

# **MORPHOLOGICAL, ANATOMICAL AND PHYSICAL PROPERTIES OF CALAMUS SPECIES OF KERALA FORESTS**

C.Renuka  
K.M.Bhat  
V.P.K.Nambiar



KERALA FOREST RESEARCH INSTITUTE  
PEECHI, THRISSUR

1987

Pages: 58

## CONTENTS

	Page	File
1 Introduction	1	r.46.2
2 Materials and methods	2	r.46.3
3 Cane in Kerala – An overview	4	r.46.4
4 Comparative morphology	11	r.46.5
5 Systematics	18	r.46.6
6 Physical characteristics	43	r.46.7
7 Discussion and Conclusion	49	r.46.8
8 References	57	r.46.9

## INTRODUCTION

Canes, included under the Lepidocaryoid palms comprise nearly 14 genera and about 600 species (Dransfield, 1981). Until very recently canes have been one of the neglected natural resources. But in the last ten years there has been an increasing surge of interest in cane products, pushing this minor forest produce as a source of a 'multimillion dollar' business. The report on the workshop on rattans held in Singapore in 1979 pointed out that the demand for well processed, good quality cane is so high that even trebling the present supplies will not meet the requirements.

Of the 14 genera of climbing palms, only four, viz. *Calamus*, *Daemonorops*, *Plectocomia* and *Korthalsia* are known to inhabit India. They comprise about 44 species, contributing about half of the total Arecaceae in India (Basu, 1985). Out of this only 12 species of *Calamus* are known to occur in Southern India (Fischer, 1931; Fernandez and Dey, 1970). Of these, only nine (*C. brandisii*, *C. gamblei*, *C. hookerianus*, *C. - huegelianus*, *C. pseudotenuis*, *C. rheedii*, *C. rotang*, *C. thwairesii*, and *C. travancoricus*) are known from the present geographic limits of Kerala. After Fischer's work, there had been no serious study on this genus in Southern India.

Though canes are found growing naturally in Kerala forests, now they are restricted mostly to remote areas. As there is a continuous and steady pressure on their natural habitat, the broad genetic base is getting reduced alarmingly.

The major reasons for the depletion of cane resources from the Kerala forest seem to be the following.

1. An imbalance between demand and supply
2. Large scale destruction of forests and
3. Past unscientific exploitation.

In the present situation enough quantity of canes is not available in the natural habitat to meet the demands of the cane industry. Some of the cane units in Kerala are known to get canes from Karnataka and some times even as far away as from Assam. Hence, there is a dire need for raising plantations of good quality canes.

Very little is known about the canes of Kerala forests. During the past many decades, no serious attempt has been made to undertake floristic, taxonomic

or anatomic studies of *Calamus*. As most of our canes are extracted before they begin to flower and fruit, it is very difficult to identify the cane using floral characters. Progress in any industry is based on a firm understanding of the characteristics and behaviour of the raw material and how the resource base can be conserved and managed. Thus, the present study was undertaken with the following objectives, (i) to make a taxonomic survey of canes of Kerala forests and to prepare a key based on vegetative characters for field identification of the species. (ii) to investigate anatomical and physical characteristics of various canes and (iii) to establish a live collection of various species in the Institute.

## MATERIALS AND METHODS

Frequent field trips were conducted in the forests of Kerala State and cane specimens collected. Ecological characters such as type and elevation of forest were noted. Representative herbarium specimens were prepared according to the method suggested by Dransfield (1979). In addition to field studies, specimens of *Calamus* from Kerala already available in the Madras Herbarium (MH), Coimbatore and Central National Herbarium, Calcutta (CAL) were also studied. Photographs of the type specimens were obtained from Kew Herbarium (K), England. Studies on nomenclature and taxonomy of the collected specimens were conducted in the laboratory. A taxonomic key based on vegetative characteristics was prepared so as to facilitate field identification.

Data on the availability and utilization potential was also collected from various cane industries at Nilambur, Varkala and Shenkottah.

A total of 147 cane stems comprising ten species of *Calamus* were collected to determine the physical characteristics. After extraction, the stem length was noted for each sample. Approximately 0.5 to 2cm thick samples, depending on the length of internodes, were taken from the middle portion of the internodes at different height levels (15, 25, 50, 75 and 95 percent of total height), starting from the lowest internode. The diameter was measured using a calliper. Specific gravity was determined on an oven dry weight to green volume basis. Water displacement method was used to measure the green volume of the samples. Two way analysis of variance (ANOVA) was performed to study the within-stem and between-stem variations of physical characteristics.

For anatomical studies, at least two samples in each species were chosen from the lowest internode. About 15-20  $\mu\text{m}$  thick transverse sections were cut

using sliding microtome and stained with safranin. Standard microtechnique procedure was followed to prepare the sections for observation under microscope. In order to examine the silica bodies (Stegmata) 20-25 $\mu$ m thick radial longitudinal sections were cut and stained with 2% Bismark Brown following the method given by Sharma and Rao (1970). Diameter of at least 20 silica bodies was measured in each section. The measurement of cell dimension was made both on a projection microscope and a binocular microscope with ocular micrometer. At least 10 wide metaxylem vessels from the central one-third of the diameter of the transverse section were selected from each sample to estimate the mean diameter. For the measurement of cell length, small radial segments were removed from inner, outer and intermediate positions and macerated following the method given by Franklin (1946). A minimum of 10 tracheary elements and 25 fibres were measured from each sample for the estimation of cell length. Depending on the frequency, the number of mucilage canals measured for diameter varied from 5 to 10. The method used in describing the anatomy of each species is essentially similar to the one suggested by Tomlinson (1961) for palms, although a few modifications were made wherever necessary. A tentative key for identification of canes based on anatomical and physical properties was also prepared.

The details of individual species are arranged in the following sequence: the correct botanical name appears in bold face followed by citations and the Malayalam name (s). The taxonomic description, distribution in Kerala forests, forest types, altitudinal details, phenology and anatomical structure follow.

## CANES IN KERALA - AN OVERVIEW

### Floristics

Canes are distributed in the evergreen, semievergreen and moist deciduous forests of Western Ghats. From Kerala nine species of *Calamus* (*C. brandisii* Becc., *C. gamblei* Becc., *C. hookerianus* Becc., *C. huegelianus* Mart., *C. pseudotenuis* Becc., *C. rheedii* Griff, *C. rotang* Linn. *C. thwaitesii* Becc. and *C. travancoricus* Bedd.) have been reported earlier. An extensive field survey during the present study has added four more species to this list. *C. metzianus* Schlecht. is a new record, while, *C. dransfieldii* Renuka and *C. vattayila* Renuka are new species. The fourth one could not be assigned to any species in the absence of flowering and fruiting materials. On the other hand, *C. rheedii*, *C. huegelianus* and *C. brandisii* reported to occur in Kerala could not be relocated. Thus the canes in Kerala are represented by 10 species as listed in Table 1. In addition to the species, an individual of a Malayan species, *C. caesius* Bl. introduced to Kerala, is found in the Kodanad Forest Rest House Compound.

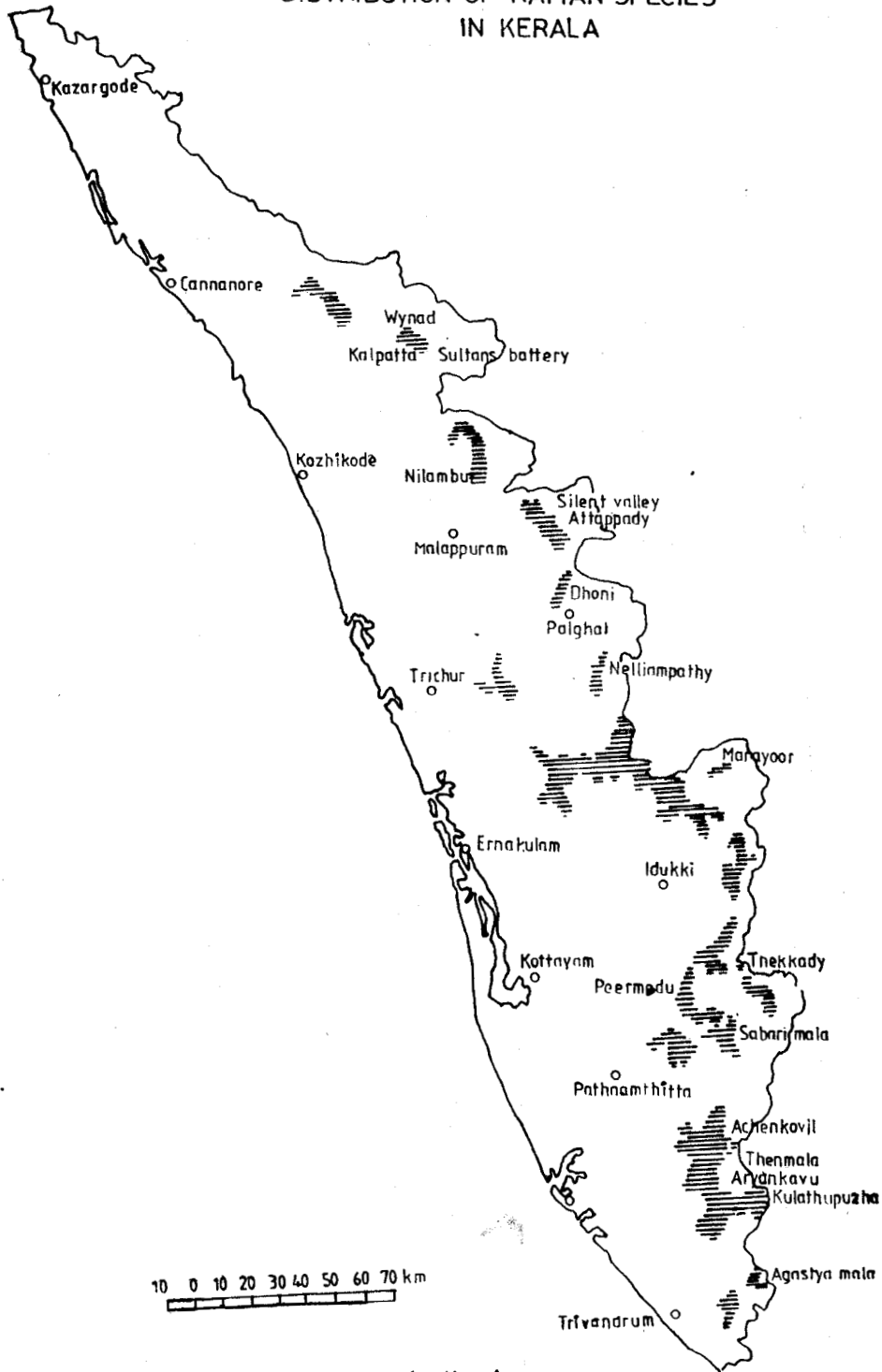
### Geographical distribution

The distribution of the canes in Kerala is given in Table I and Map I & II. *C. thwaitesii*, *C. hookerianus*, *C. gamblei*, *C. travancoricus* and *C. vattayila* are the most wide spread species, extending throughout the length of Western Ghats in Kerala. *C. pseudotenuis* is known only from the forests of Palghat and Peermedu. The rest of the species are very restricted in distribution, *C. dransfieldii* to Dhoni forests of Palghat. *C. metzianus* to the forests at Thalatkolli in Nilambur and *C. rotang* to Quilon Asram compound.

In general, the forests at Thenmala, Ranni, Palghat and Nilambur forest divisions are comparatively rich in *Calamus* population., each of them having 5-6 species. Trivandrum and Wynad divisions also have many species, but in most of the areas only small stumps could be seen. Achenkovil range (Thenmala division) and Goodrical range (Ranni division) and Kulathupuzha range (Trivandrum division) are rich in *Calamus* population. From Chittar valley in Achenkovil alone four species could be collected. Goodrical range also has four species while five species are present in the forest surrounding Shankili - Ponmudi road in Kulathupuzha range. Even in these *Calamus* rich forest divisions a drastic decrease of cane population year after year can be observed. The present study reveals that *C. gamblei*, *C. pseudorenuis* and *C. travancoricus* have become infrequent in the more accessible areas.

The state forest department has two research plots of canes, one of *C. thwaitesii* at Achenkovil and another of *C. pseudotenuis* at Peermedu.

# DISTRIBUTION OF RATTAN SPECIES IN KERALA





# DISTRIBUTION OF CALAMUS SPECIES IN KERALA

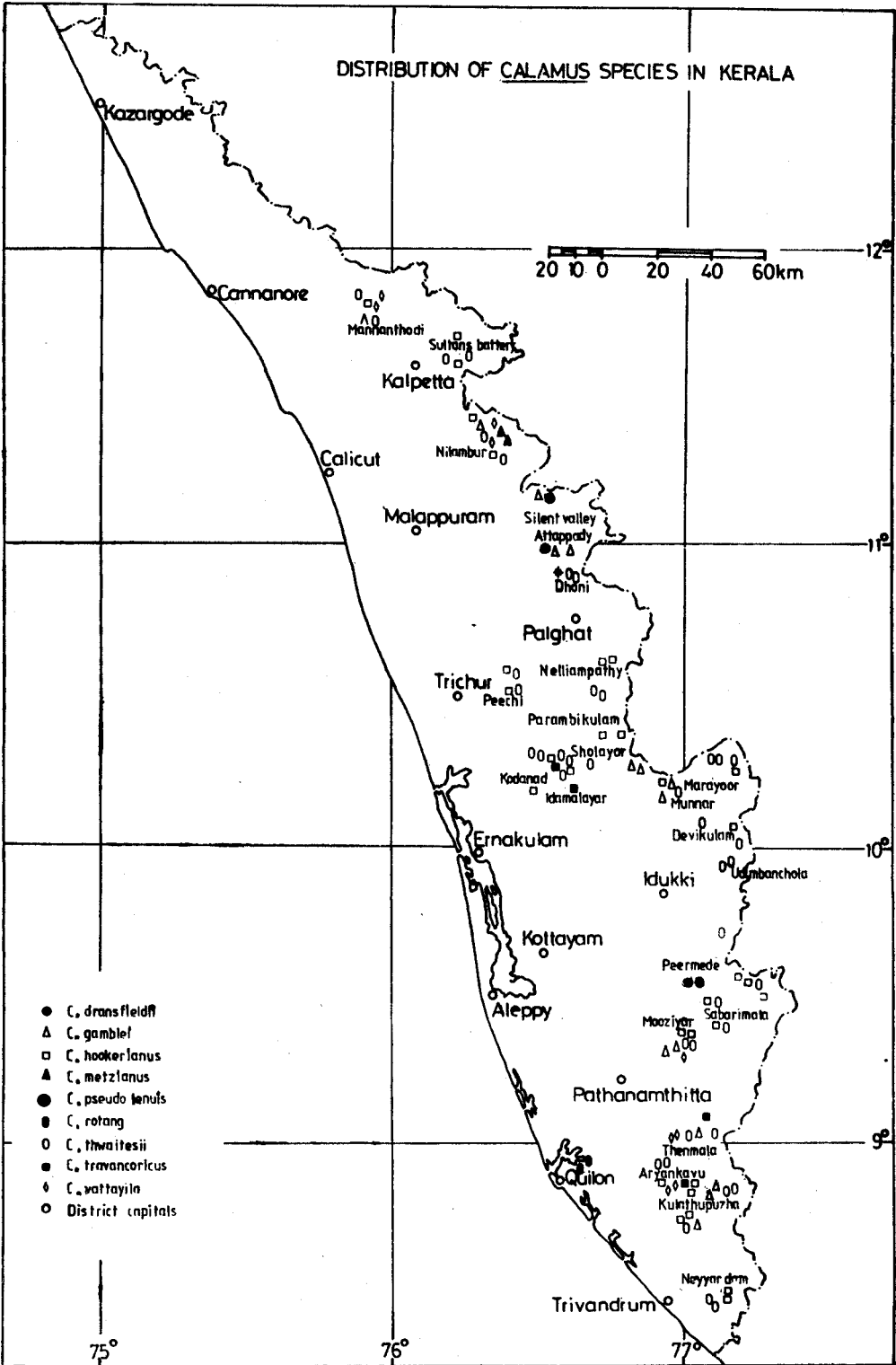


Table 1 Distribution of Canes in Kerala

Species	Forest Divisions
<i>C. dransfieldii</i>	Palghat
<i>C. gamblei</i>	Trivandrum, Thenmala, Ranni, Munnar, Palghat, Wynad
<i>C. hookerianus</i>	Trivandrum, Thenmala, Ranni, Kottayam, Munnar, Malayattur, Trichur, Nemmara, Nilambur
<i>C. metzianus</i>	Nilambur
<i>C. pseudotenuis</i>	Peermedu, Palghat
<i>C. rotang</i>	Quilon (Near backwaters)
<i>C. thwaitesii</i>	Trivandrum, Thenmala, Ranni, Munnar, Kottayam, Vazhachal, Chalakkudy, Malayattur, Trichur, Palghat, Nemmara, Nilambur, Wynad
<i>C. travancoricus</i>	Trivandrum, Thenmala, Ranni, Konni, Malayattur, Wynad
<i>C. vattayila</i>	Thenmala, Wynad, Ranni, Nilambur

#### Habitat

With the exception of *C. rotang*, a cane of marshy plains, all others are montane. Out of these, *C. pseudotenuis* and *C. gamblei* prefer higher altitudes, from 700 m above M S L and the rest are found from 50 m above M S L to 900 m above M S L. Though canes generally prefer evergreen and semievergreen forests, *C. dransfieldii*, *C. metzianus* and *C. thwaitesii* occur in moist deciduous forests also. Canes grow well where moisture is abundant. Besides water, light also is an important factor for enhanced growth. Most species grow in clumps except *C. dransfieldii* and *C. vattayila* which are usually seen as solitary climbers.

#### Nursery technique

So far no attempt has been made in Kerala for raising plantations and hence the planting techniques are not well developed. From the preliminary trials carried out in the Institute, the following method seems to be suitable for Kerala. Soon after collection, the ripe fruits are depulped and soaked in

water for about 48 hrs so as to induce the fleshy layer to ferment. This process is known as 'maceration'. The seeds devoid of the fleshy layer will settle at the bottom. The seeds are immersed in sodium pentachlorophenoxide 1% a. i. Keeping the seeds for stratification in moist saw dust for about 2 weeks hastens germination. Seeds are sown in polythene containers filled with forest topsoil and sand. The containers should be partially shaded and watered daily. The seeds start germination after a month and the germination continues upto 6 or 7 months. After a year the seedlings can be outplanted.

