

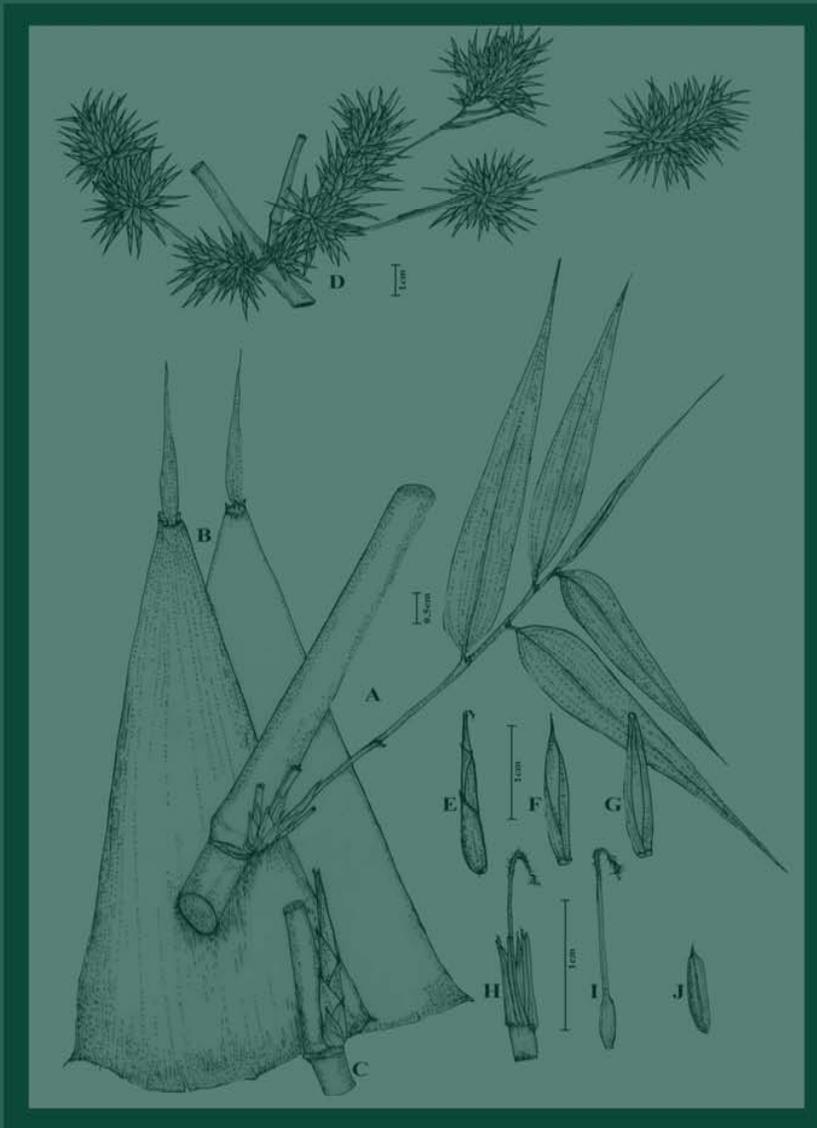
**ALL INDIA COORDINATED PROJECT ON TAXONOMY  
(AICOPTAX)**

**GRASSES & BAMBOOS**

(Part-II)

**BAMBOOS OF PENINSULAR INDIA**

**M.S. Muktesh Kumar**



**KERALA FOREST RESEARCH INSTITUTE**  
(An Institution of Kerala State Council for Science, Technology and Environment)  
Peechi, 680 653, Kerala

June 2011

ALL INDIA COORDINATED PROJECT ON TAXONOMY (AICOPTAX)

**GRASSES & BAMBOOS**

PROJECT COMPLETION REPORT  
(April 2000- March 2011)

**BAMBOOS OF PENINSULAR INDIA**

**Part-II**

**M.S. MUKTESH KUMAR**

Forest Botany Department  
Forest Ecology & Biodiversity Conservation Division



**Collaborating Unit**

Kerala Forest Research Institute

(An Institution of Kerala State Council for Science, Technology &  
Environment)

Peechi-680 6753. Thrissur District,  
Kerala, INDIA



**Co-ordinator**

DR. V. J. NAIR

Scientist Emeritus

Botanical Survey of India, Southern Regional Centre,  
Lawly Road, TNAU Campus, Coimbatore,  
TAMIL NADU

**Sponsored by**



Ministry of Environment & Forests

NEW DELHI

KFRI Research Report No. **399**

ISSN0970-8103

Taxonomy of Bamboos

Bamboos of Peninsular India

Final report of the Research Project No. KFRI 358/2000

Part -II

M.S. Muktesh Kumar  
Forest Botany Department  
Forest Ecology and Biodiversity Conservation Division



Kerala Forest Research Institute

(An Institution of Kerala State Council for Science, Technology and Environment)

Peechi 680 653, Kerala

**June 2011**

## CONTENTS

Project proposal.....	i
Acknowledgements.....	ii
Abstract.....	iv
Introduction.....	1
Materials and methods.....	15
Results and discussion.....	19
Systematic treatment.....	22
References.....	133

## **Project Proposal**

Project Title : Taxonomy Capacity Building Project on Bamboos

All India Co-ordinator : Dr. V.J. Nair  
Emeritus Scientist  
Botanical Survey of India (Southern Regional Centre, Coimbatore)

Collaborating Institute : Kerala Forest Research Institute

Principal Investigator : Dr. M.S. Muktesh Kumar  
Forest Botany Department  
Forest Ecology and Biodiversity Conservation Division

### Objectives:

- Survey, collection, identification and preservation
- Maintain collection and taxonomic data bank
- Develop identification manual
- Train college teachers and students and local communities in para taxonomy

Project Period : 2000-2011

Budget : 26.41 Lakhs

Funding Agency : Ministry of Environment & Forests  
Govt. of India, New Delhi

## Acknowledgements

The author wishes to acknowledge Dr. J. K. Sharma, Dr. R. Ganaharan, former Directors and Dr. K.V. Sankaran, present Director, Kerala Forest Research Institute, Peechi and also Dr. K. Swarupanandan, Research Co-ordinator, for their keen interest, encouragement and facilities provided during the study. I wish to thank the Directors and Curators of different Indian herbaria, like, Central National Herbarium, Kolkata (CAL); Forest Research Institute Herbarium, Dehra Dun (DD); BSI Southern Circle Coimbatore (MH); BSI Western Circle Pune (BSI); Sikkim Himalayan Circle, Gangtok (BHC); Northern Circle, Dehra Dun (BSD); Calicut University (CALI) for permitting me to study and critically examine all the required herbarium specimens deposited in the respective herbaria. I express my sincere thanks and gratitude to The PCCFs of Andhra Pradesh, Kerala, Karnataka, and Tamil Nadu respectively, for all the help rendered and for the permission and organizing of our field trip during the study. Thanks are also due the Forest Department officials, who had taken lot of pains for accompanying during the field trips and for their help during the field work. I whole-heartedly thank Dr. M. Sanjappa, Director, BSI, Central National Herbarium, Kolkata; Dr. P. Daniel, Deputy Director, BSI Southern Circle, Coimbatore; Dr. Lakshmy Narasimham, Deputy Director, BSI Western Circle, Pune; Dr. V.P. Prasad, BSI Western Circle, Pune; Dr. S.M.R Almeida, Blatter Herbarium, Bombay; Dr. Sas Biswas and S.S.Jain, Systematic Botany Division, F R I, Dehra Dun, for permitting me to visit the herbaria and library. My sincere gratitude goes to Mr. Babumani of Wildlife Institute, Dehra Dun, for the valuable help during my visit to FRI. Dr. T. Pullaiah, Professor and Head, Department of Botany, Sri Krishnadevaraya University, Anathapur; Dr. M. Janarthanam, Department of Botany, Goa University; Dr. Subharengaiyah, Department of Botany, Andhra University spent their very valuable time to help me during the field visits. I express my profound sense of gratitude to Dr. K.M. Matthew, Rapinet Herbarium, St. Josephs College, Trichy for his expert opinions given to me during the study. The help rendered by the directors and curators of different International herbaria like Kew (K), Paris (P), Edinburgh (E) and Bogor (BO) for the Cibachrome sheets received from them is also gratefully acknowledged. Sincere thanks are due to Dr. J.F. Veldkamp, National Herbarium, Universiteit Leiden, Nederland and Dr. Dan H. Nicolson, Smithsonian, Institution, Washington, USA, for providing their expert comments and clarification with regards to certain bamboo species during the study. I am thankful to the Ministry of Environment and Forests, Government of India, New Delhi, for

the financial support to the study. Thanks are due to Dr. V. J. Nair, Co-ordinator of the AICOPTAX project on Grasses and Bamboos, for the encouragement given to me. The hard work done by Dr. M. Remesh, Mr. A. J. Robi, Mr. C. Sathish and Mr. R. R. Rakesh, Research Fellows, during the study is highly appreciated. The help rendered by Mr. Jay Jay Jacob, Technical Assistant, is gratefully acknowledged. The author also wishes to thank the members of the editorial committee for their critical and valuable comments for the improvement of the manuscript.

## ABSTRACT

In Peninsular India, Bambusoideae is represented by 22 species and two varieties under seven genera. *Ochlandra* Thwaites is the dominant genus of South India comprising eleven species and one variety so far reported from South India and widely distributed. In the present report the species *Ochlandra travancorica* var. *hirsuta* Gamble, *O. sivagiriana* (Gamble) Camus and *O. soderstromiana* Muktesh & Stephen are synonymised under *O. travancorica* (Bedd.) Benth. The following species namely, *Ochlandra beddomei*, *O. scriptoria*, *O. travancorica* and *O. wightii* are typified. Critical and detailed study revealed that true monadelphous condition does not exist in the genus *Ochlandra*. Based on the affinities, the species under the genus *Ochlandra* are grouped as Travancorica group and Scriptoria group. A new combination under the genus *Dendrocalamus* is proposed. A species from the genus *Oxytenanthera* is transferred to the genus *Dendrocalamus*. The species *Dendrocalamus strictus* was typified. After a detailed study, the variety *Bambusa bambos* var. *gigantea* is treated as a synonym of *Bambusa bambos*. In the present study, the genus name *Oxytenanthera* is retained. The spelling in the specific epithet of *O. bourdillonii* and *O. ritchiei* are corrected and *O. bourdillonii* typified. The genus *Arundinaria* in South India previously treated under *Sinarundinaria* has been reverted to the genus *Arundinaria* and *A. wightiana* is typified. *Teinostachyum wightii* was previously treated under the genus *Schizostachyum* as *S. beddomei*. The basionym *Teinostachyum wightii* is accepted and typified in the present study.

According to the present study, there are 22 native species of bamboos in South India. Out of the 22 species, 20 are distributed in Kerala, 6 in Karnataka, 5 in Tamil Nadu and 2 in Andhra Pradesh. Among these, 13 species are endemic to this phytogeographic region. In the Southern Western Ghats bamboos form a major component of the biodiversity. They show a high degree of endemism and most of the species have a restricted distribution. Recently, some of the so far known endemic species are found distributed in Sri Lanka. This gives an indication of the affinities of the Sri Lankan flora with the flora of South India.

## INTRODUCTION

The importance of floristic studies and role of taxonomy in identification of a species hardly need any justification. For proper utilization of plant resources and their effective conservation, it is always essential to have floristic inventories of all types of plants from different parts of the country. This becomes imperative particularly after the Convention of Biological Diversity (CBD), which emphasizes to document a whole range of organismic diversity, to make all efforts to conserve these bioresources and monitor the efficacy of conservation measures adopted. CBD aims at conservation, sustainable use and fair and equitable benefits arising from utilization of the genetic resources of biodiversity. To achieve these objectives, there is an unequivocal need for taxonomic information. It has been found that there is an inadequacy of coverage of taxonomic groups. Comparison of distribution of expertise with that of collections and with the number of species in different types of fauna and flora shows that there are only a few taxonomists to adequately handle the less studied group of organisms and other specialised groups.

Therefore, to bridge this gap, both in terms of our knowledge on the diversity and distribution of bamboos and grasses in the country and to develop capacity building in taxonomy of these groups where a few specialists alone are available an All India Coordinated Project on Taxonomy (AICOPTAX) was initiated under the aegis of Ministry of Environment and Forests, New Delhi (MoEF) in the year 2000. A coordinating unit at Botanical Survey of India (BSI), Southern Circle, Coimbatore, under the able leadership of Dr. V.J. Nair, Emeritus Scientist, BSI, to work on bamboos and grasses and two collaborating units, one at Botanical Survey of India, Kolkata under the leadership of Dr. Paramjit Singh to work on bamboos of North East India and another unit at Kerala Forest Research Institute, Peechi, Kerala, under the leadership of the author to work on bamboos of Peninsular India were identified.

The main objectives of the project were:

Survey, collection, identification and preservation of bamboos .

Training research fellows and college teachers and capacity building in the field of bamboo taxonomy.

Maintain collection and taxonomic data banks.

Develop identification manuals.

Bamboos belong to the natural group Poaceae under the subfamily Bambusoideae. They are distributed mainly in the tropical and subtropical regions of the world. Although, bamboos are known as 'tree grass', certain bambusoid characters set them off from other grasses (McClure, 1966). A well developed rhizome system, woody culms bearing the branch complements, petioles of the leaf-blade, the culm-sheaths covering the new shoots and buds, presence of lodicules, flowering and seeding behaviour are some of the most important morphological characters that make this group distinct from other grasses.

Bamboos are considered as one of the most difficult group among plants, for taxonomical study. It is mainly due to the non-availability of flowers and fruits, since most bamboo species flower only at irregular long intervals and often die soon after. The flowering in bamboos is unpredictable. Most of the bamboos flower only once in their lifetime and the life span varies from 7-120 years (Janzen, 1976; Dransfield and Widjaja, 1995). It is also observed that some species of bamboos remain sterile. However, some of the vegetative characters such as the culm sheath, bud, well-developed branch complements, help in identifying the species. Therefore, most of these vegetative characters that are mostly species specific are used for generic and specific delimitations (Gamble, 1896; Brandis, 1899; Raizada and Chatterjee, 1963; McClure, 1966).

## GENERAL MORPHOLOGY

### Habit

Morphologically, bamboos differ from other members of the grass family with the tree-like habit, well-developed rhizome system, woody and hollow culms, branching pattern, petiolate leaves and specialised sheathing organs.

Bamboos exhibit basically three types of habits. Culms caespitose or closely packed, culms loosely arranged and culms scattered. The caespitose habit develops from short-necked pachymorph rhizomes and loosely arranged habit from pachymorph long-necked rhizomes. Culms with scattered habit arise from a leptomorph rhizome. The culms may be erect, erect and with pendulous tips, arching, or occasionally scandent.

All species of the genus *Arundinaria* are shrubby with closely packed culms. In the genera *Bambusa bambos* and *Dendrocalamus strictus* culms are closely packed.

Culms are arching in *Oxytenanthera monadelphica* and *Teinostachyum wightii*. In *Munrochloa ritchiei* and *Oxytenanthera bourdillonii* culms arise from long-necked pachymorph rhizomes. All species under the genus *Ochlandra* possess closely packed, caespitose culms.

### **Rhizome**

The rhizome system is well developed. It is subterranean and highly branched. The individual axes of the rhizome system are referred as rhizome segments. Each individual branch or axis of the rhizome system is known as a rhizome.

The rhizome consists of two parts, the rhizome neck and the rhizome proper. The rhizome neck may be short or sometimes elongated. Basically, there are two types of rhizomes. They are determinate and indeterminate or sympodial and monopodial. The determinate rhizome is called Pachymorph rhizome and indeterminate rhizome is known as Leptomorph rhizome (Figure 1).

### **Pachymorph or sympodial rhizome**

These are short, thick, curved and subfusiform structures. The internodes are broader than long, solid and lateral buds solitary. Roots arise from the lower side. The apical portion of a pachymorph rhizome always ends in a culm. The lateral buds develop only as rhizomes. Based on the length of the rhizome neck, pachymorph rhizomes belong to two categories, short-necked and long-necked. The bamboos having short-necked pachymorph rhizomes show a caespitose clump habit and in bamboos with long-necked pachymorph rhizomes the culms grow in a diffuse manner (Figure 2).

### **Leptomorph or monopodial rhizome**

This type of rhizome exhibits basically a monopodial branching pattern. The rhizome is long and slender, diameter is usually less than the culms originating from it (Figure 2). The rhizome may be cylindrical, or subcylindrical, the internodes are longer than broad, relatively uniform in length, typically hollow, rarely solid, the central lumen is separated into compartments by a cross wall at each node and the lateral buds, boat shaped. The culms develop from the lateral buds. Some of the lateral buds give rise to rhizomes.

A single ring of roots arise at the nodal region. The leptomorph rhizomes show different branching pattern. Majority of tropical bamboos have pachymorph rhizomes. In genera such as *Bambusa*, *Dendrocalamus*, all species of *Arundinaria*, *Ochlandra* and

*oxytenanthera* have pachymorph rhizome. The culms developed from long-necked pachymorph rhizomes resemble leptomorph rhizomes. They show an open diffuse clump habit as in *Melocanna baccifera*.

### **Young shoot**

Young shoot is the new aerial stem arising from the apical bud of a pachymorph rhizome, or from the lateral bud of a leptomorph rhizome. The young shoot consists of short, soft internodes protected by numerous overlapping rigid culm-sheaths, attached to the alternate sides of the successive nodes. Each shoot has a highly condensed series of nodes that subsequently elongate rapidly to develop as a mature culm. The morphology of the young shoots help in species identification. During the elongation of the internodes of the culm shoots, the culm -sheaths become prominent (Figure 1).

### **Culm-sheath**

The culm-sheaths are modified leaves that cover and protect the developing internodes of the young shoots and young culms. They fall off at culm maturity or sometimes are persistent. Culm-sheath consists of an expanded sheath, a narrow blade and a ligule. Auricles and oral setae may or may not be present. The auricles when developed are typically lobe-like or rim-like structures occurring on each side of the base of the culm-sheath blade. Ligule is present on the inner side of the sheath, where the blade joins. In some species, outer ligule may also be present. The culm-sheath blade is highly variable in size, position and morphology. It can be erect, spreading, or reflexed. In some species the blade is triangular, or dome shaped as in the genus *Bambusa*. In some cases, it is inflated, lanceolate, or narrowly linear. It may be persistent or deciduous (Figure 1).

Morphology of the culm-sheaths is species specific and therefore, is used in the identification of bamboos at the level of a species (Chatterjee and Raizada, 1963). The culm-sheath at the 5<sup>th</sup> node of the culm is considered as the one which has all the characters, typical of the species.

### **Culms**

The culms are produced apically in pachymorph rhizomes and as lateral branches in leptomorph rhizomes. The culms vary from erect, erect with drooping or pendulous tips, broadly arched, scrambling, climbing and to strongly zigzag. Culms are segmented and the nodes and internodes are distinct (Figure 1). Most of the culms are cylindrical and hollow. In some cases the culms are almost solid or completely solid.

In *Dendrocalamus strictus* the culms are solid or with a very narrow lumen. The culms are solid in *Munrochloa ritchiei*.

### **Nodes**

The culm sheath arises from the nodal region. It encloses a branch bud. The lowest portion of the node has the nodal line or a sheath scar formed as a result of fall of culm- sheath. In certain species the supra nodal ridge is prominent.

The bud is usually inserted just above the nodal line. In some bamboos down curved root-thorns develop at their lower and basal nodes. Eg. *Chimonocalamus lushaiensis*, *Chimonobambusa quadrangularis*. In *Bambusa vulgaris*, *Dendrocalamus asper*, *D. giganteus* and *D. strictus* verticels of normal roots are formed at the lower culm-nodes.

Generally, the internodes are cylindrical. In *Chimonobambusa quadrangularis* the internodes are quadrangular. In *Bambusa vulgaris* var. *wamin* the internodes are short and swollen. In *B. vulgaris* var. *striata*, the culms are yellow-streaked, green or occasionally pale yellow. In species such as *Bambusa bambos* and *Oxytenanthera bourdillonii* the internodal region is covered with a white powdery mass or wax. In *Munrochloa ritchiei* the internodes are thickly covered with golden yellow tomentum.

### **Prophyll**

It is a sheath, which occurs at the base of the node of each vegetative branch, representing the first leaf of that branch (Figure 1). It is a one or two-keeled structure, which encloses and protects the branch primordia. The back of the prophyll closely adheres to the axis from which the branch emerges. The margins of the prophyll cover the branch primordia. The morphology of the prophyll varies in different species and therefore, is considered taxonomically very important.

### **Branches**

After the attainment of full height, the lateral buds of the culm begin to grow and develop into branches (Figure 1). The buds at the lower nodes usually remain dormant. But, in *Bambusa bambos* and *Dendrocalamus strictus* the branches develop from the basal culm-nodes. In *Bambusa bambos* these branches form a thicket around the base of the culm and are spiny. In *Dendrocalamus strictus* the branches are without spines. In many other genera the primary branch emerges and remains strongly dominant. Other branches develop from its basal buds but do not attain the size of the primary branch as found in

*Bambusa bambos* and in certain species of *Ochlandra*. In certain species of *Arundinaria* there is a central branch with two secondary branches arising almost simultaneously. All these three branches produce a cluster of many subequal branches, Eg. *Arundinaria densifolia* and *A. floribunda*. In *Oxytenanthera monadelphica* the secondary axis originates earlier to the primary one and produces clusters of short branches. The primary axis remains dormant in bud stage and later produces a new culm, or long, whip-like branch.

In *Schizostachyum*, a dense cluster of subequal branches arises at each node which develops from a single primary branch axis at the node. In *Phyllostachys* there is just one primary branch bud at a node, which produces a single secondary branch at its base. Sometimes a third small branch may also develop from the base of secondary branch.

### **Leaves**

Leaves consist of basically two parts, the leaf-sheath and the leaf-blade. The leaves have a relatively small sheath and an expanded, well-developed leaf-blade (Figure 1). The sheaths are attached at the nodal region and wrapped around the branch. They support the leaf blade. On the outer surface of the sheath, veins are distinct. The inner surface is smooth and shining. They may be persistent, or deciduous. The sheaths also bear outer and inner ligules. They are present at the region of attachment of the petiole and the sheath. The outer ligule is usually inconspicuous. The inner ligule is a short extension of the adaxial surface in the central part of the sheath apex. The ligules vary in size from small to large as in *Ochlandra wightii*. The leaf-sheaths bear auricles and bristles. The auricles and bristles are prominent in younger leaves. Leaf-blade is petiolate and is dorsiventral. The size of the leaf varies from species to species. Venation of the leaves is parallel and veins of three orders namely the midrib, secondary veins and tertiary veins are present. In certain genera, the adjacent veins are connected by transverse distinct veinlets. This pattern is called tessellate venation as in the leaves of *Arundinaria*. In most of the tropical bamboos the leaf-blades are deciduous as in *Bambusa bambos* and *Dendrocalamus strictus*. The margins of the leaf are scabrous. In some species the leaf lamina may be hirsute on one side or on both sides.

### **Inflorescence**

Inflorescence consists of numerous flowers in an aggregation of spikelets. It may appear on leafy branches or as large panicles covering the whole culm. Four basic types are recognised. They are the spicate, racemose, paniculate and capitate.

In spicate inflorescence the stalk of the spikelet is highly reduced or absent. Racemose inflorescence has spikelets with stalks. In paniculate inflorescence the spikelet is stalked and shows more than one order of branching. The capitate inflorescence is similar to paniculate inflorescence, but the internodes are very short and have a dense, globose appearance (Figure 1).

In the genus *Ochlandra* the inflorescence is a large compound, spicate panicle with semiverticillate clusters of spikelets. In *Bambusa bambos* the inflorescence is a very large panicle. The spikelets arise on spicate branchlets forming loose clusters. *Dendrocalamus strictus* has large paniculate inflorescence with dense globular heads of spikelets. In *Arundinaria* the inflorescence arises as a small panicle at the tip of leafy branches. In the genus *Oxytenanthera* the inflorescence is a large panicle with spicate heads. In some of the species of *Teinostachyum* the inflorescence is a large drooping panicle.

The inflorescence composed of ordinary spikelets is also known as determinate inflorescence. The spikelets arise in a raceme or in a simple panicle, emerge and die almost simultaneously (Dransfield and Widjaja, 1995). All spikelets reach maturity almost at the same time as in the genus *Arundinaria*. An indeterminate inflorescence is composed of pseudospikelets (Figure 3). The inflorescence of *Bambusa bambos* and all the species of *Ochlandra* have this type of inflorescence. A pseudospikelet is typically subtended by a bract, consists of a prophyll, a series of one to a few gemmiparous bracts and a spikelet proper (Judziewicz *et al.*, 1999).

### **Spikelet**

The spikelet is the basic unit of a bamboo inflorescence. The spikelets are arranged on the rachilla. The number of spikelets varies from one to many. They may be short stalked or sessile. Single flower of the spikelet is the floret. In most of the bamboos the spikelets are many flowered. In the genus *Ochlandra* it is single flowered. Spikelets are subtended by one or more scaly bracts. All flowers contain two or more empty or sterile glumes. Sometimes empty glumes are absent. The fertile glumes are composed of lemma and palea. Palea is keeled in some cases. The palea encloses the lodicules, stamens and the ovary (Figures 1 and 3). The lodicules are very thin filmy, hyaline structures, 3-7 in number. They are absent in some species. Lodicules are generally considered to be true perianth appendages. At anthesis the lodicules swell up and force up the lemma and palea enclosing the flower so that the stamens and stigmas become exerted.

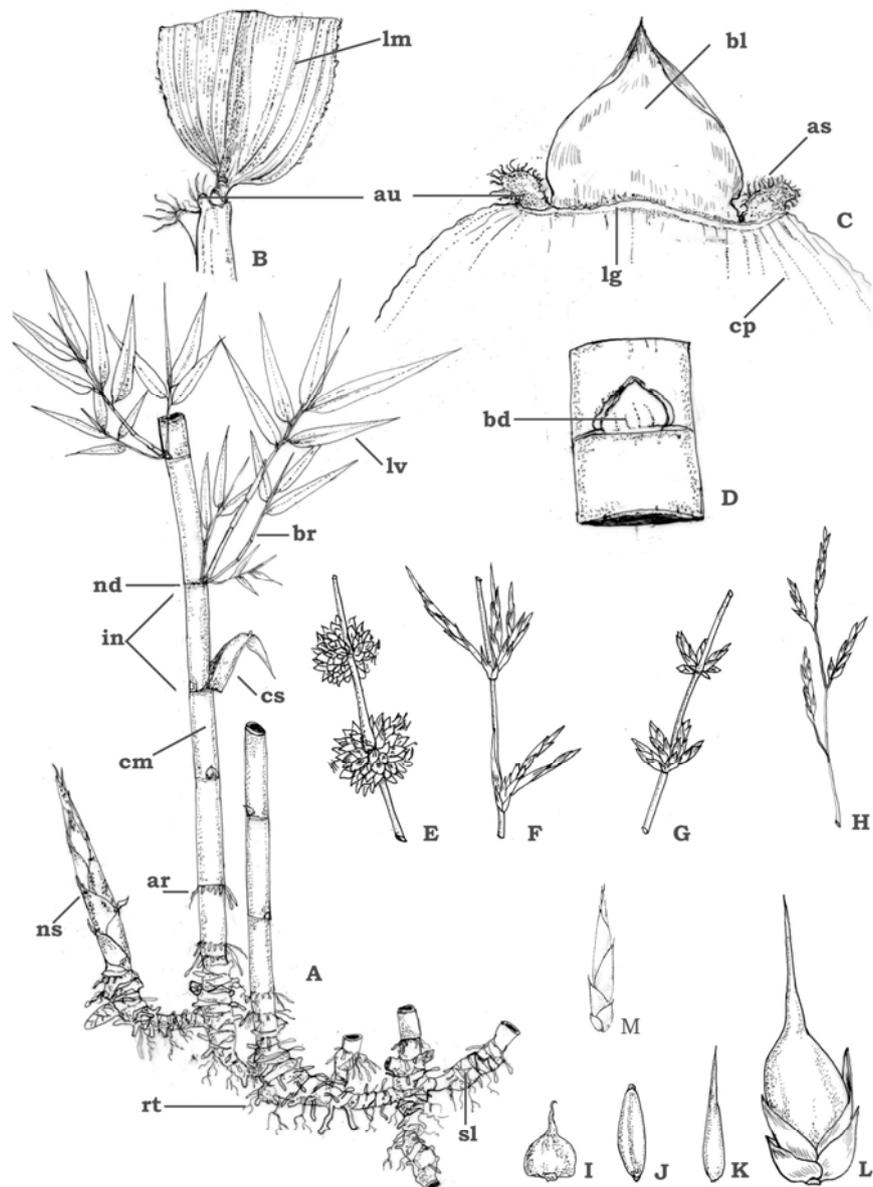


Figure 1. Parts of a bamboo plant. **A.** plant with rhizome; **B.** leaf sheath; **C.** culm sheath; **D.** node with prophyllate bud; **E., F., G. & H.** inflorescences; **I., J., K. & L.** fruits; **M.** spikelet; sl. scale leaf; rt. root; ns. new shoot; ar. aerial root; cm. culm; cs. culm sheath; nd. node; in. internode; br. branch; lv. leaves; lm. lamina; au. auricle; bl. blade; as. auricular setae; lg. ligule; cp. culm sheath proper; bd. bud

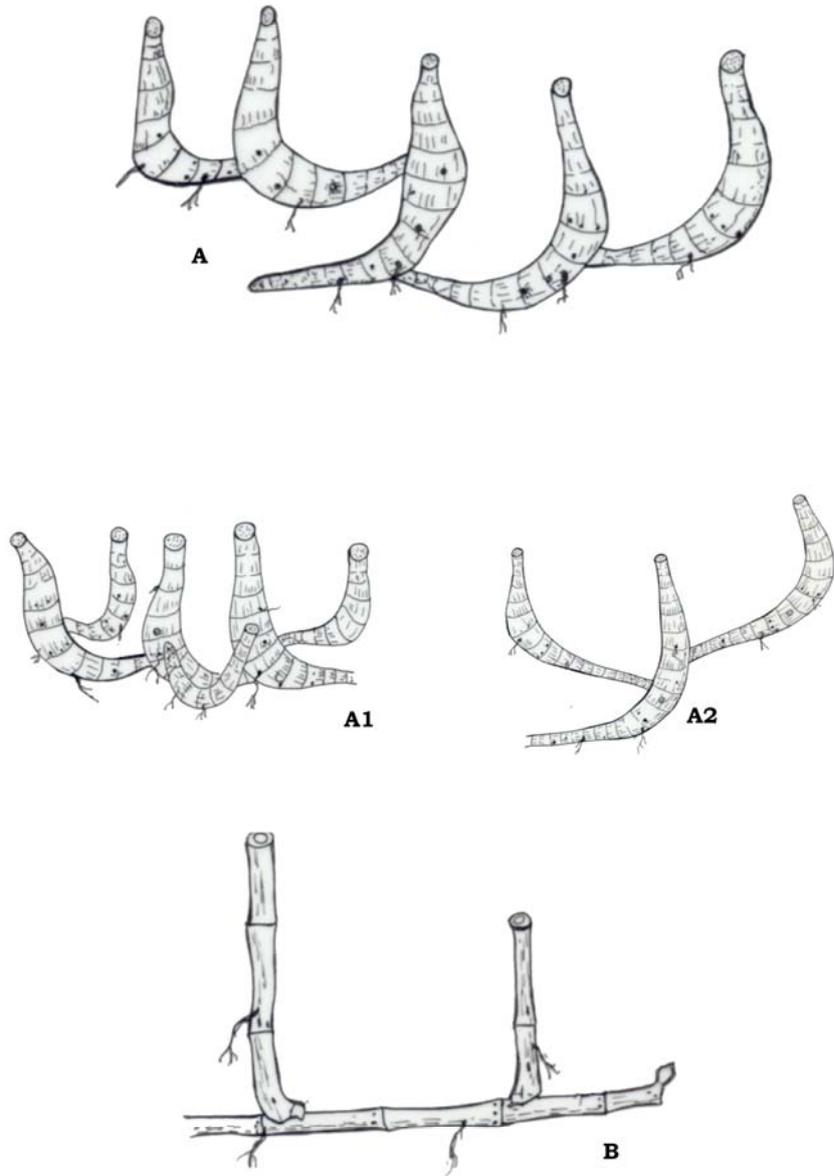


Figure 2. Rhizome. **A.** pachymorph (sympodial) rhizome; **A1.** pachymorph - short necked; **A2.** pachymorph - long necked; **B.** leptomorph (monopodial) rhizome

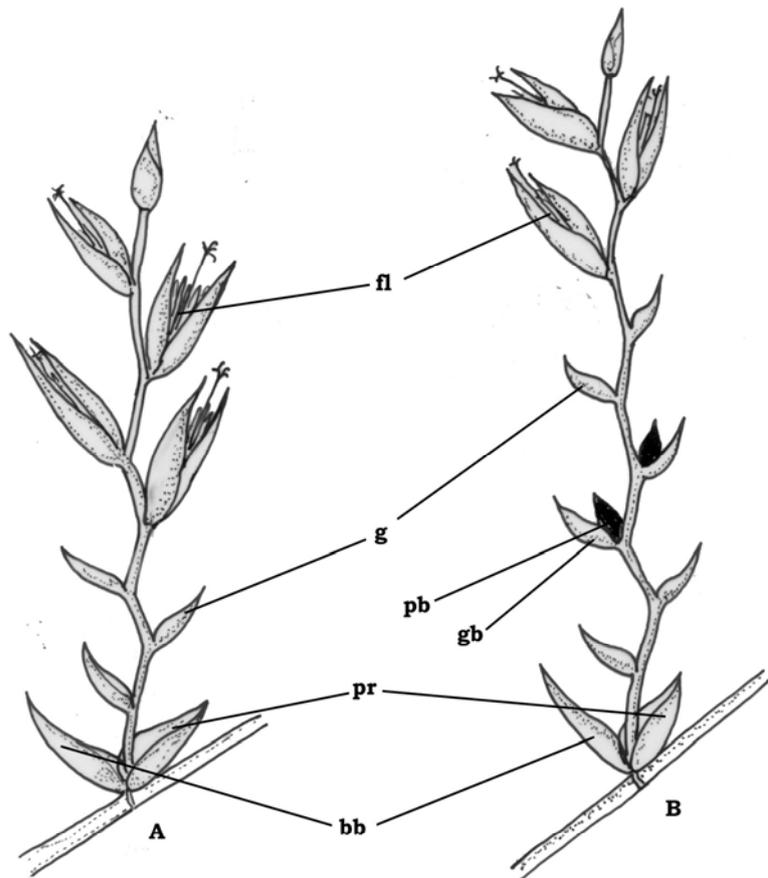


Figure 3. Comparison of spikelet and pseudospikelet. A. spikelet; B. pseudospikelet; bb. bracts; pr. prophyllated bracts; fl. florets; g. glumes; pb. prophyllated bud; gb. gemmiparous bract

The number of stamens varies from species to species. In the genus *Arundinaria* it is three and in *Ochlandra* the number of stamens vary from 17-130. Usually the stamens are free, but in certain species, the filaments are fused as in *Oxytenanthera monadelphica*. Stamens are apiculate or bifid at the tip. The ovary is surmounted by the style and stigmas. The stigma may be single or divided into 2-7 branches.

### **Fruit**

The fruit is a caryopsis, an indehiscent one-seeded structure (Figure 1). It consists of a pericarp enclosing the seed. In genera like *Ochlandra* and *Melocanna* the pericarp of the fruit is thick and fleshy. In *Ochlandra* the fruit is long-beaked and supported by the persistent lemma and palea.

### **Flowering**

The flowering behaviour in bamboos is very unique. Most of the bamboos flower synchronously at regular and or long intervals. The majority of the known bamboos fall between two physiological extremes (constant sterility and constant flowering) by manifesting a cyclic recurrence of the flowering state at intervals of few to many years. After a definite period or many years of vegetative growth all of the members of a given generation of bamboo plants (from seeds of a common origin) flower, produce seeds and die. This phenomenon is called gregarious flowering or mast flowering.

Most of the bamboo species have a characteristic and more or less sharply defined flowering cycles of 3, 7, 11, 15, 30, 48, 60 or 120 years, at the end of which, all plants of a given seedling generation flower gregariously (Janzen, 1976; Chaturvedi, 1988). In sporadic flowering, only a single culm produces flowers and the flowering culm alone dies. This is common in many species such as *Bambusa bambos*, *Dendrocalamus strictus* and certain species of *Ochlandra*.

On the basis of flowering behaviour Blatter (1929) divided bamboos into three groups. They are i) annually flowering, ii) gregariously and periodically flowering and iii) irregularly flowering. Bamboos generally die within one or two years after flowering (*Bambusa bambos*). Some other species do not die, but their vegetative growth slows down during the flowering period. Several species of *Arundinaria* belong to this category.

The exact reason for the death of bamboos subsequent to flowering and fruiting is still an enigma. Ramesh *et al.* (1998) concluded that death of bamboo clumps after flowering may

be due to the excessive deprivation of reducing sugars and moisture content, leading to loss in vitality and osmotic shock along with toxicity, generated due to enormous increase in lignin content.

## **BAMBOO DISTRIBUTION**

The *Bambusoideae* appears to be one of the most successful and diverse subfamilies of grasses. They have strong adaptability and are distributed widely from near the equator zone to boreal zone. They occupy habitats from sea level to high mountains, up to an altitude of 3300-4000 m. Most of the bamboo species need warm and humid climate and are distributed over plain and hilly area in tropical and subtropical monsoon zone between the Tropic of Capricorn and the Tropic of Cancer (Zhu Shilin *et al.*, 1994). The geographical distribution of bamboos is governed largely by the conditions of rainfall, temperature, altitude and soil. Most of the bamboos require a temperature from 8<sup>0</sup>C to 36<sup>0</sup>C, and a minimum annual rainfall of 1000 mm and high atmospheric humidity.

### **World distribution**

The true bamboos (Poaceae, subfamily Bambusoideae), with approximately 1,610 described species in 120 genera are classified into two major groups recognized as tribes (Soderstrom and Ellis, 1987; Judziewicz *et al.*, 1999).

The woody bamboos (Bambuseae) with ca. 1,500 species are distributed worldwide, while the herbaceous bamboos (Olyreae) with ca. 110 species (Ohrnburger, 1999) are restricted largely to the American continent. They appear in the natural vegetation of many parts of the tropical, subtropical and mild temperate regions of the world. They are abundant in the southern and southeastern regions of Asia, from India through China and Japan to Korea. Bamboos are also growing in Africa, Australia and in Madagascar.

In the Western hemisphere bamboos extend from eastern United States to Chile and Argentina. South America is rich in bamboos (Soderstrom and Calderon, 1979).

Three major bamboo growing geographical regions are recognized in the world:

1. Asia-Pacific (42<sup>0</sup>S-51<sup>0</sup>N): Major bamboo growing countries in these regions are China, India, Myanmar, Thailand, Cambodia, Japan, etc.
2. American (47<sup>0</sup>S-40<sup>0</sup>N): It extends across south and north Americas, Mexico, Guatemala, Honduras, Columbia, Venezuela, the Amazon valley in Brazil are the main centres of bamboo distribution in this region.

3. African (22<sup>0</sup>S-16<sup>0</sup>N): The southern Mozambique and eastern Sudan from south to north. The main places in this regions are Senegal, Guinea, Liberia, Ivory coast, Nigeria, Congo, Zaire and Madagascar Island (Zhu Shilin *et al.*, 1994).

### **Distribution of bamboos in India**

From India, 128 species of bamboos under 18 genera were reported (Seethalakshmi and Kumar, 1998). However, several new species and a few new genera have been described from different parts of India, subsequently. At present 136 species of bamboos belonging to 29 genera are found growing in India. As per the recent compilation 96 species are native bamboos and 40 species are cultivated ones. The tropical moist deciduous forests, the deciduous and semi-evergreen regions of the northeastern part show maximum diversity of bamboos (Hore, 1998). Bamboos also form secondary brakes and also occur as pure patches. *Bambusa bambos*, *Ochlandra travancorica* and *Melocanna baccifera* are some of the species, which form bamboo brakes. The main bamboo-growing regions in India are the northeastern region and the Western Ghats. In India the diversity of bamboos is mainly confined to the states of Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim, Tripura, West Bengal in the north east; some regions of Madhya Pradesh, Utter Pradesh, Bihar, Orissa in central region; Andhra Pradesh, Kerala, Karnataka and Tamil Nadu in the Peninsular region. Andaman and Nicobar Islands also have a promising diversity (Mauria and Arora, 1988; Kumar and Remesh, 2003, Kumar, 2011).

Tropical moist evergreen, semi-evergreen and moist deciduous forests are the important forest types of the Western Ghats region. Bamboos are most abundant in the semi-evergreen and moist deciduous forests. They are also rich as part of riparian flora, found along the rivers and streamsides.

### **RELEVANCE OF STUDY**

The available information on the taxonomy and classification of Indian bamboos are far from satisfactory. In many cases, generic and specific delimitations are not clearly defined. Since, orthodox system of classification was based on reproductive parts; the early workers depended mainly on herbarium specimens for their studies. Most of the herbarium specimens are incomplete consisting of bits of either only vegetative or reproductive materials and consequently generic and specific delimitations have often been based on scanty materials.

Moreover, because descriptions of bamboos so far were based on a very limited number of specimens which are insufficient to elucidate their variations, population structure and distribution, many species are placed under different ambiguous groups. In certain cases different workers treated the same genera differently. For example, Holttum (1956a) treated the genera *Cephalostachyum*, *Teinostachyum* and *Pseudostachyum* under the Malayan genus *Schizostachyum*. Other workers like Clayton and Renvoize (1986) and Majumdar (1989) treated all the above genera as congeneric. However, Dransfield (1980) kept these three genera separate from *Schizostachyum*. The generic and specific delimitations of some of the bamboos of peninsular India are doubtful. The genus *Ochlandra* is the dominant reed bamboo. From southern India 11 species and one variety were reported (Kumar, 2002). Among these, the specific delimitations and affinities of *O. soderstromiana*, *O. sivagiriana* and the varietal status of *O. travancorica* var. *hirsuta* were doubtful. The generic status of *Pseudoxytenanthera*, *Sinarundinaria* and *Schizostachyum* were also dubious. The varietal status of *Bambusa bambos* var. *gigantea* was also doubtful. Therefore, a detailed taxonomic study was taken up to analyse these problems. Most of the herbarium specimens kept in various herbaria is incomplete. The type materials of some of the bamboos were not known and some of the species were not typified. Extensive fieldwork for collection of specimens and preparation of herbarium materials were essential. A detailed taxonomic work was very relevant in this context.

### REVIEW OF WORK DONE IN PENINSULAR INDIA

The first authentic reference of bamboos of Southern India was published in Hortus Malabaricus (Rheede, 1685). Munro (1868) and Beddome (1873) described and included some of the bamboos from southern India in their publications. Gamble (1896) described and illustrated all bamboos known at that time from peninsular India. Gamble (1902) in his publication included 15 species of bamboos. Bourdillon (1908) included 10 species of bamboos in *The Forest Trees of Travancore*. Rama Rao (1914) in his book, *Flowering Plants of Travancore*, included 15 species.

The taxonomy of bamboos from Southern States was studied later by several workers (Kadambi, 1949; Andiappan and Wilson, 1963; Hussain, 1980; Nair, 1980). Nair and Ansari (1982) discussed the nomenclature problem of *Oxytenanthera monostigma*. Matthew (1999) in the Flora of Palani Hills, described six bamboos. Pullaiah and his co-workers described *Dendrocalamus strictus* and *Bambusa bambos* in the district floras of Andhra Pradesh (Pullaiah *et al.*, 1992, 1998, 2000; Pullaiah and Mohammad, 2000;

Venkata Raju and Pullaiah, 1995). Koshy and Pushpangadan (1997), Koshy and Harikumar (2001) and Koshy *et al.* (2001) studied the pollination biology of some South Indian bamboos. Seethalakshmi and Kumar (1998) published a compendium on Indian bamboos and included all the published details of 128 species of Indian bamboos. Some of the publications on bamboos from southern Western Ghats are Kumar, 1990, 1991, 1993, 1995; 2002; Kumar and Stephen, 1995, 1996, 1999; Kumar and Remesh, 1999, 2000, 2001, 2003; Manilal and Kumar, 1998; Kumar *et al.*, 1999, 2000, 2001a, 2001b.

## MATERIALS AND METHODS

### Study area

Peninsular India consists of the States of Kerala, Karnataka, Tamil Nadu and Andhra Pradesh stretching north south between 8<sup>0</sup> and 18<sup>0</sup> north latitudes and east west between 74<sup>0</sup> and 85<sup>0</sup> E longitude (Map 1). The total area is 4,67,186 km<sup>2</sup>. It is surrounded by the States of Madhya Pradesh, Maharashtra and Orissa in the north, Bay of Bengal in the east, Indian Ocean in the south and Arabian Sea in the west. There are two floristic regions, Malabar and Deccan. Malabar or Malabar Coast is the strip of land lying west of Western Ghats, running parallel to the coast of Arabian Sea. This area is floristically very rich and includes coastal plains and series of hill ranges of the Western Ghats traversing the States of Tamil Nadu, Kerala, and Karnataka up to Gujarat. The Western Ghats is more or less continuous except at Palakkad gap, which separates the Nilgiri ranges from Anamalais. It runs along the western border of the Deccan plateau. The western side of the Ghat facing the Arabian Sea and eastern side merges gradually through a series of hills with the Deccan plateau. The average altitude of Western Ghats is 1,550 m. The highest peak is Anamudi with a height of 2,695 m. It is the highest peak in the south of Himalayas. Some of the important centers of diversity in Western Ghats are Agasthyamala, Kalakkad Mundanthurai and Kothayar, Courttalam, Periyar Tiger Reserve, Anamudi and surroundings and Nilgiri Biosphere Reserve. It supports about eight major forest types. Moist evergreen and moist deciduous forests are dominating in the western slopes.

The major land area east to Western Ghats is the Deccan plateau. It extends up to the Aravallies, the Malva, the Vindhyas, and the Satpura and Chotanagpur hills in the north. Towards the south it narrows almost right down to Kanyakumari. Western and eastern sides are bordered by Western Ghats and Eastern Ghats. The northern part of the plateau slopes westwards while the southern part slopes towards the southeast. The annual rainfall

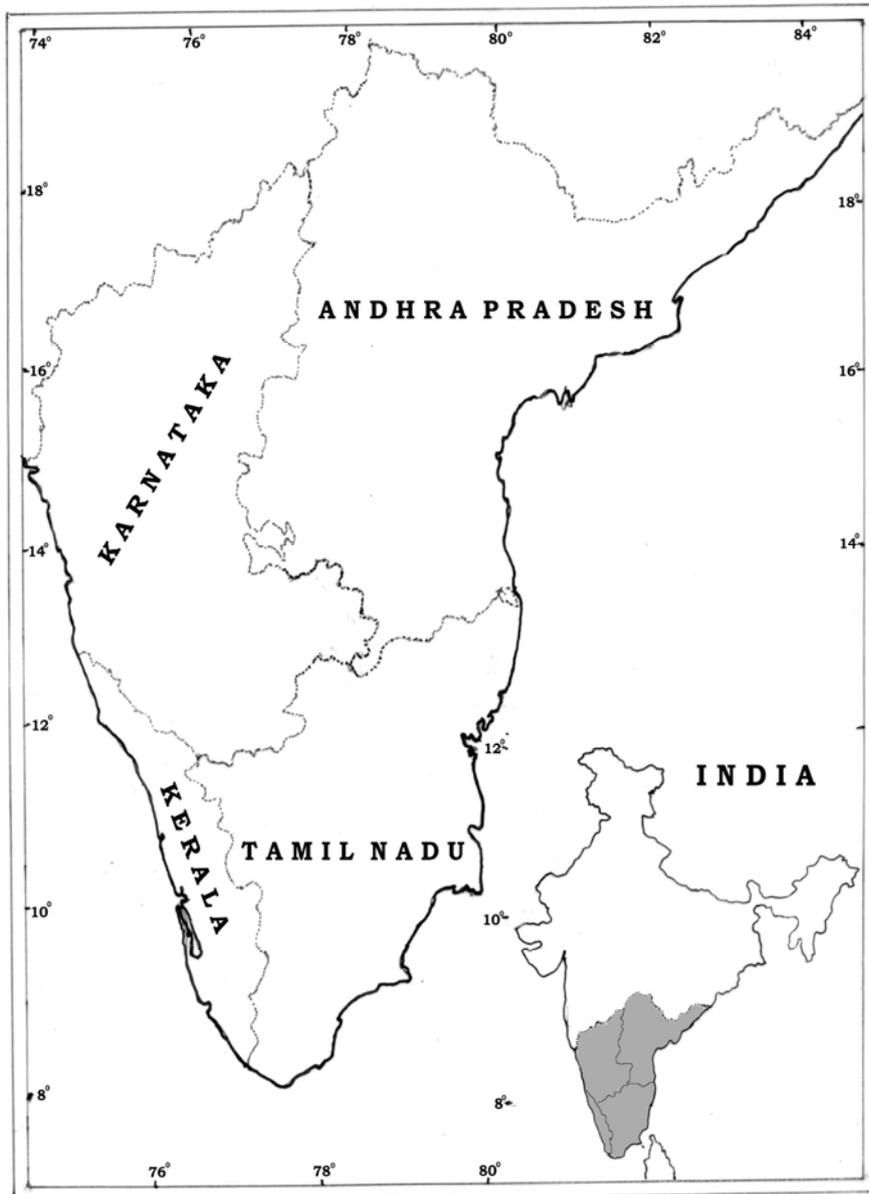
is less in this region and the vegetation is tropical deciduous type. In the open plains the climatic condition is dry and replaced by drought resistant species and thorny shrubs. The eastern sides of the plateau consist of fertile coastal plains running parallel to the Coromandel coasts. These plains are mainly formed from the deltas of Cauvery in Tamil Nadu, Godaveri and Krishna in Andhra Pradesh and a number of small rivulets and streams.

