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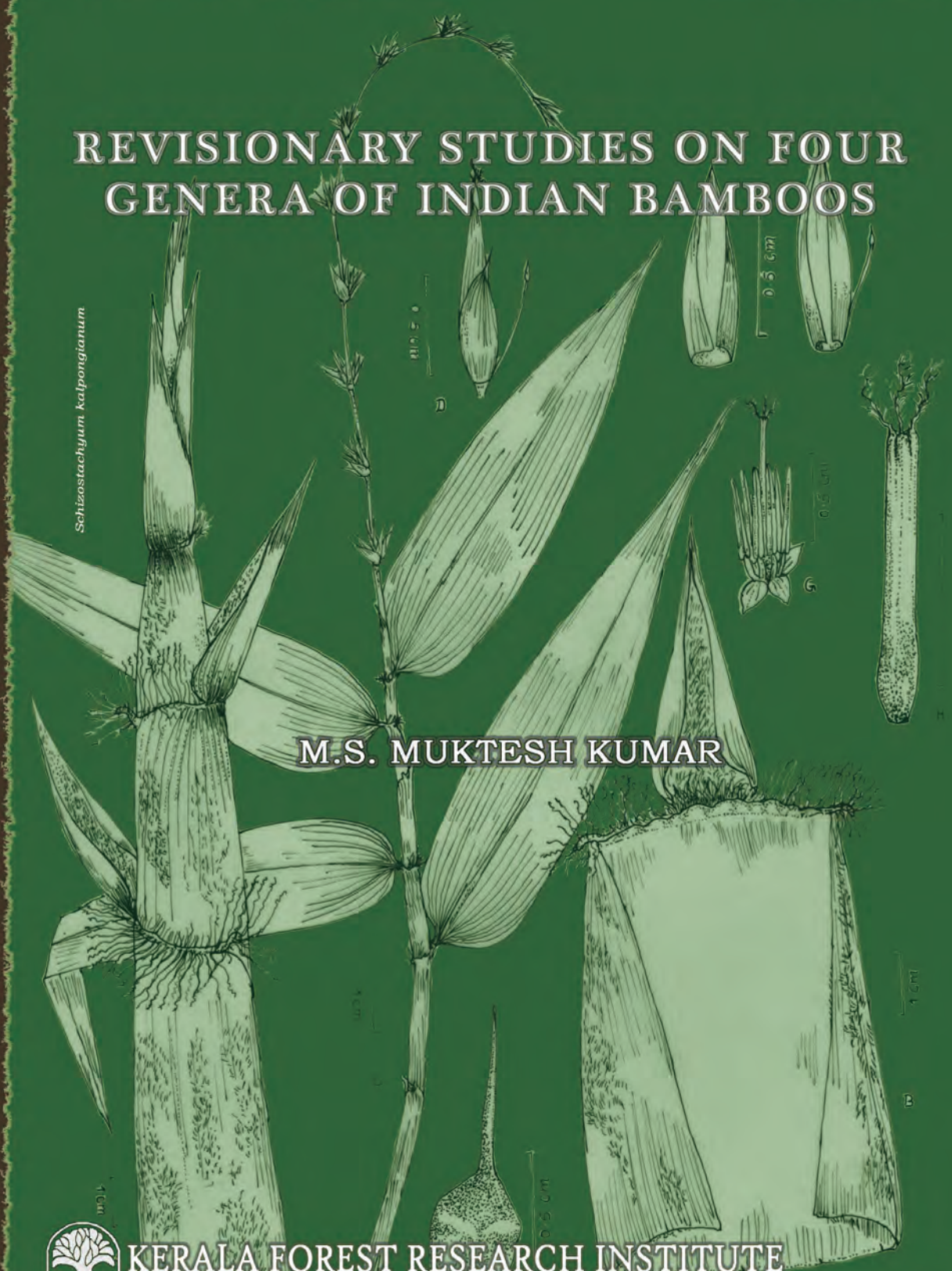
REVISIONARY STUDIES ON FOUR GENERA OF INDIAN BAMBOOS



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NOVEMBER 2009

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Revisionary studies on four genera of Indian bamboos

Final report of the Research Project No. KFRI 293/1998

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NOVEMBER 2009

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PROJECT PROPOSAL

Project code	:	KFRI 293/1998
Project Title	:	Revisionary studies on four genera of Indian bamboos
Investigator(s)	:	M.S. Muktesh Kumar Forest Botany Department, Forest Ecology and Biodiversity Conservation Division

Objectives

1. Preparation of a taxonomic monograph of the following genera: *Dendrocalamus*, *Oxytenanthera* (*Pseudoxytenanthera*), *Schizostachyum* and *Sinarundinaria* with fully illustrated description, synonyms and typification.

2. Setting a bamboo herbarium as per the modern standard.

3. Developing a field identification key for all the genera studied.

Project period	:	January 1998 - December 2001
Funding agency	:	Department of Science and Technology , New Delhi

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ABSTRACT

India is endowed with a large number of bamboo species and is perhaps having the world's one of the largest resources of bamboos. Due to the non-availability of flowers and irregular flowering phenomenon, the species identified by earlier workers have posed several problems with regard to the correct identity of the species. It has been observed that many of the workers have neglected the geo-climatic variations as a result of which several generic and specific delimitations among the Indian bamboos are confusing, it is also noted that most of the genera described by earlier workers have been treated congeneric with one taxon or the other. Therefore, the reports on the number of taxa occurring in the respective localities considerably vary.

There are over 1575 species under 111 genera (Ohrnberger, 1999) of bamboos distributed in the tropical, subtropical and temperate regions of the world. In India, so far, 128 species belonging to 18 genera are known to occur. They are distributed mainly in the geographic zones such as, Western Himalayas, Eastern Himalayas including Northeast India, Peninsular India and Andaman and Nicobar Islands. Peninsular India is one of the richest domiciles of native bamboos, second to the Eastern regions. So far, 32 species and two varieties spread over eight genera are known to occur in the region. Of these, 22 species and two varieties belonging to six genera, namely *Bambusa, Dendrocalamus, Ochlandra, Oxytenanthera, Schizostachyum* and *Sinarundinaria* are native to Kerala.

In the present study detailed taxonomic account of the genera, *Dendrocalamus, Oxytenanthera, Schizostachyum* and *Sinarundinaria* is provided. Some of the salient findings of the study are the following; one species is added to the genus *Dendrocalamus* as a new combination *Dendrocalamus stocksii*, formerly known under *Oxytenanthera-Pseudoxytenanthera* complex. The lectotypification of *Dendrocalamus stocksii, D. colletianus, D. callostachyus* and *D. longispathus*, and neotypication of *D. stictus*, the type species of the genus, have been carried out. Some of the species under *Dendrocalamus* such as, *D. sahinii, and D. somdevai* are treated as conspecific with *D. hamiltonii* and therefore synonymised under it. *Dendrocalamus sericeus* is also conspecific with *D. strictus.* The genus *Pseudoxytenanthera* is synonimised under *Oxytenanthera* with two species, *O. bourdillonii* and *O. monodelpha*. The lectotypification of *O. bourdilonii* has been carried out. The generic status of *Schizostachyum* has been critically examined and three species from Andaman

Islands alone are retained under this genus along with the two new taxa described. *Schizostachyum rogersii* is relocated after a gap of 98 years from the type locality and the lectotypification of the species was carried out.

The position of Indian Arundinoid bamboos is still not clear owing to the complexity of the group and unless further studies using molecular techniques and re-evaluation are done, the exact position of Indian genera under this group will remain ambiguous with regards to the generic status of different taxa included under the subtribe Arundinarinae. The observations made during the present study have been communicated to the International Bamboo Taxonomists for their expert comments and hence, the details on the genera (*Arundinaria* – *Sinarundinaria* Complex) are excluded from this report.

1. INTRODUCTION

The bamboos are one of the conspicuous groups of plants that have fascinated the human mind with their shining green culms and caespitose appearance since ancient times. There are over 1575 species under 111 genera (Ohrnberger, 1999) distributed in the tropical, subtropical and temperate regions of the world. Bamboos also occur in semi evergreen, the tropical moist deciduous and dry deciduous forests. It is estimated that about 80 per cent of the bamboo growing areas are confined to South and South-East Asia.

India is endowed with a large number of bamboo species and is perhaps having the world's one of the largest resources of bamboos. The people dwelling in bamboo growing areas in India irrespective of their ethnicity and culture depend on bamboos for their shelter, food, medicine and consider bamboos as the symbol of wealth. The species diversity coupled with their common occurrence in the Indian subcontinent attracted many for their utility in day-to-day needs. The over utilization of some of the genera whether for industrial or other wise, has lead to the destruction of their natural habitats. However, owing to the economic potential, many bamboo species are introduced for cultivation from the neighbouring countries.

Bamboo taxonomy in India has suffered considerable neglect over the last century and the taxonomists kept away this plant group because of their monocarpic mode of life, rarity of flowering specimens and varying morphological characters.

It was Munro (1868), who published a monograph of bamboos with descriptions of 170 species belonging to 20 genera, which included 52 unflowered species (many of them belonging to the Indian Sub-continent). Beddome's *Flora Sylvatica* (1873) dealt with 18 South Indian bamboo species. It has been over 108 years since the bamboos of India were revised by Gamble (1896), who published the most comprehensive monograph on bamboos of British India in which he described 115 species under 15 genera including that of the present Indian phyto-geographic regions. After Gamble's monumental work on Indian bamboos, Brandis (1899) and Blatter (1929) pointed some taxonomic delimitation of Indian bamboos. Subsequent studies on bamboo taxonomy undertaken in India also contributed substantially to the bamboo systematics. Bahadur (1979) emphasised the need to study and update bamboo taxonomy. Some of the significant studies on Indian bamboos are those of Bahadur and Naithani (1976,1983), Naithani and Bennet (1986,1991), Bennet (1988,1989), Majumdar (1985, 1989), Naithani (1990a, 1990b, 1992, 1993, 1994a, 1994b), Bennet and Gaur (1990), Kumar (1990, 1993, 1995), Tewari (1992), Stapleton (1994a, 1994b, 1994c,

1994d, 1994e), Sharma and Singh (1994), Chand Basha and Kumar (1994), Negi and Naithani (1994), Kumar and Stephen (1995), Kumar and Kumar (1997), Bedell (1997), Moulik (1997), Stapleton, *et. al*. (1996, 1997), Stapleton and Xia (1997) and Xia and Stapleton (1997), Manilal and Kumar (1998), Seethalakshmi and Kumar (1998), Kumar (2002), Kumar and Sequira (1999), Kumar *et. al*. (1999, 2000, 2001a, 2001b), Kumar and Remesh (2000, 2001, 2003).

2. RELEVANCE OF THE STUDY

The diverse and dispersed source of information increased the difficulties in understanding this plant group in totality. Several publications on taxonomic and phytogeographic studies of bamboo genera increased the confusion in classifying bamboos and their generic and specific delimitations. The number of bamboo genera and species occurring in India has been reported arbitrarily by various authors, each one giving different configuration. Some of the bamboo genera have been merged or certain species transferred to other genera as well as some are synonymised under a related taxon. Therefore, the number of species given in different publications is highly varying. Many genera like *Arundinaria, Chimonobambusa, Drepanostachyum, Indocalamus, Melocanna* and *Teinostachyum* are treated differently (Mc Clure, 1973; Holttum, 1958; Bahadur and Naithani, 1983 and Majumdar, 1985, 1989).Some of the recognition of certain species under the genera such as, *Arundinaria, Dendrocalamus, Bambusa, Pseudoxytenthera* and *Oxytenanthera* are ambiguous and presently, many species are arbitrarily placed. A large number of new species are also frequently described.

The genus *Arundinaria* Michuax is originally represented by the type species *Arundinaria gigantea* (Walter) Muhlenberg and all the other species occurring in Asia and Africa were treated under different genera (Mc Clure, 1973). The treatment of the Indian Arundinoid bamboos under the genus *Sinarundinaria* by Chao and Renvoize (1989a) is now considered as a mis applied name due to the invalid nomenclatural status of the generic name. The genus was based on an imperfectly described plant *Sinarudinaria nitida* and consequent to the flowering the plant showed more affinity towards the genus *Fargesia.* Franchet (1887) and subsequent workers treated the type species of genus i.e. *S. nitida sensu lato* under *Fargesia*. The rest of the species described under the genus *Sinarudinaria* have been placed under several other genera such as *Fargesia* Franchet (1887), *Yushania* Keng f., *Ampelocalamus* S. L. Chen, Wen & G. Y. Sheng, *Himalayacalamus* Keng f., *Drepanostachyum* Keng f., *Chimonobambusa* Makino, *Thamnocalamus* Munro and *Neomicrocalamus* Keng f.

The large group of Sino Himalayan bamboos with simple, open semelauctant inflorescence without enclosing spathes paved way for this conflicting treatment. The bamboos included under this group possess two types of rhizomes such as leptomorph (Monopodial) and Pachymorph (Sympodial). Few species of *Arundinaria* Michaux and *Chimonobambusa* Makino are with leptomorph rhizomes, all the others have pachymorph (Sympodial) rhizomes. During the revisionary studies on the species described under *Arundinaria* of South East Asia and Africa, Chao and Renvoize, (1989) transferred majority of the Arundinoid bamboos under *Sinarundinaria* Nakai. He also treated some species under different genera like *Thamnocalamus*, *Chimonobambusa* and only a single species i.e. *Arundinaria racemosa* was retained.

It was Nakai (1935) who erected the new genus *Sinarundinaria* to accommodate the above group and described two species i.e. *Sinarundinaria nitida* and *S. murieliae* based on vegetative characters. The genus received wide recognition. The characters like, leptomorph rhizomes and multiple branch buds, was not known at that time (Stapleton, 1994b). However, Nakai's concept on the new genus did not match with the floral characters of *Sinarundinaria murieliae*. The flowers were spathed and similar to the type species of *Fargesia,* namely *F. spathacea* (Stapleton, 1994b). *Fargesia* was considered at that time to be a synonym of *Thamnocalamus* and *Sinarundinaria murieliae* was consequently transferred to *Thamnocalamus* as a synonym of *T. spathaceus*.

The flowers of the *Sinarundinaria nitida*, the type species of genus *Sinarundinaria* Nakai, remained unknown. However, most of the species with 3 stamens, pachymorph rhizomes and loose semelauctant inflorescences were placed under it. Several other genera with 3 stamens, pachymorph rhizome with loose inflorescence described from China were treated as synonyms of *Sinarundinaria* (Stapleton, 1994b). The first genus to be described after *Sinarundianria* was *Yushania* Keng f. (1957) with type species *Y. nittakayamensis* from Thaiwan - a species with open inflorescence and pachymorph rhizome with long neck.

During the revision of some of the Chinese bamboos, Chao *et al*. (1980) recognized *Sinarundinaria* Nakai as stable genus and treated several arundinoid bamboos under it. Chao *et al*. also argued vigorously for the treatment of *Yushania* as a synonym of *Sinarundinaria* a treatment followed by Clayton and Renvoize (1986) and Chao and Renvoize (1989). But the initiation of following of the type species *Sinarundinaria nitida* (Renvoize, 1993) was against the generic concept of Chao, *et al*. and has eventually confirmed that this species also is

congeneric with the type species of the earlier described genus *Fargesia* (Franchet 1887).

The unilateral spathed inflorescences are similar to both *Fargesia spathacea* and *Sinarundinaria murieliae*. Most authorities, who had recognized *Sinarundinaria,* clearly considered *Fargesia* to be a synonym of *Thamnocalamus*. Demoly (1991), included *Fargesia* in *Thamnocalamus* with its new synonym *Sinarundinaria*, and also recognized another genera *Yushania.* Stapleton (1994b) pointed out the unsatisfactory congeneric treatment of *Thamnocalamus* and *Fargesia* and suggested a clear separation based on the arrangement of floral and vegetative characteristics. Other bamboo taxonomists (Keng f., 1957, 1982a, 1982b, 1983 and Yi, 1983) have adopted much narrower generic concept recognizing both *Fargesia* and *Yushania* as well as many other smaller genera and treated *Sinarundinaria* as a synonym of *Fargesia*. Campbell (1988) attempted to compromise between different approaches that resulted in the recognition of *Sinarundinaria* in two separate sections in addition to *Fargesia* and *Yushania*.

During the studies on Bamboos of Nepal and Bhutan, Stapleton (1994a, 1994b, 1994c) attempted to delimit Sino-Himalayan genera more satisfactorily under a range of morphological characters. The characteristics of vegetative branching and sheathing were particularly useful at the generic levels in these bamboos and were used to separate distinct group of species which matched several new genera, recently described in the Chinese literature, supported the treatment of *Sinarundinaria* as a synonym of *Fargesia*.

The position of Indian Arundinoid bamboos is still not clear owing to the complexity of the group and unless further studies are conducted using the recent molecular techniques the exact position of this complex group will not be fully understood.

The genus *Dendrocalamus* in India was known to represent by 15 species. However, presently the status of most of the species have been changed. Species like *D. patellaris* is considered as little known. The taxonomic identity of several economically important species like *D. hamiltonii, D. sahnii*, and *D. somdevai* are confusing and some of the species could not to be relocated after the type collections. *D. parishii* and *D. collettianus* are represented only by two herbarium specimens and Gamble treated them as imperfectly known taxa. *D. strictus* and *D. sericeus* are found to be conspecific. While studying the bamboos of Nepal and Bhutan, Stapleton (1995) transferred *D. membranaceus* to the genus *Bambusa* and treated *D. patellaris* under *Ampelocalamus* as new combinations. The species like *D. sericeus* and *D.*

strictus are also found to be conspecific. The identity of the other species remains inconsistent, which indicated the need for a detailed taxonomic study of the genus.

Most of the species known under *Oxytenanthera* were treated under different genera such as *Gigantochola*, *Pseudoxytenanthera,* and *Bambusa.* Soderstrom and Ellis (1988) erected a new genus *Pseudoxytenanthera* and accomodated one species, which was formerly known under *Oxytenanthera*. Subsequently the generic status of *Pseudoxytenanthera* was accepted by several authors (Naithani, 1990; Tewari, 1992; Seethalakshmi and Kumar, 1998) and included all the known Indian species of *Oxytenanthera, sensu lato* under *Pseudoxytenanthera* without considering the proper generic delimitions. However, these transfers are inadequate and therefore, it is better considered as under *Oxytenanthera* - *Pseudoxytenanthera* complex.

The genus *Oxytenanthera* was described by Munro (1868). Holttum (1956) considered it to be monotypic with *Oxytenanthera abyssinica* (A. Rich.) Munro, a native African type species while the rest of the species placed under this genus belonged to either *Gigantochloa* or *Dendrocalamus*. Widjaja (1987) also supported this view.

Soderstome and Ellis (1988) opined that *Oxytenanthera* belonged to new taxa and described it as a new taxon *Pseudoxytenanthera* and transferred *Oxytenanthera monadelpha* under this new generic name. Majumdar (1989) described it as yet another new taxon *Pseudotenanthera* which later Naithani (1990b) considered as a superfluous name and it was synonymised under *Pseudoxytenanthera.*

The genus *Schizostachyum* is distributed in South-East Asia, including Myanmar and Andaman Islands. Majumdar, (1989) transferred all the known species belonging to the genera *Pseudostachyum*, *Teinostachyum* and *Cephlaostachyum* under the genus *Schizostachyum*. Holttum (1946, 1958) emphasised the close relationship of *Neohouzeaua* and *Teinostachyum* and pointed out an inconsistent distinction between these two genera. In India there are presently only three species are known viz. *Schizostachyum andamanicum, S. kalpongianum* and *S. rogersii*.

3. MATERIALS AND METHODS

Botanical explorations were conducted in different parts of India including Andaman Islands and collected specimens from different geographical zones. Herbarium sheets were prepared using conventional methods. Besides this, herbarium specimens of all the genera included in

the present study housed in major Indian herbaria, like, Central National Herbarium Calcutta (CAL); Forest Research Institute herbarium, Dehra Dun (DD); BSI Southern circle Coimbatore (MH); Andaman & Nicobar circle Port Blair (PBL); BSI Western circle Pune (BSI), Sikkim Himalayan circle, Gangtok (BHC); Northern circle, Dehra Dun (BSD); Calicut University (CALI) and Kerala Forest Research Institute Herbarium (KFRI) were critically examined. Cibachrome sheets were also consulted from Kew (K), Paris (P), Edinburgh (E) and Bogor (BO) Herbarium. All the voucher specimens and photographs of the Type Sheets procured are deposited in KFRI herbarium.

In the present report detailed taxonomic notes and key to genera and species have been given for each genus studied except the Arundinoid bamboos. The illustrations are provided only for those taxa newly described during the present study. The typification of seven species has also been carried out during this study. Plates and photographs of the all the species of bamboos under study are also included.

4. SYSTEMATIC TREATMENT

Subtribe 1. **Arundinariinae** Benth.

Arundinariinae Benth., J. Linn. Soc. Bot. 19: 31. 1881; Soderstr. & R. P. Ellis in Soderstr. *et al*. (eds.), Proc. Int. Symp. Grass Syst. Evol. 234. 1987; Clayton & Renvoize, Kew Bull. Addl. ser. 13: 41. 1989; 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 bamboos. 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 group represents a taxonomically heterogeneous group of bamboos (Chao & Renvoize, 1989). The genera *Arundinaria* was once the largest one in Bambusoideae. There are about 380 binomials under the name *Arundinaria*. It is one of the earliest names in the group of

bamboos. All types of rhizomes are found in this subtribe, from sympodial to monopodial. The plants are shrubby or medium sized up to 8 m tall. This is a large and complex subtribe in which the generic limits are far from adequately resolved. Different authors described numerous genera namely, *Arundinaria, Chimonobambusa, Drepanostachyum, Fargesia, Himalayacalamus, Nipponocalamus, Pleioblastus, Sinarundinaria, Thamnocalamus,* and *Yushania* under this subtribe.

Ampelocalamus and *Borinda* are some of the important genera described by various workers under this subtribe. Almost all the members of this subtribe are distributed from the Old World except one species *Arundinaria gigantea* which is native of United States. Most of the genera are high altitude plants growing under temperate climatic conditions.

Arundinaria Michx.