#### Extraction and Processing

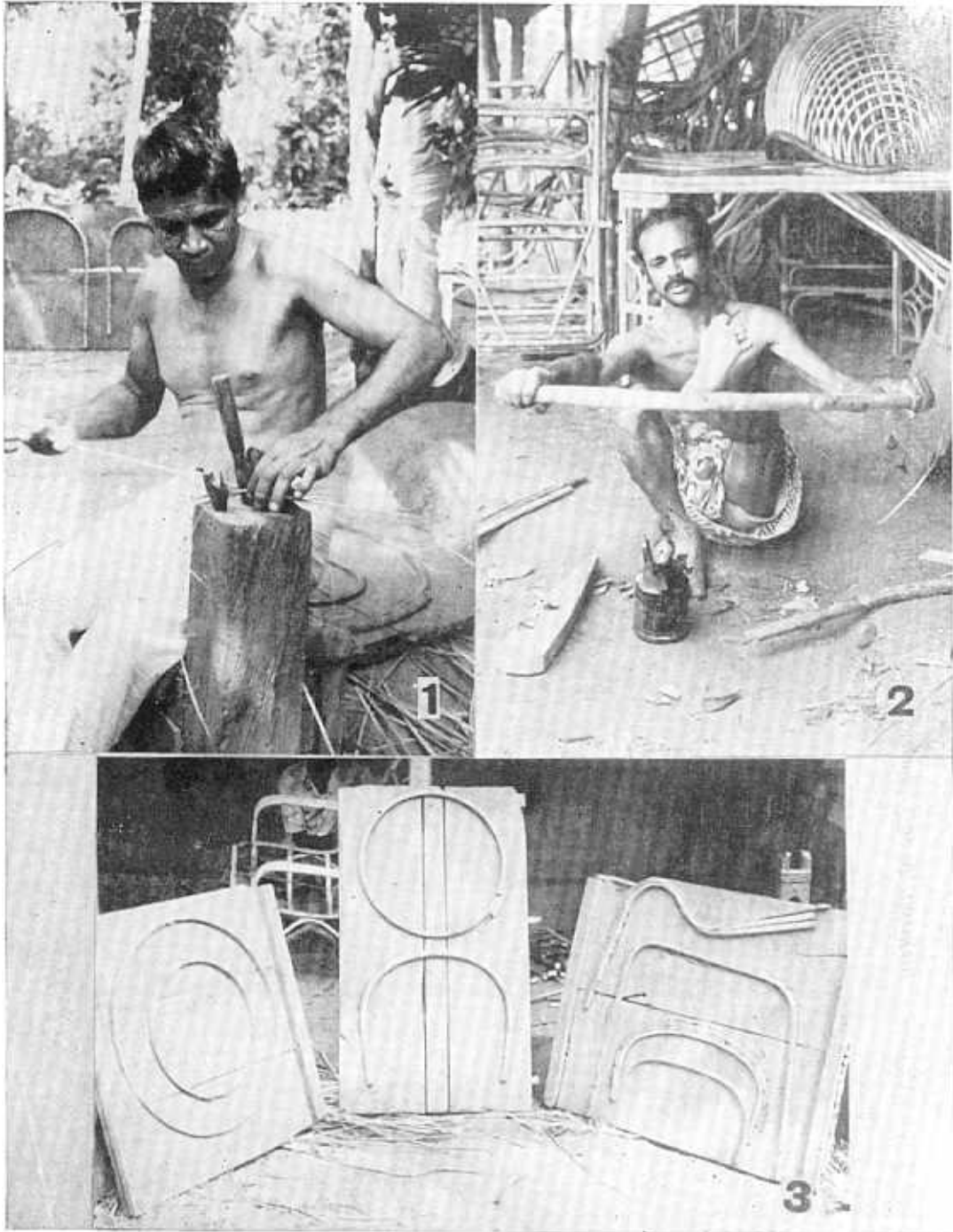
The mature canes are pulled out and the dead leaf sheaths removed using a sharp knife. The soft uppermost part measuring 2-3 m is discarded. The remaining portion is cut into suitable lengths for bundling and then transported. After reaching the processor, the canes are air dried thoroughly for about 15 days under the sun and then stacked. Sometimes any of the insecticides is sprinkled over the stack. Other than this, no particular treatment is given

Thin varieties of canes are immersed in water for a day just before the work begins to make it pliable. For export purpose, canes are rubbed with sand and coconut fibre and washed in water before drying so that the cane will be having a good lusture. For splitting the cane, a sharp knife is used and for reducing the thickness and width of the split cane simple devices are used (Plate I, Fig. 1). For bending thick cane, it is usually heated with a blow stove and bent to the desired shape applying pressure (Plate I, Fig. 2). Different kinds of moulds are also used to keep the shape intact (Plate I, Fig. 3).

#### Utilization

Next to timber canes are recognised as one of the most useful forest products. Canes play an important role in the rural economy, employing many people in remote areas. A large number of tribal people earn their livelihood through extraction of canes for Harijan-Girijan Welfare Societies and many others get employed in Cottage industries,

Canes find their use in the manufacture of a variety of products as well as in indigenous medicine (Caius, 1935; Kirtikar and Basu, 1935; Hartwell, 1970). From the data collected from various industrial sources, it is seen that *C. dransfieldii*, *C. Hookerianus*, *C. thwaitesii*, *C. travancoricus*, *C. vattuyila* and *Calamus* sp. are very good for commercial purposes. Except *C. metzianus*, which breaks easily, all species are used commercially.



**PLATE I**

**Fig. 1.** Device for reducing thickness and width of the split cane.

**Fig. 2.** Bending of cane with a blow stove. **Fig. 3.** Different moulds for bending the cane.



PLATE

Figs. *dransfieldii*, *pseudotenuis*.

# COMPARATIVE MORPHOLOGY

*Calamus* is a solitary or clustered, high-climbing spiny palm (Plate II & III. Figs. 1-5). The stem is covered with spiny leaf sheaths. When the cane matures the leaf sheaths fall off exposing the cane within. The stem consists generally of elongate internodes and well defined nodes. Length of stem and internode vary depending on the species. Some species are characteristically unbranched and single stemmed while others branch in various ways. The most usual means of branching is by formation of suckers at the base, thus building up large clumps of canes, At the base of the stem, branches appear which grow horizontally for a short distance and then grow vertically. Aerial branching is not known in *Calamus*.

Diameter of stem varies enormously ranging from 3 mm (*C. travancoricus*) to as much as 3 cm (*C. thwaitesii* in the Kerala species. Within an individual cane the diameter may vary along its length. Generally the base of the stem is thicker than the portion just above it.

Stem surface is smooth and generally straw-yellow in colour. Among the species present in Kerala forests not much variation in colour or texture is noticed after drying up the canes.

## Leaf

The leaves are large, pinnately compound and spirally arranged on the stem. The leaf is generally recognised into three or four parts; the sheath, the laminar area and the cirrus.

Leaf Sheath: the lower portion of the petiole that encircles the stem is the sheath. This is the most important part of the leaf from a field taxonomic point of view. Even a sterile specimen of cane, represented by sheath alone, can be identified upto species (Plates IV & V, Figs. 1-4). The sheaths encircle the stem along its full length and only a small apical portion is free, Sheaths of adjacent leaves overlap and imbricate so that the stem is completely hidden and the actual stem apex lies a little below within the observed tip.

The mouth of the leaf sheath is sometimes provided with an erect ligule-like structure termed *Ocrea*. The ocrea frequently disintegrates as the leaf develops. In most climbing canes leaf sheath bears a large swelling at the base of the petiole termed the *Knee*.

The leaf sheath is almost always spiny, the spines being confined to the exposed area. Below the spiny exposed area, sheath bases hidden by imbrication are also often provided with short spines; here the spines remain tightly adpressed to the sheath. The arrangement of spines on the sheath is very characteristic.

There are 3 main types of leaf sheath spines: 1. elongate triangular rigid, not eroding spines. well attached at the base, 2. papyraceous spines easily eroding, leaving a tattered stump behind and 3. spiculae which are solitary or more usually grouped in incomplete whorls, each one with a bulbous base and easily breaking off just above the base. Between the spines, in some species (*C. hookerianus* and *C. pseudotenius*) the sheath is provided with brown indumentum. Armature and indumentum seen on the juvenile leaves are often strikingly different from that found on the mature leaves. Petiole: the petiole proper is the region above the sheath. The length and armature of the petiole vary depending on the species. Leaflets: leaflet arrangement is of great taxonomic importance in the genus. In some species they are arranged regularly while in others they are grouped. The leaflets may be variously hairy, bristly or unarmed. These features are also of taxonomic significance. The pinnae are reduplicate, i. e. A - shaped in cross section,

### **Climbing organs**

There is a whip-like organ originating at the tip of the leaf sheath obliquely opposite the petiole. This is known as *flagellum*. In some species a spiny extension of the rachis beyond the leaflets is present, which is called the *cirrus*. However, cirrus is not seen in any of the species present in Kerala forests. Morphologically, the flagellum is regarded as a sterile inflorescence, Here the spines are reflexed like grapnels.

### **Inflorescence**

*Calamus* is dioecious, the male and female plants being separate. Flowering is pleonanthic, i. e. the stem continues growth even after flowering.

The inflorescence arises in the axil of a leaf and bears a series of tubular bracts. Tubular bracts are characteristic of the genus and distinguish *Calamus* from other genera of climbing palms. The inflorescence may branch to 2 or 3 orders and the ultimate branches, the rachillae, bear flowers or flower clusters in the axils of minute bracts. Usually the male inflorescence is more highly branched than the female. (Plate VI, Figs. 1-2).





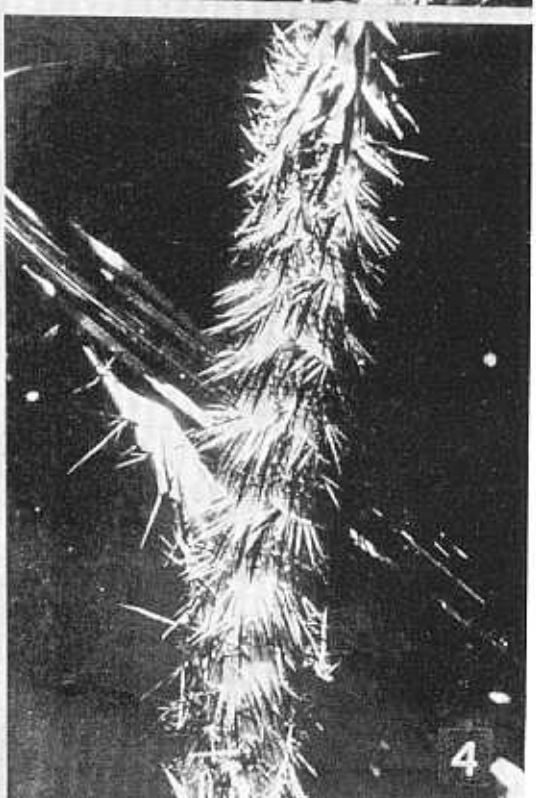


PLATE IV

Figs. Leaf sheaths 1. *C. dransfieldii*, 2. *C. hookerianus*, 3. *C. rotang*, 4. *C. thwaitesii*



PLATE VI

Figs. 1 & 2 Male inflorescence of *C. pseudotenius*

Fig. 3. Fruit of *C. pseudotenius*      Fig. 4. Fruit of *C. rotang*

The flowers are typically trimerous having 3 sepals, 3 petals, 6 stamens or staminodes and a trilobular ovary or pistillode. The ovary from the very young stage itself is covered by reflexed imbricate scales in vertical rows. The stigmas are large and reflexed.

### Fruits

Fruits are usually produced in abundance. Fruits in any one inflorescence generally seem to ripen simultaneously. They are covered with vertical rows of reflexed overlapping scales. The scales are often hard and shiny and are frequently grooved vertically along the midline. The scales are usually coloured with various shades of yellow and brown (Plate VI, Figs. 3-4). The number of vertical rows and the presence of groove are sometimes of taxonomic significance.

The ovary is 3-locular with one ovule in each locule. However, each fruit bears a single seed at maturity. The seed has an outer fleshy layer. At maturity, in some species, this is sweet and edible. The endosperm is homogenous or ruminant and the embryo basal or lateral.

### Germination and the seedling

The cane seeds cannot withstand drying out. Germination is of adjacent ligular type (Tomlinson, 1961). A short plug emerges from the seed. From the plug, roots are produced and eventually an erect swelling through which emerges the first foliar organ (Plate VII, Figs 1-3). The seedling leaves gradually increase in size, and a rosette of large leaves is produced. The juvenile leaves are pinnate or often bifid. At this stage an increase in light is required for stem elongation.

Seed propagation studies carried out in the Institute with the seeds of *C. hookerianus*, *C. pseudotenuis* and *C. thwaitesii* show that *Calamus* can be successfully propagated through seeds. The outplanted seedlings showed upto 75% establishment. The first seedling leaf of *C. thwaitesii* was bifid while that of the other two species was fan-shaped- The 3 year old seedlings are thriving well in the Institute garden.

### Anatomy

Anatomical details are given separately for each species under the Systematics.

## SYSTEMATICS

### CALAMUS LINN.

(Lat. Calamus - a reed)

Linn., Gen. Pl. Ed. 6: 174. No. 436, 1764; Becc. in Ann. Roy. Bot. Gard. Calcutta II : 1-518, 1908 and appendix 1913; *Cornera* Furtado in Gard. Bull. Singapore 14 : 518. 1955; Furtado in Gard. Bull. Singapore 15 : 32-265. 1956.

Solitary or clustered, acaulescent to high climbing, pleoanthic, dioecious rattan. Leaf cirrate or ecirrate. Sheaths usually heavily armed with spines, spines frequently highly organized, sheath often bearing a flagellum, in others flagellum absent and a cirrus present, very rarely both cirrus and flagellum present; petiole present or absent, often with a knee at the base, leaflets variously arranged. Inflorescence male and female superficially similar, often ending in a long flagellum, bracts always tubulate at the base, variously armed. Partial inflorescence usually much longer than the subtending bract, very rarely shorter. Male flowers with small cup-shaped calyx, usually with 3 well defined lobes; corolla split into 3 petals; stamens 6, very shortly epipetalous; pistillode minute. Female flower usually larger than the male, calyx shallowly 3 lobed; corolla with 3 petals; staminodes 6, joined basally to form a cup like ring; ovary tipped with 3 stigmas, covered with reflexed scales, locules 3 with one ovule in each. Fruit spherical, ellipsoid to conical-ovoid, covered with reflexed scales, Seed usually one, frequently deeply pitted or grooved, endosperm homogenous or ruminant. Embryo basal or lateral.

Stem anatomy : *Epidermis*: Single layered, cells often silicified, or with a thick cuticle, oblong or columnar, shape of lumen variable, outer wall thickened; stomata occasional, sunken. *Hypodermis*: often distinct, 1-2 layered. *Cortex*: narrow or wide, 5-6 or 20-30 cells deep, with discrete fibre bundles, cells isodiametric or elongated, often with intercellular spaces. *Central cylinder*: delimited from the cortex by small vascular bundles congested at the periphery, each with a massive fibrous sheath, central vascular bundles less congested with fibres adjacent to phloem; xylem sheath either wholly parenchymatous or including a few sclerotic parenchyma cells; phloem divided into two strands lateral to the single wide metaxylem vessel; ground parenchyma cells isodiametric or elongated with intercellular spaces; mucilage canals occasional, 50-100  $\mu$ m in diameter. *Cell inclusions*: Stegmata present, mostly associated with fibres of outer-most layer of fibre sheath of vascular and non vascular bundles, 6-16  $\mu$ m

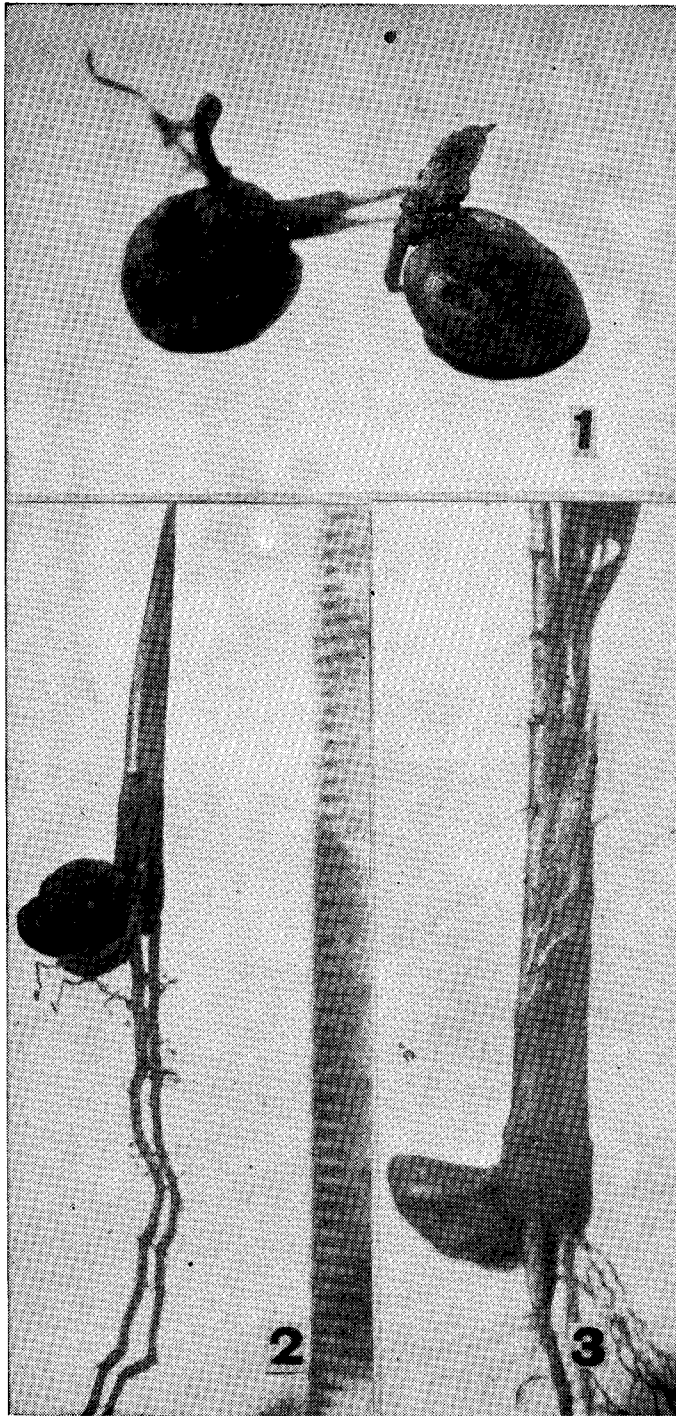


PLATE VII

Figs. 1-3. Different stages of seed germination and development.