The four major phytogeographic divisions of peninsular India are the mountain regions in the east and west, the undulating midland with hillocks, the northern plains and the sloping coastal strips. It provides a wide variety of habitat, lateritic hills and valleys, swamps, marshy low lands, sandy seacoasts, fresh water rivers, ponds and backwaters on the sea front and harbours diverse type of vegetations.

The area is fed by two rain bearing winds, the southwest monsoon (June-September) and northeast monsoon (October-December). Kerala and coastal Karnataka receive heavy rainfall from the south-west monsoon. North-east monsoon is less active in these States. It is more active in Tamil Nadu and Andhra Pradesh. During the monsoon season the west coast region receives the heaviest rainfall, more than 2,200 mm annually. Tamil Nadu and Andhra Pradesh get 1,000-2,000 mm rainfall annually. The climate of the southern parts of Andhra Pradesh is dry and getting only an annual rainfall of 500 mm.

There are four climatic types (Chowdhury and Sarwade, 1982). Based on these, the coastal districts of Andhra Pradesh, some parts of Karnataka and Tamil Nadu fall under semi-arid climate. Northern coastal Andhra Pradesh, southern districts of Karnataka and northern Tamil Nadu have dry sub-humid climate. Coastal Karnataka and northern Kerala experience moist sub-humid type of climate. The higher elevation around Coonor, Ootty and Kodaikanal is considered as super humid areas.

The area is gifted with lot of large and small rivers. Most of the rivers are originating from the Western Ghats and pour into Arabian Sea and Bay of Bengal. The major rivers are Godaveri, Krishna and Cauveri. These rivers flow through the Deccan and empty into bay of Bengal. Nethravathy, Bharatapuzha, Periyar and Pampa are some of the minor rivers that originate from Western Ghats and pour into Arabian Sea.



Map-1. Area of study-Peninsular India

## **Work done**

Extensive fieldwork was carried out throughout Peninsular India. Fresh specimens were collected. The habit of the plant, morphology of rhizome, new shoots, culms, culm-sheaths, branches, leaves and inflorescence were studied and recorded. Herbarium sheets were prepared as per the techniques given in Bridson and Forman (1992) and Soderstrom and Young (1983). Herbarium sheets are deposited at Kerala Forest Research Institute herbarium (KFRI).

The herbarium specimens of bamboos deposited at Central National Herbarium, (CAL) Calcutta; FRI Herbarium, (DD) Dehra Dun; Blatter Herbarium, (BLAT) Bombay; Madras Herbarium, (MH) Coimbatore; BSI Central Circle Herbarium, (BSI) Pune; Herbarium of Botany Department, Sri Krishna Devaraya University, (SKU) Ananthapur; Andhra University Department of Botany Herbarium, Vishakpatanam; Kerala Forest Research Institute Herbarium, (KFRI) Peechi; Calicut University Herbarium, (CALI); were consulted and comparative studies were done. Protologue and early literature were also verified and studied. The cibachromes of type specimens from Royal Botanic Gardens, Kew, (K) and Museum National d' histoire Naturelle, Laboratoire de Phanerogamie, Paris (P) were also consulted.

Comparative morphological study was carried out of all the species. Fresh and pickled flowers were dissected and the floral characters were studied in detail. The details of sterile glumes, lemma, palea, lodicules, stamens, ovary, style and stigma were studied under the STMI-SV8 binocular microscope. Morphology of the fruit was also studied. All the floral parts were illustrated and descriptions were made. Brummitt and Powell (1992) were referred for abbreviation of author names. Under the systematic treatment all the species descriptions are given in the format according to Clayton, *et al.*, 2010.

## RESULTS AND DISCUSSION

### Distribution of bamboos in Peninsular India

In South India, bamboos are found growing in plains and also as a major component of moist deciduous and semi-evergreen forests. In some places, they occupy large areas forming bamboo brakes. From South India, 22 species and two varieties of bamboos under six genera were reported (Seethalakshmi and Kumar, 1998). The maximum species diversity is in the Kerala part of Western Ghats. The dominant genus is the reed bamboo *Ochlandra*. Other genera are *Bambusa*, *Dendrocalamus*, *Oxytenanthera*, *Arundinaria* and *Teinostachyum*. Ten species and one variety of *Ochlandra* were reported from Kerala part of Western Ghats. One species and one variety of *Bambusa* and one species of *Dendrocalamus*, four species of *Oxytenanthera*, four species of *Arundinaria*, one species of *Teinostachyum* were found growing in Kerala part of Western Ghats (Kumar, 2002). The major bamboo-growing areas in Kerala are the forest areas of Trivandrum, Kollam, Pathanamthitta, Idukki, Ernakulam, Malappuram and Palakkad Districts.

In Karnataka, 50 per cent of the bamboo population belongs to *Bambusa bambos*. *Dendrocalamus strictus* contributes 40 per cent (Bennet, 1993). One species of *Bambusa*, one species of *Dendrocalamus*, three species of *Ochlandra*, two species of *Pseudoxytenanthera*, one species of *Schizostachyum* are found growing in Karnataka. The major bamboo growing areas in Karnataka are Mysore, Coorg, South Kanara, Shimoga, Chickmangalore, Bhadravati, Begur, Bababudan hill range, and Agumbe.

In Tamil Nadu, bamboos are distributed in the hills and mountains of Kanyakumari, Thirunelvelly, Courttalum, Madurai, Coimbatore, Niligiris, Salem and North Arcot districts. Here *Bambusa bambos* and *Dendrocalamus strictus* are very common. Three species of *Ochlandra*, one species of *Oxytenanthera*, two species of *Arundinaria* and one species of *Teinostachyum* are also reported from Tamil Nadu.

In Andhra Pradesh, *Bambusa bambos* and *Dendrocalamus strictus* are found growing in many places. *Dendrocalamus strictus* is the dominant species in dry areas. Adilabad, Khammam, Vishakapatnam, West and East Godaveri, Karnool and Prakasam Districts are the major bamboo growing areas in Andhra Pradesh.

## **Endemism of bamboos in Peninsular India**

In the Peninsular Indian region, especially in Western Ghats bamboos show a high degree of endemism. Among the 22 natural species, 17 are endemic to Southern Western Ghats.

Eleven species and one variety of *Ochlandra* so far known from the Western Ghats, are endemic to southern part of peninsular India. Among these, five species and one variety were reported only from Kerala part of Western Ghats. *Ochlandra talboti* is endemic to Karnataka and Goa. *Ochlandra setigera* is distributed only in North Kerala and Tamil Nadu. *Ochlandra wightii* is endemic to Southern Kerala, Tirunelveli and Courtallum.

*Oxytenanthera bourdillonii* is endemic to Kerala part of Western Ghats. It has a very restricted distribution. *Munrochloa ritchiei* is found growing in Northern Kerala and Karnataka. *Dendrocalamus stocksii* is endemic to Western Ghats up to Maharashtra. *Teinostachyum wightii* is endemic to Kerala, Karnataka and Tamil Nadu. *Arundinaria wightiana* is endemic to certain regions in Kerala and Tamil Nadu.

Some of the species such as *Oxytenanthera monadelphica*, *Arundinaria floribunda*, *A. densifolia* and *A. walkeriana* are distributed both in Western Ghats and Sri Lanka and share the endemic status. Two species such as *Davidsea attenuata* and *Arundinaria debilis* so far known as Sri Lankan endemics have been located recently from the Kerala part of Western Ghats. During a recent exploration in Sri Lanka, it was observed that bamboos of Western Ghats and Sri Lanka are similar in their distribution pattern in forest types which is well represented in high altitude regions especially with regard to the Arundinoid bamboos. The high altitude regions such as Pidurutalagala (2500 m) and Horton Plains (2200 m) in Sri Lanka, are rich in shrubby bamboos like *Arundinaria debilis*, *Arundinaria densifolia*, *Arundinaria floribunda*, *Arundinaria walkeriana*. The reed bamboo of Sri Lanka *Ochlandra stridula* is taxonomically conspecific to *Ochlandra scriptoria* of Western Ghats and therefore, according to the rules of priority, the latter species needs be synonymised under the former. A genus *Dendrocalamus cinctus* R.B.Majumdar ex Soderstrom & Ellis, newly described from Sri Lanka was found to be *Oxytenanthera bourdillonii* Gamble, so far known endemic to Southern Western Ghats. The detailed studies on type specimen (Isotype) deposited in PDA, Cibachromes from National Herbarium (US) and also field observation it was observed that the specimen available at PDA herbarium has two components from two different species, the vegetative parts like culm and culm-sheath is that of *Oxytenanthera bourdillonii* Gamble, so far known endemic

to Southern Western Ghats and the flowering twig from a *Dendrocalamus* species. This taxa needs to be critically studied for its correct identity. The genus *Davidsea* was originally proposed and erected by Soderstrom and Ellis (1987) to accommodate *Teinostachyum attenuatum* (Thwaites) Munro, a straggling bamboo so far endemic to Sri Lanka. Recently, the same species was located from the forests of Sultan Battery, Wayanad District and Kottiyoor, Kannur District of Kerala. A comparison with the *Teinostachyum wightii* Bedd. and *T. attenuatum*, revealed that both species strictly match the characters and character states with *T. wightii*, so far endemic to western Ghats. It has been proposed to conserve the name *Teinostachyum attenuatum* (Thw.) Munro, against *Davidsea attenuata* (Thw.) Soderstrom and Ellis. During the recent critical examination of all the Indian bamboo species described formerly under the genus *Oxytenanthera*, revealed that the generic character of *Oxytenanthera* is evidently applicable to only two species that are found in India, have been treated under the genus *Pseudoxytenanthera* such as, *Pseudoxytenanthera monadelpha*, the type species of *Pseudoxytenanthera* Soderstrom & Ellis and *Pseudoxytenanthera bourdillonii*. Both the species possess psedospikelets of semiverticillate clusters, 2-3 flowered spikelets, 2- keeled palea, monadelphous stamen, ovary with pubescent hollow style with three stigmas. The type species of *Oxytenanthera abyssinica* also has the similar floral characters. It was also observed that the type species of the genus *Pseudoxytenanthera* does posses characteristic features in its branching as an adaptation to climb the adjoining trees for the support. But, all the floral characters and vegetative characters are similar to the *Oxytenanthera abyssinica* (A. Richard) Munro. Therefore, the genus *Pseudoxytenanthera* is proposed to be merged under the genus *Oxytenanthera* Munro. *Oxytenanthera ritchiei* (Munro) Blatt. & McCann, has recently been transferred to the newly erected genus *Munrochloa* M. Kumar & Remesh, and a new combination *Munrochloa ritchiei* (Munro) M. Kumar & Remesh, was published (Kumar and Remesh, 2008).

## SYSTEMATIC TREATMENT

### POACEAE Barnh.

**POACEAE** Barnh., Bull. Torr. Bot. Cl. 22: 7. 1895.

*Type:* genus *Poa* L.

*Gramineae* Juss., Gen. Pl. 28. 1789; Benth. & Hook.f., Gen. Pl. 3: 1074-1215. 1883; Hack. in Engl. & Prantl, Nat. Pfl.-Fam. ed. 2, 14e. 1940; Pilger, Bot. Jahrb. 76: 271-409. 1954 (nom. alt. ICBN 1994 Art. 18.5-18.6); *Anomochloaceae* Nakai, Ord. Fam. etc. App. 222. 1943; *Bambusaceae* Nakai, Fl. Sylv. Koreana 20, 1-55. 1933.

The Poaceae is one of the largest of the families of flowering plants represented by over 10000 species under 650 genera (Clayton *et al.*, 2010). The family Poaceae was described based on the genus *Poa*. The family Poaceae is divided into subfamilies, tribes and subtribes.

### CLASSIFICATION OF THE SUBFAMILY BAMBUSOIDEAE

The first description of bamboos with illustrations was published in Rheede's *Hortus Malabaricus* (1685). Rumphius (1743) in his monumental work *Herbarium Amboinense* included *Bambusa bambos* along with other Indonesian bamboo species. He divided the bamboos into eight classes under a single name *Arundo*. Roxburgh (1814) described seven species of bamboos with a common generic name *Bambusa*. Kunth (1815) considered Bambusaceae as one of his ten natural groups of genera and referred the groups as *Gramina Bambusaceae*. Nees (1834) differentiated for the first time the woody and herbaceous groups of bamboos. He treated Bambusaea as a tribe under Gramineae. He divided bamboos into three groups as Bambuseae, Arundinariae and Streptochaetae. All the herbaceous bamboos were included under Streptochaetae. He also recognised two subgroups under Bambuseae, *Bambusa* and *Guadua*. Ruprecht (1840) in the monograph on bamboos placed 67 species of woody bamboos under two groups. Hooker (1854) treated Bambuseae as a tribe of the order Gramineae and divided recognized four subtribes namely, Arundinarieae, Eubanuseae, Dendrocalameae and Melocanneae. Munro (1868) treated bamboos under the family Gramineae. He followed the basic system of Nees (1834) but expanded to include many new taxa. He described 21 genera and about 158 species

completely and more than 50 species incompletely. He divided Bambusaceae again into 3 divisions:

Triglossae or Arundinariae - Plants with three stamens and three squamulae.  
Included eight genera under this division.

Bambuseae – included “true” bamboos with five genera under.

Bacciferae – In this group he included 8 genera and those bamboos having fleshy fruits eg. *Ochlandra*, *Melocanna* and *Schizostachyum*.

Bentham (1883) divided Bambuseae into four sub-tribes namely, Arundinarieae, Eubambuseae, Dendrocalameae and Melocanneae. Gamble (1896) described 151 species under 14 genera. He considered Bambuseae as a tribe and recognised four subtribes namely, Arundinarieae, Eubambuseae, Dendrocalameae and Melocalameae. Stapf (1897) considered bamboos as a tribe of the subfamily Pooideae and divided into five subtribes namely, Dendrocalameae, Melocanneae, Bambusineae, Arundinarieae and Puellineae based on the nature of spikelets, paleas, number of stamens and fruit characters. Holttum (1956a) proposed a new system of classification of bamboos based on the structure of the ovary. He divided bamboos under four major divisions namely, *Schizostachyum* type, *Oxytenanthera* type, *Bambusa-Dendrocalamus* type and *Arundinaria* type. Parodi (1961) in his system of classification included all woody bamboos in a single tribe Bambuseae. The herbaceous members were treated under three tribes namely, Olyreae, Phareae and Streptochaeteae. Grosser and Liese (1971) proposed a classification based on anatomical characters and described four basic type of vascular bundles in bamboos. Based on the presence of these four basic types of vascular bundles, as well as combinations of them, an anatomical system of classification was suggested.

Clayton and Renvoize (1986) in their classification of grasses treated bamboos under the subfamily Bambusoideae under five tribes. All the bamboos were included in the tribe Bambuseae under three subtribes namely, Arundinariinae (20 genera), Bambusinae (25 genera) and Melocanninae (4 genera). Soderstrom and Ellis (1987) treated Bambusoideae as subfamily of Gramineae with five tribes. Bambuseae was one among them, in which all bamboos were included. The tribe Bambuseae was again split into nine subtribes namely, Arthrostylidiinae, Arundinariinae, Bambusinae, Chusqueinae, Gauaduinae, Nastinae, Neurolepidinae, Schizostachydinae and Shibataeinae. Tsvelev (1989), in his classification of grasses divided Gramineae (Poaceae) into two subfamilies: Bambusoideae and Pooideae. The subfamily Bambusoideae was divided into 14 tribes and a group of genera

of uncertain position. Dransfield and Widjaja (1995) followed the classification of Soderstrom and Ellis (1987) with some modifications. They proposed a new sub tribe, Racemobambosinae to accommodate a new genus *Racemobambos* and abolished the subtribe Neurolipidinae.

Subfamily **Bambusoideae** Asch & Graebn.

**Bambusoideae** Asch & Graebn., Syn. Mitteleurop. Fl. 2(1): 769. 1902; Rehd.J. Arn. Arb. 26: 78. 1945; Clayton & Renvoize, Kew Bull. Addl. Ser. 13, 34-57. 1989; McClure, Kew Bull. 15: 321-324. 1961; Soderstr. & R.P. Ellis in Soderstr. *et al.* (eds.), Grass Syst. Evol. 225-237. 1987; Tzvelve, Bot. Rev. 55(3): 141-203. 1989; S. Dransf. & Widjaja (eds.), Plant Reso. S. E. Asia 7: 34. 1995; Ohrnberger, Bamb. World 7.1999.

**Type:** *Bambusa* Schreb.

*Gramineae*, Tribe - Bambuseae Nees, Linnaea 9: 461-494. 1834; Rupr., Bamb. Monogr. Exp. 1-71. 1839; Benth. & Hook. f., Gen. Pl. 3: 1094. 1883; Gamble, Ann. Roy. Bot. Gard. Calcutta 7:1. 1896; E. G. Camus, Les Bamb. 15. 1913.

Class X - Bambusacea Kunth, Mem. Mus. Hist. Nat. 2: 75. 1815.

*Bambusaceae* Link, Hort. Reg. Bot. Berol. 2: 308. 1883; Trin., Mem. Acad. St. Petersburg, Ser. 6, Sci. Nat. 1: 613. 1835; Munro, Trans. Lin. Soc. London 26: 10. 1868; Nakai, Fl. Sylv. Koreana 20: 12. 1933.

Perennial herbs, shrubs, woody and arborescent or climbers, rhizomatous, the aerial and subterranean axes segmented, rhizomes and culms bear buds and sheathing foliar organs. Culms with many well-spaced nodes, branched above, culms usually hollow, semi-solid, rarely solid, erect, scandent or climbing and vine-like, branched throughout or above, sometimes unbranched, the node of the segmented axis is marked either by a sheath scar or also by a supranodal ridge; the culm sheaths ligulate, persistent, abscissile or incompletely abscissile. Leaves petiolate, abscissile, blades usually flat, broad, lanceolate or linear-lanceolate, rarely linear, midrib more prominent on the abaxial surface, veins parallel with tessellate venations, leaf sheath persistent. Inflorescence terminal or lateral, determinate or indeterminate; determinate, paniculate, racemose or spicate racemose; indeterminate consists of pseudospikelets forming semi-verticillate clusters; spikelets often sessile or pedicellate, one to many-flowered, bisexual, often with 2 or more sterile glumes at the base; lemma mucronate or cuspidate, many-nerved; palea enclosed by lemma, many nerved, with a longitudinal dorsal sulcus; lodicules two, three or many, sometimes absent;

stamens usually 3 or six and sometimes up to 130, free, rarely connate into a tube; ovary solitary, normally one-celled with one ovule; style short or long, stigmas commonly two or three, sometimes up to seven. Fruit a caryopsis, sometimes nut-like or drupaceous, one seeded, indehiscent, sessile.

In the present report, the classification of Soderstrom and Ellis (1987) modified by Dransfield and Widjaja (1995) is followed. This classification is accepted worldwide and is found most suitable for the bamboos of Peninsular India.

Bambusoideae is divided into five tribes namely, Anomochloaeae, Buergersiochloaeae, Olyreae, Streptochaeteae and Bambuseae.

*Key to the tribes*

- 1a. Plants with woody, strong rhizomes and culms; rhizomes monopodial or sympodial; vegetative branching complex.....**Bambuseae**
- 1b. Plants with short weak rhizomes and herbaceous culms; rhizomes strictly sympodial; vegetative branching absent or simple.....2
- 2a. Inflorescence a spike; flowers bisexual, lodicules absent; stigma non plumose..... 3
- 2b. Inflorescence mixed panicles; flowers unisexual, lodicules present; stigma plumose.....4
- 3a. Leaves with prominent elongate pseudopetioles; stamens 4 .....**Anomochloaeae**
- 3b. Leaves with short pseudo petioles; stamens 6.....**Streptochaeteae**
- 4a. Inflorescence on specialized non leafy culms; filaments united .....**Buergersiochloaeae**
- 4b. Inflorescence on leafy culms; filaments free..... **Olyreae**

Tribe: **Bambuseae** Nees

**Bambuseae** Nees, Agrost. Brass. 520. 1829; Munro, Trans. Linn. Soc. London 73. 1868; Gamble, Ann. Roy. Bot. Gard. Calcutta 7: 1. 1896; Soderstr. & R.P. Ellis in Soderstr. *et al.* (eds.), Proc. Int. Symp. Grass Syst. Evol. 232. 1987; Clayton & Renvoize, Kew Bull. Addl. ser. 13, 35. 1989; S. Dransf. & Widjaja (eds.), Plant Reso. S. E. Asia 7: 34. 1995; Ohrnberger, Bamb. World 17. 1999.

**Type:** *Bambusa* Schreb.

*Arthrostylideae* E. G. Camus, Les Bambusees 16. 1913; *Shibataeae* Nakai, J. Jap. Bot. 9: 83. 1993; *Phyllostachideae* Keng, Fl. Ill. Pl. Prim. Sin. Gram. 87. 1959.

Perennial shrubs, semiarborescent or arborescent with closely tufted or loosely arranged culms. Rhizomes complex well developed, monopodial or sympodial, solid or hollow. Culms woody, semi-erect or erect or sometimes climbing, usually hollow, sometimes solid, divided into cylindrical segments by the nodes, young shoots and culms are covered with sheaths; branches well developed, grouped at each node; leaf blades linear-oblong, usually with cross-nerves and a short pseudopetiole, persistent or deciduous. Inflorescence small or large compound panicle or raceme, sometimes composed of pseudospikelets, spikelets form compact heads, semiverticillate clusters or loosely arranged on nodes; spikelets 1-many flowered, fertile and sterile florets mixed, usually laterally compressed; sterile glumes 2-many, coriaceous, many-nerved, sometimes mucronate; fertile glumes, lemma herbaceous to coriaceous, many nerved, awnless or sometimes mucronate, palea membranous, exposed or enfolded by lemma, many nerved, keeled or not keeled; lodicules 3-7, sometimes absent, 2-5 nerved; stamens 3-6, sometimes up to 130, filaments free or sometimes united; stigmas 1-3, sometimes 5-7; ovary glabrous or hairy. Fruit a caryopsis with a linear hylum, sometimes drupaceous and long beaked.

It is the largest tribe with wide distribution. The members are found growing in the temperate and tropical regions up to an elevation of 4000 m from sea level.

The Tribe Bambuseae is divided into nine sub-tribes. However, only three sub-tribes, Arundinariinae, Bambusinae and Melocanninae are represented in Peninsular India.

*Key to the subtribes of **Bambuseae***

- 1a. Inflorescence determinate, racemes or panicles; spikelets not clustered or fascicled; stamens 3; stigma 2, rarely 3 ..... **Arundinariinae**
- 1b. Inflorescence indeterminate; spikelets clustered, arise in fascicles or capitate heads; stamens six or more; stigma 3 ..... 2
- 2a. Primary branch at each node is dominant; branches few, unequal; ovary appendage short, broadly conical and hirsute..... **Bambusinae**
- 2b. Primary branch at each node is not dominant; subequal branches many arise at each node; ovary appendage long, narrow, glabrous..... **Melocanninae**

### Subtribe 1. **Arundinariinae** Benth.

**Arundinariinae** Benth., J. Linn. Soc. Bot. 19: 31. 1881; Clayton & Renvoize, Kew Bull. Addl. ser. 13, 41. 1989; Soderstr. & R.P. Ellis in Soderstr. *et al.* (eds.), Proc. Int. Symp. Grass Syst. Evol. 234. 1987; S. Dransf. & Widjaja (eds.), Plant Reso. S. E. Asia 7: 34. 1995; Ohrnberger, Bamb. World 19. 1999.

**Type:** *Arundinaria* Michx.

*Arundinarieae*, Gamble, Ann. Roy. Bot. Gard. Calcutta 7: 1. 1896; *Perrierbambusinaea* A. Camus, Arch. Mus. Hist. Nat. Paris Ser. 6, 12: 603. 1935; *Pleioblastinae* Keng, Fl. Ill. Pl. Prim. Sin. Gram. 29. 1959; *Thamnocalaminoae* Keng f., J. Bamb. Res. 1: 15-18. 1982.

Shrubby, medium sized, semi-arborescent. Rhizome sympodial to monopodial. Culms erect or scandent, usually hollow, rarely solid. Inflorescence determinate, racemes or panicles; spikelets 2-many flowered; palea always keeled; lodicules 3; stamens 3, free; ovary glabrous with 2-3 stigmas. Caryopsis with thin pericarp, adnate to the seed.

This subtribe includes taxonomically a heterogenous group. All types of rhizomes are found in this subtribe, from sympodial to monopodial. This is a large and complex subtribe in which the generic limits are far from adequately resolved (Soderstrom and Ellis, 1987). The numerous genera were described by different authors under this subtribe. *Arundinaria*, *Thamnocalamus*, *Fargesia*, *Chimonobambusa*, *Sinarundinaria*, *Pleoblastus*, *Nipponocalamus*, *Yushania*, *Drepanostachyum*, *Himalayocalamus*, *Ampelocalamus* and *Borinda* are some of the important genera newly described.

Almost all the members of this subtribe are distributed in the Old World except one species *Arundinaria gigantea* which is a native of United States. Most of the genera are high altitude plants growing under temperate climatic conditions. In Peninsular India, the subtribe *Arundinariinae* is represented by the genus *Arundinaria* formerly treated under *Sinarundinaria* Nakai.

#### ***Arundinaria*** Michx.

The genus was first described by Michaux in 1803. The type genus *Arundinaria gigantea* is a monopodial bamboo. But, later sympodial bamboos having characters like several branches, racemose or open paniculate inflorescence, three stamens with free filaments and 2-3 stigmas, were placed under the genus *Arundinaria*. This group represents a taxonomically heterogeneous group of bamboos (Chao & Renvoize, 1989a).

The genus *Arundinaria* is considered as the most advanced group among bamboos. There were about 380 binomials under the name *Arundinaria*.

*Arundinaria* Michx., Fl. Bor. Amer. 1: 73. 1803; *Ludolfia* Willd., Mag. Nevest. Entdeck. Naturk. 2: 320. 1808; *Macronax* Raf., Med. Repos. 11: 503. 1808. Munro, Trans. Linn. Soc. London 26: 13. 1868; Bedd., Fl. Sylv. S. India (3): 230. 1873; Benth. & Hook. f., Gen. Pl. 3: 1207. 1883; Gamble, Ann. Roy. Bot. Gard. Calcutta 7: 1. 1896; Brandis, Indian Trees 664. 1906; Bourd., For. Trees Travancore 397. 1908; E. G. Camus, Les Bamb. 26. 1913; *Pleioblastus* Nakai, J. Arn. Arb. 6: 145. 1925 ;Blatt. Indian For. 55(10): 542. 1929; C.E.C. Fisch. in Gamble, Fl. Pres. Madras 3: 1857. 1934; *Sinarundinaria* Nakai, J. Jap. Bot. 11: 1. 1935; *Nippocalamus* Nakai, J. Jap. Bot. 18: 350. 1942 ; *Yushania* Keng. f., Acta. Phytotax. Sin. 6: 355. 1957; McClure, Smith. Contr. Bot. 9: 21. 1973; *Oligostachyum* Wong & Ye, Nanj. Univ. J. Nat. Sci. 95. 1982 ;*Bashania* Keng. f. & Yi, J. Bamboo Res. 1(2): 37. 1982; Soderstr. & R.P. Ellis in Soderstr. *et al.* (eds.), Proc. Int. Symp. Grass Syst. Evol. 234. 1987; Soderstr. & R.P. Ellis, Smith. Contr. Bot. 72: 2. 1988; R.B. Majumdar in Karthikeyan *et al.*, Fl. Ind. Enum. Monocotyl. 282. 1989; Tzvelve, Bot. Rev. 55(3): 151. 1989; C.S. Chao & Renvoize, Kew Bull. 44: 2. 1989; Clayton & Renvoize, Kew Bull. Addl. ser. 13, 45. 1989; S. Dransf. & Widjaja (eds.), Plant Reso. S.E. Asia 7: 34. 1995; Seethalakshmi & M. Kumar, Bamb. India Comp.261. 1998; Judziewicz *et al.*, Amer. Bamb. 195. 1999; Ohrnberger, Bamb. World 35. 1999. **Type:** *Arundinaria gigantea* (Walter) Muehlenb.

**HABIT** Perennial. Rhizome neck short; sympodial. Culms erect hollow, woody. Branch compliments many, subequal; branching intravaginal and above the nodal line. Culm-sheaths persistent or deciduous. Culm-sheath blades pubescent.

**INFLORESCENCE** Inflorescence racemes or open panicles.

**FERTILE SPIKELETS** Spikelets semelauctant, 2-several flowered, the terminal aborted or reduced to a rachilla segment.

**GLUMES** Glumes 2; palea keeled.

**FLOWER** stamens 3; filaments free. Stigmas 2-3; plumose.

**FRUIT** Caryopsis with a hilum extending throughout its length.

**DISTRIBUTION** The genus *Arundinaria* is distributed in eastern United States, Brazil, Mexico, Argentina, Africa, China, Sri Lanka, India, Myanmar, Nepal, Bhutan and Vietnam. In India, this species occurs in north eastern states and Peninsular India.

In Peninsular India, the genus *Arundinaria* is represented by four species. All are high altitude plants, growing in grasslands, sholas or as a component of semi-evergreen forests.

**NOTE:** The genus *Arundinaria* was originally described by Michaux (1803). Munro (1868) accepted this generic concept and described two species of bamboos from Southern India, *Arundinaria densifolia* and *A. walkeriana*. Nees (1834) based on the specimen of Wight from Nilgiris described another species *A. wightiana*. Thwaites (1864) described *A. floribunda* based on a Sri Lankan specimen. Rama Rao (1914) reported this species from Southern India. Gamble (1896) followed Munro's concept and treated all these species under the genus *Arundinaria*. Later workers like Beddome (1873), Bentham & Hooker (1883), Brandis (1906), Bourdillon (1908), Camus (1913) and Blatter (1929) followed this generic concept, *Arundinaria*. Chao and Renvoize (1989b) revised all the species described under *Arundinaria* in south East Asia and Africa. They transferred all the species of South India previously treated as *Arundinaria*, under the genus *Sinarundinaria*. Seethalakshmi and Kumar (1998) accepted the generic concept of Chao and Renvoize (1989b) and transferred all the known species previously described under *Arundinaria* to the genus *Sinarundinaria*. Nakai (1935) erected the genus *Sinarundinaria* based on *Sinarundinaria nitida* and *S. murielae*. His description was based on the vegetative structures only. *Sinarundinaria murielae* flowered in 1970's and *S. nitida* flowered in 1993 (Stapleton, 1994a). It was found that both these species were *Fargesia spathacea*. Thus, the genus name *Sinarundinaria* became invalid. Soderstrom and Ellis (1988) while studying the bamboos of Sri Lanka followed the generic concept *Arundinaria*. Majumdar (1989) accepted Keng's (1957) generic concept *Yushania* and transferred all the species previously treated under the genus *Arundinaria* to the genus *Yushania*. Nakai (1925) treated three species of *Arundinaria*, *A. floribunda*, *A. wightiana* and *A. walkeriana* under the genus *Indocalamus*. Tewari also (1992) followed this concept.

In the present study, the generic concept *Arundinaria* of Munro (1868) Gamble (1896) and Soderstrom and Ellis (1988) is followed. All the species in South India previously described under *Sinarundinaria* are treated under the genus *Arundinaria*. Renvoize (in a personal communication) suggested treating the *Sinarundinaria* species under the genus *Arundinaria*.

*Key to the species of Arundinaria*

- 1a. Culms small, erect, up to 1.5 m tall with small narrow leaves, 2.5-3.5 cm long, 0.5-0.7 cm broad .....*A. densifolia*
- 1b. Culms large, scandent, up to 3.5 m tall with large broad leaves, 4-17 cm long, 0.8-3 cm broad .....2
- 2a. Leaf blades thick and leathery up to 3.5 cm wide; stigmas 3 ..... *A. walkeriana*
- 2b. Leaf blades not thick and not leathery up to 2 cm wide; stigmas 2.....3
- 3a. Culm dark green when young; internode flattened on one side near the node; leaf sheath hispid with bulbous based hairs; spikelets usually 3-flowered, pedicel 1.5-2 cm long ..... *A. wightiana*
- 3b. Culms having purple-black speckles when young; internode not flattened; leaf sheath sparsely hirsute; spikelets 5-7 flowered, pedicel 0.7-0.8 cm long..... *A. floribunda*

*Arundinaria densifolia* Munro, Trans. Linn. Soc. London 26: 32. 1868; Gamble, Ann. Roy. Bot. Gard. Calcutta 7: 8, t.7. 1896 & in Hook. f., Fl. Brit. India 7: 379.1897; Brandis, Indian Trees 664. 1906; Bourd., For. Trees Travancore 398. 1908; E. G. Camus, Les Bamb. 31. 1913; Rama Rao, For. Pl. Travancore 446. 1914; *Chimonobambusa densifolia* (Munro) Nakai, J. Arnold Arbor. 6: 151. 1925; Blatt. & McCann, J. Bombay Nat. Hist. Soc. 33: 900. 1929; Bahadur, Indian J. For. 2: 240. 1979; Varmah & Bahadur, Indian For. Rec. (n.s.) Bot. 6(1): 2. 1980; Varmah & Pant, Indian For. 107: 672. 1982; Soderstr. & R.P. Ellis, Smith. Contr. Bot. 72: 8, t.5,6. 1988; *Sinarundinaria densifolia* (Munro) Chao & Renvoize, Kew Bull. 44: 354. 1989; *Yushania densifolia* (Munro) R.B. Majumdar in Karthikeyan *et al.*, Fl. Ind. Enum. Monocotyl. 282. 1989; Tewari, Monogr. Bamb. 55. 1992; Seethalakshmi & M. Kumar, Bamb. India Comp.264. 1998;Ohrnberger, Bamb. World 158. 1999. [Figures 4 and 5; Plate 1].

**Type:** Sri Lanka, *Watson 25* (lectotype K. selected by Soderstrom & Ellis, 1988)

**HABIT** Perennial; caespitose; dense; gregarious;bushy. Rhizomes sympodial; pachymorph; short; covered with scales. Culms erect; 20-50 cm tall; slender; woody hollow. Culm-internodes terete; 1.5-9 cm long; 0.5-0.9 cm diameter; glabrous. Culm-nodes without supranodal ridge; marked by sheath scar; small triangular nodal bud present; enclosed in a prophyllum. Branches arise from the lower nodes

produced just above the nodal line; intravaginal; short; the primary axes develop first followed by the formation of numerous laterals from its base; form a cluster of small subequal branches; 20-30 numbers. Culm-sheaths 2.5-4 cm long; 1-2 cm broad at base; striate; coriaceous; hirsute below; tip attenuate; persistent; auricle inconspicuous; oral setae delicate. Culm-sheath ligule inner, highly reduced; membranous. Culm-sheath blade erect, small, triangular, narrow, glabrous, 0.5-1.4 cm long; 0.2-0.4 cm broad at base. Leaves 5-10 per branch. Leaf-sheaths imbricate; glabrous; auricle inconspicuous; oral setae present; deciduous. Leaf-sheath ligule a hairy membranous. Leaf-blade 2.5-3.5 cm long; 0.5-0.8 cm broad; triangular to lanceolate; stiff; glabrous on both sides; tessellate venation; margins cartilagenous; serrulate; midrib clear on the lower side; tip pungent; hard; spinous; scabrous; base truncate.

**INFLORESCENCE** Inflorescence a dense panicle; with racemes of 3-15 fertile spikelets. Panicle open; lanceolate; terminal.

**FERTILE SPIKELET** Spikelets comprising upto 3-florets. Spikelets purple coloured ; 1.5-2.1 cm long.

**GLUMES** Glumes persistent; shorter than the spikelet. Sterile glumes 2; stiff coriaceous; 0.4-0.5 cm long; ovate triangular; lanceolate; chartaceous; without keels; 1-veined. First glume lateral veins absent; apex attenuate; awned. Second glume ovate; 0.6-0.7 cm long; chartaceous; without keels; seven veined; attenuate; awned.

**FLORETS** Fertile lemma ovate-triangular; lanceolate; 0.8-0.9 cm long; coriaceous; without keel; 7-veined; surface scabrous; apex acute; stiff awned. Palea membranous; lanceolate; 0.8-0.9 cm long; keels contiguous above a sulcus; scabrous; apex scaberulous. Apical sterile florets resemble fertile floret, though underdeveloped.

**FLOWER** Lodicules 3; 0.1-0.2 cm long; hyaline, thin; flat; obtuse; 2-3 nerved; margins fimbriate. Stamens 3; 0.4-0.5 cm long; yellowish; free. Ovary elliptic; glabrous. Style short. Stigma 2; plumose.

**FRUIT** Caryopsis with persistent style; apex unappendaged; hilum linear.

**DISTRIBUTION** Asia-tropical. This species is distributed in high altitude grasslands of Southern India and Sri Lanka. In Southern Western Ghats, it is found growing in Eravikulam and Anamudi from 2000-2695 m.



Figure 4. *Arundinaria densifolia* Munro **A.** habit; **B.** culm sheath; **C.** flowering branch

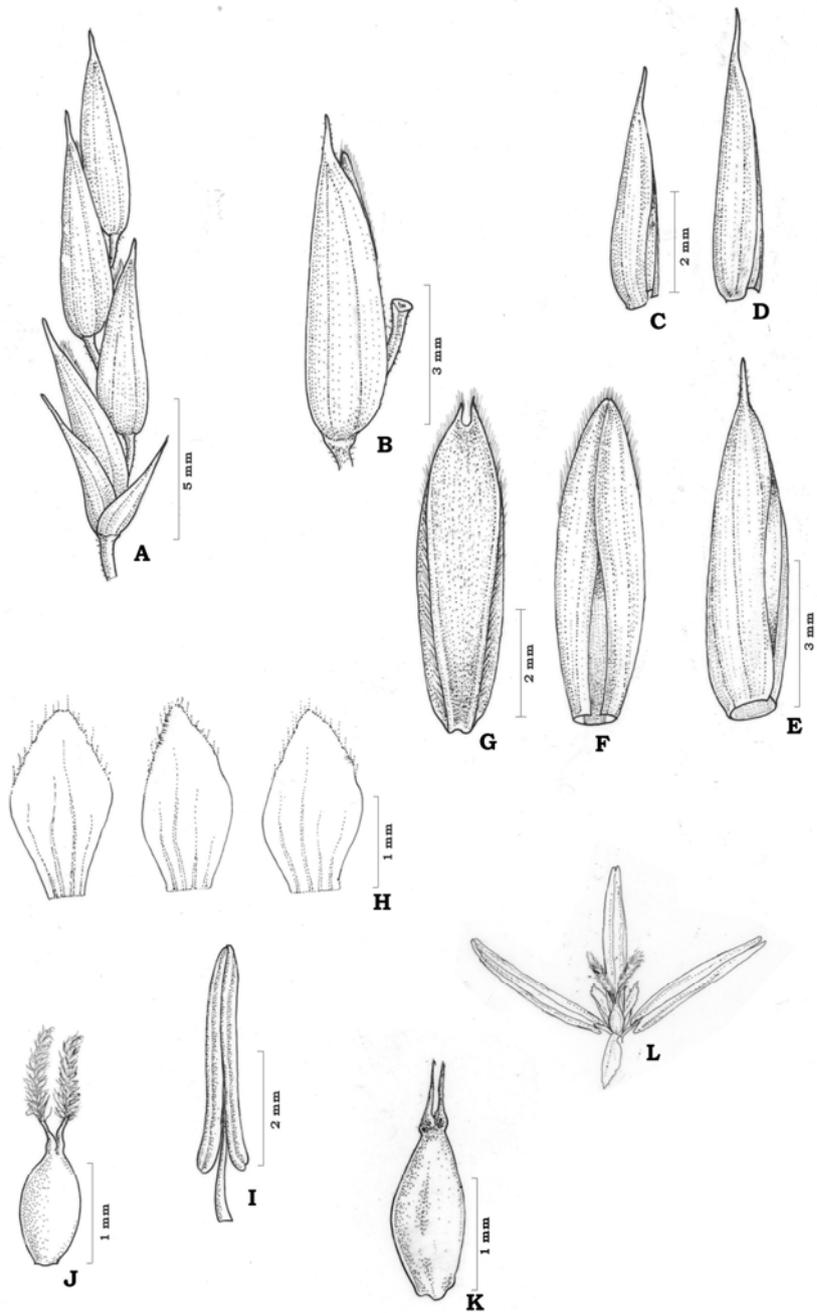


Figure 5. *Arundinaria densifolia* Munro **A.** spikelet; **B.** floret; **C. & D.** sterile glumes; **E.** lemma; **F.** palea-inner side; **G.** palea-surface view; **H.** lodicules; **I.** stamen; **J.** ovary with style; **K.** fruit; **L.** open floret (diagrammatic)

*Specimens examined:* KERALA: Idukki Dist. Anamalai, *M Remesh & Stephen Sequiera* 20732 (KFRI); Eravikulam, *Manju C Nair* 20649 (KFRI).

**NOTES** Kishore Kumar and Kumar (1997) reported *A. microphylla* from southern Western Ghats. A critical study of this specimen revealed that it was *A. densifolia*.

***Arundinaria floribunda*** Thwaites, Enum. Pl. Zeyl. 475. 1864; Munro in Trans. Linn. Soc. London 26: 20. 1868; Gamble, Ann. Roy. Bot. Gard. Calcutta 7: 5, t.3.1896 & in Hook. f., Fl. Brit. India 7: 377.1897; E. G. Camus, Les Bamb. 28. 1913; Rama Rao, For. Pl. Travancore 446. 1914; *Indocalamus floribundus* (Thwaites) Nakai, J. Arn. Arb. 6: 148. 1925; Soderstr. & R.P. Ellis, Smith. Contr. Bot. 72: 14. 1988; *Sinarundinaria floribunda* (Thwaites) Chao & Renvoize, Kew Bull. 44: 356. 1989; Tewari, Monogr. Bamb. 101. 1992; Seethalakshmi & M. Kumar, Bamb. India Comp.270. 1998; Ohrnberger, Bamb. World 46. 1999. [Figures 6 and 7; Plate 2].

**Type:** Sri Lanka, Matturatte district, 5000 ft. *Thwaites* s.n. (holotype PDA ; Isotype K., MH).

**HABIT** Perennial; caespitose. Rhizomes sympodial; pachymorph; solid; short necked; covered with scales. Culms erect; 1.5-2.5 m tall; woody; hollow; tip straight. Culm-internodes 15-20 cm long; 1-1.3 cm diameter; light-green; glabrous; thin walled with purplish black spots. Culm-nodes slightly swollen; sheath scar and supranodal ridge prominent; sheath scar clothed with ring of golden brown hairs; single branch bud present; enclosed in a prophyllum. Branches arise from the mid culm nodes; numerous; subequal; the central branch develops first; numerous laterals arise from its basal buds. Culm-sheaths 8-12 cm long; 2.5-5 cm broad at base; thin, papery and clothed with bulbous based maroon hairs when young; striate; sparsely hirsute; deciduous when old. Culm-sheath blade erect or reflexed; glabrous; linear-lanceolate; margins ciliate; narrow towards the tip acuminate; deciduous, 1.5-3.5 cm long, 0.2-0.4 cm at base; auricle short with short ciliate bristles. Culm-sheath ligule inner, very short; outer not prominent. Leaves 5-10 per branch. Leaf-sheaths imbricate; smooth; coriaceous; striate; auricle inconspicuous; bristles numerous; deciduous. Leaf-sheath ligule inner one, short; outer ligule not prominent. Leaf-blade lanceolate; 4-12 cm long; 0.5-1.8 cm

wide; glabrous; transverse veinlets present; margins scabrous; midrib narrow prominent; tip acuminate, base attenuate; petiole very short.

**INFLORESCENCE** **Inflorescence** a large panicle. Panicle open; with appressed branches which later become spreading; terminal branches glabrous; base pulvinous.

**FERTILE SPIKELETS** Spikelets comprising 5-8 florets. Spikelets purple, hirsute; 1.8-2.1 cm long; covered with minute silky pubescence. Pedicels short. The uppermost spikelets usually the smallest; sterile; each spikelet separated by a rachilla segment. Rachilla flat; glabrous at the base; pubescent upwards.

**GLUMES** Sterile glumes 2. First glume ovate; glabrous; 0.2-0.3 cm long; ciliate at apex, acute. Second ovate-lanceolate; 0.4-0.5 cm long; glabrous, many nerved; upper edge ciliated; apex mucronate.

**FLORETS** Fertile lemma lanceolate; 0.5-0.7 cm long; membranous; many-nerved; mucronate; scabrous; apex ciliate. Palea membranous; almost same size of the lemma; glabrous; apex bicuspidate; scaberulous. Keels 2 and with 2 broad wings; sulcate between keels; ciliate, ovate-lanceolate.

**FLOWER** Lodicules 3; upto 0.2 cm long; hyaline; ovate, 2-3-nerved; fimbriate; ciliate. Stamens 3; short; 0.4-0.5 cm long; yellow; filaments free. Ovary glabrous; globose. Style short. Stigma 2; plumose.

**FRUIT** Caryopsis; style persistent.

**DISTRIBUTION** It is distributed in South India and Sri Lanka at high altitudes. In South India, it is growing in Munnar on the way to Anamudi and Berijam from 1600-2200 m.