Michaux described this genus in 1803. The type species *Arundinaria gigantea* is native to the United States of America. Subsequently, different species were placed under this genus. They include American, African and Asian species. The type species *Arundinaria gigantea* is a monopodial bamboo. But, later sympodial bamboos having similar characters like several branches, racemose or open paniculate inflorescence, three stamens with free filaments and 2-3 stigmas, were placed under this genus. The genus *Arundinaria* is considered as the most advanced group among bamboos. They are shrubby and with two glumes and three stamens.

Arundinaria Michx., Fl. Bor. Amer. 1:73.1803; 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; Blatt. Indian For. 55(10):542.1929; C.E.C. Fisch. in Gamble, Fl. Pres. Madras 3:1857.1934; Mc Clure, Smith. Contr. Bot. 9:21.1973; 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; 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; Judziewicz *et al*., Amer. Bamb. 195.1999; Ohrnberger, Bamb. World 35.1999.

Type: *Arundinaria gigantea* (Walter) Muhlenberg

Ludolfia Willd., Mag. Nevest. Entdeck. Naturk. 2:320.1808.

Macronax Raf., Med. Repos. 11:503.1808.

Pleioblastus Nakai, J. Arn. Arb. 6:145.1925.

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.

Oligostachyum Wong & Ye, Nanj. Univ. J. Nat. Sci. 95.1982.

Bashania Keng. f. & Yi, J. Bamboo Res. 1(2):37.1982.

R.B. Majumdar in Karthikeyan *et al*., Fl. Ind. Enum. Monocotyl. 282.1989.

Seethalakshmi & M. Kumar, Bamb. India Comp.261.1998.

Shrubby, perennial woody bamboos with sympodial rhizomes, the rhizome neck short. Culms erect, hollow, branch compliments many, subequal; culm sheaths persistent or deciduous; branching is intravaginal and above the nodal line; leaf blades are tessellate. Inflorescence, racemes or open panicles; spikelets semelauctant, 2-several flowered, the terminal aborted or reduced to a rachilla segment; glumes 2, palea keeled; stamens 3, filaments free; stigmas 2-3, plumose. Caryopsis with a hilum extending throughout its length.

World Distribution: Africa, Argentina, Bhutan, Brazil, China, India, Mexico, Myanmar, Nepal, Sri Lanka, United States of America and Vietnam.

In India, this genus occurs in North eastern states and South India. In South India, it 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 South 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 (1913) reported this species from South India. Gamble (1896) followed Munro's concept and treated all these species under the genus *Arundinaria.* Later workers like Beddome (1873), Bentham (1883), Brandis (1906), Bourdillon (1908), E.G. Camus (1913) and Blatter (1929) also followed this generic concept.

Chao and Renvoize (1989) revised all the species described under *Arundinaria* in South-east Asia and Africa. All the species known from South India previously treated under *Arundinaria* were transferred to the genus *Sinarundinaria.* Seethalakshmi and M. Kumar (1998) accepted the concept of Chao and Renvoize (1989) and transferred all the South Indian species under the genus *Sinarundinaria.*

The genus *Sinarundinaria* was first described by Nakai (1935) based on *Sinarundinaria nitida* and *S. murielae.* His description was based on the vegetative structures only. *Sinarundinaria murieliae* flowered in 1970's and *S. nitida* flowered in 1993. It was found that both these species were *Fargesia spathacea* (Stapleton, 1994).

Majumdar (1989) accepted Keng's (1957) generic concept and transferred all the South Indian species previously treated under the genus *Arundinaria* to the genus *Yushania*.

Nakai (1925) treated three species such as, *Arundinaria floribunda, A. wightiana* and *A. walkeriana* under the genus *Indocalamus.* Tewari (1992) also followed this concept.

For confirming the generic status of the species under the subtribe Arundinarinae the details of the observations made during the present study has been communicated to international bamboo taxonomists for their expert comments and hence, the details on the genera *Arundinaria* (*Sinarundinaria*) is excluded from this report.

A comparative study of different genera so far considered under the tribe *Arundinarinae* is given in Table 1.

Dendrocalamus Nees

The genus *Dendrocalamus* was erected by Nees von Esenbeck (1834) to accommodate *Bambua stricta*, which appeared in Roxburgh's *Plants of the Coast of Coromandel* (1815). Nees described the genus based on *Dendrocalamus strictus* (Roxburgh) Nees. It was Colonel Munro (1868) in his monograph treated 8 species and one variety under this genus namely *Dendrocalamus strictus*, *D. sericeus, D. parishii, D. membranaceus, D. giganteus, D. hookeri, D. hamiltonii* var. *edulis, D. brandisii* which was formerly described as *Bambusa brandisii* by Munro (1868). Kurz (1873) added one more species *Dendrocalamus longispathus* to the genus. Gamble (1896), described 15 species from India and adjoining areas under three sections including few new species such as *Dendrocalamus longifimbriatus, D. parishii, D. sikkimensis, D. patellaris* and *D. collettianus*.

Presently, the genus *Dendrocalamus* is represented with over 52 species in the world (Ohrnberger, 1999). It is distributed throughout the Asian countries like southern part of China extending to Bangladesh, Bhutan, Borneo, Indonesia, Kampuchea, Laos, Malaysia, Malay Peninsula, Myanmar, Nepal, Philippines, Sri Lanka, Thailand, Vietnam, Papua New Guinea and Western Central and Eastern parts of India. The several species of *Dendrocalamus*

Table 1. A Comparative Study of Genera Described Under Tribe Arundinarinae

Characters	*Arundinaria*	*Yushania*	*Fargesia*	*Borinda*	*Ampelocalamus*	*Himalayacalamus*	*Pseudoarundinaria*	*Drepanostachyum*	*Thamnocalamus*	*Chimonobambusa*
Habit	Medium sized erect	Shrubby	Shrubby	Tree form	Tree form	Medium sized	Shrubby	Medium sized	Shrubby	Erect up to 6m tall
Rhizome	Long monopodial	Sympodial	Sympodial	Sympodial	Sympodial	Sympodial	Sympodial	Sympodial	Sympodial	Monopodial
Rhizome necks	Short	Neck up to 20cm	Up to 25cm	Up to 30cm	Up to 25cm	Up to 25cm	Up to 10cm	Up to 25cm	Up to 25cm	Up to 25cm
Culm length	Up to 8m	4m	2 to 7m	Up to 10m	Up to 12m	Up to 8m	Up to 1 to 4m	Up to 5m	Up to 5m	Up to 5m
Mid culm prophyll	Single 2 keeled	Double one keeled	1 keeled double	1 keeled double	1 keeled double	1 keeled double	1 keeled double	Single keeled	2 keeled double	2 keeled double
Culm sheath auricle	Small rudimentary with oral setae	Well developed with oral setae	Absent or rudimentary with or without oral setae	Absent, oral setae absent	Absent, oral setae absent	Absent, oral setae absent	Rudimentary with or without oral setae	Absent	Rudimentary with bristles	Absent, without bristles
Inflorescence	Open paniculate	Open panicle	Spathed panicle	Open panicle	Open panicle	Open panicle	Open panicle	Open panicle	Spathed panicle	Open panicle
Pulvini	Absent	Present	Absent	Present	Absent	Absent	Present	Absent	Absent	Absent
Spikelets	6-12 flowered	3-10 flowered	*DD	6-10 flowered	6-8 flowered	One flowered	3-7 flowered	2-4 flowered	8-9 flowered	6-12 flowered
Lemma	Glabrous	Glabrous	Glabrous	Glabrous	Glabrous	Glabrous	Glabrous or hairy	Glabrous	Glabrous	Glabrous
Palea	2 keeled	2keeled	2keeled	2keeled	2keeled	2keeled	2keeled	2keeled	2keeled	2keeled
Lodicule	Three	Three	Three	Three	Three	Three	Three	Three	Three	Three
Stamen	Three	Three	Three	Three	Three	Three	Three	Three	Three	Three
Stigma	Three	Three	Three	Three	Two	Three	Three or two	Three	Three	Three
Fruit	Beaked	Oblong grooved	Oblong grooved	*DD	*DD	*DD	Oblong	*DD	Linear oblong	*DD
Branch size	Unequal	Unequal	Unequal	Unequal	Equal	Unequal	Sub equal	Equal	Unequal	Unequal
Number of branches	1 to 3	4 to 6	3 to 15	Up to 7	Up to 10	15 to 40	5 to 7	Upt o 70	Up to 7	Up to 7

are widely cultivated throughout India, due to their economic potential. Some of the species such as *D. collettianus*, *D. parishii* and *D. sericeus* could not be relocated during the present survey and no good herbarium specimen in any of the Indian herbaria for any critical studies was available. The species *D. sericeus* is similar to *D. strictus* as evidently known form Gamble's description and illustrations. It is difficult to separate *D. sericeus* from *D. strictus* and therefore, is treated in this report as a synonym under *D. strictus*.

The species like *Dendrocalamus brandisii* and *D. giganteus* are widely seen in India under cultivation. The present investigation revealed that these species are native to Myanmar and South-East Asia. Though the occurrence of *D. brandisii* was reported from Andaman Islands (Parkinson, 1923), during the recent exploration in the Andaman Islands this species could not be located under natural condition but was found only under cultivation.

Gamble treated *Dendrocalamus parishii* and *D. collettianus* as imperfectly known taxa. Both the species were described based on the inflorescence, the vegetative characters still remain unknown. During the present survey these species could not be relocated. Therefore, both the species are included under the category of imperfectly known taxa in the present report.

Based on the critical studies the species such as *D. sahnii* and *D. somdevai* are synonymised under *D. hamiltonii*. The species such as *D. patellaris* and *D. membranaceus* are considered as the species are wrongly assigned to *Dendrocalamus*. The present investigation also supported the studies of Stapleton (1994c) and also Stapleton *et. al.* (1996, 1997) in the treatment of these species as *Ampelocalamus patellaris* (Gamble *emend.* Stapleton) Stapleton and *Bambusa membracea* (Munro) Stapleton & N. H. Xia. In this report, 8 species such as *Dendrocalamus calostachyus*, *D. hamiltonii*, *D. hookeri*, *D. longispathus, D. stocksii, D. sikkimensis, D. sericeus* and *D. strictus* are included.

Morphological characters

Habit and habitat: The growth habit of the species is tree form. They produce huge clumps with large culms, size ranges from 4 m to 30 m. In general, most species form densely tufted clumps. The culms are called caespitose or are very close to each other. In general, all species generally possess a sympodial short-necked rhizome, but in species like *D. longispathus, D. asper, D. giganteus*, etc. show slightly loose clumps. *Dendrocalamus strictus* is characterised with very closely packed culms. It is estimated that over 200 culms are found in a clump.

Shoots: The new culm arises from the bud at the base of an old culm. The growth of the shoot

has different colour combinations varying from species to species, which is protected by numerous overlapping rigid sheaths with spiny hairs. The colour of the hairs, which cover the edge of the sheaths, is also characteristic for each species. Waxy coatings found on the shoots makes the latter appear whitish. The size and thickness of the new shoots vary from species to species. *Dendrocalamus giganteus* produce vigorous shoots. The shoots of *D. hookeri, D. brandisii,* and *D. sikkimensis* are moderately large. The species like *D. strictus* and *D. stocksii* produce comparatively smaller shoots owing to its drought habitat. The shoots are generally produced after the precipitation and it continues almost throughout the rainy season. The features of the young shoot are useful during identification in the field.

Culms: The culms are matured shoots and grow very rapidly and reach their full height within a few days and start to produce branches. *Dendrocalamus* generally produce large culms with the length and diameter of culms varying from species to species, which ranges from 8-30m and 2.5-35cm respectively. The internode length varies from 25cm to 60cm. Powdery waxy coating especially in younger stages smother the surface of the culm of many species. The basal nodes of almost all species is characterised by the presence of aerial roots. It is prominent in *D. giganteus, D. hookeri, D. brandisii, D. sikkimensis, D. hamiltonii, D. strictus* and *D. stocksii*. The culms are generally hollow. However, in *D. strictus* and *D. stocksii* the central lumen are small. Those species growing in dry areas have semi solid culms.

Branching system: Branching is initiated from about 5^{th} - 10^{th} nodes after the culms have reached their full height. The lateral branches begin to grow by emerging from buds enclosed by the sheaths after breaking the culm sheaths. Therefore, the branching is said to be intravaginal. The branching pattern of all the species of *Dendrocalamus* is similar and does not provide any differentiation at the species level.

Culm sheath: The culm sheaths are species specific having definite characters such as, shape and size of the blade, ligule, auricle, colour, texture, presence or absence of hair on its surface, etc. The culm sheaths of all species of *Dendrocalamus* show a well-marked auricle and ligule. *D. hookeri, D. sikkimensis, D. brandisii* and *D. stocksii* show distinguishable principal appendages with auricular setae and ligule. The blade of each sheath is erect initially in all species and on maturity they become inflated or reflexed. The blade of *D. giganteus* is distinct with a characteristic constriction at the base, which appears like a pseudo-auricle. The auricles are rudimentary in *D. hamiltonii*, *D. somdevai*, *D. sahnii* and *D. strictus*. The auricular appendages are found to be absent in *D. longispathus* and *D. calostachyus.* Ligules are well

marked in all the species and it is highly toothed with leathery or membranaceous texture. It is obvious that in all species of *Dendrocalamus* the culm sheaths are distinctly distinguishable and used as an aid for identification. The culm sheaths are with leathery texture and attractively coloured in younger stages. The mature culm sheaths are caducous, papery and are partially persistent in *D. longispathus, D. stocksii* and *D. hamiltonii*.

Leaves: Leaves are linear lanceolate, subsessile, 20-34cm, long, 1.5-7cm, broad glabrous or pubescent with or without a conspicuous auricle, ligule slightly rising. The leaves are comparatively small in *D. strictus* and *D. stocksii*. They are glabrous in majority of the species but in *D. hamiltonii* the leaves are pubescent in adaxial surface.

Inflorescence: Spikelets are of semi verticillate clusters, arising in panicles. Spikelets are in dense groups at the nodes of usually leafless branches. Based on the arrangement of the spikelet two types are recognised. The *D. strictus* type has dense globose head and in others spikelets are in clusters.

Spikelets: There are 1-6 perfect florets. The apical floret is sometimes sterile or reduced and is considered as an elongated extension of the rachilla. Lemmas broad, glabrous or spiny hairy, short, fringed on the edges, many veined, palea of the lower florets two keeled, thin and translucent, veins between keels, keels usually fringed with hairs, sometimes hairs on the back and edges also, paleas of upper most perfect floret slightly keeled, often glabrous, stamens 6, filaments free, lodicules absent, ovary with hairy apex bearing a long slender hairy style with usually an undivided stigma.

Fruit: Fruit is a stoney caryopsis (Glans), ovate or oblong, pericarp thick at the top, easily separable from the seed. The size and form varies from species to species in majority of the species such as *D. strictus*, *D. hookeri*, *D. longispathus*. The fruits are sub globose and in other species of *Dendrocalamus* it is oblong.

Dendrocalamus Nees Von Esenbeck in Linnaea 9(4): 476.1834; Munro, Trans. Linn. Soc. London 26:146.1868; Beddome, Fl. Sylv. S. India 3:235.1873; Gamble, Ann. Roy. Bot. Gard. Calcutta 7:77.1896; Gamble in Hook. f., Fl. Brit. India 7:403.1896; Fischer in Gamble, Fl. Pres. Madras 3:1857.1934; Holttum, Bam. Malay. Penin. Gar. Bull. xvi:29.1958 ; Clayton & Renvoize, Kew Bull. Addl. ser. 13:54.1989; Stapleton, Edinb. J. Bot. 51(1):20.1994; S. Dransf. & Widjaja, (eds.) Plant Resources S.E. Asia 7:17.1995; K.M.Wong Bamb. Penins. Malaysia 106.1995; Seethalakshmi & M. Kumar, Bamb. India Comp. 99.1998; Ohrnberger, Bamb. World 282.1999.

Type: *Dendrocalamus strictus* (Roxb.) Nees

Klemachloa Parker Indian For. 58:7.1932.

Sinocalamus Mc Clure, Lignan Univ. Sci. Bull. 9:66.1940.

Neosinocalamus Keng. f., J. Bamb. Res. 2:148.1983.

Tree forms, rhizomes sympodial. Culms erect to suberect, never clambering or climbing. Culm sheaths with blades erect or spreading, auricles ranging from lobe-like and bristly on the margin to low and inconspicuous. Buds solitary, at every culm node. Mid-culm branch complement has a dominant primary branch and one to several secondary branches having smaller branchlets from its base. Inflorescence iterauctant. Pseudospikelets consist of several small empty bracts, one to several bracts subtending prophyllate buds, (1-) 2-4 transitional (empty) glumes (shorter than the lowest lemma), 1-3(-6) perfect flowers (1-3 in the strict sense of interpreting the genus) and typically without a vestigial terminal flower); rachilla internodes between flowers short, not disarticulating below the lemmae; palea 2-keeled except in uppermost or sole flower (then only slightly to not keeled), apex rounded, truncate or slightly cleft but not distinctly bifid; lodicules none; stamens 6, filaments free, anther apices always pointed or apiculate (the connective prolonged beyond the anther apex and bearing minute spines or hairs); ovary obovoid, summit thickened and hairy; stigma 1, plumose, arising on a short or long hairy style. Fruit a stony, globular, caryopsis with a small beack.

Key to the species

1a. Bamboos with very closely paked culms; Culms thick walled with narrow lumen; inflorescence a spinous congested spicate heads of spikelets 2

1b. Bamboos with loosely arranged culms; culms thin walled with wide lumen; inflorescence a blunt less congested spicate heads of spikelets 3

2a. Culms glabrous with white powdery mass on the surface when young; culm sheath auricle and bristles are inconspicuous; blade short; spikelet hirsute; stout, ovate ..... ***D. strictus***

2b. Culms sparsely pubescent when young, without powdery mass on the surface; culm sheath with consispicous auricles and bristles; blade long; spikelet glabrous linear lanceolate ..... ***D. stocksii***

3a. Culm sheath with well developed large recurved falcate auricle (up to 4 cm long) and long

bristles (up to 6 mm long)..... ***D. sikkimensis***

3b. Culm sheath with an inconspicuous auricle and with or without bristles or auricle almost absent 4

4a. Culm sheath lacking an auricle..... 5

4b. Culm sheath with a small auricle.....6

5a. Culm sheath longer than the internodes, ligule broad and highly fimbriate; spikelet very short (up to 0.5 cm.) supported by conspicuous scarious bracts .....***D. longispathus***

5b. Culm sheath shorter than the internodes; ligule narrow and entire; spikelet long (up to 1.5 cm.) scarious bracts rudimentary..... ***D. calostachyus***

6a. Leaves pubescent beneath at maturity; nodes of the branches without angular projections; lemma pubescent at inner side; Ovary sparsely hairy..... ***D. hamiltonii***

6b. Leaves glabrous on both sides at maturity; nodes of the branches with conspicious angular projections; lemma glabrous; ovary with thicklet of minute from base towards the apex. ..... ***D. hookeri***

Dendrocalamus calostachyus (Kurz) Kurz, Prelim. Rep. For. Veg. Pegu App. B. 94. 1875 (**Plate 1**); Kurz, For. Fl. Brit. Myanmar 2:562.1877; Gamble, Ann. Roy. Bot. Gard. Calcutta 7: 89. t. 77 1896; & in Hook. f., Fl. Brit. India 7:407.1896; Brandis, Indian Trees 678.1906; Naithani, H.B., Ind. J. For. 8(3):239.1985; Tewari, Monogr. Bamboos 60.1992; Seethalakshmi & M. Kumar, Bamb. India Comp. 103.1998; Ohrnberger, Bamb. World 284.1999.

Type: Myanmar, Ava Kurz *s.n*. (Lectotype K -selected here).

Bambusa calostachya Kurz, J. Asiat. Soc. Bengal n.s. 42(2): 250.1873.

A tufted large bamboo. Culms usually 20-30m high, green with appressed silvery hairs; nodes thickened and annulate; internodes 30-40cm long. Culm-sheaths covered with appressed hairs, truncate at the mouth; ligule very short, entire. Culm sheath orange-brown turning to green with brown hairs (not dense), blades spreading at right angles or reflexed, brownish. Leaves 22-30cm long and 3-6.5cm broad, lanceolate, acuminate, pubescent beneath, base rounded, petiole short; leaves of the side shoots are smaller; leaf-sheath striate, with white ciliae at the margins; ligule prominent, truncate, entire or serrulate. Inflorescence a large panicle of long, whip-like, curved spikes; spikelets clustered in heads of 2 to 5 with a few small

Plate 1. *Dendrocalamus calostachyus* (Kurz) Kurz- Type specimen

empty bracts at base; rachis between the heads 1.5-5cm long, flattened on one side, alternate sides glaucous, somewhat puberulous. Spikelets 1-1.5cm long, 5mm broad, faintly pubescent, ovate, acute, slightly compressed, with 4 to 6 fertile flowers; empty glumes 2 to 3, broadly ovate, acute, many nerved, with consipicous transverse veinlets, ciliate on the edges; flowering glume similar but longer palea of lower flowers keeled, acute, 5-nerved between the keels and transversly veined, 1- nerved on either side of the keel, ciliate on the keels, that of upper most flower ciliate on the edges, but not on the keels, stamens exerted; anthers yellow, mucronate; ovary ovate, rounded, sub-hemispheric, hairy, ending in a long hairy style with single purple stigma.

World distribution: China, India and Myanmar.

Habitat and distribution: Distributed in Meghalaya, Nagaland above 1050m altitudes. This species is known to be localized in distribution. Naithani (1985) reported the occurrence of this species in India. During the present survey this species could not be relocated.

Specimens examined: INDIA: Meghalaya. Shillong. 2nd March 1944, *N.L. Bor* 18385 (ASSAM); Phikrokezma, 4600 ft. 30th June 1942 *N.L.Bor* 16218 (DD); *s. loc.* 25th January 1929 *P.O. Khant* 7279 (DD); MYANMAR: Maymo, *C.E. Parkinson* 7284 (DD); Mandalay *C.G. Rogers* 696(DD).

Uses: The culms are used for building construction. people of Nagaland use it as water chungas (water carrying vessel).