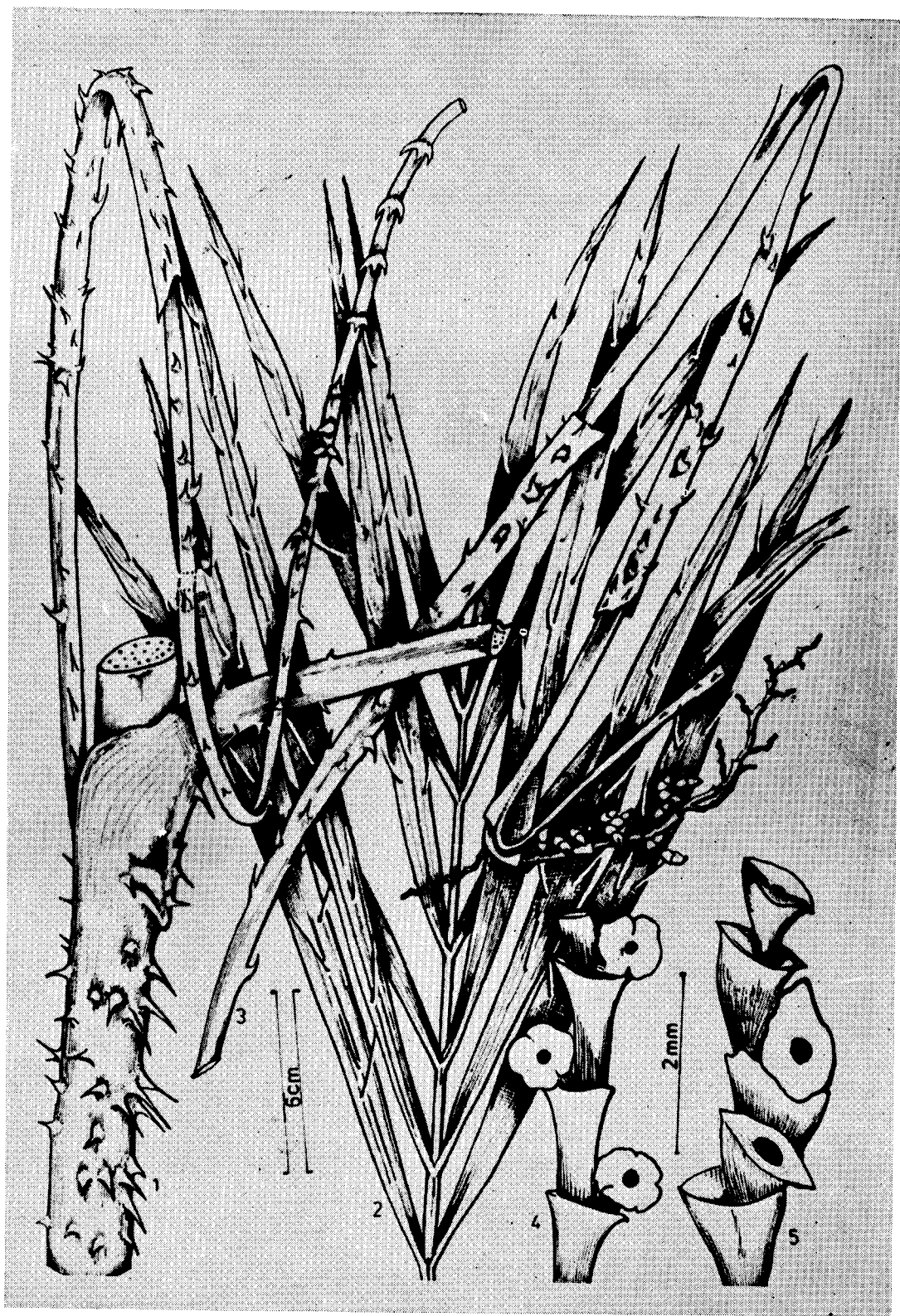


PLATE VIII

1. Sheathed stem with a portion of the flagellum; 2. A portion of the leaf;  
3. Male inflorescence; 4. Part of male rachilla; 5. Part of female rachilla.

in diameter, spherical, surface rough, *Vascular elements*: xylem elements upto 3040 µm long, end walls oblique to very oblique, perforation plates reticulate or scalariform, wide metaxylem vessel upto 420 µm in diameter, end walls transverse, perforation plate simple; fibres upto 2622 µm long; sieve tubes with transverse end walls and simple sieve plates.

## KEY TO IDENTIFICATION

- |  |                         |
|--|-------------------------|
| 1. Leaflets 6-veined, blade oblong   | <i>C. vattayila</i>     |
| 1. Leaflets 1 or 3 veined, blade linear-lanceolate   | 2                       |
| 2. Leaflet size diminishing towards the tip of the leaf  | 3                       |
| 2. Leaflet size not diminishing towards the tip of the leaf  | 4                       |
| 3. Spines on the sheath upto 1 cm long, needle like, sheath green; stem + sheath ca. 1 cm thick, leaflet margin sharply spinulose.   | <i>C. rotang</i>        |
| 3. Spines on the sheath upto 2 cm long, triangular often interspersed with many smaller spines; sheath pale green, stem + sheath 1-2 cm thick; leaflet margin not sharply spinulose. . | <i>C. metzianus</i>     |
| 4. Leaflets grouped on the rachis  | 5                       |
| 4. Leaflets not grouped on the rachis  | 6                       |
| 5. Stem + sheath 0.8 cm thick  | <i>C. travancoricus</i> |
| 5. Stem+ sheath 3-6 cm thick   | <i>C. thwaitesii</i>    |
| 6. Sheath glabrous   | 7                       |
| 6. Sheath with brown tomentum  | 8                       |
| 7. Sheath sparingly spiny, pale green  | <i>C. dransfieldii</i>  |
| 7. Sheath profusely spiny, dark green  | <i>C. gamblei</i>       |
| 8. Petiole and rachis with yellow spines, spines upto 3 cm long, mouth of the sheath without long spines   | <i>C. pseudotenius</i>  |
| 8. Petiole and rachis with brown or black spines spines upto 10cm long; mouth of sheath with long papery spines upto 18 cm long  | <i>C. hookerianus</i>   |

A tentative anatomical key to identification of 9 species of *Calamus* found in Kerala

- |       |   |   |                         |
|-------|---|---|-------------------------|
| 1. a. | Maximum stem diameter upto 13 mm  | 2 |                         |
| b.    | Maximum stem diameter above 13 mm   | 3 |                         |
| 2. a. | Epidermal cells with oval or triangular lumen, more silicified. Maximum diameter of wide metaxylem vessel upto 200 $\mu$ m, intercellular spaces and mucilage canals relatively less frequent. Mucilage canal upto 50 $\mu$ m in diameter |   | <i>C. travancoricus</i> |
| b.    | Epidermal cells columnar, somewhat oblong lumen and thick cuticle. Maximum diameter of metaxylem vessel above 200 $\mu$ m   | 4 |                         |
| 3. a. | Maximum stem diameter exceeds 26 mm, epidermal cells with oblong or rectangular lumen   | 5 |                         |
| b.    | Maximum stem diameter upto 26 mm, epidermal cells columnar with oval, oblong or bottle shaped lumen.  | 6 |                         |
| 4. a. | Hypodermis 1-2 layered, diameter of wide metaxylem vessel upto 290 $\mu$ m  |   | <i>C. metzianus</i>     |
| b.    | Hypodermis mostly single layered, diameter of wide metaxylem only upto 220 $\mu$ m  |   | <i>C. rotang</i>        |
| 5. a. | Maximum diameter of wide metaxylem upto 260 $\mu$ m, xylem elements upto 1300 $\mu$ m in length. Maximum fibre length upto 1900 $\mu$ m   |   | <i>C. dransfieldii</i>  |
| b.    | Maximum diameter of wide metaxylem exceeds 290 $\mu$ m, xylem elements upto 3040 $\mu$ m length. Fibre length upto 2185 $\mu$ m   |   | <i>C. thwaitesii</i>    |
| 6. a. | Cortex narrow, 6-8 cells deep   | 7 |                         |
| b.    | Cortex relatively wide, 25-30 cells deep  | 8 |                         |
| 7. a. | Epidermal cells with oblong or oval lumen, hypodermis 1-2 layered, wide metaxylem vessels upto 310 $\mu$ m in diameter, mucilage canals upto 92 $\mu$ m in diameter   |   | <i>C. gamblei</i>       |
| b.    | Epidermal cells with often bottle shaped lumen, hypodermis single layered, wide metaxylem   |   |                         |



vessels up to 210 $\mu$ m in diameter, mucilage  
canals up to 60 $\mu$ m in diameter

*C. pseudotenius*

8. a. Epidermal cells more columnar, with narrower  
lumen, hypodermis 1-2 layered, wide metaxylem  
vessels up to 220 $\mu$ m in diameter, mucilage canals  
not discernible

*C. hookerianus*

- b. Epidermal cells with relatively wide lumen,  
hypodermis single layered, wide metaxylem vessels  
up to 290 $\mu$ m in diameter, mucilage canals up to  
70 $\mu$ m in diameter

*C. vattayila*

***Calamus dransfieldii*** Renuka sp. nov. Kew Bull (In Press).

Plate VIII Figs. 1-5

Solitary or clustering, moderate sized cane, climbing high into the canopy. Stem to 8 m long, with sheaths to 3.5 cm in diameter, without sheaths to 2.5 cm; internodes to 35 cm long. *Leaf sheath pale green, sparingly spiny*; spines to 1 cm long, with a bulbous base. *Knee conspicuous*. Ocrea absent. *Flagellum to 6 m long*. Leaf ecirrate, to 2 m long; petiole to 55 cm, armed with spines to 5 mm; rachis armed with distant row of spines to 0.5 mm; *leaflets pale green*, long-acuminate, narrowly lanceolate, regularly arranged, 45 x 2 cm; *veins ciliated on both surfaces, cilia to 2 cm*; leaf tips armed with short bristles. Inflorescence flagellate, axis to 1 cm in diameter, male and female inflorescences superficially similar, to 3.5 m long, with up to 4-5 partial inflorescences, each to about 20 cm long, branching once; subtending bracts closely sheathing, prolonged at the distal end into a lanceolate point, densely armed with small spines to 1 cm long; rachillae to 3 cm long; subtending bracts cylindrical at the base and expanded into a cup at the upper region, about 1.5 cm long. Staminate flower about 8 mm long, stamens 6, filaments shortly epipetalous, anther medi-fixed, pistillode present. Female flowers to 4 mm long; staminodes 6, ovary 3 locular, ovule solitary in each locule, stigma recurved. Fruit not known.

Distribution: Dhoni hills, Palghat, Moist deciduous forests at ca. 275 m. above MSL, Endemic.

Etymology: The new species is named-after Dr. J. Dransfield in appreciation of his contribution to the knowledge of rattans.

Phenology; Flowering November to December; fruit setting rare. Even after repeated visits to the area for 4 years no seed could be collected.

Specimens examined: Dhoni forests, Palghat, Renuka & Nambiar 2501: 31-1-1982. Sterile; Renuka 2982 (female), 2983 (male) 16-12-1983. fls.

Stem anatomy : Specimens examined: Dhoni, Palghat, Renuka 2982: 16-12-1983.

*Epidermis*: single layered, cells often silicified or with a thick cuticle, cubical or radially elongated, lumen oblong or rectangular, walls not sinuous, outer walls thickened; sunken stomata occasional. *Hypodermis*: not distinct. *Cortex*: relatively wide cortex, 25-28 cells deep, cells isodiametric or elongated, intercellular spaces frequent, discrete fibre bundles numerous. *Central cylinder* : delimited from the cortex by small vascular bundles congested at the periphery, each with a massive fibrous sheath, central vascular bundles less congested. with fibres adjacent to phloem only; xylem sheath either wholly parenchymatous or including a few sclerotic parenchyma cells; phloem divided into two strands lateral to the single wide metaxylem vessel; ground parenchyma cells isodiametric or elongated with intercellular spaces; mucilage canals occasional, up to 100 $\mu$ m in diameter. *Cell inclusions*: stegmata present associating with fibres, spherical with rough surface, 12-16 $\mu$  m in diameter. *Vascular elements* : xylem elements upto 1300 $\mu$ m long, end walls slightly oblique to very oblique, perforation plates multiple or scalariform; wide metaxylem elements up to 290 $\mu$  m wide, end walls transverse with simple perforations; fibre elements 280-1900 $\mu$  m long; sieve tubes are with simple sieve plates.

**Calamus gamblei** Becc. in Hook. f., Fl. Brit. India 6; 493. 1892; Becc. in Ann. Roy. Bot. Gard. Calcutta 11:96, 316. 1908; Fischer in Gamble, Fl. Pres. Madras 3: 1093. 1958. Malayalam: Paccha Chural, Ottamoodan. Plate IX, Figs. 1-5.

Clustering, moderate sized cane, climbing high into the canopy. Stem to 30 m or more long, with sheaths 2.5 cm in diameter, without sheaths 1.5m; internodes to 35 cm long. *Leaf sheath green, armed with spines with a bulbous base, spines 0.5 to 1.5 cm long, horizontally held, tip slightly pointing upwards. Knee present.* Ocrea not well developed. Flagellum to 4 m long. Leaf ecirrate, to 1.2 m long, petiole to 25 cm, armed with spines up to 2 cm, rachis armed with claw-like spines; leaflets regular, long-acuminate, 40 x 2.5 cm; veins ciliated on both surfaces; leaf tips armed with short bristles. Inflorescence flagellate, axis about 1 cm in diameter, to 3 m long with up to 5-6 partial inflorescences arising well above the mouth of the sheath in female; partial inflorescence about 25 cm long in female, 90 cm in male; subtending bracts closely sheathing, prolonged at the distal end into a lanceolate point, armed with small spines to 0.5 cm

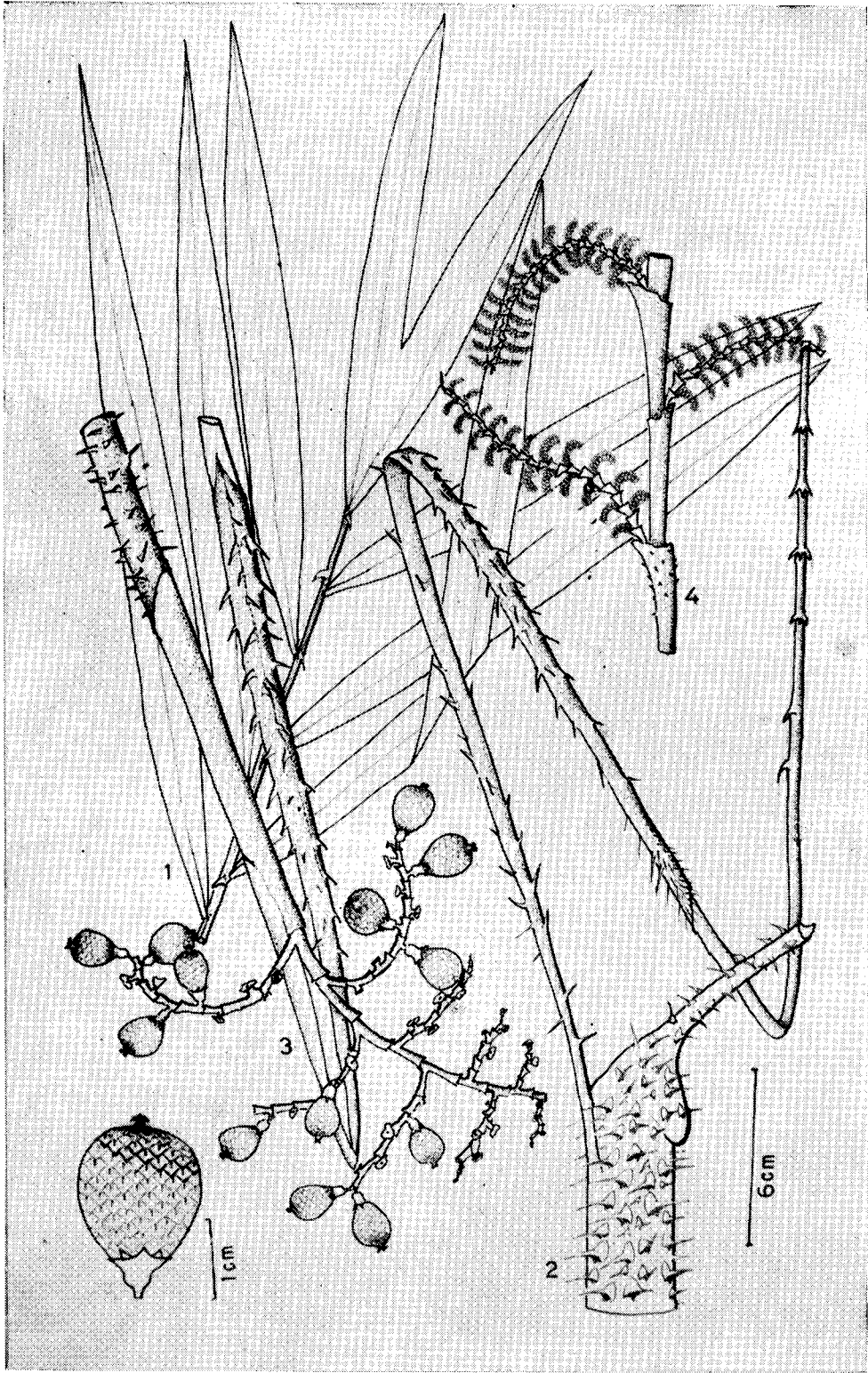


PLATE IX

*C. gamblei* 1. A portion of the leaf 2. Sheath with a portion of the flagellum  
 3. A portion of infructescence 4. A portion of male inflorescence 5. Mature fruit.

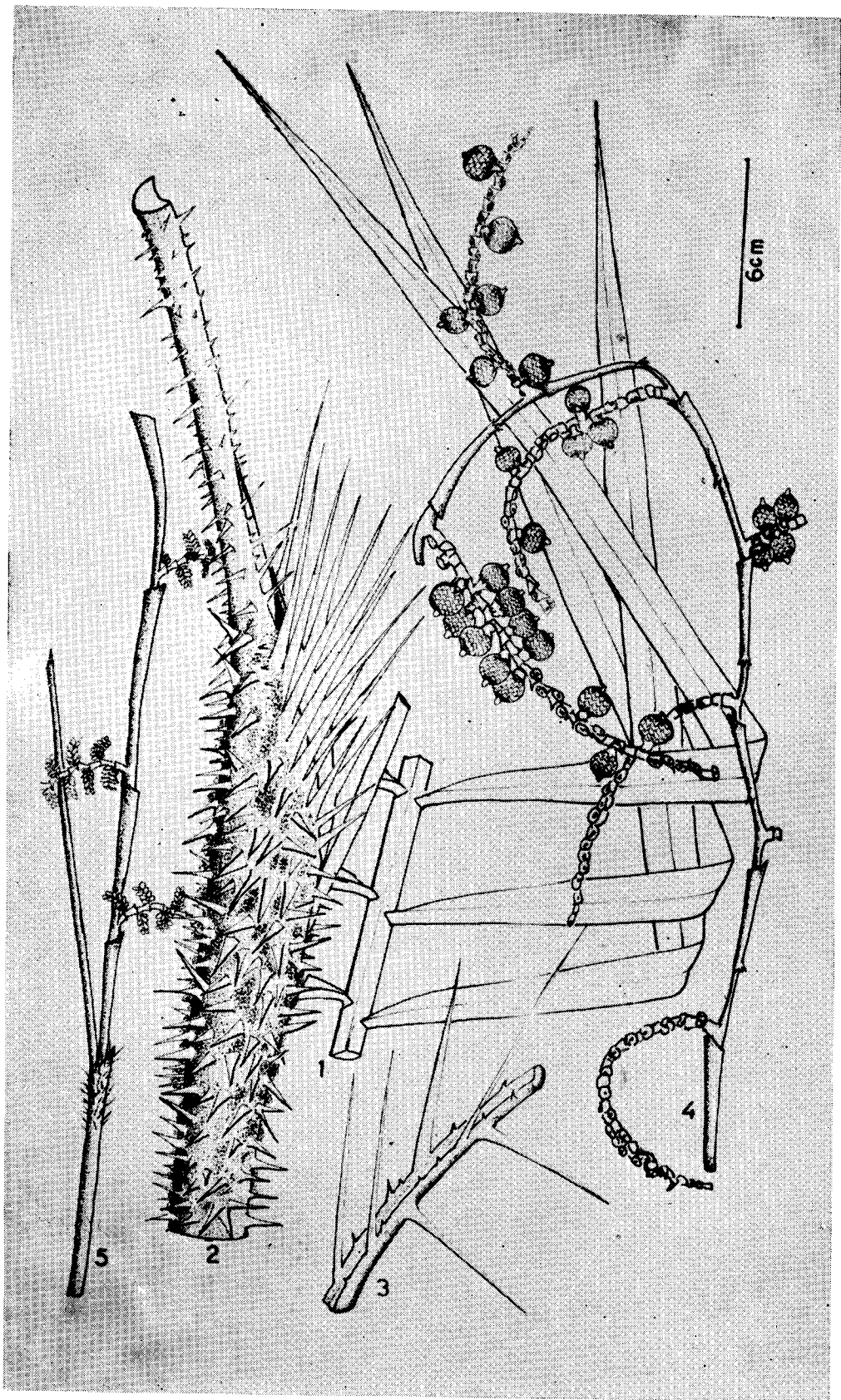


PLATE X

*C. hookerianus* 1. A portion of the leaf 2. Leaf sheath 3. A portion of the petiole showing long spines 4. A portion of infructescence 5. A portion of male inflorescence.

long; rachillae to 5 cm long in female, 2 cm in male; subtending bracts cylindrical at the base and slightly expanded into a cup at the upper region. about 2 cm long. *Fruit spherical or slightly tapering at the base*, borne on a small stalk, 2 x 12 cm, covered with 23 rows of *pale yellow scales, shiny, deeply grooved*.

