also found in the Philippines, which probably has more in common with the Celebes rattan flora than the Bornean flora. On the other hand many species are common to the islands of Borneo, and Sumatra and to the Malay Peninsula. Java has relatively fewer species in common with Borneo and Sumatra ... there are still many anomalies ... a not inconsiderable number of the endemics are probably of much wider occurrence, and their present confined distribution reflects a lack of collection and field work and a lack of appreciation of variation."

Generally, most rattan species have quite a wide altitudinal range and may be found from sea level up to about 2900 m. However, few lowland species transgress the vegetational boundary occurring at between 1000 and 1400 m. Likewise few montane species go below this boundary. The altitude at which the change takes place varies with topography, soils, and climate. Dransfield (59) gives some examples of the altitudinal range of rattan species.

Correlation between the type of rattan flora and soil type is not yet clear. However, interference with the forest can have an often drastic effect on rattans and result in either the enormous development of some species or the extinction of others.

Descriptions and/or habitats of several of the numerous species found in Southeast Asia are given by various authors. Accounts of Malaysian species are found in Ridley (118), Furtado (71, 72, 74), Dransfield (57, 63, 64), Dransfield and Whitmore (67), Dransfield and Manokaran (65), Manokaran (99), and Wong and Shane (139). For Indonesian species reference may be made to Ardy-Saputra (35), who gives details of some 25 species, Dransfield (56, 58, 60), and Alrasjid (2). Brown and Merrill (46) and Brown (47) give an account of some Philippine species. For India, information is contained in various publications, e.g. Hooker (83), Blatter (44), Watt (136), Gamble (75), Badhwar et al. (37), Ramaswamy (115), Fernandez and Dey (69), and in two notes by Sharma (123) and Shetty (124). An account of Burmese rattans is given by Kurz (91) and Blatter (44). Watt (136) and Hooker (84) give an account for Sri Lanka.

A checklist of 516 species of rattans of the whole of Southeast Asia has been compiled by Dransfield (59). Regionally, Dransfield (64) recorded 104 species from West Malaysia; Alrasjid (2) estimated that there are about 330 species in Indonesia, but that only some 150 have been recorded; and Ordinario (110) stated that in the Philippines there were 61 species. However, during a recent visit to the Forest Research Institute at Los Baños, it was confirmed that the total number now identified is 64. Originally, Dransfield (59) recorded a dozen species

for Thailand, but more recently the Royal Forestry Department has listed an additional seven species. (Dransfield now records 50 species.)

Rattan species are distributed among the genera as follows: *Calamus* (370 spp.), *Daemonorops* (115 spp.), *Korthalsia* (31 spp.), *Plectocomia* (14 spp.), *Ceratolobus* (6 spp.), *Plectocomiopsis* (5 spp.), *Calospatha* (1 sp.), *Myrialepis* (1 sp.), *Bejaudia* (1 sp.), new genus "Pogonotium" (2 spp.), new genus "Retispatha" (1 sp.). These figures are approximate and are based on Moore (106) modified by Dransfield.



Collection

A very great proportion of the rattan found in the markets comes from plants growing in their natural habitat. Large-scale plantations of rattan are found only in the Barito Selatan area of Central Kalimantan in Indonesia. In these intensively and extensively cultivated rattan plantations, whole villages depend largely on them for their livelihood. Some small-scale cultivation is done in poorly maintained rubber plantations in Central Sumatra, in small orchards around longhouses in Sarawak, in secondary forests behind some villages in Sabah, and in the Andamans. Collection of rattan is at all times unpleasant work. The long barbed whips (cirri and flagella) are a constant source of irritation to the collector, particularly when he encounters them unaware. Collection is often an arduous and at times even a dangerous chore with the ever-present possibility of hauling down a dead tree branch on one's head in the process of tugging at a climbing rattan. Apart from the tiresome job of searching for the rattan in the forests, the collector has to carry his load of rattans for (increasingly) long distances to his base camp. Despite all these difficulties and hazards, rattan collection is a low paid job, making it all the more unattractive. Little wonder, then, that rattan collection represents only a supplementary source of cash to the collector and that rattan licencees are grousing about increasing difficulties in engaging collectors and retaining them for long periods.

In Peninsular Malaysia and in the Philippines rattan collection is done by aborigines. In the northern state of Kedah in Peninsular Malaysia, villagers living near the forests do the collection. In Sarawak, though nearly all communities living adjacent to forest areas do some rattan collection, the Punans of the interior probably account for the bulk of the rattans brought out to the local rattan markets. In all other countries people in communities near remote forest areas do the collection. In India and Sri Lanka, some collection is also done by aborigines.

In Indonesia there is virtually no control over the collection of rattans from the forest. Collections are made even from nature reserves (59). In Thailand, according to the Royal Forestry Department, permits are required to cut rattan from a Reserved Forest. Outside a Reserve, permits are needed only for collection of *C. caesioides*, which is in high demand by the industry. In the Philippines, the issue of *new* licences for collection of rattan was discontinued in

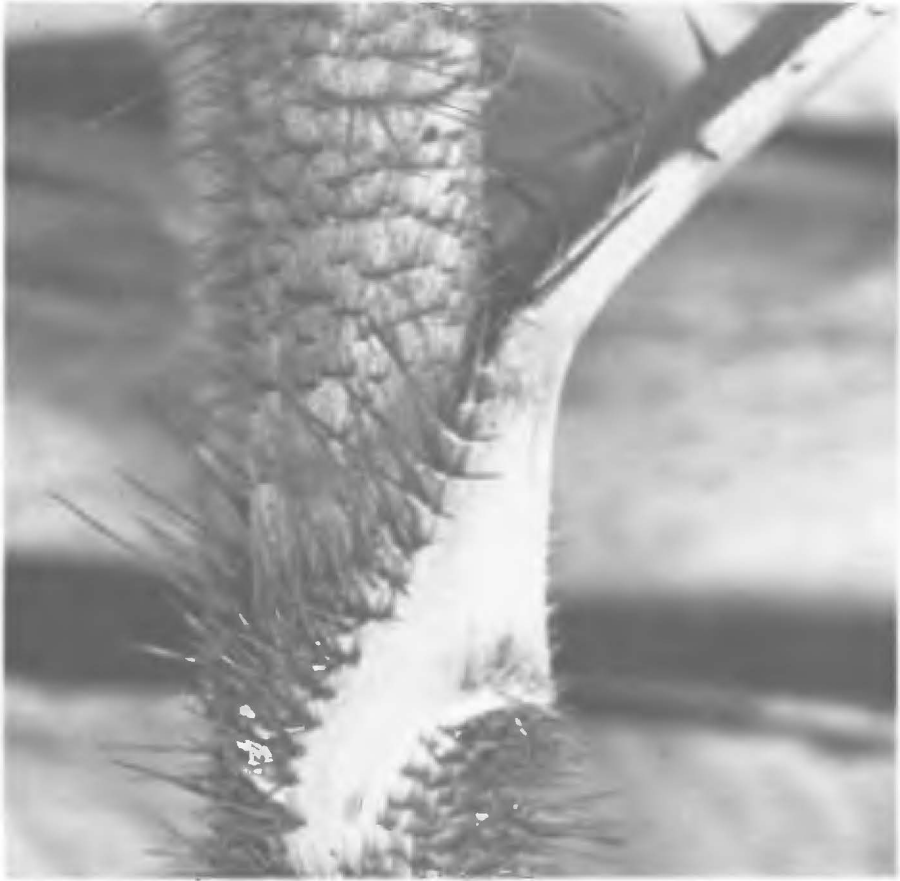
1971. Only existing licences are validated. Licences are issued based on a rough inventory of rattans in the area to be licenced, and collection is permitted only to the extent of 50% (called allowable cut) of the estimated quantity. To enable this system to work more satisfactorily, efforts are being made to devise a more effective system of rattan inventory. In Malaysia, rattan collection licences are issued over areas ranging from 50 to 500 ha. Until recently such licences were rather freely issued, but there were not many applicants. Since 1977 applications for rattan collection have increased considerably. As resources are quickly being depleted, greater care is being exercised in the issue of licences and control of exploitation. In India rattans are permitted to be cut under licence, once every 3 years in the states of Assam, Bengal, Orissa, Uttar Pradesh, and Madras. In the Nilambur valley of Kerala, cutting is permitted in alternate years (115). The Forestry Department of Kerala issues licences specifically for the collection of rattan only if the licenced area is known to carry substantial quantities of rattan. Otherwise, licences are issued to collect "minor forest products" of all types including rattan. Sri Lanka also issues licences for collection of rattan.

Collection methods vary slightly from place to place, but in all cases they are very wasteful. The selection of the rattan to be collected is based on its species and age. Mature canes can be recognized because their leaf sheaths have fallen. The stem is cut 30–200 cm above the ground with a "parang" (a cleaver or long chopper) and dislodged from the tree, from which it is suspended, by pulling the base of the stem with short, strong tugs. When the cane comes down, it can bring with it dead branches, clumps of epiphytes, ants, wasp nests, and other debris. If the cane gets stuck in the canopy, the collector must climb a neighbouring tree to cut the plant free from its support. If this cannot be done, the part of the cane that cannot be reached is abandoned. Sometimes a fishhook tied to a pole is used to pull down the rattan. As the cane is dragged down it is twisted around a tree trunk to rid it of the thorny leaf sheaths that adhere to the younger parts, or these leaf sheaths are chopped off. In some cases, holding the upper end of the cane, the collector forcibly draws the stem between two pieces of wood to strip off the spiny leaf sheaths (40). To harvest the largest rattans, such as *C. manan*, two or three men are required because the cane is normally very firmly lodged in the canopy (59).

The uppermost 3–4 m of the rattan, depending on species, is usually discarded because it is soft and immature and hence useless. Sometimes this young apical part breaks off when the cane is pulled around a tree trunk.

A combined harvester that will pull, coil, and at the same time rub off the spiny leaf sheaths has yet to be designed. Human arms still perform this job, which is hard, often painful, and always dangerous (53). Jordan (85) had devised "a small fishhook type of grapple spliced to the end of a rope. The hook is placed in position by a simple extension stick and the rope is pulled by a drum winch." However, this device does not seem to be commonly used.

Collectors go into the forests in groups of three to five and are given varying amounts of money as advances before they leave for their collection trip. Collections are brought out of the forest every 7–10 days when licencees transport them to the depots. As mentioned earlier, there are hardly any full-time collectors, except perhaps in the Central Kalimantan plantations. In West Kalimantan collection is done in the wet season when timber felling ceases. In Jambi, Central Sumatra, rice farmers turn rattan collectors in off seasons and rubber tappers at other times. Indeed, the collection of rattan and its supply to the



The sheaths of Calamus erinaceus, like most rattans, are fiercely armed with spines.

dealers is very intricately tied to the weather, agricultural practices, the price of rubber, and the local rate of unemployment (65).

Soon after the rattan is pulled down from its perch, it is cut into lengths, the size of which depends upon the species, the size of the rattan, its intended use, the specifications of the buyer, or even to suit the convenience of collectors in carrying it out of the forest. Lengths into which the rattans are cut also vary according to the practice in different countries. In Indonesia, *C. manan* and *C. scipionum* are cut into 2–3 m lengths. More slender canes such as *C. caesius* and *C. trachycoleus* are cut into 5–7 m pieces as they are pulled and bent in two. Very slender species of local rather than of commercial value, such as *C. javensis* and *C. exilis*, are used for twine and canes and are coiled in long lengths (59). In the Philippines, rattans are cut in 3–6 m lengths, bent sharply in the middle, and tied in bundles for transport (1, 46). Tumalin (*C. mindorensis*), Sika (*C. spinifolius* and *C. caesius*), and Panlis (*C. ramulosus*) are treated in this fashion. Palasan (*C. maximus*) is never bent, but bundled straight. In Malaysia, large sized canes are cut in 3-m pieces, a man being able to carry 10 such pieces. Smaller canes are usually cut into 8–9 m lengths, bent in two, and bundled in 1 picul (~60 kg weights, or in twenties.



Processing

Indonesia

In Indonesia, deglazing (“runti”) of siliceous species (*C. caesius* and *C. trachycoleus*) is done by some collectors. The inner epidermis of the leaf sheaths adhering to the cane and the silicified epidermis of the cane are removed. Several methods are employed:

Runti Gosok The rattan is pulled in and out through a hole made in a piece of bamboo tied to a tree. Dransfield (59) describes another method in which the cane is pulled through a loop between two rollers of Bornean ironwood (ulin) and as the canes are pulled they are briskly rubbed with a piece of chain.

Runti Jala The cane is pulled through a loop suspended between three bamboo poles, stood about 1 m above the ground, and rubbed briskly with a chain. In some cases the cane is passed through a thick metal (tin) ring for better results (111).

Runti Pelari The cane is hit with a piece of wood or plaited rattan. This method is less satisfactory.

However, the simplest, but most time-consuming method, is to twist the cane by hand and rub it with fine sand, steel wool, coconut fibre, or sackcloth. This produces a very clean finish. The process of “runti” must be carried out within 24 h of harvesting. If this is not possible, the canes must be steeped in water to keep them moist because deglazing of dried rattan is difficult (111). After “runti” the canes are dried for about 7 days, either directly on the ground or on a special framework that is raised above the ground to promote even drying. During wet weather the canes are dried over a fire. Quick drying is essential to prevent or reduce blemishes (fungal stains) and to prevent deterioration of the cane.