Dendrocalamus hamiltonii (Nees & Arn.) Munro, Trans. Linn. Soc. London 26:151. 1868 (**Plates 2** & **3**); Gamble, Ann. Roy. Bot. Gard. Calcutta 7:84.1896; & in Hook.f., Fl. Brit. India 7:405.1897; Camus, Les Bambusees 154.1913; Bor in Kanjilal, Fl. Assam 5:9.1940; Varmah and Bahadur, Indian For. Rec. (*n.s*.) Bot. 6(1):3.1980; R.B. Majumdar, in Karthikeyan *et al*., Fl. Indiae Enum. Monocot. 276.1989; Tewari, Monogr. Bamboo 63.1992; Stapleton, Edinb. J. Bot. 51(1):23.1994; Seethalakshmi & M. Kumar, Bamb. India Comp. 109.1998; Ohrnberger, Bamboo. World 256.1999.

Type: Assam, Goalpara, 17 vii 1808, Buch-Ham. 852 (lectotype E, selected by Stapleton)

Sinocalamus hamiltonii (Nees von Esenbeck & Arnott ex Munro) Nguyen, Bot. Zhurn. Akad. NAUK 74 (11):1662.1989.

Dendrocalamus sahnii H.B. Naithani and Bahadur, Indian For. 108(3):212-214 t. 1. 1982. Type India, Arunachal Pradesh, Sebansiri Dt., Zoram, alt. Ca 1800m., 28.04.1977, *H.B. Naithani* 902 (DD).

Plate 2. *Dendrocalamus hamiltonii* (Nees & Arn.) Munro **A.** & **B.** Habit; **C.** Culms; **D.** New shoot; **E.** Culm sheath; **F.** Leaf sheath; **G.** Inflorescence

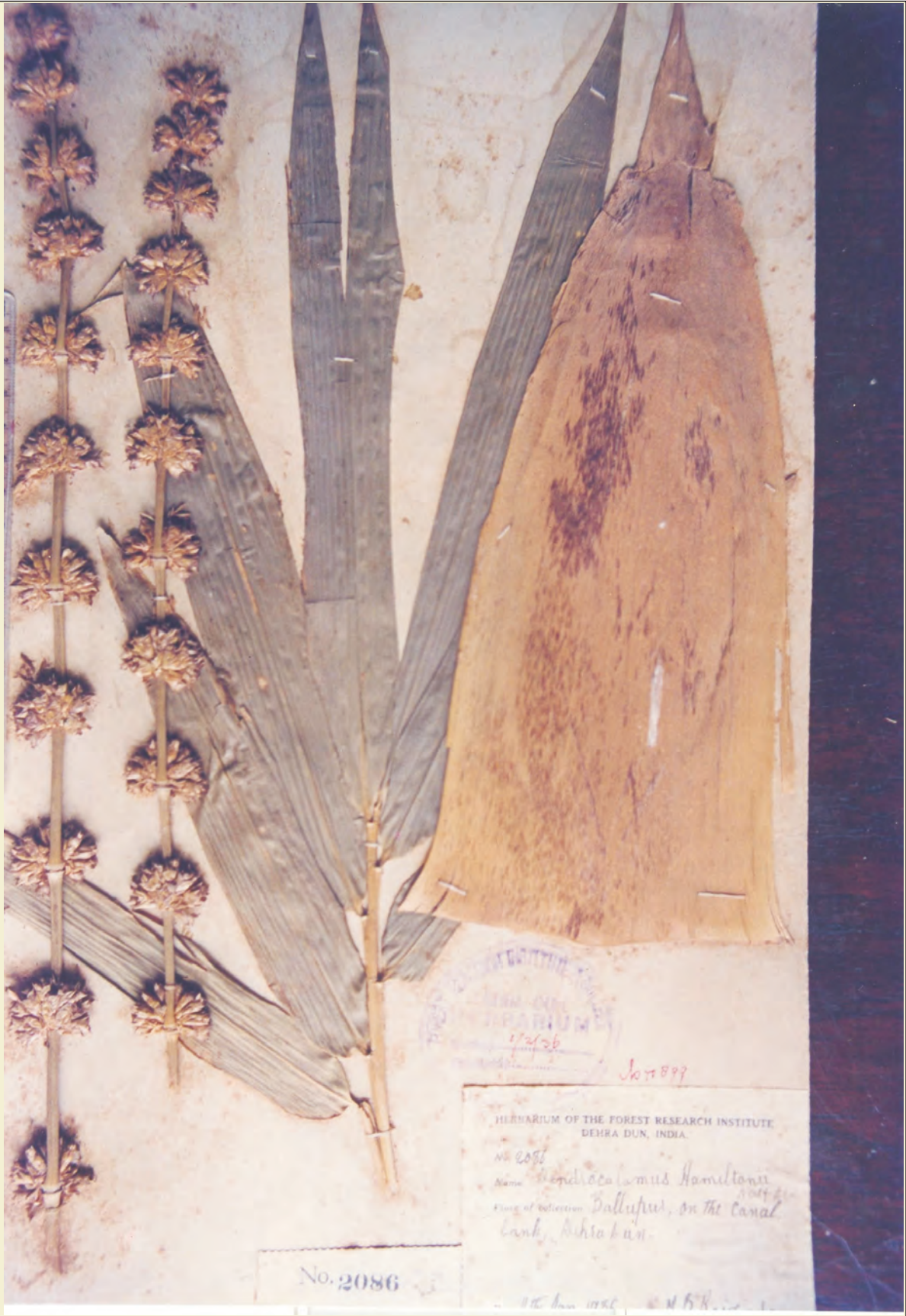

Plate 3. *Dendrocalamus hamiltonii* (Nees & Arn.) Munro- Type (DD)

Dendrocalamus somdevai H. B. Naithani, Indian For. 119(6):504-506.1993. Type: India, Dehra Dun, Haridwar Road between Jogiwala and Majri (Mokhampur), 11.03.1991, *Somadeva* 10985 (DD).

Caespitose bamboo sometimes growing tall and erect often culms at an angle or curved downwards. Culms large, 12-20m or up to 25m tall, usually naked below, much branched above, 10-18.5cm in diameter, greyish-white when young with dense appressed pubescence, dull green when old; lower nodes marked with root scars; internodes 30-50cm long, wall ca, 1.2cm thick. Culm-sheaths long and stiff, variable in size, those of the lower part of large culms 35-45cm long and 18-20cm broad, glabrous, shining within, rough and glabrous or with scanty patches of stiff brown hairs on outer side, truncate at the tip; imperfect blade about three-forths the length of the sheath, often 30cm long, ovate- lanceolate, sides incurved, glabrous on outer surface closely covered with black hairs at the base of the inner surface; ligule varying smooth, entire to dentate, rarely fimbriate. Leaves variable, small on side branches, but on new shoots reaching upto 37.5cm long and 3.75cm broad, rounded at the base into a short thick petiole, broadly lanceolate, ending in an acuminate scabrous twisted point, smooth above, rough beneath, finely serrate on the margins; leaf-sheaths covered with white appressed stiff hairs on outer surface, glabrous inside, shining on the callus, somewhat keeled; ligule long, oblique, truncate. Inflorescence a much branched large panicle with many whorls of branches, bearing half-verticillate semi-globular heads of purple spikelets, 0.8-1.5cm x 0.3-0.5cm, 2-3 flowered; lemma ciliate on the margins, inner surface hairy, outer glabrous; palea two keeled, ciliate on the keels; stamens 6, filaments free, apiculate at apex with a hairy point; style single; stigma, highly plumose, slightly coiled. Fruit a stony caryopsis with short beack at apex.

World distribution: Bangladesh, Bhutan, India and Nepal.

Habitat and distribution: This species occurs in the areas having finer textured soil, in semi-evergreen forests with lesser rainfall. It is known to be a light demanding and early successional species consequent to shifting cultivation in the Himalayas. This species is distributed in the North-West Himalaya, West Bangal, Sikkim, Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland and Tripura. Generally, cultivated in other parts of India.

Specimens examined: Arunachal Pradesh: Lohit District, Metang ling, 23rd March 1986, *K.*

Haridasan 2900 (APFH); Lower suban siri, *G.D. Pal* 77480 (AFS); Assam: above khellay Kan Front alt. 300ft., 17th April 1964 *K. C. sahnii* 5117 (DD); Assam: Burnihat Alt. 158m. 6th April 1985 *Naithani* 1231 (DD); Assam: South Kamrup, Basistha, 5th July 1969 *A. K. Das* 47673 (ASSAM); Assam: Tirap Forest Division. Margherita, *N. B. Deb* 25714 (ASSAM); Assam: Kamrup, Garlko lhauga forest 13th June 1964, *A.S. Rao* 38800 (ASSAM); Assam: Kamrup dist. Barbhange R. F., *G. Panigrahi* 9593 (ASSAM); Tirap Forest Division, Marghasita, *N. B. Deb* 25714 (ASSAM); Assam: Kamrup Dist., South Kamrup Garlo Hauga Forest 13th June 1964 *A. S. Rao* 38800 (ASSAM); South Kamrup, Basistha in the vicinity of the temple in a small Island on the stream, 5th July 1969, *A. K. Das* 47673 (ASSAM); Kamrup dist. Barbhange Reserve Forest, *G. Panigrahi* 9593 (ASSAM); Kamrup Dist. Jara Reserve, Tray Bazar, 24th May 1957, *G. Panigrahi* 9530 (ASSAM); Mikkir hills, Deggum village, 17th May 1957, *G. Panigrahi* 9354 (ASSAM); Himachal Pradesh: North West Himalaya, Palampur, Kengia Alt. 4000 ft. 26th September 1985, *G. A Gammie* 18747 (DD); Dehra Dun Rajipur, 27th October 1914, *P.N. Parker* 10186 (DD); Dehra Dun, 2000 ft. April 1898, *J. A. Gammie* 26880 (DD); Dehra Dun, 2300 ft. April 1890, *J. S. Gamble* 24481 (DD); Jausuar Dt., 3000 ft., June 1891 *J.S. Gamble* 22826 (DD); Dehra Dun, October 1890 *J. S. Gamble* 221310 (MH); Meghalaya: Jaintia wills, shyrphie near Lushery Alt 800 m. 16th April 1988, *Naithani* 1262 (DD); Garo Hills, Rongmil Alt. 200 m., 08.04.1985, *Naithani* 1212 (DD); Jaintia hills, Syaphic, Alt. 800 m, 16th April 1985, *Naithani H. B.* 1262 (DD); Kashi and Jaiusia Hills 35th mile, *R.N. De* 20147 (ASSAM); Kashia and Jaintia hills, G. S. Road 34 miles, 26th April 1947, *G.K. Deka* 21194 (ASSAM); Nagaland Naga hills Tikhang, 20th February 1910, *U. Kanjilal* 1558 (ASSAM); Gouohills, Darajiri, *U. Kanjilal* 5357 (ASSAM); Manipur Dggum, Mikir hills 17th May 1957, *G. Panigrahi* 9354 (ASSAM); K&J hills 35th mile, *R.N. De* 20147 (ASSAM); Garohills, Daragiri, *U. Kanjalal,* 5357 (ASSAM); Umaing-Noonmati, Nongpob, 11th May 1965, *J. Joseph,* 37576 (ASSAM); K&J hills G. S. Road 35th mile, 26th April 1947, *G. K. Deke* 21194 (ASSAM). Nagaland: Nagahills, 20th February 1910, *U. Kanjilal* 1558 (ASSAM); Orissa: Balimala, 23rd May 1959, *R. S. Rao* 18533 (ASSAM); Bhatipather, 3rd November 1959, *G. Panigrahi* 20800 (ASSAM); Sikkim: Alt. 6000 ft. *J. D. Hooker* 11 (MH); Sikkim Naithani part Ranrang 12th October 1986, *D.C.S. Raju* 6846 (BHSC); Sikkim: Sikkim east Dt. Rower sinche Basty 3rd October 1980, *P. K. Hajra* 697 (BHSC); Sikkim: Lower sanhe basty, *P. K. Hagra* 697 (BHSC); Sikkim North: Bangrang, 12th October 1986, *D.C.S. Raju* 6846 (BHSC); Sikkim East: Lower sinhe basty, 3rd October 1980, *P. K. Hajra* 697 (BHSC); Sikkim: Gangtok, near Raj Bhavan area, Alt. 1600m, 15.11.2000, *M.Remesh* 20796 (KFRI); Uttar pradesh: Dehra Dun Alt. 2000 ft. April 1898, *J. S. Camble* 26880 (BSI); Sikkim: June 1894, *C. Rogers s.n.* (BSI); Dehra Dun,

NearBody guard lines, october 1890 *J. N. Dathie* 10742 (DD); Dehra Dun, New forest, 11th January 1936, *M. B Raisadha* 2086 (DD); West Bengal: Jhevke Road, Banks of Testa 8th March 1986, *D. C. S. Raju* and *S. Singh* 5128 (BHSC); West Bengal, Siliguri, Shevoke, Alt. 700m, 9th November 2000, *M.Remesh* 20790 (KFRI); North Bangal, Teesta River Shevock Road, 8th March 1986, *D. C. S. Raju* and *S. Singh* 5128 (BHSC).

Local names: Chye (West Himalaya), Tame (Nepalese) Par (Lepha), Kokeva (Assamees), Pecha (Bangali) Fonay (Miker) and Wanoke (craes) Wabo- myetsangye (Burmese).

Uses: This species is used for house construction, walls of huts, mats, basket making, vessels to carry water and milk, fuels, float of timber-rafts. The young shoots are edible and tribals of Arunachal Pradesh use the tender shoots for the preparation of 'hiyup', a sour pickle (Seethalakshmi & M. Kumar, 1998). The inner layer of the culm sheath is used for covering Burmese cigarettes (Gamble, 1896).

Note: *Dendrocalamus hamiltonii* is a common bamboo distributed throughout the hills of Eastern Himalaya and North Eastern India. This species shows a high degree of variation in their vegetative characters like culm size, culm surface colouration, presence of branchlets, culm sheath size, blade, ligule etc. This has resulted in the misidentification of the species. Some authors consider it as infraspecific variations. While studying the bamboos of Nepal and Bhutan, Stapleton (1994) erected a new variety and treated these variants as infraspecific taxa. But the present study revealed that the floral variation as well as stable characters alone should be taken as a substantial evidence for treating a variety and the changes in vegetative character may be due to the geo-climatic variations.

The critical examination of the two species of *Dendrocalamus* described as new taxa from India by Naithani and Bahadur, (1982) and Naithani, (1993) namely *Dendrocalamus sahnii* and *Dendrocalamus somdevai* respectively, revealed that both the species are conspecific to *Dendrocalamus hamiltonii*. *D. sahnii* was described as bamboo up to 3m. tall. The size difference alone cannot be considered as a stable character. The ligule of the *Dendrocalamus hamiltonii* was described as narrow, entire, but present study revealed that the ligule is slightly dentate. The ligule of *D. sahnii* is described as fimbriate probably it could be a variation. The apiculate authers with a hairy apex is a common character in *D. sahnii* and *D. hamiltonii* as well. In the present report the two species *D. sahnii* and *D. somdevai* have been merged under *D. hamiltonii*. Diagnostic characters of the these species are given in Table 2.

Table 2. Diagnostic characters of *Dendrocalamus hamiltonii*, *D. somdevai and D. sahnii*

Characters	*D. hamiltonii*	*D. sahnii*	*D. somdevai*
Culm size	up to 25m. tall, 6-7 cm in diameter	Up to 3 m. tall, 2-3 cm. in diameter	Up to 20 m. tall, 6-7 cm. in diameter
Internode	25-50 cm. long	8-20 cm. long	15-40 cm. long
Culm sheath	35-45 cm long 10-20 cm. broad	18-20 long 7.5-9 cm broad	20-75 long 10-32 cm broad
Culm sheath ligule	With dentate margins	Toothed or fimbriate margins	With dentate margins
Inflorescence	Large globose head supported by scarious bract,1-2.5 cm. diameter	Large globose head supported by scarious bracts, 5-9 in diameter	Large globose head supported by secuous bracts 1-2.5 cm.indiameter.
Spikelet	Up to 1 x 0.5 cm. only	Up to 1.5 x 0.5 cm.	Up to 1 x0.5 cm.
Lemme	Ciliate on margins	Ciliate on marins	Ciliate on margins
Palea	2 keeled, ciliate on Keels	2 keeled, ciliate on Keels	2 keeled, ciliate on Keels.
Stamens	Purple, apiculate at apex with a short hairy point.	Purple, apiculate at apex with a short hairy point	Purple, apiculate at apex with a short hairy point
Style & stigma	Hairy, stigma single	Hairy, stigma sngle	Hairy, stigma single

Dendrocalamus hookeri Munro in Trans. Linn. Soc. London 26:151.1868 (**Plates 4** & **5**); Gamble, Ann. Roy. Bot. Gard. Calcutta 7:83,t.73.1896; Brandis in Indian Trees 677.1906; Bennet and Gaur, Thirty Seven Bamboos growing in India 55.1990; Tewari, Monogr. Bamboo 66.1992; Seethalakshmi and M. Kumar, Bamb. India Comp.113.1998; Ohrnberger, Bamb. World 286.1999.

Type: India, Bengal Orient. Pundua 11 June 1850, Hooker f. & Thomson 411 (Lectotype selected by Stapleton, 1994 (K)).

Bambusa hookeri (Murno) A. & C. Riviere, Bull. Soc. Acclim. 5(3): 642, t. 20 1878.

Sinocalamus hookeri (Munro) Nguyen, Bot. Zhurn. Akad. NAUK 74(11): 1662.1989.

A large tufted bamboo. Culms 15-30m high, 10-15cm diameter, dark green, usually naked below, curving branches above, with many long internodes 40- 50cm long, rough, hairy; walls 2.5cm thick. Culm-sheaths 20-50cm long, 15- 45cm broad at the base; sheaths of upper nodes narrower, densely covered with black or brown hairs outside, glabrous inside; ligule 5-8mm high, glabrous, serrate; auricles 2, small, rounded, with long stiff ciliae; blade 8- 18cm long, triangular cuspidate, hairy above. Young shoots covered with black tomentum, blade stiff and

Plate 4. *Dendrocalamus hookeri* Munro **A.** Habit; **B.** Flowering clump; **C.** Inflorescence; **D.** Culm with culm sheath

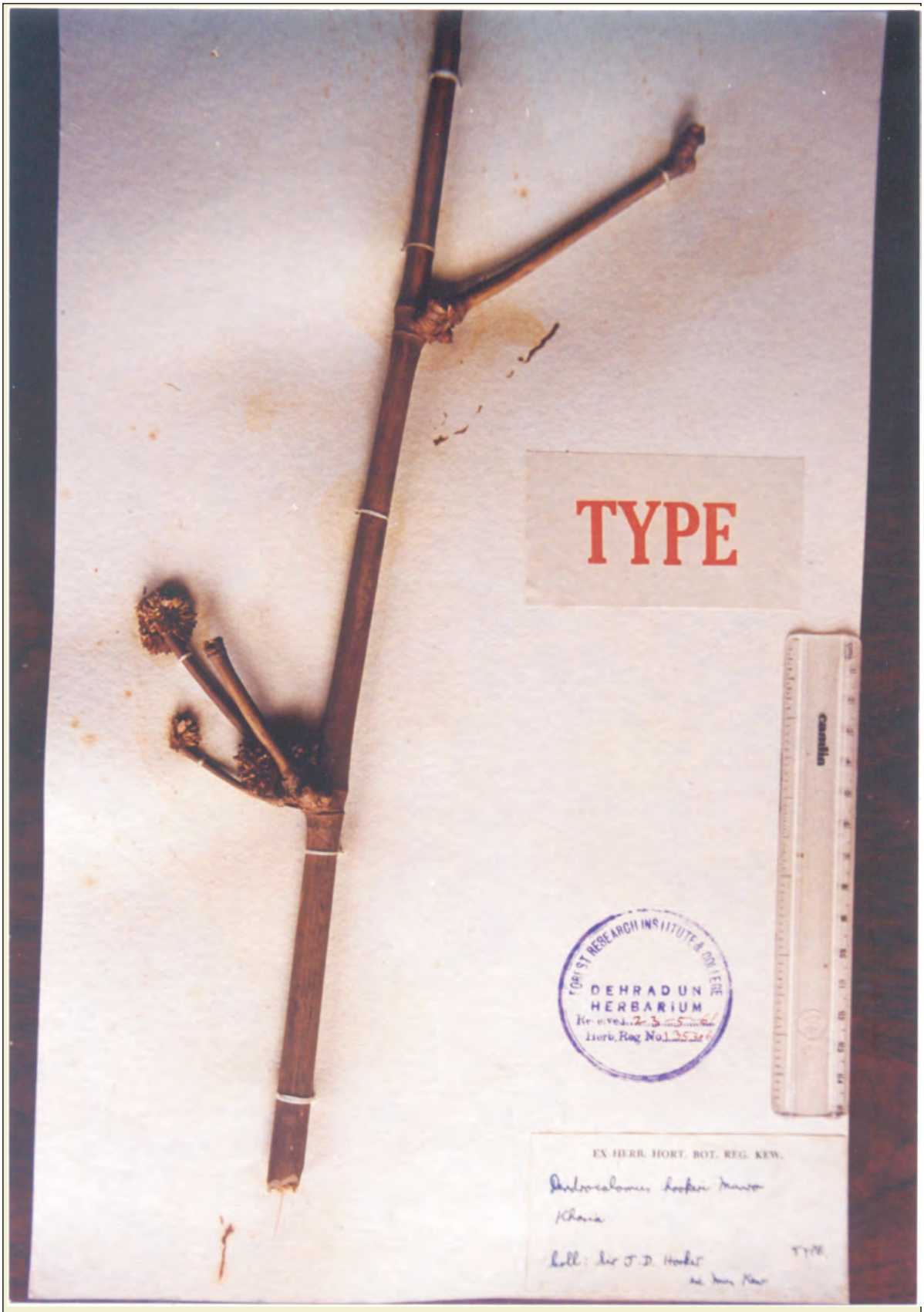

Plate 5. *Dendrocalamus hookeri* Munro - Isolectotype (DD)

pointed with long bristles at the margins. Leaves large, oblong-lanceolate, with a long acuminate tip, smooth above, rough below, hairs scattered near the base, scabrous on the margin, base oblique and rounded, short-stalked; leaf-sheath striate. Inflorescence a large compound panicle, bearing at intervals of 5- 7cm, dense globular heads of spikelets of ca. 2.5cm diameter. Spikelets 7.5-10mm long and 2.5mm broad, ovate, acute, minutely pubescent; empty glumes 2, ovate, blunt; fertile flowers 2 to 3; flowering glumes ovate, acute, many veins and frequent transverse veinlets, the upper most mucronate; palea of lower flowers 2-keeled, acute, ciliate on the keels, hardly veined between, that of upper flower not keeled or only slightly keeled and ciliate at tip. Stamens little exserted; anthers long, ending in a penicillate point. Ovary, narrowly ovoid, acuminate, hairy, surmounted by a hairy style, ending in a twisted plumose stigma. Caryopsis, globular with a pointed apex.