**Distribution:** Trivandrum, Thenmala, Ranni, Munnar, Palghat and Wynad forest divisions. Seen from 200 m above MSL upwards, but prefers higher altitudes, i.e. 700 m above MSL upwards in Evergreen forests. Common in Eravikulam Wildlife Sanctuary and Attappady hills.

**Phenology:** Flowering December to January, fruiting May to June.

**Specimens examined:** Chandanathodu, Wynad, Renuka and Nambiar 3018: 22-2-1984, young frts: Pampa (Kakki), Goodrical range, Ranni, Renuka 3173: 24-5-1984, frts; Pannithavarnachola, Munnar, Renuka 3401: 28-12-12-1984; frts.; Eravikulam, Renuka 3444: 12-2-1985 frts.; Arippa, Renuka 3433: 17-1-1985, sterile; Attappady. Palghat, Renuka 3473: 27-2-1985, sterile; Silent valley, Renuka 3474: 28-2-1985, sterile; Achenkovil, Renuka 4007: 3-1-1986, male fls.

**Stem anatomy:** Specimens examined: Pampa (Kakki), Ranni, Renuka 3173: 24-5-1984.

*Epidermis:* single layered, cells columnar, lumen oblong or oval, walls silicified, cuticle thick, outer walls thick, sunken stomata occasional. *Hypodermis:* often distinct, 1-2 layered. *Cortex:* narrow, up to 6-8 cells deep, cells isodiametric or slightly elongated; discrete fibre bundles frequently alternate with cortical parenchyma. *Central cylinder:* delimited from cortex by small vascular bundles, congested at the periphery, each with a massive fibrous sheath, central vascular bundles less congested, with fibres adjacent to phloem; xylem sheath either wholly parenchymatous or including a few sclerotic parenchyma cells; phloem divided into two strands lateral to the single wide metaxylem vessel; ground parenchyma isodiametric or slightly elongated, intercellular spaces frequent, larger in size than cortical parenchyma; mucilage canals up to 92µm in diameter. *Cell inclusions:* stegmata present, mostly associated with fibres of outer layer of fibrous sheath, up to 10µm in diameter, spherical, surface rough; starch grains occasional in ground parenchyma. *Vascular elements:* xylem elements up to 2356µm long, end walls oblique to very oblique. perforation plates multiple or scalariform; wide metaxylem up to 310µm in diameter, end walls transverse with simple perforations; fibres 418-2166µm long; sieve tubes with simple sieve plates.

**Taxonomic note :** In Kerala there are two varieties for this species.

## KEY TO THE VARIETIES

1. Fruit globose-obpyriform, slightly tapering  
towards the base ..... C. gamblei Becc. var. gamblei
1. Fruit spherical ..... C. gamblei Becc. var.  
sphaerocarpus Becc.

**C. gamblei** Becc. var. gamblei in Hook. f.; Fl. Brit. India 6: 493. 1892; Becc. in Ann. Roy. Bot. Gard. Calcutta 11: 96, 316. 1908 Fischer in Gamble, Fl. Pres. Madras 3: 1093. 1957.

Distribution: Pampa (Kakki), Goodrical range, Ranni forest division.

C. gamblei Becc. var. sphaerocarpus Becc. in Ann. Roy. Bot. Gard. Calcutta. 11 : 1908; Blatter, Palms Brit, India&Ceylon: 322. 1926.

Distribution: Pampa (Kakki), Goodrical range, Ranni forest division.

**Calamus hookerianus** Beccin Ann. Roy. Bot. Gard. Calcutta 11: 83, 226. 1908; Fischer in Gamble, Fl. Pres. Madras 3: 1094. 1957. Malayalam, Velichural, Kakkachural, Vanthal, Kallan. Plate X, Figs 1-5.

Clustering, moderate sized cane, climbing high into the canopy. Stem to 10 m or more in length, with sheaths to 4 cm in diameter, without sheaths to 2.5 cm; internodes to 26 cm. *Sheaths brownish green, densely armed with triangular spines, the largest to 2.5 cm long by 0.5 cm wide at the base, with numerous, much smaller spines between, brown tomentum abundant between spines, mouth of the sheath provided with long papery spines to 18 cm.* Knee sometimes present, not conspicuous. Ocrea to 8 cm, falling off easily. Flagellum to 5 m. Leaf to 2 m, ecirrate, petiole to 75 cm, armed with long brown or black triangular spines, spines on petiole 1-10 cm long; rachis with a single row of spines to 1.5 cm or with reflexed spines. Leaflets regular, long acuminate, narrowly lanceolate, largest 55 x 2.5 cm; median vein ciliated beneath from centre upwards; lateral veins ciliated on the dorsal surface only; leaf tips armed with short bristles. Inflorescence male and female superficially similar, to 5 cm long: partial inflorescences several, to 75 cm long; subtending bracts closely sheathing, armed with small-spines, male and female rachillae  $\pm$  17 cm long, *subtending bracts narrow at the base* and expanded into a cup at the upper region- *to 7 cm long*, armed with spines at the middle portion. Fruits subglobose, 1 x 0.8 cm, covered with scales, *yellowish brown at the base, chestnut apically.* Seedling leaf ' fan shaped.

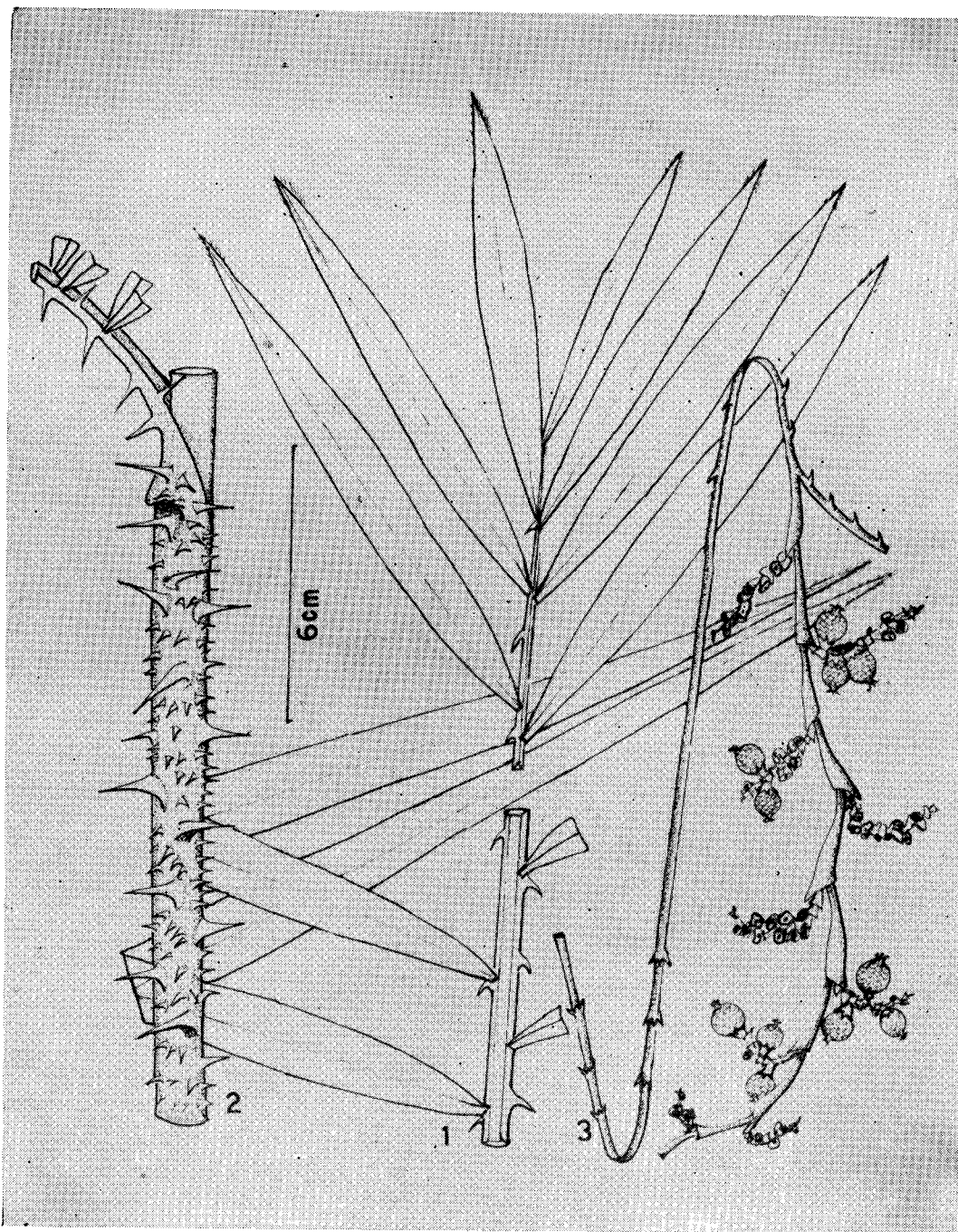


PLATE XI

*C. metzianus* 1. A portion of the leaf 2. Sheathed stem 3. A portion of infructescence.

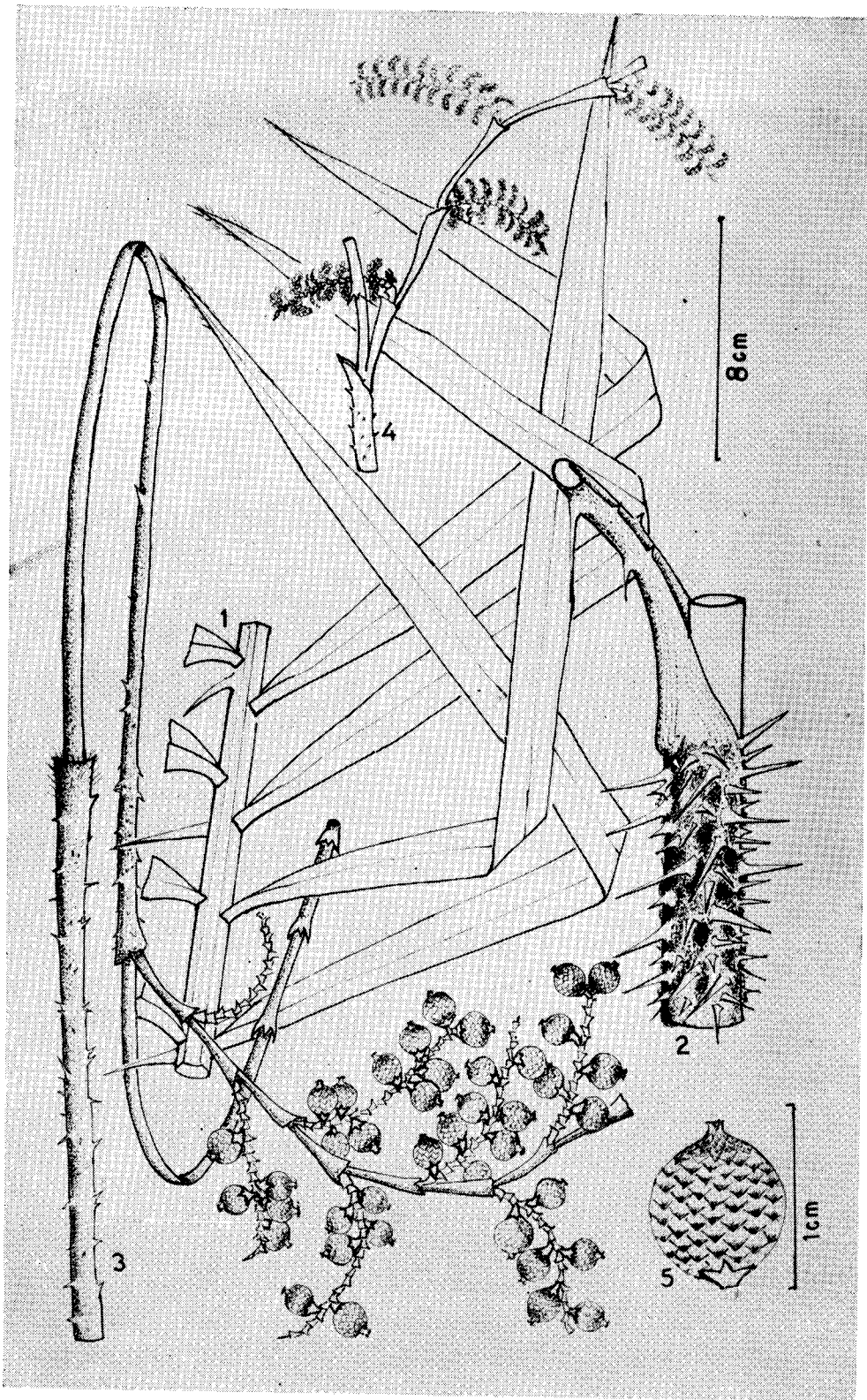


PLATE XII

*C. pseudotenius* 1. A portion of the leaf 2. Sheathed stem  
 3. A portion of infructescence 4. A portion of male inflorescence 5. Mature fruit.



Distribution : Trivandrum, Thenmala, Ranni, Munnar, Kottayam, Malayattur, Trichur, Nemmara and Nilambur forest divisions. Evergreen forests.

Phenology : Flowering February to May, fruiting January to February.

Specimens examined : Arienkavu, Sasidharan 1732 :22-3 - 1982 male fls.; Pakuthipalam, Nelliampathy, Renuka and Muktesh 2727 :6-1-1983, male fls.; Karianchola, Parambikulam, M. K. Menon 2503 :28-2-1983, frts.; Valayam, Achenkovil, Nambiar and Renuka 2902 :8-2-1983, male fls.; Renuka and Nambiar 2904 :8-2-1983, female fls.; Renuka and Nambiar 2905 :8-2-1983, male fls.; Thalapara, Arienkavu, Nambiar and Renuka 2926 :20-4-1983, sterile; Chendurini valley, Thenmala. Nambiar and Renuka 2929 :20-4-1983, sterile; Achenkovil, Nambiar and Renuka 2930 :20-4-1983, frts.; Renuka 3431 :17-1;1985 sterile; Pothupara, Kodanad, Nambiar and Renuka 2948 :29-7-1983, sterile; Peechi, Trichur, Renuka 3009 :9-1-1984, sterile; Kottiyur, Wynad, Renuka 3030: 23-2-1984, sterile; Moozhiyar, Ranni, Renuka, 3155 :23-5-1984. female fls.

Stem anatomy: specimens examined: Nelliampathy, Renuka and Muktesh 2727 :6-1-1983'

*Epidermis*: single layered, cuticle thick, cells silicified, columnar, lumen narrow, outer wall thick; sunken stomata occasional. *Hypodermis*: distinct, 1-2-layered. *Cortex*: relatively wide, 20-25 cells deep, cells isodiametric or elongated with intercellular spaces; numerous discrete fibre bundles frequently present. *Central cylinder*: delimited from the cortex by small vascular bundles congested at the periphery, each with a massive fibrous sheath, central vascular bundles less congested, with fibres adjacent to phloem; xylem sheath either wholly parenchymatous or including a few sclerotic parenchyma cells; phloem divided into two strands lateral to the single wide metaxylem vessel; ground parenchyma isodiametric or elongated, intercellular spaces frequent; mucilage canals not discernible. *Cell inclusions*: stigmata present, mostly associated with fibres of the outer layer of bundle sheath, spherical, surface rough, upto 16mm in diameter; starch grains or gummy deposits occasional in ground parenchyma. *Vascular elements*: xylem elements upto 2400 $\mu$ m long, end walls oblique to very oblique with reticulate or scalariform perforations; wide metaxylem vessels up to 220 $\mu$ m in diameter, end walls transverse with simple perforations; fibres 421-2052 $\mu$ m long; sieve tubes with simple siem plates.

**Calamus metzianus** Schlecht, In Linnaea XXVI:727. 1853; Becc. In Hoock, f., Fl. Brit. India 6 : 462. 1893; Becc. in Ann. Roy. Bot. Gard. Calcutta 11 : 82, 221. 1908. *C. rudentum* (non Lour.) Mart., Hist. Nat. Palm. 3 : 340. 1823-1853. Malayalam : Odiyanchural. Plate XI, Figs. 1-3.

Clustering, climbing high into the canopy. Stem to 15 m long, with sheaths to 2 cm in diameter, without sheaths to 1 cm in diameter; internodes to 39 cm long. *Leaf sheath pale green, densely armed with triangular yellowish spines, the largest to 2 cm long, with numerous much smaller spines in between. Knee conspicuous.* Ocrea absent. Flagellum to 2.5 m. Leaf to 1 m, ecirrate; petiole to 5 cm, armed with small yellow spines with black tip; rachis armed with claw like spines, leaflets regular, long acuminate, gradually getting smaller towards the top, the largest to 37x 2cm, leaf tip armed with short bristles. Inflorescence male and female superficially similar, to 2m long with 4-5 partial inflorescences to 25 cm long, arising well above the mouth of the sheath; subtending bracts closely sheathing, armed with minute spines; rachillae to 3 cm long; Subtending bracts narrow at the base and expanded into a cup, above about 2.5cm long. Fruit ovoid, covered with 17 vertical rows of scales; *scales light yellow with white border and brown apex*, grooved in the middle

Distribution: Nilambur forest division, Thalamkolli, 50 m above MSL in Moist deciduous forests.

Phenology: Flowering November to -January, fruiting May to June.

Specimen examined: Thalamkolli, Nilambur, Renuka 3061: 27-3-1984, frts.

Stem anatomy: Specimens examined: Nilambur, Renuka 3061: 27-3-1984.