Figure 6. *Arundinaria floribunda* Thwaites **A.** leafy branch; **B.** culm sheath; **C.** flowering branch

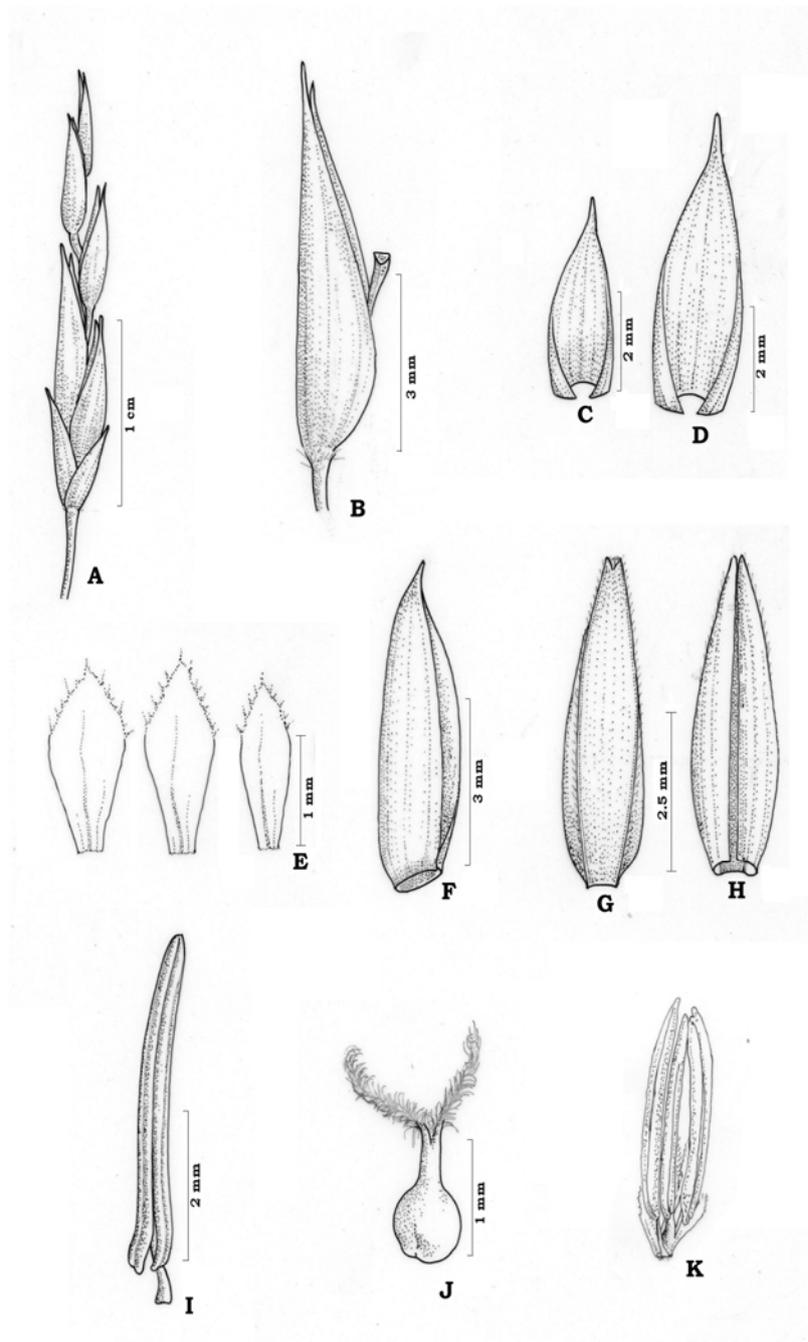


Figure 7. *Arundinaria floribunda* Thwaites **A.** spikelet; **B.** floret; **C. & D.** sterile glumes; **E.** lodicules; **F.** lemma; **G.** palea-surface view; **H.** palea-inner view; **I.** stamen; **J.** ovary with style; **K.** open floret (diagrammatic)

*Specimens examined:* KERALA: Idukki Dist. Mannavan Shola, *K Kishore Kumar 16401* (KFRI); Mannavan Shola, *M Remesh & N Unnikrishnan 20617* (KFRI); Mannavan Shola, *M Kumar & Stephen 7890* (KFRI); Munnar, *M Remesh & Stephen Sequiera 20639* (KFRI); Munnar, Top Station, *M Remesh & N Unnikrishnan 20738* (KFRI); Munnar, Top Station, *N Unnikrishnan 74023* (CALI); Way to Anamudi, *N Unnikrishnan 74026* (CALI). TAMIL NADU: Madurai Dist. Kodaikanal, Tiger Shola, *M Remesh & N Unnikrishnan 20616* (KFRI).

*Arundinaria walkeriana* Munro, Trans. Linn. Soc. London 26: 21. 1868; Gamble, Ann. Roy. Bot. Gard. Calcutta 7: 3.1896 & in Hook. f., Fl. Brit. India 7: 377, t.1. 1897; Brandis, Indian Trees 664. 1906; E. G. Camus, Les Bamb. 27. 1913; Rama Rao, For. Pl. Travancore 446. 1914; *Indocalamus walkerianus* (Munro) Nakai, J. Arn. Arb. 6: 148. 1925; Blatt., Indian For. 55(10): 542. 1929; C.E.C. Fisch. in Gamble, Fl. Pres. Madras 1857.1934; Soderstr. & R.P. Ellis, Smith. Contr. Bot. 72: 24. 1988; *Sinarundinaria walkeriana* (Munro) Chao & Renvoize, Kew Bull. 44.354.1989; *Yushania walkeriana* (Munro) R.B. Majumdar in Karthikeyan *et al.*, Fl. Ind. Enum. Monocotyl. 282. 1989; Tewari, Monogr. Bamb. 101. 1992; Seethalakshmi & M. Kumar, Bamb. India Comp.287. 1998; Ohrnberger, Bamb. World 165. 1999. [Figures 8 and 9; Plate 3].

**Type:** Sri Lanka, *Walker 96* (lectotype, K. selected by Soderstrom & Ellis, 1988).

**HABIT** Perennial; caespitose; gregarious; dense, shrubby. Rhizomes short; sympodial; pachymorph; necked. Culms erect; 1.5-3 m tall; hollow. Culm-internodes smooth; 0.5-1.2 cm long; 1-1.2 cm diameter; pale green. Culm-nodes slightly swollen; sheath scar and supranodal ridge prominent; a single nodal bud on each node; enclosed in a prophyllum. Branches arise from the lower nodes; the central axis and two laterals develop first; lateral buds develop 25-30 subequal branches. Culm-sheaths 4-6 cm long, 1-2.6 cm broad at base; papery; coriaceous; densely covered with golden brown bulbous based hairs; when young striate; sparsely hirsute; auricles not prominent, oral setae delicate, silky; deciduous. Culm-sheath ligule inner, prominent; 0.1-0.2 cm high; outer ligule not prominent. Culm-sheath blade erect; 1-2 cm long; 0.2-0.4 cm broad at base; narrow towards the apex; margin ciliate; tip acute, spiny. Leaves upto 6 per branch. Leaf-sheaths imbricate; striate;



Figure 8. *Arundinaria walkeriana* Munro **A.** leafy branch; **B.** culm sheath; **C.** flowering branch

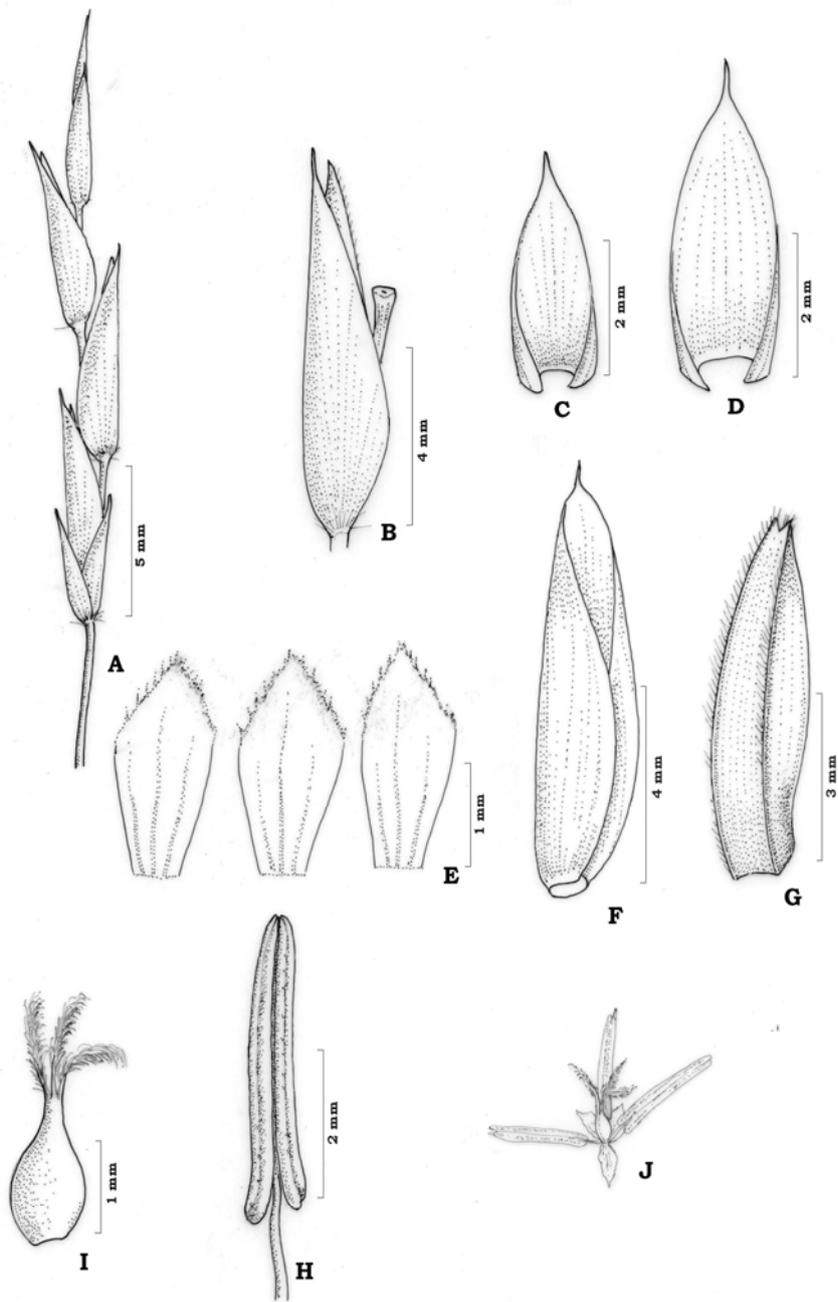


Figure 9. *Anundinaria walkeriana* Munro **A.** spikelet; **B.** floret; **C. & D.** sterile glumes; **E.** lodicules; **F.** lemma; **G.** palea; **H.** stamen; **I.** ovary with style; **J.** open floret (diagramatic)

glabrous; auricles inconspicuous; with delicate bristles; deciduous. Leaf-sheath ligule 0.1-0.2 cm high; membranous; plicate. Leaf-blade 6-10 cm long; 1.5-3.5 cm wide; ovate-lanceolate; glabrous on both side; veinlets transverse; prominent; tessellate venation; margins cartalagenous; scabrous, tip strongly spinose; scabrous; midrib prominent on the lower sides; base attenuate; leaf almost sessile.

**INFLORESCENCE** Inflorescence a spreading; terminal; compound panicle; terminal on leafy branches.

**FERTILE SPIKELET** Spikelets 3-4 florets. Spikelet 2-2.5 cm long; upper most sterile, smallest. Rachilla segment narrow; purplish; flat and glabrous below.

**GLUMES** Sterile glumes 2; 0.3-0.4 cm long, ovate or ovate-lanceolate. First glume short. Second mucronate.

**FLORETS** Fertile lemma lanceolate; 0.6-0.7 cm long; mucronate; ciliate long the margins; glabrous; many nerved. Palea almost equal to lemma; 0.4-0.6 cm long; thin; 2-keeled and with 2 wings; keels ciliate; bifid at the tip, ciliate.

**FLOWER** Lodicules 3; almost of equal size; hyaline; upto 0.2 cm long; 2-3 nerved; margins fimbriate; ciliate. Stamens 3; 0.3-0.4 cm long; filaments free; short; yellowish, obtuse. Ovary glabrous; swollen. Style short. Stigmas 3; feathery.

**FRUIT** Caryopsis with a short beak; slightly sulcate on one side.

**DISTRIBUTION** *A. walkeriana* is distributed in South India and Sri Lanka. It is found growing from an elevation of 1800-2200. In South India, it is found growing in Agasthyamala and Eravikulam.

*Specimens examined:* KERALA: Idukki Dist. Eravikulam, *Manju C Nair 20648* (KFRI); Kottamala, *Jomy Augustine 17779* (CALI). Trivandrum Dist. Agasthyamala, *N Mohanan 4283* (CALI); Agasthyamala, *N Unnikrishnan 74044* (CALI).

*Arundinaria wightiana* Nees, Linnaea 9: 182. 1834; Munro, Trans. Linn. Soc. London 26: 19. 1868; *Arundinaria wightiana* var. *hispida* (Steud.) Gamble, Ann. Roy. Bot. Gard. Calcutta 7: 5.1896; Gamble, Ann. Roy. Bot. Gard. Calcutta 7: 4, t. 2. 1896 & in Hook. f.,

Fl. Brit. India 7: 377. 1897; Brandis, Indian Trees 664. 1906; Bourd., For. Trees Travancore 397. 1908; E. G. Camus, Les Bamb. 28. 1913; Rama Rao, For. Pl. Travancore 446. 1914; *Indocalamus wightianus* (Nees) Nakai, J. Arnold Arbor. 6: 149. 1925; Blatt., Indian For. 55(10): 542. 1929; Bahadur, Ind. J. For. 2: 240. 1979; *Sinarundinaria wightiana* (Nees) Chao & Renvoize, Kew Bull. 44: 356. 1989; *Yushania wightiana* (Nees) R.B. Majumdar in Karthikeyan *et al.*, Fl. Ind. Enum. Monocotyl. 283. 1989; Tewari, Monogr. Bamb. 103. 1992; Seethalakshmi & M. Kumar, Bamb. India Comp. 289. 1998; Ohrnberger, Bamb. World 166. 1999. [Figures 10 and 11; Plates 4 and 4a].

**Type:** India, Nilgiri, *Wight* 1797 (lectotype CAL !. Isolectotype K. designated here).

**Typification:** This species was first collected by Wight from Nilgiris. This specimen was deposited at CAL. A duplicate of this specimen was deposited at K and typified by Chao and Renvoize (1989a) as the (Isotype). The specimen at CAL with the number 1797 is designated here as the (Lectotype) and the specimen deposited at K with the same number is designated as the (Isolectotype).

**HABIT** Perennial; caespitose; gregarious; shrubby. Rhizomes short; sympodial; pachymorph; solid. Culms 2.5-4 m tall; hollow; erect. Culm-internodes 20-35 cm long; 0.8-1.7 cm diameter; dark green; slightly flattened on one side; scaberulous. Culm-nodes swollen; sheath scar and supranodal ridge prominent; sheath scar clothed by hairs to form a ring at the nodal region; a branch bud is present on each node enclosed in a prophyllum. Branches arise from the lower nodes; numerous, sometimes up to 50 subequal branches; semiverticillate on the nodes. Culm-sheaths 11-15 cm long; thin, papery; golden yellow coloured; hirsute with bulbous based golden brown hairs when young; base with a ring of golden brown hairs, sparsely hirsute; auricle inconspicuous with delicate bristles; bristles deciduous. Culm-sheath ligule inner, short; often fimbriate; outer ligule not prominent. Culm-sheath blade linear; 2.5-3 cm long, 0.3-0.6 cm broad at base; erect or reflexed; deciduous; scabrid. Leaves arise on branches. Leaf-sheaths imbricate; striate; hirsute; keeled; margins ciliate; tip with a short auricle and stiff bristles. Leaf-sheath ligule inner, very short; dentate; outer not prominent. Leaf-blade linear-lanceolate; 6-17 cm long, 0.8-2 cm broad; glabrous on both sides, scabrous along the veins on the lower side; midrib prominent on the lower side; margins scabrous; tessellate venation; tip acute; base attenuate; petiole short.

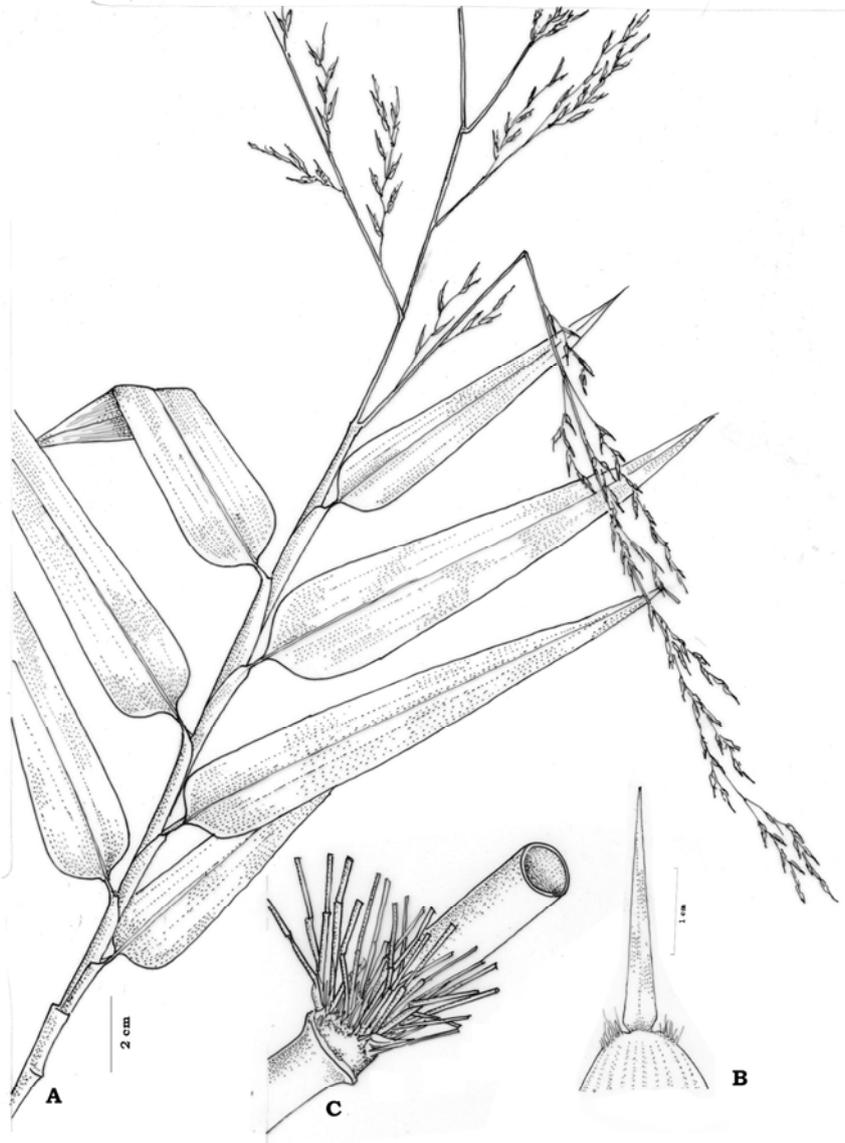


Figure 10. *Arundinaria wightiana* Nees **A.** flowering branch; **B.** culm sheath; **C.** branching

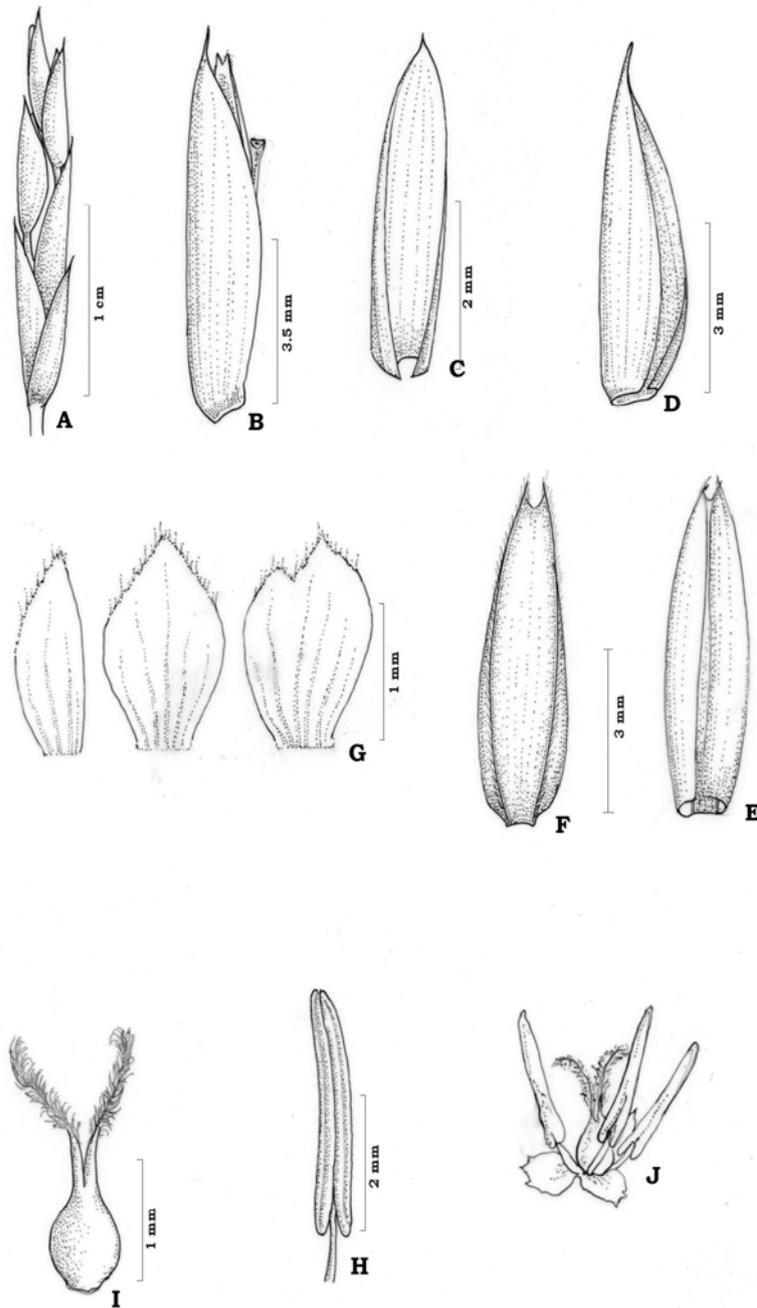


Figure 11. *Arundinaria wightiana* Nees **A**. spikelet; **B**. floret; **C**. sterile glumes; **D**. lemma; **E**. palea-inner side; **F**. palea-surface view; **G**. lodicules; **H**. stamen; **I**. ovary with style; **L**. open floret (diagrammatic)

**INFLORESCENCE** Inflorescence a dense panicle at terminal leafy branches. Panicle open; ovate. Rachilla hairy. Axils of branchlets glandular.

**FERTILE SPIKELET** Spikelets comprising 2-3 florets; rarely 4. Spikelet purple coloured; hirsute; 1.5-1.8 cm long; the terminal flower sterile. Rachilla flat; ciliate.

**GLUMES** Sterile glumes 2; 0.4-0.5 cm long; 4-5-nerved; almost of the same size, ovate-acute.

**FLORETS** Fertile lemma ovate-acuminate; mucronate, hispid towards the apex; 0.5-0.7 cm long; without keel; 9-11 nerved; surface smooth, or scabrous; apex obtuse. Palea ovate; 0.4-0.5 cm long; bifid at apex; two-keeled; hirsute along the keels; slightly sulcate between the keels with transverse nerves.

**FLOWER** Lodicules 3; ovate-obtuse; 0.1-0.2 cm long; 2-3-nerved; hyaline; margins fimbriate; ciliate. Stamens 3; filaments free, short; 0.4-0.5 cm long. Anthers yellowish-brown. Ovary glabrous; globose. Style short, entire at the base. Stigmas 2; plumose.

**FRUIT** Caryopsis with adherent pericarp; ellipsoid; sulcate on one side.

**DISTRIBUTION** This is a high altitude species endemic to South India. It grows in open mountain tops and also a component of semi-evergreen forests and sholas. In South India, it is common in the Nilgiri Biosphere Reserve, from 1800-2400 m.

*Specimens examined:* KERALA: Palakkad Dist. Sispara, *JS Gamble 13359* (DD); Sispara, *M Remesh & TR Viswakumar 20647* (KFRI); Mutthikulam, *M Remesh & Stephen Sequiera 20713* (KFRI). TAMIL NADU: Nilgiri Dist. Dodapetta, *JS Gamble 20724* (DD); Dodapetta, *JS Gamble 20733* (MH); Dodapetta, *JS Gamble 20733* (CAL); Dodapetta, *JS Gamble 17453* (CAL); Dodapetta, *M Remesh & N Unnikrishnan 20618* (KFRI); Dodapetta, *N Unnikrishnan 74010* (CALI); Coonoor, *JS Gamble 11997* (DD); Coonoor, *JS Gamble 11797* (MH); Nilgiris, *RH Beddome 88778* (CAL); Nilgiris, *RH Beddome* (s.n.) (MH); Mukkuruthi, *M Remesh & Stephen Sequiera 20623* (KFRI).

Subtribe: **Bambusinae** J. Presl.

**Bambusinae** J. Presl, Rel. Haenk. 1: 256. 1830; Clayton & Renvoize, Kew Bull. Addl. ser. 13, 48. 1989; Soderstr. & R.P. Ellis in Soderstr. *et al.* (eds.), Proc. Int. Symp. Grass Syst. Evol. 234. 1987; S. Dransf. & Widjaja (eds.), Plant Reso. S. E. Asia 7: 34. 1995; Ohrnberger, Bamb. World 19. 1999.

*Type: Bambusa* Schreb.

*Bambusoidea* Munro, Trans. Linn. Soc. London 26: 131. 1868; *Dendrocalaminae* Benth., J. Linn. Soc. Bot. 19: 31. 1881; *Eubambuseae* Gamble, Ann. Roy. Bot. Gard. Calcutta 7: 28. 1896; *Hickeliinae* E. G. Camus, Compt. Rend. Acad. Sci. 179: 480. 1924.

**HABIT** Perennial; medium sized or arborescent; caespitose; gregarious. Rhizomes sympodial; pachymorph. Culms erect; sometimes climbing; woody; armed or unarmed. Culm-internodes hollow or sometimes solid. Culm-nodes flat or with ridges. Branching intravaginal at mid-culm nodes; primary branch buds solitary; branch buds broad at nodal line; secondary branches from the lateral primordia; major primordium dormant within the prophyllum. Culm-sheaths deciduous. Leaves linear-lanceolate; pseudopetiolate.

**INFLORESCENCE** Inflorescence rarely simple; usually a compound panicle; composed of pseudospikelets. Spikelets in semiverticillate clusters; loosely packed.

**FERTILE SPIKELETS** Spikelets comprising 2-many-florets; upper most floret, usually reduced.

**GLUMES** Glumes 2 usually sterile.

**FLORETS** Palea sometimes 2-keeled.

**FLOWER** Lodicules 3, rarely 2 or lacking. Stamens 6, sometimes 3; filaments free or united. Ovary broadly conical; glabrous or hairy. Style short; sometimes long. Stigmas 3; plumose.

**FRUIT** Caryopsis.

The members of this large subtribe occur in the Old World tropics from Africa to India, South East Asia and China to northern Australia. They usually grow at low elevations. The members are with sympodial rhizomes and loose to dense clumps with hollow to solid

culms. The major genera are *Bambusa* and *Dendrocalamus*. Some of the genera distributed under this subtribe are presently, congeneric with *Bambusa* and *Dendrocalamus*. In South India, this subtribe is represented by three genera, *Bambusa*, *Dendrocalamus* and *Oxytenanthera*.

### ***Bambusa* Schreber**

This genus was originally described by Schreber (1789). When this name was proposed Schreber gave only a generic description. Later, he referred to *Bambos* Retzius as a synonym, without mentioning a species. The names *Bambusa* and *Bambos* were published in the same year and *Bambusa* was accepted as the correct name (Holttum, 1958).

In India, this genus is naturally represented by seven species. In South India, it was known to represent by one species *Bambusa bambos* and one variety, *B. bambos* var. *gigantea*. In the present study, the variety *Bambusa bambos* var. *gigantea* is synonymised and only one species is treated here.

***Bambusa*** Schreb., Caro. Linn. Gen. Pl. 1: 236. 1789; Munro, Trans. Linn. Soc. London 26: 87. 1868; Bedd., Fl. Sylv. S. India 3: 231. 1873; Gamble, Ann. Roy. Bot. Gard. Calcutta 7: 28. 1896 & in Hook. f., Fl. Brit. India 7: 395. 1897; C.E.C. Fisch. in Gamble, Fl. Pres. Madras 3: 1858. 1934; Holttum, Bamb. Malay. Penin. Gar. Bull. 16: 27. 1958; Clayton & Renvoize, Kew Bull. Addl. ser. 13, 53. 1989; Wong, Bamb. Penin. Malaysia 41: 84. 1995; S. Dransf. & Widjaja (eds.), Plant Reso. S.E. Asia 7: 17, 34. 1995; Zhu Shilin *et al.* (eds.), Comp. Chinese Bamb. 25-53. 1994; Seethalakshmi & M. Kumar, Bamb. India Comp. 31. 1998; Ohrnberger, Bamb. World 250. 1999.

**Type:** *Bambusa bambos* (L.) Voss.

**HABIT** Perennial. Rhizomes sympodial; pachymorph. Culms erect; stout or slender; closely or fairly close; woody tufted. Branches several to many, one dominant, sometimes with recurved branch-thorns at the node.

**INFLORESCENCE** Inflorescence composed of pseudospikelets, usually glumaceous, sometimes spathaceous.

**FERTILE SPIKELETS** Spikelets comprising 2-many florets. upper most 1 or 2, usually imperfect, rachilla jointed at the base of each

**FLORETS** Fertile lemmas broad and many veined. Palea 2-keeled.

**FLOWER** Lodicules 2 or 3. Stamens 6; filaments usually free; anthers sometimes apiculate with a tuft of hairs at the top. Ovary hairy at the apex. Style long or short ; 1-3 slender. Stigmas hairy.

**FRUIT** Caryopsis, almost cylindrical, hairy at top, slightly sulcate along the hilum.

**DISTRIBUTION** This is an Old World genus, distributed in the tropics and subtropics. *Bambusa* is distributed in India, Sri Lanka, Nepal, Bhutan, Bangladesh, Myanmar, Vietnam, China, Thailand, Japan, Malaysia, Singapore, Indonesia, Philippines, Papua New Guinea, Australia and Madagascar. In Australia, Madagascar and Africa, it is introduced under cultivation.

*Bambusa bambos* (L.) Voss. in Vilm., Blumeng. ed. 3, 1: 1189. 1896; Soderstr. & R.P. Ellis, Smith. Contr. Bot. 72: 19, t.30. 1988; Bennet & Gaur, Thirty Seven Bamb. India 19. 1990; Tewari, Monogr. Bamb. 33. 1992; Wong, Bamb. Penin. Malaysia 86. 1995; S. Dransf. & Widjaja (eds.), Plant Reso. S.E. Asia 7: 56. 1995; Xia & Stapleton, Kew. Bull. 52(3): 693. 1997; Seethalakshmi & M. Kumar, Bamb. India Comp.40. 1998; *Arundo bambos* L., Sp. Pl. 81. 1753; *Bambos arundinacea* Retz., Obs. Bot. 5: 24. 1788; Roxb., Pl. Corom. Coast 1: 56. 1798; *Bambusa arundinacea* (Retz.) Willd., Sp. Pl. 2, 1: 245. 1799; Gamble, Ann. Roy. Bot. Gard. Calcutta 7: 51, t.48. 1896; Holttum, Gard. Bull. Singapore 26: 59. 1958; Bedd., Fl. Sylv. S. India 231. 1873; Gamble in Hook. f., Fl. Brit. India 7: 395. 1897; Talbot, For. Fl. Bombay Pres. Sind. 2: 566. 1912; Blatt., Indian For. 55(10): 556. 1929; C.E.C. Fisch. in Gamble, Fl. Pres. Madras 3: 1859. 1934; Brandis, Indian Trees 671. 1906. *Bambusa arundinacea* (Retz.) Willd. var. *gigantea* Bahadur & Jain, Indian J. For. 4: 283. 1981; *Bambusa bambos* (L.) Voss. var. *gigantea* (Bahadur & Jain) Bennet & Gaur, Thirty seven bamboos India 21. 1990; **syn. nov.** [Figures 12 and 13; Plate 5].

**Type:** Sri Lanka, Hermann fol.15, s.loc. *Arundo indica* maxime cortice spinoso Tabaxir fundens. Mambu & Bambu dicta *Arundo arbor* B.Pin. Unaghas. (lectotype L. selected by Xia and Stapleton, 1997b).

**HABIT** Perennial; caespitose; arborescent. Rhizomes sympodial; pachymorph; solid ; short. Culms erect; 25-35 m tall; woody. Culm-internodes thick walled; 20-47 cm long; 6-18 cm diameter; bright green; hollow. Culm-nodes with aerial roots; nodes slightly swollen; sheath scar prominent; bearing a single nodal bud; enclosed in a prophyllum. Branches develop from the lower nodes; the central dominant branch develop first; 2-3 laterals produced from its lower nodes; braches recurved and



Figure 12. *Bambusa bambos* (L.) Voss. **A.** leafy twig; **B.** culm sheath; **C.** inflorescence

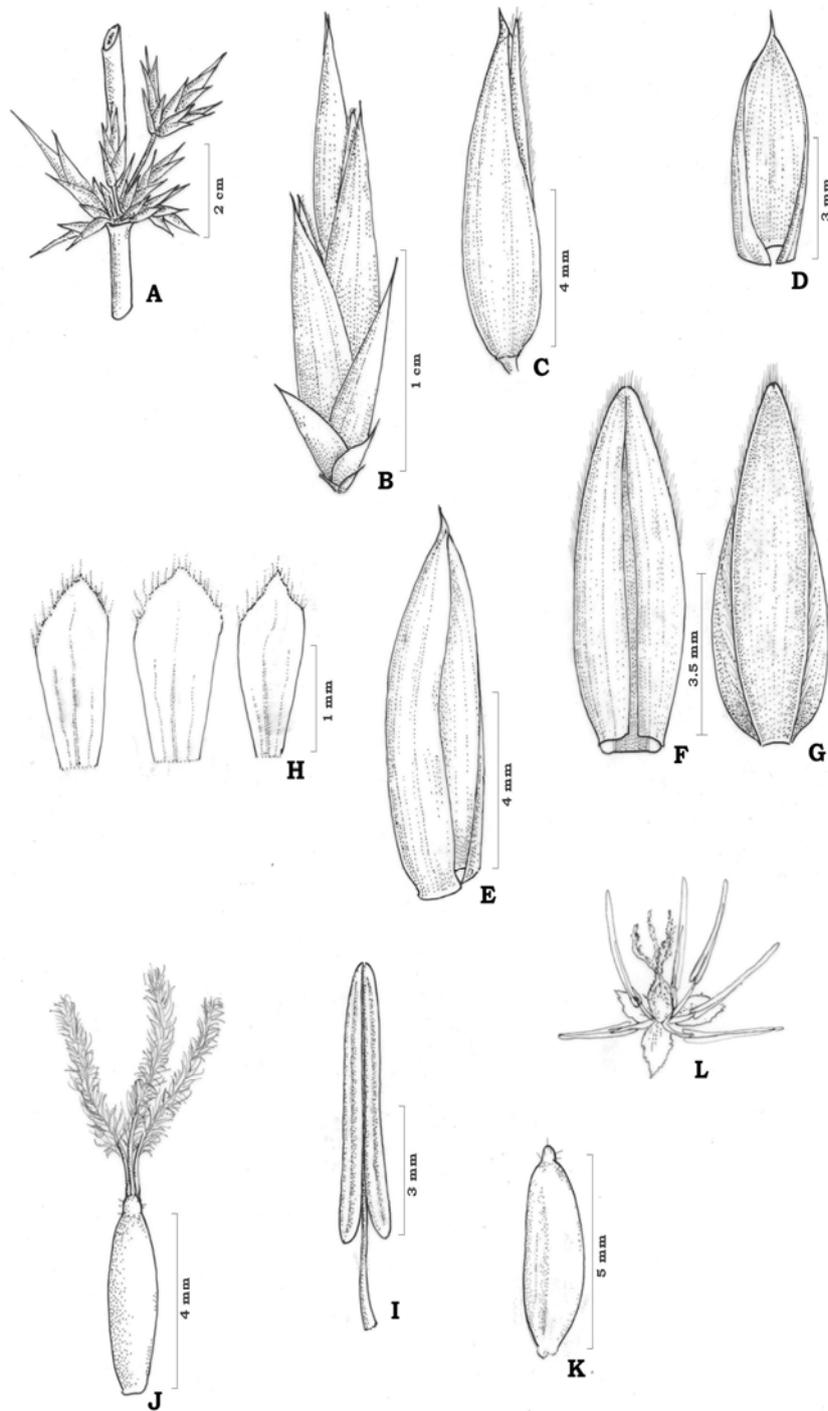


Figure 13. *Bambusa bambos* (L.) Voss. **A.** inflorescence; **B.** spikelet; **C.** floret; **D.** sterile glume; **E.** lemma; **F.** palea-inner side; **G.** palea-surface view; **H.** lodicules; **I.** stamen; **J.** ovary with style; **K.** fruit; **L.** open floret (diagrammatic)

bent downwards; become spine-like; the spiny branches long; whip-like drooping and form a dense cluster. Culm-sheaths 12-45 cm long; 10-36 cm wide at base; coriaceous, dark maroon or yellowish; thickly covered with bulbous based brown hairs when young; glabrous at maturity; striate; broad; sides almost parallel; tip truncate; wrinkled at the summit; thickly covered with brown tomentum; sometime bear thick marginal bristles, deciduous when the branches develop; auricle absent. Culm-sheath ligule inner, short; ciliate; brown membranous; outer ligule not prominent. Culm-sheath blade erect; 5-10 cm long; 6-12 cm wide at base; triangular; the base decurrent on the margins of the sheath; outer surface glabrous except at the wrinkled portion; inner side covered by velvety dark brown appressed hairs; margins involute; sharply pointed; persistent. Leaf-sheaths overlapping; striate; glabrous; auricle very short; oral setae soft, deciduous. Leaf-blade 6-20 cm long, 0.6-1.8 cm wide; linear-lanceolate; glabrous on both sides; scabrous along the margins; midrib clear on the lower surface; tip pointed; acuminate; base attenuate; narrows to a short flat petiole.

**INFLORESCENCE** Inflorescence a very large panicle; at first on terminating leafy branches; in small clusters at the nodes of leafless branches. Spikelets composed of pseudospikelets; sessile.

**FERTILE SPIKELETS** Spikelets comprising 3-4 fertile florets and 1-2 sterile florets; supported by 2-3 bracts. Spikelets cauducous; glabrous; lanceolate; acute; 1.8-2 cm long; consisting of rachilla internodes; very short often not visible; stiff; glabrous; angular.

**GLUMES** Sterile glume 0.4-0.5 cm long; ovate; mucronate; glabrous on back, short hairy near the apex; many-nerved.

**FLORETS** Fertile lemma ovate-lanceolate; 0.6-0.8 cm long; many nerved; glabrous; ciliate on the margins; mucronate. Palea almost equal in length to lemma, 0.6-0.7 cm long; 2-keeled; keels ciliate, broadly winged, tip obtuse, ciliate.

**FLOWER** Lodicules 3, 1-1.3 cm long, almost equal, obovate, hyaline, 3-4 nerved, apex acute, margin fimbriate, ciliate. Stamens 6, free; filaments long. Anthers 0.5-0.6 cm long, basifixed, yellow, exerted. Ovary elliptic, glabrous below, hairy at the tip. Style very short, ciliate. Stigmas 3; plumose.

**FRUIT** Caryopsis, elliptic, 0.5-0.6 cm long, glabrous, grooved on one side, short beaked, beak ciliate.

**DISTRIBUTION** This species is distributed in India, Southern China, Thailand, Burma, Java, Singapore, Peninsular Malaysia, Philippines and Sri Lanka. In South India, it is widely distributed in Andhra Pradesh, Karnataka, Kerala and Tamil Nadu. In Tamil Nadu and Andhra Pradesh, it grows in vast areas under dry climatic conditions. It is a highly resistant species having a wide distribution under different climatic as well as soil conditions. It is found growing from sea level to an elevation of 1200 m.

*Specimens examined:* ANDHRA PRADESH: Ananthapur Dist. Ananthapur, *N Unnikrishnan 74105* (CALI). Chittoor Dist. Mamandur, *D Rangacharyulu 1291* (MH). Cuddapah Dist. Siglabyle, *JS Gamble 20860* (DD); Lankamalai RF, *SRS Reddy 13176* (SKU). East Godavari Dist. Bhupatipalam, *T Pullaiah & MN Gayathri 12249* (SKU). Krishna Dist. Enamadala, *P Venkanna 5510* (MH). Visakhapatnam Dist. Arkavally, *N Unnikrishnan 74103* (CALI). KARNATAKA: Kodagu Dist. Sonwarpet, *AS Rao 85506* (BSI); Vir Rajapetta, *N Unnikrishnan 74201* (CALI). Mysore Dist. Bandipur RF, *BD Naithani 23139* (MH). KERALA: Idukki Dist. Mullakkudy, *BD Sharma 43848* (MH). Kannur Dist. Pariyaram, *R Ansari 67868* (MH); Panathur, *VJ Nair 59951* (MH). Kollam Dist. Punalur, *CN Mohanan 5579* (MH). Malappuram Dist. Nilambur, *SK Jain 22748* (DD); Malaparamba, *VV Sivarajan 144* (CALI). Palakkad Dist. Panthanthode, *E Vajravelu 33125* (MH). Kottayam Dist. Changanassery, *VJ Antony 1150* (MH). Thrissur Dist. Shornur, *EK Janakiammal* (s.n.) (DD); Athirapally, *BV Shetty 33496* (MH). Wayanad Dist. Sulthan Bathery, *JL Ellis 18680* (MH); Thirunelli, *M Remesh & SKM Basheer 20702* (KFRI); Kottiyur, *N Unnikrishnan 74211* (CALI). TAMIL NADU: Chennai Dist. Adayar, *JS Gamble 207603* (DD). Coimbatore Dist. Bennai RF, *KN Subramanian 135* (DD); Siruvani, *AN Henry 693* (MH). South Arcot Dist. South Arcot, *CA Barber 1000* (MH). Thirunelveli Dist. Courtallam, *KKN Nair 1192* (CALI).

**NOTES** *Bambusa arundinacea* var. *gigantea* was first described as *B. arundinacea* var. *gigantea* by Bahadur and Jain (1981). Subsequently the name was changed to *B. bambos* var. *gigantea*. This species was reported from Palakkad District of Kerala, and was published without any illustration, or mention of the type material. In 2001, this species flowered at Chittoor Dam site, Palakkad district, Kerala. The detailed study of the flowers showed that it does not differ from *Bambusa bambos* in its floral characters except the size of the plants. The plants in the FRI campus, Dehra Dun, under cultivation Bennet and Gaur (1990b) were also studied.

The size difference may be due to the edaphic and climatic conditions and a varietal status cannot be assigned. Therefore, in this work *Bambusa bambos* var. *gigantea* is synonymised under *Bambusa bambos*.

### ***Dendrocalamus* Nees**

This genus was first described by Nees (1834). This genus is closely related to *Bambusa* but can be distinguished by the presence of single-keeled prophylls throughout the inflorescence (Stapleton, 1994a). The inflorescence is highly branched and forms compact capitulum. The spikelets are short with long styles and lodicules absent.

***Dendrocalamus*** Nees, *Linnaea* 9(4): 476. 1834; Munro, *Trans. Linn. Soc. London* 26: 146. 1868; Bedd., *Fl. Sylv. S. India* 3: 235. 1873; Gamble, *Ann. Roy. Bot. Gard. Calcutta* 7: 77. 1896 & in Hook. f., *Fl. Brit. India* 7: 403. 1897; *Klemachloa* Parker *Indian For.* 58: 7. 1932 ;C.E.C. Fisch. in Gamble, *Fl. Pres. Madras* 3: 1857. 1934; McClure, *Sinocalamus* Lignan *Univ. Sci. Bull.* 9: 66. 1940; Holttum, *Bamb. Malay. Penin. Gar. Bull.* 16: 29. 1958; Keng. f., *Neosinocalamus* *J. Bamb. Res.* 2: 148. 1983; Soderstr. & R.P. Ellis in Soderstr. *et al.* (eds.), *Proc. Int. Symp. Grass Syst. Evol.* 235. 1987; Clayton & Renvoize, *Kew Bull. Addl. ser.* 13, 54. 1989; Stapleton, *Edinb. J. Bot.* 51(1): 20. 1994; S. Dransf. & Widjaja (eds.), *Plant Reso. S.E. Asia* 7: 17. 1995; Seethalakshmi & M. Kumar, *Bamb. India Comp.* 99. 1998; Ohrnberger, *Bamb. World* 282. 1999.

**Type:** *Dendrocalamus strictus* (Roxb.) Nees

**HABIT** Perennial; arborescent. Rhizomes short; sympodial; pachymorph. Culms strong; erect; 10-15m tall; woody; usually thick walled; sometimes solid; without nodal roots, or with prop roots, or rooting from lower nodes, or with root dots on the nodes, or with areal roots from the nodes. Culm-internodes terete. Culm-nodes flush with internodes, or swollen. Branch complements one, or several; with subequal branches, the primary branch dominates; thinner than stem. Culm-sheaths persistent, or tardly deciduous, or decidous; without auricles or auriculate. Culm-sheath blade usually reflexed; narrowly triangular or lanceolate; constricted at base, or narrower than sheath or as wide as sheath at base. Leaf-sheath auricles absent, or erect, or falcate. Leaf-sheath ligule membranous, eciliate, or ciliolate, or ciliate. Leaf- blades persistent, or decidous at the ligule; linear, or lanceolate, or oblong, or ovate; midrib conspicuous. Leaf-blade base without a false petiole, or with a petiole like connection to sheath.

**INFLORESCENCE** Inflorescence bractiferous; clustered at the nodes; in globose clusters, or stellate clusters; leafy between clusters, or leafless on bare branches. is Fertile spikelets sessile. Pseudospikelets present.

**FERTILE SPIKELETS** Spikelets comprising 0-1 basal sterile floret; 1-6-fertile florets; with or without rachilla extension, or with diminished florets at the apex. Spikelets lanceolate, or elliptic, or oblong, or ovate; laterally compressed, or subterete. Rachilla internodes short upto lowest fertile floret, or elongatd between glumes; definite.

**GLUMES** Glumes 2-3, or several; persistent; shorter than spikelet. First glume ovate, or orbicular; chartaceous, or coriaceous; without keels, or 1 keeled. Second glume lanceolate, or ovate, or orbicular, or obovate; chartaceous, or coriaceous; without keels, or 1 keeled .

**FLORETS** Basal florets sterile. Fertile lemma ovate, or orbicular, or obovate; without auricles, or auriculate at base; membranous, or chartaceous, or coriaceous; without keels, or keeled; wingless. Palea 2 -keeled, or imperfectly keeled. Palea surface glabrous, or puberulous, or pubescent; apex entire, or dentate; keels eciliate, or puberulous, or ciliolate, or ciliate.

**FLOWER** Lodicules absent; rarely present; glabrous, or ciliate. Stamens 3-6; filaments usually free. Ovary unappendaged; glabrous, or with a few apical hairs. Stigmas 1-3; plumose, or pubescent.

**FRUIT** Caryopsis with adherent pericarp; oblong, or ovoid, or orbicular, or obovate; apex rostrate; hilum linear.

**DISTRIBUTION** This genus is distributed in the tropics and subtropics. It is found growing in tropical Asia, different parts of China, throughout India, Myanmar, Malaysia, Philippensis and Papua New Guinea. In India, six native species are distributed. In South India, this genus was known to represent by one species. In the present study, a new combination under the genus *Dendrocalamus* was added.

*Key to the species of Dendrocalamus*

- 1a. Culms tomentose, without powdery mass when young, culm sheath with prominent auricle and persistent bristles, blade narrow, lanceolate, spikelet glabrous, thin, lanceolate..... *D. stocksii*
- 1b. Culms glabrous with white powdery mass on the surface when young, culm sheath with inconspicuous auricle and bristles, blade short, triangular, spikelets hirsute, stout, ovate .....*D. strictus*

*Dendrocalamus stocksii* (Munro) M. Kumar, Remesh & Unnikrishnan, **comb. nov.**, Sida 21(1):93-96, 2004. [Figures 14 and 15; Plates 6 and 6a]

**Type:** India, Concan, *Stocks* s.n. (lectotype K. designated here, Cibachrome seen).

*Oxytenanthera stocksii* Munro, Trans. Linn. Soc. London 26: 130. 1868; Bedd., Fl. Sylv. S. India 3: 233. 1873; Gamble, Ann. Roy. Bot. Gard. Calcutta 7: 75 t. 66. 1896; Gamble in Hook. f., Brit. India 7: 403. 1897; Brandis, Indian Trees 674. 1906; Talbot, For. Fl. Bombay Pres. Sind. 2: 570. 1912; E. G. Camus, Les Bamb. 149. 1913; Rama Rao, For. Pl. Travancore 446, 447. 1914; C.E.C. Fisch. in Gamble, Fl. Pres. Madras 3: 1861. 1934; Varmah & Bahadur, Indian For. Rec. (n.s.) Bot. 6(1): 4. 1980 ; *Pseudotenanthera stocksii* (Munro) R.B. Majumdar in Karthikeyan *et al.*, Fl. Ind. Enum. Monocotyl. 280. 1989 ; *Pseudoxytenanthera stocksii* (Munro) Naithani, J. Nat. Hist. Soc. 87: 440. 1990; Tewari, Monogr. Bamb. 129. 1992.