World distribution: Bhutan, India, Nepal and Myanmar.

Habitat and distribution: This species is commonly found in hill slopes of Eastern Himalayan regeion at an altitude of 900m-1800m. Distributed in North Eastern States such as, Kasia Jaintia hills and Kalimpong of West Bengal.

Specimens examined: INDIA: Arunachal Pradesh: Subansiri Dt. 28th April 1927 *H. B. Naithani* 900 (DD); Assam: New colony 15th October 1965, *Beke G. K.* 36844 (ASSAM); Tytiang near Garampor, 24th August 1968, *N. P. Balakrishnan* 47072 (ASSAM); Eyo to Tumbing Alt. 457.2m, 23rd November 1958, *R. S. Rao* 17978 (ASSAM); NEFA, Lohit forest Division, Shoeliang to Paya Alt 625-300m, 15th November 1957, *R.S. Rao* 10587 (ASSAM); Nisa to Niusa 31st August 1958, *G. Panigrahi* 14875 (ASSAM); NEFA, Tirap forest division. Niasa to wanu, Alt. 1434 1st November 1958, *G. Panigrahi* 15028 (ASSAM); NEFA, Tirap Forest Division Komong, *N. B. Deb* 26089 (ASSAM); NEFA Tirap Forest Division Komong, *N. B. Deb* 26089 (ASSAM); Nam check to Soha Alt. 182 to747m. 20th October 1959, *R.S. Rao* 20349 (ASSAM); Meghalaya Shillong, Alt, 4500 ft. *N. L. Bor* 15301 (DD); Khasia, *J. D. Hooker* 135303 (DD); Northern Eastern Part Alt. 5000feet *JD Hooker* (MH); Shillog, Kasia and Jaintia hills, Alt. 4800 feet, 24th May 1934, *N. L. Bor* 13916 (ASSAM); Grohillis Darugiil reserve near Ringu string 18th September 1965, *M. K. V.Rao* 64168 (ASSAM); Jaintia hills, Ka- feiat jari 4000 feet *G. Mann. s. n.* (ASSAM); Jaintia hills, 4000 feet *H. B. Naithani* 1260 (DD); Khasi hills Chirapunji, 23rd April 1985, *H. B. Naithani* 1292 (DD); Chirapunchi, 1650m, 19th November 2000, *M. Remesh* 20743 (KFRI); Sikkim: rivulek near BSI office 3rd April 1984, *Banerjee* 2898 (BHSC); Burbekbusey 25th April 1980, *P. K Hajra* 145 (BHSC); Southern District Sulphate reserve forests Vasne *D. K.* 5468 (BHSC); Mizorom: Manwar

Reserve, Katha Forests Division, Khonkke Beet, 11th November 1924, *M. Gynee* 39524 (DD); Uttar Pradesh: Kumaon, Waldk, patti malle village Basi 4500-5000feet 13th February 1981, *R. Phulera s.n.* (DD); North East Kanger Dt. Hannirpor 9th February 1933, *R. N. Parker* 62379 (DD); Dehra Dun, 2000feet, March 1984, *Gamble* 24568 (DD); West Bengal: Kalimpong, Alt.1250, 16th November 2000, *M. Remesh* 20743 (KFRI); BHUTAN: Wangdi Phodrang, Chhusutsa 27^0 31' N 89^0 58' E, *Stapleton* 818 (THMPHU); NEPAL: Nepal sirkapur 26^0 51' N 87^0 16' E 5500ft. *Williams* 173 (K); Dhankuta, Pakhribas 27^0 03' N 87^0 17' E, *Stapleton* 187; Mamamkhe 27^0 25' N 87^0 52' E, *Crawford et. al., KEKE* 1127 (E, K)

Local names: Seiat, Sejsai, Sijong (Assam), Ukotang. Ussey (Jaintia) -Siejong, Denga; Lepcha-Patu (Khasi); Ooei (Manipuri); Tiji bans Kalo bans, Bhalu bans (Nepal); Pag shi (Dzong kha).

Uses: The large Culms are useful in house construction, basket making and as water bottles. Young shoots are edible.

Dendrocalamus longispathus (Kurz) Kurz, Prelim. Rep. For. Veg. Pegu, App. B 94.1875 (**Plate 6**); Kurz, For. Fl. Brit. Myanmar 2:561.1878; Gamble Ann. Roy. Bot. Gard. Calcutta 7:89, t.78.1896; Brandis, Indian Trees 671.1906; R. B. Majumdar in Karthikeyan *et al.*, Fl. Indiae Enum. Monocot. 276.1989; Bennet and Gaur, Thirty-Seven Bamboo. Growing in India 57.1990; Tewari, Monogr. Bamboo. 69.1992; Seethalakshmi and M. Kumar, Bamb. India Comp. 114-118, t. 32.1998; Ohrnberger, Bamboo. World 288. 1999 .

Type: Myanmar, 1871, Kurz *s.n*. (Lectotype K- selected here)

Bambusa longispatha Kurz, J. Asiat. Soc. Bengal n.s. 42(2): 250 .1873.

A large tufted bamboo. Culms usually 10-18m high, glaucous green when young, greyish-green on maturity; nodes slightly swollen, often rooting; internodes 25- 60cm long, 6-10cm diameter, covered by long papery remnants of sheaths and dark-brown pubescence, walls ca. 1.2cm thick. Culm-sheaths 35-55cm long and 10-20cm broad, longer than internode, inner surface glabrous and outer surface clothed densely with patches of stiff dark-brown hair; margin light straw-coloured in the upper half; ligule broad, much serrate or often long fimbriate; auricles usually absent, sometimes very small on one side; blade 25-40cm long and 2.5-3.5cm broad, lanceolate-acuminate, recurved. Young shoots spear-shaped. Leaves 10-30cm long and 2.5-4.5cm broad, oblong-lanceolate to linear-lanceolate, acuminate, short-stalked margins rough; leaf-sheath ligulate, covered with brown hairs, margin ciliate.

Inflorescence a large panicle of interruptedly spicate clusters of spikelets, sometimes-leafy

Plate 6. *Dendrocalamus longispathus* (Kurz) Kurz **A.** Habit; **B.** Culms; **C.** Culm sheath; **D.** New shoot; **E.** Inflorescence

rachis flexuose, flattened on alternate sides 1.3-3.8cm between clusters, glaucous-green, sometimes rough. Spikelets in heads, sometimes few-flowered blunt, nearly glabrous, 5-7.5mm long; empty glumes 2-3, obovate, blunt, with short rachillae between; flowers 2-3-fertile; flowering glume blunt, obovate, cucullate, ciliate on the edges, many-nerved; palea oval, truncate, faintly keeled, 2-nerved between the keels, faintly pubescent. Stamens, short; anther yellow, short, ending in a black mucronate point; filaments short; Ovary, broadly ovoid, somewhat acute, hairy, ending in a rather short style and short purple stigma. Caryopsis, ovoid, somewhat oblique, yellow, surmounted by a beak formed by the base of the style.

World distribution: Bangaladesh, India, Myanmar and Thailand.

Habitat and distribution: This species is distributed in mixed forests in evergreen primary forests. Commonly found near the streams. Distributed in Mizoram, Tripura and Bihar. This species is introduced to Orissa and Western Peninsula. Generally, found in cultivation in other states.

Specimens examined: INDIA: Mizoram: Dholai, near Boarder, Cacher, October 1978, *R. Majumdar* 74117 (ASSAM); I. L Reserve, Dhalai Block, Kachar hills *D. F. O Mizoram* 45368 (DD); Cacher, October 1978, *R. Majumdar* 73433 (ASSAM); Uttar Pradesh: FRI, Dehradun Arb. 5th April 1975, *K. N. Bahadur* 31(DD); Dehradun, 26th April 1928, *P. N. Parker* 45624 (DD); Dehradun, 26th April 1928, *P.N. Parker* 45639 (DD); MYANMAR: Pegu, December 1891, *P. I. Carter s.n.* (DD); Pegu noma, Alt. 1500 ft., 6th July 1906, *J. H. Lace* 2897 (DD); January 1892, *J.S. Gamble* 23310 (DD); December 1888, *J.S. Gamble* 21106 (DD); December 1888, *J.S. Gamble* 21109 (DD); January 1896, *J. W. Oliver s.n.* (DD); Magaye dist., Yabe ReserveAlt. 4000 ft., February 1915, *C. G. Rogers* 559 (DD); BANGLADESH: Chittagong, February 1880, *mamible* 7756 January 1892, *J. S. Gamble* 23310 (DD); Chittagong, kaptai, 6th March 1979, *J. S. Gamble* 6783 (DD); January 1892, *J. S. Gamble* 23310 (DD); Chittagong, 11th April 1934, *R. J. Maclpine* 65520 (DD).

Uses: This species is generally used for the manufacture of paper. In Tripura it is used for making baskets and containers. It is also found to be an ideal material for making good quality toothpicks. Occasionally, grown as a garden plant due to the elegance of the species.

Dendrocalamus sikkimensis Gamble *ex* Oliver in Hooker's Icon. Pl. Ser. 3: 8, t. 1770 (**Plates 7** & **8**); Gamble, Ann. Roy. Bot. Gard. Calcutta 7:82, t. 72.1896; & in Hook.f. Fl. Brit. India 7:405.1897; Camus, Less Bambusees 5.1913; Troup, Silviculture of Indian Trees 3: 1008.1921;

Plate 7. *Dendrocalamus sikkimensis* Gamble **A.** Habit; **B.** Culms

Plate 8. *Dendrocalamus sikkimensis* - Isolectotype (CAL)

Bor in Kanjilal, Fl. Assam 5:7.1940; Varmah and Bahadur, Indian For. Rec. (n.s.) Bot, 6(1): 2.1980; Tewari, Monogr. Bamboo 74.1992; Stapleton, Edinb. J. Bot. 51(1):26.1994; Seethalakshmi and M. Kumar, Bamb. India Comp. 129.1998; Ohrnberger, Bamboo. World 290. 1999.

Type: India, Sikkim, 20th July1885, *Pantling s. n.* (Lecto type: K, selected by Stapleton; Isolectotype: CAL, DD selected here.).

A large bamboo with caespitose stems and few culms. Culms large, 17-20m high, bare at the base, 12-20cm diameter, dark green; internodes up to 45cm long, rough. Culm-sheaths 36cm long and 30cm broad, densely covered with golden-brown hairs; imperfect blade lanceolate, often as long as the sheath, recurved, decurrent into two auricles fringed with pale bristles; ligule 5mm wide, sharply serrate. Leaves 15- 25cm long and 3.5-5cm broad, oblong-lanceolate, unequal at the base, tapering into a twisted point, shortly petiolate, smooth above, strigosely hirsute and rough below; leaf sheaths smooth, edges falcate, auricles fringed with stiff bristles; ligule short, fimbriate. Inflorescence a large panicle, with stiff nodes, branches bearing large red-brown globose heads; rachis dull brown, sparsely pubescent. Spikelets 1.2-2cm long, lanceolate; empty glumes 3-4, broadly ovate, rounded with ciliate keels; fertile florets 2-3; lemmas ovate-acute, glabrous, mucronate, ciliate; palea of the lowest floret 2-keeled, hairy on the keels, many-nerved, shortly bifid. Stamens 6. Ovary sub-globular, hairy; style hairy with club- shaped stigma. Caryopsis, obovate, depressed, apiculate, shining above with few hairs.

World distribution: North-East India

Habitat and distribution: This species grows in high elevation of Himalayan forests up to an altitude of 2100m. Distributed in Sikkim, West Bengal and Northeastern States of India. Generaaly, found cultivated in several parts of India.

Specimens examined: Meghalaya: East Garo hills, Rangmalagiri, Alt. 300 ft., 9th April 1985, *H. B. Naithani* 1235(DD); Tura park, Garo hills, Alt. 3500 ft., November 1989, *G. Mann s.n.* (DD); Mizoram, Western Rawmi, Chalfith. Metain, Alt. 4000 ft., 21st November 1985, *H. B. Naithani* 1384 (DD); Sikkim: Sikkim Himalaya, 20th July 1885, *R. Pantling*, 20th July1885, *Pantling s. n.* (DD); Namsai, 8th September 1969, *R. S. Rao* 47713 (ASSAM); Uttar pradesh, Dehradun, Forest college campus, October 1913, *P. N. Parker* 6238 (DD); West Bengal: Dargeeling, Alt. 5000 ft., 8th October 1902, *J. H. Laee* 2431(DD); British Bhutan, Taugta, Alt. 5000 ft., April 1897, *Philsing* 132(DD).

Local names: Wadah, Lepcha, Pugriang (Garos); Rawami, Sangau (Mizoram); Bhalu.bans (Nepal).

Uses: The large Culms are useful in house construction, basket making and as water bottles. Young shoots are edible.

Dendrocalamus stocksii (Munro) M. Kumar, Remesh & Unnikrishnan, comb. nov. Sida 21(1): 93-96, 2004 (**Plates 9** & **10, Figures 1** & **2**).

Type: *Oxytenanthera stocksii* Munro, Trans. Linn. Soc. London 26:130.1868; Gamble, Ann. Roy. Bot. Gard. Calcutta 7:75 t. 66.1896; & in Hook. f., Fl. Brit. India 7:403.1897; E. G. Camus, Les *Bambuseae* 149.1913; Varmah & Bahadur, Ind. For. Rec. (n.s.) Bot. 6(1):4.1980. Type: South India, Concan, *Stocks s.n*.(lectotype (K) selected here)

Pseudotenanthera stocksii (Munro) R. B. Majumdar in Karthikeyan *et al*., Fl. Ind. Enum. Monocotyl. 280. 1989.

Psuedoxytenanthera stocksii (Munro) Naithani, J. Bombay Nat. Hist. Soc. 87: 440. 1990; Tewari, Monogr. Bamb. 129. 1992.

An erect, tall, arborescent, gregarious bamboo with closely placed culms. Rhizomes sympodial, pachymorph, with short necks, solid. Culms erect self supporting, lumen, narrow or solid, 12-16m tall, tip straight; node slightly swollen; sheath scar prominent, nodal ridge clear, each node bears a single nodal bud enclosed inside a prophyllum, lower nodes have aerial roots; internodes 20-38cm long, 2.5-4cm diameter, yellowish-green, covered with soft greyish-white pubescens when young, glabrous when old, almost solid with very thick walls. Culm sheath 12-25cm long, 10-15cm broad at base, striate, coriaceous, hirsute, covered with bulbous based brownish hairs, tip concavely truncate, persistent; blade erect, subulate, 5-8cm long, 0.8-1.4cm broad at base, striate, involute, glabrous, persistent, acuminate; auricle 0.2-0.3cm long, clothed with numerous, erect, stiff, bristles, bristle persistent; inner ligule prominent, conspicuous, 0.8-1cm high, deeply fimbriate. Branches, branching starts from the lower nodes, the central dominant branch arise first, 2-4 laterals are produced from its basal nodes, the primary and secondary branches rebranch at each node, intravaginal emergence. Leaves arise on branches, linear-lanceolate, 6-25cm long, 0.8-2.2cm broad, dorsal side glabrous, ventral side faintly hirsute, one of the margins and midrib regions scabrous, tip acute, ending in a setaceous point, midrib narrow, prominent on the lower side, base attenuate, petiole short; leaf sheath overlapping, glabrous, striate; auricle short, bristles not found; inner ligule short, 0.1-0.2cm high, outer ligule inconspicuous. Inflorescence a large

Plate 9. *Dendrocalamus stocksii* (Munro) M. Kumar, Remesh & Unnikrishnan **A.** Habit; **B.** Culms; **C.** Flowers; **D.** Flowering branch; **E.** New shoot

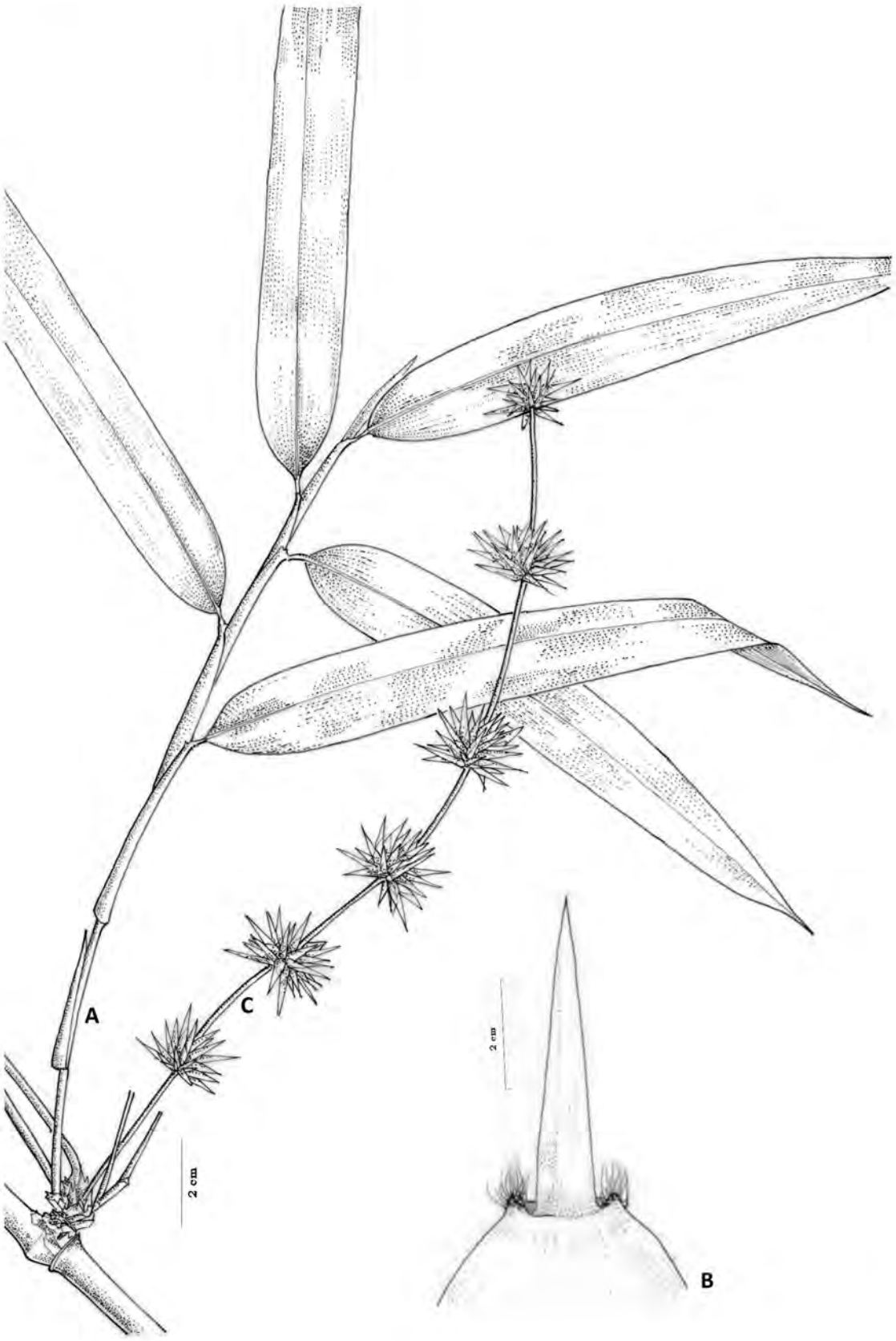

Figure 1. *Dendrocalamus stocksii* (Munro) M. Kumar, Remesh & Unnikrishnan **A.** Leafy branch; **B.** Culm sheath; **C.** Inflorescence

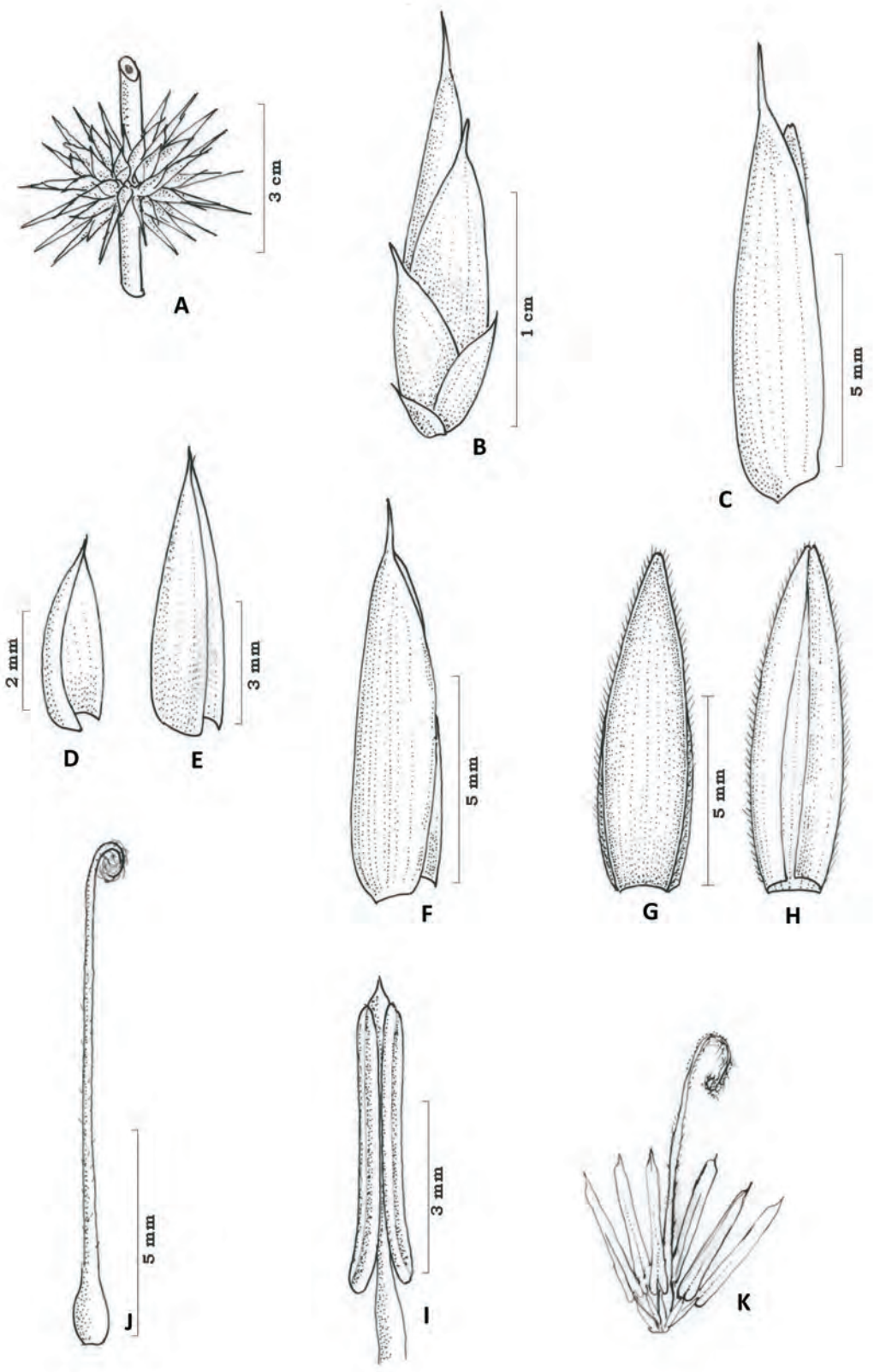

Figure 2. *Dendrocalamus stocksii* (Munro) M. Kumar, Remesh & Unnikrishnan **A.** Portion of inflorescence; **B.** Spikelet; **C.** Floret; **D. & E.** Sterile glumes; **F.** Lemma; **G.** Palea-surface view; **H.** Palea - inner view; **I.** Stamen; **J.** Ovary with style; **K.** Open floret (diagramatic)

Plate 10. *Dendrocalamus stocksii* (Munro) M. Kumar, Remesh & Unnikrishnan - Lectotype (K)

panicle, terminal and axillary as verticillate clusters or large globose heads on the nodes, composed of closely packed spinous spikelets. Spikelets 2-flowered, lanceolate, glabrous, mucronate, 1.2-1.5cm long, 0.1-0.2cm broad, fertile and sterile spikelets mixed, sterile glumes 2, 0.4-0.7cm long, ovate-lanceolate, glabrous, mucronate, many-nerved; fertile glumes, lemma 1-1.2cm long, ovate-lanceolate, mucronate, strongly spinose, many nerved; palea slightly shorter than lemma, 2 keeled, ciliate on the keels, 3-4 nerved between, tip obtuse, convolute; lodicules 0; stamens 6, free, filaments short, exserted, anthers 0.4-0.5cm long, basifixed, apiculate, tip ciliate; ovary ovate, sparsely hirsute, style 0.8-1cm long, ciliate, stigma single plumose. Fruit a caryopsis, pericarp dry, oblong.