Rattan that has gone through the “runti” process is called “rotan asalan.” Much of the rattan exported from Indonesia is processed to this stage. When the exporter sorts this rattan, normally 30–40% is rejected.

Further processing is carried out by the exporter, whose methods vary from district to district (86, 122).

No Washing, No Fumigation with SO₂ (Sulfur Dioxide)

Dependent on its state of dryness, the “rotan asalan” is dried in the sun for a few days until the moisture content is about 5–10%. It is then sorted according to diameter and defects, weighed, and tied into bundles with rattan. These rattans are recognized as “U.W.S.” (unwashed and unsulfured rattan).

Washed Rattan

“Rotan asalan” is dried for a few days, then sorted according to diameter, length, and defects. Next, it is washed in water and at the same time rubbed with white sand and coconut husk. This is followed by drying to a moisture content of 5–10%, and sorting into quality classes. Immature tops are removed and the ends are squared. The rattan is then weighed and bundled to order. These rattans are recognized as ‘W’ (washed rattan).

Washed, Fumigated with SO₂

“Rotan asalan” is dried and sorted according to diameters (medium and large), lengths, and defects. After this sorting, it is washed and rubbed with white sand and coconut husk. Large diameter rattan is scraped before washing. Subsequently, the rattan is fumigated with SO₂ for 24 h or more, dried in the sun to 5–10% moisture content, sorted into quality classes, and trimmed to remove immature tops and square the ends. These are recognized as “W.S.” (washed and sulfured).

Washed, Fumigated, and Steeped in Kapurit

Same process as W.S. (above) but before fumigation the rattan is steeped in a solution of “Kapurit” for 24 h.

Boiling in Oil (“Sumatra Barat” — Especially for C. manan)

“Rotan asalan” is sorted to separate defective canes and canes of unsuitable lengths. The selected canes are steeped in a hot (as per Osli Rachman (111), 150 °C — in Padang) 1:1 mixture of diesel and coconut oil for 30–45 min. After removal from the oil, they are dried and rubbed with coconut husk, sackcloth, or sand. In Padang no drying is done prior to the rubbing (111). They are then further dried in the sun for 1–12 days according to weather conditions. Subsequently, the rattan is washed in water and rubbed with coconut husk or sackcloth, while in the water, until the rattan has a glazed appearance. It is then dried in the sun for 2–3 days until it reaches a moisture content of 5–10%, sorted into quality classes, cut into lengths as per the buyers’ orders, weighed, and bundled, ready for export.

Variations of the above processes are practiced in different regions of Indonesia. Osli Rachman (111) states that in Southern Celebes the following procedure is adopted: “Rotan asalan” is steeped in a thick mud solution, roasted over a low fire for about 24 h, rubbed clean with coconut husk, dried in the sun for about a week, and then sorted and bundled.

Hong Kong

A substantial quantity of Indonesian rattan is imported into Hong Kong where further processing is carried out.

The rattan is steeped in a solution of sodium hypochlorite (Man Chong Rattan Company in Hong Kong says it is “hydrochlorine”) in a tank (5 × 1 × 1 m) for about 1 h (75–100 lb (35–45 kg) of the hypochlorite is mixed with water



A trough partially filled with diesel oil for treatment of "manau" sticks in Jambi, Sumatra.

to about 3/5 the height of the tank). After repeated use of the mixture "more chemical and water is added as and when felt necessary." If bleaching is required, hydrogen peroxide is used.

The rattan is removed and steeped in an adjacent tank of the same size (except that its height may be a little less) and washed with water. After being washed, the rattan is transferred to a fumigation (SO₂) chamber (6 × 5 × 3 m), which is fitted with an external container for burning the sulfur and a flue leading into the chamber to convey the sulfur fumes. The rattan is fumigated overnight and, if the colour is not sufficiently even, it is fumigated for a longer period.

Treated rattan is sorted into diameter classes as required and machine-cut into the required lengths. Bulging nodes on the larger diameter rattans are scraped to the level of the internodal diameter by experienced labourers who take care not to scrape the internodal skin. Separation into quality and length classes is next. Lower quality material is used locally for the manufacture of low-priced furniture or for core and peel. Better quality material is either exported or retained for splitting.

In addition to this treatment, one other has been noted (86) in Hong Kong and also Singapore. The rattan is first sorted into "Hard," "Medium Hard," and "Soft" as follows:

Hard When the rattan is bent by hand and released, it springs back and regains its original form quickly;

Medium Hard When the rattan is bent by hand and released, it regains its original form rather slowly but not fully; and

Soft If the rattan is bent, it cracks at the bend or breaks and if the bent rattan is released before it cracks or breaks, it regains its original form completely.

"Hard" and "Medium Hard" rattan is steeped in water for 24 h, rubbed with sand and coconut husk, dried in the sun, fumigated with SO₂ for 24 h, dried again, refumigated for 24 h, and finally sorted by length, diameter, and quality.

"Soft" rattan is treated (in Hong Kong) in the manner described earlier, i.e. with hypochlorite, etc.

Singapore

Importing a substantial portion of its rattan requirements from Indonesia, Singapore processes rattan in a manner similar to that described for Hong Kong.

In addition, according to Kadarisman (86), the special treatments described for "Hard," "Medium Hard," and "Soft" rattan in the case of Hong Kong are also followed except that in the case of "Soft" rattan, particularly larger canes, the treatment is as follows:

The soft rattan is sorted as either good or bad. The good but dry ones are steeped in water for 24 h before further treatment. The good but wet ones, as well as the ones steeped for 24 h in water, are rubbed with coconut oil and fumigated with SO₂ several times as necessary. Subsequently they are rubbed with sawdust, tied in bundles, and the bundles are stood erect to dry in the sun. Sorting is done on the basis of colour, diameter, and length.

Malaysia

The larger diameter canes like *C. manan*, *C. ornatus*, and *C. scipionum* and also some smaller sized ones (noticed in some treatment depots) are boiled in a mixture of diesel and coconut oil or a mixture of diesel oil and palm oil for varying lengths of time. Pure coconut oil is said to be the best, and in fact mixtures began to be used only when coconut oil became too expensive for the purpose.



Manau sticks drying after treatment in Kuala Lipis, W. Malaysia.

The proportion of coconut to diesel oil or palm oil in the mixtures varies virtually from depot to depot as do immersion periods and oil temperatures. There is no rational explanation for these variations, except that each depot chooses its immersion times, temperatures, and “strength” of mixture, either according to the dictates of its customers or according to its own judgment through experience. The size and species of cane to be treated also influences these choices.

The oil boiling process removes the large quantities of gums and resins and most of the moisture in the canes. Removal of the gums and resins is said to make the canes more durable. However, there is considerable controversy concerning the optimum proportion of diesel and coconut oil compound to be used in the mixture, the period of immersion, and the temperature at which the mixture is to be maintained.

Mixtures vary from 50 parts of diesel oil and 50 of coconut oil to 90:10; temperatures from lukewarm to 130 °C; and periods of immersion from 5 or 10 min to 30 or 40 min, and even in one case up to 3 h. Treated canes are rubbed with sawdust, rag waste, or gunnysack. The large diameter canes, which are usually about 3-m long, are tied loosely at one end and stood upright with the untied end on the ground and the basal ends spread out forming a cone. The smaller diameter canes, usually 8–9 m long, are hung over wooden stands or bent double and leaned against such stands with their ends down. In some cases, they are spread over the ground, over a wooden frame on the ground, or on wooden racks. Drying time varies from 1 to 2 or even 3 weeks. In all cases, the drying canes are moved into a shed in the evenings and taken out again as the sun comes up. Canes are also taken into the shed if rain is expected. The drying ground is sometimes cemented or covered with about 15 cm of sand to promote quicker drying. Following drying, the rattan is bundled and stored until sold.

The trough for heating the oil mixture is either made of iron (4 m long \times 0.6 m \times 0.6 m) or of halves of empty oil drums welded together and heated by wood fires from below.

India

In the states of Assam and West Bengal, the larger diameter rattans are rubbed with sand and gunny cloth, treated with linseed oil, and heated over a fire for about a minute. The canes are then rubbed with gunny cloth soaked in kerosene and dried upright in the sun for 10 days. Finally they are tied in bundles of 100 for sale.

In Kerala, the Forestry Department authorities stated that some years ago, small canes for weaving were steeped in the caldron in which paddy was being parboiled. Apparently this process gave the cane a good sheen and protected it from insect attack. This practice is no longer in vogue. Another method, still practiced by some, is to boil small canes for weaving in water containing a mixture of coconut milk and turmeric in equal proportion. This is also said to improve the appearance of the cane. Canes for export are steeped in water and rubbed with fine sand.

Other Countries

No special processing of rattan is done prior to conversion and manufacture in the other countries, other than the drying done by collectors, and some additional drying done by dealers or manufacturers. The total drying period in all these cases varies from 1 to 3 weeks.



Trade Names and Grades

Trade names for rattan are developed by rattan merchants and bear little or no relationship to botanical origin. Practically no research has been undertaken to study the commercial names given to the various species or groups of species of rattan. A study of this nature, though useful, would meet with almost insurmountable difficulties and be very time consuming.

Usually commercial names are derived from the locality from which they come, e.g. Sampit, Palembang, Djermasin, or by their appearance, e.g. sega (polished or smooth), rotan batu (stony), etc. Further confusion is caused because rattans may also be described by locality and appearance or quality, e.g. rotan sampit kobo or rotan sampit jahab.

Burkill (49) states that though the number of names recognized by the trade is very large, they can generally be classified into four main groups:

Sega All canes with a siliceous outer layer that cracks and springs off when the cane is bent;

Lunti Same kinds as *Sega* except that the silica layer is removed;

Ayer Nonsiliceous rattan not included elsewhere; and

Sticks Straight lengths where stiffness and straightness are the main considerations, e.g. for walking sticks and furniture frames.

These group names are still being used, e.g. by the rattan planters in Dedahup on the Barito River.

The same species form the *Sega* and *Lunti* groups: *C. caesioides*, and *C. trachycoleus* (the little-known *C. optimus* and *C. leiocaulis* are also frequently cited as *Sega* and *Lunti* sources). They are highly valued in commerce because their stems are even-sized all along their length, and they have "flush" nodes that make them highly acceptable for peel. The *Ayer* group covers a number of species and includes *C. erinaceus*, *D. angustifolia*, and *D. micracantha*. Most well known of the *Stick* group are *C. scipionum*, *C. manan*, *C. ornatus*, and *C. maximus*.

Ardy-Saputra (35) gives a lengthy account of grading and quality classes. According to him four quality classes are recognized in Indonesia, with the first three further divided into four subqualities (I, II, III, and IV). These qualities are known as *Sega*, *Djahab*, *Kobo*, and *Uitschot* (rejects). Dransfield (64) gives a list

of trade names used in Peninsular Malaysia with the presumed botanical and Temuan (aborigine) equivalents. In India, thin and medium canes are sorted into two grades: (1) lead-pencil thickness; and (2) thicker than (1). Each grade is then sorted into tender tops, middle, and bottom portions. In the case of slender canes, the tender tops are discarded (38).

The Philippines appears to be the only country that has made an attempt to bring some order into trade names and grades. The Bureau of Standards defines trade names and grades as follows (4):

Palasan Group Includes true palasan (*C. maximus*) and others with a diameter of over 2.5 cm and internodes of 25 cm or more. This group is divided into six grades based on diameter sizes A to E and one mixed grade. The diameter at the small end is measured and increased by 0.25 cm for each grade. The range is from Grade E with a diameter of 2.5–2.75 cm to Grade A with a diameter of 3.5 cm or more. The mixed grade is a mixture of sizes A to E. Canes of all grades must be mature, clean, thoroughly seasoned, free from fungal stain, scar, bruise, checks, and discolorations. Specifications for substandard classes for each of the grades A to E are also given (6).

Tumalin Group Includes genuine tumalin (*C. mindorensis*) and other species with a diameter of 1.5–2.5 cm.

Sika Group Includes Palawan sika (*C. caesius*, Dransfield personal comm.) and others that are glossy, flexible, bright yellow when dry and are less than 1.5 cm in diameter.

Panlis Group Includes those with a diameter of less than 1.5 cm, but which are rather light cream in colour and therefore not included under Sika.

The Philippines has now banned the export of unprocessed rattan, but apparently the above grades continue to be used for local purchases.

Within the entire production area, grading is very subjective, and grade classes are usually derived from long trading practices established in specific localities or even by individual companies. However, in almost all cases, the basic factors taken into consideration are: (1) size (diameter) — starting as low as 4 mm and going up to 45 mm+, the size classes may rise by 2, 3, 4, 5, or 6 mm or even as a mixture of these classes; (2) length; (3) colour; (4) hardness; (5) defects and blemishes; (6) length of nodes; and (7) evenness of thickness along the length.

Grading is a highly skilled operation that is done by specialists employed by each company. Apparently these specialists have a knack for readily understanding a buyer's requirement. Disputes between the parties concerned are few and far between. No company seems to possess written notes on the system of grading it uses, and the graders either "dry up" after answering a few questions or give uncertain answers.