**Typification:** This species was first collected by Stocks from Concan (Gamble, 1896). Two sheets of these specimens were deposited at Kew herbarium (K). Munro (1868) in his description of this species labelled both these specimens as *Dendrocalamus stocksii*. But, he described it as *Oxytenanthera stocksii*. Both these specimens are without any number or the year. On one of the sheets, the locality is written as Concan, Stocks. This specimen is selected for typification and designated here as the (Lectotype).

**HABIT** Perennial; arborescent; gregarious. Rhizomes short; sympodial; pachymorph. Culms 12-16 m tall; erect; woody. Culm-internodes terete; solid; 20-38 cm long; 2.5-4 cm diameter, yellowish-green, covered with soft greyish-white pubescens when young, glabrous at maturity; distally glabrous, or pubescent. Culm-nodes slightly swollen; sheath scar prominent; nodal ridge prominent; each node bear a single nodal bud enclosed in a prophyllum; lower nodes have aerial roots. The central dominant branch arises first. Lateral braches dendroid; primary and secondary branches rebranch at their nodes; intravaginal; apex straight. Culm-sheaths 12-25 cm long; 10-15 cm broad at base; striate, coriaceous; hirsute; covered with bulbous based brownish hairs; concavely truncateat apex; auriculate; 0.2-0.3 cm long, clothed with numerous, erect, stiff, bristles, bristle persistent; setose on shoulders. Culm-sheath ligule prominent; conspicuous; 0.8-1 cm high; deeply



Figure 14. *Dendrocalamus stocksii* (Munro) M. Kumar, Remesh & Unnikrishnan **comb. nov.** **A.** leafy branch; **B.** culm sheath; **C.** inflorescence

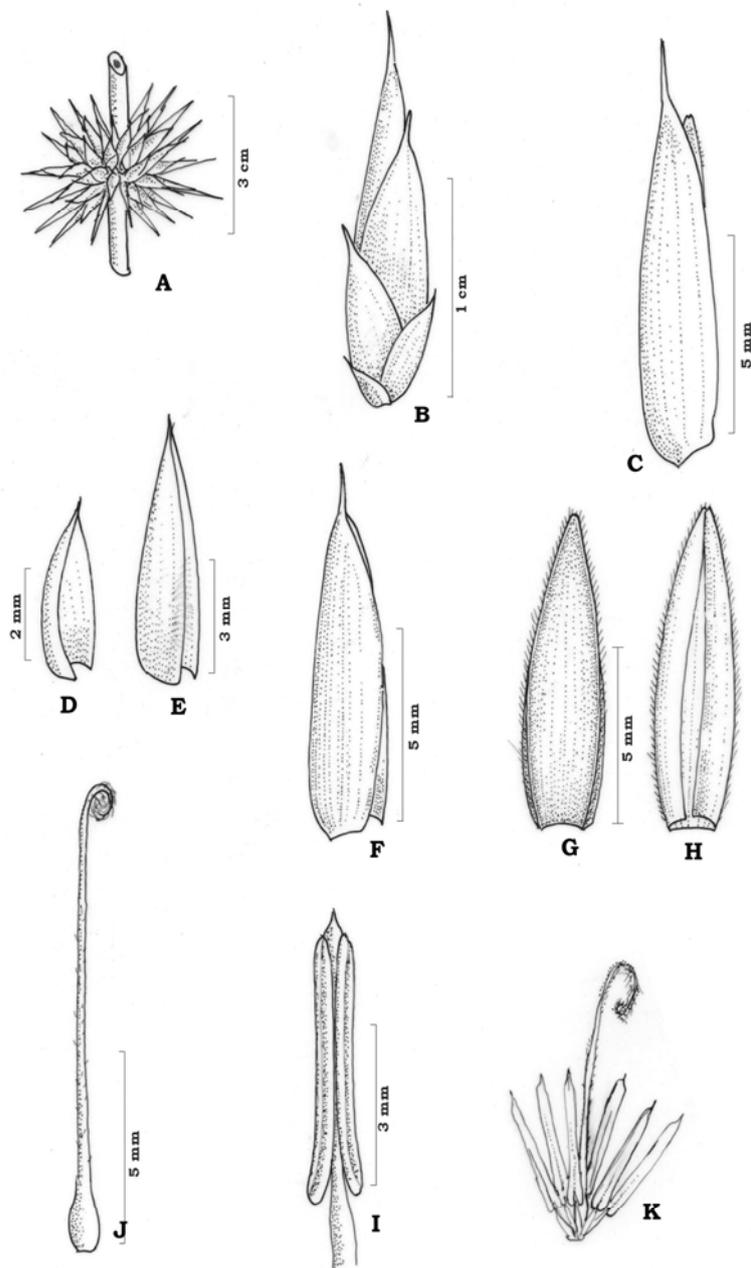


Figure 15. *Dendrocalamus stocksii* (Munro) M. Kumar, Remesh & Unnikrishnan **comb. nov.**

**A.** portion of inflorescence; **B.** spikelet; **C.** floret; **D. & E.** sterile glumes; **F.** lemma; **G.** palea-surface view; **H.** palea-inner view; **I.** stamen; **J.** ovary with style; **K.** open floret (diagrammatic)

fimbriate. Culm-sheath blade linear; erect; subulate; 5-8 cm long; 0.8-1.4 cm broad at base; striate; involute; glabrous; persistent; acuminate. Leaf-sheaths striately veined; glabrous, or pubescent. Leaf-sheath ligule short, eciliate membranous; erose; 0.1-0.2 cm high; outer ligule inconspicuous. Leaf-blades linear-lanceolate; 6-25 cm long; 0.8-2.5 cm wide; leaf blade dorsal side glabrous; ventral side faintly hirsute; one of the margins and apex acute, ending in a setaceous point; midrib narrow; scabrous; prominent on the lower side; base attenuate; leaf-blade base with a small petiole like connection to sheath; petiole 0.2 cm long.

**INFLORESCENCE** Inflorescence bractiferous panicle; verticillate clusters, or large globose heads at the nodes; 2.5 cm long; dense; with axillary buds at base of spikelet; prophyllate below lateral spikelets; leafless between clusters.

**FERTILE SPIKELETS** Spikelets comprising 2 fertile florets. Spikelets lanceolate; laterally compressed; 1.2-1.5 cm long; 0.1-0.2 cm wide; glabrous; mucronate; without rachilla extension. Fertile and sterile spikelets mixed.

**GLUMES** Glumes 2; similar; 0.4-0.7 cm long; shorter than spikelet. First glume ovate-lanceolate; glabrous; without keels; apex acuminate; mucronate; many-nerved.

**FLORETS** Fertile lemma ovate-lanceolate; 1-1.2 cm long; mucronate; strongly spinose; apex acuminate. Palea slightly shorter than lemma; 3-4-nerved; 2-keeled; ciliate on the keels; tip obtuse, convolute.

**FLOWER** Lodicules absent. Stamens 6. filaments short; free. Anthers exerted; 0.4-0.5 cm long; basifixed; apiculate; apex ciliate. Ovary ovate; sparsely hirsute. Style ciliate; 0.8-1 cm long. Stigma 1; plumose.

**FRUIT** Caryopsis with adherent pericarp. Hilum linear.

**DISTRIBUTION** It is endemic to southern peninsular India and distributed in northern Kerala and Karnataka along Concan coast up to Karwar. It is also found distributed in Goa and Mahabaleshwar in Maharashtra. It is found growing from sea level to an altitude of 800 m. It is widely cultivated in Karnataka and northern Kerala.

*Specimens examined:* KARNATAKA: North Kanara Dist. Coompta, WA Talbot 269 (BSI); Flora of North Kanara WA Talbot 549974 (CAL). KERALA: Kasaragod Dist.

North Kasargod, *Bamboo Products Exports 140317* (DD); Kanjangad, *VP Raveendran 20637* (KFRI). Thrissur Dist. Palapilly, *N Unnikrishnan 74039* (CALI); Palapilluy, *M Remesh & M Kumar 20646* (KFRI).

**NOTES** *Oxytenanthera stocksii* was first described by Munro (1868). It was first collected by Stocks from Concan, Karnataka. Munro labelled the herbarium sheet of Stocks as *Dendrocalamus stocksii*. The resemblance of this species with *Dendrocalamus* was first mentioned by Gamble (1896). He pointed out the similarity of the narrow leaves, long petiole and the culm sheath with that of *Dendrocalamus strictus*. The culms and branching of *Oxytenanthera stocksii* also resembles with that of *Dendrocalamus* group. In *Oxytenanthera stocksii* and *Dendrocalamus* the basal nodes bear aerial roots. The culms are erect, the internodes are short, the lumen of the culm is narrow and sometimes solid and the lower nodes bear aerial roots. The inflorescence of *D. stocksii* is a large panicle of spikate heads. It is similar to the inflorescence of the genus *Dendrocalamus*. In both, the species the spikelets are few flowered and lodicules are absent. In *O. stocksii* and in *Dendrocalamus* the palea is keeled, and ciliate on the keels. The palea of the upper flower in both cases is not keeled. The stamens are shortly apiculate. In *O. stocksii* the style is sparsely ciliate and ends in a single feathery stigma. The style of *Dendrocalamus* is also ciliate and ends in a single feathery stigma.

*Oxytenanthera stocksii* differs from *O. bourdillonii* in growth habit and culm characters. *Oxytenanthera bourdillonii* is a large arborescent bamboo with long internodes. The culm wall is thin and culm sheath is very specific. Stamens are monadelphous and strongly apiculate. The stigma is divided into three. The type genus of *Oxytenanthera* is *O. abyssinica* of Africa. *Oxytenanthera stocksii* differs from the type in two important characters. In *O. abyssinica* stamens are monadelphous and the style is divided into three stigmas. In *O. stocksii* the stamens are free and the style monostigmatic. The above observations strongly support the separation of the species *Oxytenanthera stocksii* from the genus *Oxytenanthera* and support its placement under the genus *Dendrocalamus*.

***Dendrocalamus strictus*** (Roxb.) Nees, *Linnaea* 9(4): 476. 1834; Munro, *Trans. Linn. Soc. London* 26: 147. 1868; Bedd., *Fl. Sylv. S. India* 3: 235. 1873; Gamble, *Ann. Roy. Bot. Gard. Calcutta* 7: 78, t. 68, 69. 1896 & in Hook. f., *Fl. Brit. India* 7: 404. 1897; Brandis, *Indian Trees* 675. 1906; Bourd., *For. Trees Travancore* 401. 1908; Talbot, *For. Fl. Bombay Pres. Sind.* 2: 567. 1912; Rama Rao, *For. Pl. Travancore* 446, 448. 1914; E. G. Camus, *Les Bamb.* 152. 1913; Blatt., *Indian For.* 55(11): 593. 1929; C.E.C. Fisch. in Gamble, *Fl. Pres. Madras* 3: 1858. 1934; Holttum, *Bamb. Malay. Penin. Gar. Bull.* 16: 98. 1958; Bennet &

Gaur, Thirty Seven Bamb. India 61. 1990; Tewari, Monogr. Bamb. 77. 1992; Stapleton, Edinb. J. Bot. 51(1): 26. 1994; S. Dransf. & Widjaja (eds.), Plant Reso. S.E. Asia 7: 93. 1995; Seethalakshmi & M. Kumar, Bamb. India Comp.129. 1998; Ohrnberger, Bamb. World 291. 1999 [Figures 16 and 17; Plate 7].

**Type:** India, Andhra Pradesh, East Godavari district, Devipatanam CA Barber 4929 (neotype MH designated here).

**Typification:** *Dendrocalamus strictus* was first described by Roxburgh (1798) as *Bambos stricta* based on the specimen collected from the Coromandel coast. Roxburgh's collections were destroyed in an inundation (King, 1895). Roxburgh's original illustration is rather stylized and not adequate for typification (Stapleton, 1994a). Therefore, neotypification was essential for *D. strictus*. Barber in 1902 collected *D. strictus* from Devipatanam, Godavari district, Andhra Pradesh. These specimens were deposited at MH. During this study, the specimens deposited at MH were critically verified and found that most suitable for neotypification. The specimens of *Dendrocalamus strictus* collected by Barber and deposited at MH are selected here as the *Neotype*.

**HABIT** Perennial; caespitose: gregarious; densely tufted. Rhizomes short; sympodial; pachymorph. Culms 8-15 m tall; erect; woody; slightly arched at the apex. Culm-internodes terete; solid, or with a small lumen; 20-35 cm long; 4-7 cm diameter; yellowish green; long; sparsely covered with white powdery mass when young. Culm-nodes faintly swollen; sheath scar prominent; nodal ridge conspicuous, aerial roots arise from the basal nodes. Branches arise from the lower nodes; central primary branch dominant; strong. Lateral branches 3-4; branches of the upper nodes are long, drooping; extravaginal. Culm-sheaths striate; papery; glabrous; deciduous when old; tip truncate; 12-22 cm long; 4-6 cm wide; coriaceous, covered with golden brown hairs when young; auricle very short; aural setae present. Culm-sheath ligule 0.1-0.2 cm long; outer ligule inconspicuous. Culm-sheath blade almost triangular; erect; 5-8 cm long; 2-3.5 cm broad; smooth; persistent. Leaves arise on branches. Leaf-sheath overlapping; hirsute when young; striate; lateral sides at the tip projecting to a prominent callus; auricle short, ciliate; Leaf-sheath ligule inconspicuous. Leaf-blade linear-lanceolate; 7-24 cm long; 1-2.4 cm wide; dorsal surface rough and hirsute; lower side softly hirsute; scabrous along the margins; midrib prominent on the lower

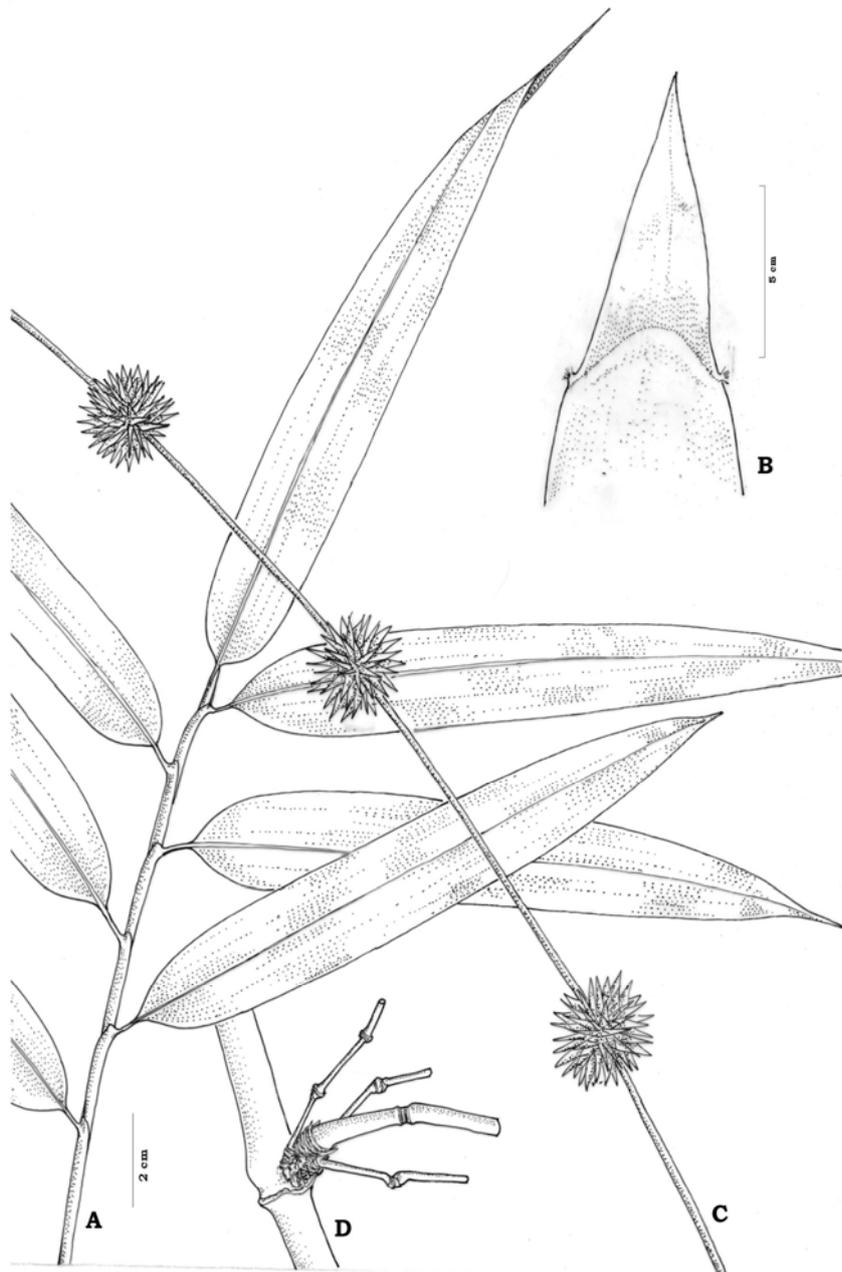


Figure 16. *Dendrocalamus strictus* (Roxb.) Nees **A.** leafy branch; **B.** culm sheath; **C.** inflorescence; **D.** branching

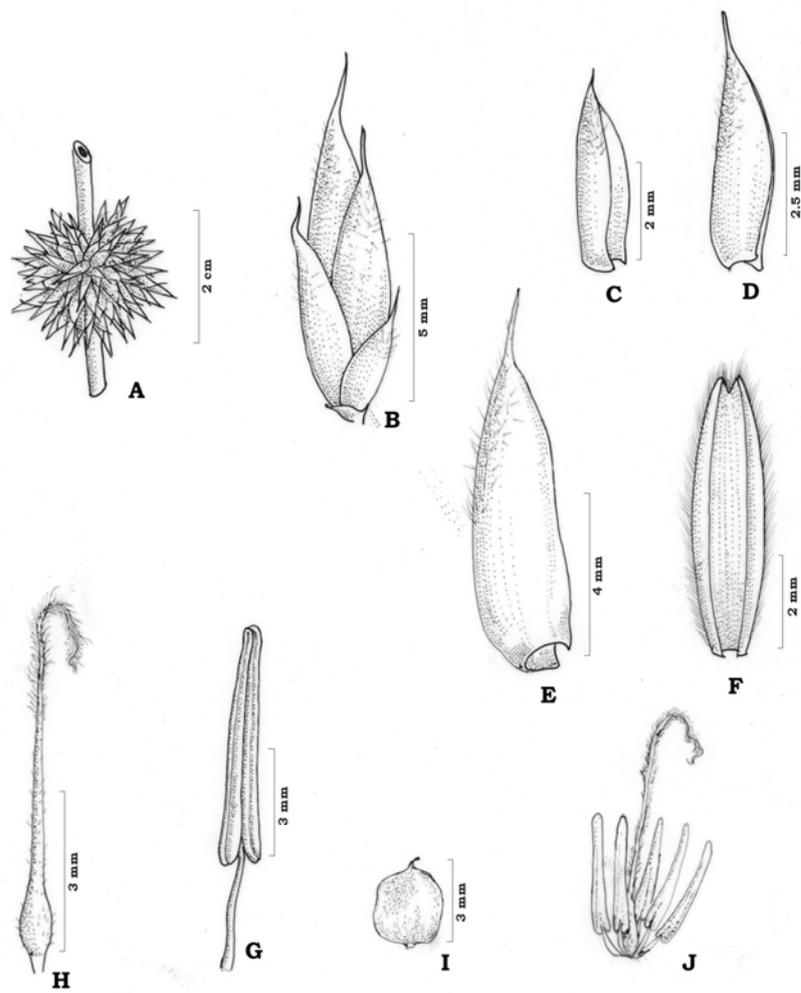


Figure 17. *Dendrocalamus strictus* (Roxb.) Nees **A.** portion of inflorescence; **B.** spikelet; **C. & D.** sterile glumes; **E.** lemma; **F.** palea; **G.** stamen; **H.** ovary with style; **I.** fruit; **J.** open floret (diagramatic)

side, pellucid dots present on the lamina; apex acuminate; base attenuate to a short petiole.

**INFLORESCENCE** Inflorescence bractiferous panicle; verticillate clusters, or in large globose heads at the nodes; 2.5 cm long; dense. with axillary buds at base of spikelet. Spikelets prophyllate below lateral spikelets; leafless between clusters.

**FERTILE SPIKELETS** Spikelets 2-3-florets. Spikelets ovate; hirsute; 0.8-0.1 cm long; sharply spinous.

**GLUMES** Sterile glumes 2. Fertile and sterile glumes intermixed; hirsute; ovate; 0.4-0.5 cm long; spiny; many- nerved.

**FLORETS** Fertile lemma ovate-lanceolate; strongly spinescent; hirsute; 0.7-0.8 cm long. Palea ovate; 0.6-0.7 cm long; 2-keeled; ciliate on the keels; emarginated; convolute. Palea of the uppermost floret not keeled.

**FLOWER** Lodicules absent. Stamens 6; free; filaments long. Anthers short; 0.6-0.7 cm long; exerted; slightly apiculate. Ovary turbinate; short stalked; hirsute. Style 0.5-0.6 cm long; ciliate. Stigma single; plumose.

**FRUIT** Caryopsis obovate to subglobose; reddish-brown; beaked with persistent style.

**DISTRIBUTION** It is distributed in India, Nepal, Bangladesh, Myanmar and Thailand. It is one of the most common bamboos in India. In South India, it is distributed in Andhra Pradesh, Karnataka, northern Kerala and Tamil Nadu. This species is found distributed from sea level to an altitude of 800 m.

*Specimens examined:* ANDHRA PRADESH: Adilabad Dist. Debumallaloddi, *T Ravisankar* 85227 (MH); Sadarmott, *T Pullaiah & PV Prasanna* 4104 (SKU). Anantapur Dist. Kalasamudram RF, *N Yesoda* 398 (MH). East Godawari Dist. Devipatanam, *CA Barber* 4929 (MH); Bhupatipalam, *T Pullaiah & MS Gayathri* 12251 (SKU). Kurnool Dist. *JS Gamble* 18698 (MH); way to Nallamalis, *JL Ellis* 32572 (MH); Velugode, *SK Wagh* 4937 (BLAT). Visakapatnam Dist. Arkavalley, *N Unnikrishnan* 74102 (CALI). KARNATAKA: Uttara Kanara Dist.: s.loc. *WA Talbot* 1788 (BSI); Dandeli, *J Fernandez* 1061 (BLAT). Carvar, *WA Talbot* 1824 (BSI). KERALA: Malappuram Dist. Nilambur, *N Unnikrishnan* 74106 (CALI). Palakkad Dist. Nelliampathy, way to Kaikatty, *Stephen Sequiera* 7593 (KFRI);

Mukkali, *M Kumar & Stephen Sequiera* 7896 (KFRI); Parambikulam, *SKM Basheer* 20722 (KFRI). TAMIL NADU: Coimbatore Dist. Varadimalai, *CEC Fischer* 2753 (DD). Chennai Dist. Adayar, *JS Gamble* 20810 (DD). Nilgiri Dist. Coonoor, *JS Gamble* 11536 (DD).

**NOTES** *Dendrocalamus strictus* has a very wide distribution in India, especially in areas under dry climatic conditions. It is a drought resistant species. In South India, it is common in the States of Andhra Pradesh, Tamil Nadu and Karnataka. In Kerala, it has only a restricted distribution in the northern part. It is commonly known as male bamboo. The culms are very strong with a narrow lumen or sometimes solid. The gregarious flowering cycle varies from 25-45 years. But, sporadic flowering is common in this species. During this study, flowering was observed at Arkavally, Andhra; Nelliampathy and Marayoor, Kerala.

Subtribe: **Bambusinae** J.Presl

#### ***Munrochloa*** M. Kumar & Remesh

*Munrochloa* a new genus was erected and described based on a bamboo species, which was described under the genus *Oxytenanthera* Munro. A new combination *Munrochloa ritchiei* (Munro) M. Kumar & Remesh, was proposed.

This genus is similar to *Oxytenanthera* Munro in general appearance and inflorescence type but differs in the presence of solid culms; clothed with silky white tomentum on the surface; imperfectly keeled; midculm prophyllum buds; palea without keels and monostigmatic ovary.

***Munrochloa ritchiei*** (Munro) M.Kumar & Remesh, J. Bot.Res.Inst.Texas (1): 374.2008; *Bambusa ritchiei* Munro, Trans. Linn. Soc. London 26: 157. 1868; *Oxytenanthera monostigma* Bedd., Fl. Sylv. S. India 3: 233. 1873; Gamble, Ann. Roy. Bot. Gard. Calcutta 7: 74, t. 65. 1896 & in Hook. F., Fl. Brit. India 7: 402. 1897; Brandis, Indian Trees 674. 1906; Bourd., For. Trees Travancore 400. 1908; *Oxytenanthera ritchiei* (Munro) Blatt. & McCann, J. Bombay Nat. Hist. Soc. 33: 773. 1929, "ritcheyi"; Nair & Ansari, J. Econ. Tax. Bot. 3: 616. 1982; C.E.C. Fisch. In Gamble, Fl. Pres. Madras 3: 1861. 1934; *Pseudotenanthera ritchiei* (Munro) R. B. Majumdar in Karthikeyan *et al.*, Fl. Ind. Enum. Monocotyl. 280. 1989; *Pseudoxytenanthera ritcheyi* (Munro) Naithani, J. Bombay Nat. Hist. Soc. 87: 440. 1990; Tewari, Mongr. Bamb. 127. 1992; Seethalakshmi & M. Kumar,

Bamb. India Comp.225. 1998; *Pseudoxytenanthera ritchiei* (Munro) Ohrnberger, Bamb. World 313. 1999. [Figures 18 and 19; Plate 8 and 8a]

**Type:** India, Bombay, Kalanuddi, *Ritchie* 820 (Lectotype K, designated here).

**HABIT** Perennial; caespitose; gregarious. Rhizomes sympodial; pachymorph; long-necked.

Culms erect; 3-5 m tall; strong, solid. Culm-internodes 25-34 cm long; 2.5-5 cm diameter; densely clothed with golden yellow to white velvet tomentum; smooth at maturity. Culm-nodes slightly swollen; sheath scar and nodal ridge prominent; nodal bud present; enclosed in a prophyllum. Branches arise from the lower nodes; the central primary branch dominant; 3-4 secondary branches develop from its lowermost nodes to form a cluster. Culm-sheaths deciduous; 15-26 cm long, 6-9 cm wide at base; coriaceous; sparsely hirsute; with bulbous based golden brown hairs; margins papery; brittle; striate, shining, glabrous at maturity; conical, gradually attenuate towards apex; apex narrow with a semi-round sinus; auricles absent. Culm-sheath ligule, inner 0.4-0.5 cm high; membranous, fimbriate at apex, outer ligule inconspicuous. Culm-sheath blade erect; 12-24 cm long; 1.2-3 cm wide; narrow; glabrous; linear-lanceolate; persistent. Leaves arise on branches. Leaf-sheath ligule, inner prominent. Leaf-blades linear-lanceolate; pale green; glabrous on both sides; scabrous along one of the margins; base attenuate to a very short petiole.

**INFLORESCENCE** Inflorescence a large compound spikate panicle; terminal; in dense globose heads.

**FERTILE SPIKELET** Spikelets comprising usually 1 floret, sometimes 2 florets. Spikelets lanceolate; 1.5-1.8 cm long, 0.2 cm wide, both fertile and sterile mixed; glabrous, mucronate, spinose.

**GLUMES** Sterile glumes 2-3; stiff; coriaceous; glabrous; ovate or ovate-lanceolate; mucronate; many-nerved. First one 0.2-0.3 cm long. Second 0.3-0.4 mm. Third 0.5-0.7 mm long.

**FLORETS** Fertile lemma linear-lanceolate; 1.4-1.6 cm long; glabrous; coriaceous towards the base; apex strongly mucronate; spinose. Palea 1.2-1.4 cm long; membranous; glabrous; concave; margins folded towards inside and ciliate towards apex; narrow; acute.

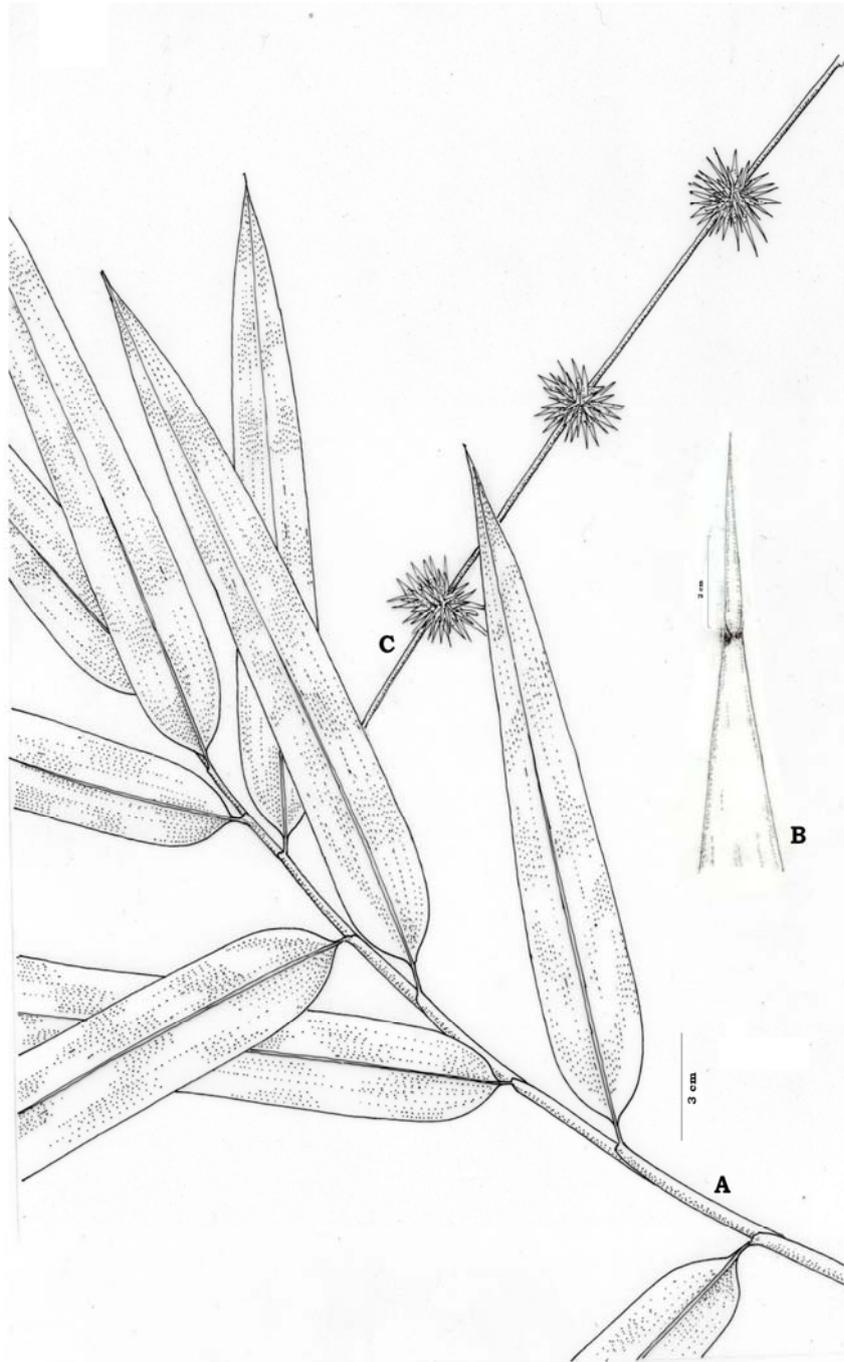


Figure 18 . *Munrochloa ritchiei* (Munro) M.Kumar & Remesh **A.** leafy branch; **B.** culm sheath; **C.** inflorescence

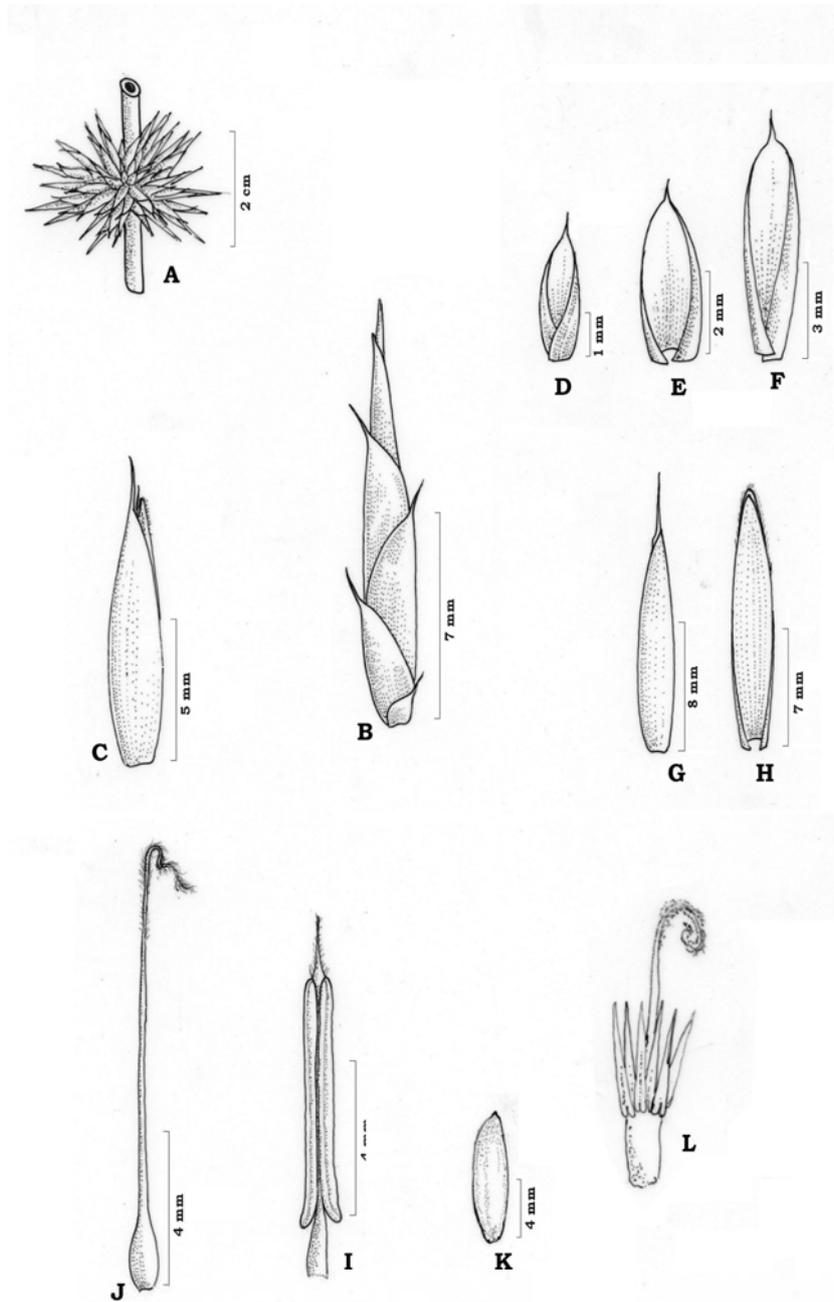


Figure 19. *Munrochloa ritchiei* (Munro) M.Kumar & Remesh **A.** portion of inflorescence; **B.** spikelet; **C.** floret; **D., E. & F.** sterile glumes; **G.** lemma; **H.** palea; **I.** stamen; **J.** ovary with style; **K.** fruit; **L.** open floret (diagrammatic)

**FLOWER** Stamens 6; monadelphous. Anthers 0.6-0.8 cm long, exerted; strongly apiculate; apex ciliate. Ovary glabrous; ovate. Style 1.2-1.4 cm long; slightly ciliate towards the apex. Stigma single; curved; plumose.

**FRUIT** Caryopsis; linear-oblong; faintly grooved ;small beaked.

Specimens examined: INDIA, KARNATAKA: Uttara Kannda Dist. *s. loc.*, 1884, WA Talbot 583 (BSI); Feb 1889 WA Talbot 906 (CAL); Dandeli, 21 Jan 1924, RN Sarkar 2142 (DD). KERALA: Kannur Dist. Panathur, 28 Jan 1979, VJ Nair 59948 (MH); 28 Jan 1979, Panathady, 28 Jan 1979, VS Ramachandran 59291 (MH). Malappuram Dist. Nilambur, 11 Feb 1934, HG Champion 1135 (DD); Manikkamudy, 6 Feb 2001, M Remesh & N Unnikrishnan 20650 (KFRI); Vazhikkadavau, 7 Aug 1983, Philip Mathew 34163 (CALI). Palakkad Dist. Manthanpotti, 20 Nov 1999, M. Kumar & Stephen Sequiera 20635 (KFRI).

**DISTRIBUTION** This species is endemic to Western Ghats. It is distributed in northern Kerala and Karnataka. It was also reported from Maharashtra. It is found growing upto an altitude of 200-1100 m.

**NOTES** While working on the revisionary studies on the genera *Oxytenanthera* Munro, *Pseudoxytenanthera* Soderstrom & Ellis, it was observed that the position of the species *Pseudoxytenanthera ritchiei* (Munro) Naithani *sensu lato* was found to be inadequate under the genus *Pseudoxytenanthera* due to certain characters confined to this taxon. Detailed morphological studies revealed that the species possess unique characters, which are very distinct from, the generic characters of *Oxytenanthera* and *Pseudoxytenanthera*. Therefore, a new generic concept is required to accommodate the species.

### **Inter generic affinities**

The genus *Munrochoa* is allied to *Dendrocalamus*, *Oxytenanthera*, *Pseudoxytenanthera* and *Gigantochloa*. The habit and habitats of this taxon resembles *Denrocalamus stocksii* and *Dendrocalamus strictus* both having thick walled culms. *Munrochloa ritchiei* possess solid culms with imperfectly keeled prophyllum. In *Munrochloa* spikelets are usually supported with leaf sheaths. The spikelets are single flowered. The palea is without any

keels. The stigma is monostigmatic. The inter generic affinity of the *Munrochloa* shows a linkage between *Dendrocalamus* and *Oxytenanthera* and distinct generic key characters.

**Key to *Munrochloa* and allied Genera**

- 1a. Floret with undivided stigma.....2
- 1b. Floret with stigma, divided into three.....3
- 2a. Culms hollow, mid-culm prophylls and palea keeled.....4
- 2b. Culms fully solid, mid-culm prophylls and palea not keeled.....*Munrochloa*
- 3a. Culms erect.....*Oxytenanthera*
- 3b. Culms scandent or climbing.....*Pseudoxytenanthera*
- 4a. Inflorescence strongly packed in semiverticellate clusters  
of spikelets, filaments free..... *Dendrocalamus*
- 4b. Inflorescence loosely packed in semiverticellate clusters  
of spikelets, filaments united.....*Gigantochloa*

***Oxytenanthera* Munro**

This genus was originally described by Munro (1868). It is closely related to the genus *Dendrocalamus*. The loosely arranged culms, strongly apiculate anthers and presence of three stigmas separate this genus from *Dendrocalamus*.

*Oxytenanthera* Munro, Trans. Linn. Soc. London 26: 126. 1868; Benth. & Hook. f., Gen. Pl. 3: 1211. 1883; Gamble, Ann. Roy. Bot. Gard. Calcutta 7: 68. 1896 & in Hook. f., Fl. Brit. India 7: 400. 1897; Brandis, Indian Trees 673. 1906; Bourd., For. Trees Travancore 400. 1908; Talbot, For. Fl. Bombay Pres. Sind. 2: 567. 1912; E. G. Camus, Les Bamb. 143. 1913; Blatt., Indian For. 55(11): 591. 1929; C.E.C. Fisch. in Gamble, Fl. Pres. Madras 3: 1860. 1934; Soderstr. & R.P. Ellis in Soderstr. *et al.* (eds.), Grass Syst. Evol. 235. 1987; *Pseudoxytenanthera* Soderstr. & R.P. Ellis, Smith. Contr. Bot. 72: 52.1988; Clayton & Renvoize, Kew Bull. Addl. Ser. 13, 56. 1989; *Pseudotenanthera* R.B. Majumdar in Karthikeyan *et al.*, Fl. Ind. Enum. Monocotyl. 280. 1989; Naithani, J. Bombay Nat. Hist. Soc. 87: 450. 1990; Seethalakshmi & M. Kumar, Bamb. India Comp.221. 1998; Ohrnberger, Bamb. World 311. 1999.

**Type:** *Oxytenanthera abyssinica* (A. Rich.) Munro

**HABIT** Perennial. Rhizomes sympodial; pachymorph; long-necked. Culms 6-10 m tall; erect, woody; hollow. Culm-nodes thick walled, or sometimes solid; girdle prominent.

Branching short; the primary axis is prominent with few secondary branches. Culm - sheaths abscissile. Leaves pseudopetiolate.

**INFLORESCENCE** Inflorescence indeterminate with pseudospikelets; spicate, globose clusters, spikelet condensed into a capitulum at the branch tip.

**FERTILE SPIKELETS** Spikelets comprising 1-2-florets. Spikelets narrow; long. Rachilla extension absent.

**FLOWER** Lodicules absent. Stamens 6; monadelphous. Ovary ovoid. Stigmas 1, or 3; plumose.

**FRUIT** Caryopsis. Pericarp distinct.

**DISTRIBUTION** *Oxytenanthera* is distributed in Africa, Sri Lanka and India. The type genus *O. abyssinica* is found in tropical Africa. Four species of this genus were known from India and all the species are distributed in South India. However, in the present treatise, one species is transferred to the genus *Dendrocalamus*, and another species have been separated to a new genus *Munrochloa*. Two species that are known from South India are endemic to southern peninsular India. Among this, recently, one species is found to occur in Sri Lanka.

**NOTES** Holttum (1956a) conducted studies on the ovary structure of this genus and considered it as a monotypic species. He also suggested that all other Asiatic species under the genus *Oxytenanthera* either belong to *Dendrocalamus* or *Gigantochloa*. But, later Pattanath and Rao (1969) and Grosser and Liese (1973) conducted anatomical studies of different species of *Oxytenanthera* including *O. abyssinica*. According to them, the anatomical structure of vascular bundles of different Asiatic species of *Oxytenanthera* is similar to the structure of vascular bundles of *O. abyssinica*.

Soderstrom and Ellis (1988) transferred *Oxytenanthera monadelpha* to a new genus *Pseudoxytenanthera*. Majumdar (1989) included the *Oxytenanthera* under a new genus *Pseudotenanthera*. According to Naithani (1990b) the name *Pseudotenanthera* was superfluous and treated it as a synonym of *Pseudoxytenanthera*. Therefore, all the South Indian species were included under the genus *Pseudoxytenanthera*. Soderstrom and Ellis (1988) justified their new combination, *Pseudoxytenanthera* referring to Holttum (1956a). However, their

justification is not relevant at the present context. *Pseudoxytenanthera monadelpha* resembles with the type genus *Oxytenanthera abyssinica* in key characters such as, loosely arranged culms, monadelphous stamens, keeled palea, strongly apiculate anthers and hairy style with three stigmas. Sharma, (1996) has rightly pointed out that the morphological characters such as, branching and whip-like culm apex alone, are not sufficient enough to separate this taxon from *Oxytenanthera* Munro.

In the present report the generic name *Oxytenanthera* is retained.

*Key to the species of Oxytenanthera*

- 1a. Culms erect, tip straight, culm sheath without auricle and auricular setae .....***O. bourdillonii***
- 1b. Culms semi-erect, tip whiplike, drooping, culm sheath with auricle and auricular setae.....***O. monadelpha***

***Oxytenanthera bourdillonii*** Gamble, Ann. Roy. Bot. Gard. Calcutta 7: 76, t. 67. 1896 'bourdillonii' & in Hook. f., Fl. Brit. India 7:403.1897; Brandis, Indian Trees 675. 1906; Bourd., For. Trees Travancore 401. 1908; E. G. Camus, Les Bamb. 149. 1913; C.E.C. Fisch. in Gamble, Fl. Pres. Madras 3: 1861.1934; Varmah & Bahadur, Indian For. Rec. (n.s.) Bot. 6(1): 4. 1980; *Pseudotenanthera bourdillonii* R.B. Majumdar in Karthikeyan *et al.*, Fl. Ind. Enum. Monocotyl. 280. 1989; *Pseudoxytenanthera bourdillonii* (Gamble) Naithani, J. Bombay Nat. Hist. Soc. 87: 440. 1990; Tewari, Monogr. Bamb. 124. 1992; Seethalakshmi & M. Kumar, Bamb. India Comp., 222. 1998. *Pseudoxytenanthera bourdillonii* (Gamble) Ohrnberger, Bamb. World, 311. 1999. [Figures 20 and 21; Plate 9 and 9a].

**Type:** India, Kerala, Travancore, *JF Bourdillon* s.n. (lectotype K. designated here. Cibachrome seen, isotype CAL ).

**Typification:** Bourdillon collected this species first from Travancore hills in 1889, based on which Gamble (1896) described this species. This specimen was deposited at K. A duplicate specimen was deposited at CAL. The specimen collected by Bourdillon at K is designated here as lectotype and the specimen at CAL is designated as lectotype

**HABIT** Perennial; arborescent; straggling. Rhizomes sympodial; pachymorph, solid. Culms erect; 15-20 m tall; loose open culms; hollow. Culm-internode 40-60 cm long, 6-30 cm diameter; pale green, smooth, densely covered with white powdery mass when young; not swollen; nodal rings prominent and a single nodal bud enclosed in a prophyllum. Branches at upper nodes; nodal line prominent; extravaginal; the central primary dominant; secondary branches numerous from its basal buds. Culm-sheaths 15-36 cm long; 13-32 cm broad at base; striate; coriaceous; golden yellow; hirsute at base, covered with white powdery mass; callus present, auricle absent. Culm-sheath ligule, inner 0.4-0.6 cm high; membranous; faintly serrate; outer ligule not prominent. Culm-sheath blade 6-12 cm long; 12-18 cm broad at base; stiff; coriaceous ; base broad; ear-shaped, or winged; the wing rounded; entire; recurved; decurrent and run the entire, upper edge of the sheath; foliose in young shoots; almost vertical to the main axis; triangular with sharp mucronate apex; glabrous. Leaves arise on branches and branchlets. Leaf -sheaths imbricate; thin papery; sparsely hirsute; striate; auricle not prominent; oral setae absent. Leaf-sheaths ligule 0.1-0.2 cm high; serrate; outer very short; keeled; Leaf-blade 10-25 cm long; 1.5-3.8 cm wide; lanceolate; dorsal and ventral side glabrous; one of the margins scabrous; midrib; tip acute-acuminate; setaceous; base attenuate, narrowed to a short petiole; callus prominent on the apex of the petiole.

**INFLORESCENCE** Inflorescence a large panicle. Spikelets as semiverticillate heads on leafy branches. Pseudospikelets present.

**FERTILE SPIKELETS** Spikelets comprising 3-florets. Spikelets ovate-lanceolate; glabrous; shining; 1.2-2 cm long; 0.2-0.3 cm broad; almost sessile; bracts 2 at base.

**GLUMES** Sterile glumes 3; ovate to ovate-lanceolate, mucronate, glabrous, many nerved. First glume 0.3-0.4 cm long; ovate. Second glume 0.4-0.6 cm long; ovate. Third glume 0.6-0.9 cm long; ovate-lanceolate.

**FLORETS** Fertile lemma; ovate-lanceolate; membranous; 1.2-1.4 cm long; 0.2-0.3 cm broad; glabrous; mucronate; many nerved. Palea 1-1.2 cm long; thin, membranous; oblong; tip almost retuse; 2-keeled; 3-nerved between the keels; ciliate. Palea of the terminal floret grooved; ciliate along the groove. Keels absent.