*Epidermis:* single layered, cells often silicified or with thick cuticle, columnar, lumen somewhat oblong, outer wall thickened; sunken stomata occasional. *Hypodermis:* distinct, 1-2 layered. *Cortex:* narrow, up to 10-12 cells deep cells isodiametric with alternate discrete fibre bundles. *Central cylinder:* delimited from the cortex by small vascular bundles congested at the periphery, each with a massive fibrous sheath, central vascular bundles less congested, with fibres adjacent to phloem; xylem sheath either wholly parenchymatous or including a few sclerotic parenchyma cells; phloem divided into two strands lateral to the single wide metaxylem vessel; ground parenchyma cells thin walled, isodiametric or elongated, intercellular spaces frequent; mucilage canals occasional, up to 80µm in diameter. *Cell inclusions:* stegmata present mostly associated with the outer layer of fibrous sheath, up to 8µm in diameter, surface rough, gummy deposits common in xylem and ground parenchyma. *Vascular elements:* xylem elements up to 3330µm long, end walls oblique to very oblique with multiple and scalariform perforations; wide metaxylem vessels up to 290µm in diameter, end walls transverse, perforation plates simple; fibres 399-2090µm long; sieve tubes with simple sieve plates.

Note: The cane is not of much commercial value since it breaks easily.

**Calamus pseudotenuis** Brcc.in Hook. f., Fl. Brit. India 6; 445. 1893 Trimen, Fl. Ceylon 4: 430. 1898; Cooke, Fl. Bombay 2: 806. 1907; *C. tenuis* Thw. (non Roxb) Enum. 330 (excl. Syn.); Becc. in Ann. Roy. Bot. Gard. Calcutta 11: t. 69. 1908; Fiseher in Gamble, Fl. Pres. Madras 3: 1903. 1957. Plate XII, Figs. 1-5.

Clustering, moderate sized cane, climbing high into the canopy. Stem to 7 m or more in length, with sheaths to 2.5 cm in diameter, without sheaths to 1.5 cm; internodes to 35 cm long. *Sheath brownish green, armed with yellow needle like spines with bulbous base; spines to 3.5 cm long, pointing in different directions, brown tonientum abundant between spines.* Knee rarely present, not conspicuous. Ocrea small, falling off easily. Flagellum to 3 m. Leaf to 1.6m, ecirrate; petiole to 22 cm, armed with yellow spines to 3 cm; rachis armed with spines to 0.5 cm or with claw like spines; leaflets regular, long acuminate, narrowly lanceolate, 50 x 2.5 cm; veins sparsely ciliated on the ventral surface. Inflorescence male and female superficially similar, to 3 m long with several partial inflorescences to 55 cm long; subtending bracts slightly lacerating at the mouth, armed with spines to 3 mm long; rachillae to 8 cm; long subtending bracts narrow at the base and expanded upwards, about 3 cm long, armed with minute spines. Male flower 0.4 mm long. Fruit subovoid, 1.5 x 0.8 cm, covered with greenish yellow scales with a dark brown border. Seedling leaf fan shaped.

Distribution : Peermedu and Palghat forest divisions. 750 m above MSL upwards.

Phenology : Flowering October to January; fruiting February to May.

Specimens examined : Kozhikkanam, Peermedu, Nambiar and Renuka 2620: 24-11-1982, frts.; Valanchankanam, Peermedu, Nambiar and Renuka 2625 : 24-11-1982, femalefls. and frts.; Nambiar and Renuka 2628 : 25-11-1982, male fls.; Nambiar and Renuka 2629: 25-11-1982, male fls.: Nambiar and Renuka 2630: 25-11-1982, male fls.; Attappady, Palghat, Renuka 3471 : 27-2-1985. male fls.; Renuka 3472 : 27-2-1985, frts.

Stem anatomy : Specimen examined : Peermedu, Nambiar and Renuka 2625 : 24-11-1982.

*Epidermis* ; single layered cells, silicified, cuticle thick, cells columnar, lumen oblong or bottle shaped, outer wall thickened; sunken stomata occasional. *Hypodermis*: distinct, single layered. Cortex : narrow, 6-8 cells deep, cells

isodiametric or slightly elongated with alternate discrete fibre bundles. *Central cylinder*: delimited from the cortex by small vascular bundles congested at the periphery, fibrous sheath massive, central vascular bundles less congested, with fibres adjacent to phloem; xylem sheath either wholly parenchymatous or including a few sclerotic parenchyma cells; phloem divided into two strands lateral to the single wide metaxylem vessel; ground parenchyma isodiametric or elongated with intercellular spaces; mucilage canals frequent, up to 60µm in diameter. *Cell inclusions*: stigmata present, associated with outer layer of fibrous bundle sheath; spherical, surface rough, up to 10µm in diameter; starch grains or gummy deposits occasional in ground tissue, *Vascular elements*: xylem elements up to 1995µm long; end walls oblique to very oblique, with reticulate and scalariform perforations. Wide metaxylem vessels up to 210µm in diameter, end walls transverse with simple perforations; fibre 280-2318µm long; sieve tubes with simple sieve plates.

**Calamns rotang** Linn. Sp. pl. ed. 2: 463, 1753; Mart., Hist. Nat. Palm. 3: 334. t. 116. f. 8 and t. xxxii, f. XII. 1823-1853; Bl., Rumphia 3 :33. 1849. Becc. in Hook. f., Fl. Brit. India. 6: 447. 1893; Becc. in Ann. Roy. Bot. Gard. Calcutta 11 :98, 269. 1908; Fischer in Gamble, Fl. Perts. Madras 3 ; 1093. 1957. Plate XIII, Figs. 1-4.

Clustered, climbing cane. Stem to 10 m long; with sheaths 1.3 cm in diameter, without sheaths to 1 cm in diameter; internodes to 45 cm long. *Sheath green with needle like yellow spines; spines to 1 cm long, Knee prominent-Ocrea absent.* Flagellum to 2.5 m. Leaf to 80 cm, ecirrate; *petiole absent*; rachis armed with spines to 1 cm long; spines yellow with black tip; leaflets regular, long acuminate, 35 x 2 cm, margins sharply spinulose; median vein ciliated beneath. from centre upwards; leaf tip armed with bristles. Inflorescence male and female superficially similar, to 3 m long with 4-5 partial inflorescences to 70 cm long; subtending bracts closely sheathing, armed with minute spines, male rachillae to 3 cm long, recurved, female rachillae to 8 cm long; subtending bracts tapering at the base and expanding into a cup at the upper region, about 2.5 cm long. Fruit ovoid, scales in 21 series, faintly channeled along the middle.

Distribution, This is not a montane species and seen only on marshy plains. In Kerala this is localised near the backwaters of Quilon.

Phenology : Flowering October to December; fruiting March to May.

Specimens examined : Quilon Asram Compound, Renuka and Sasidharan 3443 : 18-1-1985, female fls. and young frts.; Renuka and Sasidharan. 4004 : 18-1-1985, male fls.

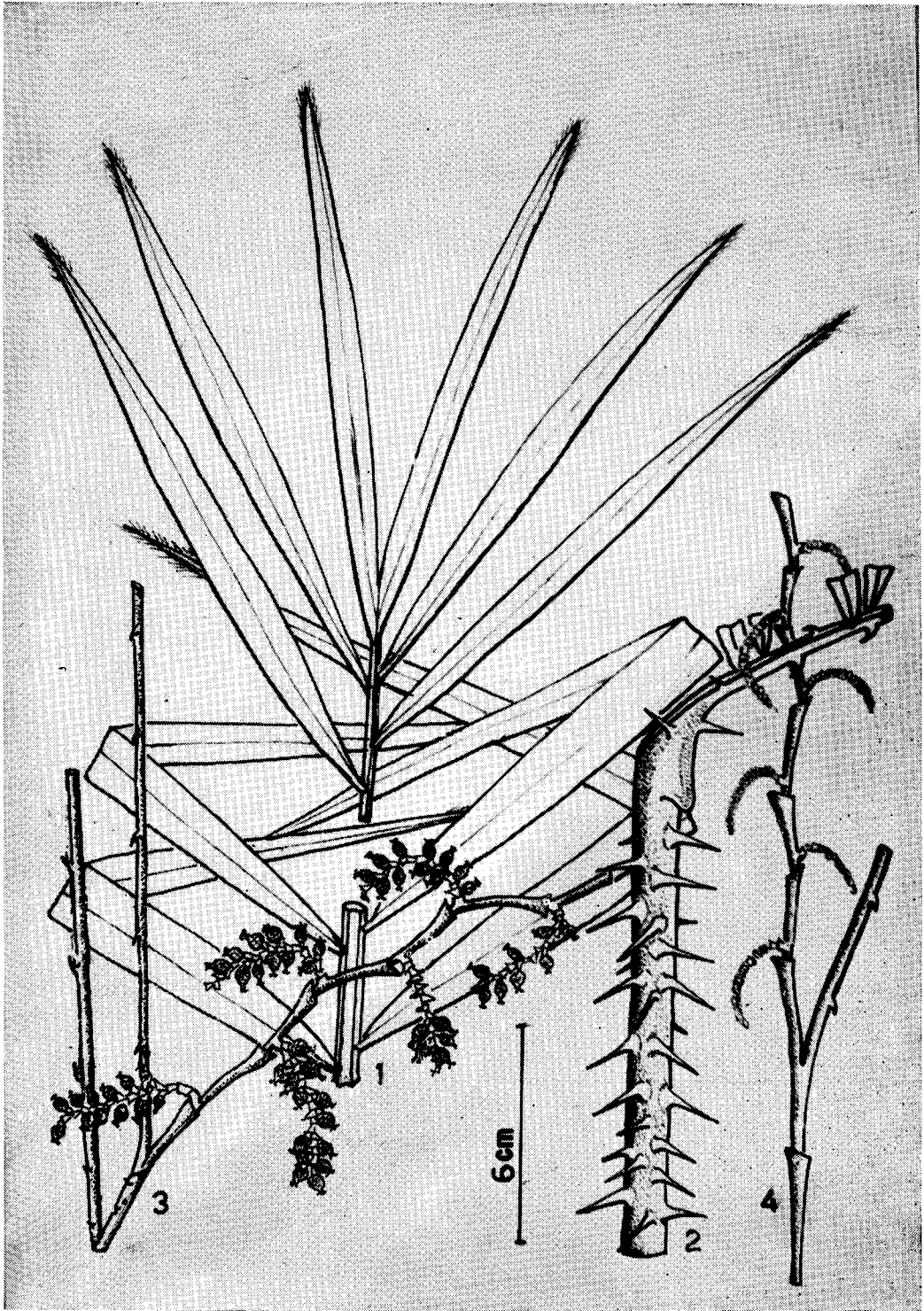


PLATE XIII

*C. rotang* 1. A portion of the leaf 2. Leaf sheath 3. A portion of infructescence  
4. A portion of male Inflorescence.

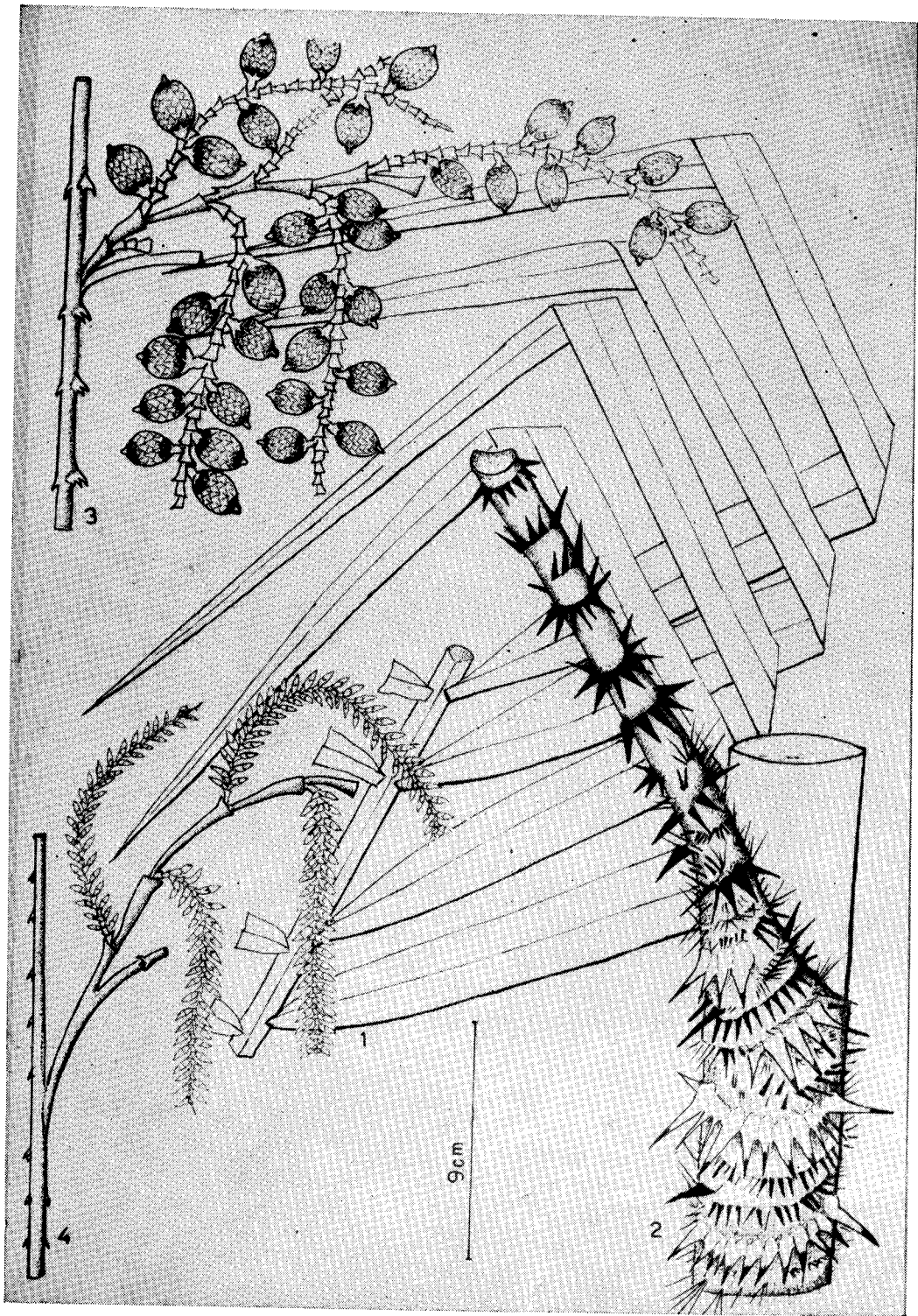


PLATE XIV

*C. thwaitesii* 1. A portion of the leaf 2. Sheathed stem  
3. A portion of infructescence 4. A portion of male inflorescence.

Stem anatomy : Specimens examined : Quilon Asram Campus, Renuka and Sasidharan 3443 : 18-1-1985.

*Epidermis* : single layered, cells often silicified or with thick cuticle, cells columnar, lumen oblong, outer wall thickened. sunken stomata occasional. *Hypodermis* : distinct, single layered. *Cortex* : narrow, up to 6-8 cells deep, cells isodiametric or slightly elongated, discrete fibre bundles small. *Central cylinder* : delimited from the cortex by small vascular bundles congested at the periphery, fibrous sheath massive, central vascular bundles less congested, with fibres adjacent to phloem; xylem sheath either wholly parenchymatous or including a few sclerotic parenchyma cells; phloem divided into two strands lateral to the single wide metaxylem vessel; ground parenchyma isodiametric or elongate, intercellular spaces frequent; mucilage canals solitary or often in clusters of 4-5, up to 88  $\mu\text{m}$  in diameter. *Cell inclusions*: Stegmata present, associated with outer layer of fibrous bundle sheath, spherical, surface rough, up to 6  $\mu\text{m}$  in diameter; gummy deposits common in ground parenchyma. *Vascular elements*: xylem elements up to 2280  $\mu\text{m}$  long, end wall oblique to very oblique, perforation plates multiple or scalariform; wide metaxylem vessels upto 220  $\mu\text{m}$  in diameter, end walls transverse, perforations simple; fibres 230-2622  $\mu\text{m}$  long; sieve tubes with simple sieve plates.

*Calamus thwaitesii* Becc. in Hook. f. Fl. Brit. India 6 : 441. 1893; *C longisetus* Thw. Enum. Plant. Zeyl. 330 (non Griff.) 1864; Becc. in Ann. Roy. Bot. Gard. Calcutta 11 : 71, 137, 1908. Pl. 10, 11 (Appendix) 1913, *Calamus thwaitesii* Becc. var. *Canaranus* Becc. in Ann. Roy. Bot. Gard. Calcutta 11 : 138. 1908. pl. 12 (Appendix) 1913; Fischer in Gamble, Fl. Pres. Madras 3 : 1093. 1957. Malayalam : Pannichural, Vandichural, Thatiyanchural. Plate XIV, Figs. 1-4.

Very robust, high climbing cane, stem to 20 m or more in length; with sheath to 6 cm in diameter, without sheath to 3.5 cm in diameter; internode to 45 cm long, sometimes with brown spots. *Sheath yellow, densely armed with black flattened spines with yellow base; spines of varying length arising from a raised rim like surface, the longest to 30 cm long by 0.7 cm wide at the middle with smaller spines scattered in between. Knee absent. Ocrea absent. Flagellum to 9m.* Leaf to 3 m long, ecirrate, petiole to 35 cm long; rachis and petiole yellowish, armed with flat black spines arranged in oblique rows; leaflets numerous, variable in arrangement, usually grouped, the longest to 80 x 45 cm, sharply spinulose along the margins and the upper side of mid veins, with long bristles

to 1 cm long on the mid vein beneath. Inflorescence male and female superficially similar, to 6 m long, subtending bracts with tapering limbs, up to 10 cm, densely armed with reflexed spines, spines arranged in a semicircular row; partial inflorescence to about 70 cm long; subtending bracts to 3 cm long in female and to 4 cm in male. Male flowers distichous or rachillae to 8 cm long. Female flowers on rachillae to 15 cm long. Fruit 2 x 1.3 cm, ovoid, covered in 12 vertical rows of yellow scales with deep brown margins, scales with median grooves. Seedling leaf bifid.

Distribution : Trivandrum, Thenmala, Ranni, Munnar, Kottayam, Vazhachal-Chalakkudy, Malayattur, Trichur. Palghat, Nemmara, Nilambur and Wynad forest divisions. From 75 to 900 m above M S L. Evergreen and Moist deciduous forests,

Phenology : Flowering November to January; fruiting February to April.

Note : This is the thickest cane available in Kerala.

Specimens examined : Vazhachal, Renuka 1891 : 9-7-1982, sterile; Dhoni hills, Palghat, Nambiar & Renuka 1949 : 8-9-1982, sterile; Nambiar and Renuka 2502 : 31-1-1983; sterile; Kadannalkkappu, Nilambur, Renuka 1954 : 18-9-1982, sterile; Renuka 3062 : 28-3-1984, male fls.; Panampuzha, Nilambur, Renuka 3060 : 27-3-1984, male fls.; Valayam, Achenkovil, Nambiar and Renuka 2903 : 8-2-1983, sterile; Nambiar and Renuka 2905 : 8-2-1983, male fls.; Arippa, Renuka 3430 : 17-1-1985, sterile.

Stem anatomy : Specimens examined : Achenkovil, Nambiar and Renuka 2903 : 8-2-1983.