Economic Species

Names of botanically identified or commercial species of rattan are given in several publications. In some of them the habitat, characteristics, and uses are also briefly mentioned. The publications include Ardy-Saputra (35), Dransfield (56, 59, 60), and Dransfield and Suwanda (66) on Indonesian species; Manokaran (99), Dransfield (64), Dransfield and Manokaran (65), and Anonymous (27) on Malaysian species; Aguilar (1), Anonymous (8), and Ordinario (110) on Philippine species; and Blatter (44), Nair (109), Anonymous (5, 9), Badhwar et al. (37), and Fernandez and Dey (69) on Indian species.

Dransfield (59), noting the poor state of knowledge of rattan species' identification on the whole, comments that apart from some anomalous cases, the bulk of rattans are usually quite easy to determine at least up to the generic level. He gives two keys (keys to fertile and sterile materials) to illustrate the differences between the genera, provides some guidelines on how to make herbarium specimens (see appendix p.75), and lists more than 500 Southeast Asian rattans. Hooker (84) and Vivekanandan (135) list some species found in Sri Lanka, while Indian species are listed by Watt (136) and Gamble (75). Philippine species are given by Brown and Merrill (46), and Malaysian ones by Dransfield (64).

Despite recent work in certain areas of the region, the monographs on Lepidocaryoid palms by Beccari (40, 41 a,b,c,d) remain the most important taxonomic source.



Supplies and Cultivation

The conversion of large tracts of forests for agriculture is rapidly depleting rattan resources, particularly in the more accessible forests. In some areas important species of rattans like *C. manan* are practically gone, and other species like *C. caesius* are being overexploited. More and more immature canes are being cut as accessibility becomes more difficult. It is also becoming increasingly difficult to find collectors willing to go deep into the forest to collect the more mature canes. Moreover, collectors are finding more lucrative and less hazardous jobs. Despite this, rattan collection continues unabated.

Demand for canes is on the other hand increasing. Many of the traders in various countries are of the opinion that the demand for well-processed, good quality canes is so high that even trebling the present supplies will not meet requirements. In brief, it may be said that rattan is in short supply, despite the fact that there are yet abundant resources in some countries (Brown and Merrill (46) in the Philippines, Zainal Abidin (141), Setiadi (122) and Alrasjid (2) in Indonesia). But, these resources are in remote, inaccessible areas.

Brown (47) reporting on the yield of rattan from two plots of forest in the eastern part of Mindora in the Philippines stated that 5000 linear metres of commercial canes were obtained per hectare (6700 feet per acre). Brown and Merrill (46) confirmed this several years later.

Zainal Abidin (141) estimated that potentially about 67 000 t of six commercial types (2) of rattan can be reaped per annum on a sustained basis from 7.9 million hectares of forests (including plantations) in Kalimantan, Sulawesi, and Sumatra. Of the 67 000 t, plantations can potentially yield 7000 t (145), i.e. Riau 1500 t, Kalimantan Tengah 4000 t, and Sulawesi Tengah 1500 t.

Between 1950 and 1970 Indonesia produced an average of 40 000 t per annum of which 35 000 t were exported and 5000 t were used locally. Thus only 60% of the potential (67 000 t) was harvested.

Indonesia exports 90% of the world's requirement of rattan (122). Noting this fact and the potential as assessed for that country together with production in other countries, it appears that rattan supplies may yet be plentiful. But, because: (1) many of the rattan growing areas are difficult to reach; (2) rattan

collectors are becoming increasingly difficult to find and to persuade to collect mature canes deeper in the forests; (3) the demand for steady supplies of good quality rattan is growing rather rapidly; and (4) the rattan industry is basically a rural industry with the potential to benefit the socioeconomic conditions of rural areas, it has become necessary to find ways and means to cultivate sufficient quantities of good quality rattan in accessible areas.

Various countries in the rattan-growing regions of Asia have attempted to establish plantations of different species of rattan with varying degrees of success or failure. The first, the best known, the most widely reported, and by all accounts the most successful are the plantations of *C. caesius* and later *C. trachycoleus* said to have been established by missionaries in "the neighbourhood of Beneden-Dayak in or about the year 1850" in Kalimantan, Indonesia (Heyne, 81).

Writing about *C. scipionum* (the Malacca cane), Corner (53) says that "it is one of the few rattans which are deliberately planted; it seems to thrive both in the forest and, unlike most rattans in the open." He continues to say that "two other species are cultivated by planting them along cut lines in the forest. One is *C. caesius* in Malaya, Sumatra, and Borneo, and the other *C. leiocaulis* of Celebes. They are perhaps the only cultivated climbers that, like many tropical timbers, must be grown wild."

Brown (45) reports a plantation of *C. caesius* along the Pahang River in Peninsular Malaysia and gives a very brief description of planting with seeds and seedlings. However, there is no trace of this plantation today. Apparently another attempt at establishing a plantation of *C. caesius* was made in Peninsular Malaysia about the same time by the Forest Administration of Perak, which reported in 1930 that "the rotan sega plantation in Pondok Tanjong, which was established 20 years ago, has proved a complete failure and further experiments have been stopped." Meijer (104), reports "some acres" of *C. caesius* planted in secondary forests behind Kampong Komansi on the lower Labuk River in Sabah, East Malaysia, and states per-acre yield as "10,000 pieces of 3 fathoms (depa) length." *C. caesius* is also commonly cultivated by the Iban in the basin of the Rejang River, Sarawak, East Malaysia (48).

Beccari (41a,b,c,d) states that *C. khasianus* "appears to receive a primitive cultural attention in Assam (India) for the sake of its fruits, which are eaten as a substitute for those of the Areca Palm." Numerous attempts have been made to cultivate species of *Calamus* in the greenhouses of nontropical countries but none have become permanently established. Beccari says that the "Report on the Progress and Condition of the Royal Gardens at Kew" for the year 1882 records 37 species of *Calamus* as being under cultivation but that only one specimen of *C. javensis* was noted to have flowered.

Experimental planting of Malayan canes in the Indian State of Madras "several years ago" proved unsuccessful (37). Blatter (44) reports cultivation of *C. rotang* in India, but when the plant is 1.5–2 m tall it is cut down because of its thorny, whip-like flagella.

Forestry authorities in India are attempting to establish plantations of *C. viminalis* and *C. rotang* in the Andaman Islands. Details are not available. However, trial plantings are said to have begun in 1965. Up to 1974, 680 ha are believed to have been planted, and an annual planting of 500 ha is now planned. In Chenkota, Madras, a 40-ha plantation of small-size canes (species unknown) is said to have been done by villagers using rhizomes. The Indian National Commission on Agriculture has recommended regeneration and planting of canes and has suggested that for the next 15 years a sum of Rs 3 million be set aside for this purpose (123).



Calamus erinaceus growing just landward of a mangrove forest in Jason Bay, Johore, W. Malaysia.

In the Philippines, the Philippines Reforestation Administration attempted to grow rattan in the Magat Reforestation Project, Diadi, Nueva Viscaya, but had little success (110). Thailand made an attempt in the late forties to establish *C. caesius* plantations in Narathivat, Patani (113), but again there was little success. Attempts to establish plantations resumed in 1968, with the government requesting that 80 ha be planted yearly.

On a journey from Bandjarmasin to Muara Uja between Martapura and Kandangan, South Kalimantan, Indonesia, Dransfield (56) noted two rattan gardens of *C. caesius* planted by the roadside at the edge of orchards and rubber plantations. However, only in Central Kalimantan are rattans cultivated on a vast scale, and the only species cultivated are *C. caesius* and *C. trachycoleus*, two relatively slender species with stems about 1.2 cm in diameter (59). Apart from Central Kalimantan, Zainal Abidin and Djajapertjunda (145) mention two other areas in Indonesia, Riau in Sumatra and Central Celebes, as large cultivation areas although the combined production from these areas is only about three-fourths of that from Central Kalimantan.

Currently there is a great lack of taxonomic and silvicultural knowledge for the serious pursuit of large-scale establishment of rattan plantations. However, until research results are obtained, cultivation of *C. caesius* and *C. trachycoleus* could begin in suitable areas by the adoption or adaptation of methods that have already been successfully used by the cultivators long engaged in the intensive cultivation of the two species in many parts of South Borneo. A large-scale project for cultivation of *C. trachycoleus* and *C. caesius* is already planned in Sabah (80), and more than a quarter million U.S. dollars will be spent by 1980.

From Bandjarmasin (S. Kalimantan, Indonesia) up the Sungai Barito to plantations in Marabahan and Dedahup, the first 50 km of river bank are devoid of any signs of plantations, but an abundance of *C. trachycoleus* can be seen on both banks after this. The basal portions of the rattan plants at the edges of the river are virtually being washed by the flowing water. The absence of rattan plantations in the southern portions of the river is attributed by some villagers and forestry officials to the salinity of the water. The water level of the Sungai Barito is said to fluctuate between 5 and 10 m (140), while the total annual rainfall can vary between 2130 (Kuala Kapuas) and 3090 mm (Muaratewe). Much of the rain falls between November and April.

Thousands of hectares of the two species of *Calamus* are planted in old "ladangs" or "belukar" (cleared land where a moderate number of trees are retained to support the climbing rattan plant) along the moist riverside alluvium in the Barito Selatan area of Central Kalimantan, which is flooded for 3–5 months a year (59).

At Dedahup, where 95% of the plantation was of *C. trachycoleus*, old rubber and a common riverside tree Bungor (*Lagerstroemia*) were the support trees. When planting is done in secondary forests along riversides, the larger trees are ring-barked before planting to provide sufficient sunlight to the growing plant. The undergrowth is also cleared.

The cultivators in Dedahup prefer rubber trees or even Bungor as support trees because: (1) the trees "winter" once a year and permit the growing rattan to receive more sunlight (ring-barking large trees in secondary forests gives the same effect); and (2) the branches of the trees are sufficient in numbers and strength to support the climbing rattan stems. Tuil (132) states that a Chinese rattan planter informed him that the presence of trees of *Dillenia* sp. and *Litsea* sp. in an area indicates the "exceptional suitability" of the soil for growing *C. caesius*.

According to the cultivators in the Dedahup area, the two species of *Calamus* only began to be cultivated along Sungei Jaya in the early twenties. *C. caesius* is cultivated on the higher ground less subject to flooding. The total area now under cultivation in South Borneo is said to be 15 000–20 000 ha; however, no survey has been done.



*Rattan fruit are covered with overlapping scales. This species, *Daemonorops lasiospatha*, has sweet tasty flesh.*

The following account of the planting technique for *C. trachycoleus* largely emerged from a discussion I had with a very enthusiastic group of planters at Dedahup in 1978.

Ripe fruit is yellowish in colour and is collected in the months of October and November. One indication that the fruits are ripe enough is that the birds begin to eat them. The fruits are crushed and allowed to rot 1 or 2 days, after which the scaly pericarp and the flesh can be easily removed. Seeds are then put into baskets or gunnysacks, placed in a cool place, and watered daily. Alternatively the baskets or sacks containing the seeds are hung in a river next to a lavatory that is

built into the river so that they are washed regularly by the effluent, which is said to act as a fertilizer and help in faster germination of the seeds.

Germination takes place in 7–14 days (an average of 10 days). When the seedlings are about 1–3 months old they are ready to be transferred to the nursery. Dransfield and Suwanda (66) state that seedlings are ready to be transplanted to the nursery when 1 month old, the roots are well developed, and the first leaf is about 8 cm long. The nursery seen at Dedahup was about 5 m × 7 m and was situated some 10 m from the river bank, under light shade in silty-clay soil. The nursery is cleared of all undergrowth and seedlings are planted in January (a rainy month) in shallow (\cong 5–6 cm deep) holes dug with a pointed stake. Seedlings are planted 2 or 3 per hole, and the holes are dug 25–30 cm apart. The roots are lightly covered with humus.

The seedlings grow rapidly; in one nursery in Sungei Jaya a 14-month-old seedling had attained a height of 1 m and had 7–8 leaves and one sucker (66). Alrasjid (2) notes that, after 2 months, canes were 15 cm tall and had about 4–5 leaves. When Menon visited Dedahup, he noted that seedlings that were 18-month-old leftovers were more than 1 m high and had some 10–12 leaves and two suckers. In such cases the main stem is cut off before transplanting.

Transplanting is best done in the rainy season, but prolonged flooding of transplants may kill them. As soon as the plant has produced one sucker, it can be transplanted. The plants are dug up with their roots intact (a 20 cm² ball of earth is suggested — 66), planted in a shallow hole, and covered with humus. However, the roots must not be pressed in (to avoid damage), the planting hole must not be too deep (to maintain aeration of the roots), and further the covered hole should be at the same level as the surrounding ground (the reason for this is not clear).

Planting distances appear to vary considerably. In Dedahup the spacing was 5 × 5 m, but Alrasjid (2) mentions that spacings of 7 × 7 m and 20 × 20 m are also used. Dransfield and Suwanda (66) recommend a 20 × 10 m spacing. *C. trachycoleus* establishes itself quickly and spreads rapidly to cover the ground. It requires little further attention except an occasional (6–8 monthly) clearing of the canopy or the undergrowth.