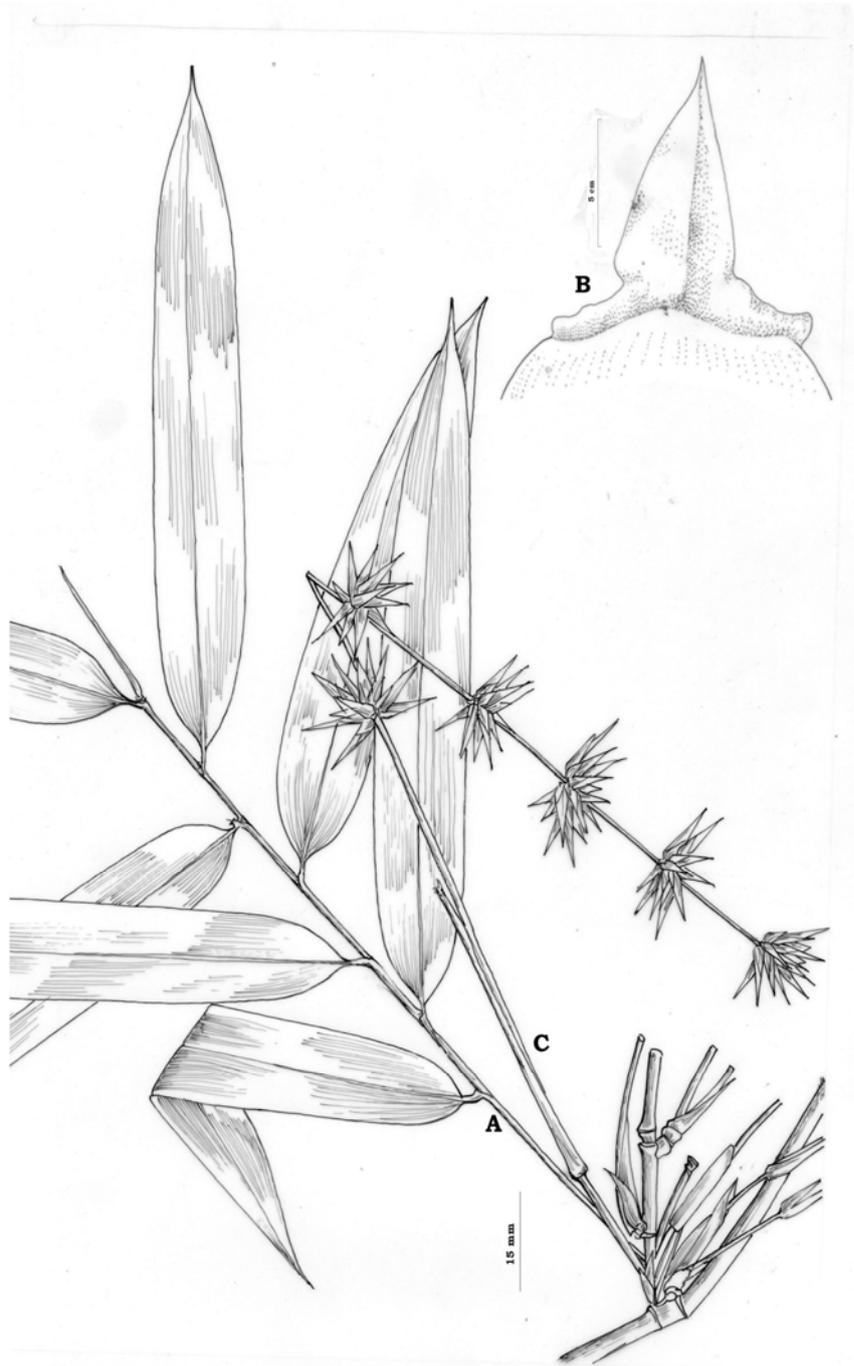


Figure 20 . *Oxytenanthera bourdillonii* Gamble **A.** leafy branch; **B.** culm sheath; **C.** inflorescence

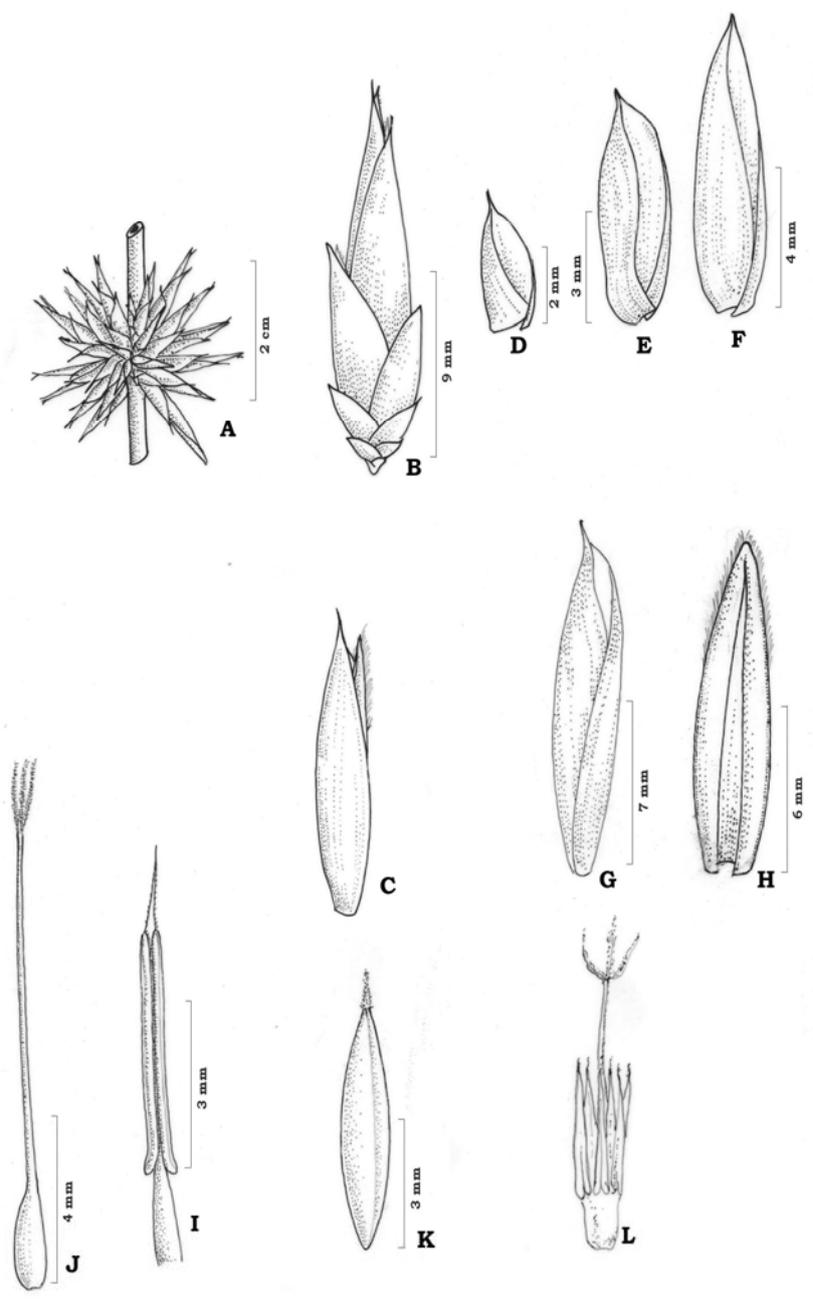


Figure 21. *Oxytenanthera bourdillonii* Gamble **A.** portion of inflorescence; **B.** spikelet; **C.** floret; **D., E. & F.** sterile glumes; **G.** lemma; **H.** palea; **I.** stamen; **J.** ovary with style; **K.** fruit; **L.** open floret (diagrammatic)

**FLOWER** Lodicules absent. Stamens 6; monadelphous. Anthers 0.6-0.7 cm long; exerted; apiculate; apex ciliate. Ovary ciliate; ovate. Style 1-1.2 cm long; ciliate. Stigmas 3; plumose.

**FRUIT** Caryopsis; elliptic; one side sulcate; beaked.

**DISTRIBUTION** *Oxytenanthera bourdillonii* has a restricted distribution in Southern Western Ghats. It is endemic to Kerala part of Western Ghats. It grows only on steep precipitous places from an elevation of 800-1300 m. Recently, it is found that this species is distributed in Sri Lanka as well.

*Specimens examined:* KERALA: Travancore, *JF Bourdillon* (s.n.) (CAL). Idukki Dist. Kurisumala, *Jomy Augustine 13050* (CALI); Peerumed, *N Unnikrishnan 74207* (CALI). Malappuram Dist. New Amarambalam, *R Jayakumar 22212* (KFRI). Palakkad Dist. Nelliampathy, Ranimedu, *M Kumar & TR Viswakumar 8869* (KFRI). Thrissur Dist. Sholayar, *Seethalakshmi* s.n. (KFRI).

**NOTES** This genus was originally described by Gamble (1896). The spelling of the specific epithet in the protologue was '*bourdillonii*'. Many workers later treated the specific epithet as '*bourdillonii*'. The correct spelling of the specific epithet accepted here is '*bourdillonii*'. It was confirmed with Dr JF Veldkamp in a personal communication. The pertinent articles are 32.5, 60.11, Rec. 60.C.2 ICBN.

*Oxytenanthera monadelphus* (Thwaites) Alston in Trim., Fl. Ceylon 6 (Suppl.) 342.1931; C.E.C. Fisch. in Gamble, Fl. Pres. Madras 1861.1934; Varmah & Bahadur, Indian For. Rec. (n.s.) Bot. 6(1): 4. 1980; Tewari, Monogr. Bamb. 124. 1992 [Figures 22 and 23; Plate 10]

**Type:** Sri Lanka, Ambagamuwa, *Thwaites* s.n. (lectotype PDA. selected by Soderstrom & Ellis, 1988; isotype MH !).

*Dendrocalamus monadelphus* Thwaites, Enum. Pl. Zeyl. 376.1864; *Oxytenanthera thwaitesii* Munro, Trans. Linn. Soc. London 26: 129. 1868; Gamble, Ann. Roy. Bot. Gard. Calcutta 7: 72, t. 63.1896 & in Hook. f., Fl. Brit. India 7: 402. 1897; Brandis, Indian Trees 673. 1906; Bourd., For. Trees Travancore 400. 1908; E. G. Camus, Les Bamb. 147. 1913; Rama Rao, For. Pl. Travancore 447. 1914; *Pseudoxytenanthera monadelphus* (Thwaites) Soderstr. & R.P. Ellis, Smith. Contr. Bot. 72: 52.1988; *Pseudotenanthera monadelphus* (Thwaites) R.B. Majumdar in Karthikeyan *et al.*, Fl. Ind. Enum. Monocotyl. 280. 1989; Seethalakshmi & M. Kumar, Bamb. India Comp. 224. 1998.

**HABIT** Perennial; caespitose. Rhizomes sympodial; pachymorph; solid, long-necked; covered with scale leaves. Culms erect; 7-10 m tall; hollow; apex gradually become curved and whip like. Culm-internodes 30-35 cm long, 1.5-2.5 cm diameter; dull green, hirsute, scabrous. Culm-nodes swollen; sheath scar prominent; girdle conspicuous; supranodal ridge not distinct; a single dormant branch bud at each node enclosed in a prophyllum. Branches numerous; branches starts at lower nodes, just above the sheath scar, extravaginal; semiverticillate clusters; the primary bud dormant and numerous laterals from its sides; the central axis prominent, whip like resembling the main culm. Culms-sheaths 15-25 cm long; 7-11 cm wide at base; purplish-green; coriaceous; margins ciliate; covered with bulbous based brown hairs; yellowish orange when young; striate; brittle; abscissile; straw coloured, hirsute towards the base; apex truncate; auricles very prominent, ear-shaped, falcate, with stiff bristles, oral setae numerous, persistent. Culms-sheath ligule, inner large; prominent ; 0.5-1 cm high; short in smaller sheaths; erose; outer ligule not distinct. Culm-sheath blade reflexed; foliose; upper surface glabrous; lower side slightly hirsute; broad; acuminate; 7-12 cm long, 1.2-3 cm wide at base; base truncate, spreading and decurrent along the top of the sheath; deciduous when old. Leaves arise on branches. Leaf-sheaths closely attached; overlapping; smooth; striate; keeled; tip ends in a callus; auricle prominent; falcate with stiff bristles; bristles deciduous. Leaf-sheath inner ligule prominent; 0.4-0.5 cm high; erose; membranous; outer ligule short. Leaf-blade size highly variable; linear-lanceolate; glabrous on both sides; 4-32 cm long; 0.5-3.2 cm wide; margins rough and scabrous; apex acuminate; midrib prominent; base attenuate; Petiole short.

**INFLORESCENCE** Inflorescence a spicate panicle on leafy branches. Spikelets arise at all nodes. Pseudospikelets in semiverticillate clusters, or large globose heads.

**FERTILE SPIKELETS** Spikelets comprising 1-3-florets. Spikelets ovate-lanceolate; acute; 1-1.4 cm long; 0.2-0.3 cm wide, supported by two bracts; hirsute along the margins.

**GLUMES** Sterile glumes 2; stiff; coriaceous; many-nerved; mucronate; hirsute along the sides. First glume 0.4-0.5 cm; ovate. Second glume 0.6-0.8 cm long; ovate-lanceolate.

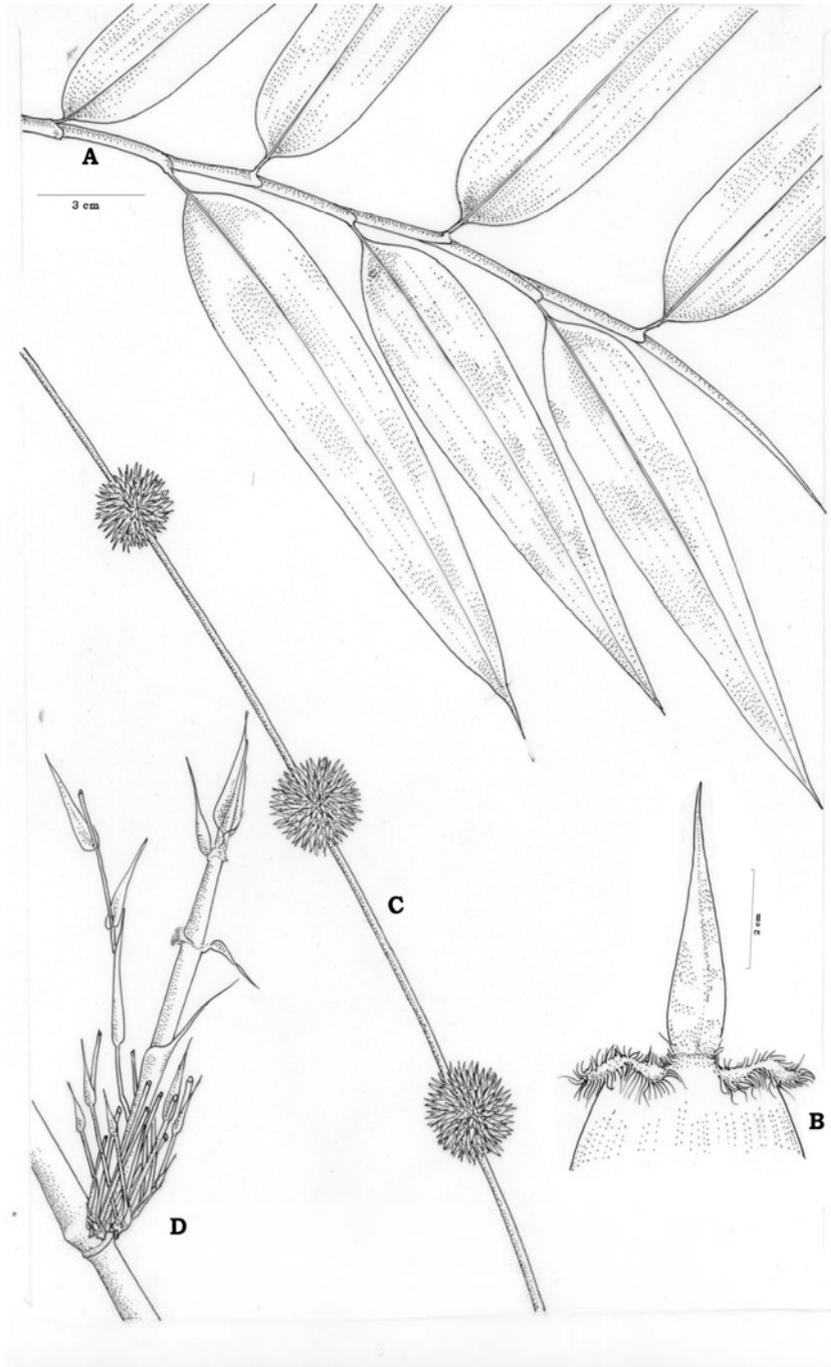


Figure 22. *Oxytenanthera monadelphica* (Thwaites) Alston **A.** leafy branch; **B.** culm sheath; **C.** inflorescence; **D.** branching

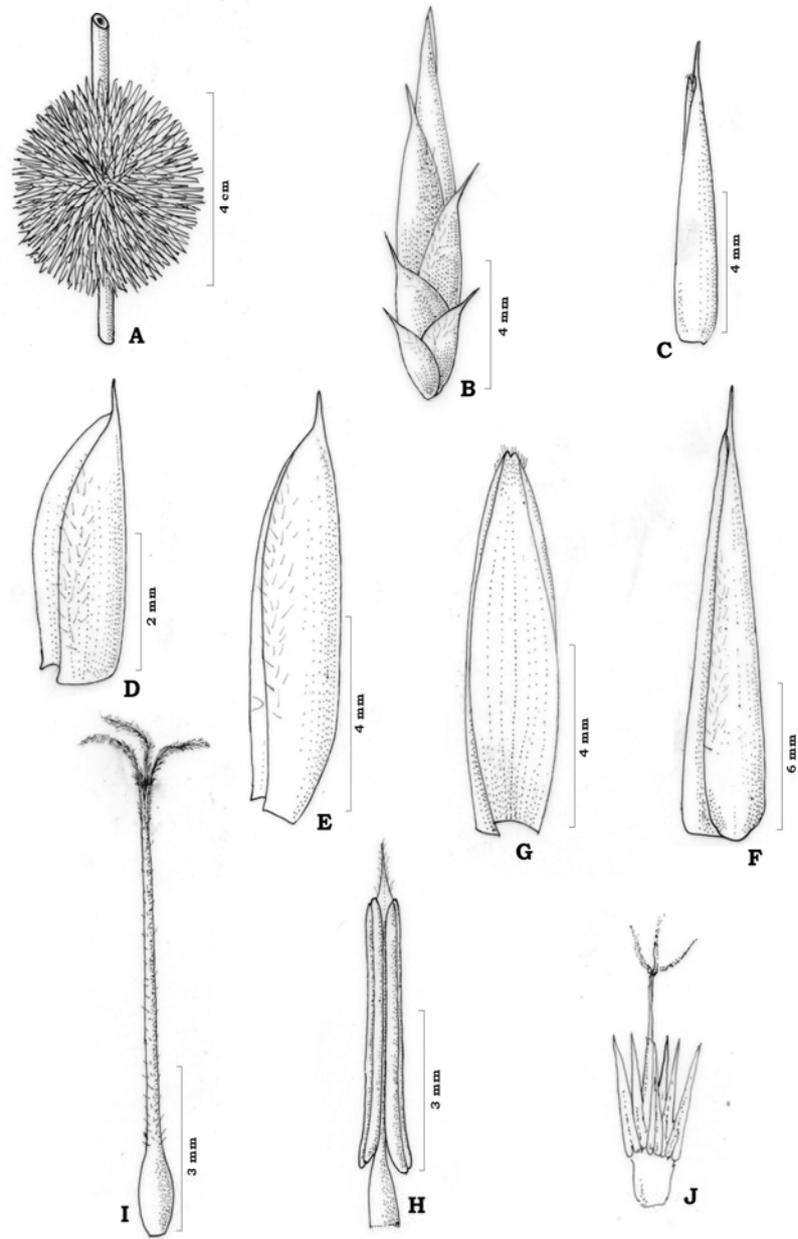


Figure 23. *Oxytenanthera monadelphina* (Thwaites) Alston **A.** portion of inflorescence; **B.** spikelet; **C.** foret; **D. & E.** sterile glumes; **F.** lemma; **G.** palea; **H.** stamen; **I.** ovary with style; **J.** open floret (diagrammatic)

**FLORETS** Fertile lemma ovate-lanceolate; thin; 1-1.2 cm, many-nerved; strongly mucronate; ciliate along the sides and at apex. Palea thin, membranous; concave; 0.8-1 cm long; 2-keeled; ciliate on the keels; convolute; minutely bifid; apex ciliate.

**FLOWER** Lodicules absent. Stamens 6; monadelphous; yellowish. Anthers 0.5-0.6 cm long; exserted; short; apiculate; ciliate at apex. Ovary glabrous; fusiform. Style 0.8-1 cm long; hairy. Stigmas 3; plumose.

**FRUIT** Caryopsis; 0.4-0.5 cm long; thin; fusiform; scabrous; sulcate along one side; apex mucronate; hairy; pericarp dry.

**DISTRIBUTION** This species is distributed in southern Peninsular India and Sri Lanka. It is a component of moist deciduous and semi-evergreen forests and found growing from 600-2000 m altitude.

*Specimens examined:* ANDHRA PRADESH: Kurnool Dist. Kurnool Forest, *RH Beddome* s.n. (MH). KARNATAKA: Chickmangalore Dist. Bababudan, *NS Adakoli* 156635 (DD). KERALA: Idukki Dist. Vellimala, *Jomy Augustine* 13334 (CALI); Munnar, *N Unnikrishnan* 74022 (CALI); Munnar, Chokkanad, *N Unnikrishnan* 74206 (CALI). Palakkad Dist. Mutthikulam, *Stephen Sequiera & Michiale* 8821 (KFRI); Sispara, *M Remesh & Stephen* 20712 (KFRI). Wayanad Dist. Manantoddy, *Rodes Morgen* s.n. (MH); Mundakai, *Stephen Sequiera & Michiale* 8162 (KFRI). TAMIL NADU: Madura Dist. Highway Mountains, *Cheriyen Jacob* 17614 (MH). Nilgiri Dist. Nilgiris, *Perrottet* 1344:773 (DD); Nilgiris, *JS Gamble* 20642 (DD); Nilgiris, *JS Gamble* 21450 (MH); Ochterlomy valley, *JS Gamble* 20531 (DD); Coonoor, *JS Gamble* 12155 (DD); Coonoor, *JS Gamble* 12165 (MH). Thirunelveli Dist. Thirunelveli, *Forest Ranger* 40544 (DD).

Subtribe: **Melocanninae** Benth.

**Melocanninae** Benth., J. Linn. Soc. London 19, 31. 1881; Clayton & Renvoize, Kew Bull. Addl. Ser. 13, 46. 1989; S. Dransf. & Widjaja (eds.), Plant Reso. S.E. Asia 7: 35. 1995; Ohrnberger, Bamb. World 20. 1999.

*Type:* *Melocanna* Trin.

*Melocanneae* Gamble, Ann. Roy. Bot. Gard. Calcutta 7: 111. 1896; *Schizostachydinae* Soderstr. & R.P. Ellis in Soderstr. *et al.* (eds.), Grass Syst. Evol. 237. 1987.

**HABIT** Perennial; caespitose; gregarious tufted. Rhizomes sympodial; pachymorph, short-necked, or long-necked. Culms erect; clump forming, or scandent; vining, or drooping. Branches intravaginal; many; subequal. Culm-sheaths mostly deciduous, or persistent.

**INFLORESCENCE** Inflorescence spicate panicle. Spikelets on leafy or leafless branches. Pseudospikelets present.

**FERTILE SPIKELET** Spikelets comprising 1-many florets.

**GLUMES** Sterile glumes 2-4.

**FLORETS** Lemma convolute. Palea keeled, or not keeled.

**FLOWER** Lodicules 3 to 7; sometimes absent. Stamens 6 - numerous, upto 130. Style elongated, persistent. Ovary glabrous. Stigmas 3 to 7.

**FRUIT** Caryopsis with strongly thickened pericarp; easily separable from the seed; nut-like, or drupaceous; fleshy.

Clayton and Renvoize (1986) accepted this subtribe in their new system of grass classification. Soderstrom and Ellis (1987) treated this subtribe as *Schizostachydinae*. Dransfield and Widjaja (1995) treated *Schizostachydinae* as a synonym of *Melocanninae*. The genera included under this subtribe are *Cephalostachyum*, *Davidsea*, *Melocanna*, *Neohouzea*, *Ochlandra*, *Pseudostachyum*, *Schizostachyum* and *Teinostachyum*.

**DISTRIBUTION** The members of this subtribe are distributed in the Old World tropics. They are found growing in Africa, Madagascar, Sri Lanka, India, China, Myanmar and South East Asia. In South India, the subtribe Melocanninae is represented by two genera *Ochlandra* and *Teinostachyum*.

*Key to the genera*

- 1a. Branches numerous forming a cluster at the nodal region, spikelets many flowered, sterile glumes 2; lodicules 3; stamens 6; fruit with dry pericarp.....***Teinostachyum***
- 1b. Branches few; spikelets single flowered, sterile glumes 3-4; lodicules 3-7; stamens numerous; fruit with fleshy pericarp .....***Ochlandra***

***Ochlandra*** Thwaites

This genus was first mentioned in Rheede's Hortus Malabaricus (1685) as *Beesha*. It was first scientifically described by Thwaites (1864) based on the Sri Lankan species, *O. stridula*. Munro (1868) accepted this genus name and described three species. Beddome (1873) treated this genus as *Irulia*. Gamble (1896) accepted the genus name *Ochlandra* and he described seven species and one variety. In 1913, E. G. Camus described *Ochlandra capitata* based on *Nastus capitatus* (*Beesha capitata* (Kunth) Munro). This species was known to be distributed in Madagascar. Another species of *Ochlandra*, *O. perrieri* was also described by A. Camus (1935) from Madagascar. Dransfield (1998a) after a detailed study on these species found that they did not belong to the genus *Ochlandra*. She transferred *O. capitata* to *Cathariostachys capitata* and *O. perrieri* to *Valiha perrieri*. Gamble (1896) described another species of *Ochlandra*, *O. ridleyi* from Malay Peninsula. He raised another new species, *Schizostachyum latifolium* based on the same species. Dransfield (1983b) treated *Ochlandra ridleyi* as a synonym of *Schizostachyum latifolium*. Basha and Kumar (1994) studied the little known species of *Ochlandra* from Western Ghats. All species of *Ochlandra* including the Sri Lankan species *Ochlandra stridula*, the type genus, is endemic to Peninsular India. Eleven species and one variety of *Ochlandra* were reported from South India. Two species and one variety are synonymised in the present study and one new species is added.

***Ochlandra*** Thwaites, Enum. Pl. Zeyl. 376. 1864; Benth. & Hook. f., Gen. Pl. 3: 1215. 1883; Gamble, Ann. Roy. Bot. Gard. Calcutta 7: 121. 1896 & in Hook. f., Fl. Brit. India 7: 418. 1897; E. G. Camus, Les Bamb. 180. 1913; Blatt., Indian For. 55(11): 609. 1929; C.E.C. Fisch. in Gamble, Fl. Pres. Madras 3: 1863. 1934; Soderstr. & R.P. Ellis in Soderstr. *et al.* (eds.), Grass Syst. Evol. 237. 1987; Soderstr. & R.P. Ellis, Smith Contr. Bot. 72: 66. 1988; Clayton & Renvoize, Kew Bull. Addl. Ser. 13, 57. 1989; Tewari,

Monogr. Bamb. 109 1992; Seethalakshmi & M. Kumar, Bamb. India Comp.177. 1998; Ohrnberger, Bamb. World 326. 1999.

**Type:** *Ochlandra stridula* Thwaites

*Beesha* Rheede Hort. Malab. 5: 119. t. 60, 1685; Munro, Trans. Linn. Soc. London 26: 144. 1868; *Irulia* Bedd., Fl. Sylv. S. India 235. 1873.

**HABIT** Perennial; caespitose, gregarious. Rhizome sympodial; pachymorph; short-necked. Culms erect, or semi-erect; hollow. Culm-internodes terete; thin walled. Culm-nodes more or less flat; not prominent; with, or without an upper ridge. Branch buds solitary at nodal line; broad. Branch complements at mid-culm nodes; intravaginal; few to numerous; subequal; unarmed. Culm-sheaths persistent with Culm-sheath blades erect or reflexed. Leaves long and broad; thick; glabrous; petiolate.

**INFLORESCENCE** Inflorescence a large compound, spicate panicle. Bracts subtending pseudospikelets deciduous.

**FERTILE SPIKELETS** Spikelets single flowered.

**GLUMES** Sterile glumes several.

**FLORETS** Palea not keeled; glabrous.

**FLOWER** Lodicules 3-7. Stamens numerous; 15-130; free. Ovary glabrous. Style long. Stigmas 5-7; verticillate; twisted.

**FRUIT** Caryopsis long beaked; pericarp fleshy.

**DISTRIBUTION** This genus is distributed in India and Sri Lanka. In India, the genus *Ochlandra* is endemic to southern Western Ghats.

*Key to the genus Ochlandra Thwaites*

- 1a. Leaves broad, 8-10 cm across, spikelet ovate-oblong, lodicules broad, 3-4, fruit subglobose to ovate-oblong .....2
- 1b. Leaves narrow, 1.5-3.5 cm across, spikelets ovate-lanceolate, lodicules narrow, 6-7, fruit oblong-lanceolate.....7
- 2a. Internodes rough, ventral side of the leaf rough, stamens around 40 .....

*O. kadambaranii*

- 2b. Internodes smooth, ventral side of the leaf smooth, stamens 55-130 .....3
- 3a. Ligule conspicuous .....4
- 3b. Ligule inconspicuous .....5
- 4a. Ligule stiff, short, lacerate, 0.3-0.5 cm long .....*O. ebracteata*
- 4b. Ligule membranous, long, fimbriate, 1.5-2.5 cm long ..... *O. wightii*
- 5a. Auricle conspicuous; leaf sheath hirsute.....*O. keralensis*
- 5b. Auricle inconspicuous; leaf sheath smooth.....6
- 6a. Style coiled or having a bend ..... *O. spirostylis*
- 6b. Style straight .....*O. travancorica*
- 7a. Branches few, unequal .....8
- 7b. Branches numerous, subequal..... *O. talboti*
- 8a. Culm sheath tip thick; spikelets hirsute, inner side of the blade hirsute .....  
.....*O. beddomei*
- 8b. Sheath tip thin; spikelets glabrous, inner sides of the blade glabrous.....9
- 9a. Sheath papery, persistent, blade needle like .....*O. setigera*
- 9b. Sheath coriaceous, deciduous, blade narrow .....*O. scriptoria*

*Ochlandra beddomei* Gamble, Ann. Roy. Bot. Gard. Calcutta 7:124. t. 110.1896 & in Hook. f., Fl. Brit. India 7: 419.1897; E. G. Camus, Les Bamb. 182. 1913; Rama Rao, For. Pl. Travancore 448. 1914; C.E.C. Fisch. in Gamble, Fl. Pres. Madras 3: 1863.1934; Varmah & Bahadur, Indian For. Rec. (n.s.) Bot. 6(1): 3. 1980; Tewari, Monogr. Bamb. 109. 1992; Chand Basha & M. Kumar, Rheedia 4(1): 25. 1994; M. Kumar, Rheedia 5(1): 66. 1995; Seethalakshmi & M. Kumar, Bamb. India Comp.178. 1998; Ohrnberger, Bamb. World 327. 1999 [Figures 24 and 25; Plate 11 and 11 a].

**Type:** India, West slopes of Nilgiris-Wayanad, 3000-4500 ft., *Beddome* s.n. (lectotype K. designated here. Cibachrome seen).

**Typification:** This species was first collected by Beddome from Wayanad. The specimen was deposited at K. Based on which Gamble (1896) described this species. This specimen is selected for lectotypification and designated here as lectotype

**HABIT** Perennial; caespitose; gregarious. Rhizomes sympodial; pachymorph, solid; short necked; clothed with scale leaves. Culms erect, hollow, 6-7 m tall; tip slightly arched. Culm-internodes 30-45 cm long; 2-3.5 cm diameter; glabrous, pale green. Culm-nodes somewhat swollen; sheath scar and nodal ridge prominent; a single nodal bud is present; enclosed in a prophyllum. Branches arise from the 5<sup>th</sup> or 6<sup>th</sup> node; just above the sheath scar; intravaginal; the primary axis prominent; 6-8 laterals develop from its basal buds; subequal. Culm-sheaths 14-22 cm long; 7.5-12 cm broad at base; coriaceous; covered with bulbous based brown hairs when young; sparsely hirsute; persistent or deciduous; striate; apex thick and truncate. Culm-sheath ligule, inner short; 0.1-0.2 cm high; outer ligule inconspicuous. Culm-sheath blade reflexed; glabrous; subulate; 3.5-5.5 cm long; 0.2-0.3 cm broad at base; auricle short with numerous stiff bristles. Leaves arise on branches towards the tip. Leaf-sheaths imbricate; slightly hirsute; striate; ciliate along the margins; auricle prominent; decurrent with erect, stiff bristles. Leaf-sheath ligule, inner very short; outer not prominent. Leaf-blade oblong-lanceolate; 15-28 cm long; 1.5-3.8 cm broad; glabrous on both sides; margins rough; scabrous; midrib prominent on lower side; tip acuminate; setaceous and scabrous; obtuse at the base into a short thick petiole.

**INFLORESCENCE** Inflorescence short terminal or auxiliary spicate panicle on leafy branches. Pseudospikelets and spikelets in semiverticillate clusters on all branches at successive nodes.

**FERTILE SPIKELETS** Spikelets comprising single floret. Spikelets ovate-lanceolate; hirsute; 1.6-2.8 cm long; 0.2-0.4 cm wide; short stalked; supported by 2-3 bracts.

**GLUMES** Sterile glumes three; stiff and coriaceous. First two, ovate-lanceolate. Third lanceolate; mucronate; hirsute towards the apex; many-nerved.

**FLORETS** Fertile lemma lanceolate; glabrous; thin; coriaceous; many-nerved; 2.5-3 cm long; mucronate. Palea thin; membranous; glabrous; ovate-lanceolate; 2.2-2.8 cm long, 0.2-0.3 cm wide, many-nerved; convolute; apex acute; slightly bifid.

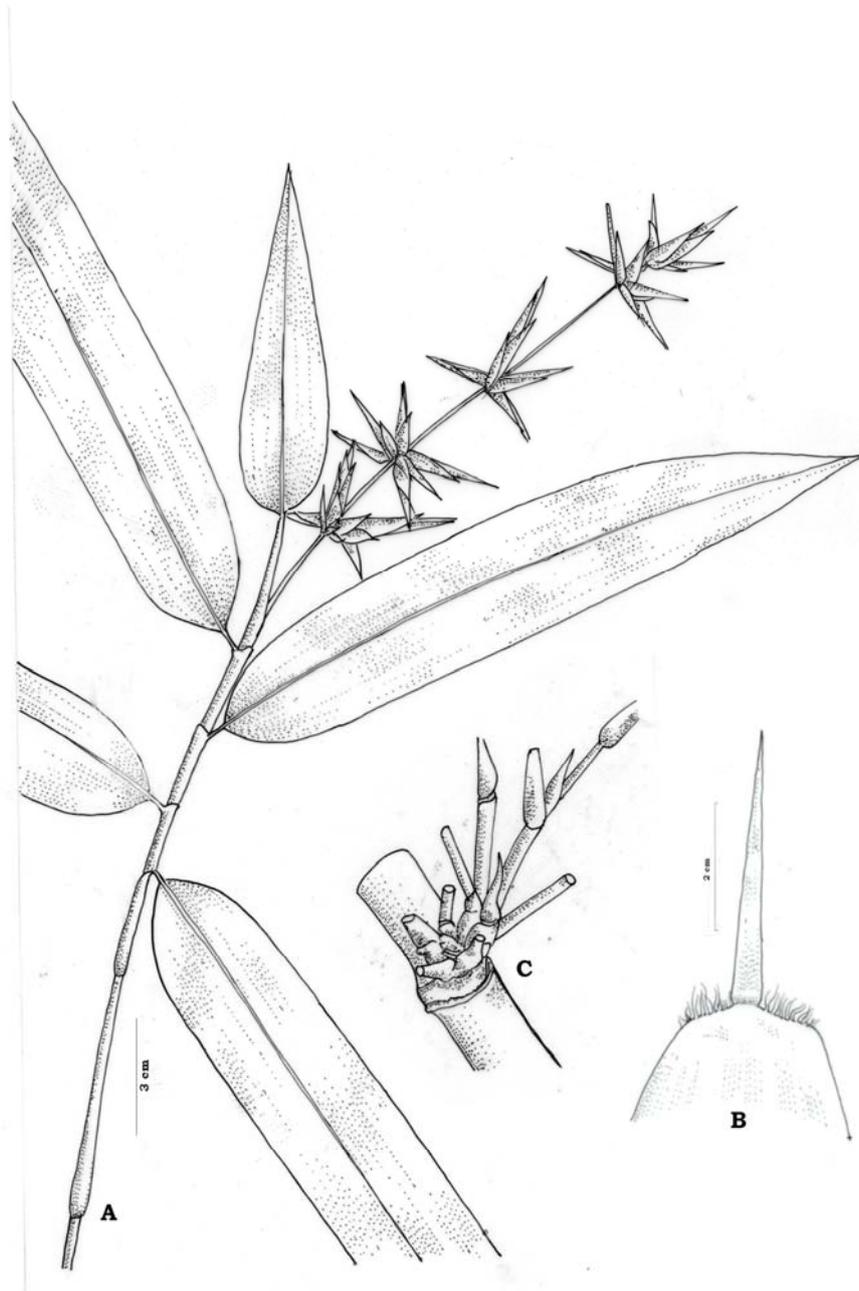


Figure 24. *Ochlandra beddomei* Gamble **A.** flowering branch; **B.** culm sheath; **C.** branching

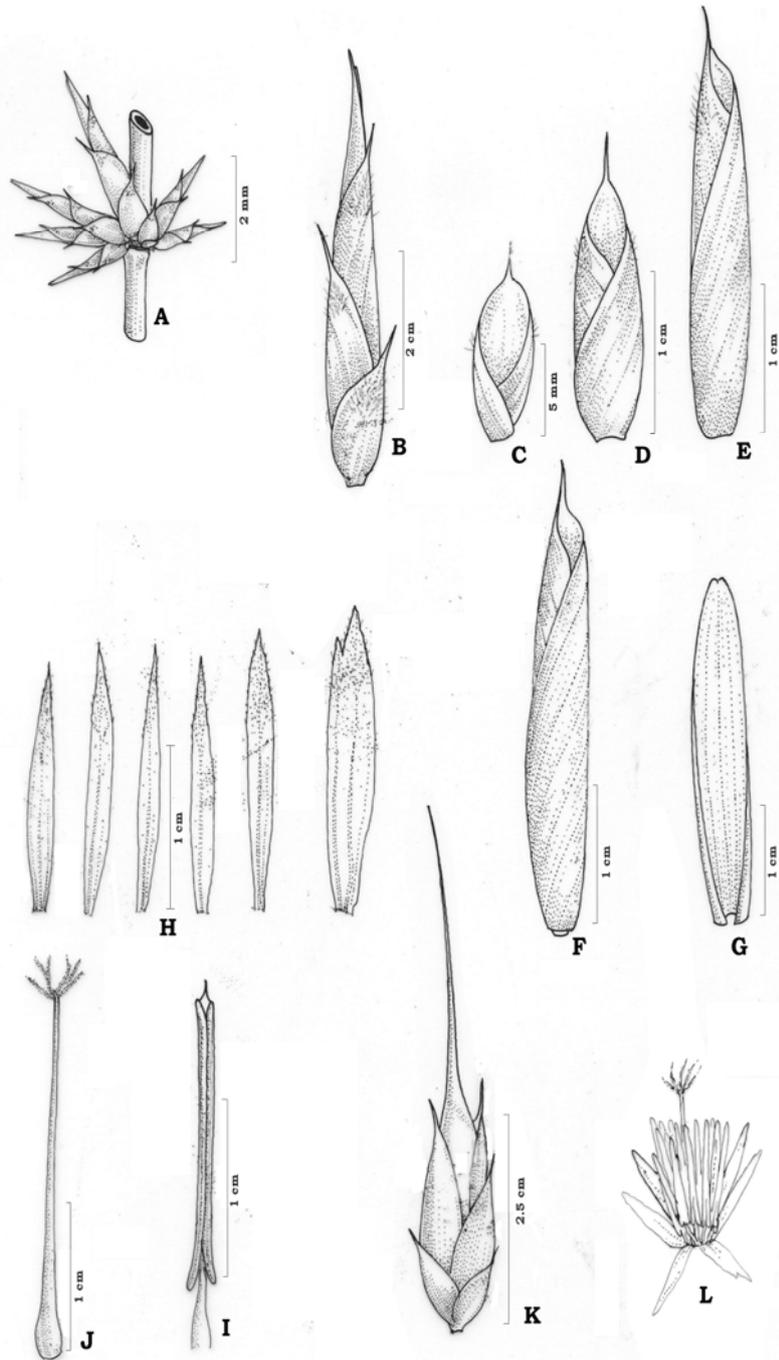


Figure 25. *Ochlandra beddomei* Gamble **A.** portion of inflorescence; **B.** spikelets; **C., D. & E.** sterile glumes; **F.** lemma; **G.** palea; **H.** lodicules; **I.** stamen; **J.** ovary with style; **K.** fruit; **L.** open floret (diagramatic)

**FLOWER** Lodicules 6; hyaline;narrow; all equal in size; 1.3-1.5 cm long; 3-4-nerved, margins fimbriate; ciliate. Stamens 28-32; yellowish; filaments free; short; 1.5-1.7 cm. Anthers basifixed; apiculate; apex ciliate. Ovary glabrous; slightly globose. Style 2.3-2.7 cm long; covered by an angular perigynium. Stigmas 6; plumose.

**FRUIT** Caryopsis; fleshy; long beaked; 5-6 cm long; 0.7-1.2 cm diameter; oblong, glumes persistent.

**DISTRIBUTION** This species is endemic to Wayanad district, Kerala, growing at an altitude of 1000 to 1500 m. It is a component of moist deciduous and semi-evergreen forests. Flowering is rare.

*Specimens examined:* KERALA: Wayanad Dist. Thariyode, *M Kumar 6466C* (KFRI); Thariyode, *N Unnikrishnan 74109* (CALI).

*Ochlandra ebracteata* Raizada & Chatterjee, Indian For. 89:362. 1963; Tewari, Monogr. Bamb. 110. 1992; M. Kumar, Rheedeia 5:68.1995; Seethalakshmi & M. Kumar, Bamb. India Comp.180. 1998; Ohrnberger, Bamb. World 327. 1999  
[Figures 26 and 27; Plate 12 ].

**Type:** India, Paruthipally range, Kottur Reserve, Trivandrum, *Managing Agents, Punalur Paper Mill 132695* (holotype DD).

**HABIT** Perennial; caespitose; gregarious. Rhizomes sympodial; pachymorph; solid; short necked; covered with scale leaves. Culms erect; 6-7 m tall; hollow; apex arched. Culm-internodes, 60-65 cm long; 2-2.3 cm in diameter; pale green; smooth. Culm-nodes swollen; sheath scar and supranodal ridge prominent; single nodal bud present enclosed in a prophyllum. Branches, arise from the 6<sup>th</sup> or 7<sup>th</sup> node; just above the sheath scar;intravaginal ; the central axis dominates; 2-3 lateral branches develop from its basal buds; subequal. Culm-sheaths 14-22 cm long; 9-12 cm wide at base; coriaceous, striate; covered with dark brown bulbous based hairs; deciduous; striate; apex truncate; auricle very short with numerous stiff bristles. Culm-sheath ligule prominent; inner ligule 0.8-1 cm long; lacerate; margins fimbriate; outer ligule inconspicuous. Culm-sheath blade refluxed; smooth; subulate; 7-11 cm long; 0.8-1.2 cm wide at base. Leaves arise from branches towards the tip. Leaf sheaths overlap; closely attached and smooth, striate; auricle short with stiff bristles. Leaf sheath ligule inner, prominent; 0.2-0.3 cm long; outer

inconspicuous. Leaf blade oblong-lanceolate; 20-35 cm long; 5-7 cm wide; smooth on both sides; margins rough; one of the margins scabrous; midrib prominent on the lower side; apex acuminate; setaceous; scabrous; sometimes twisted; truncate at the base; petiole short and thick.

**INFLORESCENCE** Inflorescence a large compound, spicate panicle on leafy branches. Pseudospikelets and spikelets in semiverticillate clusters on all branches at successive nodes.

**FERTILE SPIKELETS** Spikelets comprising single floret. Fertile floret mixed with small sterile ones; ovate-lanceolate; glabrous; 2.5-4 cm long; 0.3-0.5 cm wide; supported by 3-4 bracts; stalked.

**GLUMES** Sterile glumes 3; stiff; coriaceous; ovate-lanceolate; mucronate; many-nerved; 1.5-3 cm long.

**FLORETS** Fertile lemma linear-lanceolate; thin; coriaceous; many-nerved; 2.2-3.7 cm long; acuminate; mucronate. Palea thin; membranous; 2-3.4 cm long; glabrous; oblong; apex retuse.

**FLOWER** Lodicules 3; hyaline; 1.2-1.5 cm long; 0.6-0.9 cm wide; 3-4-nerved; margins fimbriate; ciliate. Stamens 65-75; yellowish; filaments free; long; filiform. Anthers 1.2-1.6 cm long; basifixed; apiculate, apex ciliate. Ovary glabrous; spherical at the base. Style 2.5-2.9 cm long. Stigmas 6; plumose.

**FRUIT** Caryopsis; large; pericarp fleshy; ovate-oblong; long beaked; 6-6.5 cm long; glumes persistent.

**DISTRIBUTION** Endemic to Southern Western Ghats (Kerala), from an altitude of 500 to 1000 m. It is a component of semi-evergreen forests. It flowers gregariously and sporadically. Flowering continuous for one year and all the culms die after fruiting.

*Specimens examined:* KERALA: Kollam Dist. Achenkoil, *M Kumar & Stephen Sequiera* 7610 (KFRI); Kottavasal, *Jayalakshmi* 6494 (KFRI); Thenmala, Ambanadu, *N Unnikrishnan* 74006 (CALI). Thrissur Dist. Palapilly, *M Kumar & CC Joy* 6769 (KFRI). Thiruvanthapuram Dist. Kottoor, *Managing Agents, Punalur Paper Mill* 132695 (DD).



Figure 26. *Ochlandra ebracteata* Raizada & Chatterjee **A.** flowering branch; **B.** culm sheath; **C.** branching

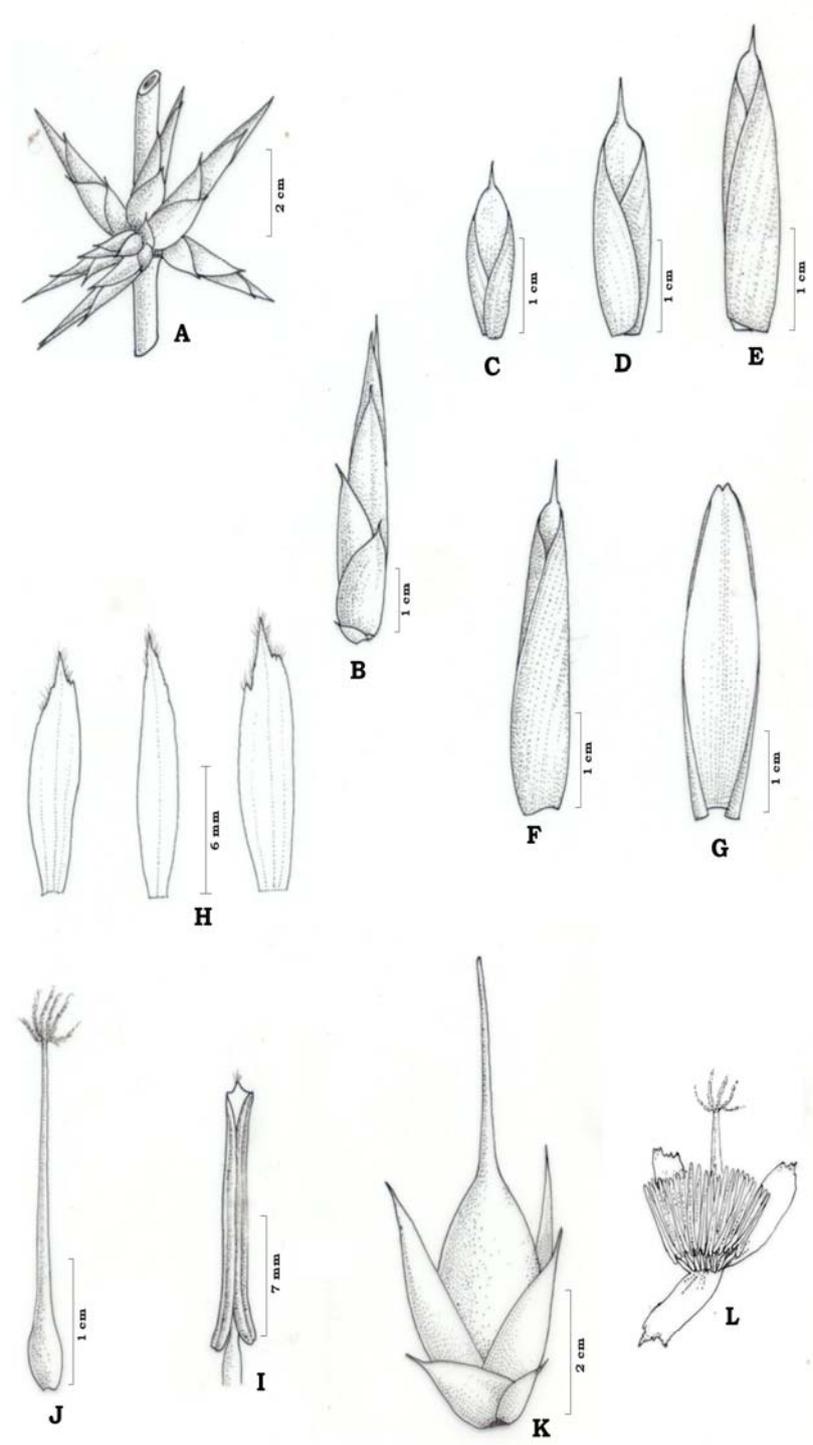


Figure 27. *Ochlandra ebracteata* Raizada & Chattejee **A.** portion of inflorescence; **B.** spikelet; **C., D. & E.** sterile glumes; **F.** lemma; **G.** palea; **H.** lodicules; **I.** stamen; **J.** ovary with style; **K.** fruit; **L.** open floret (diagrammatic)

**NOTES** This species was first described by Raizada and Chatterjee (1963). According to them, this species is without bracts and the stamens are monadelphous. During this study it was observed that the spikelets are with bracts and also the filaments of the stamens are free.