*Epidermis* : single layered, cells often silicified or with thick cuticle, cells somewhat cubical, lumen oblong or rectangular, outer walls thickened; sunken stomata occasional. *Hypodermis* : distinct, single layered. *Cortex* : relatively wide cortex, often 35-40 cells deep, cells isodiametric or elongated, intercellular spaces less frequent, discrete fibre bundle numerous, *Central cylinder* : delimited from the cortex by small vascular bundles congested at the periphery, each with a massive fibrous sheath, central vascular bundles less congested with fibres adjacent to phloem only; xylem sheath either wholly parenchymatous or including a few sclerotic parenchyma cells; phloem divided into two strands lateral to the single wide metaxylem vessel; ground parenchyma cells isodiametric or elongated with intercellular spaces; mucilage canals occasional up to 100  $\mu$ m in diameter. *Cell inclusions* : stegmata spherical, up to 12-15  $\mu$ m in diameter, associated with fibre, more abundant on the outer surface of fibrous sheath. *Vascular elements* :



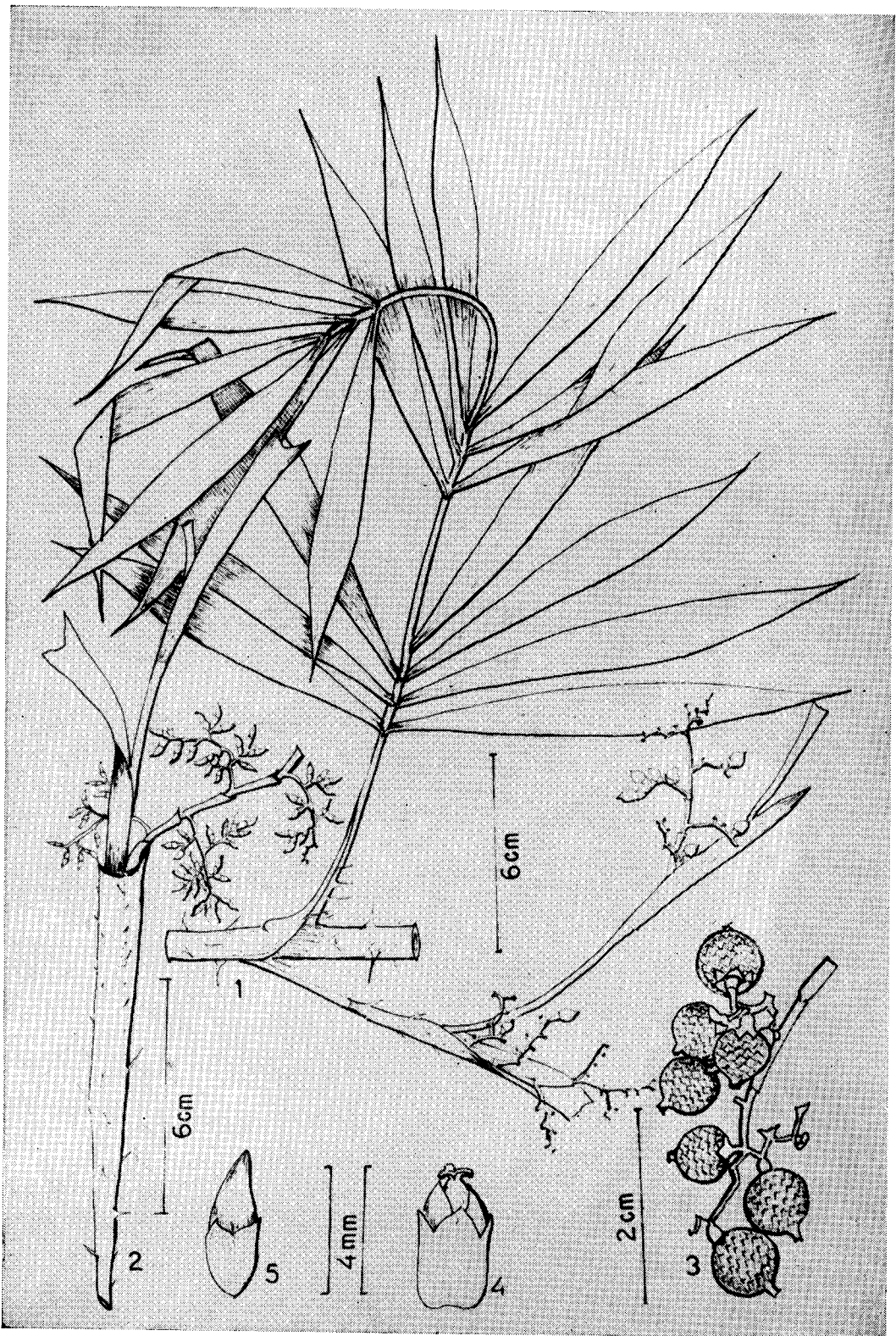


PLATE XV

*C. travancoricus* 1. A portion of sheathed stem with a leaf and a portion of inflorescence 2. A portion of male inflorescence 3. Mature fruits 4. Female flower 5. Male flower.

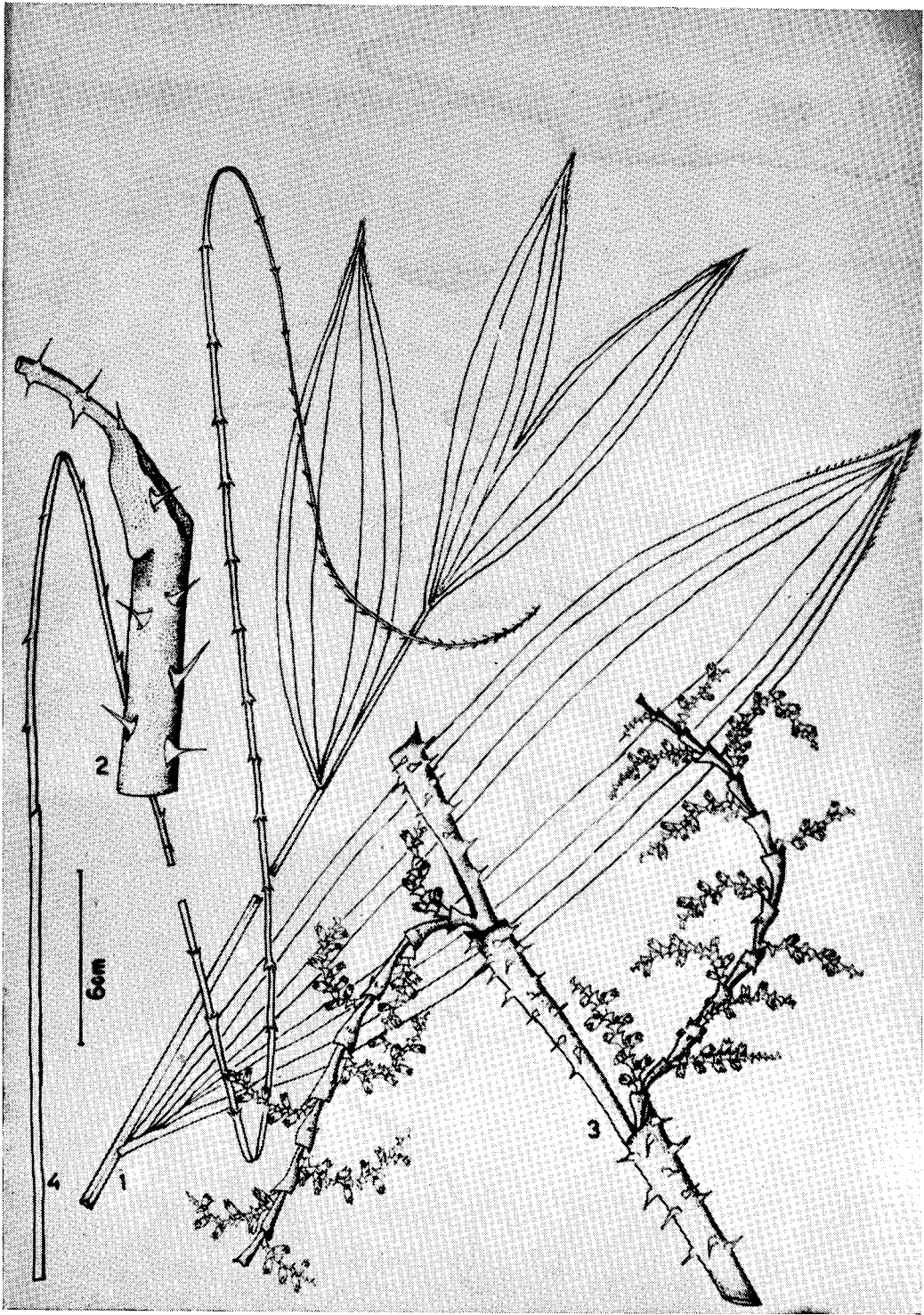


PLATE XVI

- C. vattayila* 1. A portion of the leaf    2. Leaf sheath  
3. A portion of female inflorescence    4. Flagellum.

xylem elements 270-3040 $\mu$ m long, end walls oblique to very oblique, perforation plates multiple and scalariform; wide metaxylem vessels up to 420 $\mu$ m in diameter, end walls transverse, perforation plates simple; fibres 200-2185 $\mu$ m long; sieve tubes with simple sieve plates.

*Calamus travancoricus* Bedd. mss. in Herb. Kew; *C. gracilis* (non Roxb.) Griff., Palms Brit. India 64. 1850; Becc. in Hook. f., Fl. Brit. India 6 : 452. 1893; Becc. in Ann. Roy. Bot. Gard. Calcutta 11 : 95, 310, 1908; Fischer in Gamble, Fl. Pres. Madras 3 : 1093. 1957. Malayalam : Arichural. Plate XV, Figs. 1-5.

Clustering, very slender, climbing cane. Stem to 5 m or more in length. *With sheaths to 0.8 cm in diameter, without sheaths to 0.4 cm in diameter* ; internodes to 22 cm long. Sheath green with spines to 0.5 cm, *mouth of the sheath provided with slightly longer spines to 1 cm long. Knee small.* Ocrea papery, 1.5 cm long. Flagellum to 1.3 m, Leaf to 45 cm long, ecirrate; petiole to 11 cm, armed with small spines; rachis armed with claw like spines; leaflets grouped, the number of leaflets in a group vary, the longest to 25 x 2 cm, long acuminate. Inflorescence male and female superficially similar, to 1 m long with spiny bracts and up to 4-5 partial inflorescences; rachillae about 12 cm long: subtending bracts to 1.5 cm long. Mature fruit almost rounded, to about 1 cm x 8 mm, covered in brown edged yellowish scales in up to 24 rows.

Distribution : Trivandrum, Thenmala, Ranni, Konni and Malayattur forest divisions from 200 to 500 m above MSL. Evergreen forests.

Phenology : Flowering October to November; fruiting May to June

Specimens examined : Arienkavu, Sasidharan 1731 : 22-3-1982 , young frts.; Nambiar and Renuka 2925 : 19-4-1983, young frts.; Edamalayar, Malayattoor, Sasidharan 2516 : 21-10-1982 , male fls.; Pothupara, Kodanad, Malayattoor, Nambiar and Renuka 2949 : 29-7-1983, sterile; Moozhiyar, Ranni, Renuka 3154 : 23-5-1984, frts.; Renuka 4002 : 9-10-1985, male fls.

Stem anatomy : Specimens examined : Arienkavu, Nambiar and Renuka 2925 : 19-4-1983.

*Epidermis* : single layered, cells silicified or with thick cuticle, cell lumen triangular or oval, outerwall thickened; sunken stomata occasional. *Hypodermis*: distinct, single layered. *Cortex*: narrow, up to 6-8 cells deep, cells isodiametric or slightly elongated, small fibre bundles often alternate with cortical parenchyma, globular starch grains present. *Central cylinder* : delimited from

the cortex by small vascular bundles congested at the periphery, fibrous sheath massive, central vascular bundles less congested, with fibres adjacent to phloem: xylem sheath either wholly parenchymatous or including a few sclerotic parenchyma cells; phloem divided into two strands lateral to the single wide metaxylem vessel; ground parenchyma isodiametric or slightly elongated; intercellular spaces relatively less frequent; mucilage canals up to 50 $\mu$ m in diameter. *Cell inclusions* : stegmata present, mostly associated with fibres; grains spherical, surface rough, up to 10 $\mu$ m in diameter; globular starch grains abundant; gummy deposits frequent in cortex and ground tissues. *Vascular elements* : xylem elements up to 2090 $\mu$ m long, end walls oblique to very oblique, perforation reticulate or scalariform; wide metaxylem vessels up to 200 $\mu$ m in diameter, end walls transverse, perforations simple; fibres 200-1900 $\mu$ m long; sieve tubes with simple sieve plates.

**Calamus vattayila** Renukasp. nov. Curr. Sci (In Press).

Malayalam : Vattayilayan, Ottaman. Plate XVI, Figs. 1-4.

Solitary, high climbing cane. Stem to 15 m long, with sheaths 2.5 cm in diameter, without sheaths 1.8cm; internodes to 27 cm. *Leaf sheath dark green, sparingly spiny: spines to 2 cm long, sometimes pointing upwards*. Knee conspicuous. Ocrea small, 0.5 cm long. *Flagellum dark green*, to 4 m long. Leaf ecirrate, to 1 m long; petiole to 25 cm, armed with spines to 1 cm; rachis armed with claw like spines in 3 rows; *leaflets dark green, with 6 veins*, arranged alternately, 40 x 10 cm, leaf tips armed with short bristles. Inflorescence flagellate, axis about 1 cm in diameter, to 60 cm long with up to 5 partial inflorescences each to about 28 cm long, branching once in each type; subtending bracts closely sheathing, prolonged at the distal end into a lanceolate point, armed with small spines to 3 mm long; rachillae to 5 cm long; subtending bracts expanded into a cup at the upper region, about 2 cm long, stout, provided with small spines. Female flowers to 5 mm long, outer tepal to 3 mm, inner tepal to 4 mm, staminodes 6, basally united, ovary tricarpeal. Fruit not known.

Distribution : Thenmala, Ranni, Nilambur and Wynad forest divisions. 200 to 750 m above MSL,. Evergreen forests. Very sporadic in distribution.

Etymology : The new species is named after its Malayalam name 'Vattayilayan'.

Phenology : Flowering September to October. Fruits could not be collected.

Specimens examined : Chittar valley, Achenkovil. Renuka and Nambiar 2907 :9-2-1983, sterile; Kottiyur, Wynad, Renuka and Nambiar 3029 : 23-2-1984, sterile; Moozhiyar, Ranni, Renuka 4001 :9-10- 1985, female fls. ; Thenmala, Renuka 4003 : 11-10- 1985, sterile.

Stem anatomy: Specimens examined: Thenmala, Renuka 4003: 11-10-1985.

*Epidermis*: single layered, cells silicified with thick cuticle, columnar, lumen somewhat oblong, outerwall thickened; sunken stomata occasional. *Hypodermis*: distinct, single layered. *Cortex*; relatively wide, 25-30 cells deep, cells isodiametric or elongated, discrete fibre bundles in 5-6 tiers, alternating with cortical parenchyma. *Central cylinder*: delimited from the cortex by small vascular bundles congested at the periphery, fibrous sheath massive; central vascular bundles less congested, with fibres adjacent to phloem; xylem sheath either wholly parenchymatous or including a few sclerotic parenchyma cells; phloem divided into two strands lateral to the single wide metaxylem vessel; ground parenchyma isodiametric or elongated, intercellular spaces frequent, mucilage canals up to 70  $\mu$  m in diameter. *Cell inclusions*: stegmata present, associated with fibres of outer layer of fibrous sheath, spherical, surface rough, up to 12  $\mu$  m in diameter; starch grains occasional in ground tissue. *Vascular elements*: xylem elements up to 2100 $\mu$  m long, end walls oblique to very oblique, with reticulate and scalariform perforations; wide metaxylem vessels up to 290  $\mu$  m in diameter, end walls transverse, perforations simple; fibres 362-1900  $\mu$  m long; sieve tube with simple sieve plates.

## PHYSICAL CHARACTERISTICS

Three most important physical characteristics used in grading and assessing the utilization potential are stem diameter, internode length and specific gravity. The means, ranges and coefficients of variation (cv) of these physical characteristics among the stem are given in Table 2.

### Diameter

The mean values given in Table 2 shows that the stem of *C. travanroricus* is as slender as 3 mm in diameter while thickest stem of *C. thwaitesii* measures up to 23.5 mm. As stem diameter is an important criterion in determining the end-use, canes in Kerala may be classified into 3 groups as follows.

1. Large diameter canes ( $> 18$  mm) : Two species viz. *C. drnnsfieldii* and *C. thwaitesii* with relatively thick stems, come under this group (Plate XVII, Fig. 1). These canes may be used either as round stem in

Table 2 Means, ranges and coefficients of variation (cv) of physical characteristics among the stems

Species	Diameter mm			Internode length cm			Specific gravity		
	Mean	(Range)	cv%	Mean	(Range)	cv%	Mean	(Range)	cv%
<i>C. dransfieldi.</i>	21.2	(12.0—43.0)	33.4	15.6	(1.3—34.5)	45.7	0.443	(0.271—0.612)	18.6
<i>C. gamblei</i>	14.1	(11.0—24.0)	21.4	17.3	(1.0—25.6)	42.4	0.443	(0.250-0.690)	24.1
<i>C. hookerianus</i>	13.0	(5.0—25.0)	31.2	11.9	(0.5-25.6)	53.4	0.515	(0.320—0.720)	16.4
<i>C. metzianus</i>	8.5	(5.0-13.0)	21.2	25.1	(10.0—38.8)	23.7	0.368	(0.250—0.655)	24.3
<i>C. pseudotenuis</i>	13.5	(8.0—26.0)	23.8	15.0	(2.5—33.7)	43.3	0.518	(0.230-1.040)	33.9
<i>C. rotang</i>	6.4	(4.0—10.0)	20.6	25.6	(10.4-44.5)	32.3	0.441	(0.214—0.571)	22.3
<i>Calamus</i> sp.	7.4	(3.0-13.0)	33.6	13.7	(0.7—27.0)	41.5	0.615	(0.437-0.923)	20.7
<i>C. thwaitesii</i>	23.5	(13.0—35.0)	21.5	23.5	(2.5-43.3)	41.2	0.423	(0.230—0.689)	17.8
<i>C. travancoricus</i>	3.0	(2.0-4.0)	20.5	10.1	(2.0—22.0)	52.0	0.649	(0.400-1.000)	21.3
<i>C. vattayila</i>	10.5	(5.0-18.0)	28.0	12.3	(0.9—26.2)	55.8	0.533	(0.277-1.000)	22.8