The first harvest is in the 8th year after planting, although in localities with better soil the first harvest can be in 7 years. Subsequent harvests take place every 2–3 years. The first harvest yields about 7 t/ha, the second and third about 9–10 t/ha, and the fourth harvest about 8 t/ha. In Dedahup, replanting is done after the fourth harvest as it is said that yield decreases rapidly thereafter.

Mature canes attain lengths of 15–18 or even 20 m. During harvest, done in the drier months of April to October, the top 2 m is discarded. Wet months are generally unsuitable for harvesting because of floods. By the time the rattans are cleaned, dried, and graded for export, the total harvested quantity of rattan is reduced by about 40% in weight.

C. caesius is planted on higher ground less subject to flooding because prolonged inundation kills the plant. It is normally planted closer and requires much greater care than *C. trachycoleus*. The cane buds have to be regularly cleared of debris for healthy growth. The first harvest is carried out in the 9th year and yields only 3.5 t/ha. The second harvest is about 4 years later when the yield drops to about 3 t/ha. Because the yield drops rapidly, after this, planters in Dedahup do not like to plant this species.

However, Heyne (81) gives an account (the extract here is from a rather unclear English translation of Heyne's work) of the cultivation of *C. caesius*. He states that the rattan is planted in secondary forest, in which the undergrowth is

cleared and tall trees are girdled, and in rice fields, but often mortality of the plant in the latter is high under the open conditions.

In Palembang the seeds are planted 10 cm apart in seed beds and covered with palm leaves. They are kept moist by watering. When the sprouts are 4 cm tall the cover is removed, but watering is continued. After a year the seedlings attain a height of about 15 cm and have 4–5 leaves. They are carefully removed and wrapped in a piece of banana leaf and transplanted in the rattan gardens.

In Borneo, the skin and pulp of the fruit are removed as mentioned in the case of *C. trachycoleus*. Germination starts after 14 days. The seeds are then planted 5 cm apart on shaded seed beds or loose earth, covered with 2–3 cm of earth, and watered daily. After the plants are 10–12 cm high, they are transplanted into the field during the wet season.

Broers of Bandjarmasin, S. Kalimantan, who are recorded as very successful cultivators of rattan are said to be of the opinion that the best results are obtained by planting on 2-m wide paths cut in an east–west direction, and by spacing the plants at 6 × 8 m. If the plants are placed too closely, they smother other plants, damage supporting trees with the weight of the vines, and tangle their stems, making extraction difficult and wasteful. Again, more intensive tending is required for *C. caesius* than for *C. trachycoleus* because debris must be removed from the cane buds if they are to grow. Harvesting may start in 6–8 years, but only after 15 years is the clump in full production. It will then have about 50 climbing stems and from these some 10 stems, each of which will have attained a length of 26–35 m may be cut. This will yield about 2 piculs (about 122 kg) of rattan per clump.

Browne (48) gives a brief account of planting of *C. caesius* in the basin of the Rejang River (Sarawak). The methods employed and results obtained are not unlike those described by Heyne (81).

Cost of Cultivation

Details on cultivation costs are not available, but some indications are given in Wong et al. (140). The presence of large areas of cultivated rattan, and the total dependence of whole villages on cultivation, extraction, and processing of *C. trachycoleus* and *C. caesius* for several decades in areas along the Sungai Barito and its tributaries, give ample evidence not only of the feasibility of extensive and intensive cultivation but also of its profitability for both small holders and large-scale planters. Wong et al. (140) computed the net profit per annum per acre in 1977 to be \$1500 Malaysian ringgit (which is roughly the same amount in U.S.\$/ha). In the calculation of these profits, only collection, extraction, and processing costs were taken into account. Cost of cultivation was considered negligible. Land rental was excluded.



Conversion and Manufacture

Thin rattan canes that are “runtied,” dried, and fumigated are sold whole as rattans or are further processed by dealers, exporters, or manufacturers into rattan skin and rattan core, which are used for basketry, mat making, binding, weaving, furniture making, and other purposes.

To produce the rattan skin, the outer 1–2 mm of the cane is pared off with a knife in even strips running the whole length of the rattan. It is a laborious but skilled job. Specially designed machines are also used for this purpose. Coring is done by machine and the core is used for basketry or furniture manufacture. The waste produced during splitting and coring is known as “rattan wool.” This waste is unutilized in the rattan-producing countries, but in Singapore and Hong Kong, where some of the splitting and coring is done, the rattan wool is sometimes used as stuffing for furniture or as packing.

In Hong Kong low quality peel (skin) and core used to be coated with plastic and exported for furniture making. However, this practice is gradually dying out.

According to Dransfield (64), core is made from cheap, otherwise poor quality rattan such as *D. angustifolia* and *C. erinaceus*, but subsequently this has proven to be unusual. For production of rattan skin, a limited number of species are used. The best quality strips come from *C. caesioides* and *C. trachycoleus*.

Some importers prefer to buy the *C. caesioides* with its silica unscraped, to guarantee that they are getting the true “sega” and not substitutes of inferior quality. The silica is removed by the importers and processed before sale. However, for certain uses the siliceous layer is left intact as it greatly enhances the beauty and value of the cane for these purposes.

In India “pencil sized” rattan with nodal lengths of 20–45 cm is used whole or split for ribs in protective sports gear such as cricket gloves and pads. In one of the large rattan factories in Hong Kong, small diameter (6 mm or slightly larger) rattan is peeled, planed, and trimmed by machines. The peels are woven by machine into 15-m (50-ft) long pieces, 0.3–0.6 m (1–2 ft) wide that are sold to furniture makers at U.S.\$4.40–7.70/m² (U.S.\$0.40–0.70/ft²) depending upon quality. Core is also produced by machine, either round (wicker core for weaving) or flat (core for weaving and binding). It is of interest to note that the factory produces no fewer than 30 varieties or types of peels, cores, or poles for export!



“Rotan sega” (Calamus caesius) being cleaned with sand in preparation for further processing (Jambi, Sumatra).

Large-diameter canes like *C. manan*, *C. ornatus*, and *C. scipionum* are used whole for various purposes such as furniture frames, sports goods, and numerous other uses. The traditional method of bending the canes is by heating with fire, either by using a blowtorch directly on the part to be bent or by applying the heat indirectly with a piece of heated metal (preferably a soldering iron). In both methods, care is taken not to burn the skin of the rattan too severely. Heated and bent rattan is left in a mould to take the required shape and removed on cooling. This process is difficult to control and standardize and is labour intensive.

Large-diameter canes, unsuitable for use because their skin has fungal stains or other blemishes, are used in some modern furniture factories after the canes are debarked or decorticated by machine. This debarking does not alter the physical properties of the cane very much. After debarking the canes are cut to the required lengths, sanded, steamed for 20–30 minutes in cylindrical chambers, bent by hand to the required shapes in moulds immediately after steaming, and left in the moulds for half an hour to set. After removal from the moulds, they are “brush-sanded” by machine, assembled, and stained using spray guns. This process requires less skilled labour and allows standardization and high production of better quality products, but more capital investment is required.

In the sporting goods industry, large-diameter rattan is laminated with wood (willows, mulberry, ash, etc.) and layers of rubber and used for handles of rackets, bats, or sticks. Small-scale operations presently dominate the manufacture of rattan furniture, sporting goods, etc., as this remains very largely a cottage or village industry. However, modern factories with high production capacity are appearing on the furniture manufacturing scene, mainly aiming at export markets, and are employing the steam-bending process.

Some useful tips for the improvement of product quality, production capacity, and productive use of skilled labour have been published (34). And in the Philippines advice on technical and marketing aspects for prospective rattan manufacturers, and lists of equipment needed and their prices in the Philippines are available (6). Indonesia, the Philippines, and Malaysia have started schools for providing training in the manufacture of rattan products.



Marketing of Rattan Products

No comprehensive list of the myriad uses of rattan has ever been compiled. Almost every author listed in the bibliography cites some. Rattan's versatility, its inherent qualities, and its characteristics make it almost impossible for any substitute material to make any serious and lasting inroads into its domain.

Judging from the export performance of the various producing countries in the region, interest in rattan and rattan products has increased greatly in the last 4 or 5 years. The managing director of a Malaysian firm of consultants, Markiras Corporation Sdn. Bhd., who carried out a brief study of the United States market for rattan products very recently, gives many reasons for the upward trend in the popularity of rattan products — "light, durable (if well treated), hand-touched, easy to maintain, natural looking (with possibilities for colour scheming), blends well with other materials (wood, chrome, etc.), has an outdoor look brought indoors, very malleable and thus useful for imaginative designs, can be manufactured into modular units, very pleasing to the eye, and acceptable to many market segments."

A report from Ottawa, Canada (116), states that "traditional styles of rattan furniture promise to be the rage for 1978" and that successful furniture manufacturers in Canada are turning to rattan. The popularity of rattan is stated to have increased in Japan since 1973 (32) because it is strong, light, has many applications, is easily moved, biodegradable, ideally suited to the environment of wood, straw, and paper, and convenient to use.

Jordan (85) summing up his study of the rattan industry concludes that "on the available evidence, it is reasonable to assume that consumption of raw material (rattan) could increase provided additional sources can be found, and production, marketing, and promotion are conducted in accordance with up-to-date principles." From discussions with exporters and importers, it would seem that consumption of rattan could be immediately tripled, provided good quality raw material was consistently available in much larger quantities, and marketing and promotion were conducted in a more organized manner.

A brief survey in the United States done recently by the aforesaid Malaysian firm of consultants indicates that, given a similar marketing structure and with no structural changes in the industry, the FOB value of U.S. imports would peak at

U.S.\$100 million for the next 5 years and stabilize at U.S.\$60 million thereafter. However, if there were a change of market structure and of the entire industry, with dynamic changes in industry organization, government policies, increased supplies through plantations, etc., the FOB import value in the United States could well increase steadily to a peak of U.S.\$500 million in 10 years.

Indonesia has been the dominant world supplier of raw rattans, providing about 90% of the world's requirements, despite the overall increases in exports from various other producing countries. Hong Kong and Singapore, though not producers of rattan, have dominated processing, conversion, manufacture, and trade in rattan and rattan products. During the last 5 years Hong Kong has been absorbing on average 55% or more of the total exports of raw rattan from the Southeast Asian producing countries, while Singapore has been absorbing more than 25% of the exports.

However, Singapore is concerned mainly with the processing and conversion aspects, preparing the canes for direct use in manufacturing and then exporting them to nearly 60 countries of the world: Italy, Taiwan, the United States, the Federal Republic of Germany, Hong Kong, Spain, and France take 70% of her exports. In 1977 Singapore earned more than U.S.\$21 million from processed and converted (but not manufactured) rattan exports. A direct comparison with the value of raw rattan imports is not possible because available statistical data do not show the substantial imports from Indonesia. Discussions with importers indicate that about 90% of Singapore's supplies come from Indonesia. The value of the remaining imports was slightly more than U.S.\$1 million, meaning that total imports for 1977 would have amounted to about U.S.\$10 million. Hong Kong imported more than U.S.\$26 million worth of rattan and rattan products and exported more than U.S.\$68 million. Imports from Indonesia



A shop beside a canal in Banjarmasin, Kalimantan, Indonesia. Shops like this sell a wide range of domestic articles made from rattan, such as fish traps, baskets, mats, and brooms.

alone were valued at a little less than U.S.\$17 million. (Available Indonesian statistics, however, show a great discrepancy in its export figures, which show only one-third of this amount.) Hong Kong is providing raw materials for mainland China and is also the market outlet for China's finished or semifinished products.

Taiwan (and the Philippines in a much smaller way) is another big exporter of manufactured rattan products, particularly to the United States. Thailand is also beginning to export some knock-down furniture to the U.S. Both Thailand and the Philippines have banned exports of raw rattan, and some states in India have prohibited interstate movement of raw rattan.

How the cost of raw rattan escalates from the time it is extracted to the time it is finally sold to the user is demonstrated below:

Average Costs (Before Shipping)

| | |
|---|--------------------------------------|
| Raw, unprocessed material | M\$ 300 per tonne (1965 estimate) |
| Whole rattan (selected, bundled, and cured) | M\$ 500 per tonne |
| Processed rattan core | M\$ 800 per tonne |
| Rattan peel | M\$1500 per tonne |
| Furniture (made up) | M\$3000 per tonne |

(The above figures are a comparative estimate extracted from Jordan, 85.)

Profits from Rattan (Shipped from Bangkok for Final Sale in Paris)

| | |
|---|-----------|
| FOB Bangkok cost | 100 units |
| Landed in Paris (including cost price, insurance, freight, transit, customs, transportation to Paris and fumigation — even if already fumigated in Bangkok) | 162 units |
| Importer doubles this price in selling to retailer | 324 units |
| Retailer sells at | 908 units |

Cost to Paris buyer is nine times the FOB Bangkok price. (The above information was extracted from Anonymous (32), which was a resume of a JETRO seminar on rattan furniture held in Bangkok in 1978.)