*Ochlandra kadambaranii* M. Kumar, Unnikrishnan & Remesh, **sp. nov.** [Figures 28 and 29; Plate 13].

**Type:** India, Kerala, Kollam district, Nilamel, 150 m, *Unnikrishnan 74009* (holotype CALI, Isotype KFRI)

**HABIT** Perennial; caespitose; gregarious. Rhizomes sympodial; pachymorph; solid; short necked; covered with scale leaves. Culms slender; erect, or semi-erect; hollow; 3-5 m tall; apex slightly arching. Culm-internodes 23-38 cm long; 1.5-2.5 cm diameter; dark green; rough. Culm-nodes swollen; sheathscar and nodal ridge prominent; each node with a single prophyllate bud. Branches arise from the 5<sup>th</sup> or 6<sup>th</sup> node; intravaginal; the primary central axis dominant; 2 or 3 lateral branches subequal. Culm-sheaths 11-15 cm long; 4-6.5 cm wide at base; coriaceous; brittle; glabrous except at the centre; middle portion sparsely hirsute; striate; apex truncate; auricles inconspicuous; bristles numerous; persistent. Culm-sheath ligule not distinct. Culm-sheath blade narrow; subulate; reflexed; 5-7 cm long; 0.5-1 cm wide at base; glabrous; deciduous. Leaves arise from the branches towards the tip. Leaf-sheaths closely attached; glabrous; striate; auricle inconspicuous; bristles absent. Leaf-sheath ligule, inner prominent; 0.2-0.3 cm high; membranous; outer ligule not distinct. Leaf-blade linear-lanceolate; 20-38 cm long, 5-10 cm wide; glabrous on dorsal side and rough on the ventral side; the ventral side of leaves of young plants pubescent; margins rough and scabrous; midrib prominent on lower side; apex acuminate, scabrous and sometimes twisted; attenuate at base into a thick, short petiole.

**INFLORESCENCE** Inflorescence a large compound, spicate panicle on leafy branches. Pseudospikelets and spikelets in semiverticillate clusters on all branches at successive nodes.

**FERTILE SPIKELETS** Spikelets comprising single floret. Spikelets stout; short ovate-lanceolate; glabrous; 2.2-2.5 cm long; 0.3-0.4 cm diameter; short stalked; supported by 2-3 bracts.

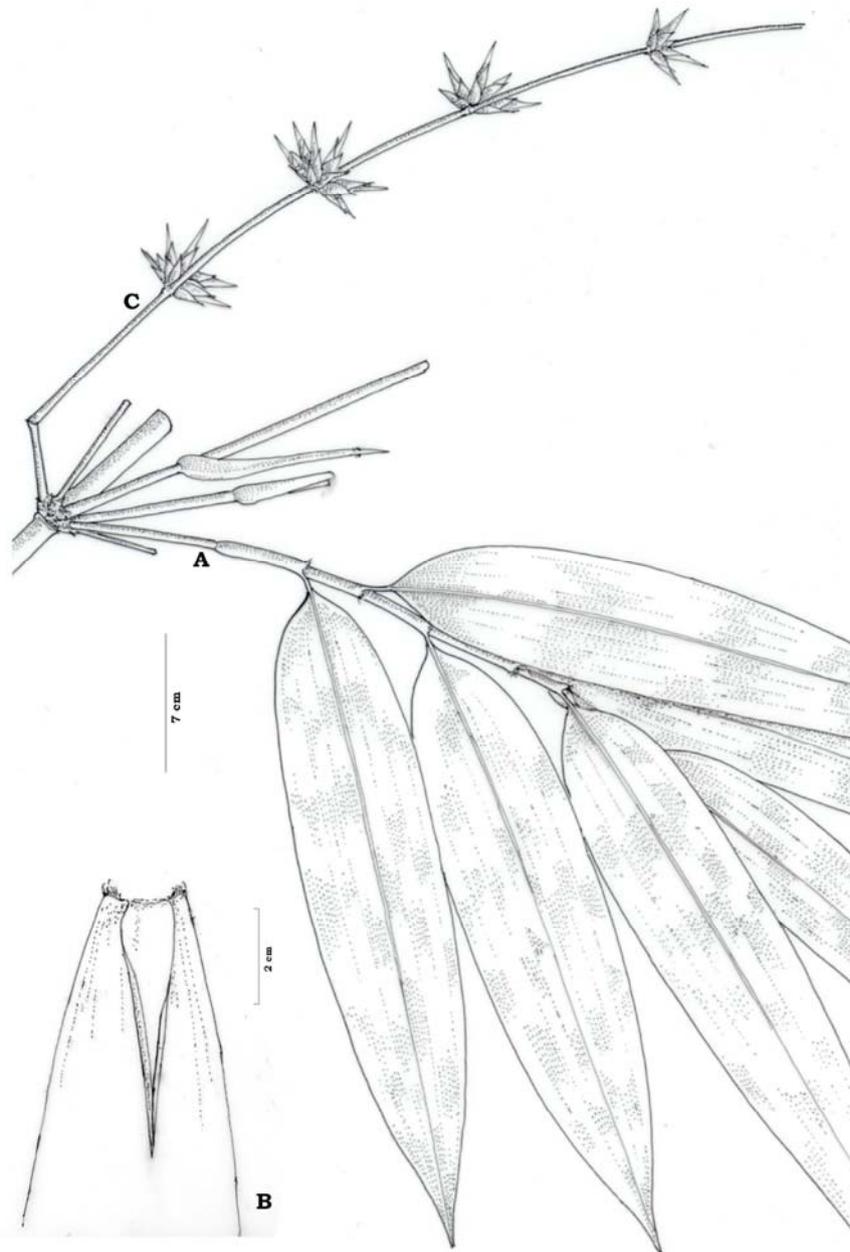


Figure 28. *Ochlandra kadambaranii* M. Kumar, Unnikrishnan & Remesh **sp. nov.**  
**A.** leafy branch; **B.** culm sheath; **C.** inflorescence

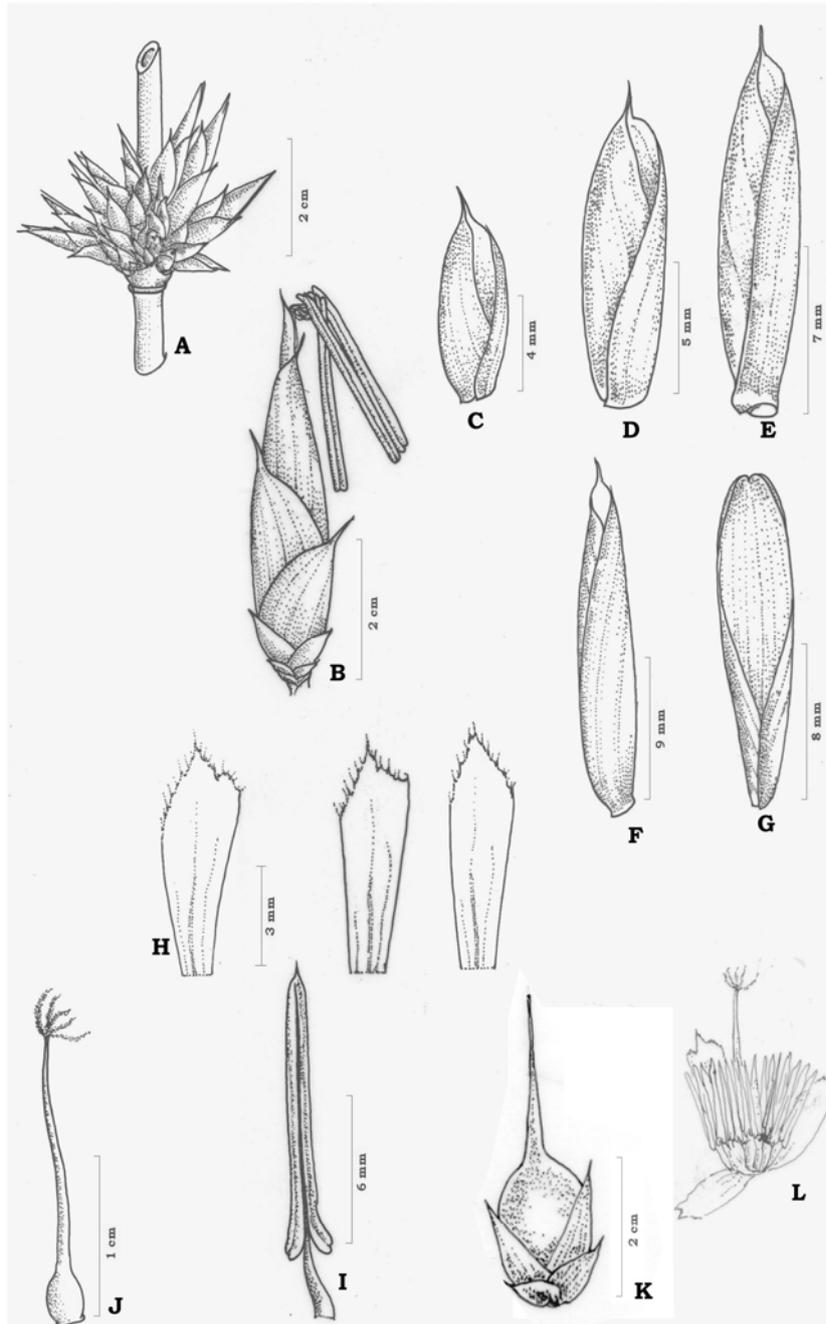


Figure 29. *Ochlandra kadambaranii* M. Kumar, Unnikrishnan & Remesh **sp. nov.**  
**A.** portion of inflorescence; **B.** spikelet; **C., D. & E.** sterile glumes;  
**F.** lemma; **H.** lodicules; **I.** stamen; **J.** ovary with style;  
**K.** open floret (diagrammatic)

**GLUMES** Sterile glumes 3; stiff; coriaceous; mucronate, many-nerved. First two ovate, 0.8-1 cm long. Third ovate-lanceolate; 1.2-1.5 cm long.

**FLORETS** Fertile lemma ovate-lanceolate; membranous; 1.5-1.8 cm long; many-nerved; glabrous; acute;. Palea oblong; thin; membranous; 1.5-1.7 cm long; glabrous; apex retuse; ciliate.

**FLOWER** Lodicules 3; hyaline; broad; 0.6-0.7 cm long; 3-4- nerved; bilobed; margins fimbriate; ciliate. Stamens 37-40; brownish; short; in bundles of 5-9 stamens. Anthers 1.2-1.4 cm long; basifixed; apiculate; apex ciliate. Ovary glabrous; slightly globose. Style 2-2.3 cm long. Stigmas 7; plumose.

**FRUIT** Caryopsis; globose; long beaked; 3.5-4 cm long; pericarp fleshy; glumes persistent.

**DISTRIBUTION** This new species is endemic to Southern Western Ghats and distributed in Southern Kerala. It was first collected from Nilamel, Kollam district. It was also reported from Pandimotta, Kollam district and found under cultivation at Kottayam district and Palapilly, Thrissur district. The species flowered gregariously in 1999-2000 at Pandimotta and Nilamel, Kollam district, Kerala.

*Etymology:* This is named after late Prof. Kadambaran Namboodiri, Head of the Department, Botany, NSS Hindu College, Changanassery, Kottayam district to commemorate his sound knowledge in taxonomy.

*Specimens examined:* KERALA: Kollam Dist. Pandimotta, VB Sreekumar 20652 (KFRI). Kottayam Dist. Kottayam, N Unnikrishnan 74046 (CALI). Thrissur Dist. Palapilly, M Remesh & N Unnikrishnan 20651 (KFRI).

**NOTES** This species has affinities with *Ochlandra travancorica*. It is characterised by rough internodes. Leaves rough on the ventral side, prominent ligule, stamens around 40 and globose fruits. The ventral side of the leaves are pubescent in seedlings and in younger plants.

*Ochlandra keralensis* M. Kumar, Remesh & Stephen, J. Econ. Tax. Bot. 25: 49. 2001 [Figures 30 and 31; Plate 14].

**Type:** South India, Kerala, Pathanamthitta district, Pachakkanam, 1000 m, *Remesh & Stephen 20730* (Holotype KFRI !).

**HABIT** Perennial; caespitose, gregarious. Rhizomes sympodial; pachymorph; solid, short necked; clothed with scales. Culms erect; 5-6 m tall; strong; hollow, tip slightly arched. Culm-internodes 45-60 cm long; 2-3.5 cm diameter; pale green; slightly rough towards the tip. Culm-nodes swollen; sheath scar and supranodal ridge prominent; single nodal bud present enclosed in a prophyllum. Branches arise from the 5<sup>th</sup> or 6<sup>th</sup> node; intravaginal; the primary central axis dominant; 2-3 lateral branches subequal. Culm-sheaths 13-21 cm long; 6-9 cm wide ; coriaceous; greyish or black bulbous based hairs present when young; hairs restricted to base, when old; deciduous; striate; tip truncate; inner side smooth and shining; auricle prominent, ear shaped, decurrent, bearing numerous stiff bristles. Culm-sheath ligule very short, inconspicuous. Culm-sheath blade reflexed; glabrous; subulate; 5-8 cm long; 0.5-1 cm wide at base. Leaves arise towards the tip of the branches. Leaf sheaths overlap; closely attached; hirsute; clothed with stiff hairs; striate; auricle prominent; falcate; bear stiff bristles; bristles deciduous. Leaf-sheath ligule, inner short; outer inconspicuous. Leaf-blade linear-lanceolate; 18-40 cm long; 3.5-6.5 cm wide; glabrous on both sides; margins rough and scabrous; midrib prominent; apex acuminate; scabrous; truncate at the base; petiole short; thick.

**INFLORESCENCE** Inflorescence a large compound, spicate panicle on leafy branches. Pseudospikelets and spikelets in semiverticillate clusters on all branches at successive nodes.

**FERTILE SPIKELETS** Spikelets comprising single floret. Spikelets oblong-lanceolate; smooth; 5-6.7 cm long, 0.5-0.8 cm wide; short stalked; supported by 2-3 bracts.

**GLUMES** Sterile glumes 3; stiff; coriaceous. First two ovate-elliptic; 1.6-2 cm long; 0.5-0.7 cm broad. Third lanceolate; apex acuminate; 2-2.3 cm long; 0.6-0.8 cm wide; mucrone prominent; stiff bristles at the base of mucrone.

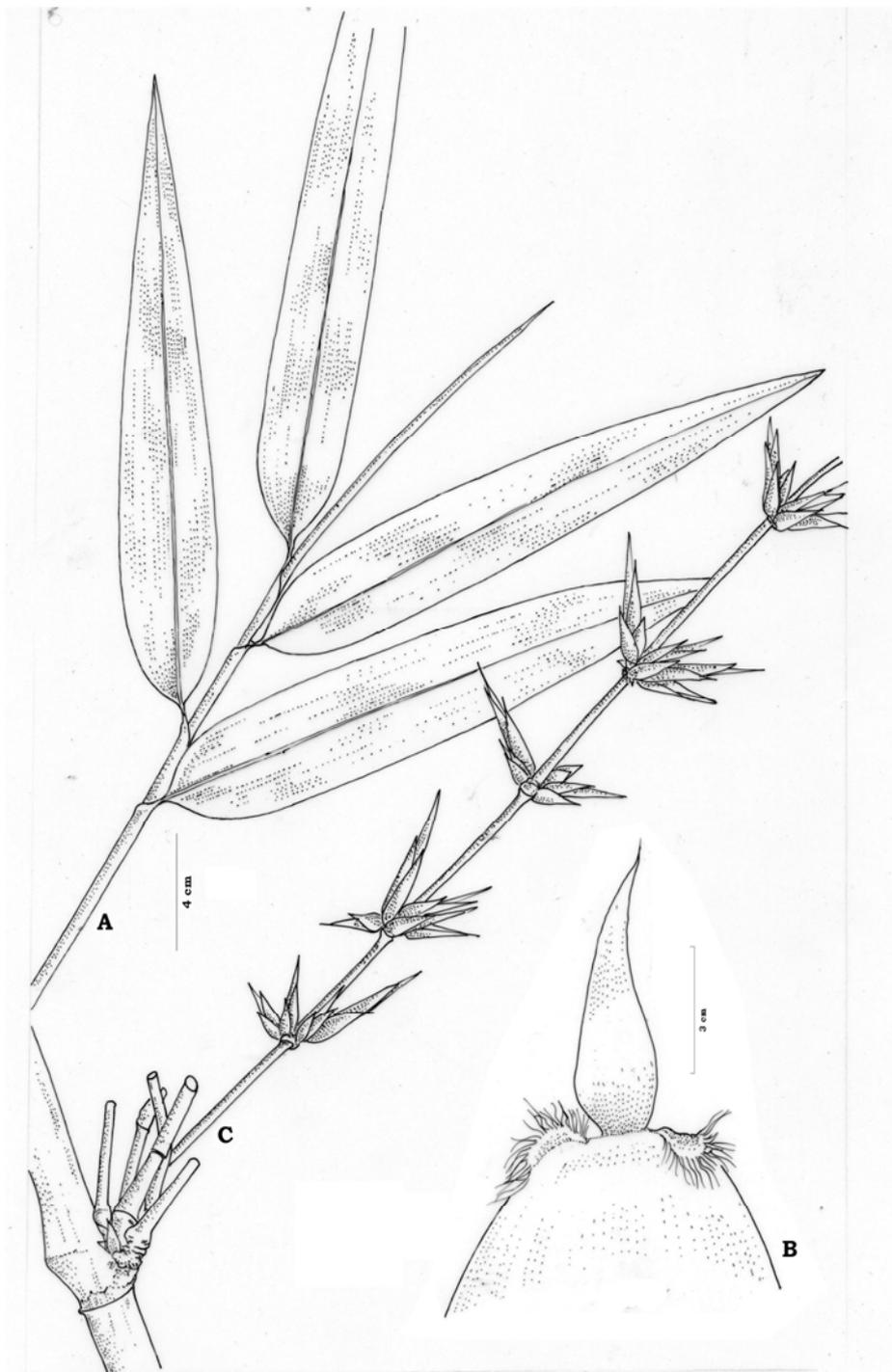


Figure 30 *Ochlandra keralensis* M. Kumar, Remesh & Stephen  
A. leafy branch; B. culm sheath; C. inflorescence

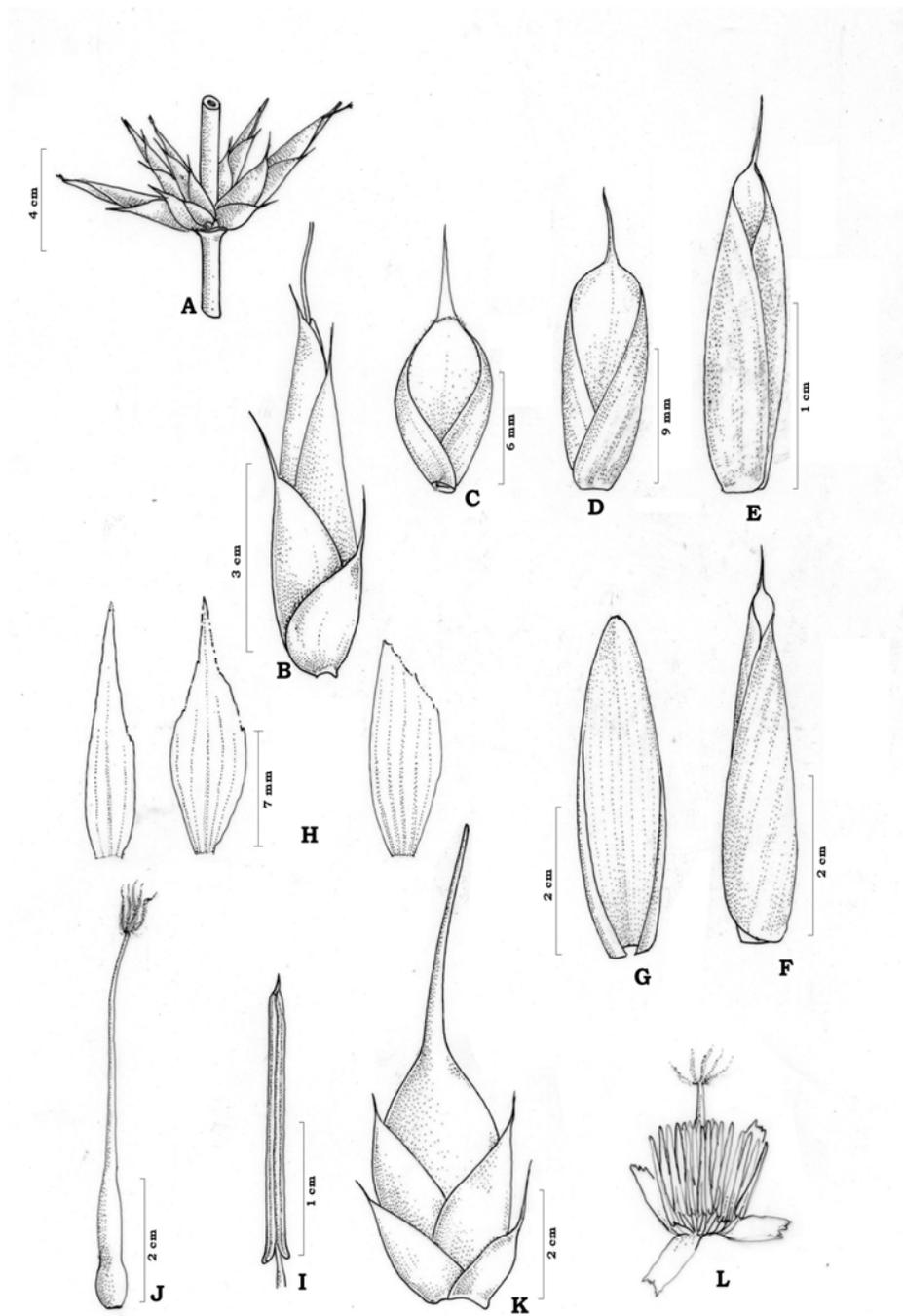


Figure 31. *Ochlandra keralensis* Muktesh, Remesh & Stephn **A.** portion of inflorescence; **B.** spikelet; **C., D. & E.** sterile glumes; **F.** lemma; **G.** palea; **H.** lodicules; **I.** stamen; **J.** ovary with style; **K.** fruit; **L.** open floret (diagramatic)

**FLORETS** Fertile lemma ovate lanceolate; membranous; many-nerved; 3.5-5 cm long; 0.7-0.9 cm wide; mucronate. Palea ovate-lanceolate; 4.5-5 cm long; thin; membranous; margins overlap; apex slightly notched; ciliate.

**FLOWER** Lodicules 3-4; filmy; hyaline; 1.3-1.5 cm long; narrow towards the base; 4-5 – nerved; margins fimbriate; ciliate. Stamens 90-92; number of stamens varies from flower to flower; yellow ; filaments free; long, filiform. Anthers 2.0-2.2 cm long; basifixed; apiculate; apex ciliate. Ovary glabrous; slightly spherical at base; gradually elongates into a perigynium. Style 5.5-6.5 cm long. Stigmas 5-7; plumose .

**FRUIT** Caryopsis; large; fleshy; ovate-oblong; 8-9 cm long; 2.5-3 cm wide; glumes persistent.

**DISTRIBUTION** Endemic to South India, distributed only in the type locality. Not reported from anywhere. Growing near and an open marshy place at an elevation of 1000 m.

*Specimens examined:* KERALA: Pathanamthitta Dist. Pachakkanam, *M Remesh & Stephen Sequiera 20730* (KFRI); Pachakkanam, *N Unnikrishnan 74012* (CALI).

**NOTES** This species has close affinity with *O. travancorica*. In the protologue it was mentioned that the number of lodicules is four. But it was found that majority of flowers have 3 lodicules. When 4 lodicules are present one is very small.

*Ochlandra scriptoria* (Dennst.) C.E.C. Fisch. in Gamble, Fl. Pres. Madras 3: 1863. 1934; Varmah & Bahadur, Indian For. Rec. (n.s.) Bot. 6(1): 3. 1980; Tewari, Monogr. Bamb. 110. 1992; M. Kumar, Rheedia 5(1): 70.1995; Seethalakshmi & M. Kumar, Bamb. India Comp.182. 1998; Nicolson *et al.*, Interpr. Hort. Malab. 311. 1998; Ohrnberger, Bamb. World 327. 1999 [Figures 32 and 33; Plates 15 and 15a].

**Type:** India, Malabar, *Johanstone* s.n. (lectotype CAL. designated here).

*Bambusa scriptoria* Dennst., Schluess. 9, 19, 31. 1818; *Beesha rheedei* Kunth, Enum. 1: 434.1833; Munro, Trans. Linn. Soc. London 26:144.1868; *Beesha* Rheede, Hort. Malab. 5: 119. t. 60, 1685; *Ochlandra rheedei* (Kunth) Benth. & Hook.f. ex Gamble, Ann. Roy. Bot. Gard. Calcutta 7:121, t.107.1896 & in Hook. f., Fl. Brit. India 7:418.1897; Brandis, Indian

Trees 684. 1906; Bourd., For. Trees Travancore 403. 1908; E. G. Camus, Les Bamb. 181. 1913.

**Typification:** This species was first mentioned in Rheede's Hortus Malabaricus (1685) as *Beesha*. Dennstedt (1818) named this species as *Bambusa scriptoria*. This species was first scientifically described by Munro (1868) as *Beesha rheedei*. The description was based on the specimens collected by Wight and also by Johanstone. According to Gamble (1896) this species was first collected by Wight and by Johanstone in 1836. From this description it is evident that Munro (1868) used specimens collected by Wight and Johanstone for his description. The specimen collected by Johanstone was deposited at CAL. Wight's collections was found missing

Specimen collected by Johanstone was deposited at CAL which is selected here for lectotypification and designated as lectotype.

**HABIT** Perennial; caespitose; gregarious; shrubby. Rhizomes sympodial; pachymorph; solid; short necked. Culms erect, sometimes straggling; hollow; 5-6 m tall; tip arched or drooping. Culm-internodes 20-60 cm long; 1-2 cm diameter; pale green; smooth. Culm-node swollen; sheath scar and nodal ridge prominent; each node bears a bud enclosed in a prophyllum. Branches arise from the 5<sup>th</sup> or 6<sup>th</sup> node onwards; young branches arise just above the sheath scar; intravaginal; the central primary axis dominant; three or four lateral branches subequal. Culm-sheaths 15-20 cm long; 6-8 cm wide at base; sparsely hairy when young; hairs restricted to the base and margins when old; deciduous, or persistent; striate; papery; tip rounded and truncate; inner side smooth and shining; auricles falcate with stiff bristles; auricle and bristles fall off at maturity. Culm-sheath ligule very short; 0.2 cm high. Culm-sheath blade erect; glabrous; narrow; deciduous; 2.5-4.5 cm long; 0.3-0.5 cm wide at base. Leaves arise from the nodes of branches towards the tip. Leaf-sheaths overlapped; smooth; striate; auricles small; falcate with stiff bristles; bristles deciduous. Leaf-sheath ligule inner, very short; outer ligule absent. Leaf-blade linear-lanceolate; narrow; 11-30 cm long; 1.5-3.5 cm wide; glabrous on both sides; one of the margins scabrous; midrib prominent; apex acuminate; scabrous; truncate at the base into a very short petiole.

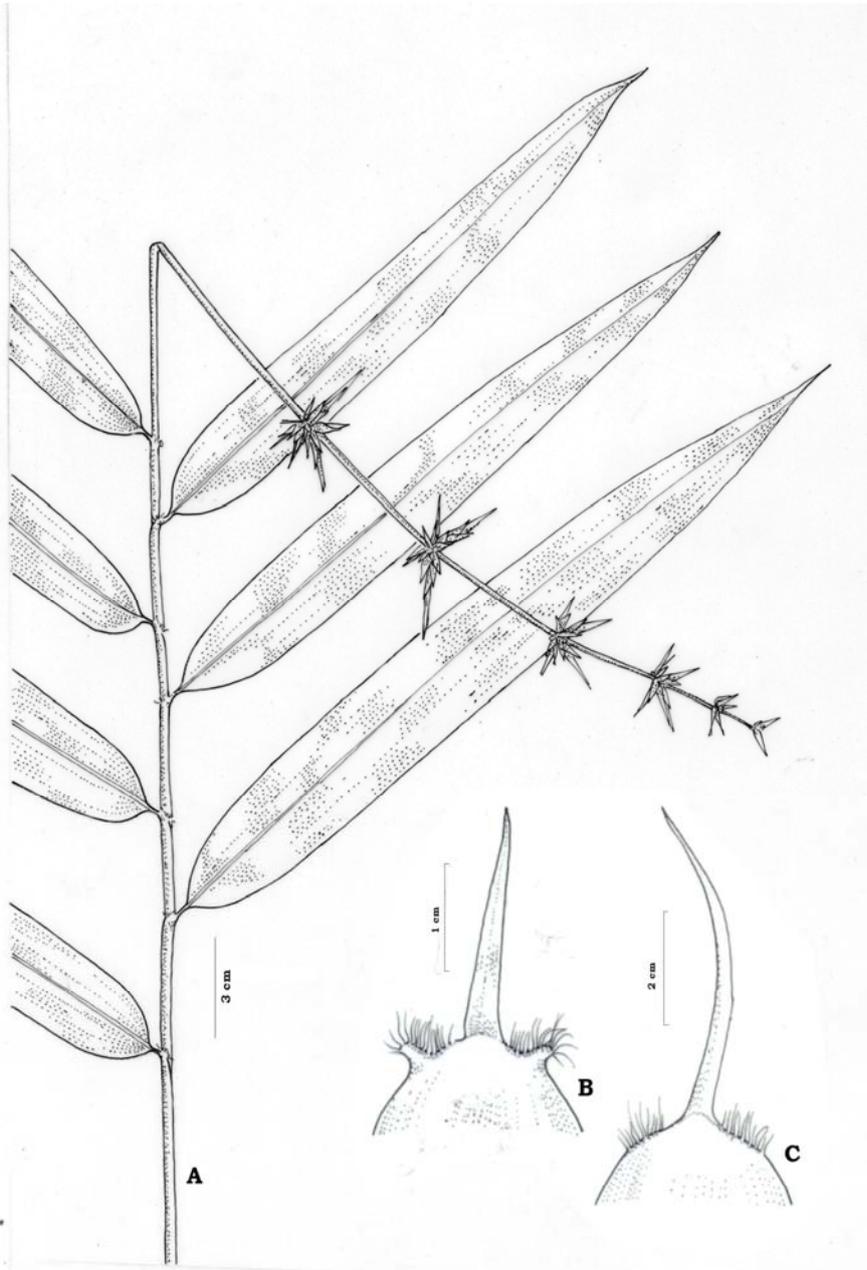


Figure 32 *Ochlandra scriptoria* (Dennst.) C.E.C. Fisch. **A.** flowering branch;  
**B. & C.** culm sheaths

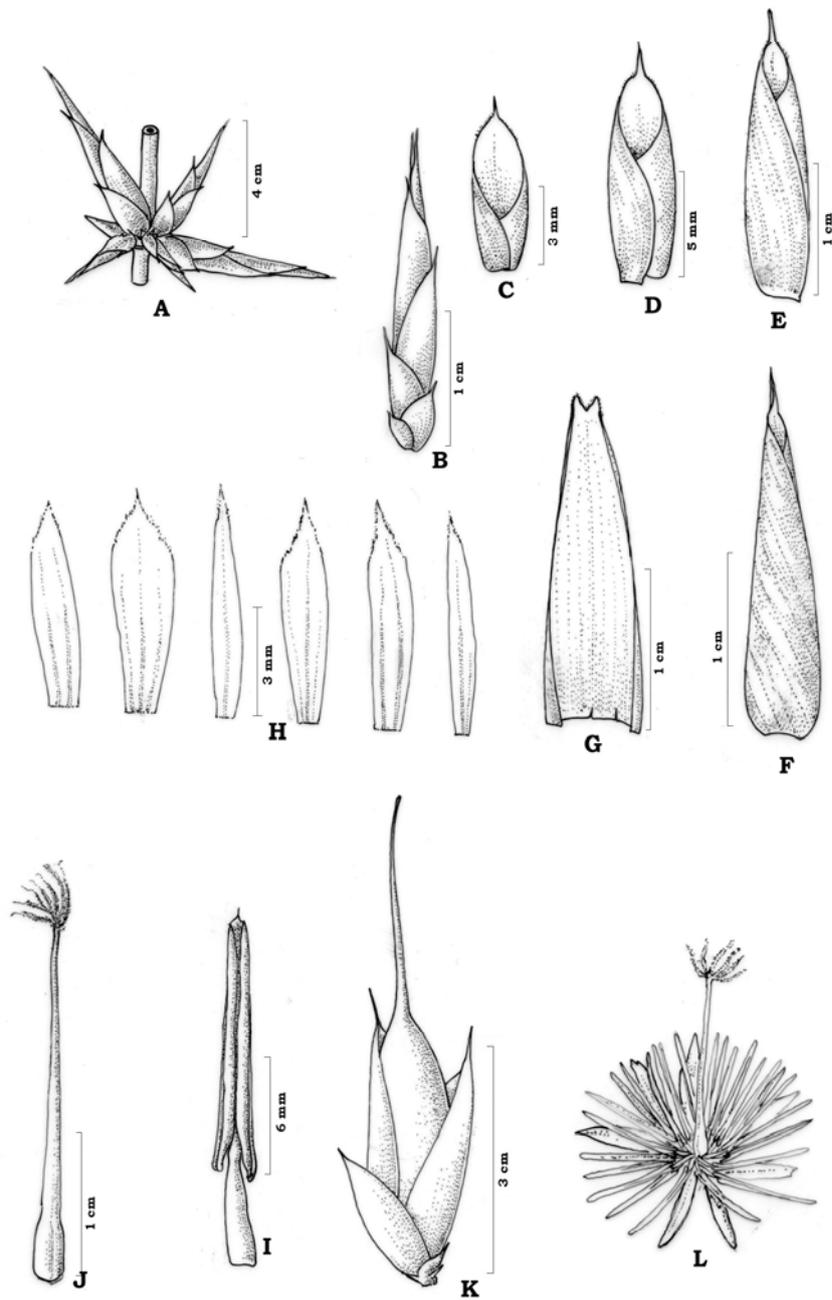


Figure 33. *Ochlandra scriptoria* (Dennst.) C.E.C. Fisch. **A.** portion of inflorescence; **B.** spikelet; **C., D. & E.** sterile glumes; **F.** lemma; **G.** palea; **H.** lodicules; **I.** stamen; **J.** ovary with style; **K.** fruit; **L.** open floret (diagrammatic)

**INFLORESCENCE** Inflorescence a large compound spicate panicle; terminal on the leafy branches. Pseudospikelets from the nodes of all branches in semiverticillate clusters; fertile and sterile flowers mixed.

**FERTILE SPIKELETS** Spikelets comprising single floret. Spikelets ovate-lanceolate; glabrous; 0.8-2.4 cm long; 0.2-0.3 cm wide; short stalked; supported by 2-3 sterile bracts.

**GLUMES** Sterile glumes 3. First two ovate; 0.6-1.2 cm long; 0.4-0.6 cm wide. Third 2-2.3 cm long; 0.8-1 cm wide; ovate-lanceolate; coriaceous; acute; mucronate; many-nerved; hairy along the margins.

**FLORETS** Fertile lemma lanceolate; thin, many-nerved; sub-mucronate; 1.9-2.1 cm long; 0.3-0.5 wide. Palea, smaller than lemma; membranous; 1.5-1.7 cm. long; 0.3-0.4 wide; ciliate along the margins; retuse; apex slightly fimbriate.

**FLOWER** Lodicules 6-7; hyaline; narrow; equal size; 0.5-0.7 cm long, 0.2-0.3 cm wide; 3-4 -nerved. Stamens 15-25, number not fixed; filaments free; short filiform. Anthers 1-1.2 cm long; yellow; apiculate; apex ciliate. Ovary glabrous; oblong; terminating into a perigynium. Style 1.3-2.8 cm long. Stigmas 5-6; plumose.

**FRUIT** Caryopsis; fleshy; oblong; 6-6.5 cm long; 0.7-1 cm wide; glumes persistent.

**DISTRIBUTION** This species is endemic to South India, found growing in Kerala and Southern Karnataka. It is distributed from sea level to an altitude of 600 m. It is common along the river and stream sides. Sporadic flowering is frequent in this species. Gregarious flowering was observed in Pathanamthitta district in the year 2000.

*Specimens examined:* KERALA: Malabar, s.loc. *Johanstone* s.n. (CAL); Flora of Travancore, s.loc. *JF Bourdillon 6821* (DD). Ernakulam Dist. Peruvannamuzhi, *M Kumar 6418* (KFRI). Kannur Dist. Iritti, *N Unnikrishnan 74037* (CALI). Kollam Dist. Kallada, *N Unnikrishnan 74036* (CALI); Pattazhi, *N Unnikrishnan 74205* (CALI). Kottayam Dist. Mundakkayam, *A Meebold 12783* (DD); Erattupetta, *N Unnikrishnan 74001* (CALI); Puthupally, *N Unnikrishnan 74003* (CALI); Manimala, *N Unnikrishnan 74007* (CALI). Malappuram Dist. Nilambur, *N Unnikrishnan 74016* (CALI). Pathnamthitta Dist. Kattoor, *N Unnikrishnan*

74043 (CALI). Thrissur Dist. Vazhachal, *N Unnikrishnan* 74035 (CALI). Wayanad Dist. Chandanathode, *VS Ramachandran* 66838 (KFRI); Cherukattorr, *N Unnikrishnan* 74030 (CALI).

**NOTES** *Ochlandra scriptoria* is common along the river banks in different parts of Kerala and South Karnataka. It flowers almost every year. According to Bourdillon, this species flowers annually, and culms are not dying after flowering (Gamble, 1896). Presence of falcate auricle is considered is a key character of this species. However, it is visible only in younger shoots.

*Ochlandra setigera* Gamble, Ann. Roy. Bot. Gard. Calcutta 7:128.1896 & in Hook. f., Fl. Brit. India 7:420.1897; Brandis, Indian Trees 685. 1906; E. G. Camus, Les Bamb. 184. 1913; C.E.C. Fisch. in Gamble, Fl. Pres. Madras 3: 1863. 1934; Varmah & Bahadur, Indian For. Rec. (n.s.) Bot. 6(1): 3. 1980; Tewari, Monogr. Bamb. 113. 1992; Chand Basha & M. Kumar, Rheedea 4(1): 26. 1994; M. Kumar, Rheedea 5(1): 66.1995; Seethalakshmi & M. Kumar, Bamb. India Comp.185. 1998; Ohrnberger, Bamb. World 328. 1999 [Figures 34 and 35; Plate 16].

**Type:** India, Nilgiris, Gudallur, 3000 ft., *JS Gamble* 25503, (holotype K. Cibachrome seen).

**HABIT** Perennial; caespitose ; gregarious. Rhizomes sympodial; pachymorph; solid, short necked; covered with scales. Culms erect, or straggling; hollow; 5-8 m tall; the tip whip like and pendulous. Culm-internodes yellowish green; 23-35 cm long; 1.5-2.2 cm diameter; smooth; a white band present just below the nodes. Culm- nodes slightly swollen; sheath scar and supranodal ridge prominent; each node with a single bud enclosed in a prophyllum. Branches arise from the 5<sup>th</sup> or 6<sup>th</sup> node; arise just above the sheath scar; intravaginal; the central primary axis dominant; lateral branches numerous; almost of equal size. Culm sheaths papery; dry; thin; 12-18 cm long, 7-9 cm wide at base; sparsely hirsute when young; become glabrous; the

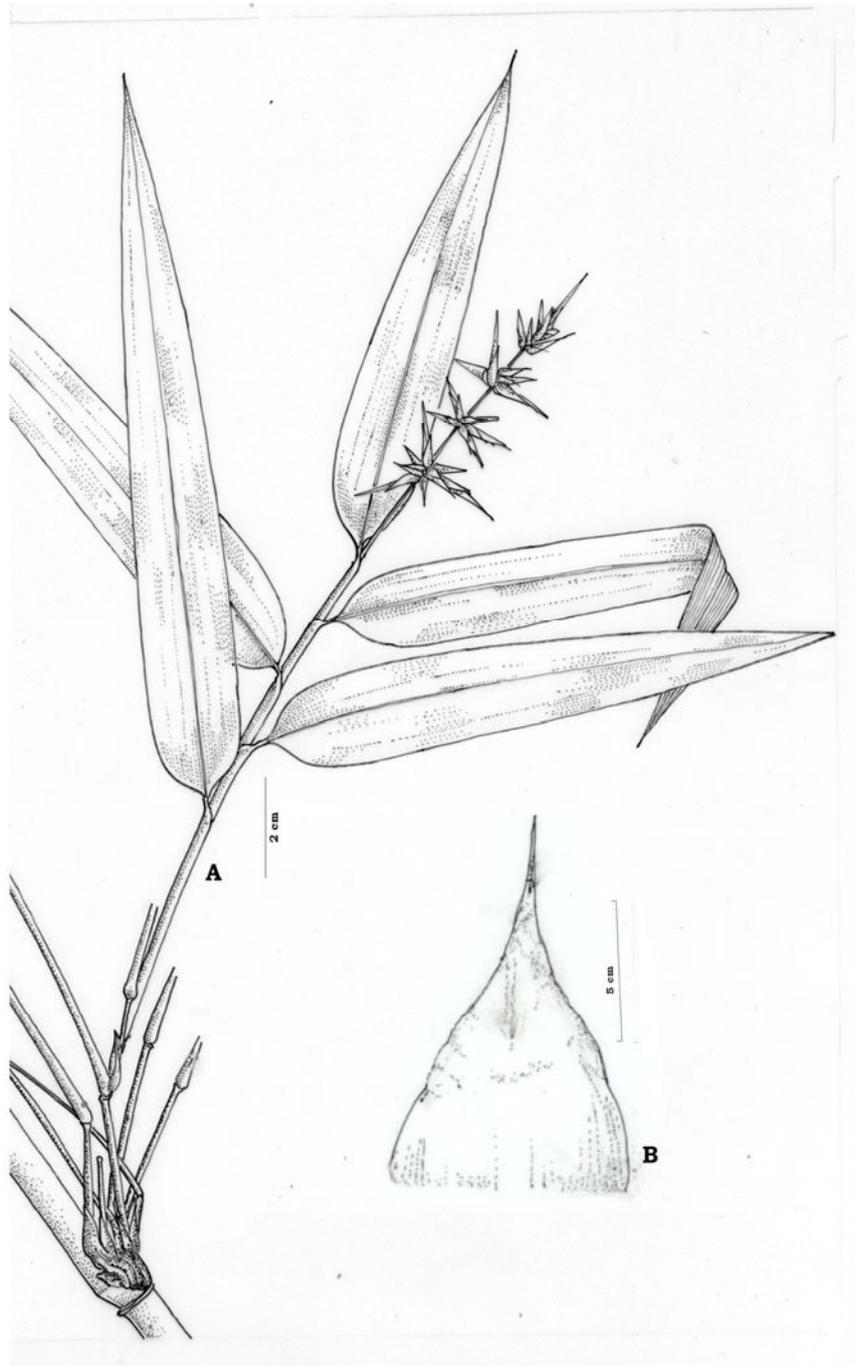


Figure 34. *Ochlandra setigera* Gamble **A.** flowering branch; **B.** culm sheath

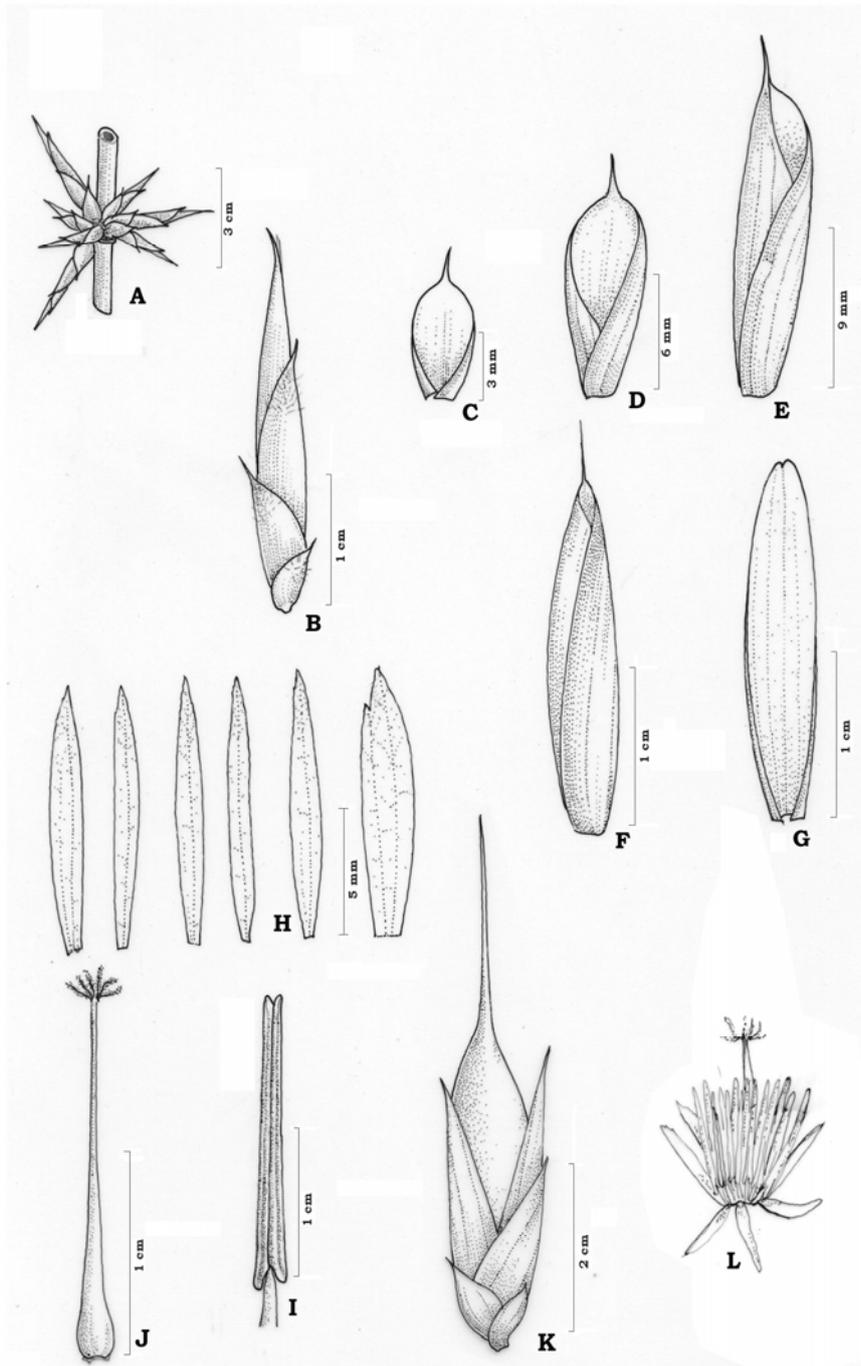


Figure 35. *Ochlandra setigera* Gamble **A.** portion of inflorescence; **B.** spikelet; **C., D. & E.** sterile glumes; **F.** lemma; **G.** palea; **H.** lodicules; **I.** stamen; **J.** ovary with style; **K.** fruit; **L.** open floret (diagrammatic)

apex of the sheath wrinkled and break off and the rest remain persistent; striate when old; apex narrow; rounded; auricle absent, oral setae inconspicuous. Culm-sheath ligule not prominent; Culm-sheath blade very narrow; needle like; involute, hirsute inside; 2-3 cm long. Leaves arise on branches towards the tip. Leaf -sheaths closely adhered to the branch; smooth; striate; auricle very short with stiff bristles; bristles deciduous. Leaf -sheath ligule, inner very short, outer not prominent. Leaf -blade linear-lanceolate; 6-23 cm long; 1-2.3 cm wide; glabrous on both sides; one of the margins rough; scabrous; many pellucid glands present; midrib prominent on the lower side; apex acuminate; setaceous; scabrous, truncate at the base; narrows into a short, thick petiole.