World distribution: Peninsular India.

Habitat and distribution: It is found growing from sea level to an altitude of 800m. Sporadic flowering is common in this species. Endemic to northern Western Ghats. This species is comonly found in the northern Kerala and Karnataka along Concan Coast, Goa, Maharashtra. It flowered at Palapilly, Thrissur district under cultivation in the year 2000. It is widely cultivated in Karnataka and Northern Kerala.

Specimens examined: Concan, *Stocks s.n.* (K); GOA: South Goa Dist.: Noowary, *H. B. Naithani* 1189 (DD); 3rd March 1985. Karnataka: North Kanara Dist.: Coompta, *WA Talbot* 269 (BSI); North Kanara, 1884 *WA Talbot* 549974 (CAL); Kerala: Kasargod, *Bamboo Products Exports* 140317 (DD); Kanchangad, 29th October 1999 *Raveendran* 20637 (KFRI); Thrissur dist. Palapilly, 16th December 2000 *M. Remesh* 20646 (KFRI); 26th February 2001 *N. Unnikrishnan* 74039 (CALI).

Local names: Uyi, Mula (Malayalam), Konda (Karnataka).

Uses: It is a very strong bamboo with tall culms. It is ideal for construction purposes. This species is also used for making furniture, ladders and supports.

Note: *Dendrocalamus stocksii* (*Oxytenanthera stocksii*) was first described by Munro (1868) based on the specimen collected by Stocks from the Concan area. This species is distributed in South India, along the Konkan coast up to Karwar. Subsequently, Talbot also collected it from the Coompta River in 1884 and Karwar in 1889. Munro's species was recognized by many workers, e.g., Beddome (1873), Gamble (1896), Camus (1913), etc. It was, however, Holttum (1956) who asserted that the genus *Oxytenanthera* was truly represented by the African species *O. abyssinica* due to the peculiar nature of its ovary i.e. the ovary attenuate upwards very gradually

into a more or less three angled hollow structure which bears the stigmas at its apex and the cavity of the style appears not to be continuous with the cavity which contains the ovule. He concluded that the rest of species described within this genus should be transferred to some other genera. Based on this analysis, Majumdar (1989) transferred this species under a new genus, *Pseudotenanthera* Majumdar. Unfortunately, *Pseudotenanthera* is nom. Superfl. and illegitimate for *Pseudoxytenanthera* Soderstr. & Ellis (1988) therefore, Naithani (1991a) transferred this species to *Pseudoxytenanthera* as a new combination *P. stocksii* (Munro) Naithani. *Pseudoxytenanthera* is characterized by the presence of straggling culms, inflorescence with spikelets of semiverticillate clusters, monadelphous stamens, and three plumose stigmas. *Pseudoxytenanthera stocksii* possesses erect culms, free stamens, and a single plumose style. Although the earlier authors described this species with fused filaments, during the present study, it was observed that the anther filaments are short and do not show true monadelphous condition. A close examination from the young stamens to mature stamens revealed that the filaments are totally free. Owing to these charcteristic features, it cannot be accommodated within the genus *Oxytenanthera* Munro either. *Oxytenanthera stocksii* differ from *O. abyssinica*, the type species, by having free stamens and monostigmatic ovary. In *O. abyssinica* the stamens are monadelphous and the style is divided into three stigmas.

The culms and branching patterns of *Oxytenanthera stocksii* also resemble those of species under *Dendrocalamus* Nees. As in the case of the type species (i.e., *D. strictus*), *O. stocksii* shows erect culms with short internodes, which have narrow lumen (solid). The inflorescence of *O. stocksii* is a large panicle of spicate heads. Even in *Dendrocalamus,* the inflorescence is composed of round congested globose heads. In both species, the spikelets are few-flowered and there are no lodicules. In *O. stocksii* and in *D. strictus*, the palea is keeled and ciliate on the keels and the paleas of the upper flowers are not keeled. The stamens have short-apiculate anthers and free filaments. Another important character is the vestiture of style and stigma. In both species, the style is sparsely cliliate and ends in a single feathery stigma. In *O. stocksii* and other species of the genus *Dendrocalamus* the basal nodes bear aerial roots.

Oxytenanthera stocksii can easily be separated from *Dendrocalamus strictus* by the distinct auricles and bristles in the culm sheath, comparatively large leaves (15-22 x 1.5-2.5 cm), slender spikelets, slightly apiculate anthers with short filaments, elongated ovary, and oblong caryopsis.

Dendrocalamus strictus (Roxb.) Nees Von Esenbeck, Linnaea 9(4):476.1835 (**Plate 11**, **Figures 3** & **4**); Munro, Trans. Linn. Soc. London 26:147.1868; Beddome, Fl. Sylv. S. India 3:235.1873; Gamble, Ann. Roy. Bot. Gard. Calcutta 7:78.1896; & in Hook. f., Fl. Brit. India 7: 404.1896; Brandis, Indian Trees 675.1906; Bourd., Forest Trees Travancore 401. 1908. Talbot, For. Fl. Bombay Pres. Sind. 2: 567.1912; Rama Rao, Fl. Pl. Travancore 446, 448. 1914; E. G. Camus, Les Bamb. 152.1913; Blatt., Indian For. 55(11):593. 1929; Fischer in Gamble, Fl. Pres. Madras 3:1858.1934; Holttum, Bam. Mala. Penin. Gar. Bull. xvi: 98.1958; Bennet & Gaur, Thirty Seven Bam. Growing India 61.1990; Tewari, Monogr. Bam. 77.1992; Stapleton, Edinb. J. Bot. 51(1):26.1994; S. Dransf. & Widjaja, (eds.) Plant Resources S.E. Asia 7:93.1995; Seethalakshmi & M. Kumar, Bamb. India Comp. 129.1998; Ohrnberger, Bamb. World 291.1999 .

Type: South India, Andhra Pradesh, Godaveri district, Devipatanam *CA Barber 4929,* 27.11.1902, Neotype MH (selected here).

Bambos stricta Roxb., Plants Coromandel Coast 1, 58.1798.

Bambusa stricta (Roxb.) Roxb., Hort. Beng. 25.1814.

Nastus strictus (Roxburgh) Smith in A. Rees The Cyclopaedia or Universal dictionary of arts, science and literature 24 (2):11.1819.

Dendrocalamus sericeus Munro, Trans. Linn. Soc. London 26: 148. 1868; Gamble, Ann. Roy. Bot. Gard. Calcutta 7: 81.1896 & in Hook. f., FI. Brit. India 7: 404.1896 ;Tewari, Monogr. Bamboo 74.1992.

A medium sized, caespitose, gregarious, densely tufted, deciduous bamboo with erect strong culms. Rhizome sympodial, pachymorph, solid and with short necks.

Culms erect, strong self supporting, height varies under different climatic conditions, 8-15m tall, slightly arched at the top; node faintly swollen, sheath scar prominent, nodal ridge clear, aerial roots arise from the basal nodes, lower nodes often bear branches; internodes 20-35cm long, 4-7cm diameter, short, yellowish green, long, sparsely covered with white powdery mass when young smooth and yellowish when old, wall very thick, sometimes solid; culm sheath 12-22cm long, 4-6cm broad at base, coriaceous, covered with golden brown hairs when young, striate papery, glabrous, deciduous when old, tip truncate, auricle, very short, aural setae represented by short hairs, deciduous; blade erect, almost triangular, 5-8cm long, 2-3.5cm broad at base, smooth, persistent; inner ligule 0.1-0.2cm long, outer ligule inconspicuous. Branches arise from the lower nodes, the central primary branch become dominant, strong, 3-4 laterals develop from it's base, rebranch, branches of the upper nodes are long, drooping, extravaginal; leaves arise on branches, linear-lanceolate, 7-24cm long, 1-

Plate 11. *Dendrocalamus strictus* (Roxb.) Nees **A.** & **B.** Habit; **C.** Culms; **D.** Culm sheath; **E.** Flowering branch

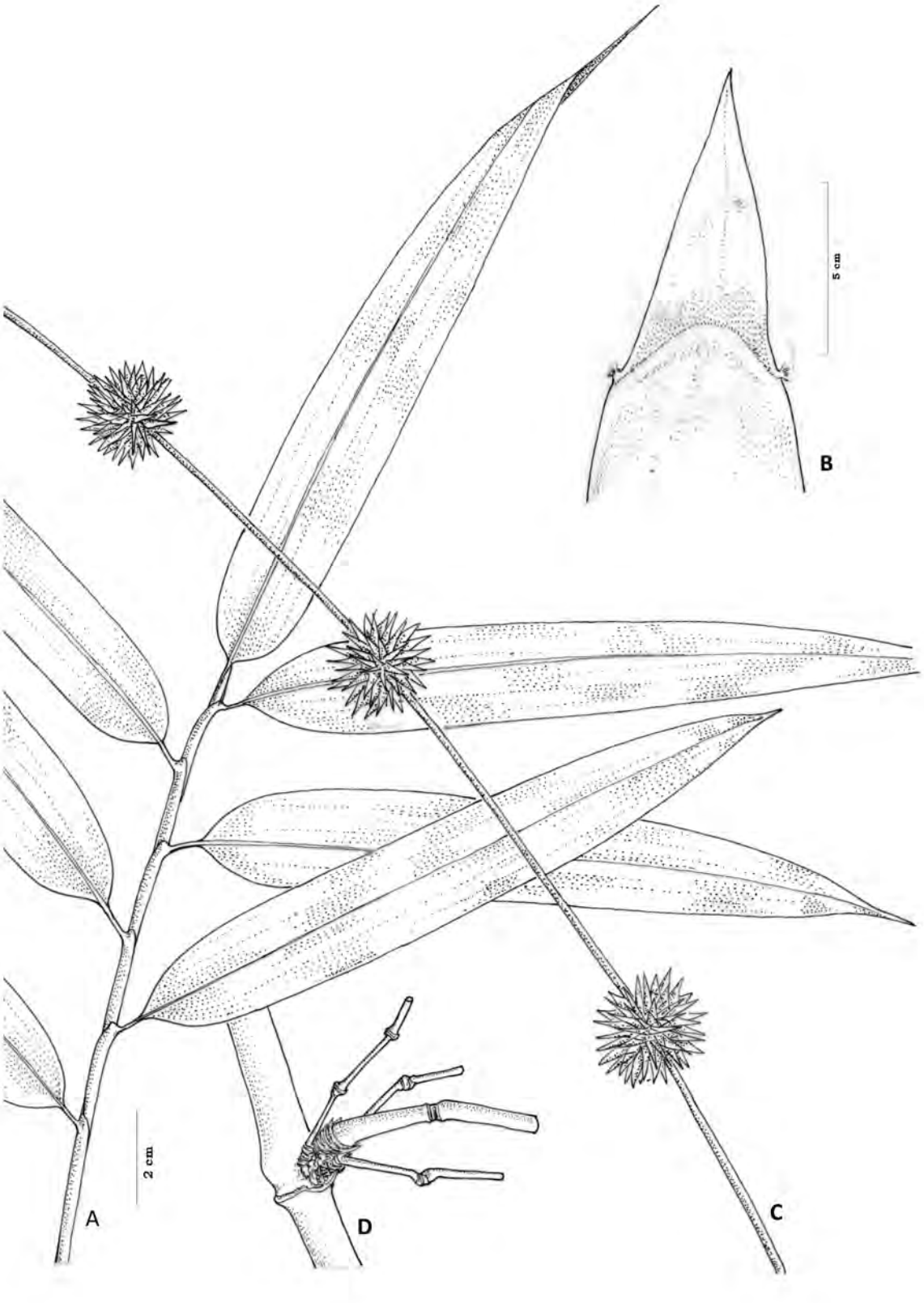

Figure 3. *Dendrocalamus strictus* (Roxb.) Nees **A.** Leafy branch; **B.** Culm sheath; **C.** Inflorescence; **D.** Branching

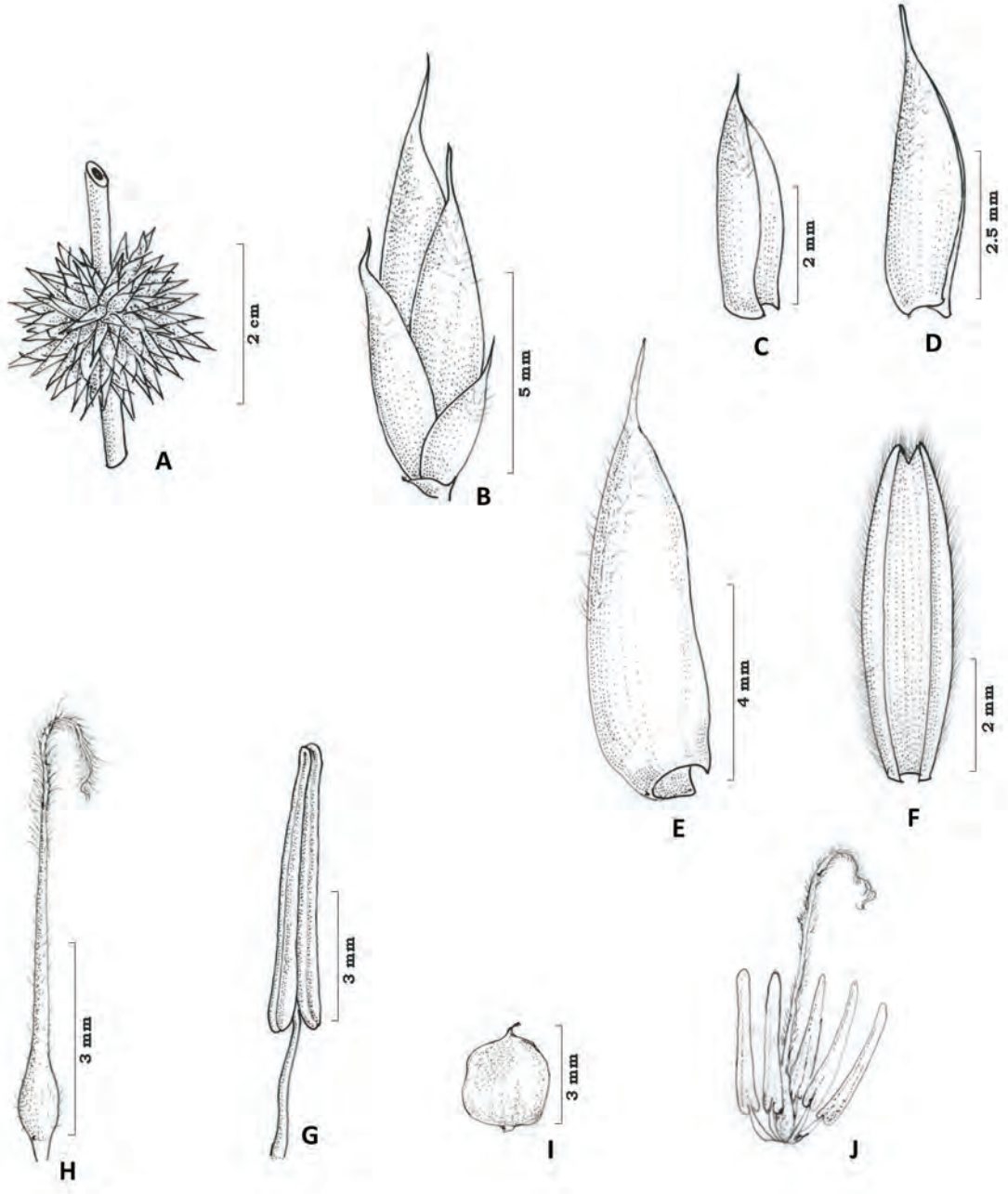

Figure 4. *Dendrocalamus strictus* (Roxb.) Nees **A.** Portion of inflorescence; **B.** Spikelet; **C.** & **D.** Sterile glumes; **E.** Lemma; **F.** Palea; **G.** Stamen; **H.** Ovary with style; **I.** Fruit; **J.** Open floret (diagramatic)

2.4cm broad, dorsal surface rough and hirsute, lower side softly hirsute, scabrous along the margins, midrib prominent on the lower side, pellucid dots present on the lamina, tip acuminate, base attenuate to a short petiole, leaf sheath overlapping, hirsute when young, striate, lateral sides at the tip projecting to a prominent callus, ligule inconspicuous; auricle short, ciliate. Inflorescence a large, leafless branching panicle with dense globular heads, rachis rounded, smooth, heads supported by striate, ovate-lanceolate, deciduous bracts; spikelets 0.8-0.1cm long, ovate, 2-3-flowered, hirsute, sharply spinosus, fertile and sterile ones intermixed; sterile glumes 2, hirsute, ovate, spiny, 0.4-0.5cm long, many nerved, fertile glumes, lemma 0.7-0.8cm, ovate-lanceolate, strongly spinescent, hirsute; palea 0.6-0.7cm long, ovate, 2-keeled, ciliate on the keels, emarginate, convolute, palea of the uppermost flower not keeled; lodicules absent; stamens 6, free, filaments long, anthers short, 0.6-0.7cm long, exserted, slightly apiculate; ovary ovoid, short stalked, hirsute, narrowed upward in to a style; style 0.5-0.6cm long, ciliate, stigma single, feathery. Fruit a caryopsis, reddish-brown, obovate, beaked with persistent base of the style.

World distribution: Bangladesh, India, Myanmar and Thailand.

Cultivated in Sri Lanka, Malaysia, Indonesia, Philippines and Vietnam.

Habitat and distribution: This is one of the predominant bamboo species naturally occurring in semi dry and dry zone along plains and hilly tracks usually up to an altitude of 1000m. It grows in well-drained, poor, coarse, grained and stony soils. It is a drought resistant species and can grow under extreme dry climatic conditions as in Tamil Nadu and Andhra Pradesh. It is also seen growing as a component of dry and moist deciduous forests. It is one of the most common bamboos in India predominantly found in Uttar Pradesh, Madhya Pradesh, Orissa, Andhra Pradesh, Karnataka, Kerala and Tamil Nadu.

Specimens examined: Arunachal Pradesh: Mandi, Alt. 1000ft., 19th June 1958, *M. A. Rao,* 5746 (DD); Himachal Pradesh: Near Punjab, Kalka, 14th November 1959, *T. A. Rao* 10875 (DD); Near Kalka, 3rd March 1961, *M. A. Rao* 14549 (DD); Hathi pani, Corbet National park, *P. C. Panth* 43758 (DD); NWF, Sikarambus Dist., Alt.3000ft., January 1891, *J. S. Gamble* 22531(DD); Kahlae state, Kusal Forest, 26th December 1892, *J. N. Lace,* 706 (DD); Jammu & Kashmir: Panal, 9th August 1986, *P. K. Hajra* 82342 (DD); Karnataka: Shangerim, Jan. 1903, *Shaik Makm* 1114 (BSI); North Kanara, Dauddi, 17th March 1950, *J. Fernandes* 1061 (BLATT); National Park Borish January 1954, *K. K. Fernandes* 1750 (BLATT); North Kanara, Nagargali forest, 20th March 1951, *J. Fernades* 2287 (BLATT); Kerala**:** Malappuram Dist. Nilambur, *N. Unnikrishnan* 74106 (CALI);

Palakkad, Nelliampathy, Kaikatty, 8th September 1995, *Stephen* 7593 (KFRI); Parambikulam, 17th September 1999, *Basheer* 207722 (KFRI); Maharashtra: Nagpur, January 1901, *G. Smith s.n.* (DD); Chota Nagpur, December 1890, *J. S. Gamble* 8807 (DD); Punjab: Kalka 14th November 1959, *T.A. Rao* (BSI, DD); Hashipur dist., Talwara, 4th September 1977, *J. N. Vohra* and *P. Daniel* (DD); Punjab, Hosarinpur, Brindhaban, 24th April 1972, *O. P. Misra* 47150 (DD); Uttar Pradesh: Garwal, Katdwan, 26th February 1960, *D. N. Vohra* 10663 (DD); Dehra Dun, 10th April 1964, *C. R. Babu* 34962 (DD); Kumaon, Tanakpur, *U. C. Bhattacharya* 20400 (DD); Dehradun, Kaulvi Garden, 13th June 1922, *R. N. Parker s.n.* (DD); Corbet National Park, Dhikala Road, Kalagarh Division, Alt. 325m., 15th December 1972, *K. P. Janardhanan* 51472 (DD).