The value and significance of the rattan trade can be gauged from these estimates of costs and profitability when current prices of raw rattan and the total volume of world rattan trade are applied. The value and importance of further processing and manufacturing within the producing countries is also amply evident. Wolter (138) and Quohar (114) in presenting their papers at a seminar on minor forest products in Kalimantan suggested ways the rattan industry and trade in Indonesia could be improved.

Quohar is of the opinion that there is enough raw material in Indonesia. What is needed is guidance in the development of the industry and more capital. He feels the government should rationalize taxes on the rattan industry and streamline procedures for collection of taxes, issue of export permits, etc.

Fattah (68), at the same seminar, suggested that the government should provide guidance on standardization of the "lampit and tikar" (rattan mats)

products — the only manufactured rattan commodity exported from Indonesia (mainly to Japan). Further he suggested that efforts should be made to improve the organization, processing, and production aspects of their manufacturing industry and to widen the markets for the products.

Wolter stated that world markets for rattan products were increasing, which would favour imports from countries with lower labour costs because labour represents a significant part of the total cost. He also noted that handling and freight costs were high but that a 75% savings in shipping costs could be effected if knock-down furniture were produced. He contended that though the styling of Indonesian rattan products sold locally was effective, there was scope for improvement of skills and workmanship. Production facilities are crude but could be improved by some mechanization. Manufacturers also must have capital to finance stocks. He felt that closer links between suppliers, manufacturers, exporters, and importers would need to be established; training facilities made available; and market preferences studied. Overall, Wolter thinks the government should step in and give a helping hand to improve the industry.

To sum up, it may be said that there is sufficient evidence to emphasize the fact that the rattan industry can play a significant role in the economic and social welfare of rattan-producing nations, if a dynamic, purposeful, and speedy restructuring of all aspects of the rattan industry and trade in those producing countries is effected through the cooperative efforts of both the private and public sectors.



Rattan Research

Although rattans have been utilized for centuries, it was not until early in this century that scientists began to study them. Even then, interest in rattans as an object of research apparently resulted largely because they were incidental to the study of the large family of palms, *Palmae*, of which the rattan is a member. Consequently, the botanical or biological aspects of the rattans attracted the main attention of these researchers, and only a handful of them dabbled with those aspects specifically dealing with rattans. Prominent among these researchers are Ridley, Beccari, Furtado, Corner, Whitmore, and Dransfield, the last of whom has fast gained a reputation as a noted rattan taxonomist. It was a natural sequence to these efforts and the increasing and wider utilization and trade in rattans, coupled with the realization that stocks of rattans in the more accessible forests were becoming exhausted due to overexploitation or were disappearing due to conversion of these accessible forests for agriculture, that the distribution and availability of rattans in the rattan-growing areas began to receive attention in the twenties. In the late thirties research attention began to be focused on the cultivation and utilization of rattans. The tempo of research in these aspects increased after World War II, particularly on utilization, notably in the Philippines. However, it was not until just before the mid-seventies that planned and organized research on cultivation and utilization of commercially valuable rattans began, with Malaysia and the Philippines taking the lead.

Long before research scientists began to direct their attention to rattan, commercial interest in a popular species (*C. caesius*) and later also in *C. trachycoleus* whetted the interest of villagers along the Sungai Barito in Kalimantan, Indonesia, and they began to cultivate these species in the mid-nineteenth century, reportedly "at the instigation of the missionaries in the neighbourhood of Beneden-Dayak" (81).

Brown's (45) report of some "very primitive" cultivation of "rotan sega" (*C. caesius*) by Malay villagers along the Sungai Pahang, Peninsular Malaysia, suggests that cultivation must have begun by the turn of the century. There were also "scattered reports of the planting of *Calamus caesius* in villages in Perak," also in Peninsular Malaysia (64). The species has also been noted to be "commonly cultivated" in the Rejang by the Sea Dayaks in Sarawak (48), and by

villagers behind Kampong Komansi in Sabah (104), both in East Malaysia. Brown also notes that apart from *C. caesius*, *C. retrophyllus* (= *C. laevigatus*) is also planted near longhouses in the 1st Division of Sarawak.

These efforts by villagers to cultivate two important commercial species of rattan (with pronounced success in Indonesia) provide ready information for the establishment of plantations with these species in other suitable parts of Southeast Asia. The “remarkably different habits” of the two closely related species and the silvicultural significance of their differences in habit are recorded by Dransfield (62, 64).

In his manual (64), which is to be published shortly, Dransfield makes some interesting remarks on the two species of *Calamus*: “*Calamus trachycoleus*...is a most remarkable rattan and is known only in this area (Central Kalimantan, Indonesia) of Borneo. It is closely related to *Calamus caesius* but differs in having long stolons rather than very short rhizomes. This slight difference in habit is of extraordinary potential. The stolon of *Calamus trachycoleus* metamorphoses into an aerial stem and at the point of metamorphosis produces two lateral buds which grow out as stolons. This means that the growth of an individual of *Calamus trachycoleus* can produce an exponential increase in the number of aerial stems. As the stolons are long, the plant is invasive and there is little competition between aerial stems of the same individual whereas in *Calamus caesius* there is considerable competition between the stems because of the close nature of the stump.” The silviculture of these two species is given in Dransfield’s manual.

The experience of the rattan cultivators of Indonesia, recorded by Heyne (81) and Tuil (132) and the habitat, habits, and silviculture as recorded by Dransfield, constitute a good starting point for researchers and others interested in cultivating rattans.

Cultivation Research

India

The earliest attempts at cultivation research in India are recorded briefly by Ramaswamy (115), who states that “apart from a few haphazard attempts no work was done on artificial regeneration of canes in India until a supply of cane seeds was obtained in 1932–33 from the Federated Malay States for propagation in South Arcot and Nellore districts in Madras,” but the seeds failed to germinate. He made a recommendation that trials should be carried out with economically important Indian species, taking the cue from the Indonesian experience in cultivation, and suggested a list of those for trial in Assam, Bengal, Uttar Pradesh, South India, and the Andaman Islands. However, a suggestion was later made (37) that apart from the Indian species proposed by Ramaswamy, trials of the more important Malaysian species (*C. caesius*, *C. scipionum*, *C. manan*, and also *C. ornatus*) be conducted.

In 1955 the Forest Research Institute, Dehra Dun, obtained 380 seedlings and suckers of *C. caesius* from Indonesia by air (9). Only 95 survived the journey. Twenty seedlings were planted at Kodanad in Kerala and another 20 in Assam, while the rest were planted in Dehra Dun. Severe winter conditions in Dehra Dun killed the seedlings planted there. Nothing further is known about the Assam trials, but the Kerala trial ended with one seedling surviving. It began suckering in 3 years from planting and flowered (but no fruits) in 7 years. It still lives and has

some 20 shoots, the longest being 30.4 m (109). Suckers removed from this surviving clump and planted out, did not survive.

Experimental trials were repeatedly made in Kerala with four indigenous species, *C. rheedei*, *C. gamblei*, *C. rotang*, and *C. travancoricus*. All showed poor results except for the last, 80% of which survived and showed satisfactory initial growth.

In Madras, seed weight and germination tests were started in 1955 with five species, the indigenous *C. rotang*, *C. pseudotenuis*, *C. rheedei*, and two exotic species *C. scipionum* and *C. caesius*, at four research centres. None germinated except for *C. rotang* (50%). In 1958 species survival tests were conducted at the Topslip and Tanjore research centres. *C. guruba* showed good results in both the centres, *C. travancoricus* gave good results at Topslip, and *P. himalayana* at Tanjore. Details are given by Shetty (124).

In Dehra Dun a rattan species trial was established 3 years ago with *C. tenuis*. Although detailed results were not available, the species were noted to be growing satisfactorily. The majority of the plants were between 1.5 and 2 m, and all of them appeared to be healthy. Earlier trials with exotic species failed due to severe climatic conditions.

At Kerala Forest Research Institute, research on tissue culture of rattan is being carried out at the Madhurai University, Madras State. It is believed that initial success has been attained. No further details are available.

Sharma (123) reported that rattan cultivation research is being pursued in the Andaman Islands where *C. viminalis* and *C. rotang* are being cultivated. Growth and other data obtained in the early years are said to be contained in an article entitled "Bamboo and cane plantations in Andamans, their silviculture and management" by S.K. Sharma and S. Rajeswaran, presented at a symposium, 11-13 November 1968, held by the Society of Indian Foresters. Unfortunately, this article could not be traced.

Sharma reports that in Coorg, Karnataka, the Forestry Department has initiated germination and planting trials with *C. thwaitesii* and *C. travancoricus*. Germination of these species is accelerated if the "scaly coat and the mucilaginous seed coating" are removed. Rhizomes of these species, however, establish and multiply much quicker. Average height growth recorded was 2 m in 4 years. Species suitable for planting in different parts of India are listed in the literature (9, 37, 115).

Chacko (51) deals with some feasible sampling methods for the survey of bamboo, canes, and reeds, and states that "the promising method for the survey of canes and reeds is a low intensity line plot sampling," which he describes in his paper. An outline of a proposed pilot survey for rattan, the method to be used to estimate the accuracy of the survey, and the costs involved, are also given.

Indonesia

Dransfield (59) and Alrasjid (2) give some details of the species of rattan found in different parts of Indonesia. Brief notes on the relationship between some of the species of rattan and the soil type, forest type, and altitude are given. However, Dransfield concludes that the relationship between rattan species and soil type is yet to be established. Taxonomic work in Sumatra is fairly well covered (114).

Experience gained by Dransfield in Indonesia on the botanical aspects of rattan is recorded (59). However, he comments: "It should be made very clear that the real result of the four years' field work will not be felt until taxonomic

monographs of the rattan are written. Such monographs, however, will require long and painstaking herbarium work in Europe and elsewhere."

As stated earlier, his work (62) on the comparison of *C. caesius* and *C. trachycoleus* can be considered a direct contribution to cultivation research. In his manual (64), Dransfield gives an account of the silviculture of *C. trachycoleus* and *C. caesius*, both of which are cultivated on a large scale in Kalimantan.

At BIOTROP, in Bogor, research on the ecology of rattans (*C. trachycoleus* and *C. caesius*) is being carried out. Specifically, in 1976, trials were started on the effects of light intensity and soil moisture on growth. Research plots have been set up in Central Kalimantan and Sumatra. Results are expected to be published shortly. The LPH (Forest Research Institute, Bogor) is planning studies on harvesting, optimum rotation periods, and on the possibilities of establishing plantations in Java and West Sumatra.

Malaysia

Botanical information on Malaysian rattans is contained in various publications including those of Ridley (118), Beccari (41a,b,c,d), Foxworthy (70), Burkill (49), and in particular in the works of Furtado (71-74), who in the fifties pioneered taxonomic work on the Malayan rattans. Further information can be found in Whitmore (137) and in Dransfield (64). Peninsular Malaysia is well covered.

As already mentioned, rudimentary or small-scale cultivation of *C. caesius* at the turn of the century by villagers is recorded by Brown (45) in the Malay Peninsula, by Browne (48) in Sarawak, and by Meijer (104) in Sabah. The scale of this cultivation is obviously nowhere near that found in Indonesia. Brown (45) collected some information on cultivation of *C. caesius* by Malays along the Pahang River in the hope that the British estate owners with "considerable forest reserves (adjacent to the estates) which at present serve no useful purpose" might utilize the information to start growing rattan in these forests. But his suggestion does not seem to have been taken up.

The earliest attempts at cultivation research were conducted about 1910 when experiments were carried out to establish a plantation of "rotan sega" (*C. caesius*) in Pondok Tanjong in Perak (10). In 1930, the Annual Report of the Forest Administration of the Federated Malay States reported that the plantation experiment was "a complete failure and further experiments have been stopped. Those canes planted in the forest have always been eaten by some animals and those grown in the open do not produce the necessary hard, shiny skin."

Dransfield and Manokaran (65) report that rattan trial plots were laid out at the FRI, Kepong, between 1926 and 1929, but that the trials did not provide any worthwhile information. Between 1962 and 1964 a number of species of rattan were planted in a trial plot at Kepong. Between 1966 and 1972 more trial plots were established in Sungei Buloh, Ulu Langat, and Kuala Lipis, all using *C. manan*.

All these trial plots were incorporated into a later main project, which is mentioned below. Meanwhile some growth data were obtained from the 1962-64 trials for some dozen or more species. From the plots of *C. manan* established between 1966 and 1972 the following preliminary observations were made:

- (1) planted *C. manan* appear to do best in humid but well-drained conditions as is the case with natural crops of the species;
- (2) performance is better where undergrowth and shade are partially cleared;

- (3) seedlings do not survive for long under bertam (*Eugeissona tristis* Griff.);
- (4) fertilizer applications apparently give good response; and
- (5) seedlings that remain in the nursery longer (i.e. planted out when larger) may survive better than smaller ones.

In late 1973, the decision was taken by the Forestry Department of Peninsular Malaysia to initiate rattan research in a planned and organized manner. Preliminary work on gathering existing information, arrangements for funding, local staffing, and for specialist foreign assistance, and subsequent planning of research and approval of the plans took up the next year or more. Seeds were planted in the nursery for use in the project, which started in mid-1975. The two main objectives of the project were: (1) to prepare a manual on the taxonomy of Malayan rattans; and (2) to select species of marketable value for silvicultural trials to determine whether rattan could be cultivated as a plantation crop on a commercial basis (65, 98).