**INFLORESCENCE** Inflorescence a short spicate panicle on leafy branches, terminal, or axillary. Pseudospikelets in semiverticillate clusters at the nodes.

**FERTILE SPIKELETS** Spikelets single floret. Spikelets ovate-lanceolate; sparsely hirsute; 2-3 cm long; 0.3-0.4 cm wide; almost sessile; supported by 2-3 bracts.

**GLUMES** Sterile glumes 3; stiff and coriaceous; mucronate; hirsute towards the apex; many -nerved. First two ovate; 0.6-1.8 cm long; 0.3-0.7 cm wide. Third ovate-lanceolate; 1.2-1.8 cm long; 0.6-1 cm wide.

**FLORETS** Fertile lemma ovate-lanceolate; mucronate; thin; membranous; 2-2.8 cm long; 0.3-0.4 cm wide, many- nerved; smooth. Palea thin membranous; ovate-oblong; 2.2-2.6 cm long; 0.3-0.5 cm wide; glabrous; many -nerved; tip obtuse; slightly notched.

**FLOWER** Lodicules 6-7; hyaline; almost same size; 1-1.3 cm long; margins fimbriate; ciliate. Stamens 25-32; yellow; filaments free; short. Anthers basifixed; 1.8-2 cm long; non apiculate. Ovary glabrous; slightly globose at base; apex elongated into a perigynium. Style glabrous; 2.4-2.7 cm long. Stigmas 6; plumose.

**FRUIT** Caryopsis; oblong; long beaked; fleshy, 6 to 6.5 cm long; 1-1.5 cm wide; glumes persistent.

**DISTRIBUTION** Endemic to Nilgiri Biosphere Reserve. It is distributed in Malappuram and Palakkad districts, Kerala and Gudallur, Tamil Nadu at an elevation of 600-1000 m. It is a component of moist deciduous and semi-evergreen forests. It forms pure reed breaks in the Silentvalley National Park. Gregarious flowering is at long intervals. Sporadic flowering is common in summer months.

*Specimens examined:* KERALA: Malappuram Dist. Nilambur, *M Kumar 6413B* (KFRI); Nilambur, *M Kumar 6413C* (KFRI); Nilambur, *N Unnikrishnan 74044* (CALI).

**NOTES** This species was first described by Gamble (1896) based on vegetative specimen collected from Gudallur, Tamil Nadu. Basha and Kumar (1994) collected flowers of this species from Nilambur, Malappuram district, Kerala and illustrated the floral parts for the first time.

**Ochlandra spirostylis** M. Kumar, Seetha *et* Stephen, *Rheedea* 9(1):31.1999 [Figures 36 and 37; Plate 17].

**Type:** India, Kerala, Idukki District, Adimali, Chattuparakkudy, 900 m, *Stephen 00884* (holotype, KFRI).

**HABIT** Perennial; caespitose; gregarious; densely tufted. Rhizomes sympodial; pachymorph; solid; short necked; covered with scales. Culms erect; 5-6 m tall; hollow tip slightly arched. Culm-internodes 30-48 cm long; 1.5-3 cm diameter; pale green; rough towards the upper part; a greyish band with appressed hairs present just below the sheath scar. Culm-nodes slightly swollen; the sheath scar and supranodal ridge prominent; single bud enclosed in a prophyllum. Branches arise from the 5<sup>th</sup> or 6<sup>th</sup> node; the young branches arise just above the sheath scar; intravaginal; the primary, central axis dominant; 2-3, or more laterals on each side; almost subequal. Culm-sheaths 13-16 cm long; 6-10 cm wide at base; coriaceous; covered with dark or grey bulbous based hairs when young; hairs restricted to the lower portion at maturity; striate; deciduous; apex truncate; inner side smooth and shining; auricle short; inconspicuous; oral setae numerous; stiff; deciduous. Culm-sheath ligule inner, very short, outer not prominent. Culm-sheath blade reflexed; glabrous; subulate; 6-8 cm long; 0.5-1 cm wide at base. Leaves arise on the branches towards the tip. Leaf sheath imbricate; closely attached; glabrous; striate; apex of the sheath with minute auricles and bristles; bristles deciduous. Leaf sheath ligule very short. Leaf-blade linear-lanceolate; 16-38 cm long; 2-4.5 cm wide;

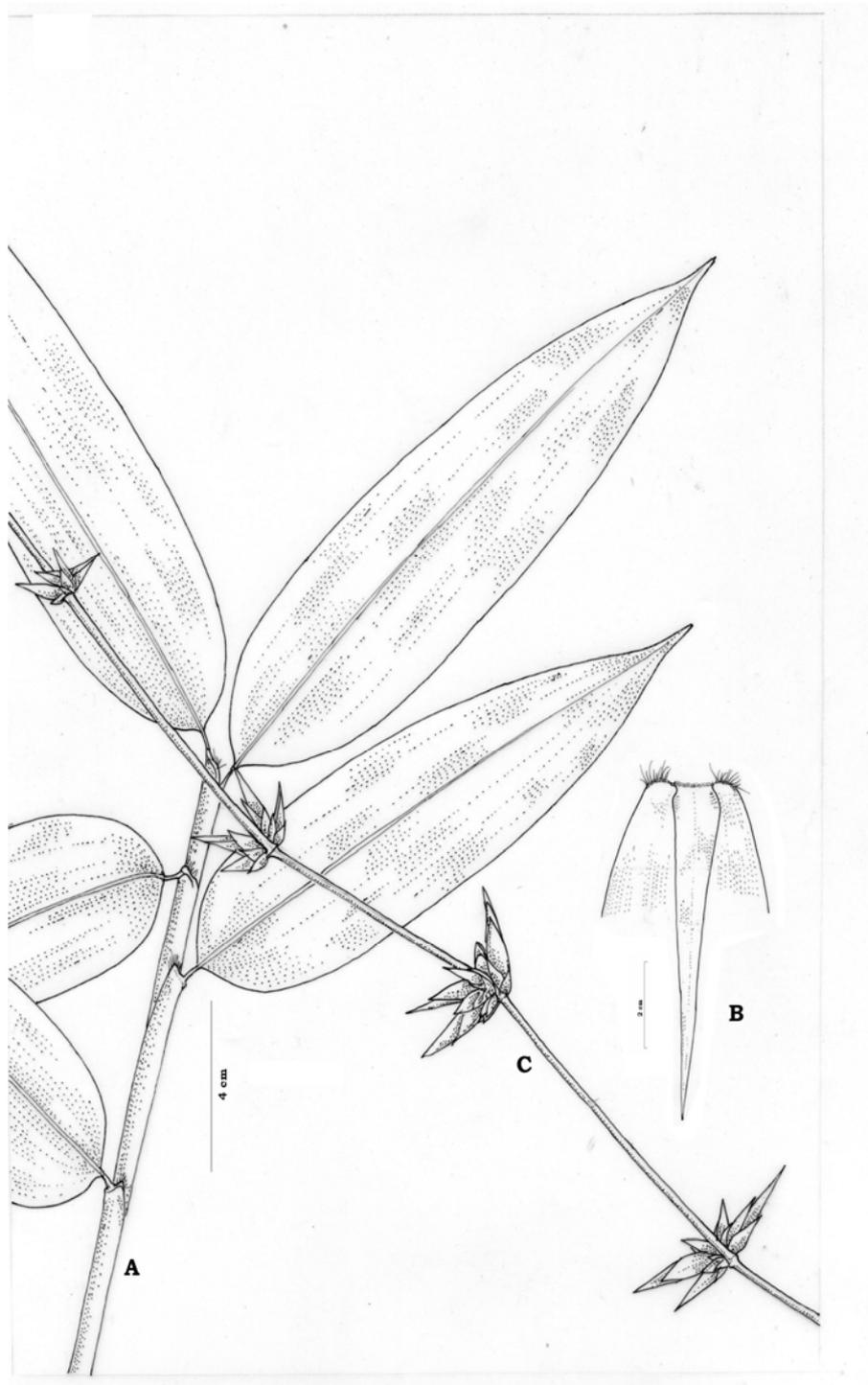


Figure 36. *Ochlandra spirostylis* M. Kumar, Seetha. & Stephen **A.** leafy branch; **B.** culm sheath; **C.** inflorescence

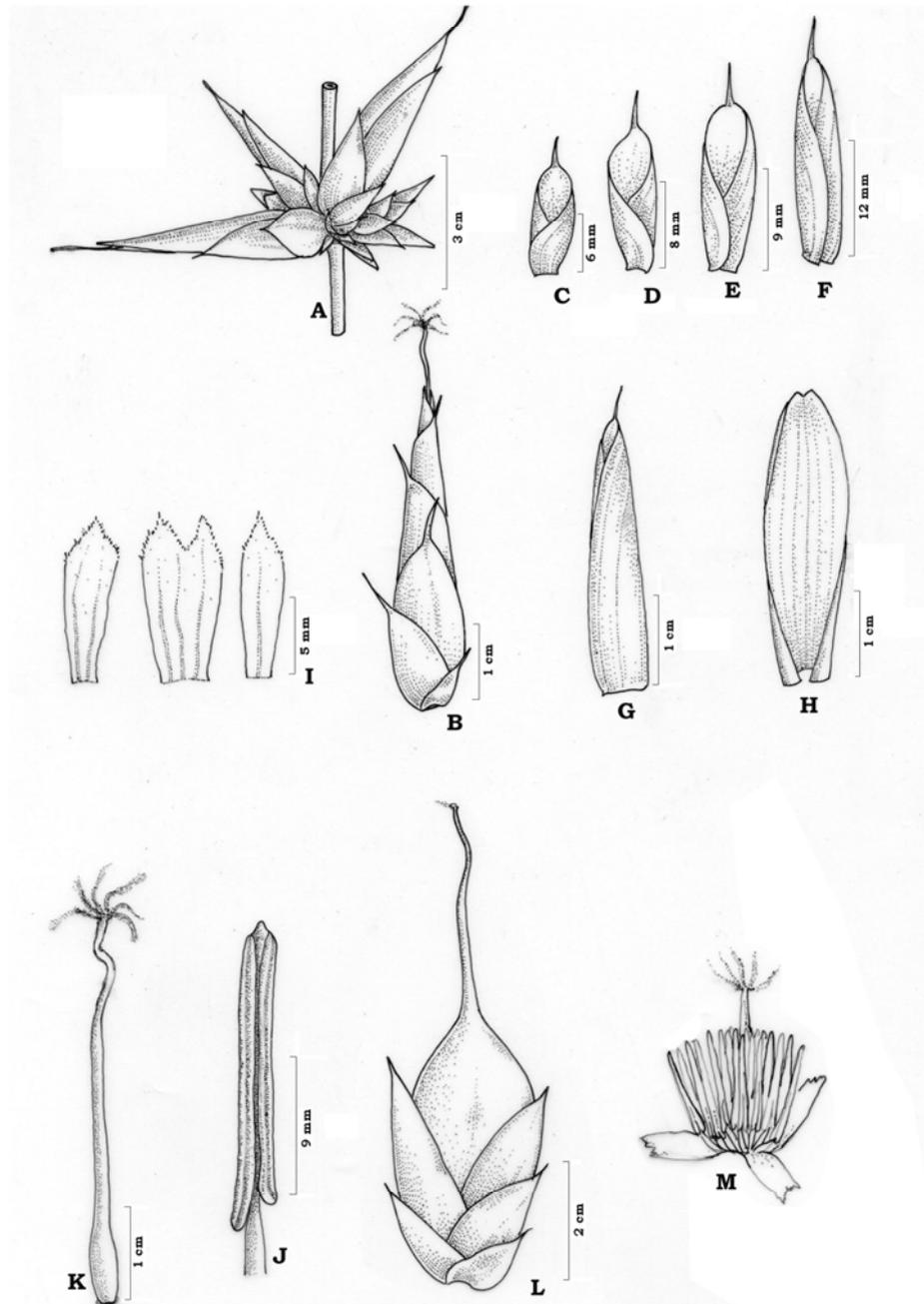


Figure 37. *Ochlandra spriostylis* M.Kumar, Seetha, & Stephen **A.** portion of inflorescence; **B.** spikelet; **C., D., E. & F.** sterile glumes; **G.** lemma; **H.** palea; **I.** lodicules; **J.** stamen; **K.** ovary with style; **L.** fruit; **M.** open floret (diagrammatic)

glabrous on both sides; margins rough and scabrous; midrib prominent in the lower side; apex acuminate; setaceous; scabrous; the base truncate; petiole short; thick.

**INFLORESCENCE** Inflorescence a large spicate panicle on leafy branches. Spikelets arise on the nodes of all branches, composed of pseudospikelets in semiverticillate clusters at the nodes.

**FERTILE SPIKELETS** Spikelets single floret. Spikelet ovate-lanceolate; glabrous; 4-5.5 cm long, 0.4-0.7 cm wide; short stalked; 2-3 bracts at the base.

**GLUMES** Sterile glumes 4; stiff; coriaceous; glabrous; margins ciliate; mucronate; many-nerved. First two glumes ovate; to ovate-lanceolate; 1.5-1.7 cm long. Third 1.7-1.9 cm long and fourth 2-2.5 cm long.

**FLORETS** Fertile lemma lanceolate; strongly mucronate; many-nerved; 3.5-3.8 cm long. Palea ovate-lanceolate; thin; membranous; 3-3.3 cm long; margins overlap, apex acute; notched; ciliate.

**FLOWER** Lodicules 3; thin; hyaline; one large; 1-1.2 cm long; 0.2-0.4 cm wide; 3-4 nerved. Stamens 68-75; dark yellow; filaments free; long; filiform. Anthers basifixed; narrow; 1.5-1.8 cm long; apiculate; apex ciliate. Ovary glabrous; globose at the base. Style 3.8-4.5 cm long; spirally coiled, or having a bend. Stigmas 5-6; plumose.

**FRUIT** Caryopsis; large; fleshy; ovate-oblong; 7.5-8 cm long; 2-2.8 cm diameter; pericarp fleshy; glumes persistent.

**DISTRIBUTION** Endemic to South India. Reported only from the type locality.

*Specimens examined:* KERALA: Idukki Dist. Chattuparakkudy, *Stephen Sequiera 884* (KFRI); Chattuparakkudy, *N Unnikrishnan 74045* (CALI)

**NOTES** In the protologue it is mentioned that this species is allied to *O. setigera*. But, comparative studies proved that it is closely related to *O. travancorica*. Two types of flowers were found in this species. In majority of the flowers the style is spirally coiled. But in some flowers the style is with an 'S' shaped bend.

*Ochlandra talbotii* Brandis, Indian Trees 684. 1906; Talbot, For. Fl. Bombay Pres. Sind. 2: 572. 1912; E. G. Camus, Les Bamb. 181. 1913; Blatt. & McCann, J. Bombay Nat. Hist. Soc. 33: 774. 1929; Varmah & Bahadur, Indian For. Rec. (n.s.) Bot. 6(1): 3. 1980; Tewari, Monogr. Bamb. 115. 1992; M. Kumar, Rheedeia 5(1): 80.1995; Seethalakshmi & M. Kumar, Bamb. India Comp.189. 1998; Ohrnberger, Bamb. World 328. 1999 [Figures 38 and 39; Plate 18 and 18 a].

**Type:** India, North Canara, Gursoppa falls, *WA Talbot* 3628 (lectotype BLAT).

**HABIT** Perennial; caespitose; gregarious. Rhizomes sympodial; pachymorph; solid; short necked; covered with scale leaves. Culms slender; erect; 4-8 m tall, self supporting, or straggling, or sometimes scandent; hollow, tip arching, when erect, or drooping. Culm-internodes 25-45 cm long; 2-3 cm diameter; pale green; rough towards the tip. Culm-nodes swollen; sheath scar and nodal ridge prominent; a single node bud enclosed in a prophyllum. Branching starts from 5<sup>th</sup> or 6<sup>th</sup> node; just above the sheath scar; intravaginal; the central axis dominant; 18-20 branches develop from its basal buds; almost equal. Culm- sheaths 14-22 cm long; 7.5-11 cm wide at base; coriaceous, covered by dark brown hairs when young; sparsely hirsute; striate when old; apex truncate; auricle very short, oral setae numerous, stiff, deciduous. Culm-sheath ligule not prominent. Culm-sheath blade narrow; 2-4.5 cm long; 0.2-0.3 cm wide at base, deciduous. Leaves arise on the branches. Leaf sheaths overlap; closely adhere to the branches; smooth; striate; auricle small; falcate with stiff bristles; bristles deciduous when old. Leaf-sheath ligule, inner very short; outer inconspicuous. Leaf-blade oblong-lanceolate; 18-32 cm long; 3.5-5.5 cm wide; glabrous on both sides; scabrous along one margin; apex acuminate; setaceous; scabrous; midrib clear along the lower side; base truncate leading to a short, thick petiole.

**INFLORESCENCE** Inflorescence a large spicate panicle on leafy branches. Spikelets arise on the nodes of all branches, composed of pseudospikelets in semiverticillate clusters at the nodes. Fertile and sterile spikelets mixed.

**FERTILE SPIKELETS** Spikelets comprising single floret. Spikelets ovate-lanceolate; glabrous; 2.5-3 cm long; almost sessile; supported by 2-3 bracts.

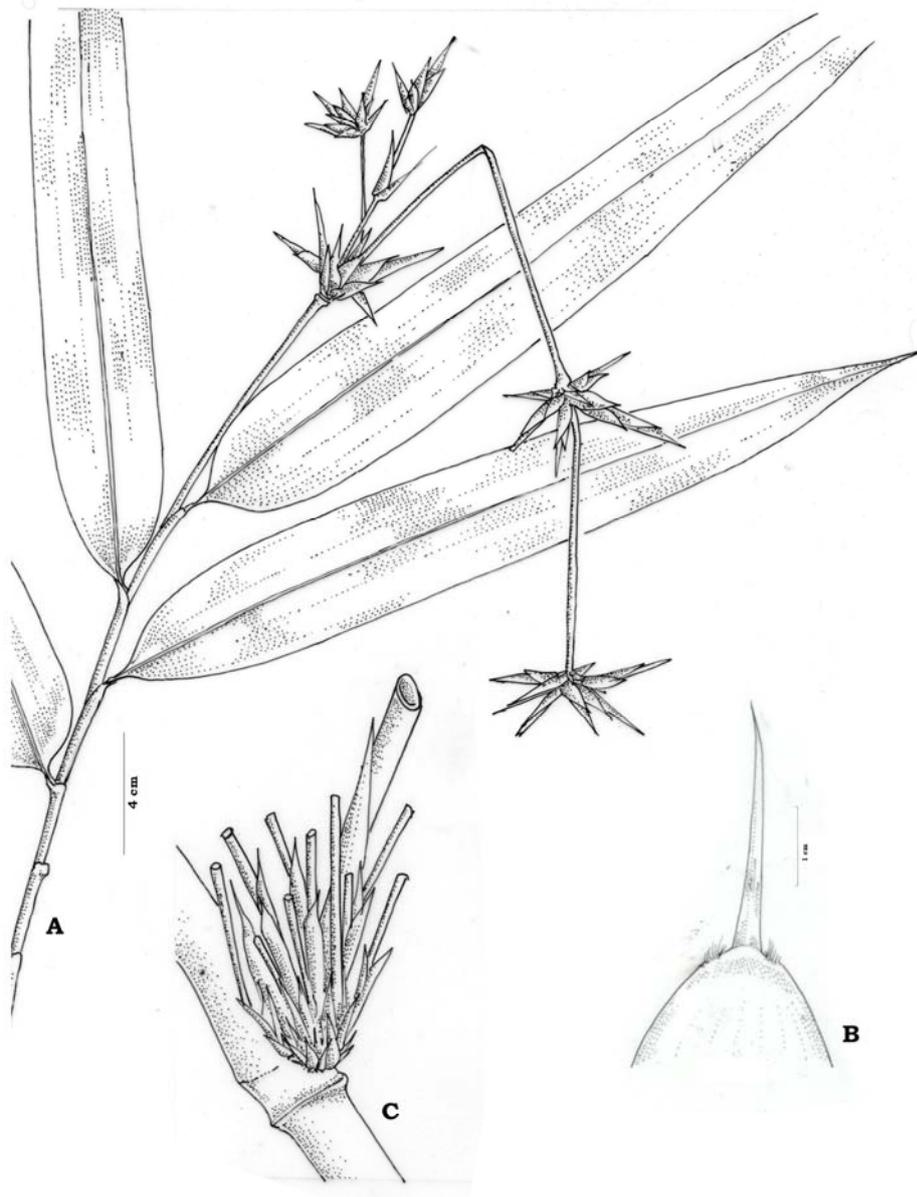


Figure 38. *Ochlandra talboti* Brandis **A.** flowering branch; **B.** culm sheath; **C.** branching

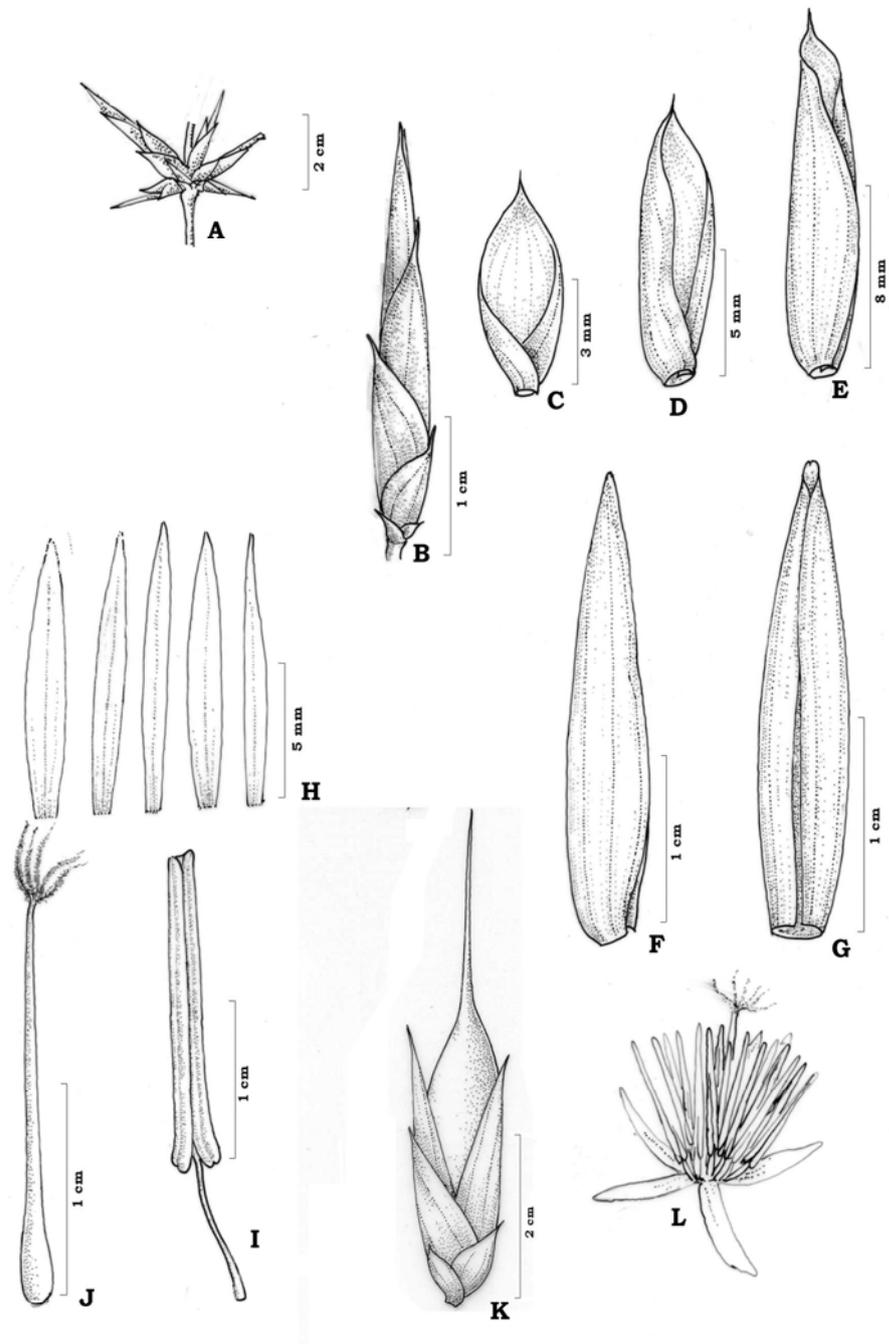


Figure 39. *Ochlandra talboti* Brandis **A.** portion of inflorescence; **B.** spikelet; **C., D. & E.** sterile glumes; **F.** lemma; **G.** palea; **H.** lodicules; **I.** stamen; **J.** ovary with style; **K.** fruit; **L.** open floret (diagrammatic)

**GLUMES** Sterile glumes 3; stiff; coriaceous. First one 0.5-0.8 cm long. Second 1-1.2 cm long. Third 1.2-2 cm long; ovate-lanceolate; pungent; mucronate; many-nerved, sparsely hirsute towards the apex.

**FLORETS** Fertile lemma ovate-lanceolate; thin; membranous; 2.3-2.8 cm long; many – nerved; acute. Palea oblong; thin membranous; smooth; 2-2.5 cm long; apex retuse.

**FLOWER** Lodicules 5-6; hyaline; narrow; 2-3 nerved, 1-1.3 cm long; margins fimbriate; ciliate. Stamens 25-40; yellowish; filaments free; short. Anthers 1.7-2 cm long; basifixed; non-apiculate; retuse. Ovary glabrous; narrow; tip elongates to a perigynium. Style 1.8-2.3 cm long; glabrous. Stigmas 5; plumose.

**FRUIT** Caryopsis; oblong; long beaked; 5.6-6 cm long; pericarp fleshy; glumes persistent.

**DISTRIBUTION** This species is endemic to Peninsular India and distributed in Karnataka and Goa. It grows from an altitude of 200-1000 m. It is a component of moist deciduous and semi-evergreen forests. It is also found growing along river and stream sides. Flowering is in summer months. Sporadic flowering is frequent.

*Specimens examined:* KARNATAKA: Kodagu Dist. Vir Rajpetta, Makutta, *M Kumar* 7533 (KFRI); Vir Rajpetta, Makutta, *N Unnikrishnan & M Remesh* 74110 (CALI). North Kanara Dist. Gaurasoppau falls, *WA Talbot* 3569 (BSI); Gaurasoppau falls, *WA Talbot* 3628 (BLAT); Sool Geri, *TR Bell* 3351 (BSI); Sampkhadu, *Hallberg & McCann* s.n. (BLAT).

*Ochlandra travancorica* (Bedd.) Benth. in Benth. & Hook.f., Gen. Pl. 3: 1215. 1883; Gamble, Ann. Roy. Bot. Gard. Calcutta 7:125.t.111.1896 & in Hook. f., Fl. Brit. India 7:419.1897; Brandis, Indian Trees 684. 1906; Bourd., For. Trees Travancore 403. 1908; E. G. Camus, Les Bamb. 182. 1913; Rama Rao, For. Pl. Travancore 448. 1914; C.E.C. Fisch. in Gamble, Fl. Pres. Madras 3: 1863.1934; Varmah & Bahadur, Indian For. Rec. (n.s.) Bot. 6(1): 4. 1980; Tewari, Monogr. Bamb. 115. 1992; M. Kumar, Rheedia 5:82.1995; Seethalakshmi & M. Kumar, Bamb. India Comp.191. 1998; Ohrnberger, Bamb. World 328. 1999 [Figures 40 and 41; Plates 19 and 19 a].

**Type:** India, Travancore Hills, *Beddome* s.n. (lectotype K. designated here. Cibachrome seen).

*Beesha travancorica* Bedd., Fl. Sylv. 239. t. 324.1873; *Nola-illy* Rheede, Hort. Malab. 5: 119, 120. 1685 ; *Ochlandra travancorica* Benth. var. *hirsuta* Gamble Ann. Roy. Bot. Gard. 7: 126. 1896. **syn. nov.** *Ochlandra sivagiriana* (Gamble) E. G. Camus, Les Bamb. 181. t. 99. 1913. **syn. nov.** *Ochlandra soderstromiana* M. Kumar & Stephen, Rheedeia 9(1): 33. 1999. **syn. nov.**

**Typification:** Three specimens of *O. travancorica* collected by Beddome in 1873 from Travancore hills were deposited at MH, labelled as holotype. But, a specimen collected by Beddome in 1869 is deposited at K. This specimen was used by Beddome for describing the species. In the present study, Beddome's specimen collected in 1869 and deposited at K is designated as lectotype. Kumar (1995) designated this specimen as type .

**HABIT** Perennial; caespitose, gregarious. Rhizomes sympodial; pachymorph; solid; short-necked; covered with scales. Culms erect; 4-10 m tall; hollow, tip slightly arched, or some times whip like; close packed and impenetrable. Culm-internodes 0.5-1.2 m long, 4-6 cm in diameter; dark green; smooth below and rough towards the apex. Culm-nodes slightly swollen; sheath scar and nodal ridge prominent; a single nodal bud enclosed in a prophyllum. Branches arise from the fifth or sixth node; the young branches from just above the sheath scar; intravaginal; the primary central branch dominant; numerous lateral branches arise from basal buds. Culm-sheaths coriaceous; 15-26 cm long; 8-12 cm wide at base; covered with bulbous based golden brown hairs, when young; smooth, or sparsely hirsute; deciduous and striate, when old; truncate at the apex, inner side smooth and shining; auricle short, inconspicuous, ornamented with numerous stiff bristles. Culm-sheath ligule, inner 0.2-0.3 cm high; outer ligule inconspicuous. Culm-sheath blade reflexed; glabrous; subulate; 5-12 cm long; 0.6-1.2 cm wide at base. Leaves arise on branches. Leaf-sheaths over lap; closely attached; smooth; striate; auricle very short and oral setae at the apex; oral setae deciduous, when old. Leaf-sheath ligule short. Leaf blade linear-lanceolate; 19-40 cm long; 2-6 cm wide; glabrous on both sides; margins rough and scabrous; midrib prominent; clear on the lower side; apex acuminate; setaceous; scabrous and sometimes twisted; truncate at the base into a short, thick petiole.

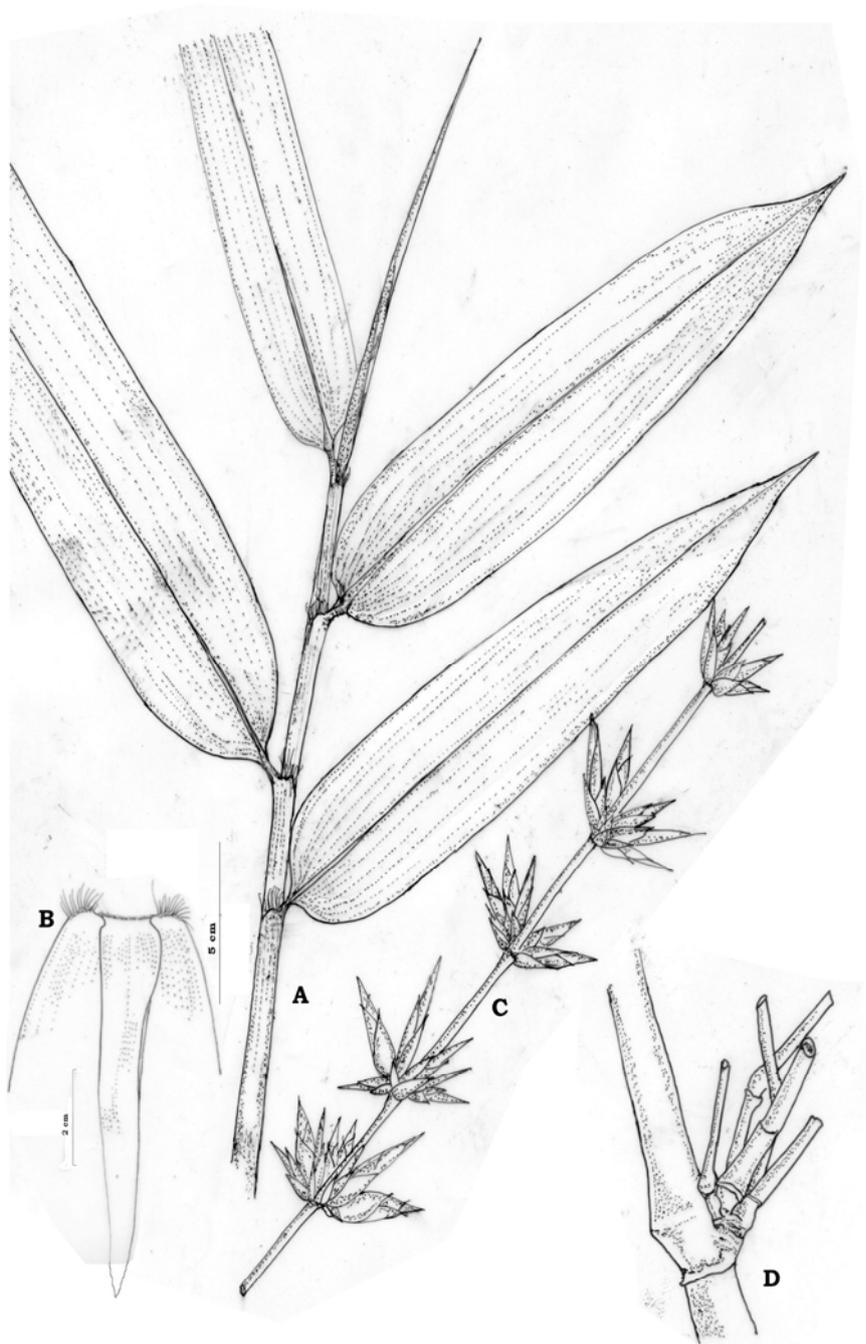


Figure 40. *Ochlandra travancorica* (Bedd.) Benth. **A.** leafy branch; **B.** culm sheath; **C.** inflorescence; **D.** branching

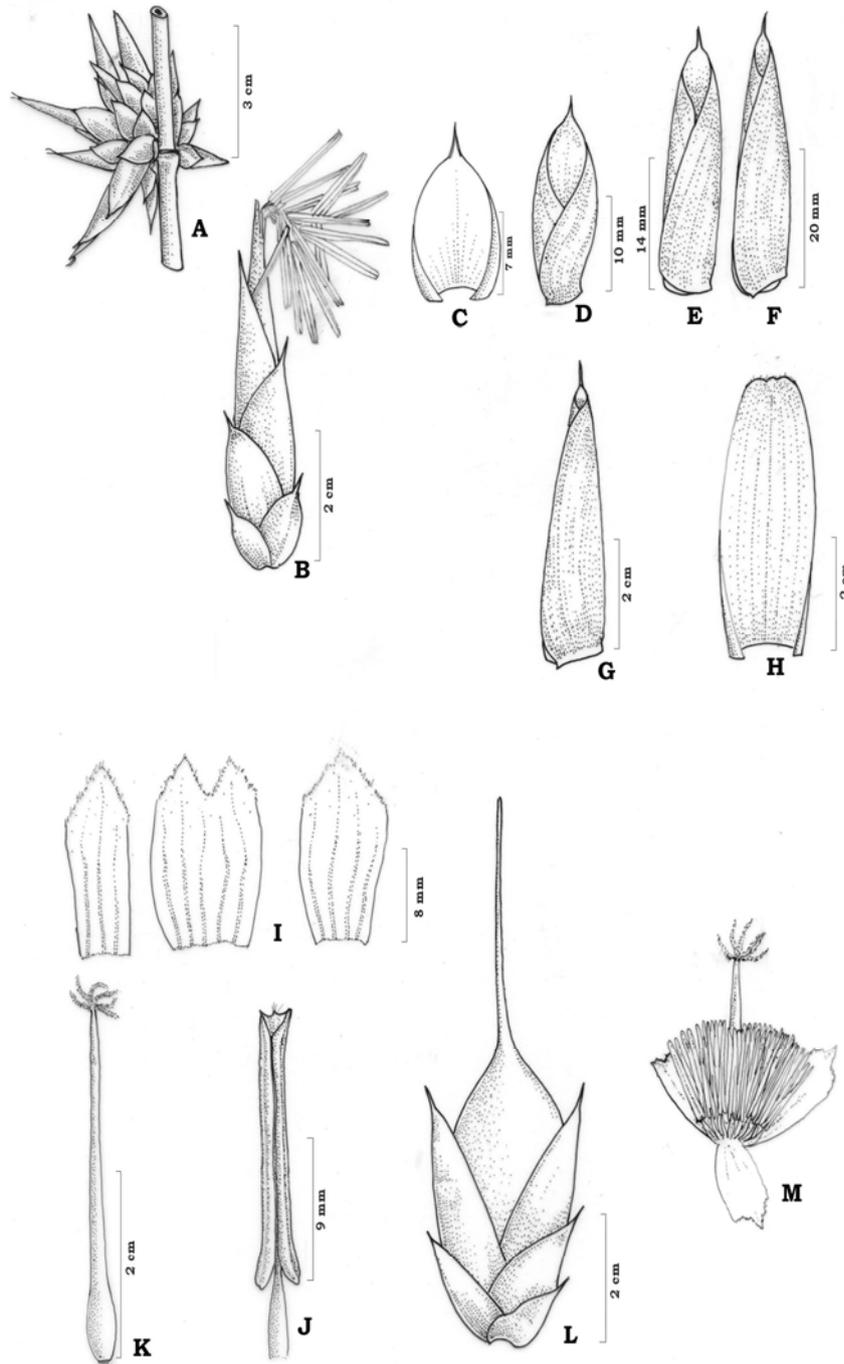


Figure 41. *Ochlandra travancorica* (Bedd.) Benth. **A.** portion of inflorescence; **B.** spikelet; **C., D., E. & F.** sterile glumes; **G.** lemma; **H.** palea; **I.** lodicules; **J.** stamen; **K.** ovary with style; **L.** fruit; **M.** open floret (diagrammatic)

**INFLORESCENCE** Inflorescence a large compound spicate panicle on leafy branches.

Spikelets borne at all branches at successive nodes, also on the main culm nodes, composed of pseudo-spikelets, form semiverticillate clusters at the nodes. Fertile and sterile flowers mixed.

**FERTILE SPIKELETS** Spikelets single floret; ovate-lanceolate; glabrous; 4-6 cm long; 0.7-1 cm wide; short stalked; supported by 3-4 bracts.

**GLUMES** Sterile glumes 3-4. First glume ovate; 1.2-1.5 cm long; 0.6-0.8 cm wide. Second ovate-lanceolate; 1.8-2.3 cm long; 1-1.2 cm wide. Third ovate-lanceolate; 2.5-3 cm long; 1.7-2 cm broad. Fourth glume lanceolate; 4-4.5 cm long; 2-2.5 cm wide; stiff and coriaceous; ciliate along the margins; many-nerved; acute; strongly mucronate; stiff hairs at the base of mucro in the lower glumes.

**FLORETS** Fertile lemma long-lanceolate; mucronate; thin; 4-5 cm long; 2.5-3.2 cm wide; many-nerved. Palea ovate-oblong; thin; 4.3-4.5 cm long; 1.8-2.3 cm wide; membranous; margins overlap; ciliate, apex retuse; slightly notched; ciliate.

**FLOWER** Lodicules 3; hyaline; almost of the same size; 1.3-1.8 long; 3-4 cm wide; narrow towards the base; 5-6-nerved; margins fimbriate; ciliate. Stamens 65-130; yellow; filaments free; long; filiform. Anthers basifixed, 1.6-2 cm long; apiculate; apex ciliate. Ovary glabrous; rounded at the base and gradually elongated into a, perigynium. Style 3.8- 4.7 cm long. Stigmas 6; plumose.

**FRUIT** Caryopsis large; flesh; ovate-oblong; 8-9.5 cm long; 2.8-3 cm diameter; pericarp fleshy; glumes persistent.

**DISTRIBUTION** This is the most common reed bamboo and has a wider distribution in southern Western Ghats. It is found growing in Kerala, South Karnataka and Tamil Nadu from sea level to an elevation of 2000 m. It is a component of moist deciduous and semi-evergreen forests, and form reed breaks. It also grows along river and stream sides. Sporadic flowering is very common in summer months.

*Specimens examined:* KERALA: Ernakulam Dist. Pooyankutty, *AG Pandurangan* 79243 (MH); Edamalayar, *N Unnikrishnan* 74025 (CALI). Idukki Dist. Adimali, *N Unnikrishnan* 74024 (CALI); Vallakkadavu, *BD Sharma* 43940 (MH); Pambanar *MY Ansai* 51549 (BSD); Kallar, *N Unnikrishnan* 74018 (CALI); Vagamon, *N*

*Unnikrishnan 74002* (CALI). Kollam Dist. Shenduruny, *Punalur Paper Mill 140613* (DD); Shenduruny, *KJ Joseph 130257* (DD); Kulathupuzha, *N Unnikrishnan 74017* (CALI). Kottayam Dist. Mundakkayam, *N Unnikrishnan 74015* (CALI). Malappuram Dist. Nilambur, *N Unnikrishnan 74027* (CALI); Nilambur, Thalichola, *Philip Mathew 33922* (CALI). Pathanamthitta Dist. Plapilly, *M. Kumar 6429* (KFRI); Goodrical, *N Unnikrishnan 74005* (CALI). Thrissur Dist. Kollethirumudi, *M. Kumar 6412* (KFRI); Poringal *GS Puri 15905* (BSI). Thiruvananthapuram Dist. Agasthyarmalai, *M Kumar 6481* (KFRI); Agasthyarmalai, *N Mohanan 11463* (CALI); Bonnaccord, *M Mohanan 61719* (MH); Nedumangad, *CA Barber 7178* (MH); Kottur RF, *J Joseph 44088* (MH); Travancore hills, *Beddome s.n.* (MH). TAMIL NADU: Kanyakumari Dist. Muthukuzhivayal, *AN Henry 4945* (MH). Thirunelveli Dist. Thirunelveli, *EAC Forests 39687* (DD); Nangunery Range, *Forest Ranger 40541* (DD).

**NOTES** This species shows a great variation in its growth habits. It grows normally up to a height of 4-10 m. The tip is normally arched. Plants with very long whip like pendulous tip were also observed during the field study. Beddome (1873) was the first to describe this species. Beddome (1873) and Gamble (1896) described this species as having monadelphous stamens. The number of stamens is not fixed in this species. It varies from 55-130. Detailed studies of numerous specimens from different parts of south India showed that stamens are free. They remain very close in young buds, which appear as monadelphous.

The variety *Ochlandra travancorica* var. *hirsuta* was first described by Gamble (1896). He treated this as a variety because the spikelets of this species are clothed with light brown velvety pubescence. However, there is no difference in floral characters and in other vegetative characters in *O. travancorica* and in *O. travancorica* var. *hirsuta*. During the study, it was found that the hairy nature is not a stable character. This variety flowered under cultivation at Kerala Forest Research Institute, Peechi and it was observed that the spikelets were glabrous. The hairy nature may be due to some environmental factors. Owing to these reasons, in this treatise, *Ochlandra travancorica* var. *hirsuta* is treated as a synonym of *O. travancorica*.

*Ochlandra sivagiriana* was first described by Gamble (1896). He first proposed it as a variety of *O. rheedii* (*O. scriptoria*). In the description, he commended that 'it is

*possible that this should have been described as a species*'. This comment was written on the sheet of *Ochlandra sivagiriana* deposited at MH, Coimbatore. Based on this, Camus (1913) recognized it as a species *Ochlandra sivagiriana*. His description is very brief and without any proper illustration. Kumar (1995) described and illustrated this species based on a specimen collected from Vazhachal, Thrissur district, Kerala. However, subsequently it was revealed that the specimen collected by Kumar (1995) was that of *O. scriptoria*. The type locality of *Ochlandra sivagiriana* is Palani and Sivagiri hills (Gamble, 1896). Extensive field study was conducted at Palani hills and it was not relocated. In the flora of Palani hills, Matthew (1999) commented '*presumably not collected since the first report*'. In 2002, this species flowered at Sivagiri and adjacent hills. A detailed study of the herbarium sheet at MH and specimens collected from Sivagiri hills undoubtedly proved that it was *Ochlandra travancorica*. Therefore, in this report *Ochlandra sivagiriana* is synonymised with the species *Ochlandra travancorica*.

*Ochlandra soderstromiana* was first described by Kumar and Stephen (1999). This species was collected from Kallar Valley, Idukki district, Kerala. In the protologue, it was mentioned that affinity of this species was to *Ochlandra talbotii* which is a species growing in Karnataka and Goa. During the re-examination of the species it was found that this species is closely allied to *Ochlandra travancorica*. The broad leaves, large spikelets, three large lodicules, the numerous stamens and the large caryopsis and hence in this report, *O. soderstromiana* is synonymised under *O. travancorica*.

***Ochlandra wightii*** (Munro) C.E.C. Fisch. in Gamble, Fl. Pres. Madras 3: 1864.1934; Varmah & Bahadur, Indian For. Rec. (n.s.) Bot. 6(1): 4. 1980; Tewari, Monogr. Bamb. 117. 1992; M. Kumar, Rheedeia 5(1): 88.1995; Seethalakshmi & M. Kumar, Bamb. India Comp. 199. 1998; Ohrnberger, Bamb. World 329. 1999 [Figures 42 and 43; Plates 20 and 20 a].

**Type:** India, Courtallam-Tennavelly, *Brandis* s.n. (neotype K. Cibachrome seen. designated here).

*Bambusa wightii* Munro, Trans. Linn. Soc. London 26:111.1868; *Ochlandra brandisii* Gamble, Ann. Roy. Bot. Gard. Calcutta 7:126, t.113.1896 & in Hook.f., Fl. Brit. India 7:420.1897; Brandis, Indian Trees 684. 1906; Bourd., For. Trees Travancore 405. 1908; E. G. Camus, Les Bamb. 182. 1913.

**Typification:** This species was first collected by Wight (1835) from Courtallam. Later, it was collected by Brandis in flower in 1882 from the same locality (Gamble, 1896). The first specimen collected by Wight was found missing. Brandis's specimen is deposited at K and is designated here as neotype .

**HABIT** Perennial; caespitose; gregarious. Rhizomes sympodial; pachymorph; solid, short-necked, clothed with scale leaves. Culms erect; closely packed; hollow; 5-6 m tall; slightly arched above. Culm-internodes 50-70 cm long; 1.2-1.3 cm in diameter; light green; rough. Culm-nodes swollen at the region of supra nodal ridge; sheath scar prominent; a single bud present; enclosed in a prophyllum. Branches arise from the 5<sup>th</sup> or 6<sup>th</sup> node; intravaginal; central axis prominent; 3-4, lateral branches arise ; subequal. Culm-sheaths coriaceous; 15-19 cm long; 6.5-8.5 cm wide at base; hirsute; covered with bulbous based brown hairs, when young; glabrous, when old; deciduous, striate; apex truncate; inner side smooth and shining; auricle inconspicuous, bear stiff erect oral setae. Culm-sheath ligule, inner prominent; large; 1.8-2.5 cm high; striate; thin; membranous; margins fringed. Culm-sheath blade reflexed; smooth; subulate; 8-10 cm long; 0.7-1 cm wide at the base; deciduous. Leaves arise on branches. Leaf-sheath overlapping; striate; smooth; auricle short with stiff deciduous bristles. Leaf-sheath ligule, inner prominent; papery; 1.5-2 cm high; fimbriate; outer ligule very short; 0.1-0.2 cm long. Leaf-blade oblong-lanceolate; 28-45 cm long; 3-11 cm wide; glabrous on both sides; margins rough and scabrous; midrib prominent on the lower side; apex acuminate; scabrous; base attenuate to a thick, short petiole.