Local names: Bans (Hindi); Karail (Bengali); Myin-wa (Burmese); Kllan mula, Kurathi mula (Malayalam). Kanka kara, Sandapa veduru (Telungu)

Uses: Due to the very narrow lumen of the culm it is used for the manufacture of umbrella handles, knife handle, etc. Culms are also used as pillars. It is extensively used as a raw material in paper mills and also for variety of purposes such as construction, agricultural implements, furniture, etc. Young shoots and seeds are edible. Decoction of leaves, nodes and siliceous matter (bamboo manna) are used in the traditional medicine. The rhizomes are useful in bamboo sculpture work.

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, 1994). Therefore, neotypification is essential for *D. strictus.* Barber (1902) collected *D. strictus* from Devipatanam, Godaveri district, Andhra Pradesh. These specimens were deposited at MH. Roxburgh's description of *D. strictus* was based on the collections from the Coromandel Coast. During this study, the specimens kept at MH were critically verified and found that they are most suitable for neotypification.

Dendrocalamus sericeus is similar to *Dendrocalamus strictus* in vegetative and floral characters and this species could not be relocated after the type collection. Comparative studies and illustrations revealed that this species is a geoclimatic varient of *D. strictus* and hence synonymised under *D. strictus.*

The species so far recognized under this genus is lacking a complete descriptions and the herbarium representation is also inadequate therefore, all such species are listed under a

separate group as imperfectly known taxa.

Imperfectly known taxa

Dendrocalamus collettianus Gamble, Ann. Roy. Bot. Gard. Calcutta 7:93. 1896 (**Plate 12**); Varmah and Bahadur, Indian For. Rec. (n.s.) Bot. 6 (1): 3. 1980; Tewari, Monogr. Bamboo 60. 1992.

Type: Upper Myanmar, Fort Stedman Abul Huck *s. n.* (Isotype CAL) .

Dendrocalamus parishii Munro, Trans. Linn. Soc. London 26: 149. 1868; Gamble, Ann. Roy. Bot. Gard. Calcutta 7:93. 1896 and in Hook. f., Fl. Brit. India 7:408. 1896; Camus, Les Bamboos 156. 1913; Tewari, Monogr. bamboo 70.1992.

Dendrocalamus hookeri Munro var. *Parishii* (Munro) Blatter, Indian For. 55: 594. 1929; Varmah and Bahadur, Indian For. Rec. (n.s.) Bot. 6(1): 3. 1980.

Note: This species was known by inflorescence and represented by a single collection. Further critical evaluation is required for confirming the identity and occurrence of this species.

Oxytenanthera Munro

The genus *Oxytenanthera* was proposed by Munro in 1868 based on an African bamboo *Oxytenanthera abyssinica* which was formally treated under the genus *Bambusa*. Munro (1868) described 5 species under this genus namely *O. abyssinica*, *O. nigrociliata*, *O. albociliata*, *O. thwaitesii* and *O. stocksii*. Gamble (1896) gave three addition to Munro's *Oxytenanthera* by describing *Oxytenanthera sinuata*, *O. parvifolia* and *O. bourdillonii*. The genus was widely accepted by subsequent authors like Bourdillon (1908), Talbot (1912), Camus (1913) and Blatter (1929).

The genus *Oxytenanthera* is characterised by the nature of pseudospikets in semi-verticelate clusters, keeled palea, hollow, hairy style with three stigmas and monadelphous stamens. Holttum (1956) described the characteristic ovary structure in the type species of the genus *O. abyssinica*. According to Holttum the hairy top and the ovary attenuates upwards very gradually into a more or less three angled hollow style, which bears the stigma at its apex. Based on the ovary structure, Holttum also maintained that *O. abyssinica* is a native bamboo of Africa owing to the charecteristic ovary structure and suggested it as a distinct mark of the genus *Oxytenanthera.* He suggested that Asiatic species are to be treated either under

Plate 12. *Dendrocalamus collettianus* Gamble- Isotype (CAL): An imperfectly known taxa

Dendrocalamus or *Gigantochloa*. Clayton and Renvoize (1986) and Widjaja (1987) have supported this view. While working on the bamboos of Sri Lanka, Soderstrom and Ellis (1988) conducted critical studies on the *Oxytenanthera thwaitesii* Munro and pointed out that due to the feature of the spikelets such as, capitate clusters, elongate, pubescent style, 6 stamens and lack of lodicules allies this species to *Dendrocalamus*, but the unique branching pattern and vine-like nature of culms keeps it apart. The large central bud remains dormant with simultaneous production of numerous basal branches, the bud breaks through the hard sheath or pushes it off during its development. They concluded that the comparable characters with the genera like *Dendrocalamus*, *Bambusa,* and *Gigantochloa* are inadequate and therefore, separated all the species from the genus *Oxytenanthera* Munro. Comparing with *O. abyssinica* (A. Richard) Munro and other Asiatic species of *Oxytenanthera* they erected a new genus *Pseudoxytenanthera* to accommodate the *Oxytenanthera thwaitesii* sensulato. The specific epithet *thwaitesii* is less prior to the specific epithet 'monadelphous', which was used by Thwaites in 1864. While preparing an enumeration of Sri Lankan plants, Soderstrom and Ellis (1988) proposed a new combination as *Pseudoxytenanthera monadelpha* (Thwaites) Soderstrom & Ellis. Majumdar (1989) in his enumeration of Indian bamboos independently came to the conclusion that Indian species of *Oxytenanthera* differ from the original generic concept and he treated these genera under a new genus *Pseudotenanthera*. Naithani (1990) considered it as a superfluous name and treated it as a synonym of *Pseudoxytenanthera* Soderstom and Ellis and proposed four new combinations such as, *Pseudoxytenanthera monadelpha, Pseudoxytenanthera ritchiei, Pseudoxytenanthera stocksii* and *Pseudoxytenanthera bourdillonii.* The transfer of *Oxytenanthera monadelpha* under new genus *Pseudoxytenanthera* by Sodertrom and Ellis (1988) was supported by subsequent authors (Tewari 1992, Kumar 1998, Ohrnbeger 1999). The transfer of the remaining species of *Oxytenanthera* under the genus *Pseudoxytenanthera* was pointed out by Sharma (1996) and accepted the generic concept of *Pseudoxytenanthera* sodertrom and Ellis owing to the typical braching pattern exhibited by the type species *O. monadelpha* and considered it as monotypic. Sharma, (1996) supported the conclusion of (Groser and Liese, 1973) that the assessment of the distinctiveness of the ovary character of *O. abyssinica* was possibly wrong and these observations needed a re-analysis. Based on the anatomical observation conducted by Groser and Liese (1973) and Pattanath and Rao (1969) in having a similar vascular bundle structure in *O. abyssinica* and *O. albociliata* generated an opinion that at least some species of *Oxytenanthera* do occur in Asia.

However, after the critical studies conducted on all the species described formerly under the genus *Oxytenanthera* from India revealed that, the generic character of *Oxytenanthera* is evidently applicable to only two species that are found in India, and presently treated under the genus *Pseudoxytenanthera* such as *P.monadelpha* the type species of *Pseudoxytenanthera* Soderstrom and Ellis and *P. bourdillonii*. Both the species possess pseudospikelets of semiverticillate clusters, 2-3 flowered spikelets, 2 keeled palea, monadelphous stamen, ovary with a pubescent hollow style with three stigmas. The type species of *O. abyssinica* also has the similar floral characters. It was also observed that the type species of the genus *Pseudoxytenanthera* do possess characteristic features in its branching as an adaptation to climb for the support. But all the floral characters and vegetative characters are similar to the *Oxytenanthera abyssinica*. Ohrnberger (1999) enumerated 12 species distributed in India, Bangladesh, Myanmar, Thailand, Laos, Kampuchea and Vietnam. Among these species, *Pseudoxytenanthera stocksii* possesses all the generic characters of *Dendrocalamus* and recently a new combination *Dendrocalamus stocksii* is proposed by Kumar *et. al.* (2004). With regard to the other species distributed in Western Ghats known under the genus *Pseudoxytenanthera* need to be transferred to *Gigantochloa* or *Dendrocalamus*. In the present treatise, only two species *O. bourdillonii* and *O. mondelpha* is considered under the genus *Oxytenanthera*. A comparative account of the two species with *O. abyssinica* is given in Table-3.

Morphological characters

Habit and Habitat: A bamboo with densely tufted culms arising from sympodial rhizomes and is erect or straggling and shows a tendency to climb on the neighbouring trees. Generally found growing along the ecotone of the evergreen forests.

Culms: The culm at first, stout and erect in *Oxytenanthera bourdillonii*, becoming thin and whip-like at the tip and arching over neighbouring trees in *O. monadelpha,* respectively. The walls are relatively thick. Nodes contain a single broadly ovoid to round bud with a glabrous prophyllum.

Branching: Branches arise from all nodes except the lowest ones. The secondary axes develop clusters of short branches that push away the sheath or break through it at the base, the primary axis remain dormant in bud stage or germinate to produce a new culm or long whip-like branch. Branch initiate from about 4^{th} - 6^{th} nodes onwards.

Table 3. Comparison of the characters of *Oxytenanthera abyssinica*, *O. bourdillonii* and *O. monadelpha.*

Characters	***O. abyssinica***	***O. monadelpha***	***O. bourdillonii***
Culms	Erect	Straggling or semiclimbing	Erect
Culm surface	Glossy, wax thin	Glossy, wax thin	Wax furry
Culm wall thickness	Thin walled	Moderately thick walled	Thin walled
Culm sheath auricle	Small and rudimenary	Well developed with oral setae	absent
Spikelets	1-3 flowered	1-3 flowered	2-3 flowered
Lemma	Sparsely hair	Glabrous	Glabrous
Palea	2-keeled	2-keeled	2-keeled
Apex of anthers	apiculate	apiculate	apiculate
Filaments	Monadelphous	Monadelphous	Monadelphous
Stigma	Divided in to three	Divided in to three	Divided in to three

Culm sheath: The culm sheath possess well-developed auricles with auricular setae, blade ligule and culm sheath proper or body of the culm sheath with few black stiff hairs. Sheath is generally hard and brittle, pushed off by the emerging branches, abscissile from a thickened persistent band, the lower part covering the bud, blade deciduous, horizontal or reflexed in *Oxytenanthera monadelpha.* Culm sheath lacking a distinct auricle and auricular seatae in *O. bourdillonii.*

Leaves: The leaves pseudopetiolate with leaf sheath and leaf blade. Blade glabrous linear-lanceolate, tip narrow to acuminate.

Inflorescence: Semiverticillate clusters of pseudospikelets terminating leafy branches. Pseudospikelet sessile.

Spikelets: 2-3 flowered, obovate, lanceolate, slightly curved at tip consisting of 2 empty glumes. Lamina glabrous, palea thin, 2-keeled with 3 nerves between the keels, lodicule 9, stamen 6, filaments fused, anthers apiculate at apex; ovary glabrous, fusiform with a thickened knob like summit narrowing into a long hairy style, remaining entire or divided into

3 stigmas.

Fruit: A caryopsis, plano convex, more or less fusiform.

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; Gamble in Hook. f., Fl. Brit. India 7: 400. 1896; Brandis, Indian Trees 673. 1906; Bourd., Forest 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; Fischer in Gamble, Fl. Pres. Madras 3: 1860. 1934; Soderstr. & R.P. Ellis in Soderstr. *et al*., (eds.) Grass Syst. Evol. 235. 1987; Clayton & Renvoize, Kew Bull. Addl. Ser. XIII, 56. 1989; Seethalakshmi & M. Kumar, Bamb. India Comp. 203. 1998; Ohrnberger, Bam. World 309. 1999.

Type :*Oxytenanthera abyssinica* (A. Rich) Munro (**Plates 13** & **14**)

Pseudoxytenanthera Soderstrom & Ellis in Smithson. Contr. Bot. 72: 52.1988

Pseudoxytenanthera monadelpha (Thwaites) Soderstrom & Ellis; *Pseudoxytenanthera* (Thwaites) R.B. Majumdar in S. Karthikeyan *et al.*, Fl. India Enumer. Monocotyl. 280.1989.

Pseudoxytenanthera monadelpha (Thwaites) R.B. Majumdar

Medium or small sized bamboo, rhizome sympodial, sometimes with long necks. Culms erect, hollow, thick walled or sometimes solid, branching, the primary axis is prominent with few secondary branches. Inflorescence indeterminate with pseudospikelets, form spicate, globose clusters, sometimes the spikelet condensed in to a capitulum at the branch tip; spikelets long, narrow, 1-2-flowered, usually rachilla extension not present; lodicules none; stamens 6, monadelphous; ovary ovoid, stigmas 1 or 3, plumose. Fruit, a caryopsis.

The genus *Oxytenanthera* is distributed in Africa, Sri Lanka and India. The type genus *O. abyssinica* is found in tropical Africa. In India, two species are distributed. Among which one species is endemic to southern Peninsular India and the other species is found both in south India and Sri Lanka. They are found growing from sea level to an altitude of 1500 m.

Key to the species *Oxytenanthera* in India

1a. Culms erect self supporting up to 20 m tall culms sheath auricle and bristils absent blade broad; spikelets few, not congested..... *O. bourdillonii*

1b. Culms straggling supported by adjoining trees up to 12 m tall, culm sheath with well

Plate 13. *Oxytenanthera abyssinica* Munro - Type

Plate 14. *Oxytenanthera abyssinica* Munro - Type

developed auricles and bristles blade narrow; spikelets many highly congested..... *O. monadelpha*

Oxytenanthera bourdillonii Gamble, Ann. Roy. Bot. Gard. Calcutta 7: 76.1896 (**Plates 15** & **16**, **Figures 5** & **6**); Gamble in Hook. f., Fl. Brit. India 7: 403 .1896; Camus, Les Bambusees 149.1913; Varmah & Bahadur, Ind. For. Rec. (n.s.) Bot. 6(1): 4.1980.

Type: Travancore, J.F. Bourdillon *s.n*. (Lectotype K Selected here, Isolectotype CAL - selected here).

Pseudoxytenanthera bourdillonii (Gamble) R.B. Majumdar in Karthikeyan *et al*., Fl. Ind. Enumer. Monocotyl. 280 1989.

Pseudoxytenanthera bourdillonii (Gamble) H.B.Naithani, J. Bombay nat. Hist. Soc. 87: 440.1990; Tewari, Monogr. Bamboo 124.1992.

Seethalakshmi & M. Kumar Bamb. India Comp. 222 .1998.

Ohrnberger, Bamb. World Introd. Ed. 4: 20.1997; Ohrnberger, Bamboos World 311.1999.

Arborescent, straggling bamboo forming loose, open culms, rhizome sympodial, pachymorph, very thick, solid, neck slightly long; culms erect, self supporting, hollow, 15-20 m tall; node not swollen, marked by a nodal ring and a single nodal bud enclosed by prophyllum; internodes 40-60 cm long, 6-14 cm diameter, pale green, smooth, densely covered with white powdery mass when young; culm sheath 15-36 cm long, 13-32 cm broad at base, striate, coriaceous, golden yellow, hirsute at base, covered with white powdery mass when young, provided with curious calluses, tip round; blade foliose in young shoots, almost vertical to the main axis, triangular with sharp mucronate tip, glabrous, 6-12 cm long, 12-18 cm broad at base, stiff, coriaceous in mature culms, base broad, ear-shaped or winged, the wing rounded, entire, recurved, decurrent and run the entire, upper edge of the sheath; inner ligule 0.4-0.6 cm high, membranous, faintly serrate, outer ligule not prominent; branches arise from the upper nodes, just above the nodal line, extravaginal, the central primary axis develops first and become dominant, numerous secondary branches, develop from its basal buds, the mature branches rebranch form their lower nodes; leaves arise on branches and branchlets, 10-25 cm long, and 1.5-3.8 cm broad, lanceolate, dorsal and ventral side glabrous, one of the margins and midrib region, scabrous, midrib prominent in the lower side, tip acute-acuminate, setaceous, base attenuate, narrowed to a short petiole, secondary veins not clear, leaf sheath imbricate, thin, papery, sparsely hirsute, striate, keeled, the tip on each side of the

Plate 15. *Oxytenanthera bourdillonii* Gamble **A.** Habit; **B.** Culms; **C.** Culm sheath; **D.** New shoot; **E.** Inflorescence

Figure 5. *Oxytenanthera bourdillonii* Gamble **A.** Leafy branch; **B.** Culm sheath; **C.** Inflorescence

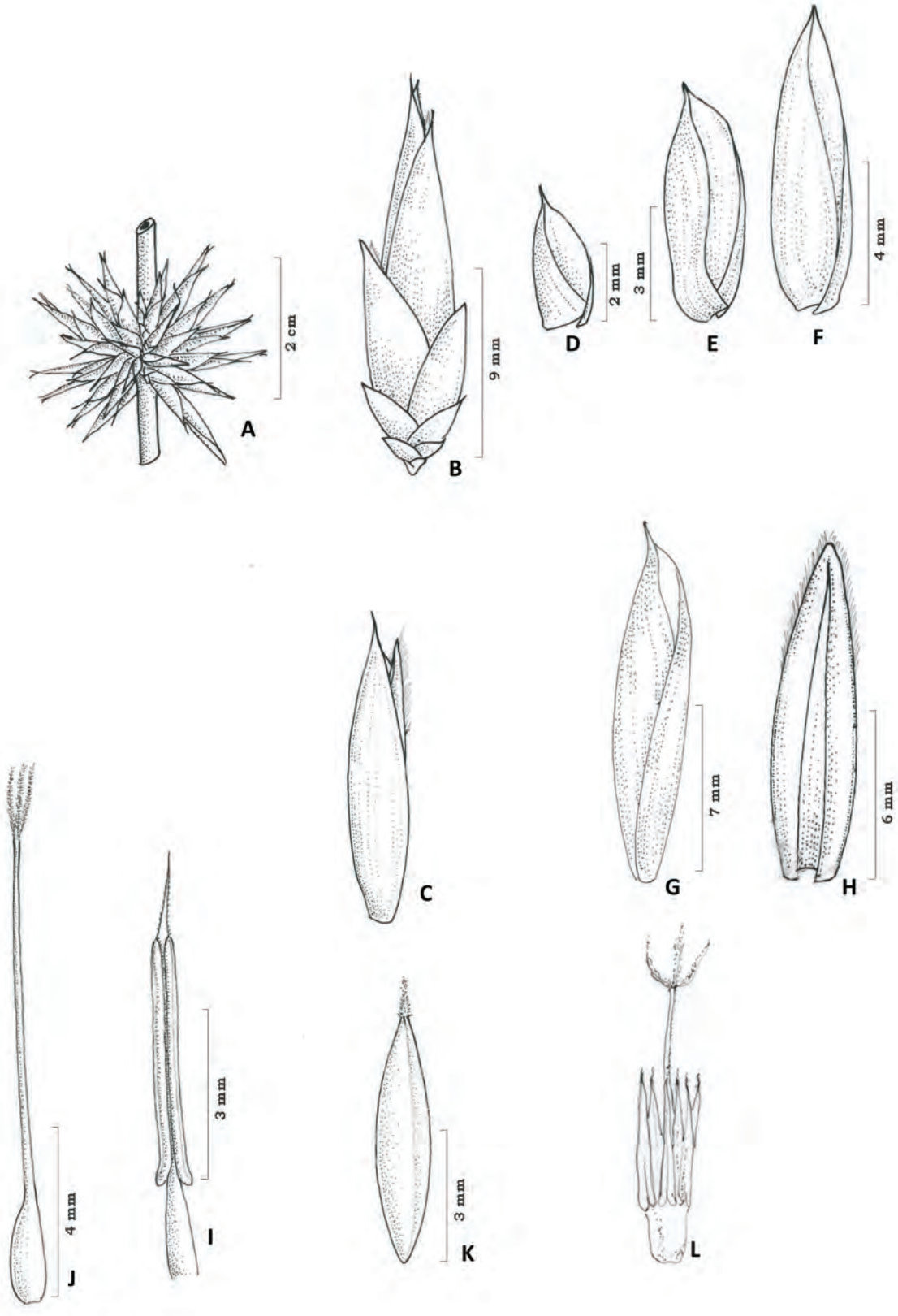

Figure 6. *Oxytenanthera bourdillonii* Gamble **A.** Portion of inflorescence; **B.** Spikelet; **C.** Floret; **D., E.** & **F.** Sterile glumes; **G.** Lemma; **H.** Palea; **I.** Stamen; **J.** Ovary with style; **K.** Fruit; **L.** Open floret (diagramatic)

Plate 16. *Oxytenanthera bourdillonii* Gamble - Lectotype (K)

petiole form raised callus; auricle not prominent, oral setae absent; inner ligule 0.1-0.2 cm high, serrate, outer very short. Inflorescence a large panicle bearing semiverticellate heads of spikelets on leafy branches, composed of pseudospikelets, arise on the nodes of branches; spikelets 3-flowered, ovate-lanceolate, glabrous, shining, 1.2-2 cm long, 0.2-0.3 cm broad, almost sessile, supported by 2 bracts at the base; sterile glumes 3, ovate to ovate-lanceolate, mucronate, glabrous, many nerved, first one ovate, 0.3-0.4 cm long, second ovate, 0.4-0.6 cm long, third ovate-lanceolate, 0.6-0.9 cm long; fertile glumes lemma, ovate-lanceolate, membranous, 1.2-1.4 cm long, 0.2-0.3 cm broad, glabrous, mucronate, many nerved; palea thin, membranous, oblong, tip almost retuse, 2- keeled, 3-nerved between the keels; keels strongly ciliate, palea of the terminal flower is not keeled, grooved, ciliate along the groove; lodicules absent; stamens 6, monadelphous, exerted, anthers 0.6-0.7 cm long, apiculate, tip ciliate; ovary ciliate, ovate, surmounted by a style; style 1-1.2 cm long, ciliate, tip divide to form 3 plumose stigma. Fruit, a caryopsis, elliptical, one side sulcate, shortly beaked by the persistent base of the style.