To investigate the taxonomy of species of potential value as plantation crops, fresh fieldwork was undertaken because existing rattan herbarium collections were "generally speaking very poor" (65). The opportunity was taken to record information provided by the aborigine collectors on the uses of the species that were collected.

Arrangements were made with State Forestry Department authorities for bulk collection of seeds for sowing in the nursery, and rattan species lists were prepared for 20 localities spread all over Peninsular Malaysia and Sarawak. Preliminary keys and lists of distinctive features for identification of the genera of rattans were prepared as a guide for research personnel working on the project, and a note on the collection of rattan seeds was prepared as a guide for collectors. In addition, observations on species encountered during the field work were tabulated to give information on local names and their derivation, size classes, and uses. An outline of how trial plantings were to be done, with what species, and where, and guidelines on what to observe and record were also prepared for both research staff (65) and field officers (98).

Trial plots of *C. scipionum* (2 plots) and *C. caesius* (6 plots) were established in 1975 and 1976 in Sungei Buloh Forest Reserve, the Forest Research Institute at Kepong, and Bukit Ceraka Forest Reserve for assessment of seedling survival and growth. Observations made 2 years after planting are to be published shortly (Manokaran, personal communication). Immediate further expansion of trials was hindered because of a lack of seedlings of the required planting height (99). However, thousands of seeds of *C. manan*, *C. tumidus*, *C. scipionum*, *C. caesius*, *C. laevigatus*, *Korthalsia* spp. (especially *K. flagellaris*), *D. angustifolia*, *C. insignis*, *C. filipendulus*, *C. speciosissimus*, and *K. echinometra* were collected or purchased from aborigine collectors and sown in the FRI nursery at Kepong, in readiness for planting at the end of 1976. In late 1976, one of the trial plots, that at the Ulu Langat Forest Reserve started in 1967 and incorporated into the project, was lost to research because of the construction of a small dam. Information obtained from this plot was published by Manokaran (101).

Mortality rates in this plot of *C. manan* were judged to be high mainly because of human interference and partial neglect in the early years of its establishment. Generally, growth rate was slow, possibly because of a heavy overhead canopy. It was observed that the faster-growing individuals (maximum rate of growth 1.2 m per year) were normally under a relatively open canopy,

suggesting the importance of adequate overhead light for rapid seedling growth of the species. This observation is substantiated by Dransfield (64) who notes that *C. manan* under dense shade in the natural forest remains for many years as a rosette plant, until an opening in the canopy admits more light and allows the plant to shoot.

Recording further observations of rattan species Dransfield (64) notes that there are two extreme situations under which rattans grow. Species like *Daemonorops calicarpa*, *D. didymophylla*, *Calamus castaneus*, *C. longispatus*, *C. sedens*, and *C. perakensis* grow in deep shade in the forest undergrowth and appear not to require the presence of light gaps for their development into mature plants. At the other extreme, species like *Plectocomiopsis geminiflorus*, *Plectocomia* spp., *Myrialepis scortechinii*, some species of *Korthalsia*, and *Daemonorops angustifolia* require very high light intensities for growth and are confined to large light gaps, landslips, or seral forests on river banks.

Commenting on observations made on growth rates, Dransfield says "We know next to nothing about the rates of growth." *C. manan* planted in two different localities showed a maximum per annum growth of 1.2 m in one locality and 3 m in the other. *C. caesius* was observed to grow at 4 m a year. Studying available growth data on five species planted at the Kepong Arboretum, Dransfield states that the data "suggest that some forest undergrowth species may be adapted to grow at a relatively fast rate in deep shade and that light-demanding species may grow slower in the same conditions." *C. exilis*, a slender forest undergrowth species is noted to have grown at a rate of 120 cm per year, whereas under the same conditions an apparently light-demanding species *D. angustifolia* grew at only 21 cm a year. The remaining three species at the arboretum grew at 94 cm/year (*D. verticillaris*), 21 cm/year (*D. geniculata*), and 68 cm/year (*C. conirostris*).

C. manan presents problems not encountered in *C. trachycoleus* or *C. caesius*. Because it is a solitary species of great size, only one harvest is possible and its huge size usually causes considerable damage to tree crowns. Observations in a sample plot indicate that considerable protection and manipulation could well be needed if the plants are to grow successfully (64).

Besides *C. trachycoleus*, *C. caesius*, and *C. manan*, Dransfield (64) suggests that several other species would probably succeed in cultivation. "Some of the largest species of *Calamus* in Celebes (species unknown) are clustered and hence if grown would provide a sustained rather than once only harvest." *Calamus palustris* var. *malaccensis*, a clustering species, seemingly tolerant of extensive disturbance, is suggested as another species for cultivation. Several species of *Calamus* closely related to *C. caesius* and varieties of *C. caesius* are stated to have advantages over the normally cultivated *C. caesius* and could be worth cultivation trials.

In Kepong, seeds for sowing in the nursery are first cleaned of their flesh and surrounding pericarp by washing. They are then shallowly buried in wooden seed trays containing compost made from forest soil, peat, and sand in equal proportions (64). However, Manokaran (102) states that he used soil consisting of 7 parts forest topsoil, 3 parts peat, and 2 parts river sand for his germination tests (mentioned below). Where the number of seeds involved was large, sowing was done on nursery beds in which the soil consisted of equal amounts of topsoil and river sand. When the seeds germinate and produce two or three leaves, the

seedlings are picked out, planted singly in black plastic bags, kept under shade for about 18 months, and then planted out in the field.

Manokaran (102) studied the germination of 12 species of *Calamus*, 14 of *Daemonorops*, 3 of *Korthalsia*, and 1 of *Ceratolobus*. He found some variation in germination, not only within genera (e.g. *Calamus* and *Daemonorops*) but also between different samples of the same species — attributable probably to the general differences, as well as to different degrees of ripeness of the various seed samples, 65 lots of which constituted the total test material. The author describes the method used in his tests and tabulates the percentage germination, the period for 50% successful germination, elapsed time between the first and last germination, and total number of seeds sown for each species.

In the case of *C. manan*, it was noted that if the pericarp were not removed from the seed, germination percentage was poor, and both first and last germination were delayed. The one seed sample of *C. tumidus* that was tested germinated much more slowly than *C. manan*. *C. scipionum* required at least 4 weeks to germinate; *C. caesius* had a high germination percentage if the pericarp were removed, with germination beginning 7 weeks after sowing; and *C. trachycoleus* seeds germinated in 4 weeks and germination percentage was high.

Some preliminary studies on the physiological aspects of germination have been done (28) using seeds of *C. manan*. Removal of the sarcocarp and the embryo cover promoted the fastest germination.

Manokaran (103) recorded the number of mature fruits produced and the total number of fruits present on the solitary stemmed *C. manan* and *C. laevigatus* and on the clustering species *C. scipionum* and *C. caesius*. All, except *C. laevigatus*, produced abundant fruit during the fruiting period. *C. laevigatus* produced a relatively lower number (fewer than 500), judging from collections made from a single plant. *C. caesius* can bear a total of 4000 or more fruits with half that number maturing at any one time; *C. manan* can bear as many as 5000 fruits that can all be mature at the same time; and *S. scipionum* can have 2000–3000 fruits with a third or more maturing together.

In Sabah, species trials with *C. caesius*, *C. trachycoleus*, and *C. manan* have been started with the intention of setting up plantations (80); however, results are not yet forthcoming.

Philippines

The earliest attempt at cultivation research was undertaken in the late thirties. Doloquin (55) determined the possibility of using wild seedlings of *D. ochrolepis* (291 seedlings) and *C. siphonospathus* (223 seedlings) collected from Makiling National Park, to establish a plantation. A secondary goal of the study was to determine the optimum size of seedlings for transplanting.

Wildings 10–40 cm high were selected and dug out with a spade. The root system was gently freed of its soil. Wildings were “heeled in” for 24 h and sorted into height classes: 11–20 cm; 21–30 cm; and 31–40 cm. They were planted a foot apart in shaded areas. Survival after 147 days (half of them rainy days) was 77.1% for *C. siphonospathus* and 72.3% for *D. ochrolepis*. The highest percentage of survival was among the smallest seedlings — 82% and 90.1%, respectively. Further information on this experiment is lacking, although a remark in Anonymous (18), 35 years later, notes that previous investigations on bare root planting met with “limited success.”

In 1976, an attempt was made, using *C. maximus* and *C. ornatus*, to determine the best pretreatment method when germinating rattan seeds, and the

best sowing and growing medium for the seedlings (76). There was a significant difference among methods of seed pretreatment, but none among germination media. There was no interaction between pretreatment and germination media. Stratification in sawdust for 12 days as a seed pretreatment gave the highest rate of germination (27.48%). Other pretreatments gave significantly lower germination percentages than did the control.

Tandug (127), studying the sampling method for the inventory of Philippine rattan, concluded that the most efficient size and shape of sample plot was a 10 m × 10 m plot. To determine the distribution of the various rattan species found in the study area, three mathematical distribution functions (binomial, Poisson, and negative binomial) were fitted to the observed frequency distributions. The empirical distribution of each particular rattan species was best fitted by the negative binomial distribution.

Thailand

In the late forties attempts were made to cultivate *C. caesius* in its natural habitat in South Thailand at Narathiwat, Patani, using seeds and wildings (113), but they failed. Planting cost was estimated at 1950 bahts/acre (U.S.\$220/ha). In 1968, a fresh attempt was made to plant the same species in the same area. The results are not yet available. Seeds were not used because earlier germination trials proved a failure.

Utilization Research

India

Various Indian species of canes of economic importance have been classified by thickness into thick, medium, and thin and the uses of each are mentioned by Anonymous (9) and Badhwar et al. (37). Tests show that canes such as *C. tenuis*, *C. rotang*, and *C. latifolius* "are as good in strength as the more well known Malayan canes."

In India (40) green canes have been found to contain from 60% to as much as 125% moisture on an oven-dry weight basis. It is said in Bengal and Assam that a 2-m piece of *Plectocomia himalayana* will provide "enough potable water to quench a worker's thirst in the dry season."

With regard to processing, the authors (40) state that Indian canes, having no thick silica covering as in some Malaysian canes, need no desilication. However, they say that processing of a cane should be in accordance with the intended use of the cane. They have suggested grouping Indian canes into six use classes for purposes of treatment: rattaning canes (for chairs); ballast or coal basket canes; furniture frame canes; sporting goods canes; umbrella handles; and walking sticks. Details of treatment are suggested for each of these classes and are described by them.

Indonesia

Setiadi (122) studied the effects of dipping rattan in a mixture of hot diesel oil and coconut oil as is practiced by some rattan processors, ostensibly "to increase its value." He found that the colour is best when immersion is for 30 min. Increased oil temperature reduces the moisture content of the rattan, but the oil slows down the rate of drying after treatment, as it prevents evaporation from within the rattan. Setiadi found the immersion generally improves colour but has a negative effect on the mechanical quality of tension. Mixtures of coconut oil and



Utilization research will help small rattan businesses such as this one in Kuala Lipis, W. Malaysia, where a trough for boiling "manau" sticks, and stacks of sticks for drying can be seen.

diesel oil in the proportion of 1:2 were found to give high colour value and also to improve tension qualities and reduce the moisture content. Increased temperature and time of boiling lowered the physical and mechanical qualities but not the colour.

Setiadi's recommendations were: (1) dip the rattan in water for 24 h prior to the oil treatment to achieve best results; (2) use a coconut oil : diesel oil mixture in the proportion 1:2; (3) maintain the temperature between 120 and 130 °C; and (4) immerse for 30 min.

Malaysia

Field surveys have been carried out to gather available information on the uses of rattan (69), and some of the current processing practices are also recorded (64, 65). For example, Tan (126) discusses the possibility of colour improvement of Malaysian rattan by bleaching and outlines a method for bleaching on a commercial scale.

Based on a combination of diagnostic anatomical features (128) the genera of rattans studied can be separated into three related groups: (1) *Calamus*, *Ceratolobus*, *Calospatha*, and *Daemonorops*; (2) *Korthalsia*; and (3) *Myrialepis*, *Plectocomia*, and *Plectocomiopsis*. However, at the species level only some species can be identified in this manner. Species like *C. manan* and *C. tumidus*, for example, cannot be separated by this method.

Philippines

Just as in the case of cultivation research, available records show that the Philippines began rattan utilization research in the late thirties with trials on air seasoning of rattan to prevent staining. Cortes (54), studying air-drying of *C.*

maximus and *C. ornatus*, observed that active growth of stain fungi occurred when the moisture content of scraped pieces was about 100% and unscraped pieces about 143%. Moisture content dropped in scraped poles to 13% in 5 weeks from an initial average of 120% and in unscraped ones from 160% to 22% in 26 weeks.

If canes are not dried sufficiently quickly, they are liable to attack by stain fungi, which lower cane quality (1). Mabesa and Mabesa (96), using a furnace-type kiln to dry scraped and unscraped rattan poles, recommended starting with a temperature of 60 °C and gradually increasing it to 65 °C in 96 h. They controlled the temperature in the kiln by the damper in the chimney and the amount of wood wastes fired in the furnace. Laxamana (92) using an experimental steam-heated, automatic, electronically controlled kiln demonstrated that a well-designed and controlled steam-heated kiln will turn out better quality poles and will dry at a faster rate than the furnace-type kiln used by Mabesa and Mabesa (96). However, such sophisticated kilns are not presently within the reach of the ordinary rattan collector or processor.