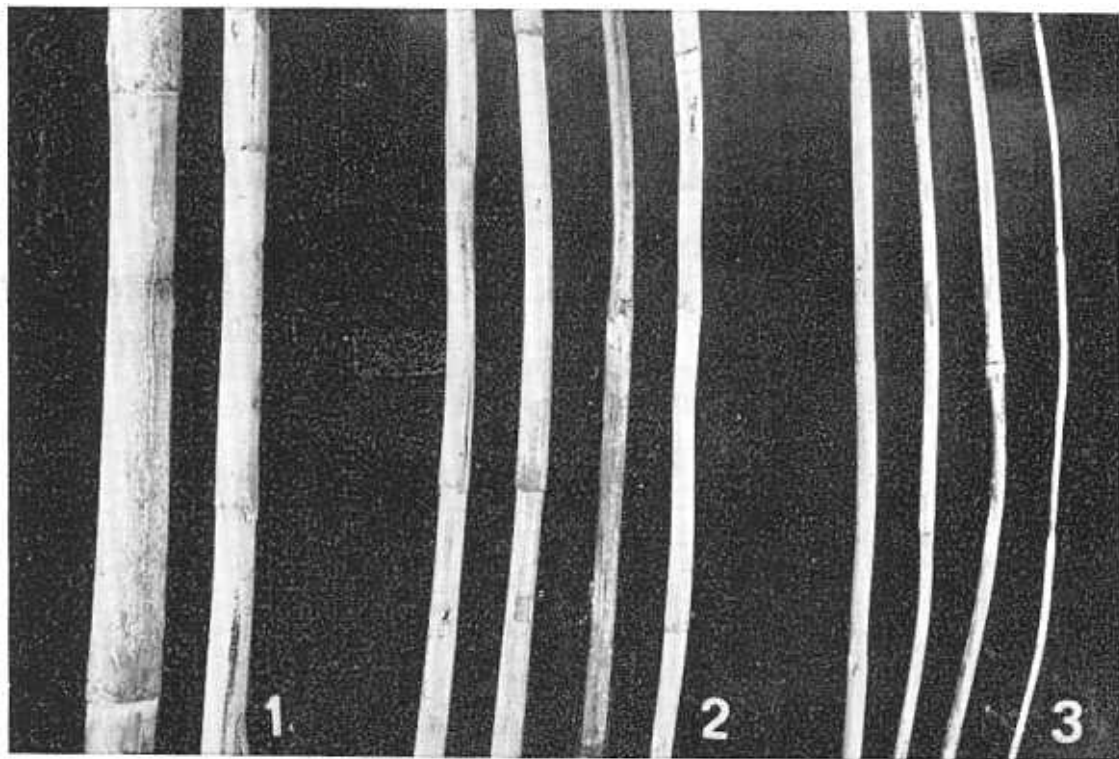


PLATE XVII

Three grades of rattans

- Fig. 1.** Large diameter Canes (*C. thwaitesii* and *C. dransfieldii*)  
**Fig. 2.** Medium sized Canes (*C. gamblei*, *C. hookerianus*, *C. pseudotenuis* and *C. vattayila*)  
**Fig. 3.** Small diameter Canes (*C. metzianus*, *C. rotang*, *Calamus* sp. and *C. travancoricus*)



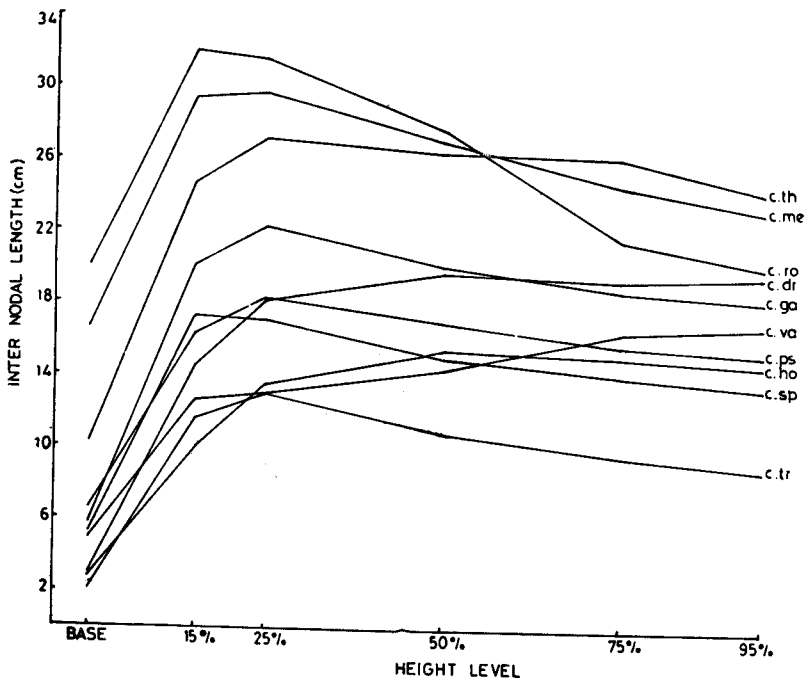
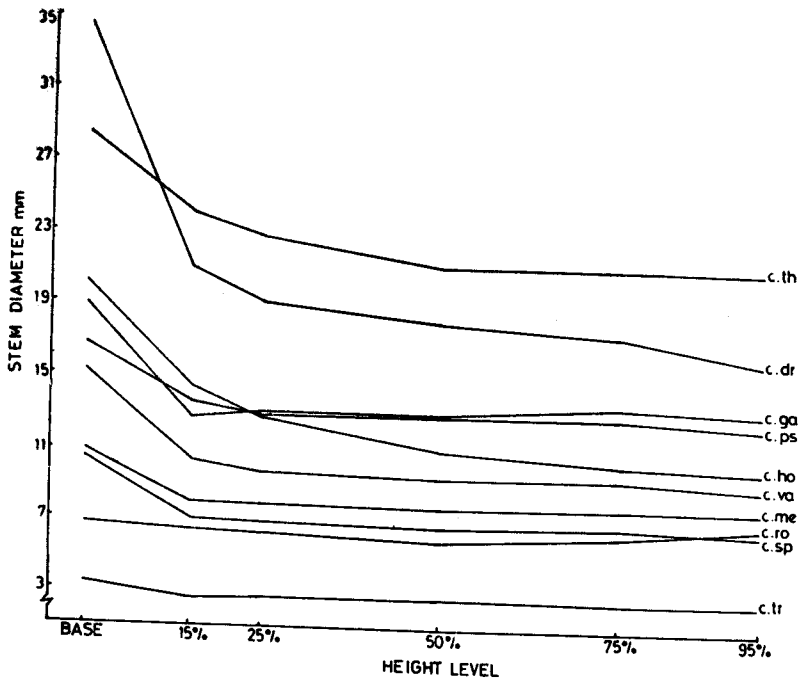


PLATE XVIII

Fig. 1. Average stem diameter at different height levels. (top)

Fig. 2. Average internode length along the stem at different height levels. (bottom)

C. dr — *Calamus dransfieldii*, C. ga — *C. gamblei*, C. ho — *C. hookerianus*, C. me — *C. metzianus*,  
 C. ps — *C. pseudotenius*, C. ro — *C. rotang*, C. sp — *Calamus* sp., C. th — *C. thwaitesii*,  
 C. tr — *C. travancoricus*, C. va — *C. vattayila*.

furniture frames, walking sticks or as peeled layers in chair seats and basket weaving.

2. Medium-sized canes (10-18 mm): Four species, viz. *C. gamblei*, *C. hookerianus*, *C. pseudotenuis* and *C. vattayila* have stems with mean diameter range of 10-14 mm (Plate XVII, Fig. 2). They find application in walking sticks, hockey sticks, umbrella handles etc.
3. Small diameter canes (< 10 mm): Rest of the four species, viz. *C. nietzianus*, *C. rotang*, *C. travancoricus* and *Calamus* sp. have slender stems (Plate XVII, Fig. 3) in which the mean diameter does not exceed 10mm. They are mostly used as round stems in furniture items and a variety of handicrafts.

Diameter gradually decreases from bottom to top. (Plate XVIII, Fig. 1). The analysis of variance (Table 3) reveals that the diameter both within and between the stems of a species, in general, is significant in almost all the species.

#### Internode length

The mean internode length varies from 10.1 cm in *C. travancoricus* to 25.6 cm in *C. rotang* (Table 2). The analysis of variance (Table 3) reveals that there is significant variation in internode length both within and between the stems of each species. Within the same cane the internode length increases from bottom to 15-25% or rarely 50% of cane length and then decreases slowly towards the tip (Plate XVIII, Fig. 2).

#### Specific gravity

The mean specific gravity ranges from 0.368 in *C. metzianus* to 0.649 in *C. travancoricus* (Table 2). Two small diameter canes, viz. *Calamus* sp. and *C. travancoricus* have highest values of specific gravity while another species of the same category, *C. metzianus*, has exceptionally low value with easily breakable stem. Specific gravity variation within the species is considerable, as both within and between stem variations are significant. As in diameter, the general trend is a decline in specific gravity with an increase in height level from bottom to 95% of stem height (Plate XIX).

Table 3. Analysis of variance of physical characteristics among (within and between) the stems

Species	Source of variation	Degrees of freedom	Diameter		Internode length		Specific gravity	
			Mean square	F	Mean square	F	Mean square	F
<i>C. dransfieldi</i>	Between	10	37.8	6.16**	49.89	5.63**	0.011	11.0 **
	Within	5	515.5	83.91**	470.97	53.15**	0.053	53.0 **
	Error	50	6.1		8.86		0.001	
<i>C. gamblei</i>	Between	9	10.5	3.15**	116.83	8.51**	0.026	8.66**
	Within	5	48.5	15.15**	301.64	21.97**	0.046	15.33**
	Error	45	3.2		13.72		0.003	
<i>C. hookerianus</i>	Between	33	10.6	3.78**	82.60	9.80**	0.017	8.50**
	Within	5	507.0	181.07**	819.19	97.18**	0.097	48.50**
	Error	165	2.8		8.42		0.002	
<i>C. metzianus</i>	Between	9	8.6	9.21**	39.93	3.33**	0.015	3.75**
	Within	5	14.7	15.70**	238.71	19.95**	0.028	7.00**
	Error	45	0.9		11.96		0.004	
<i>C. pseudotenius</i>	Between	9	21.1	3.24**	98.00	6.42**	0.118	11.80**
	Within	5	25.3	3.89**	185.77	12.18**	0.056	5.60**
	Error	45	6.5		15.25		0.010	
<i>C. rotang</i>	Between	9	8.4	18.25**	126.99	4.37**	0.019	3.16**
	Within	5	1.2	2.63**	321.37	11.08**	0.028	4.66**
	Error	45	0.4		29.00		0.006	
<i>Calamus</i> sp.	Between	15	35.5	27.30**	49.08	5.07**	0.029	2.23*
	Within	5	20.6	15.84**	305.06	31.70**	0.024	1.8ns
	Error	75	1.3		9.66		0.013	
<i>C. thwaitesii</i>	Between	16	38.2	3.23**	170.70	7.51**	0.092	3.06**
	Within	5	197.2	16.69**	652.90	28.73**	0.028	9.33**
	Error	80	11.8		22.72		0.030	
<i>C. travancoricus</i>	Between	14	13	14.20**	44.13	2.71**	0.099	49.5 **
	Within	5	1.3	13.00**	156.13	9.60**	0.022	11.0 **
	Error	70	0.1		16.27		0.002	
<i>C. vattayila</i>	Between	11	14.1	0.60ns	102.63	13.09**	0.029	2.90**
	Within	5	66.5	2.83**	356.90	45.52**	0.033	3.30**
	Error	55	23.5		7.84		0.010	

\*\*Significant at 1% level

\*Significant at 5% level

ns Not significant

## DISCUSSION AND CONCLUSION

During the present study 10 species of *Calamus*, viz. *C. dransfieldii*, *C. gamblei*, *C. hookerianus*, *C. metzianus*, *C. pseudotenius*, *C. rotang*, *C. thwaitesii*, *C. travancoricus*, *C. vattayila* and *Calamus* sp. could be collected. Of these *C. dransfieldii* and *C. vattayila* are new species and *C. metzianus* is a new record to Kerala. Earlier keys on *Calamus* are mainly based on the arrangement of leaflets, floral characters and nature of fruits (Fischer, 1931: Beccari and Hooker J. D., 1892, 1893). In the absence of fruits which are scarcely present in many localities due to the dioecious nature of the plant as well as extraction of canes before they attain the flowering stage, identification of *Calamus* seems to be difficult. However, the present study proves that stem diameter, the leaf sheath, nature of spines on the petiole and rachis, leaflet arrangement and shape and size of leaflet are important diagnostic features. Leaf sheath is strikingly different for each species studied. The colour of the sheath, the nature and arrangement of spines and the presence or absence of knee are species specific. The leaf length also varies from 45 cm in *C. travancoricus* to 3 m in *C. thwaitesii*. In some species leaflets are grouped together (*C. thwaitesii* and *C. travancoricus*) while in others they are regularly arranged. *C. vattayila* is the only species in Kerala having oblong leaflets with 6 veins. All other have linear-lanceolate leaves with 1-3 veins. Hence the key prepared based on these vegetative characters help in the field identification of canes with remarkable accuracy.

The physical characteristic which can be used in the identification is the diameter of the cane.

The anatomical description, given for each species, indicates that there is no appreciable difference in the epidermis among the species studied. Nevertheless, certain minor variations do exist in size and shape of epidermal cells and their lumens (Plate XX, Figs. 1-2; Plate XXI, Figs. 1-4). These differences with the combination of other characteristics can be used to some extent to distinguish *Calamus* species growing in Kerala. Similarly, Siripatanadilok (1983) suggested that lumen shape and siliceous layer (outside epidermis) can be used along with other characteristics to separate some cane species of Thailand.

Hypodermis is often distinct in some species as observed in *C. gamblei*, *C. hookerianus*, *C. metzianus*, *C. pseudotenius*, *C. rotang*, *C. travancoricus* and *C. vattayila* (Plate XX, Figs. 1-2; Plate XXI, Figs. 1-4). The uniseriate or unihypodermal layer may also offer additional clues for identification.

Another useful diagnostic feature in palm species is the type or shape of silica bodies (Parthasarathy and Klotz, 1976). All the species observed in this study have almost the same type of spherical silica bodies with rough surface (Plate XX1, Figs. 5-6) and hence they are of little significance in the identification of canes of Kerala. However, the size of silica grains may vary from species to species and hence the diameter range is given for each species in anatomical description.

Cell size is often important in the identification. The wide metaxylem has the maximum diameter of 420mm in thickest cane (*C. thwaitesii*) and 200mm in slender most cane (*c. travancoricus*). However, the diameter of metaxylem is not correlated with stem diameter among the species. On the other hand, it increases with a raise in stem height of the species, the correlation coefficient being as high as 0.937. This observation supports the hypothesis that the widest vessels occur in species with longest stems in order to maintain the conduction efficiency for greater heights from the ground level (Klotz, 1978a). Obviously, in practice, once the stem is cut, it is not easy to identify the species based on diameter of wide metaxylem. The perforation plates also do not seem to offer diagnostic clues due to the fact that several types of perforations such as reticulate, scalariform and simple exist even within the individual species (Plate XXII, figs. 1 & 3). Rarely, reticulate perforation plates are found in the wide metaxylem vessels of *C. pseudotenius* (Plate XXII, Fig. 2). The observation disagrees with the statement made by Klotz (1978b) that the lepidocaryoid lianas have only simple perforations.

Finally, the use of metaphloem characters for diagnostic purposes seems to be possible only to a limited degree as the sieve tubes mostly have simple sieve plates as observed by Parthasarathy (1968).

Thus it is evident that with the help of anatomical characters alone the identification of cane is not possible upto species level. Beccari (1918) and Tomlinson (1961) also conclude in earlier studies that it is difficult to trace any clear cut divisions that are based entirely on anatomical evidence not only within the genus *Calamus* but also within the group of lepidocaryoid palms. Nevertheless, with the possible combination of several physical and anatomical characters, canes can be identified upto species level. Such a key based on the present observation also is prepared.

From the present study it is clear that stem height, diameter, internodal length and specific gravity are not consistently related to each other (Table 4). There is significant within and between stem variation in diameter, internode

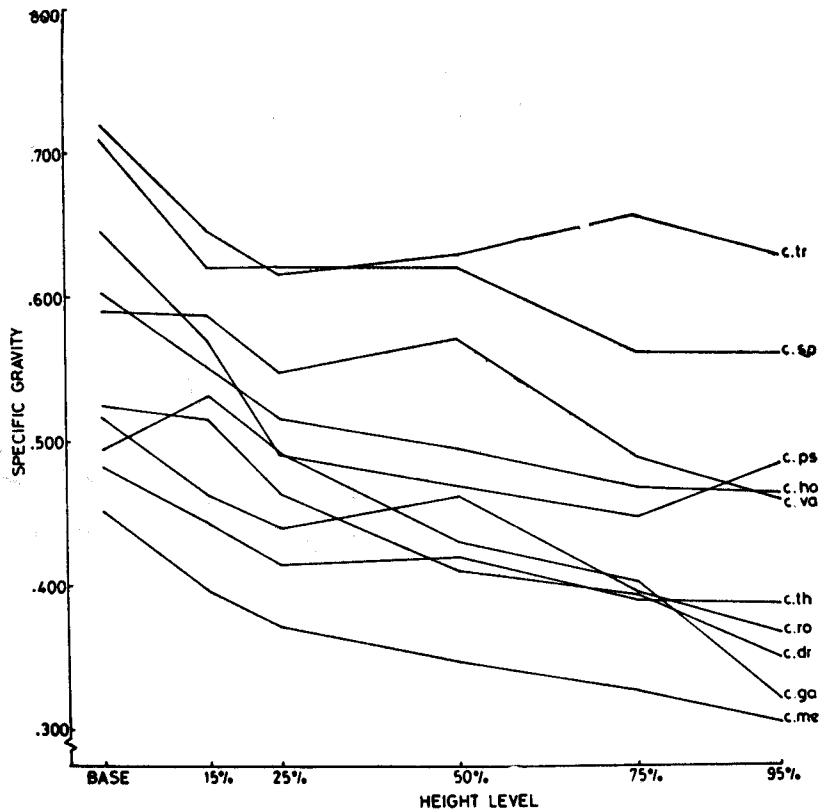


PLATE XIX

Fig. 1. Average specific gravity along the stem at different height levels. C. dr — *Calamus dransfieldii*, C. ga — *C. gamblei*, C. ho — *C. hookertanus*, C. me — *C. metzianus*, C. ps — *C. pseudotenius*, C. ro — *C. rotang*, C. sp — *Calamus sp.*, C. th — *C. thwaitesii*, C. tr — *C. travancoricus*, C. va — *C. Vattayila*.