Specimens examined: INDIA: Kerala, Travancore, 1889, *T. F. Bourdillon s.n.* (K, CAL); Travancore 24th March 1893 *T. F. Bourdillon s.n* (K). Thrissur dt. Sholayar, Alt. 850m 8th February 1985, *Seethlakshmi s.n.* (KFRI); Palakkad dt. Nelliampathy, Ranimedu, *M. Kumar and T. R. Viswakumar* 8869 (KFRI); Idukki dt. Kurisumala *J. Augustine* 13050 (CALI); Peerumede *N. Unnikrishnan* 74207 (CALI).

World distribution: India endemic to southern Western Ghats.

Habitat and distribution: This species is found growing on steep precipitous places and wet rocks of moist deciduous forests at an altitude of 750-1300m.

It is found endemic to southern Western Ghats. Distributed in Kerala part of Western Ghats (Kuttikkanum, Kumali, Kurisumla, Meenmutty, Mukkali, Nilambur, Nelliampathy, Odalapara and Vazhachal).

Local names: Arambu, Arayambu, Kumam, Vellimula (Malayalam) Ponmugil.

Uses: culms are used for making toothpicks. The mature culms are useful in house construction, honey bottles and baskettary. Rhizome and culm sheaths are used for making handicrafts.

Oxytenanthera monadelpha (Thwaites) Alston Trimen, Suppl. Fl. Ceyl. 6: 342.1931 (**Plates 17** & **18**, **Figures 7** & **8**); Fischer in Gamble, Fl. Pres. Madras 1861.1934; Varmah & Bahadur, Ind. For. Rec. (*n.s.*) Bot. 6(1): 4.1980; Tewari, Monogr. Bam. 124.1992.

Type: Sri Lanka, Ambagamuwa, Dec. 1854 C. P. 3359 (lectotype PDA, selected by Soderstrom & Ellis, 1988; Isotypes US, MH).

Pseudoxytenanthera monadelpha (Thwaites) Soderstrom & Ellis in Smithson. Contr. Bot. 72: 52.1988; H. B. Naithani, J. Bombay nat. Hist. Soc. 87: 440.1990; Tewari, Monogr. Bamboo 124.1992; Seethalakshmi & M. Kumar Bamb. India Comp. 221. 1998; Ohrnberger, The Bamboos of the World 312.1999.

Dendrocalamus monadelphus Thwaites in Thwaites & J. D. Hooker, Enum. Pl. Zeyl. 376 . 1864.

Oxytenanthera thwaitesii Munro, Trans. Linn. Soc. London 26: 129. 1868; Gamble, Ann. Roy. Bot. Gard. Calcutta 7: 64.1896; Gamble in Hook.f. Fl. Brit. India 7: 402. 1896.

Pseudoxytenanthera monadelpha (Thwaites) R. B. Majumdar in S. Karthikeyan *et. al*., Fl. India Enumer. Monocotyl., 280.1989.

Medium sized, semi climbing or straggling bamboo, forming loose clumps. Rhizome sympodial, pachymorph, solid, neck slightly long, covered with scale leaves. Culms erect, 7-10m tall, tip gradually become curved and whip like; node slightly swollen; sheath scar is very prominent forming a girdle; internodes 30-35cm long, 1.5-2.5cm diameter, dull green, hirsute, scabrous; culms sheath 15-25cm long, 7-11cm broad at base, purplish-green, coriaceous, margins ciliate, covered with bulbous based brown hairs when young, striate, brittle, abscissle, straw coloured, hirsute towards the base when old, tip truncate; blade reflexed, foliose, upper surface glabrous, lower side slightly hirsute, broad, acuminate, 7-12cm long, 1.2-3cm broad at base, base truncate, spreading and decurrent along the top of the sheath, deciduous when old; auricles very prominent, ear-shaped, falcate, with stiff bristles, oral setae numerous, persistent; inner ligule large, prominent in large sheaths, 0.5-1cm high, short in smaller sheaths, erose, outer ligule not clear; branches starts form the lower nodes, arise just above the sheath scar, extravaginal, branches numerous, forming semiverticillate clusters on the nodes, the primary bud remain dormant and numerous laterals, develop from its sides, sometimes the central axis become prominent, whip like similar to the main culm; leaves arise on branches, size highly variable, 4-32cm long, 0.5-3.2cm broad, linear-lanceolate, glabrous on both sides, margins rough and scabrous, tip acuminate, midrib prominent, base attenuate, narrows in to a short petiole, leaf sheaths

Plate 17. *Oxytenanthera monadelpha* (Thwaites) Alston **A.** Habit; **B.** Culms; **C.** New shoot; **D.** Inflorescence

Figure 7. *Oxytenanthera monadelpha* (Thwaites) Alston **A.** Leafy branch; **B.** Culm sheath; **C.** Inflorescence; **D.** Branching

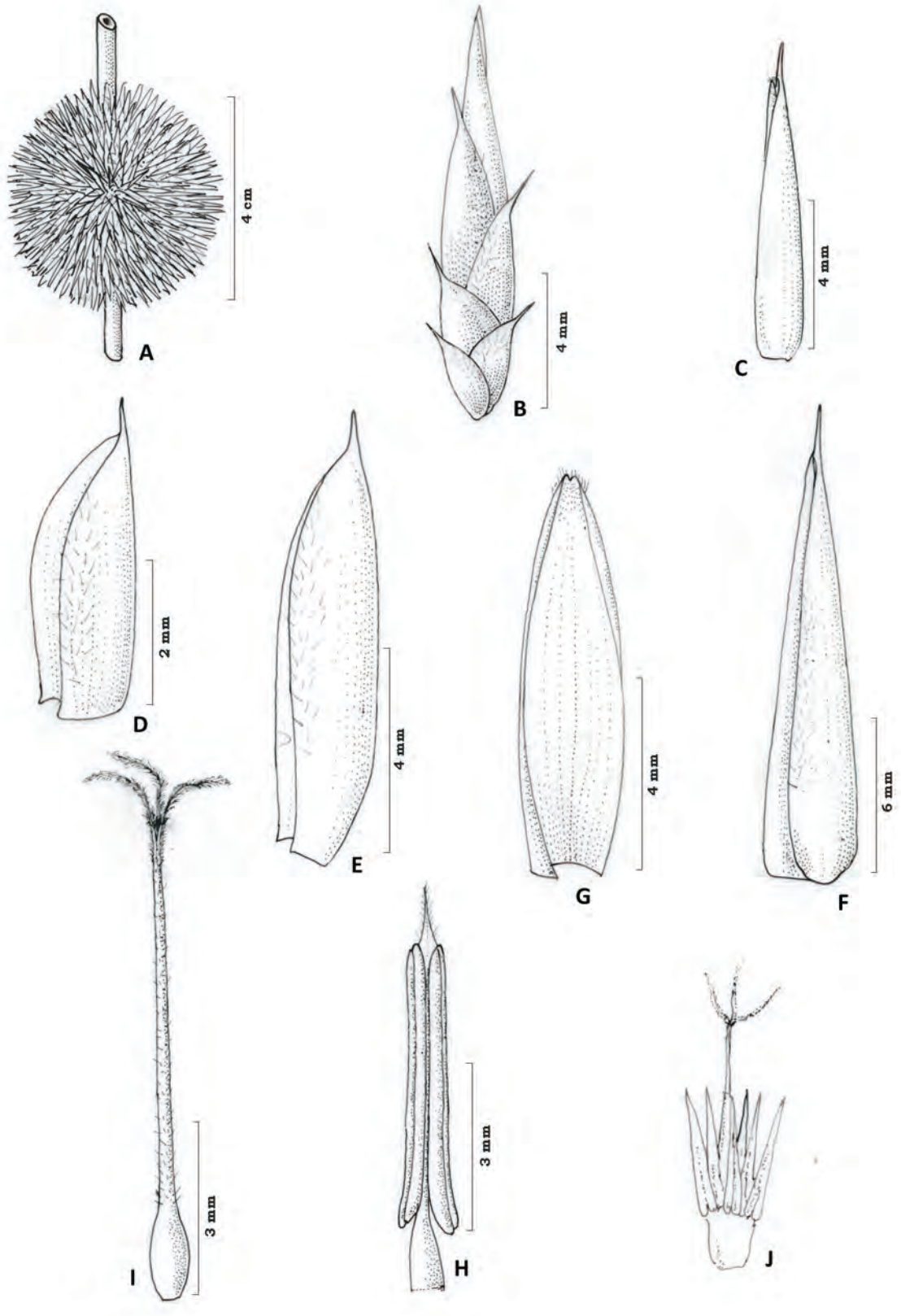

Figure 8. *Oxytenanthera monadelpha* (Thwaites) Alston **A.** Portion of inflorescence; **B.** Spikelet; **C.** Floret; **D.** & **E.** Sterile glumes; **F.** Lemma; **G.** Palea; **H.** Stamen; **I.** Ovary with style; **J.** Open floret (diagramatic)

Plate 18. *Oxytenanthera monadelpha* (Thwaites) Alston - Isotype (MH)

closely attached, overlapping, smooth, striate, straminous, keeled, tip ends in a callus; auricle prominent, falcate with stiff bristles, bristles deciduous; inner ligule prominent in mature branches, 0.4-0.5cm high, arose, membranous, outer ligule short. Inflorescence a large compound spicate panicle of semiverticillate clusters on leafy branches, spikelets arise on the nodes of all branches, composed of pseudospikelets form semiverticellate clusters or as very large globose heads, those at the ends of the branchlets are small; spikelets 1-3 flowered, ovate-lanceolate, acute, 1-1.4cm long, 0.2-0.3cm across, supported by two bracts, hirsute along the margins of glumes, the lower most develop first and dominate with reduction upwards; sterile glumes 2, stiff, coriaceous, mucronate, hirsute along the sides, first glume 0.4-0.5cm, ovate, second glume 0.6-0.8cm long, ovate-lanceolate; fertile glumes, lemma ovate-lanceolate, thin, 1-1.2cm, many nerved, strongly mucronate, ciliate along the sides and also the tip; palea thin, membranous, concave, 0.8-1cm long, two keeled, ciliate on the keels, convolute, slightly bifid, tip ciliate; lodicules absent; stamens 6, monadelphous, yellowish, exserted; anthers 0.5-0.6cm long, short, apiculate, ciliate at the tip. Ovary, glabrous, fusiform, style long, 0.8-1cm long, hairy; stigma 3, plumose. Fruit a caryopsis, 0.4-0.5cm long, thin, fusiform, scabrous, sulcate along one side, tip mucronate, hairy, pericarp dry.

Specimens examined: INDIA: Andhra pradesh: Kurnool Dist. Kurnool Forest, *R. H. Beddome s.n.* (MH); Karnataka: Chickmangalore Dist., Bababudan, *N. S. Adakoli* 156635 (DD); Kerala: Idukki Dist. Vellimala, *J. Augustine* 13334 (CALI); Munnar, *N. Unnikrishnan* 74022 (CALI); Munnar, Chokkanad, *N. Unnikrishnan* 74206 (CALI); Palakkad Dist. Mutthikulam *Stephan Sequiera & Michiale* 8821(KFRI); Sispara, *M. Remesh & Stephan* 20712 (KFRI); Wayanad Dist. Manantoddy, *Rodes Morgen s.n.* (MH); Mundakai, *Stephan Sequiera & Michiale* 8162 (KFRI); Tamil Nadu: Madura Dist. Highway Mountains, *Cheriyan Jacob* 17614 (MH); Nilgiris, *J. S. Gamble* 20642 (DD); *J. S. Gamble* 21450 (MH); Ochterlomy valley, *J. S. Gamble* 20531 (DD); Coonoor, *J. S. Gamble* 12155 (DD); Coonoor, *J. S. Gamble* 12165 (MH); Thirunelveli Dist. Thirunelveli, *Forest Ranger* 40544 (DD).

World distribution: India, Sri Lanka

Habitat and distribution: This species is generally found in ecotone of the evergreen forests particularly near streams or watercourse at an elevation ranging from 800 - 1800 m. found on hill slopes attaching with neighbouring trees as climber or straggler. This species is endemic to Southern India and Sri Lanka.

Local names: Eata, Illy, Valleeta (Malayalam) Watti (Tamil).

Uses: It is used for fencing and basket making. The semi solid culms are ideal for making walking sticks.

> *Note*: This species was considered as monotypic under the genus *Pseudoxytenanthera*. But this species agree with all generic characters of the genus *Oxytenanthera*. Munro transferred *Dendrocalamus monadelphus* to a new genus as *O. thwaitesii* and commented that "Roxburgh's drawing in the *Plants of the Coast of Coromandal* was undoubtedly of this species; but the description with which the drawing does not agree, was probably written at a later date, and is very nearly in the same words as those used in the *'Flora Indica'* ii. 193, for *Dendrocalamus strictus.* I have been unwilling to change Thwaites's specific name for this plant but as the whole genus have monadelphous stamens, it was no longer a distinctive one, and I have therefore, named it after the excellent botanist who first described the plant correctly". The specific epithet *'thwaitesii*' has been accepted by various authors like Gamble (1896) and Camus (1913).

Schizostachyum Nees Agrost. Bras. 534. 1829

The genus *Schizostachyum* was described by Nees Von Esenbeck in 1829 based on *Schizostachyum blumei*. Since then many species name were described from South China. While describing the genus, Nees (1829) briefly stated that the spikelet of the genus has one flower and several glumes. Nees's description was accepted by subsequent workers until Mc Clure (1934, 1966), redescribed and gave a broader view of the genus. He proposed the term pseudospikelet for the basic element of the infloresence in *Schizostachyum* (Dransfield, 1983). According to Mc Clure (1966) the pseudospikelet is used to distinguish a whole spikelet like ultimate branch of an indeterminate inflorescence from the spikelet proper that terminates it and consist of a prophyll at the base. One to several bract-like sheaths supporting the buds are spikelet. The buds enclosed in the bract like sheaths are known as gemmiparous bracts. The buds enclosed by these bracts later develop into other pseudospikelets.

The genus is characterised by sympodial rhizomes, erect or straggling, with thin walled culms, many branches of same length arising from the node, indeterminate inflorescence, absence of glumes in the spikelets, presence of lodicules, slender ovary with long, glabrous stiff style which is hollow around a central strand of tissue, anthers usually with blunt apex.

In *Schizostachyum* the spikelet has no glumes and consists of one or more florets with a

rachilla extension beyond the upper one bearing a very much-reduced floret. The glume like supporting sheaths is represented by gemmiparous bracts.

In some of the *Schizostachyum* species when there is only one floret in the spikelet, lemme and palea are usually rolled so that the spikelet is more or less cylindrical, slender and with a pointed tip. The palea is usually not distinctly 2- keeled or keels almost absent. In *S. grande* Ridl. and its allied species the palea is distinctly 2-keeled, rachilla- internodes are relatively long, and the lemma and palea are not rolled (Dransfield, 1983).

Dransfield (1983) recognized three groups for the genus *Schizostachyum*.

Group I - culm erect with a nodding tip and the culm sheath broadly triangular erect (E.g. *Schizostachyum brachycladum*, *S. gracile*).

Group II -The culm is usually erect with a drooping tip and the culm sheath long, narrow, deflexed or reflexed blade (E.g. *S. blumei* and *S. jaculens*).

Group III -The young culm erect but, when mature, leaves are with a broad base and tapering tip (E.g. *S. grande* and allied species).

The Genus Shizostachyum in India

The first species described under the genus *Schizostachyum* Nees from the Indian phytogeographic region was *Schizostachyum rogersii*. It was Brandis (1906) who described *S. rogersii* based on the specimen collected by Gillbert Rogers from Andaman Islands. Camus (1913) included this species in his book *Les Bambusaceae.* While working on the Flora of Andaman Islands, Parkinson (1923), also listed this species in his enumeration. This was followed by Blatter (1929). The presence or absence of the schizostahyoid bamboos in Indian subcontinent was interpreted and treated differently by several workers due to the misconcept regarding the generic characters of the other allied genera such as *Cephalostachyum*, *Teinostachyum*, and *Pseudostachyum*. The generic delimitation of the genus was studied in detail by Holttum (1958) and put forwarded some generic characteristics with regard to the treatment of the genera under the subtribe *Dendrocalameae*. He was not satisfied with Gamble's separation under this subtribe and the generic delimits of the *Teinostachyum* and *Cephalostachyum* were compared with species of *Schizostachyum* such as *S. branchycladum,* and *S. grande*. These taxa lack some of the generic characters of *Schizostachyum* and showed the characters like keeled palea, spikelet with more than one

flower. Therefore, Holttum (1958) brought forward a congeneric concept for *Scizostachyum* and other genera.

During the enumeration of the monocotyledonous plants of India, Majundar (1989) treated 15 species under *Schizostachyum* with 2 new species and one variety, which were formely treated under the genera like *Cephalostachyum*, *Teinostachyum*, *Pseudostachyum*. In his treatment Majumdar did not give any justification in support of the placement of other genera under the genus *Schizostachyum*. However, this concept was followed by subsequent authors such as Tewari (1992) and Seethalakshmi & M. Kumar (1998). The studies conducted by Dransfield (1983, 2000), revealed that the genus *Schizostachyum* could easily be separated from the other genera in the presence of indistinctly keeled palea, presence of gemmiparous bracts at the base of spikelets, semi verticallate clusters of the spikelets originating from the leafy branches.

Recently, two new species under the genus *Schizostachyum* were described from Andaman Islands (Kumar and Remesh, 2003). The present treatise reveals that the genus *Schizostachyum* in India is represented only by three species such as *S. rogersii*, *S. andamanicum* and *S. kalpongianum*. The remaining species formerly treated under this genus should be treated as different taxa.

Majumdar (1989) erected two species in his enumeration such as *S. manii and S. seshagirianum.* The species *Schizostachyum manii* was mentioned as *Bambusa khasiana* sensu Gamble which was published in Gamble's (1896) monumental work *Bambuseae of British India* (page 39 and plate 37). But the treatment of the species under this genus is totally erroneous because this specimen represented an abnormal growth of the culm sheath which resembled a culm sheath (probably attacked by a pathogen) and the flowering twings and illustrations of the ovary and style are of *Bambusa* species. Therefore, in the present report it is included under a separate category, wrongly assigned to *Schizostachyum.*

The species *schizostachyum seshagirianum* was erected based on a specimen deposited at CAL. The description is lacking in several details such as, floral and vegetative charecters. Therefore, it also cannot be treated under *Schizostachyum*. Naithani also described a species under *Schizostachyum* based on a sterile specimen. Critical studies on the specimen reveal that it has anffinity with the species of *Teinostachyum* or *Cephalostachyum* in vegetative condition. It is the floral characters that evidently support the generic character of

Schizostachyum and hence the vegetative details alone are not enough for recognising S. *arunachalensis* as a distinct species.

Key to the genera formerly treated under *Schizostachyum*

1.a Rhizome long necked; culms loosely arranged; spikelets slightly curved; lodicules 3-5; fruit a compressed globose caryopsis..... *Pseudostachyum*

1.b Rhizome short necked; culms closely packed; spikelets stright; lodicule strictly 3; fruit on ovate or oblong caryopsis.....2

2.a Culms always drooping, culm sheath lacking a distinct auricle; Inflorescence loosely arranged panicles; spikelet many flowered; caryopsis oblong..... *Teinostachyum*

2.b Culms always erect, rarely straggling, culm sheath with well-developed auricle; inflorescence closely packed, spikelet clustered; 1-2 flowered caryopsis ovate.....3

3.a Inflorescence densely crowded globose distinct clusters spikelet supported by glumes, gemmiparous bract absent, palea 2 -keeled distinct, caryopsis without a long prominent beak..... *Cephalostachyum*

3.b Inflorescence Pseudo spikelets of semi verticelate clusters spikelets supported by gemmiparous bracts, glumes absent; palea not keeled, Keels indistinct; caryopsis with a long prominent beak..... *Schizostachyum*

Morphological characters

Habit and habitat: The members under this genus generally form dense clumps with erect or straggling culms. In majority of the species the culms are erect as in *Schizostachyum brachycladum, S. blumei, S. pilosum* the culms are straggling in *S. andamanicum, S. kalpongianum, S. rogersii, S. gracile, S. cheilanthum etc.* The species are wild and spontaneous at low and medium elevations from the sea level to 1000 m in forest, clearings and also in the open field preferring humid conditions.

Rhizomes: The rhizomes are sympodial and short necked.

Shoots: New culms arise from the base of the old culm and are with attractively coloured sheaths, shoots are rich in nutrients.

Culm: The culms grow rapidly and most of the species have erect or scandant thin walled

culms, except *Schizostachyum caudatum* Backer ex Heyne. The surface of the young culm bears closely appressed white hairs. The culms are with narrow lumen in *S. caudatum*. Due to the thin walled nature of culms species such as *S. tenue*, *S. chilianthum*, *S. rogersii* and *S. andamanicum* show straggling or semi climbing habits.

Branching system: Branches sub equal, densely tufted at the nodes which arise mainly from upper nodes.

Culm sheaths: Culm sheath with broad or narrow, erect or reflexed blade, auricles small or rudimentary, some times conspicuous as in *S. auriculatum*, *S. gracile* always with slender curved bristles, ligule often with short fringe of hairs, or slender bristles.

Leaves: Leaves are linear lanceolate, 10-25 cm long and 1-2.5 cm wide, subsessile, surface smooth and glabrous; auricle inconspicuous, with or without bristles.

Inflorescence: Spikelets of semi verticillate clusters at the distal node of very slender more or less flexuous leafy branchlets. Each group has 6-10 spikelets. Pseudospikelets 10-14 mm long, lemma 8-9 mm long, one or two flowered, tightly rolled on the palea with a short spine like tip rather loosely enclosing the palea, palea similar to the lemma in texture, 10-12mm long, stamens usually 6; filaments usually free, in some species transitions between the stamens and lodicule may occur; lodicules usually present; ovary smooth, continued upwards into a gradually tapering stiff style, which is hollow around the central strand of tissue, terminating in to three short spreading stigmas, the style at flowering usually little longer than the palea.