Various investigations were made to try and find an effective control for stain fungi on rattan. Reyes (117) dipped unscraped poles of rattan into a copper sulfate solution up to 1.0% strength, but failed to obtain completely stain-free poles. Sagardo (119) submerged unscraped rattan poles in swift running water, but this did not prevent staining when the poles were air-dried. Battad (39) was also unsuccessful in controlling stain fungi when he dipped poles in kerosene and gasoline for up to 20 h. Casin (50) reports that Roldan made several studies to determine the identity of the stain fungi. *Ceratocystis* and *Diplodia* were identified. Three species of *Ceratocystis* were identified and are said to be responsible for the staining in freshly cut poles, whereas *Diplodia* is thought to be associated with the dark colour stain in older poles.

A study of the proper utilization of rattan poles, specifically their drying and other related properties, was initiated under the leadership of Casin (50) in early 1974. This project consisted of two parts: (1) to find the most suitable and practical method of controlling staining fungi and insect infestation of rattan and to determine its drying characteristics and basic physical and mechanical properties; and (2) to design and construct a simple but effective rattan dryer for the industry.

Casin's report is a progress report on the first part of the study. He reviews all available literature on the subject, gives details of materials and methods, and the results of the investigations obtained until April 1975. The highlights of his recommendations are:

1. *Stain-control.* Dip for 30–60 s in 7 lb Dovicide G per 100 gal (0.8 kg/100 l) water after standing the canes vertically for at least 15 min to free them of dripping sap. Treatment must be done within 8 h of cutting. Scrape the nodes, if possible, before treatment. The treatment is effective for 4 weeks. For longer periods of protection, dry the treated pole in a rattan dryer to bring the moisture content down to 12–14%. Several hints on drying are given.

2. *Insect-control.* A 0.5% concentration of Dieldrin or Lindane in water protects the pole for 6 months. Dip pole for 3 min after processing and before manufacture.

3. *Drying characteristics.* Poles scraped at the nodes will dry to 15% moisture content in 10 weeks if stacked in a near-vertical position.

4. *Physical and mechanical properties.* The average moisture content of the pole increases from the base to the top. Except for the static bending test,

compression parallel to grain, hardness, and nail and screw withdrawal were always lower in stained rattan.

5. *Bleaching*. Hypochlorite and peroxide did not totally remove stain. Stain remained distinct and visible, though there was some bleaching effect.

Thailand

The Royal Forestry Department has been collecting information on species used for manufacture of rattan articles, particularly furniture.



Ongoing Research and Future Plans

India

Currently rattan research efforts are limited, but the major research centres are planning to augment these efforts almost immediately. Some research now under way includes:

(1) Rattan regeneration in heavily logged forests in the Andaman Islands. No details were available.

(2) Rattan plantation research with *C. viminalis* and *C. rotang*, also in the Andamans. No details were available.

(3) Tissue culture research is being carried out at the Department of Morphology, School of Biological Sciences, Palkalainagar, Madurai, Tamil Nadu State.

(4) Species trials are being conducted by the Forestry Department of Coorg, Karnataka District (Mercara Division).

No written documents were available on plans for research. However, the following were expected to be implemented:

FRI, Dehra Dun

- (1) Rattan cultivation with special reference to effect of light density.
- (2) Rattan processing research — initially, the better known processing methods employed elsewhere are to be tested and if possible improved.
- (3) Rattan production economics.
- (4) Furniture design research.

Kerala FRI, Peechi

If funds were approved by its governing body,

- (1) Species trials.
- (2) Tissue culture.

Preinvestment Survey of Forest Resources, Dehra Dun

(1) A survey of rattan resources in the Andamans to be done as an integral part of a forest resources survey of the Islands.

Karnataka Forestry Department, Mercara Division

- (1) Species trial.

Indonesia

The LPH (Forest Research Institute), the LPHH (Forest Products Research Institute), and the BIOTROP, all at Bogor, are currently engaged in research into different aspects of rattan. The first two are the main centres of forest research, including research on rattan, but hitherto research efforts by them are stated to have been minimal and no specific research program exists. Examples of the type of research being pursued include:

BIOTROP

(1) Trials on light intensity and soil moisture conditions. Two 4-ha plots of *C. trachycoleus* and *C. caesioides* are being studied, one in Central Kalimantan and another in Jambi (Sumatra).

LPH

(1) Study of cultivation research plots established earlier at East and South Kalimantan.

(2) Collection of rattan herbarium material for taxonomic studies.

LPHH

(1) Monitoring of information on the status of rattan utilization to determine research needs.

Both the LPH and LPHH were planning to start research on rattan in 1978. The following items of research were being considered:

LPH

(1) Establishment of pilot plantations in Java and West Sumatra, using species now being cultivated.

(2) Determination of the optimum rotational period for harvesting of cultivated species.

LPHH

(1) Establishment of economical and more efficient methods of harvesting and extraction. (Responsibility for research into this aspect may be shared between LPH and LPHH or conducted in cooperation with LPH).

(2) Testing and improvement of existing methods of processing.

(3) Prevention of stains and insect attack.

(4) Improvement of designs and manufacturing methods.

(5) Investigating the possibilities for standardization of rattan grading rules.

BIOTROP

(1) Extension of existing studies on light intensity and soil moisture conditions to Java.

In addition, it should be noted that LIPI (Lembaga Ilmu Pengetahuan Indonesia), which rates "minor forest products" including rattan as the third commodity in its list of priority commodities, considers that an effort should be made to cultivate species of rattan that are now commercially utilized. They suggest that LPH and LPHH, who have the facilities, should jointly undertake research work on this aspect.

Malaysia

The Forest Research Institute, Kepong, is mainly responsible for rattan research. It has a 5-year (1976-80) research program (20) that aims to enhance the production of rattan. A special program was initiated in July 1975 to study the taxonomy, ecology, and silviculture of rattans with the view to developing suitable cultivation methods. The projects include:

(1) Taxonomy of Malayan rattans — This project was initiated in 1975 with the aid of John Dransfield who has prepared "A Manual of the Rattans of the

Malay Peninsula" (64). With this work, the taxonomy of rattans of Peninsular Malaysia is well covered.

(2) Germination and early growth of rattans — This is a continuing project to determine the percentages and rates of germination of Malaysian rattans. The results of the first series of tests carried out by N. Manokaran were to be published in the *Malaysian Forester* (102). Some preliminary trials in the pretreatment of seeds to stimulate germination and some studies of germination processes have been conducted, but not published (28). Currently, physical methods of stimulating germination are being pursued.

(3) Studies on the distribution of rattans in relation to soil and forest types — Collection of specimens and gathering of information on the ecological and geographical distribution of rattans are being pursued.

(4) Establishment of trial plots and study of the silviculture of rattans — Observations are continuing on the species trial plots established earlier. Some 7000 seedlings of *C. manan* and about half this number of *C. caesioides* raised in the FRI nursery were planted out in March and mid-June. Observations are being made of their survival and growth.

(5) Cane quality studies — The use of rattan for reinforcement of concrete is being investigated in cooperation with the Institute Teknologi Mara. Existing methods of processing rattans are being surveyed.

The Universiti Pertanian Malaysia, Serdang, has initiated a project on rattan utilization that considers:

(1) Production aspects — Trials are being conducted to determine important physical properties of both the rattan and its different structural components like the skin, pith, and core. Currently experiments are under way to determine both tension and compression strength.

(2) Utilization aspects — The use of rattan skin as a fibre component for fibrous concrete is being investigated, as is its use as a reinforcing material (replacing steel reinforcement) in concrete.

The Universiti Malaya chose rattan anatomical research for a thesis for one of its ecology honours degree students (128). This thesis was based on attempts to identify generic and specific levels of rattans by the use of their anatomical features.

Research plans until the end of 1980 include the continuation of the pursuit of the projects already mentioned, except that at the FRI, Kepong, taxonomic work will be low key. The Universiti Malaya has no immediate plans for selecting rattan as a subject for thesis preparation by its students. However, the FRI hopes to extend its work to the silvicultural aspects of rattans.

Philippines

The Forest Research Institute (FORI) is responsible for research into the growing aspects, and the Forest Products Research and Industries Development Commission (FORPRIDECOM) is responsible for utilization research. Both are situated at Los Baños. So is the University of the Philippines College of Forestry, which has contributed to rattan utilization research. Rattan research has been actively pursued for some time, with FORI making a strong contribution in the last 4 or 5 years. Ongoing research includes:

FORI

(1) Mensurational studies and sampling design for Philippine rattans.

(2) Germination studies on *C. maximus* and *C. ornatus* and the effect of fertilizer on the seedlings.

(3) Evaluation of seedling survival and growth in trial plantations.

FORPRIDECOM

(1) Development of lightweight field drying equipment (work on this is almost completed, and a 7 kg (15 lb) dryer is expected to be developed).

(2) Physical, mechanical, and chemical characteristics of commercial rattan.

(3) Identification and control of stain fungi and insects attacking rattan.

The UPLB (University of the Philippines, Los Baños) is also contributing toward rattan research. At present, one of its students is preparing a thesis on organisms causing the discoloration of *C. maximus* and its effects on the physical and chemical characteristics of the species.

Research proposals being considered by FORI include:

(1) Phenology of rattan species in different climatic conditions in the Philippines.

(2) Rattan cuttings in plantations under different spacing.

(3) Treatments to hasten germination of rattan seeds.

(4) Effect of rooting hormones on cuttings of selected rattan species.

(5) Survival and growth and development of *C. maximus* and *C. ornatus* in established fast-growing species plantations.

(6) The effect of hormones on the flowering and fruiting of *C. maximus* and *C. ornatus*.

FORPRIDECOM will continue research efforts along its present lines but all future work on utilization will be on an integrated basis.

Thailand

The Royal Forestry Department is responsible for rattan research. Ongoing research is currently confined to the collection of information on species used for the manufacture of furniture and other cane articles. Proposals submitted for approval include (in order of priority):

(1) Germination trials.

(2) Transplanting trials with wildings.

(3) Storage of rattan and rattan seeds.

(4) Treatment of rattan.

(5) Propagation of species other than *C. caesius*.

(6) Determination of the best period (months of the year) for collection of canes.

The Royal Forestry Department also has plans to set up 80 ha (200 acres) of trial plantations of *C. caesius* using wildings in each of the different regions, particularly in the swampy areas of Eastern Thailand.

Sri Lanka

It is proposed to initiate research on the distribution and availability of rattan and on cultivation techniques. It is also hoped to introduce known techniques of rattan processing to obviate the heavy wastage and deterioration of quality due to improper cane processing.



Status and Evaluation of Research and Information

Rattan is growing in importance. After timber, it is the second most important forest product. However, in comparison with timber, rattan rates a poor second. It has been for a long time dubbed along with various other forest products as a "minor forest product." Consequently, it has not been given any serious attention from any quarter other than from those directly involved in rattan collection, growing, processing, trading, and manufacturing. They seem to have worked in comparative obscurity using their own ingenuity, knowledge gained through prolonged experience, traditional practices, and sheer hard work to build up an industry and trade that is increasingly compelling the attention of governments, entrepreneurs, researchers, and others.

In the rattan-producing countries, the rattan industry and trade is beginning to be recognized as a labour-intensive, comparatively low investment, rural-based industry with bright prospects for earning foreign exchange. Although no accurate statistical information is available on direct employment, estimates indicate that some half a million people could be employed throughout Asia. The value of the trade in raw canes is estimated at U.S.\$50 million, whereas sales to the final consumer approach U.S.\$1.2 billion. Investment per worker in the rattan industry is estimated at about U.S.\$1750 compared with U.S.\$26 250 in petrochemicals.

There still is rattan growing naturally in the forests but much of it is in the less accessible areas. Agricultural development, overexploitation, lack of regeneration operations, greater exploitation of immature canes, and a greater preference for certain species are all contributing to a steady decline in supplies. Until recently demand for rattan has remained fairly constant but in the past few years, there has been a notable increase in demand that supply has not been able to keep pace with.

Much of the collection of rattan from natural forests is done by aborigines or villagers settled near forest areas. Collection is a hazardous, low-paid job. Apparently there is hardly anyone who is entirely dependent on the collection of rattan. Invariably, collection is done to supplement income from other sources and often it is dependent on weather, agricultural practices, local rate of unemployment, rate of income from other sources, and the like. As less hazardous

and more profitable modes of living become available to the collector, and as resources of naturally growing rattan become increasingly difficult to secure, dealers are finding it more and more difficult to obtain the services of collectors who at the best of times never considered rattan collection as a permanent means of livelihood.

In some countries there is virtually no control of felling. In others there is a semblance of indifference, and rattan-cutting licences are given for the asking. No country appears to exercise strict supervision of felling and extraction, the licensee being almost free to take what he wants and how, provided he stays within the limits of his licenced area. Traditional methods are employed in the collection and extraction of rattan, and these are wasteful. At times much of the usable material is left in the forest canopy because it is difficult to collect. And increasing quantities of immature canes are beginning to find their way into the cane markets.