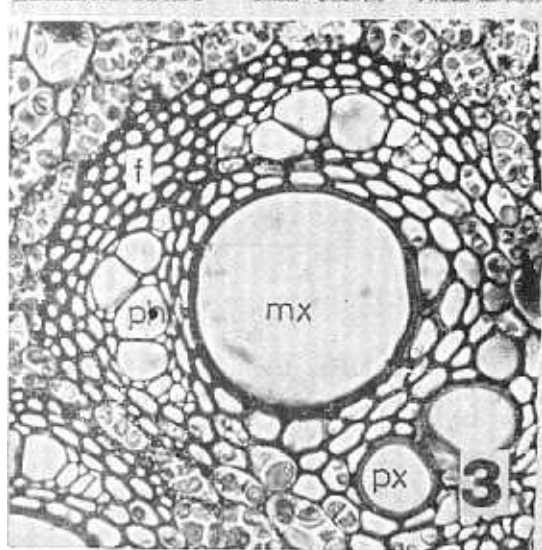
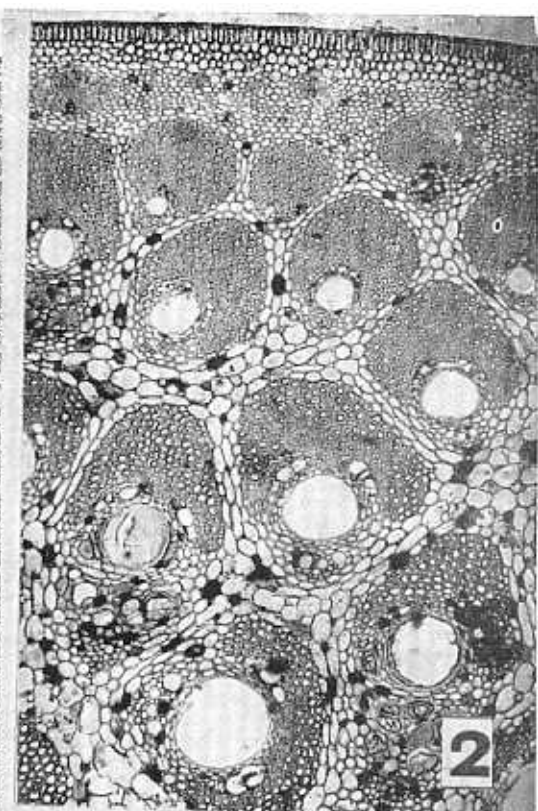
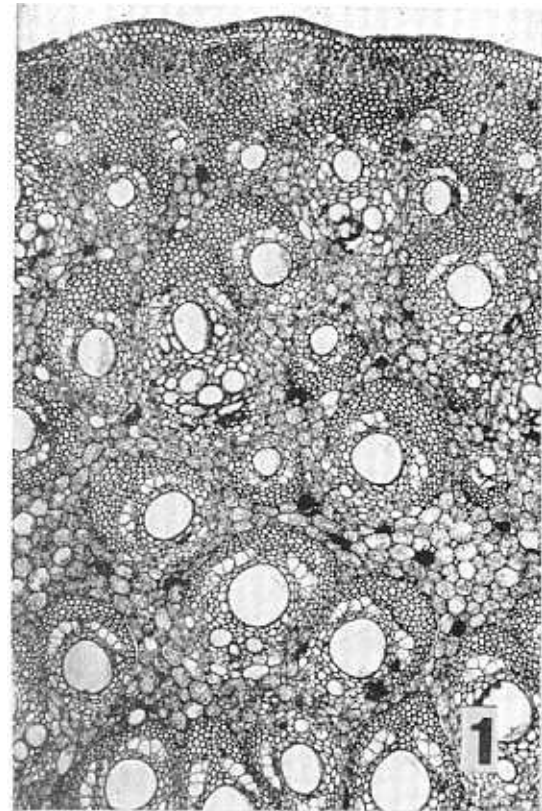


PLATE XX

Fig. 1. X20. *C. travancoricus*. T. S. of stem. Note the epidermal cell with oval lumen; narrow cortex & ground parenchyma with abundant starch grains.

Fig. 2. X14. *C. metzianus*. T. S. of stem.

Fig. 3. X80. *C. travancoricus*. Single vascular bundle.

ph — phloem strands px — protoxylem mx — metaxylem f — fibrous sheath

Fig. 4. X128. *C. gamblei*. Individual mucilage canal.

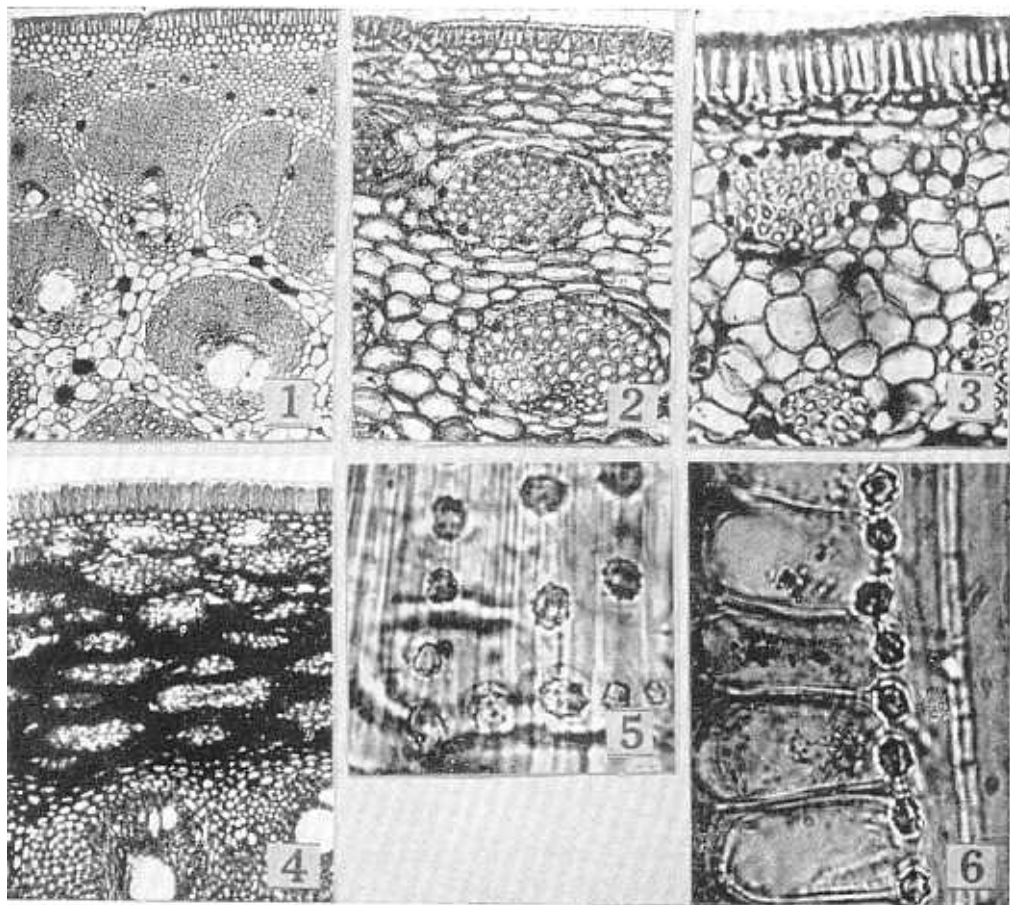


PLATE XXI

- Fig. 1. X14. *C. metzianus*. T. S. of stem. Note sunken stomata (Arrow) and columnar epidermal cells with oblong lumen.
- Fig. 2. X36. *C. thwaitesii*. T. S. Stem. Epidermal cells with oblong lumen and fibre bundles in the wide cortex.
- Fig. 3. X42. *C. hookerianus*. T. S. of stem. Distinctly columnar epidermal cells, fibre bundles in the wide cortex.
- Fig. 4. X22. *C. vattayila*. T. S. of stem. Epidermal cells with oblong lumen, cortex with numerous fibre bundles.
- Fig. 5. X160. *C. hookerianus*. L. S. of stem showing silica bodies.
- Fig. 6. X160. *C. metzianus*. L. S. of stem showing silica bodies associated with the outermost layer of fibrous sheath of the vascular bundle.



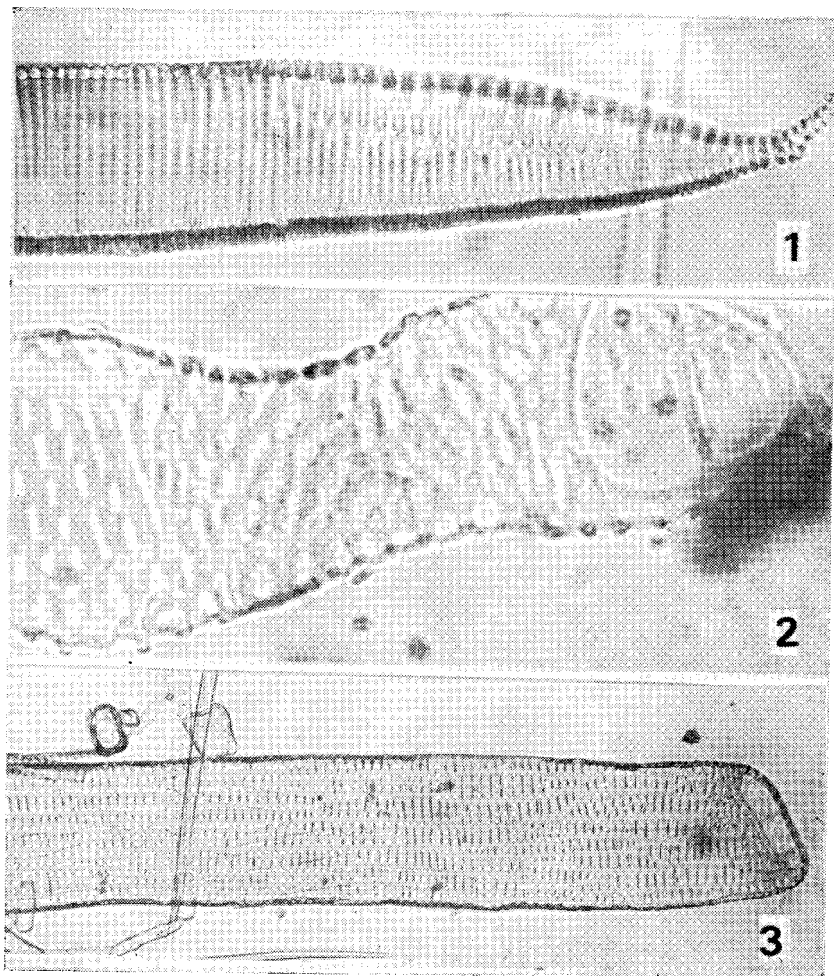


PLATE XXII

- Fig. 1. X61 *C. thwaitesii*. Scalariform perforation plate of protoxylem.  
 Fig. 2. X15 *C. pseudotenuis*. Reticulate perforation plate of wide metaxylem.  
 Fig. 3. X18 *C. thwaitesii*. Simple perforation plate of wide metaxylem.

**Table 4. Correlation coefficients for the interrelationships among selected characteristics**

<b>Species</b>	<b>Stem height vs mean diameter</b>	<b>Stem height vs mean specific gravity</b>	<b>Mean diameter vs Mean specific gravity</b>	<b>Internode length vs Diameter</b>	<b>Stem height vs Mean Internode length</b>
<i>C. dransfieldii</i>	0.413 <sup>ns</sup>	0.440 <sup>ns</sup>	-0.007 <sup>ns</sup>	0.174 <sup>ns</sup>	-0.350 <sup>ns</sup>
<i>C. gamblei</i>	0.185 <sup>ns</sup>	0.537 <sup>ns</sup>	0.140 <sup>ns</sup>	-- 0.737 <sup>**</sup>	0.142 <sup>ns</sup>
<i>C. hookerianus</i>	0.351 <sup>*</sup>	-0.405 <sup>*</sup>	-0.177 <sup>ns</sup>	-0.534 <sup>**</sup>	0.666 <sup>**</sup>
<i>C. metzianus</i>	0.306 <sup>ns</sup>	0.772 <sup>*</sup>	0.202 <sup>ns</sup>	-0.416 <sup>**</sup>	-0.806 <sup>**</sup>
<i>C. pseudotenuis</i>	0.019 <sup>ns</sup>	-0.005 <sup>ns</sup>	-0.551 <sup>ns</sup>	-0.474 <sup>**</sup>	0.452 <sup>ns</sup>
<i>C. rotang</i>	0.187 <sup>ns</sup>	-0.091 <sup>ns</sup>	-0.693 <sup>*</sup>	0.233 <sup>ns</sup>	-0.264 <sup>ns</sup>
<i>Calamus sp.</i>	-0.630 <sup>**</sup>	-0.275 <sup>ns</sup>	-0.246 <sup>ns</sup>	-0.536 <sup>**</sup>	0.655 <sup>**</sup>
<i>C. thwaitesii</i>	0.048 <sup>ns</sup>	0.544 <sup>*</sup>	0.137 <sup>ns</sup>	-0.180 <sup>ns</sup>	0.100 <sup>ns</sup>
<i>C. travancoricus</i>	0.181 <sup>ns</sup>	-0.418 <sup>ns</sup>	-0.225 <sup>ns</sup>	-0.138 <sup>ns</sup>	0.236 <sup>ns</sup>
<i>C. vattayilu</i>	0.418 <sup>ns</sup>	0.021 <sup>ns</sup>	-0.339 <sup>ns</sup>	0.642 <sup>**</sup>	0.658 <sup>*</sup>

\*1 significant at 1% level

• significant at 5% level

<sup>ns</sup> Not significant

length and specific gravity (Table 3). Both stem diameter and specific gravity decrease sharply from the lowest internode to 15% of the stem height and then more slowly towards the top of the stem while internode length increases initially from bottom to 15% or 25% of the stem height and then decreases gradually towards the top.

The highest specific gravity in the lowest internode indicates that the bottom portion is strong and rigid, (Badhwar *et al.*, 1961). Similarly, low specific gravity at the top is indicative of weak top portion which is not suitable for the purpose where strength and pliability are required. The middle portion, with modest specific gravity, appears to have good utilization potential for general purpose.

The present study reveals that with the increase in the trade of canes, large scale depletion of resource is apparent in the state. Thus at present the canes are restricted largely to inaccessible areas. Absence of once recorded *C. brandisii*, *C. huegelianus* and *C. rheedii* in Kerala forests indicates exploitation has depleted even the genetic resources. Therefore domestication trials of our indigenous species are to be initiated. In conducting the domestication trials, care should be taken to study the ecological adaptability of the species. Most species of canes prefer the habitat of a cool evergreen forest. However, *C. dransfieldii*, *C. metzianus* and *C. thwsitesii* are also found to inhabit semi evergreen and deciduous forests. Species like *C. pseudotenuis* and *C. gamblei* prefer elevations from 700 m above M S L upwards while all others are seen below 900m above M S L.

Raising plantations require stocking material in large scale. Seed is the best source of propagation. But field observation indicates that to a certain extent availability of seeds in large scale has a bearing on phenology. *Calamus* which is dioecious flowers annually. Besides, there are other factors such as extraction of canes before flowering and shrinking and destruction of natural habitat of canes, which directly affect the seed source. Hence vegetative propagation by suitable methods also are to be evolved. In *C. hookerianus* and *C. gamblei* axillary shoot development and root development from the distal nodes are reported (Renuka and Nambiar, 1985).

As domestication of canes is yet to begin, the stocking materials and genetic resources for future plantations and experiments should derive from naturally growing stocks. Therefore conservation of the fast depleting genetic base is an urgent need. There is every possibility of *C. rheedii* being extinct. After 1904 this species could not be relocated. *C. brandisii* and *C. huegelianus*

also seem to be absent in the Kerala forests. *C. dransfieldii*, *C. metzianus*, *C. travancoricus* and *C. vattayila* are really endangered species. *C. dransfieldii* is endemic and seed setting is very rare, More over, this is a solitary climber with no suckering habit. Hence the following conservation methods are recommended.

Conservation of the forest surrounding Shankili-Ponmudi road in Kulathupuzha range itself will save five species of canes. Likewise the canes in Chittar valley in Achenkovil and Goodrical range in Ranni forest division also should be protected. Each area is having four species of canes. The protection of the cane research plots of *C. thwaitesii* and *C. pseudotenius* in Achenkovil and Peermedu respectively under the Silvicultural Research wing of the State Forest Department should continue. In the natural habitat of *C. dransfieldii* and *C. metzianus* viz. Dhoni forests of Palghat and Thalamkolli in Nilambur, human interferences are more and hence it is better to cultivate these two species in a suitable protected area. Both these species will grow in moist deciduous conditions.

## REFERENCES

- Badhwar, R. L., Dey, A. C., Ramaswami, S. and Sethi, S. 1961. Collection and processing of canes. *Indian For.*, 87: 257-261.
- Basu, S. K. 1985. The present status of rattan palms in India - An overview. In: K. M. Wong & N. Manokaran (Eds.), *Proceedings of the Rattan seminar*, 2-4 Oct. 1984. pp. 77-94. Kuala Lumpur. The Rattan Information Centre, Malaysia.
- Beccari, O. 1908. Asiatic palms. *Lepidocaryeae*. pt. 1. The species of *Calamus*. *Ann. Roy. Bot. Gard. Calcutta*, 11 : 1-518. Pl. 1-11, 1-238.
- Beccari, O. 1918. Asiatic palms - *Lepidocaryeae*. Part 111. The species of the genera *Ceratolobus*, *Calospatha*, *Plectocomia*, *Plectocomiopsis*, *Myrialepis*, *Zalacca*, *Pigafetta*, *Korthalsia*, *Metroxylon*, *Eugeissona*. *Ann. Roy. Bot. Gard. Calcutta*, 12(2): 1-231.
- Beccari, O. and Hooker, J. D. 1892. 1893. *Palmae*. In Hooker, J. D. *Fl. Brit. India*. 6 : 402-483. (Repr. 1973), M/s. Bishen Singh Mahendra Pal Singh and Periodical experts, Delhi.
- Caius, J. F. 1935. The medicinal and poisonous palms of India. *J. Bombay Nat. Hist. Soc.* 37 : 917-941.
- Dransfield, J. 1979. A manual of the rattans of the Malay Peninsula. Forest Department, Ministry of Primary Industries. Malaysia.

- Dransfield, J. 1981. The biology of Asiatic rattans in relation to the rattan trade and conservation, *In*: H. Synge (Ed.), The Biological aspects of rare plant conservation. pp. 179-186. John Wiley & Sons Ltd., London.
- Fernandez, R. R. and Dey, A. C. 1970. A new species of *Calamus* from Western Ghats. *Indian For.*, 96 :223-225.
- Fischer, C. E. C. 1931. Family Palmaceae. *In* Gamble, J. S. and Fischer, C. E. C. Flora of the Presidency of Madras (Repr. 1957), Botanical Survey of India, Calcutta.
- Franklin, G. L. 1946. A rapid method of softening wood for microtome sectioning. *Trop. Woods*, 88 :35-36.
- Hartwell, J. L. 1970. Plants used against cancer. *Lloydia*, 33 :315-318.
- Kirtikar, K. R. and Basu, B. D. 1935. *Indian Medicinal Plants*. 4 v. M/s. Periodical experts, Delhi .
- Klotz, L. H. 1978a. Observations on diameters of vessels in stems of palms. *Principes*, 22 :99-106.
- Klotz, L. H. 1978b. Form of perforation plates in the wide vessels of metaxylem in palms. *J. Arnol. Arbor.*, 59 :105-128.
- Parthasarathy, M. V. 1968. Observations on the metaphloem in the vegetative parts of palms. *Amer. J. Bot.*, 55: 1140-1168.
- Parthasarathy, M. V. and Klotz, L. H. 1976. Palm "wood". I. Anatomical aspects. *Wood Sci. Technol.*, 10 : 215-229.
- Renuka, C. and Nambiar, V. P. K. 1985. Axillary shoot development in the aerial stem of *Calamus*. *Principes*, 29 : 160-161.
- Sharma, M. & Rao, K. R. 1970. Investigations on the occurrence of silica in Indian timbers. *Indian For.*, 96 : 740-754.
- Siripatanadilok, S. 1983. Characteristics of epidermal cells in relation to taxonomy and quality of rattan canes. *RIC Bull.*, 2:3-1.
- Tomlinson, P. B. 1961. *Anatomy of Monocotyledons I I Palmae*. Press, Oxford. 453p.