Fruit: A caryopsis, smooth as long as the lemma, bearing stiff style at its apex. Seed more or less cylindrical, oblong or ellipsiod, separated from the thin pericarp.

Schizostachyum Nees von Esenbeck, Agcost. Brazil 535.1829; Gamble, Ann. Roy. Bot. Gard. Calcutta 7: 114.1896; Blatt. Indian For. 603-606.1929; Mc Clure, Lingnan Sci. J. 14(4): 575-602.1935; Mc Clure, Lingnan Sci. J. 15(2): 301-304.1936; Mc Clure, Taxon 6(7): 208.1957; Holttum, Gard. Bull. Singapore 16: 31.1958; S. Dransfield, Kew Bull. 38(2): 321.1983; R. B. Majumdar in Karthikeyan, S. *et al.* Fl. Indiae Enum. Monocot. 280.1989; N. H. Xia, J. Trop. Subtrop. Bot. 1(1): 1-10.1993; K. M. Wong, Bamboo. Peninsular Malaysia 163. 1995; Seethalakshmi and M. Kumar, Bamb. India Comp. 233.1998; Ohrnberger, Bamboo. World 330.1999.

Type: *Leptocanna chinensis* (Rendle) Chia & H.L. Fung Acta Phytotax. Sin. 19(2): 212.1981.

Schizostachyum subg. *Leptocanna* (Chia & H.L. Fung) N.H. Xia in J. Trop. Subtrop. Bot. 1(1): 5 .1993.

Schizostachyum chinense Rendle; *Schizostachyum* subg. *Schizostachyum* N.H. Xia, J. Trop. Subtrop. Bot. 1(1): 5 .1993.

Schizostachyum blumei Nees von Esenbeck; *Melocanna* Trinius, Sprengel, Neue Enta. 2: 43.1821.

Melocanna baccifera (Roxburgh) Kurz; *Teinostachyum* Munro in Trans. Linn. Soc. 26:143.1868.

Teinostachyum griffithii Munro; *Cephalostachyum* Munro in Trans Linn. Soc. 26: 138. 1868.

Cephalostachyum capitatum Munro; *Pseudostachyum* Munro in Trans Linn. Soc. 26: 141. 1868.

Pseudostachyum polymorphum Munro in Trans Linn. Soc. 26: 142. 1868.

Rhizomes sympodial. Culms erect to suberect, in one known species (*S. terminale*) clambering or climbing; internodes with pale appressed hairs all over and a white-waxy zone just below the node.

Culm sheaths with blades erect or spreading or reflexed, auricles lobe-like to rim- like and bristly on the margin. Buds, at each culm node, solitary. Mid-culm branch complement a cluster of slender subequal branches, in *S. terminale* the primary axis resembls the original culm. Leafy branches develop inflorescences along their apical portion and then succeed by new leafy branches from their proximal part, which flower and rebranch. Pseudospikelets short or long, sometimes several cm long, consisting of several small empty bracts, bracts subtending prophyllate buds, usually no transitional (empty) glumes, 1-2(-4) perfect flowers and 1-2 terminal vestigial flowers; rachilla internodes between flowers short or elongated, disarticulating below the lemmae; palea 2-keeled, often exceeding the lemma in length, apex distinctly bifid or sometimes acute; lodicules 3 (abnormally I, or 4 to 5), margins hairy; stamens 6, filaments free or (in some species) fused into a tube, anther apices emarginate or apiculate (the connective prolonged beyond the anther apex); ovary slender-ovoid, glabrous, gradually narrowing upwards into a persistent stiff style; stigmas 3, plumose. This genus is represented by about 45-50 species distributed in the tropical and subtropical Asia from the southern China through out the Malaysian region, extending to the Pacific Islands with the majority of the species in Malaysia (Dransfield, 1983, 2000; Wong, 1995).

Key to the species of Schizostachyum

1.a Culm sheath auricle rudimentary, blade truncate at base, glabrous in both sides spikelets in dense clusters (upto 14) Palea slightly keeled.....*S. rogersii*

1.b Culm sheath auricle well developed with long bristles blade cuneate at base, sparsly pubescent at ventral side, spikelet in small clusters.....2

2.a Culms highly straggling, internode 18-22 cm long, nodes swollen with a smooth spongy nodal ring, spikelet one flowered, caryopsis with a slightly bent beak..... *S. andamanicum*

2.b Culms less straggling, internodes 40-45 cm long, nodes not swollen, spikelet two flowered caryospsis with smooth surface, beak straight .....*S. kalpongiaum*

Schizostachyum andamanicum M. Kumar & Remesh**,** Blumea 48:187.2003 (**Plates 19** & **20**, **Figure 9**).

Type: India, Andaman Islands, Saddle Peak (North Andaman), 150-732 m., 25.05.2000. *Remesh & Viswakumar,* 20780 (holotype-KFRI, isotype-MH, L).

A semiscandant sympodial bamboo with highly straggling culms arching over neighbouring plants and forming large bushes in hill slopes. Internode hollow, thin walled, 18-22 cm long, 1.2-1.8 cm in diameter, pale green with purplish tinge when young, yellowish green to golden yellow when mature, clothed with minute silky hairs. Nodes swollen with smooth spongy nodal ring. Branch complements typically a cluster of slender subequal branches. Young shoot greyish green with pale orange to purplish brown tinge. Culm sheath rigid, 13-16 cm long, at base 4-6 cm wide; at apex 4-5 cm wide, greyish green with purplish orange tinge, clothed by few brown hairs. Auricle small elongated, dark brown up to 2 mm high with many long silky, white bristles coiled. Culm sheath blade linear lanceolate, 5-7 cm long, up to 0.8 cm wide, purplish-brown bearing few bristles near the rounded basal part, inner surface sparsely hairy, hairs silky white, outer glabrous. Ligule, up to 2 mm long. Leaf blade linear lanceolate, 8-32 x 2.6-4.8 cm, base broadly attenuate, glabrous. Leaf sheath glabrous, margin serrulate, auricle small, 1 mm high with few bristles. Inflorescence *indeterminate*, terminating leafy branches. Spikelets arranged in a group of semiverticillate clusters at each node, thin, up to 1.2 cm long single flowered. Lemma membraneous, up to 9 x 4 mm, bearing a rachilla extension at the base. Palea membraneous, up to 7 x 5 mm, apex bifurcated. Lodicules 3,

Plate 19. *Schizostachyum andamanicum* M. Kumar & Remesh **A.** & **B.** Habit; **C.** Culm with culm sheath; **D.** New shoot

Figure 9. *Schizostachyum andamanicum* M. Kumar & Remesh **A.** Young shoot; **B.** Culm sheath; **C.** Culm with flowering branch Floret; **D.** Spikelet; **E.** Lemma; **F.** Palea; **G.** Floret with lodicule; **H.** Stamen; **I.** Ovary; **J.** Fruit

Plate 20. *Schizostachyum andamanicium* - Type specimen (KFRI)

unequal, 2 large (3 x 2 mm, 3 x 3 mm) and one small (2 x 1 mm), margins and apices toothed. Stamens 6. Filaments free. Anthers 2.5-3 mm long, apex obtuse, unequal, with fine hairs. Ovary slender, glabrous. Style flattened up to 1 cm long. Stigma 3, unequal, plumose, tufted. Caryopsis up to 15 x 4 mm with globular basal part and slightly bent beak.

World distribution: Andaman Islands of India.

Habitat and distribution: This species ccurrs in hilltop stunted evergreen forests at an altitude of 350-732 m. and endemic to North Andaman Islands.

> *Note*: *Schizostachyum andamanicum* is similar to *S. gracile* (Munro) Holttum, in general appearance and culm sheath structure, but it differs from the latter in having a highly straggling culm, short internodes (up to 20 cm), a well marked nodal line with a spongy ring, short anthers with obtuse apex and a fringe of fine hairs, unequal stigma and caryopsis with a slightly bent beak.

Schizostachyum kalpongianum M. Kumar & Remesh, Blumea 48:189.2003 (**Plate 21**, **Figure 10**).

Type: India, Andaman Islands, North Andaman, Kalpong Damsite, 200 m, 22.05.2000. *M. Kumar & Remesh* 20778 (holotype KFRI, isotype - MH, L).

Straggling sympodial bamboo, culms up to 5 m tall, sometimes arching over neighbouring trees. Internodes up to 40-45 cm long, hollow thin walled, 2-2.5 cm in diameter, pale green with brownish hairs when young, becoming dull green and glabrous with white powdery below the nodes. Branch complements typically a cluster of slender subequal branches. Young shoots pale orange red. Culm sheaths 15-20 cm long, 9-14 cm wide at the base, rigid, orange-red with golden brown to dark brown hairs. Auricle conspicuous up to 4 mm high with long bristles, tip coiled up to 2.5-3 cm. Blade 8-12 cm long, 2.5 cm wide near the base, brownish orange, rigid, conical, outer surface glabrous, inner surface with silky white hairs (up to 9 mm), base slightly rounded, 1.6-1.8 cm wide at junction with the sheath, apex acuminate, from the inner side of the blade numerous silky white hairs originated behind the ligule. Ligule, short up to 4 mm long, margin wavy. *Leaves* linear lanceolate, base broadly attenuate, glabrous on both surface. Leaf blade 22-34 x 3.5-5 cm. Leaf sheath with appressed white hairs, hairs caduceus. Auricle up to 2 mm long, bearing white bristles. Inflorescence indeterminate, terminating leafy branches. Spikelets arranged in a group of semiverticillate clusters at each node, thin 1.2-1.3 cm long two flowered, consisting of a sterile and fertile

Plate 21. *Schizostachyum kalpongianum* M. Kumar & Remesh **A.** Habit; **B.** Culm with culm sheath; **C.** New shoot

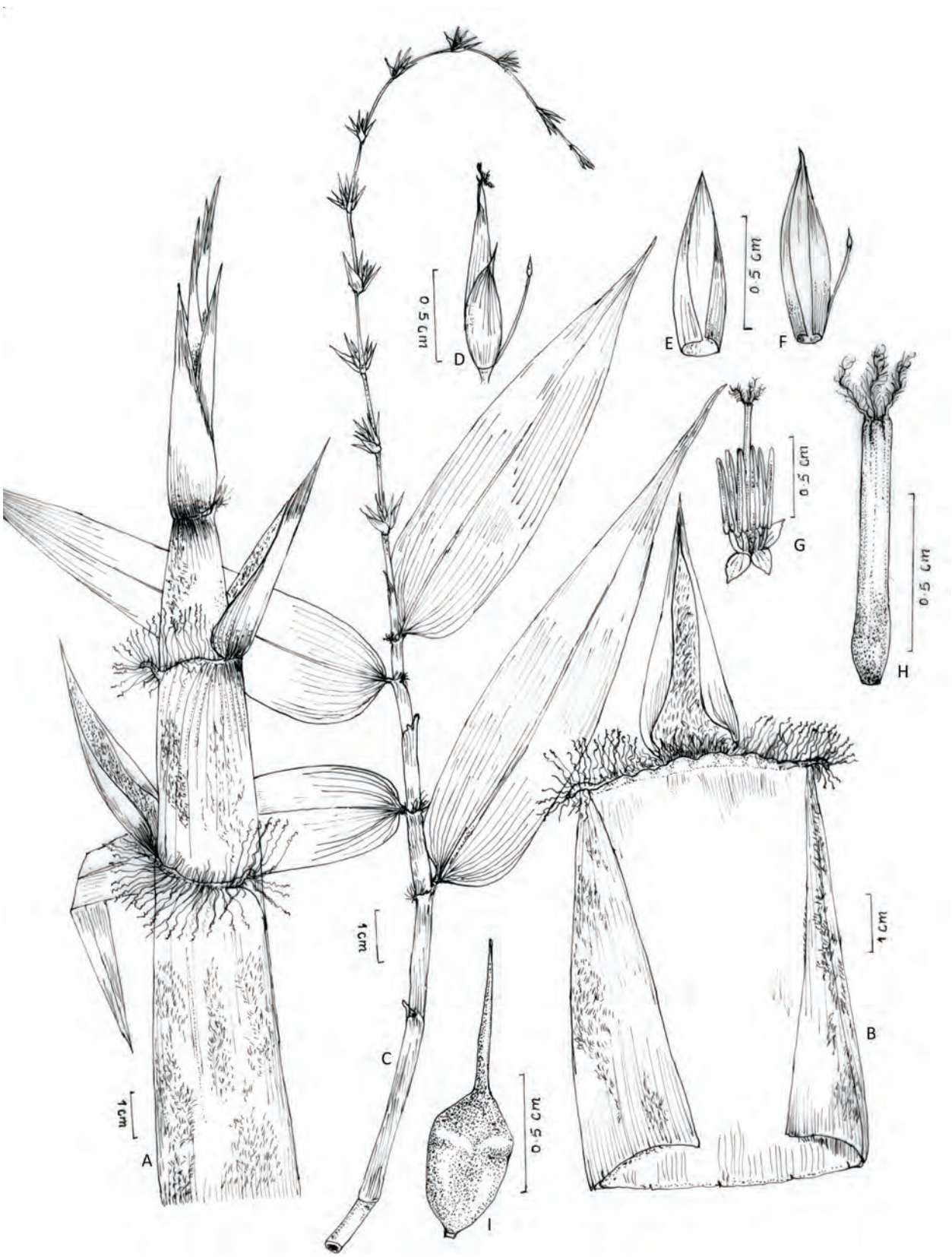

Figure 10. *Schizostachyum kalpongianum* M. Kumar & Remesh **A.** Young shoot; **B.** Culm sheath; **C.** Flowering twig; **D.** Spikelet; **E.** Lemma; **F.** Palea with rachilla extension; **G.** Floret with lodicule; **H.** Ovary; **I.** Fruit

floret and a rachilla extension of 7-8 mm long, bearing a rudimentary floret (up to 2 mm long). Lemma 7 x 4 mm. *Palea* 8-9 x 5-6 mm, glabrous, apex fringed with fine hairs; lodicules 3, equal up to 3 x 2 mm, ovate, apex acuminate, margin serrate. Stamens 6. Anthers up to 5 mm long, apex rounded. Filaments free. Ovary tubular, glabrous, 9 mm long, with long glabrous *style* having well marked stigmatic base, bearing 3 short stigmas at apex. Stigma equal, pinkish and highly plumose. Caryopsis 15-18 x 2-6 mm, ovoid, rounded basal part an acute tip with a long beak, surface with angular projections, glabrous.

World distribution: Andaman Islands of India.

Habitat and distribution: Grows near the ecotone of moist deciduous forest at an altitude of 50-250 m. This species is endemic to Andaman Islands, North Andaman, Kalpong Damsite, Panighat, Bikentikri, Aerial Bay and Kalighat.

Uses: The natives of Andaman Islands use this bamboo for making basketteries.

> *Note*: *Schizostachyum kalpongianum* is similar to *S. gracile* (Munro) Holttum in appearance and nature of culm sheath etc. but it is distinct from the former in having a straggling culm and long internodes (up to 45 cm), characteristic features of culm sheath such as ligule, blade and caryopsis oblong with angular projections. *Schizostachyum kalpongianum* is also closely related to *S. andamanicum* in appearance but differs in having a less straggling culm habit, large culms with long internodes (up to 45 cm), conical blade with silky white to golden brown hairs on the inner surface, a fringe of silky white hairs in between the blade juncture and ligule, equal sized stigma and lodicule, caryopsis with angular projections and a straight beak.

Schizostachyum rogersii Brandis, *Indian Trees* 679. 1906 (**Plates 22** & **23**); Camus, Les Bambusees 178 .1913; Parkinson, For. Fl. Andaman Islands 272.1923; Blatter, Indian For. 55: 603.1929; Varmah and Bahadur, Indian For. Rec. (n.s) Bot. 6(1): 4.1980; R. B. Majumdar in S. Karthikeyan *et al.* Fl. Indiae Enum. Monocot.282.1989; Tewari, Monogr. Bamboo. 147.1992; Seethalakshmi and M. Kumar, Bamb. India Comp. 257.1998; Ohrnberger, Bamboo. World 335.1999.

Type: India, Andaman Islands, Potatang Creek, February 1904. C. Gilbert Rogers Alt. ±40ft., 69 (Lectotype: K selected here).

Sympodial bamboo with straggling culms. Culms tufted, weak, 3-9 m high and 0.5-2cm diameter, overarching or supported by trees, walls thin. Culm sheaths much shorter than the

Plate 22. *Schizostachyum rogersii* Brandis **A.** Habit; **B.** Flowering branch

Plate 23. *Schizostachyum rogersii* Brandis - Lectotype (K)

internodes, thin, 7.6-10 cm long, hairs very fugacious, base 5-6.3 cm broad, tapering to 2 cm, with 2 small auricles at the apex almost devoid of bristles; blade narrow, reflexed, as long as the sheath. Leaves 18-23 cm long and 2.5-3.8 cm broad, long fine hairs on the underside, transverse veins prominent, oblique and bent. Inflorescence a long spike terminating leafy branchlets with distant half whorls of spikelets supported by bracts which are often furnished with a blade. Spikelets 1-flowered, glabrous, the fertile 1.2 cm long, the sterile shorter. Empty glumes 2-4; palea convolute, minutely 2-dentate, keels distinct. Lodicules 3, unequal; Stamen six in number, filamens free, anthers yellow, obtuse, 4 mm long apex fringed with minute hairs. Ovary glabrous; style thick, cylindric, hollow, terminated by 3 long plumose stigmas. Caryopsis ellipsoid to ovoid, 15-16 x 2-6 mm, rounded basal part with an acute tip with a long beak of long persistent style.

World distribution: Andaman Islands of India.

Habitat and distribution: This species grows near the ecotone of moist deciduous forest at an altitude of 50-100m and found endemic to north Andaman Islands.

Specimens examined: INDIA: Andaman Islands, Middle Andaman, India, Potang Creek, February 1904. Alt. ±40ft., *C. Gilbert Rogers* 69 (K); Bakulthala, Kousalya Nagar Alt. 100m *M.Remesh & Viswakumar* 20784 (KFRI).

Uses: Great Andamanese use the culms of this species for making arrows and blowpipes.

Note: *Schizostachyum rogersii*, hitherto not collected after the type collection. C. Gilbert Rogers first collected this species on 05.02.1904, which was subsequently critically studied by Brandis (1906) and published as a new species in Indian Trees in 1906. No representative herbarium specimen is available in any of the Indian herbaria either at Port Blair (PBL) or in the Central National Herbarium, Kolkota (CNH). However, a cibachrome sheet of the type specimen obtained from Kew herbarium is deposited in the National Herbarium.

After the type collection no one has relocated this species. The collection of this specimen during the present study from Middle Andamans is hence, a rediscovery of this endemic, rare and threatened species from Andamans, after a lapse of 96 years.

Names wrongly assigned to *Schizostachyum*

Schizostachyum manii R. B. Majumdar in Karthikeyan *et al.*, Fl. Ind. Euum. Monocat 282,

1989; Tewari, Monogr Bamboo 144. 1992. Seethalakshmi & M. Kumar Bamb. India Comp. 250. 1998.

Note: The name *S. manii* was used by Majumdar to refer to the species of *Bambusa.* The Inflorescence, spikelet, ovary are clearly referable to *Bambusa* sp. Illustrated in Plate 37 (Gamble 1896).

Imperfectly known taxa

Schizostachyum seshagirianum Majumdar in Karthikeyan *et. al.* Ind. Enum. Monocot 282.1989; Tewari Monogr. Bamboo. 148.1992; Seethalakshmi & M. Kumar, Bamb. India Comp. 258.1998

Specimens examined: INDIA: Arunachal Pradesh; Garsing to Eyo 609 m, Spiang *R.S. Rao* 1774 (CAL).

Note: This species could not be relocated and lack in several distinguishing characters, which is represented by a single collection, no detailed description and illustrations are avialble. Further critical study and information is necessary to ascertain the species status of this taxon.

Schizostachyum arunachalensis Naithani, Indian For. 118:230.1992, Tewari Monogr. Bamboo. 130.1992; Seethalakshmi & M. Kumar, Bamb. India Comp. 234.1998.

Note: Two species were described by Naithani (1992) from Subansiri district of Arunachal Pradesh. The species was compared to the imperfectly known *S. seshagirianum* Majundar. It is known only by vegetative characters.

The genus *Schizostachyum* is characterised by its sub equal branching at nodes and pseudo spikelet, ovary, style, and caryopsis. Without observing these characters it is too difficult to include this species under the genus *Schizostachyum* and even in the sub tribe *Melocannineae*. The leaf of this species is described as very large (up to 45 x 18 and these gigantic size of leaves do not match with any of the species of *Schizostachyum.* For confirming the status of this species further morphological details are essential.

Specimens examined: INDIA: Arunachal Pradesh, Subansiri district, *H. B. Naithani 1046* (DD).

5. CONCLUSION AND SUMMARY

Based on the study following are the conclusions drawn:

1. One species is added to the genus *Dendrocalamus* as a new combination *Dendrocalamus stocksii* (Munro) Kumar, *et.al.,* formerly treated under *Oxytenanthera-Pseudoxytenanthera* complex.

2.The lectotypification of *Dendrocalamus stocksii, D. collettianus, D. callostachyus, D. longispathus* and the neotypication of *D. strictus*, the type species of the genus have been carried out.

3. Two species of *Dendrocalamus* namely, *D. sahinii, D. somdevai* have been considered as conspecific and synonymised under *D. hamiltonii.* Another species *D. sericeus* is found to be conspecific with *D. strictus.*

4. The genus *Pseudoxytenanthera* is merged under *Oxytenanthera* and the genus *Oxytenanthera* is retained with two species, *O. bourdillonii* and *O. monodelpha*. The lectotypification of *O. bourdillonii* has been carried out.

5. The generic status of *Schizostachyum* is critically examined and three species from Andaman Islands alone is retained under this genus with two new taxa described under it.

6. The species *Schizostachyum rogersii* was relocated after a gap of 98 years from the type locality and the lectotypification of the species is carried out.

7. The position of Indian Arundinoid bamboos is still not clear owing to the complexity of the group and unless further studies are conducted the exact position of Indian genera under this group will not be understood. For confirming the generic status of the species under the subtribe Arundinarinae the details of the observations made during the present study has been communicated to international bamboo taxonomists for their expert comments and hence, the details on the genera *Arundinaria* (*Sinarundinaria*) is excluded from this report.

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