**INFLORESCENCE** Inflorescence a large spicate panicle, terminal on leafy branches. Spikelets arise on the nodes of all branches, composed of pseudospikelets in semiverticillate clusters at the nodes.

**FERTILE SPIKELETS** Spikelets single floret. Spikelets ovate; glabrous; 3.5-4 cm long; 0.7-0.9 cm wide; short stalked; base covered by 2-3 bracts; mucrones prominent; projected.

**GLUMES** Sterile glumes 4; stiff; coriaceous. First two ovate; 1-1.5 cm long. Second 2-2.5 cm long. Third 2.8-3 cm long; ovate-lanceolate; many -nerved; mucronate; mucron, hirsute.

**FLORETS** Fertile lemma lanceolate; mucronate; glabrous; thin; many-nerved, 2.5-3 cm long, 1.8-2.3 cm wide. Palea thin; membranous; 2.5-2.8 cm long; 1.3-1.5 cm wide; margins overlap; smooth; apex retuse; notched; ciliate.

**FLOWER** Lodicules 3 thin; filmy; hyaline; almost of the same size; 1-1.2 cm long; 0.2-0.4 cm wide; 5-6- nerved; margins fimbriate; ciliate. Stamens 75-80; yellow; filaments free; long; filiform. Anthers basifixed; 1.8-2 cm long; apiculate; apex ciliate. Ovary glabrous; globose at the base; tip gradually terminates into a perigynium. Style 2.6-3 cm long. Stigmas 6-7 ; plumose.

**FRUIT** Caryopsis; large; fleshy; ovate-oblong; 7-8 cm long; 2.3-2.5 cm diameter; glumes persistent.

**DISTRIBUTION** Endemic to South India and has a restricted distribution in South Kerala and Tamil Nadu at an altitude from 200 m to 1000 m. It is reported from the southern most part of Western Ghats. It is a component of moist deciduous and semi-evergreen forests at Trivandrum district, Kerala and Keerippara, Thirunelveli and Courtallum in Tamil Nadu. Flowering starts in summer months. Sporadic flowering is common. Gregarious flowering was observed in 2001 at Bonnaccord and on the way to Agasthyamala in Trivandrum district.

*Specimens examined:* KERALA: Thiruvananthapuram Dist. Kallar, CA Barber 7176 (MH); Palode, N Unnikrishnan 74008 (CALI); Nanniode, N Unnikrishnan 74033 (CALI); Bonnaccord, N Unnikrishnan 74034 (CALI); Nedumangad, N Unnikrishnan 74204 (CALI). TAMIL NADU: Kannyakumari Dist. Keerippara, N Unnikrishnan 74004 (CALI).

**NOTES** Munro (1868) first described this species as *Bambusa wightii*. Gamble (1896) treated it as *Ochlandra brandisii*. The characteristic feature of this species is the presence of a large ligule. It is the largest among the genus *Ochlandra*. According to Gamble (1896) this species has one lodicule and the stamens are monadelphous. A detailed study of specimens collected from different localities of southern Western Ghats revealed that this species is having 3 lodicules and the stamens are free.

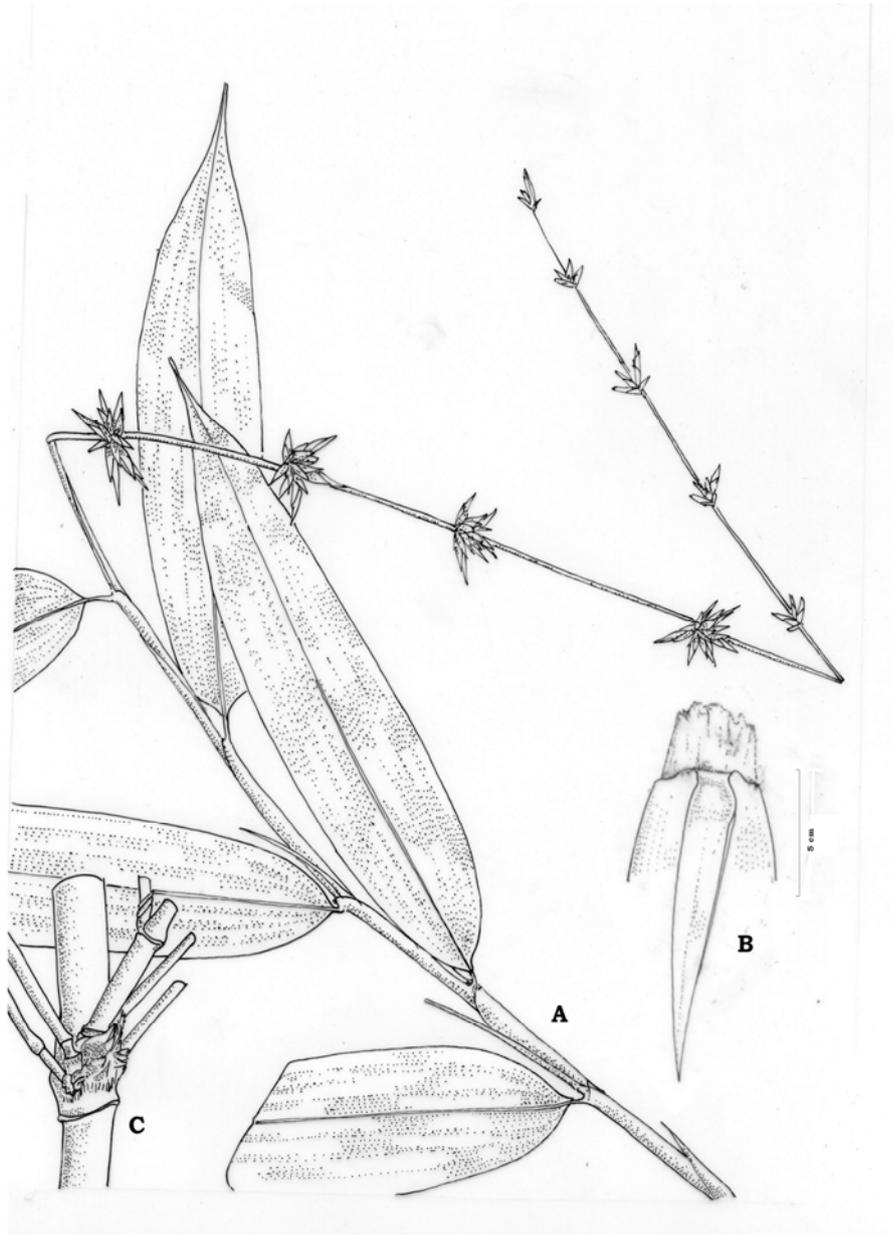


Figure 42. *Ochlandra wightii* (Munro) C.E.C. Fisch. **A.** flowering branch; **B.** culm sheath; **C.** branching

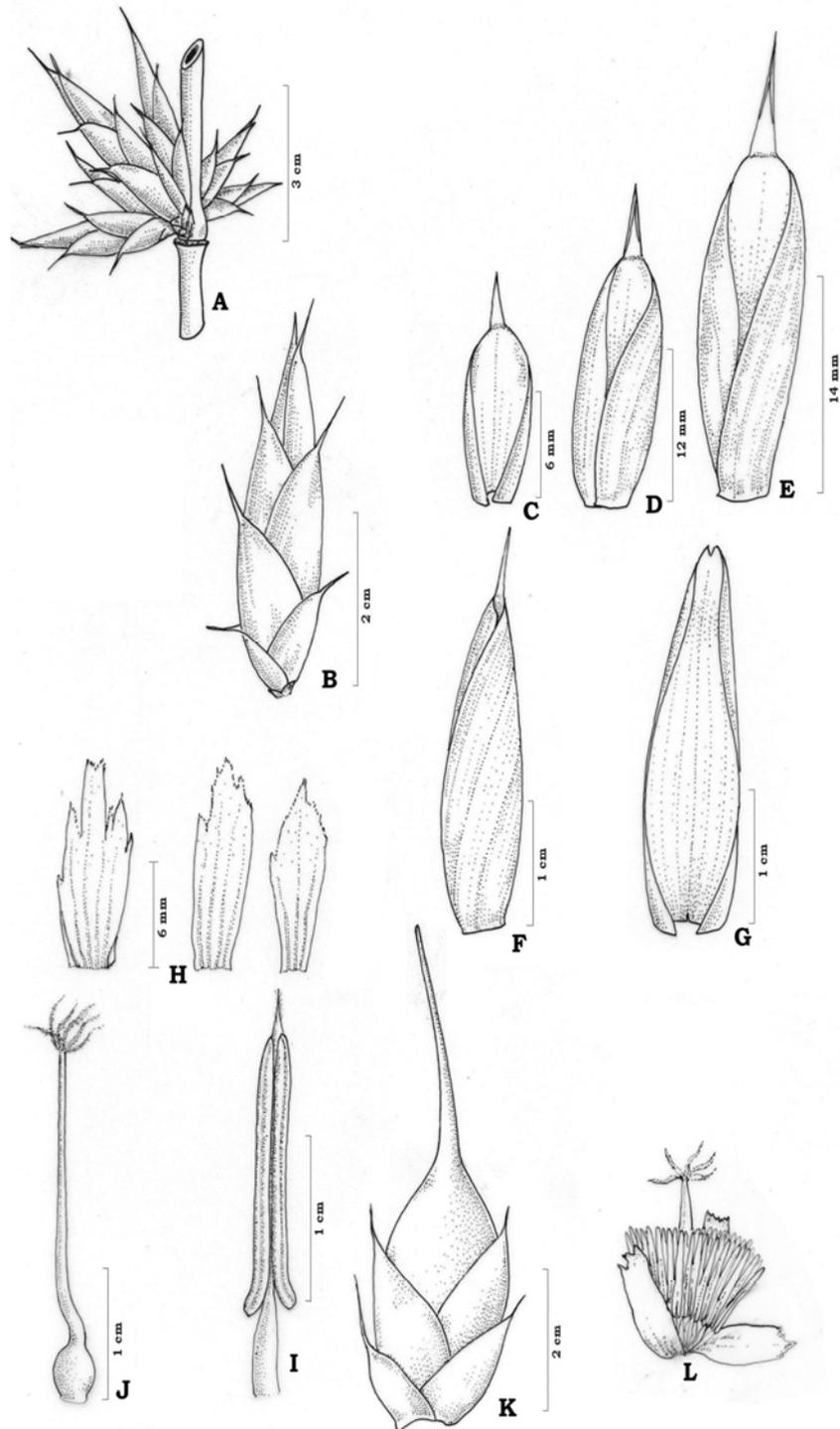


Figure 43. *Ochlandra wightii* (Munro) C.E.C. Fisch. **A.** portion of inflorescence; **B.** spikelet; **C., D. & E.** sterile glumes; **F.** lemma; **G.** palea; **H.** lodicules; **I.** stamen; **J.** ovary with style; **K.** fruit; **L.** open floret (diagrammatic)

The species *Ochlandra travancorica* was originally described by Beddome (1873). According to him, the stamens of this species are monadelphous. *Ochlandra wightii* and *O. ebracteata* were also described as species with monadelphous stamens. This was considered as a major character in all the keys. A detailed study of all the species mentioned above, collected from different localities in the southern Western Ghats revealed they possess free stamens. In all these species the number of stamens vary from 55-130. The filaments remain very close in buds and appear as monadelphous.

A critical evaluation of the *Ochlandra* showed that this genus could be categorized under two groups. The species *O. scriptoria* and *O. travancorica* were the first species described under the genus *Ochlandra*. All other species of *Ochlandra*, which were described later, show affinity to either *O. scriptoria* or to *O. travancorica*. Based on the affinity, the species under this genus can be included under the Travancorica group and the Scriptoria group.

A comparison of these two groups is given in the following table.

Character	Character state	
	Travancorica group	Scriptoria group
Habit	caespitose, gregarious, erect, sometimes drooping	caespitose, gregarious, drooping, sometimes scandent
Culms	strong, erect, tip arching, sometimes drooping	strong or slender, tip whiplike, drooping or scandent
Branches	few, strong, subequal	numerous, weak, subequal
Spikelets	long and broad	short and narrow
Glumes	apex mucronate	apex not mucronate, acuminate
Lodicules	3-4, broad	6-7, narrow
Stamens	numerous, 55-130	few, 15-42
Caryopsis	large, subglobose to ovate-oblong	small, linear-lanceolate

**Travancorica group:** In this group, the culms are strong, erect, arching at the tip and rarely drooping. The branches are few in number and almost subequal. The spikelets are large, long and broad. The apex of the sterile glumes is strongly mucronate. The number of

lodicules is usually 3, rarely 4. The number of stamens varies from 55-130, rarely less than 55. The fruit is large, subglobose to ovate-oblong.

**Scriptoria group:** In this group, the culms are strong or slender and the tip is drooping or whiplike, sometimes scandent. Branches are numerous, weak and subequal. The spikelets are short and narrow. The apex of the glumes is acuminate, not mucronate. Lodicules are narrow and 6-7. Stamens are less in number and vary from 15-42. The caryopsis is small and linear-lanceolate.

### *Teinostachyum* Munro

This genus was originally described by Munro (1868) and he treated two species under this genus. He distinguished this genus from other related genera by the presence of elongated spikelets (spikelets) with several perfect flowers and long joints of the rachilla. Gamble (1896) also followed this and included three more species under this genus. In South India, only a single species is represented.

*Teinostachyum* Munro, Trans. Linn. Soc. London 26: 142. 1868; Bedd., Fl. Sylv. S. India 3: 233. 1873; Gamble, Ann. Roy. Bot. Gard. Calcutta 7: 97. 1896; Brandis, Indian Trees 679. 1906; Bourd., For. Trees Travancore 402. 1908; E. G. Camus, Les Bamb. 162. 1913; C.E.C. Fisch. in Gamble, Fl. Pres. Madras 3: 1859. 1928; Soderstr. & R.P. Ellis in Soderstr. *et al.* (eds.), Grass Syst. Evol. 237. 1987; S. Dransf. & Widjaja (eds.), Plant Reso. S.E. Asia 7: 35. 1995; Ohrnberger, Bamb. World. 336. 1999.

**Type:** *Teinostachyum griffithii* Munro

**HABIT** Perennial; caespitose; shrubby or arborescent. Rhizomes sympodial; pachymorph. Culms erect and whip like; drooping; closely packed. Culm-sheath long; lanceolate; reflexed; auricle absent. Branches numerous; almost equal; intravaginal. Leaves with minute silky pubescence, on the lower side.

**INFLORESCENCE** Inflorescence terminal. Panicles drooping; itercaucant.

**FERTILE SPIKELETS** Spikelets 3-4 florets with a terminal sterile floret.

**GLUMES** Sterile glumes 1-2.

**FLORETS** Lemma convolute. Palea 2-keeled; ciliate on the keels.

**FLOWER** Lodicules 3. Stamens 6; free. Anthers exerted; obtuse, or slightly apiculate. Ovary globose, or ovate. Style enclosed inside a perigynium. Stigmas 3.

**FRUIT** Caryopsis; ovoid; acuminate; short -beaked.

**DISTRIBUTION** This genus is distributed in India, Bangladesh, Myanmar and Thailand.

In India, this genus is represented by 4 species and is distributed in north-eastern states and South India. In South India, this genus is represented by one species, *Teinostachyum wightii*.

**NOTES** The species described under the genus *Teinostachyum* was treated under other genera like *Pseudostachyum*, *Neohouzea* and *Schizostachyum* by various authors. Holttum (1956a) suggested that *Cephalostachyum*, *Teinostachyum* and *Pseudostachyum* should be merged with the Malaysian genus *Schizostachyum*. However, he did not give any justification for this opinion, and there are no comparative studies to investigate generic delimitation in this subtribe (Stapleton, 1994a).

Clayton & Renvoize (1986) and Majumdar (1989), followed Holttum's suggestions and treated all 4 genera as congeneric. Based on this, Majumdar (1989) transferred all Indian species of *Teinostachyum* under the genus *Schizostachyum* without giving any proper justification. Although, *Teinostachyum* and *Schizostachyum* are closely related, Munro (1896) clearly distinguished these two species. Gamble (1896) also followed Munro and treated *Teinostachyum* and *Schizostachyum* separately. Dransfield (1980) and Stapleton (1994a) treated *Cephalostachyum*, *Teinostachyum*, *Pseudostachyum* and *Schizostachyum* as separate genera. In this report, the treatment of Munro (1868), Gamble (1896), Dransfield (1980) and Stapleton (1994a) are followed and the genus name *Teinostachyum* Munro is retained.

*Teinostachyum wightii* Bedd., Fl. Sylv. 3: 233 t. 323. 1873; Gamble, Ann. Roy. Bot. Gard. Calcutta 7: 99, t. 87. 1896 & in Hook. f. Fl. Brit. India 7: 410. 1897; Brandis, Indian Trees 679. 1906; Bourd., For. Trees Travancore 402. 1908; E. G. Camus, Les Bamb. 163. 1913; Rama Rao, For. Pl. Travancore 448. 1914; Ohrnberger, Bamb. World 336. 1999 [Figures 44 and 45; Plates 21 and 21a].

**Type:** India, Tamil Nadu, Nilgiris, *Beddome 62* (lectotype K. designated here. Cibachrome seen).

*Teinostachyum beddomei* C.E.C. Fisch. in Gamble, Fl. Pres. Madras 3: 1860. 1934; Varmah & Bahadur, Indian For. Rec. (n.s.) Bot. 6(1): 4. 1980; *Schizostachyum beddomei* (C.E.C. Fisch.) R. B. Majumdar in Karthikeyan *et al.*, Fl. Ind. Enum. Monocotyl. 281.

1989; Tewari Monogr. Bamboo. 130. 1992; Seethalakshmi & M. Kumar, Bamb. India Comp.235. 1998.

**Typification:** This species was collected by Beddome from the Anamalai hills in 1873. This specimen was deposited at MH. Another specimen collected by Beddome in 1869 from Nilgiris was deposited at K. This is the specimen used by Beddome for the description and is selected for lecto typification and designated as type .

**HABIT** Perennial; caespitose; shrubby or arborescent; culms. Rhizomes sympodial; pachymorph; short -necked. Culms erect; apically whip-like and strongly arching; dense with closely packed clumps; hollow; 10-12 m tall. Culm-internodes 30-50 cm long; 2.5-3.8 cm diameter; rough; cylindrical; pale green; having a white band towards the summit. Culm- nodes not swollen; the sheath scar prominent; girdle, or ring conspicuous; a single branch bud present enclosed in a prophyllum. Branches arise from the 5<sup>th</sup> or 6<sup>th</sup> node; the central primary branch dominant ; lateral branches 2, or 3; additionally 20-25 branches develop to form a cluster; the primary branch elongates, become whip-like; intravaginal. Culm-sheath 15-40 cm long; 6-18 cm wide at base; glabrous; coriaceous; covered with scattered appressed black hairs, when young; smooth and striate, when old; apex truncate; acuminate; auricle absent. Culm-sheath ligule, inner membranous; entire; 0.1-0.2 cm high; fimbriate. Culm-sheath blade reflexed; long; narrow; linear-lanceolate; striate; sparsely hirsute. Leaves arise on branches. Leaf-sheath overlapping; glabrous; striate; auricle and oral setae absent. Leaf-sheath ligule, inner very short; outer, not prominent. Leaf-blade lanceolate; 8-32 cm long; 1.5-4.5 cm wide; dorsal side glabrous; ventral side with minute silky pubescence; midrib prominent on the lower side; margins scabrous; apex acuminate; scabrous; base attenuate to a short petiole.

**INFLORESCENCE** Inflorescence a large spicate panicle; terminal; drooping; on short leaf less branches; clustered. Rachilla flat at base and thickened upwards. Spike at the base supported by a firm; persistent; ovate-acuminate; glabrous; bracts.

**FERTILE SPIKELETS** Spikelets comprising 3-4 fertile florets. Terminal floret sterile; glabrous; lanceolate; 4-4.5 cm long.

**GLUMES** Sterile glume 1; coriaceous; 0.8-1 cm long; lanceolate; many-nerved; mucronate; faintly hirsute.

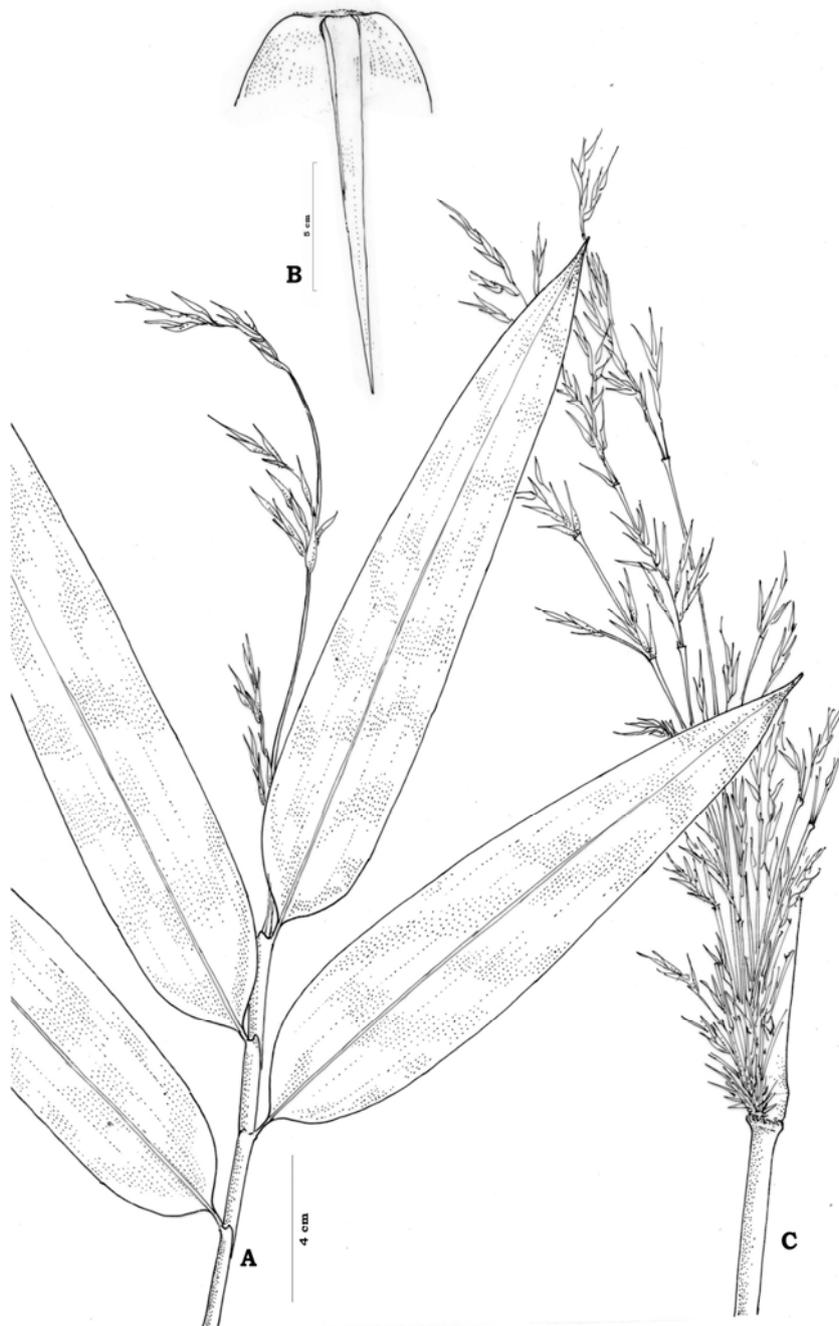


Figure 44. *Teinostachyum wightii* Bedd. **A.** flowering branch; **B.** culm sheath; **C.** inflorescence

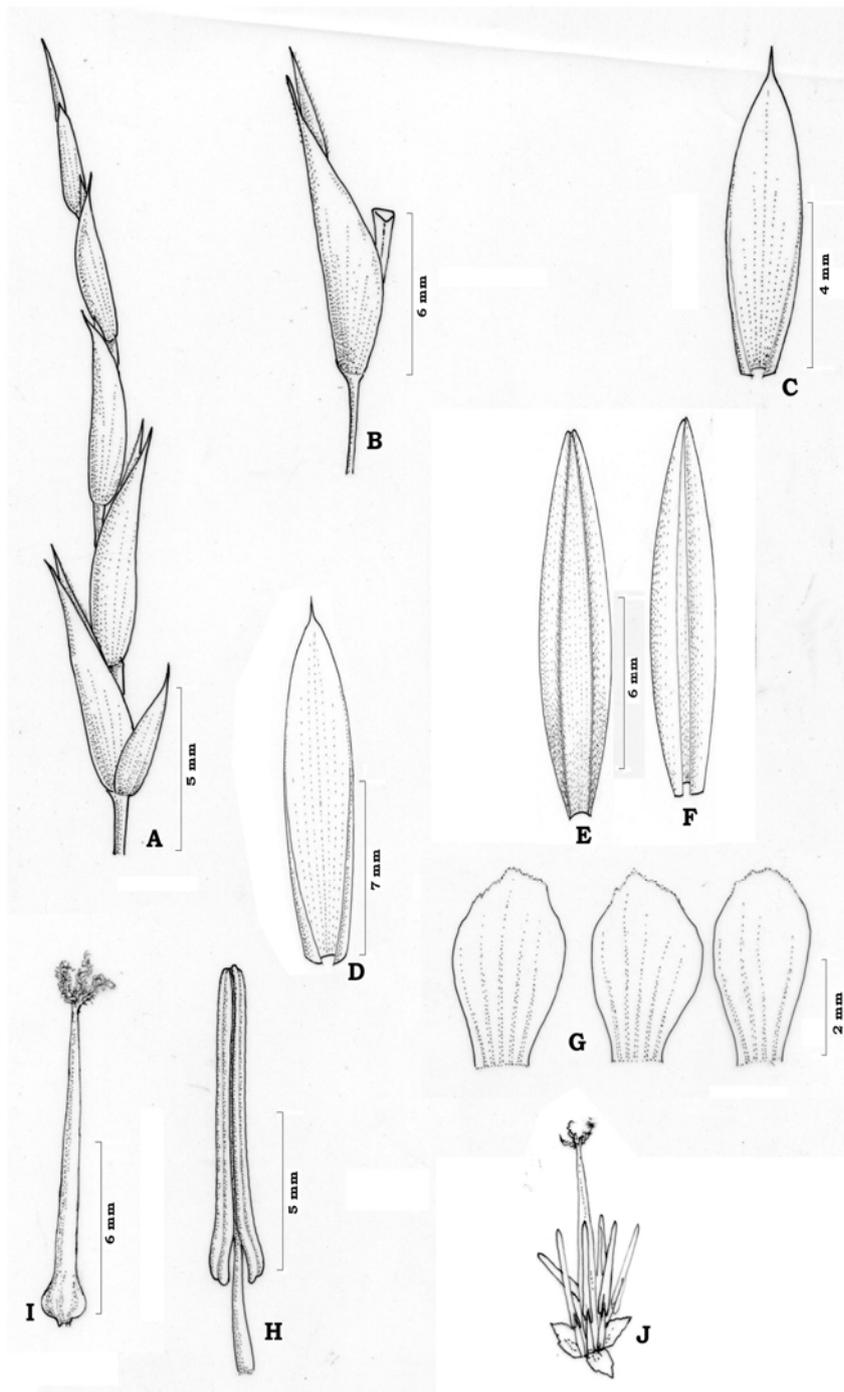


Figure 45. *Teinostachyum wightii* Bedd. **A**. spikelet; **B**. floret; **C**. sterile glume; **D**. lemma; **E**. palea-surface view; **F**. palea-inner side; **G**. lodicules; **H**. stamen; **I**. ovary with style; **J**. open floret (diagrammatic)

**FLORETS** Fertile lemma ovate-lanceolate; 1.2-1.4 cm; mucronate; glabrous; many-nerved; tightly convolute. Palea shorter than lemma; membranous; 1-1.2 cm long; thin; 2-keeled; ciliate on the keels; 1-2-nerved between the keels; apex obtuse; ciliate.

**FLOWER** Lodicules 3; equal, 0.3-0.5 cm long; hyaline; 2-3 nerved; ovate; margin fimbriate; ciliate. Stamens 6; filaments free; short. Anthers 0.8-1 cm long; basifixed. Ovary glabrous; base globose, tip gradually narrow into a perigynium. Style 1.2-1.5 cm long. Stigmas 3; plumose.

**FRUIT** Caryopsis; glabrous; ovoid, short -beaked.

**DISTRIBUTION** This species is endemic to Southern Western Ghats and distributed in Kerala, Karnataka and Tamil Nadu. It is found growing from an altitude of 300-1300 m. It grows in moist deciduous and semi-evergreen forests.

*Specimens examined:* KERALA: Travancore, *JF Bourdillon* s.n. (DD). Idukki Dist. Anamally, *RH Beddome* s.n. (MH); Munnar, *DB Deb 30762* (MH). Kannur Dist. Paithalmala, *M Remesh & N Unnikrishnan 20628* (KFRI). Palakkad Dist. Karappara, *N Unnikrishnan 74212* (CALI); Siruvani, *Stephen Sequiera & Michiale 8817* (KFRI). Pathanamthitta Dist. Kakki, *N Unnikrishnan 74011* (CALI). Thrissur Dist. Sholayar, *N Unnikrishnan 74019* (CALI). Wayanad Dist. Nalukettumchola, *N Unnikrishnan 74020* (CALI). TAMIL NADU: Nilgiri Dist. Nilgiris, *JS Gamble 18267* (DD); Ochterlomy valley, *JS Gamble 20549* (DD).

**NOTES** This species was first described by Beddome (1873). Fischer (1934) changed the specific epithet and treated it as *Teinostachyum beddomei*. Holttum (1956a) treated *Teinostachyum* as congeneric with *Schizostachyum*. Majumdar (1989) followed Holttum (1956a) and transferred the genus *Teinostachyum* to *Schizostachyum*. He described *Teinostachyum wightii* as *Schizostachyum beddomei*. The *Teinostachyum* can be separated from the genus *Schizostachyum* by several characters such as inflorescence as a panicle of loosely arranged spikelets, absence of gemmiparous bracts in spikelets and perfectly keeled palea. In the present report, the concept of Munro (1868), Beddome (1873), Gamble (1896), Dransfield and Widjaja (1995) and Stapleton (1994a) are followed and *Teinostachyum* is considered as a separate genus. The change in the specific epithet to *beddomei* is invalid (ICBN Section 3, Art. 11.4). In this report the binomial *Teinostachyum wightii* is retained.

## REFERENCES

- Andiappan K. and Wilson C. 1963. A note on the working of bamboo coupes in Coimbatore circle. *Indian Forester* 89(11): 763-765.
- Bahadur K.N. and Jain S.S. 1981. Rare bamboos in India. *Indian Journal of Forestry* 4(4): 280-286.
- Basha S. Chand and Kumar M. 1994. Three little known species of *Ochlandra* Thwaites (Poaceae) from Western Ghats, India. *Rheedea* 4(1): 24-30.
- Beddome R.H. 1873. The Flora Sylvatica for Southern India, 3 vols. (Reprint edn.) 1978. International Book Distributors, Dehra Dun.
- Bennet S.S.R. 1993. Status of bamboos in India. National Seminar on Forest Produce, IFGTB, Coimbatore.
- Bennet S.S.R and Gaur R.C. 1990b. Thirty seven bamboos growing in India. Forest Research Institute, Dehra Dun.
- Bentham G. 1883. Gramineae. In: G. Bentham & J.D. Hooker. Genera Plantarum, vol. 3(2). Reeve, London.
- Blatter E. 1929. The Indian bamboos brought up-to-date. *Indian Forester* 55(10-11): 541-562; 586-612.
- Bourdillon T.F. 1908. The Forest Trees of Travancore. The Travancore Govt. Press, Trivandrum.
- Brandis D. 1899. Biological notes on Indian bamboos. *Indian Forester* 25(1): 1-25.
- Brandis D. 1906. Indian Trees. Bishen Singh Mahendra Pal Singh, Dehra Dun (reprint).
- Bridson D. and Forman L. 1992. The Herbarium Handbook. Revised edition, Royal Botanic Garden, Kew.
- Brummit R.K. and Powell C.E. 1992. Authors of Plant Names. Royal Botanic Garden, Kew.
- Camus A. 1935. *Ochlandra perrieri* A. Camus bambou nouveau de Madagascar. *Bulletin de la Societe Botanique de France* 82: 310-311.
- Camus E.G. 1913. *Les bambusees*. 2 vols. Paul Lechevalier, Paris.

- Chao C.S. and Renvoize S.A. 1989a. Revision of species described under *Arundinaria* (Gramineae) in South East Asia and Africa. *Kew Bulletin* 44: 349-367.
- Chao C.S. and Renvoize S.A. 1989b. Three new combination of bamboos. *Kew Bulletin* 44(2): 368.
- Chatterjee R.N. and Raizada M.B. 1963. Culm sheaths as aid to identification of bamboos. *Indian Forester* 89(11): 744-756.
- Chaturvedi A.N. 1988. Management of bamboo forests. *Indian Forester* 114(9):489-495.
- Chowdhury A. and Sarwade G. S. 1982. A simple approach for climatic classification of India. *Tropical Ecology* 23: 234-246.
- Clayton D.K. and Renvoize S.A. 1986. Genera Graminum: Grasses of the World. Her Majesty's Stationery Office, London.
- Clayton W.D., Vorontsova M.S., Harman K.T. and Williamson H. 2010. Grass Base - The Online World Grass Flora, Royal Botanic Gardens, Kew.
- Dennstedt A.W. 1818. *Schlüssel Zum Hortus Indicus Malabaricus*. Weimar.
- Dransfield S. 1980. Bamboo taxonomy in the Indo-Malayan region. Bamboo Research in Asia. Proceedings of a Workshop, 28-30 May 1980, Singapore. IDRC, Ottawa: 121-130.
- Dransfield S. 1983b. Notes on *Schizostachyum* (Gramineae-Bambusoideae) from Borneo and Sumatra. *Kew Bulletin* 38(2): 321-332.
- Dransfield S. 1998a. *Valiha* and *Cathariostachys*, two new bamboo genera (Gramineae-Bambusoideae) from Madagascar. *Kew Bulletin* 53(2): 375-397.
- Dransfield S. and Widjaja E.A. 1995. Plant resources of South--East Asia No. 7 Bamboos. Backhuys Publishers, Leiden.
- Fischer C.E.C. 1934. Gramineae. In: Gamble J.S. Flora of the Presidency of Madras. Vol 3. London.
- Gamble J.S. 1896. The Bambuseae of British India. *Annals of the Royal Botanic Garden* 7(1): 1-133.
- Gamble J.S. 1902. A Manual of Indian Timbers. Marston and Company, London.
- Grosser D. and Liese W. 1971. On the anatomy of Asian bamboos, with special reference to their vascular bundles. *Wood Science and Technology* 5: 292-312.

- Grosser D. and Liese W. 1973. Present status and problems of bamboo classification. *Journal of the Arnold Arboretum* 54(2): 293-308.
- Holttum R.E. 1956a. The classification of bamboos. *Phytomorphology* 6(2): 73-90.
- Holttum R.E. 1956b. The typification of the generic name *Bambusa* and the status of the name *Bambusa bambos* L. *Taxon* 5(1): 26-28.
- Holttum R.E. 1958. The bamboos of the Malay Peninsula. *Gardens Bulletin* 16: 135p.
- Hooker J.D. 1854. Bamboos: *Chusquea abietifolia*. *Himalayan Journal* Vol. 1. London.
- Hore D.K. 1998. Genetic resources among bamboos of north eastern India. *Journal of Economic and Taxonomic Botany* 22(1): 173-181.
- Hussain S.S. 1980. Regeneration and management of bamboo. Proceedings of the Third Southern Silviculturists and Forest Research Officers Conference, 3-5 March 1980, Dharwad. Karnataka Forest Department: 34-39.
- Janzen D.H. 1976. Why bamboos wait so long to flower. *Annual Review of Ecology and Systematic* 7: 78-84.
- Judziewicz E.J., Clark L.G., Londono X. and Stern M.J. 1999. American Bamboos. Smithsonian Institution Press, Washington and London.
- Kadambi K. 1949. On the ecology and silviculture of *Dendrocalamus strictus* in the bamboo forests of Bhadravati division, Mysore state, and comparative notes on the species *Bambusa arundinacea*, *Ochlandra travancorica*, *Oxytenanthera monostigma* and *O. stocksii*. *Indian Forester* 75(8), 75(9), 75(10): 289-99, 334-49, 398-426.
- Keng K.H. 1957. One new genus and two varieties of Chinese bamboos. *Acta Phytotaxonomica Sinica* 6: 355-360.
- King G. 1895. A brief memoir of William Roxburgh. *Annals of Royal Botanical Garden, Calcutta* 5: 1-9.
- Kishore Kumar K. and Kumar M. 1997. *Sinarundinaria microphylla* (Munro) Chao & Renvoize: A new record of a bamboo for Peninsular India. *Rheedea* 7(1): 11-14.
- Koshy K.C. and Harikumar D. 2001. Reproductive biology of *Ochlandra scriptoria*, an endemic reed bamboo of the Western Ghats, India. *Bamboo Science and Culture: The Journal of the American Bamboo Society* 15(1): 1-7.
- Koshy K.C. and Pushpangadan P. 1997. *Bambusa vulgaris* blooms, a leap towards extinction? *Current Science* 72(9): 622-624.

- Koshy K.C., Harikumar D. and Narendran T.C. 2001. Insect visits to some bamboos of the Western Ghats, India. *Current Science* 81(7): 833-838.
- Kumar M. 1990. Reed bamboos *Ochlandra* in Kerala: Distribution and management. Bamboos: Current Research. Proceedings of the International Bamboo Workshop, 14-18 November 1988, Cochin. Kerala Forest Research Institute, Peechi and IDRC, Canada: 39-43.
- Kumar M. 1991. Rare bamboos of Western Ghats: Distribution and conservation. In: Karunakaran C.K. (Ed). Proceedings of the Symposium on Rare, Endangered and Endemic Plants of Western Ghats, Trivandrum, 30-31 August 1991. Kerala Forest Department, Trivandrum: 167-173.
- Kumar M. 1993. Status of bamboo taxonomy in India. *BIC India Bulletin* 3(2): 29-36.
- Kumar M. 1995. A re-investigation on the taxonomy of the genus *Ochlandra* Thw. (Poaceae - Bambusoideae). *Rheedea* 5(1): 63-89.
- Kumar M. 2002. Field identification key to native bamboos of Kerala. Kerala Forest Research Institute, Peechi.
- Kumar M. 2011. Bamboos of Andaman and Nicobar Islands. KFRI Report No. 387. Kerala Forest Research Institute, Peechi.
- Kumar M. and Remesh M. 1999. Native bamboos of South India: Diversity, taxonomy and ethnobotany - A fresh perspective. Ninth IAAT Annual Conference and National Seminar on Plant Systematics, Biodiversity, Conservation and Ethnobotany, Calicut.
- Kumar M. and Remesh M. 2000. Diversity of bamboos in Kerala and their conservation. In: M.R. Das (ed.) Proceedings of the Twelfth Kerala Science Congress, Kumily, STEC, Trivandrum: 209-212.
- Kumar M. and Remesh M. 2001. Status of bamboo diversity in Andaman Islands: Present scenario. National Symposium on Biodiversity vis-a-vis resource exploitation: introspection, Port Blair.
- Kumar M. and Remesh M. 2003. New Species of *Schizostachyum* (Poaceae-Bambusoideae) from the Andaman Islands, India. *Blumea* 48(1): 187-192.
- Kumar. M. and Remesh. M. 2008. *Murochloa*, A new genus (Poaceae; Bambusoideae) with a new combination from India. *J.Bot. Res.Inst. Texas* 2(1: 373-378).

- Kumar M., Remesh M. and Stephen Sequiera. 2001a. *Ochlandra keralensis* (Poaceae-Bambusoideae) - A new reed-bamboo from Southern Western Ghats, India. *Journal Economic and Taxonomic Botany* 25(1): 49-51.
- Kumar M., Remesh M. and Stephen Sequiera. 2001b. Field identification key to the native bamboos of Kerala, India. *Bamboo Science and Culture* 15(1): 35-47.
- Kumar M., Seethalakshmi K.K. and Stephen Sequiera. 1999. Two new species of *Ochlandra* Thw. (Poaceae - Bambusoideae) from Southern India. *Rheedea* 9(1): 31-35.
- Kumar M. and Stephen Sequiera. 1995. *Pseudoxytenanthera stocksii* (Munro) Naithani- A bamboo new record to Kerala. *Journal of Economic and Taxonomic Botany* 19(3): 525-528.
- Kumar M. and Stephen Sequiera. 1996. Distribution of South Indian bamboos and their taxonomic status. In: Proceedings of the National Seminar on Bamboo. Bamboo Society of India, Bangalore.
- Kumar M. and Stephen Sequiera. 1999. Concepts in bamboo taxonomy - Past, present and future: A global perspective. In: Sivadasan M. & Philip Mathew. Eds. Biodiversity, Taxonomy and Conservation of Flowering Plants. Mentor Books, Calicut: 167-188.
- Kumar M., Stephen Sequiera and Remesh M. 2000. The position of Indian bamboos in bamboo systematics. *Rheedea* 10(1): 33-48.
- Kunth C.S. 1815. *Considerations generales sur les Graminees. Memories du Musum d'Histoire Naturelle* 2: 62-75.
- Majumdar R.B. 1989. In: Karthikeyan S., Jain S.K., Nayar M.P. and Sanjappa M. *Flora Indicae, Enumeratio Monocotyledonae*. Botanical Survey of India, Howrah, Calcutta: 274-283.
- Manilal K.S. and Kumar M. 1998. Modern trends in bamboo taxonomy. A Handbook on Taxonomy Training: 207-225.
- Matthew K.M. 1999. Flora of Palani Hills, South India, Part 3. Monocotyledons. The Rapinet Herbarium, St. Joseph College, Trichi.
- Mauria S. and Arora R.K. 1988. Genetic resources of bamboos - An Indian perspective. *Indian Forester* 114(9): 539-548.

- McClure F.A. 1966. The bamboos: A fresh perspective. Harvard University Press, London, Oxford University Press, Cambridge.
- Michaux A. 1803. *Flora Boreali-Americana*. Vol. 1. Paris and Strasbourg.
- Munro W. 1868. A monograph of the Bambuseae. *Transactions of the Linnean Society of London* 26: 1-157.
- Nair K.S. 1980. A base paper on bamboos in Kerala. Proceedings of the Third Southern Silviculturists and Forest Research Officers Conference, 3-5 March 1980, Dharwad. Karnataka Forest Department: 131-141.
- Nair V.J. and Ansari R. 1982. Correct name of *Oxytenanthera monostigma* Bedd. (Bambusaceae). *Journal of Economic and Taxonomic Botany* 3(2): 616.
- Naithani H.B. 1990b. Nomenclature of Indian Species of *Oxytenanthera*. *Journal of Bombay Natural History Society* 87: 439-440.
- Nakai T. 1925. The new genera of Bambusaceae with special remarks on the related genera growing in eastern Asia. *Journal of the Arnold Arboretum* 6(3): 145-153.
- Nakai T. 1935. *Novitates Bambusacearum In Imperio Japonico Recentissime Detectae* (III). *Journal of Japanese Botany* 11(1): 1-9.
- Nees von Esenbeck C.G.D. 1834. *Bambuseae brasilienses: recensuit et alian in Indiae Orientalis provenientes adjacit*. *Linnaea* 9(4): 461-494.
- Ohrnberger D. 1999. Bamboos of World: Annotated Nomenclature and Literature of the species and higher and lower taxa. Elsevier, Amsterdam.
- Parodi L.R. 1961. *La taxonomia de las Gramineae Argetias a la luz de las investigaciones man recientes*. In: Recent Advances in Botany 1: 125-130. Toronto Univ. of Toronto Press.
- Pattanath P.G. and Rao K.R. 1969. Epidermal and internodal structure of the culm as an aid to identification and classification of bamboo. Recent Advances in the Anatomy of Tropical Seed Plants Vol. 7. Hindustan Publishing Corporation, Delhi: 179-196.
- Pullaiah T. and Mohammad M.S. 2000. Flora of Ranga Reddi district, Andhra Pradesh. Regancy Publisher, New Delhi.
- Pullaiah T., Prabhakar C. and Rao B.R. 1998. Flora of Medak district, Andhra Pradesh. Daya Publishing House, New Delhi.

- Pullaiah T., Prasanna P.V. and Obulesu G. 1992. Flora of Adilabad district, Andhra Pradesh. CBS Publishers, Shahdara, New Delhi.
- Pullaiah T., Ramakrishnaiah V., Sandhya Rani S. and Rao P.N. 2000. Flora of Guntur District, Andhra Pradesh. Regancy Publications, New Delhi.
- Raizada M.B. and Chatterjee R.N. 1963. A new bamboo from South India. *Indian Forester* 89(5): 362-364.
- Rama Rao M. 1914. Flowering Plant of Travancore. Govt. Press Trivandrum.
- Ramesh K.G., Rajesh K.S. and Kothari R.M. 1998. Some insight on the death of Bamboo after flowering. *Indian Forester* 124(5): 342-346.
- Rheede tot Drakenstein H.A. van. 1685. *Horti indici malabarici pars quinta*. Amstelodami.
- Roxburgh W. 1798. Plants of the Coast of Coromandel. London.
- Roxburgh W. 1814. *Hortus Bengalensis*. Serampore.
- Rumphius G.E. 1743. *Herbarium Amboinense*. Vol. 4. Amsterdam, Netherlands.
- Ruprecht F.J. 1840 *Bamboseaes monographice exponit*. St. Petersburg.
- Schreber J.C.D. von. 1789. *Caroli a Linne Genera Plantarum editio octava*, 2 vols. Frankfurt.
- Seethalakshmi K.K. and Kumar M. 1998. Bamboos of India: A Compendium. Kerala Forest Research Institute, Peechi and International Network for Bamboo and Rattan, Beijing.
- Sharma M.L. 1996. The genus *Oxytenanthera* in Asia. *Indian Forester* 122(2): 187-188.
- Soderstrom T.R. and Calderon C.E. 1979. Distribution and environment of the bambusoideae. Ecology of Grasslands and Bamboo lands in the World. Dr. W. Junk Pub, London: 223-236.
- Soderstrom T.R. and Ellis R.P. 1987. The position of bamboo genera and allies in a system of grass classification. Grass systematics and evolution. Smithsonian Press, Washington: 225-233.
- Soderstrom T.R. and Ellis R.P. 1988. The woody bamboos (Poaceae: Bambuseae) of Sri Lanka: A morphological-anatomical study. Smithsonian Institution Press, Washington.

- Soderstrom T.R. and Young S.M. 1983. A guide to collecting bamboos. *Annals of the Missouri Botanical Garden* 70: 128-136.
- Stapf O. 1897. *Flora Capensis* Vol. 7. L. Reeve & Co. London.
- Stapleton C.M.A. 1994a. Bamboos of Nepal and Bhutan Part I: *Bambusa*, *Dendrocalamus*, *Melocanna*, *Cephalostachyum*, *Teniostachyum* and *Pseudostachyum* (Gramineae, Poaceae, Bambusoideae). *Edinburgh Journal of Botany* 51(1): 1-32.
- Tewari D.N. 1992. A monograph on bamboo. International Book Distributors, Dehra Dun.
- Thwaites G.H.K. 1864. *Enumeratio Plantarum Zeylaniae: An Enumeration of Ceylon Plants, with Descriptions of the New and Little-known Genera....* 5 Volumes, 483 pages London. [Volume 5: 321-483 includes the Graminae].
- Tsvelev N.N. 1989. The System of Grasses (Poaceae) and their Evolution. *The Botanical Review* 55(3): 141-203.
- Venkata Raju R.R. and Pullaiah T. 1995. Flora of Kurnool district, Andhra Pradesh. Bishen Singh Mahendra Pal Singh, Dehra Dun.
- Xia N.H. and C.M.A. Stapleton. 1997b. Typification of *Bambusa bambos* (L.) Voss. (Gramineae: Bambusoideae). *Kew Bulletin* 52(3): 693-698.
- Zhu Shilin, Ma Naixum and Fu Maoyi 1994. A Compendium of Chinese Bamboo. China Forestry Publishing House.