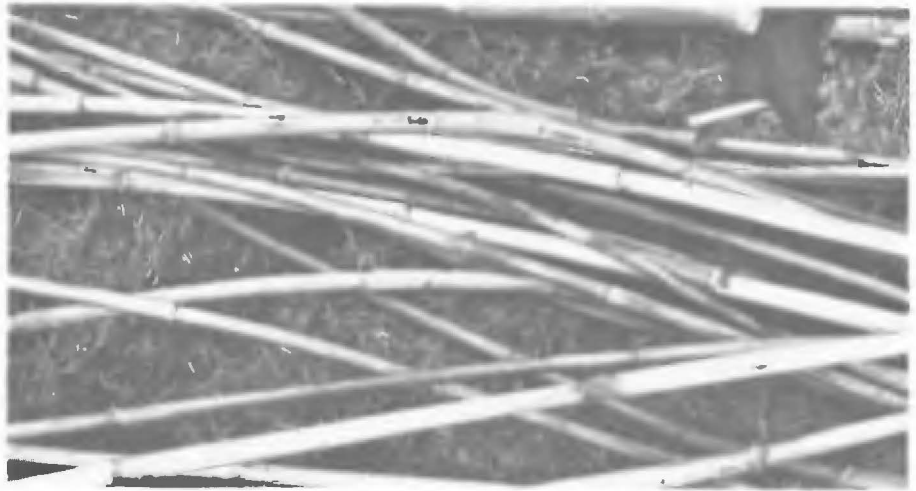
Processing of canes in some countries is almost nonexistent, except for some drying, and processing practices differ from country to country or even within countries. Much is dependent on traditional practices or on the dictates of buyers. Some 30–40% or more of the canes produced do not meet export requirements and these low-quality products are marketed locally. In addition, a further 15–20% of the imports are rejected at the processing centres located in Singapore and Hong Kong.

Great confusion exists in trade names and grades and it is beyond the comprehension of, and a wonder to, one not engaged in the trade as to how the trade functions. However, these trade names and grades have long been established, are often specific to individual localities, and indeed are the basis for daily trade.

Ninety percent of the world's demand for rattan is met by Indonesia, the rest coming from the other producing countries of Asia and a little from Africa. Hong Kong and Singapore dominate the rattan trade scene, without themselves growing any of the produce. Recognizing the importance of the rattan industry in socioeconomic development, the Philippines and Thailand have banned exports of raw rattan. In India some states have banned interstate movement of raw rattan for the benefit of the people of those states.

Cultivation of rattan dates back to the midnineteenth century and was reputedly first established by missionaries in the Lower Barito area of Kalimantan. Today there are large-scale plantations in that area and whole villages are dependent on these plantations for their livelihood. Commercial size plantations also exist in Sumatra and the Celebes. These together produce 7000 t or about a sixth of Indonesia's total production. Rudimentary cultivation of rattan is done by villagers in East Malaysia and plantations were started in the Andamans in 1965 in a small way and the rate of planting is expected to gather momentum.

The rattan trade has been branded as disorganized by modern standards. But, the fact remains that the trade and all its supporting components such as collection, cultivation, and processing are well established though the practices involved are chiefly traditional. What is today a multimillion dollar business was built by a small band of people, mainly collectors, cultivators, and processors, living in the obscurity of far away forests and remote villages in producing countries, and enterprising traders and manufacturers of rattan and rattan products.



These stems of "rotan ayer" (including Calamus erinaceus and Daemonorops angustifolia) are being dried in preparation for processing as core. The effects of processing methods on the quality of the final product need study.

A look at the rattan research that has been conducted in the various producing countries of Southeast Asia shows that researchers have paid but scanty and sporadic attention to rattan. More serious attempts have been made in the sixties and early seventies to study some aspects of cultivation and utilization, mainly in Malaysia and the Philippines, and to a lesser extent in India. In the last 4 or 5 years the rattan industry has been receiving increasing attention. Organized research has started in Malaysia and the Philippines, and India and Indonesia have expressed their intention to initiate or augment research into some of the more important aspects of the industry. Thailand too has indicated its desire to pay more heed to development of the rattan industry through research.

In India, with a recent recommendation of the Indian National Committee on Agriculture that efforts must be made to regenerate or cultivate rattans, and the Indian Government's expressed desire to encourage rural-based industries such as rattan, research efforts are expected to gain momentum.

In the past, botanical studies, species trials, germination studies, rattan survey methods, silvicultural trials, some physical and mechanical tests, and processing research have been attempted by various research organizations and universities and forestry department authorities spread throughout India. These have met with varying degrees of success. None have had an impact on the industry.

Plans are now afoot to have more formal and organized research in all those aspects, plus research on regeneration, ecological aspects, production economics, and furniture design. There is also interest in furthering research on tissue culture of rattan.

In Indonesia botanical aspects have received some attention. The work that is likely to have immediate and greatest impact on the industry is the study conducted on the silvicultural aspects of cultivation of *C. trachycoleus* and *C. caesioides* recorded by Dransfield. Ecological aspects of these two species are under observation. BIOTROP has been responsible for sponsoring these studies.

Perhaps the only study of the effect that boiling rattan in a mixture of diesel oil and coconut oil to improve colour has on the physical and mechanical

properties was conducted about 4 years ago for the preparation of a thesis. Further work on this is strongly indicated.

Till now, there has been little or no planned or organized research on rattan in either the LPH or the LPHH at Bogor. Studies that are being pursued by LPH relate to collection of information on rattan utilization, and studies on the problems of utilization are being carried out by LPHH to determine research needs.

Plans for initiating organized research at LPH include pilot plantation establishment and determination of the optimum rotation period for cultivated species, whereas LPHH plans to initiate research on more economical and efficient harvesting and extraction methods, testing and improving existing processing practices, prevention of stain and insect attack, and the possibilities of standardizing rattan-grading rules.

Malaysia appears to have given more emphasis in the past to the growing aspects of rattan, with little or no work being done on aspects of utilization. The botany of the rattans seems to have been comparatively well studied and the results of a recent taxonomic investigation of rattan in Peninsular Malaysia are being published shortly.

Some species trials were conducted in the fifties and the sixties, but there were no serious organized attempts at such research until proper plans were drawn up in late 1974 for the years 1976–80 for both cultivation and utilization research. Research work began in earnest on seed germination, inducement of germination, nursery practices, species trials, etc.

Field expeditions were also mounted to gather information on ecological aspects and geographical distribution. Trial plots have been established to study growth and survival of two commercially important species, *C. manan* and *C. caesioides*. A summary of these results was given earlier.

Some uses of various species of rattans have already been recorded and published. Bleaching studies have also been undertaken, and the identification of generic and specific levels of rattan species through their anatomical attributes has received attention and produced some interesting results. In the meantime, growth and survival studies are continuing. The use of rattan as an integral part of concrete structure is being investigated and so are its physical and mechanical properties. Research into the processing of rattan is due to begin soon.

The Philippines, unlike Malaysia, has placed more emphasis on utilization research. Air and artificial seasoning of rattan, nonchemical handling of rattan to reduce stain infection, and treatment against stain and insect attack are among those topics previously investigated. As in Malaysia, there have been renewed and vigorous attempts since 1974 to carry out research on both growing and utilization aspects. A study of pretreatment methods for germinating rattan seeds of *C. maximus* and *C. ornatus* was concluded, and preliminary results of a study of a sampling method for the inventory of Philippine rattans are already available. Research efforts on stain control, drying characteristics, physical and mechanical properties, and bleaching, complete with results and relevant recommendations, have been published. An interesting piece of equipment, a lightweight (7 kg, 15 lb) field drying machine, is now being developed and work on this project is almost completed. And in preparation is a thesis on the organisms causing stain fungi on *C. maximus* and their effect on the physical, mechanical, and chemical properties.

A number of projects to study growth are under way and others are proposed for implementation. Projects now in progress include those on aspects

of mensuration, inventory, germination, survival, growth, fertilization, direct seeding and seedling planting methods, survival and growth of wildings, and spacing. Proposals include phenological studies, planting with cuttings, induction of germination, and effect of hormones on flowering and fruiting.

In Thailand, some attempts at establishing *C. caesius* plantations in the late forties failed. Fresh attempts are now being made using seedlings of the same species. Proposals for research include those on germination, wilding transplanting, storage of rattan and rattan seeds, treatment of rattan, optimum period for rattan collection, and propagation of species other than *C. caesius*.

Information on existing practices and experiences in the rattan industry of Southeast Asia is available but is scattered in various publications or is unpublished. Much of the available information is inevitably on modes of collection, cultivation, processing, and trade practices in Indonesia as it is the only country with large, long-established plantations and is also the world's largest supplier of rattan. Dependent on the locality from which the writer collects his information, some variation in detail will be noted, though basic facts remain the same.

Available silvicultural information on *C. trachycoleus* and *C. caesius* cultivated in Indonesia could be utilized to start plantations of these species in other suitable locations. As recorded earlier, small or rudimentary plantations of *C. caesius*, *C. scipionum*, *C. manan*, and *C. leiocaulis*, and *C. khasianus* (for its fruits) do exist but no information on the planting practices adopted are available, except for a brief account of the planting practices adopted by villagers in the now defunct plantation of *C. caesius* in Pahang, Peninsular Malaysia. Information on planting practices adopted in the case of *C. viminalis* and *C. rotang*, said to be cultivated on a plantation scale in the Andamans, is unavailable.

Until the early seventies, the small amount of research that had been done on cultivation or utilization can be said to have been carried out mostly because of the initiative of individual workers. Their results have had practically no impact on the industry.

Formal research plans and activities began in the last 4 or 5 years, but only in Malaysia and the Philippines. Consequently, more effective work is being done in these countries than ever before. Results of some trials and tests are beginning to trickle in and, more importantly, attempts are being made to publish them quickly. Workers in the Philippines are working on a number of projects, particularly on cultivation, and more are in the pipeline.

In India, with the recent government pronouncements emphasizing the need to develop rural-based industries, the main forestry research establishments can be expected to and in fact already are preparing to draw up and execute rattan research. Indonesian research authorities are already planning to formalize rattan research projects, while in Thailand a list of projects has been submitted for funding, but the research authorities are not too hopeful of getting any substantial amounts.

There is plenty of scope not only for the exchange of publications on rattan among research institutions, but also for exchange of information on ongoing research, proposals for research, and even of interim results. The better processing techniques currently employed in some countries appear to be unknown to processors or even research agencies in other countries. The quality of perhaps thousands of tonnes of rattan could be improved by the use of some of these techniques, particularly those involving the boiling of large size canes in oil.

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Appendix: Guidelines for the Collection of Rattan Herbarium and Cane Samples

John Dransfield

The importance of collecting voucher specimens in rattan research cannot be stressed too highly. Confusion over local names and the difficulty field workers experience in identifying rattan emphasize the need for maintaining a collection of vouchers, especially when seed for silvicultural trials is being sought. Unfortunately, the collection of rattan herbarium specimens is time-consuming and it is necessary to clarify what is required; at the same time as the herbarium collections are being made, cane samples to be examined for commercial potential can be obtained.

As rattans are generally too large to be represented on one herbarium sheet, it is usual to take pieces of different parts of the rattan and to make extensive field notes. The following table indicates the sort of notes that should be made in the field.

No:

Collector:

Locality:

Habitat:

Frequency:

Native Name: (indicating language)

Local Uses:

Habit: single-stemmed/clustered; short-, moderate-, or long-stemmed

Cane: internode length; diameter above and below node; colour

Sheath: knee present/absent; ocrea present/absent; colour; notes on spines

Leaf: petiole present/absent; length

cirrus present/absent; length

length of whole leaf including petiole and cirrus

Leaflets: number on each side; arrangement regular/irregular/grouped/fanned or not; colour

Inflorescences: terminal/lateral; length; colour of flowers; scent

Fruit: colour; degree of ripeness; taste

The cane sample should consist where possible of four pieces each 120 cm long (if large-diameter cane) or ten smaller pieces (if small-diameter cane) and these should be air dried and transported for property analysis as soon as possible.

The voucher herbarium specimen should consist of:

- (1) a section of stem with fresh leaf sheaths taken from a climbing stem (not a young sucker), consisting of at least one internode;
- (2) the flagellum (if present) folded up;
- (3) pieces of the petiole, midleaf leaflets and leaf tip (if cirrus present then this folded up);
- (4) inflorescence (if too large then a section of the axis with one partial inflorescence);
- (5) fruit (even if in small quantity, ripe fruit can be sown to provide material for a rattan gene-pool).

Each piece should be given its own hanging tag numbered with the collector's number so as to avoid confusion between collections. Furthermore where male and female plants of the same species are collected, it is important to number these separately. Collections can be oven- or sun-dried while under pressure (in a plant press), or may be stored temporarily doused with methylated spirits in newspaper in a plastic bag. Where possible more than one duplicate should be collected — one for the home institute and the other for sending elsewhere, preferably to Royal Botanic Gardens, Kew, Richmond, Surrey, U.K., for confirmation of names.

Credits

All photographs by John Dransfield

